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LEAD SCAVENGER COMPOSITIONS

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This invention relates to compositions which are useful as scavengers with lead anti-knock compounds.

The use of lead compounds in gasolines to increase the octane ratings thereof is extremely widespread. There are, however, several rather serious adverse effects which accompany the use of leaded gasolines. One of these effects, the deposition of various lead compounds within the combustion chambers of the engines, has been at least partially remedied by the use of halohydrocarbon scavengers such as ethylene dibromide. Another adverse effect, which has been attributed to the lead anti-knock compounds, is misfiring of the engine due to spark plug fouling. This spark plug fouling is quite prevalent under conditions of high temperature engine operation and, particularly in the case of aircraft engines, is a very serious type of trouble.

It is therefore, an object of the present invention to overcome the previous shortcomings arising from the use of leaded gasolines. It is a further object to provide novel scavenger compositions for use with lead anti-knock compounds and in gasoline fuels. Another object is to provide novel fuel compositions containing said scavenger compositions. Another object is to provide novel compounds for the above and other uses. Other objects will be apparent hereinafter.

It has now been found that the use, as a lead scavenger in leaded gasoline fuel compositions, of a mixture of a halohydrocarbon scavenger and of a smaller amount of a hydrocarbyl-substituted alicyclic derivative of a chalcogenide, including oxide, sulfide, selenide, and telluride or a hydride of arsenic, antimony or bismuth, will result in greatly improved operation of spark ignition internal combustion engines. More particularly, the use of such scavenger compositions substantially eliminates spark plug fouling, or at least minimizes such fouling to a point where it is no longer a material consideration in engine operation. This outstanding advantage is obtained without having the other necessary characteristics (such as stability, performance rating, etc.) of the fuel deleteriously affected to any material degree by the presence of the scavenger compositions.

The arsenic, antimony and bismuth compounds of the present invention will be referred to hereinafter as "anti-fouling compounds" or "anti-fouling agents."

The halohydrocarbon scavenger which makes up the major proportion of the scavenger compositions of the present invention may be, for example, any one or more of the numerous halogen scavenger compounds already known, such as ethylene dibromide and ethylene dichloride (U. S. 2,398,281), acetylene tetrabromide (U. S. 2,490,606), hexachloropropylene, mono- and polyhalo propanes, butanes and pentanes (U. S. 2,479,900 and U. S. 2,479,902), polyhalo-alkyl benzenes (U. S. 2,479,901 and U. S. 2,479,903), and the like, having a volatility between about 100 and about 0.1 mm. Hg at 50° C.

In general, the most effective anti-fouling agents of the present invention are a class of new compounds containing an element having an atomic number of at least

33, exhibiting a valency of three or five, and being selected from group V–B of the periodic table as presented in Pauling's "General Chemistry" (1948, Freeman & Co.), and including in said molecule at least one hydrocarbyl-substituted alicyclic radical connected directly by a carbon atom thereof or indirectly through only one intervening non-carbon atom to the element having an atomic number of at least 33, preferably through an atom of a bivalent non-metallic element having an atomic number of at least 8, namely oxygen, sulfur, selenium, or tellurium, oxygen and sulfur being preferred. The hydrocarbyl radicals attached directly by carbon-to-carbon linkage or indirectly through only one intervening non-carbon atom to the alicyclic radical can be the same or different alkyl, alkenyl, aryl, alkaryl, aralkyl, etc. Alkyl radicals having a total of not more than 15 carbon atoms are generally preferred, those with less than 5 carbon atoms in the alkyl chain being preferable.

The essential alicyclic group required in the present anti-fouling agents is a cyclic group, preferably monocyclic group of non-aromatic character. Alkyl (and other aliphatic hydrocarbon) groups containing a total up to about 12 or 15 carbon atoms, substituted upon the alicyclic groups markedly increase the anti-fouling effectiveness of the present anti-fouling compounds. A multiplicity of such substitutions, e. g., two or three methyl, ethyl or propyl groups, is very advantageous. While substituents other than hydrocarbon radicals do not, in general, adversely affect the efficiency of compounds of this invention as anti-fouling agents, it is preferred that the substituent groups be unsubstituted hydrocarbyl radicals.

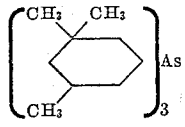
A preferred class of the above compounds is the hydrocarbyl-substituted cyclic derivatives of the hydrides, oxides and sulfides of arsenic, namely, alicyclic hydrocarbon arsines, arsenates, arsenites, thioarsenates, thioarsenites, arsonates, etc.

Compounds of this invention can be readily prepared without recourse to any special equipment or technique. Thus, the full or partial esters of arsenic, antimony or bismuth can be prepared by treating the appropriately substituted cycloalkanols with halides of arsenic, antimony or bismuth. The alcohols can be prepared by conventional means such as by hydrogenation of substituted cyclic ketones, hydrogenation of substituted phenolic compounds or aromatic mercaptans, or by catalytic hydrogenation of suitable carboxylic acids such as described in U. S. Patents 2,105,664 and 2,328,719.

For example, arsine compounds of this invention can be prepared from a hydrocarbyl-substituted cycloalkanol or the mercapto analogs by replacing the —OH or —SH group with a halogen such as by the action of halogen acids so as to form the hydrocarbyl-substituted alicyclic halide. This material in turn can be treated with a Grignard reagent to form the hydrocarbyl-substituted alicyclic metal salt $(Q)_y$—R—MX wherein Q is one or more hydrocarbyl substituent radicals, R is the alicyclic radical; M is an active metal, e. g., Mg; X is a halide and y is an integer of at least 1 and preferably about 3. This salt is then treated with a halide of arsenic, antimony or bismuth to form the new product of this invention.

Suitable alicyclic alcohols for use as starting materials in the preparation of compounds of this invention include cycloalkanols, such as cyclopentanols, cyclopentenols, cyclohexanols, cycloheptanols, cycloheptenols, bicycloheptanols, etc. Specific compounds are 3,3,5-trimethylcyclohexanol, 4,6-ditertiarybutyl-2-methylcyclohexanol, borneol, isoborneol, abietyl alcohol, cycloalkanols produced by hydrogenation of isophrone and isophrone bottoms as described in Adelson Patents 2,481,487 and 2,502,408 as well as cycloalkenols described in U. S. Patents 2,433,008, 2,467,451, 2,493,733, 2,497,349, 2,574,077 and 2,597,843.

A particularly preferred compound, tris(3,3,5-trimethylcyclohexyl) arsine, was prepared by treating 3,3,5-trimethylcyclohexanol with HBr to form 3,3,5-trimethylcyclohexyl bromide. About 3 moles (636 g.) of the bromide was refluxed in an ether medium with about 78 g. (3.2 moles) of magnesium in the presence of iodine. The Grignard thus formed was reacted with about 0.4 mole of $AsCl_3$ at about zero degrees centigrade in an ether solution. The ether layer was separated and filtered and thereafter the ether was flashed off leaving a residue, which by analysis is representable by the formula



namely, tris(3,3,5-trimethylcyclohexyl) arsine.

Following the above procedure but using 4,6-ditertiarybutyl-2-methylcyclohexanol as starting alicyclic alcohol, tris(4,6-ditertiarybutyl - 2 - methylcyclohexyl) arsine was prepared.

Tris(3,3,5-trimethylcyclohexyl) arsenite was prepared by refluxing 3,3,5-trimethylcyclohexanol with an excess of $AsCl_3$ in an ether medium.

Tris(3,3,5-trimethylcyclohexyl) arsenate was prepared by refluxing 3,3,5-trimethylcyclohexanol with an excess of $AsCl_5$ in an ether medium.

Other specific illustrative and representative compounds of this invention and which compounds are particularly suitable for use as anti-foulants in hydrocarbon fuels, such as aviation gasoline, are: tris(3,3,5-triethylcyclohexyl) arsine, tris(4,6-ditertiarylbutyl-3-methyl-cyclohexyl) arsine, di(p-dodecylcyclohexyl) arsine, di(p-heptylcyclohexyl arsine, 2-octyl-3,5-dimethylcyclohexyl arsine, tris(3,5,5-trimethylcycloheptyl) arsine, tris(2-methylcyclopentyl) arsine, phenyl - 3,5 - dimethylcyclohexyl arsine, allyl-3,5-dimethylcyclohexyl arsine, naphthyl 2,5-diethylcyclohexyl arsine, laurylcyclohexyl diphenyl arsine; tris(3,3,5-trimethylcyclohexyl) arsenite, tris(3,5,5-triethyl-cyclohexyl) arsenite, 3-methylcyclohexyl di-p-toluene arsenite, 2-allylcyclopentyl dibenzene arsenite, tris(3,3,5-trimethylcyclohexyl) arsenate, tris(2,4-dimethylcyclopentyl) arsenate, tris(3,5,5-tributylcyclohexyl) arsenate, 3-butylcyclohexyl dibutyl arsenate, 2-butylcycloheptyl diphenyl arsenate, tris (3,3,5-trimethylcyclohexyl arsonate, di(2-ethylcyclohexyl) benzene arsonate, tris(3,3,5-trimethylcyclohexyl) stibine, 3,3,5 - trimethylcyclohexyl stibine, 3,3,5 - trimethylcyclohexyl arsine oxide, 3,3,5-triethylcyclohexyl arsine oxide, 3,3,5 - trimethylcyclohexyl arsine sulfide, 2 - methylcyclohexyl bismuthine, 3-methylcyclo hexane arsonous acid, 2,4-dibutylcycloheptane arsenic acid, and the corresponding analogs of the antimony and bismuth compounds.

The arsenic, antimony and bismuth compounds of this invention can be supplied to the combustion zone of the engine in various ways to accomplish reduction in fouling of spark plugs due to the combustion of leaded fuels therein. Thus, they can be injected directly into the combustion zone, separately from either or both the fuel and the anti-detonant, or injected directly and separately into the intake manifold, either intermittently or substantially continuously, as desired, or they can be incorporated with the leaded fuel. They can be added separately to the leaded fuel, or they can be blended first with either the gasoline or the anti-detonant; in the latter case, an anti-detonant, scavenger and anti-foulant concentrate is suitably prepared which can be stored and shipped as such and blended with the gasoline as desired.

The following are illustrative examples of compositions suitable for use according to the present invention:

Example I

Tetra-ethyl lead
1.0 theory ethylene dibromide
0.2 theories tris(3,3,5-trimethylcyclohexyl) arsine

Example II

Tetra-ethyl lead
1.0 theory ethylene dibromide
0.1 theory trimethylcyclohexyl bismuthine

Example III

Tetra-ethyl lead
1.0 theory ethylene dibromide
0.1 theory p-octyl dimethylcyclohexyl stibine oxide

Example IV

Tetra-ethyl lead
1.0 theory acetylene tetrabromide
0.4 theory methylcyclohexyl dibenzene arsinate

Example V

80 octane aviation gasoline containing, per gallon
0.5 cc. tetra-ethyl lead
1.0 theory ethylene dibromide
0.2 theory trimethylcycloheptyl stibine
0.02 gr. 2,4-dimethyl-6-tertiary-butylphenol

Example VI

Aviation alkylate containing, per gallon
4.6 cc. tetra-ethyl lead
1.0 theory ethylene dibromide
0.04 gr. 2,4-dimethyl-6-tertiary-butylphenol
0.1 theory tris(3,3,5-trimethylcyclohexyl) arsenate

Example VII

Tetra-ethyl lead
1.2 theories hexachloropropylene
0.2 theory tributylcyclohexyl bismuthine

Example VIII

Tetra-ethyl lead
0.8 theory ethylene dibromide
0.2 theory trimethylcyclohexyl arsine sulfide

Example IX

Tetra-ethyl lead
1.5 theories hexachlorobutadiene-1,3
0.1 theory tris(3,3,5-trimethylcyclohexyl) arsenite

Example X

76 octane motor fuel containing, per gallon
2.1 cc. tetra-ethyl lead
1.0 theory ethylene dichloride
0.5 theory ethylene dibromide
0.2 theory di(methylcyclohexyl) benzene arsonate
0.06 gr. N,N'-dibutyl p-phenylene diamine

Example XI

115/145 grade aviation gasoline containing, per gallon
4.6 cc. tetra-ethyl lead
1.0 theory ethylene dibromide
0.2 theory tributylcycloheptyl bismuthine
0.04 gr. 2,4-dimethyl-6-tertiary-butylphenol

Example XII

Tetra-ethyl lead
0.5 theory ethylene dibromide
0.1 theory methycyclohexyl di-p-toluene arsenite

Example XIII

Tetra-ethyl lead
0.8 theory ethylene dichloride
0.2 theory allyl di(methylcyclohexyl) stibine sulfide

Example XIV

Tetra-ethyl lead
1.0 theory ethylene dibromide
0.1 theory trimethylcyclohexane arsonous acid

Example XV

Motor gasoline containing, per gallon
1.6 cc. tetra-ethyl lead
1.0 theory hexachlorethane
0.2 theory allyl di(trimethylcyclohexyl) arsine
0.06 gr. N-butyl-p-aminophenol

Example XVI

Tetra-ethyl lead
1.0 theory ethylene dibromide
0.05 theory di(methylcyclohexyl) stibinic acid

Example XVII

Tetra-ethyl lead
1.0 theory ethylene dibromide
0.5 theory tributylcyclohexyl arsine oxide

Example XVIII

Tetra-ethyl lead
0.8 theory ethylene dibromide
0.2 theory phenyl di(laurylcyclopentyl) stibine

Example XIX

Tetra-ethyl lead
1.0 theory ethylene dichloride
0.1 theory di-(m-tolyl) dimethylcyclohexane arsonate

Example XX

Tetra-ethyl lead
1.0 theory ethylene dichloride
0.5 theory ethylene dibromide
0.5 theory di(methylcyclohexyl) benzene bismuthine

Example XXI

Tetra-ethyl lead
1.0 theory ethylene dibromide
0.1 theory diethyl ethylcycloheptyl stibine

Example XXII

Tetra-ethyl lead
1.0 theory ethylene dibromide
0.1 theory di(3,5-xylyl) dimethylcyclohexyl arsenite

Example XXIII

Tetra-ethyl lead
1.0 theory ethylene dibromide
0.1 theory trimethylcyclopentyl arsine

Example XXIV

Tetra-ethyl lead
1.0 theory ethylene dibromide
0.1 theory p-octyl di(ethylcyclohexyl) arsenate

Example XXV

Tetra-ethyl lead
1.0 theory ethylene dibromide
0.1 theory p-octyl di(allyl cyclohexyl) stibine

As already indicated, the order of mixing the various constituents of the present compositions is immaterial. For example, the anti-fouling compound may be added to a gasoline which already contains the anti-knock compound and halogen scavenger. Likewise, the metallo-organic anti-knock agent, the halogen-scavenger and the anti-fouling compound may be first mixed, stored and handled as a concentrate, and added to the gasoline at a later time. A typical concentrate of this latter type has approximately the following composition:

	Weight percent
Tetra-ethyl lead	55–60
Ethylene dibromide	25–30
Tris(3,3,5-trimethylcyclohexyl) arsine	10–15
Kerosene, inhibitor, dye stabilizer, etc	3–6

Under other circumstances it may be desirable to mix the halogen scavenger and the anti-fouling agents, or the anti-knock agent and the anti-fouling agent, in the desired relative proportions and handle or store this mixture, with or without stabilizers, inhibitors, etc., as a concentrate for later incorporation with the other components of the ultimate fuel composition.

When using the scavenger compositions of the present invention, the total amount of halogen scavenger plus anti-fouling agent will generally fall between about 0.6 and about 1.5 theories, based upon the lead content of the gasoline, but may advantageously be as low as 0.4 or as high as 2.0 in some cases. The preferred range is from about 0.9 to about 1.2 theories.

The ratio of the two components of the scavenger composition is rather important. For example, if the proportion of halogen scavenger present is too large, excessive wear and corrosion of certain operating parts, such as exhaust valves and valve guides, is noted. If too small a quantity of halogen scavenger is used, the lead deposits are not effectively scavenged. If too small a quantity of the anti-fouling compound is used, the spark plug fouling will not be materially reduced; and if too much of that compound is present the amounts of deposits and the plug fouling both may be increased. In general, the theory ratio of the halogen scavenger or scavengers to the anti-fouling agents should be between about 3:2 and about 100:1. For best results this ratio should be between about 2:1 and about 15:1. As an additional limitation, the total scavenger mixture and the ratio of components therein should be adjusted so that the anti-fouling compound is present in an amount of between about 0.01 and about 0.6 theories, and preferably between about 0.1 and about 0.2 or if desired between about 0.05 and about 0.4 theories. A particularly desirable composition comprises 1 theory of the halogen scavenger and 0.1 theory of the anti-fouling compound. It is to be understood that more than one of the compounds from each class (i. e., halogen scavenger or anti-fouling agent), may be used in any single composition, just so the total quantity of each type falls within the limits set forth above.

The term "theory," when used in conjunction with a halogen scavenger compound, designates the amount of scavenger required to react stoichiometrically with a given amount of lead anti-detonant so that all of the lead atoms and all of the halogen atoms form $PbBr_2$ or $PbCl_2$. In other words, a theory of scavenger is an amount which contains two atomic proportions of halogen for each atomic proportion of lead in the anti-detonant, or, a theory of the halohydrocarbon scavenger is one mol of the halohydrocarbon scavenger divided by one-half the number of halogen atoms per molecule, for each gram atom of lead in the lead anti-detonant present, and therefore, the number of theories of halohydrocarbon scavenger present in a given composition is equal to the number of mols of halohydrocarbon scavenger present multiplied by one-half the number of halogen atoms per molecule, for each gram atom of lead in the lead anti-detonant present. As applied to the anti-fouling compounds, the term "theory" designates the amount required to react stoichiometrically with the lead so that all of the lead atoms and all of the arsenic, antimony, or bismuth atoms could be in the form of $Pb_3(ZO_4)_2$, wherein Z is: an element such as arsenic, antimony or bismuth, that is, two atomic proportions of "Z" element for for each 3 atomic proportions of lead. Therefore a theory of the anti-fouling compound is one mol thereof multiplied by two-thirds (that is, two-thirds of a mol of the anti-fouling compound), for each gram atom of lead in the lead anti-detonant present, and therefore the number of theories of anti-fouling compound present in a given composition is equal to the number of mols of the anti-fouling compound present multiplied by three-halves, for each gram atom of lead in the lead anti-detonant present.

While it is to be understood that the present compositions may be utilized in any leaded gasoline fuel, the compositions are of particular importance with respect to use in reciprocating internal combustion engine gasoline fuels, and especially such aviation fuels. This is true because of the relatively more frequent occurrence of spark plug fouling in spark ignition aviation engines, with the greater inherent danger to human life in the case of failures of such engines. In addition to the lead anti-detonant and the scavenger compositions, the gasoline fuels, or the concentrates for addition thereto may also contain corrosion inhibitors and stabilizers, such as 2,4-dimethyl-6-tertiary-butylphenol and other alkyl phenols, N,N'-dibutyl-p-phenylene diamine, hydroquinone, phenyl-alpha-naphthyl-

amine, N-butyl-p-aminophenol, alpha-naphthol, etc., dyes and the like.

By the term "leaded gasoline," and the terms of similar import, is meant a petroleum fraction boiling in the gasoline hydrocarbon range (between about 50° F. and about 450° F.) to which has been added a small amount, usually between about 1 and about 6 cc. per gallon, of a metallo-organic, usually an organo-lead, anti-knock compound, such as a tetra-alkyl lead, e. g., tetra-ethyl lead, tetra-i-propyl lead, etc.

The fuels to which the present scavenger compositions are added are preferably those which are relatively stable with respect to oxidation or gum formation. The stability may result from the use of stable base stocks such as aviation alkylate, straight run gasoline fractions, or other fractions which have been highly refined to remove olefins, or the stability may result from the use of oxidation stabilizers, such as those mentioned above. The term "stable gasoline" as used herein refers to gasoline fuels having a maximum of 5 mg. existent gum per 100 ml. of fuel (ASTM D–381–50), and a maximum of 10 mg. of gum per 100 ml. of gasoline after accelerated aging for 16 hours at 100° C. and 100 p. s. i. O_2 pressure. (The foregoing gum values apply to the fuel before addition of non-volatile additives, such as the anti-fouling agents of the present invention.)

As indicated above, the scavenger compositions of this invention are particularly useful in aviation gasoline. By the term "aviation gasoline" is meant a relatively high grade of gasoline fuel used in aviation engines, as distinguished from the lower quality gasolines, or "motor fuels" used in automotive engines. Aviation fuels have a more clearly specified boiling range, generally running from a minimum of about 100° F. to a maximum of about 350° F. The anti-knock rating of such fuels is often appreciably higher than that of 100 octane number gasoline. Because of the demand for high quality, thermally cracked fractions are never used in aviation gasolines. Catalytically cracked fractions may sometimes be used, but only after treatment to remove olefins. One of the reasons for the restrictions upon incorporation of cracked gasolines in aviation fuels is that the oxidation stability of aviation fuels must be much greater than that required for motor fuels. For example, when tested according to a method such as described in the patent issued to Thomas W. Bartram, U. S. 2,256,187, an aviation fuel base stock will go well beyond 4 or 5 hours before the oxygen pressure will have decreased by 5 pounds per square inch.

The present application is a continuation-in-part of our copending application Serial No. 242,309, filed August 17, 1951, which is in turn a continuation of our application Serial No. 167,376, filed June 10, 1950, now abandoned.

We claim as our invention:

1. A fuel composition for internal combustion engines consisting essentially of a stable gasoline, a minor effective anti-detonant amount of an organo-lead anti-detonant, and a scavenger mixture for said anti-detonant consisting essentially of a halohydrocarbon scavenger and a compound selected from the group consisting of hydrocarbyl-substituted-cycloalkyl hydrides, oxides and sulfides of an element of group V–B of the periodic table having an atomic number from 33 to 83, inclusive, wherein said group V–B element is attached to an alicyclic ring through not more than one atom, said atom being a chalcogen atom, each cycloalkyl group bearing from 1 to 3 aliphatic hydrocarbyl substituents, said halohydrocarbon scavenger and said group V–B compound being present in amounts such that, where (*a*) is the number of mols of said halohydrocarbon scavenger present multiplied by one-half the number of halogen atoms per molecule, for each gram atom of lead in the lead anti-detonant present, and (*b*) is the number of mols of said group V–B compound present multiplied by three-halves, for each gram atom of lead in the lead anti-detonant present, the total of (*a*) plus (*b*) is from about 0.4 to about 2.0, (*b*) is from about 0.01 to about 0.6, and the ratio of (*a*) to (*b*) is from about 3:2 to about 100:1.

2. A gasoline fuel additive composition consisting essentially of an organo-lead anti-detonant and a scavenger mixture for said anti-detonant consisting essentially of a halohydrocarbon scavenger and a compound selected from the group consisting of hydrocarbyl-substituted-cycloalkyl hydrides, oxides and sulfides of an element of group V–B of the periodic table having an atomic number from 33 to 83, inclusive, wherein said group V–B element is attached to an alicyclic ring through not more than one atom, each cycloalkyl group bearing from 1 to 3 aliphatic hydrocarbyl substituents, said atom being a chalcogen atom, said halohydrocarbon scavenger and said group V–B compound being present in amounts such that, where (*a*) is the number of mols of said halohydrocarbon scavenger present multiplied by one-half the number of halogen atoms per molecule, for each gram atom of lead in the lead anti-detonant present, and (*b*) is the number of mols of said group V–B compound present multiplied by three-halves, for each gram atom of lead in the lead anti-detonant present, the total of (*a*) plus (*b*) is from about 0.4 to about 2.0, (*b*) is from about 0.01 to about 0.6, and the ratio of (*a*) to (*b*) is from about 3:2 to about 100:1.

3. A lead scavenging composition for use with a leaded anti-detonant fuel for internal combustion engines consisting essentially of a halohydrocarbon scavenger and a compound selected from the group consisting of hydrocarbyl-substituted-cycloalkyl hydrides, oxides and sulfides of an element of group V–B of the periodic table having an atomic number from 33 to 83, inclusive, wherein said group V–B element is attached to an alicyclic ring through not more than one atom, each cycloalkyl group bearing from 1 to 3 aliphatic hydrocarbyl substituents, said atom being a chalcogen atom, said halohydrocarbon scavenger and said group V–B compound being present in amounts such that, where (*a*) is the number of mols of said halohydrocarbon scavenger present multiplied by one-half the number of halogen atoms per molecule, and (*b*) is the number of mols of said group V–B compound present multiplied by three-halves, the ratio of (*a*) to (*b*) is from about 3:2 to about 100:1.

4. A composition in accordance with claim 1, wherein the group V–B compound is a tri-hydrocarbyl-substituted cycloalkyl compound.

5. A composition in accordance with claim 1 wherein the group V–B element is arsenic.

6. A composition in accordance with claim 1 wherein the group V–B compound is a hydrocarbyl-substituted-cycloalkylarsine.

7. A composition in accordance with claim 1 wherein the group V–B compound is an alkyl-substituted-cycloalkylarsine.

8. A composition in accordance with claim 1 wherein the group V–B compound is an aryl-substituted-cycloalkylarsine.

9. A composition in accordance with claim 1 wherein the group V–B compound is tris(3,3,5-trimethylcyclohexyl)arsine and the gasoline is an aviation gasoline boiling within the range 100° F. and 350° F., containing no thermally cracked gasoline fractions and no olefinic catalytically cracked gasoline fractions, and having a maximum of 5 mg. of existent gum per 100 ml. of gasoline as determined by ASTM test D–381–50.

10. A composition in accordance with claim 1 wherein the group V–B compound is tris(3,3,5-trimethylcyclohexyl)arsenite.

11. A composition in accordance with claim 1 wherein the group V–B compound is tris(3,3,5-trimethylcyclohexyl)arsenate.

12. A composition in accordance with claim 1 where-

in the group V–B compound is tris(3,3,5-trimethylcyclohexyl)stibine.

13. A composition in accordance with claim 1 wherein (*b*) is from about 0.05 to about 0.4.

14. A fuel composition for internal combustion engines consisting essentially of a stabilized automotive gasoline, a minor effective anti-detonant amount of tetraethyl lead, and a scavenger mixture for said tetraethyl lead consisting essentially of ethylene dibromide, ethylene dichloride and tris(3,3,5-trimethylcyclohexyl)arsine, said ethylene dibromide, ethylene dichloride and said tris(3,3,5-trimethylcyclohexyl)arsine being present in amounts such that where (*a*) is the total number of mols of ethylene dibromide and ethylene dichloride present for each mol of tetraethyl lead present, and (*b*) is the number of mols of tris(3,3,5-trimethylcyclohexyl)arsine present multiplied by three-halves, for each mol of tetraethyl lead present, the total of (*a*) plus (*b*) is from about 0.4 to about 2.0, (*b*) is from about 0.01 to about 0.6, and the ratio of (*a*) to (*b*) is from about 3:2 to about 100:1.

15. A fuel composition for internal combustion engines consisting essentially of a stable aviation gasoline boiling within the range 100° F. and 350° F., containing no thermally cracked gasoline fractions and no olefinic catalytically cracked gasoline fractions, and having a maximum of 5 mg. of existent gum per 100 ml. of gasoline as determined by ASTM test D–381–50, a minor effective anti-detonant amount of tetraethyl lead, and a scavenger mixture for said tetraethyl lead consisting essentially of ethylene dibromide and tris(3,3,5-trimethylcyclohexyl)arsine, said ethylene dibromide being present in an amount such that the number of mols of ethylene dibromide, for each mol of tetraethyl lead present, is about 1.0, and said tris(3,3,5-trimethylcyclohexyl)arsine being present in an amount such that the number of mols of tris(3,3,5-trimethylcyclohexyl)arsine multiplied by three-halves, for each mol of tetraethyl lead present, is about 0.1.

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