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COMPOSITIONS FOR USE AS HYDRAULIC FLUIDS

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This invention is concerned with non-flammable compositions suitable for use as lubricants and for transmitting power in hydraulic power systems, particularly in aircraft.

There is at the present time a considerable need for an efficient hydraulic fluid which is also non-flammable in order that fire and explosion hazards may be reduced to a minimum. This is particularly true of fluids for use in the hydraulic system of aircraft and in steel rolling mills and die-casting shops where hydraulic machinery is employed in moving hot equipment or parts. A hydraulic fluid for such uses should also possess low oxidation susceptibility and low corrosion characteristics so that it will not deteriorate in use and will not corrode the materials with which it comes into contact. It is also desirable that the hydraulic fluid should have a low volatility at the elevated temperatures at which it will be used. This temperature may be at least 200° F. For use at low temperatures, for example, of —40° to —60° F., such as are encountered in the operation of aircraft, it is necessary that the hydraulic fluid should possess a low pour point. A low rate of change of viscosity with temperature, i. e. a high viscosity index, is also desirable so that the fluid will operate over a wide range of temperature. The fluid should also possess sufficient lubricity and mechanical stability to permit its use in the self-lubricated pumps and valves of hydraulic apparatus.

Non-flammable hydraulic fluids have been proposed in which the basic constituent consists of one or more esters of phosphoric acid. These esters possess good lubricating properties but are not entirely satisfactory as hydraulic fluids. Thus, the lower trialkyl phosphates exhibit high wear characteristics and are somewhat inflammable, due in part to their volatility. Triaryl phosphates, such as tricresyl phosphate, possess relatively poor viscosity indices and phosphate esters containing both alkyl and aryl groups, such as diphenyl octyl phosphate, exhibit high copper and cadmium corrosion. In order that hydraulic fluids based on phosphate esters should be as non-flammable as possible, it is necessary to employ blends containing a higher proportion of aryl phosphates than alkyl phosphates, but such blends have poor low temperature properties. It has also been proposed to

incorporate minor amounts of viscosity index improvers, such as the polymerized esters of acrylic and methacrylic acid, in such phosphate esters.

Hydraulic fluids based on halocarbon compounds and containing a minor proportion of a viscosity index improver such as a polymerized ester of acrylic or methacrylic acid have also been proposed. Such fluids possess excellent non-flammability, low temperature and lubricating properties, but their high specific gravity, which may be as high as 1.9, depending on the halocarbon used, is somewhat of a disadvantage, particularly for aircraft.

The present invention provides a non-flammable composition suitable for use as a hydraulic fluid and having excellent lubricating properties which comprises 15 to 80% by weight of a normally liquid trialkyl phosphate containing at least twelve carbon atoms in the molecule, 1 to 15% by weight of a polymer of an ester of an acrylic (including alkylacrylic) acid and 10 to 70% by weight of a normally liquid, chlorofluorinated carbon compound containing at least carbon, fluorine and chlorine atoms and, optionally, hydrogen atoms having a boiling point above 75° C. and a pour point lower than —5° C.

The trialkyl phosphates to be used in the present invention are present in amounts from 15 to 80% by weight and perferably from 30 to 50% by weight. The trialkyl phosphates are preferably those in which each alkyl group has from four to nine carbon atoms. The alkyl groups may be either in a straight-chain or in a branched-chain configuration, the latter being preferred. The trialkyl phosphate employed may contain the same alkyl group in all three positions or it may contain different alkyl groups. Mixtures of different trialkyl phosphates may be used. Suitable trialkyl phosphates which may be employed in the compositions of the invention include the tributyl phosphates, trihexyl phosphates, trioctyl phosphates and trinonyl phosphates. A particularly effective type includes the branched homologues such as tri(2-ethylbutyl) phosphate, tri(2-ethylhexyl) phosphate and tri(3,5,5-tri-methylhexyl) phosphate. The physical characteristics of typical trialkyl phosphates are given in Table I.

TABLE I.—PROPERTIES OF VARIOUS TRIALKYL PHOSPHATES

	Tri-n-butyl	Tri-n-amyl	Tri-2-ethylbutyl	Tri-n-hexyl	Tri-2-ethylhexyl	Tri-n-octyl	Tri (3, 5, 5-trimethylhexyl)
Boiling point, ° C., 1 mm. Hg	113.8	129.1	146.4	166.1	186.3	211.0	----------
Freezing point, ° F	[1] —50	[1] —50	[1] —50	[1] —50	[1] —50	[1] —30	----------
Open-cup flash point, ° F	340	355	----------	410	400	440	----------
Viscosity, centistokes at 210° F	380	380	----------	445	465	515	----------
Viscosity, centistokes at 100° F	1.06	1.36	1.68	1.76	2.29	2.49	4.11
Viscosity, centistokes at —40° F	46.9	114	240	153	847	----------	18.42
Viscosity index	89	91	122	150	96	135	146

[1] Lower than.

A normally liquid triester of phosphoric acid containing at least one aryl group may be incorporated in the compositions of the invention in an amount up to 50% by weight to increase the non-flammability. The aryl phosphates may be triaryl phosphates, diaryl monoalkyl phosphates or monoaryl dialkyl phosphates. Preferably the aryl groups are alkyl substituted phenyl groups containing not more than 5 carbon atoms in each alkyl substituent, such as the tolyl, xylenyl, cumenyl or pseudocumenyl groups. The aryl groups in di- and triaryl phosphates may be the same or different aryl groups and the alkyl groups in the dialkyl aryl phosphates may be the same or different alkyl groups. Mixtures of the aforesaid aryl phosphates may be used.

Particularly suitable triaryl phosphates which may be employed in the compositions of the invention are tricresyl phosphate and trixylenyl phosphate. Other suitable triaryl phosphates are diphenyl cresyl phosphate, phenyl dicresyl phosphate, diphenyl xylenyl phosphate, diphenyl ethylphenyl phosphate and diphenyl o-chlorophenyl phosphate.

Examples of suitable alkylaryl phosphates are octyl diphenyl phosphate, dihexyl cresyl phosphate, octyl phenyl cresyl phosphate and butyl octyl cresyl phosphate.

The chlorofluorinated carbon compounds which are used in the compositions of the invention are preferably hydrocarbons in which at least 30% of the hydrogen atoms in the molecule have been replaced by halogen. The non-flammability of the compound improves with increasing halogen content. Compounds with a high halogen content such as the halocarbons also possess fire-extinguishing properties which may, on occasion, be of considerable advantage. The halogen compounds may be acyclic or cyclic compounds and may be saturated or unsaturated.

The stability of the C—F bond to chemical reactions, e. g. to hydrolysis and oxidation, makes the chlorofluorinated hydrocarbons particularly suitable compounds for use in the compositions of the invention. The groups $>CF_2$ and $—CF_3$ are remarkably stable and appear to enhance the stability of any C—Cl bonds which are situated in close proximity to them. Such stability, particularly to hydrolysis and oxidation, is a very desirable property of hydraulic fluids if formation of acidic compounds and corrosion of metal parts in contact with the fluid are to be avoided. Fluoro compounds containing at least one chlorine atom in the molecule generally possess greater solubility in mineral oils and other solvents and are generally liquid over a wider range of temperature than analogous compounds containing fluorine only.

Suitable acyclic chlorofluoro carbons include those in which at least half the hydrogen atoms of a hydrocarbon have been replaced by fluorine atoms and the rest by chlorine atoms, for example, tetrafluorotetrachloropropane,

$$CF_2Cl{:}CCl_2{:}CF_2Cl$$

or in which at least half the hydrogen atoms are replaced by chlorine atoms and the carbon-chlorine groups are stabilized by $>CF_2$ or $—CF_3$ groups, for example, the perhalopropane of the formula $CCl_3{:}CCl_2CF_3$; or in which at least half the hydrogen atoms are replaced by halogen atoms in the ratio of at least 3 F atoms to 2 Cl atoms per molecule, as for example, the perhalopentanes of formulae C_5ClF_{11}, $C_5Cl_2F_{10}$ and $C_5Cl_3F_9$, the perhalohexanes of formulae C_6ClF_{13}, $C_6Cl_2F_{12}$ and $C_6Cl_4F_{10}$.

Other suitable species include chloropentafluoroethanes, chlorotrifluoroethylene, chloropentafluoro-1,3-butadiene, 2,3-dichlorohexafluoro-2-butene, hexachlorotetrafluorobutanes, trifluorotetrachloropropane, chlorooctafluoropentane, and chlorodecafluorohexane.

Liquid products having a boiling point above 75° C. obtained by homopolymerization of unsaturated chlorofluoro hydrocarbons, or by copolymerization of these compounds with other polymerizable unsaturated compounds may also be used. Suitable products are the polymerized difluorovinyl chlorides and the polymerized monochlorotrifluoroethylene sold under the registered trademark "Fluorolube."

Preferably, the cyclic compound should have at least one $—CF_3$ group and at least one chlorine atom directly attached to the aromatic nucleus, for example, to the benzene ring. Such compounds are liquid over a wide range of temperatures and show improved compatibility with the other components of the composition as well as increased solubility in hydrocarbon oils. The aromatic nucleus may also carry an ethyl, propyl or butyl group in which hydrogen atoms have been replaced by halogen atoms. Chlorine substituents in these alkyl groups should preferably be stabilized by the presence of a $>CF_2$ or $—CF_3$ group, as for example in the haloethyl group $—CClF{:}CF_3$. Examples of suitable cyclic compounds are chloro 1,3-bis (trifluoromethyl) benzene, dichloro (trifluoromethyl) benzene, dichloro bis(trifluoromethyl) benzene and chloro-1-(trifluoromethyl)-4-(chlorotetrafluoroethyl) benzene. Particularly suitable compounds are trichloro(trifluoromethyl) benzene and tetrachloro-(trifluoromethyl) benzene. These compounds are liquid over a very wide range of temperatures, are highly stable and are non-corrosive to magnesium, mild steel and copper.

Other suitable species include chloro(difluoromethyl) benzene, trifluoro (choromethyl) benzene, (dichlorotrifluoroethyl) benzene, trichloro trifluorobenzene, dichlorotetrafluorobenzene and pentachloro(trifluoromethyl) benzene.

Some of the physical properties of these preferred compounds are set out in Table II.

TABLE II

TRICHLORO(TRIFLUOROMETHYL) BENZENE

(1) Boiling range, 180–210° C.
(2) Freezing point, ca. —60° C.
(3) Specific gravity and viscosity:

Temperature, C.	Specific gravity	Kinematic viscosity (centistokes)
−45	1.63	17.60
−30	1.61	6.47
−15	1.59	3.68
0	1.57	2.31
+25	1.53	1.29
+38	1.52	1.03
+100	------------	0.5

TETRACHLORO(TRIFLUOROMETHYL) BENZENE

(1) Boiling range, 210–250°C.
(2) Freezing point, —7° C.
(3) Kinematic viscosity:

Temperature, ° C.	Centistokes
31.5	2.23
51	1.50
78	0.95

By mixing the phosphate esters with chlorofluorinated hydrocarbons (or perhalocarbons) according to the invention, a blend is obtained having an overall specific gravity of about 1.1 to about 1.3, compared with specific gravities up to about 1.9 for the halogen compound alone. The blends have the further advantage that any evaporation of the halogen compound which may occur at elevated temperatures will leave an oily non-flammable residue of phosphate esters of good lubricating properties.

The incorporation of chlorofluorinated hydrocarbons into the phosphate esters according to the invention substantially improves the non-flammability properties and can be used either to reduce greatly the low temperature viscosities or, for a given low temperature viscosity, to allow the incorporation of a greater proportion of aryl phosphate ester into the blend at the expense of alkyl phosphate ester, thus remarkedly increasing the non-flammability properties.

The third essential component of compositions of the invention is a polymer of an ester of an acrylic (including alkylacrylic) acid. The aforesaid esters are preferably derived from aliphatic alcohols having from two to fifteen carbon atoms and the polymers may be homopolymers of a single ester or may be copolymers of a mixture of such esters. The term "polymer" as used herein is intended to be construed accordingly, and is directed especially to polymers having an average molecular weight of at least 25,000. Typical esters of the polymers which may be so employed are the methyl, ethyl, n-propyl, isopropyl, isobutyl, lauryl, phenyl or benzyl esters of acrylic, methacrylic, 1-ethylacrylic and 1-propylacrylic acids.

Polymers of methacrylic acid esters suitable for use in the present compositions are readily available as commercial products and are sold under the trade name "Acryloid." They are generally available as concentrated dispersions in a solvent such as a light mineral oil, usually containing about equal amounts of polymer and solvent. These concentrated dispersions can be used as such in the compounding of the present compositions. Typical Acryloid viscosity index improving agents are Acryloid 710, Acryloid HF–855, Acryloid HF–860 and Acryloid HF–8125. Acryloid 710 is a polymethacrylic ester, wherein the alkyl radicals of the ester groups are lauryl and octyl groups as shown in Bos et al. U.S. Patent 2,681,891.

The above viscosity index improving agents may be present in an amount of from 1 to 15% by weight of the total composition. In general, it is desirable to employ these agents in an amount between 2% and 10% by weight, preferably between 5% and 10% by weight of the total composition.

While the compositions described above exhibit satisfactory corrosion and stability characteristics, it is preferable to include corrosion inhibitors and anti-oxidants to protect the equipment for extended use. It has been found that the combination of an epoxy compound and a sulfur-containing organic compound is especially effective as a corrosion inhibitor and anti-oxidant for the compositions of the present invention.

The epoxy compounds alone are effective corrosion inhibitors for the compositions of the invention, and may be present in an amount between about 0.5% and 5% by weight of the total composition. Of the epoxy compounds the glycidyl ethers are preferred and of these, glycicyl ethers containing one carbocyclic group directly attached to the ether oxygen atom, such as the glycidyl aryl ethers, provide maximum protection against corrosion, especially of copper and cadmium. Specific glycidyl ethers which may be employed include glycidyl phenyl ether, glycidyl benzyl ether, glycidyl cyclohexyl ether and glycidyl o-cresyl ether. Other epoxy compounds which may be employed include the lower glycidyl alkyl ethers, such as glycidyl methyl ether and glycidyl isopropyl ether, isobutylene oxide, butadiene monoxide, styrene oxide, cyclohexylene oxide, cyclopentene oxide, decene oxide, 2,3-epoxybutane, 1,2-epoxybutane and epichlorhydrin.

While the above epoxy compounds alone are satisfactory, excellent protection against corrosion and oxidation is afforded by their use in combination with a sulfur-containing organic compound. Suitable sulfur-containing organic compounds for the above combination are the hydrocarbyl sulfides, especially the hydrocarbyl disulfides, such as the dialkyl disulfides and diaryl disulfides, and they may be present in an amount between about 0.05% and 1% by weight of the total compositions. Benzyl disulfide, butyl disulfide and wax disulfide are particularly useful.

The wax disulfide is preferably a reaction product of sodium disulfide and a chlorinated paraffin wax and may be prepared in the following manner. Approximately 5.5 parts by weight sodium disulfide is dissolved in about 2.2 parts by weight of water, the solution is heated and about 0.7 part by weight sulfur dissolved therein with stirring. The resulting solution together with about 5.2 parts by weight of a chlorinated paraffin wax (chlorine content approximately 30% by weight) and about 10 parts by weight each of denatured alcohol and naphtha are charged into an autoclave and stirred therein at a temperature of about 145–150° C. for 10 hours. The maximum pressure developed is about 220–230 p. s. i. After cooling about 16 parts by weight water are added and thoroughly admixed. Two layers separate upon standing, a naphtha layer and an aqueous layer. The naphtha layer is separated, dried over anhydrous sodium sulfate, filtered and the naphtha distilled off under reduced pressure, the maximum kettle temperature being not greater than 140° C. There are obtained 21.6 parts by weight of wax disulfide as a viscous, oil-soluble, dark-colored liquid. A typical analysis of a wax disulfide employed in the compositions of the invention is set forth below:

Specific gravity 20° C./4° C.	1.024
Molecular weight	1050
Sulfur content	[1] 20–23
Chlorine content	[1] 1.5–4

[1] Percent by weight.

Suitable substitutes for chlorinated paraffin wax in the preparation of the wax disulfides include high molecular weight unsaturated hydrocarbons and the chlorinated synthetic waxes obtained by the polymerization and halogenation of olefins such as ethylene and propylene.

In general, compounds of the formula R′—S—S—R, where R and R′ denote alkyl or aryl groups, and alkyl mercaptans having at least 7 carbon atoms are suitable sulfur-containing compounds and further specific examples are di-isoamyl disulfide, di-n-propyl disulfide and diphenyl disulfide.

Compositions of the invention which are especially useful and effective include between about 0.5% to 3% by weight of an epoxy compound such as glycidyl phenyl ether and between about 0.05 and 1% by weight, preferably between 0.05% and 0.2% by weight, of a hydrocarbyl sulfide such as wax disulfide.

While the above types of corrosion inhibitors are preferred for use in the compositions of the invention, other inhibitors may be used as well. Of these, a salt of a metal of group II of the periodic table and of an aromatic carboxylic acid, an aromatic hydroxy carboxylic acid or a phenol, which salt is soluble in the mixture phosphate ester, halogenated hydrocarbon and polymer to the required extent, is particularly suitable. These salts increase the oxidation and thermal stability of the compositions under high temperature conditions of working. Of the group II metals, zinc and calcium are the most suitable for the present purpose. The aromatic carboxylic acid or phenol chosen should have sufficient oleophilic properties to ensure that the metal salt employed is soluble in the aforesaid mixture sufficiently to allow a metal content in the finished composition of between 0.01 and 1.0% by weight. Normal or basic salts or mixtures of normal and basic salts may be employed.

The most effective among the metal salts referred to above for the present purposes are the normal or basic zinc or calcium salts of alkylated salicylic acids containing from 12 to 20 carbon atoms, particularly from 14 to 18 carbon atoms, in the alkyl group.

Other inhibitors which may be used are the salts of alkyl malonic acids, condensation products of sulfanols with unsaturated carboxylic acids, the polyvalent metal salts of hydrocarbon sulfonic acids, amines, aminophenols and other substituted phenols.

In preparing the compositions of the invention, no special precaution or order of addition of the components is necessary. A suitable method consists in adding an appropriate weight of each component to a suitable vessel, if necessary warming the mixture to about 40° C., and stirring the mixture, when a clear solution is obtained.

The following examples illustrate the compositions of the invention:

Example I

A blend was prepared by mixing together 32.5 parts by weight (p. b. w.) of tri(2-ethylhexyl) phosphate, 32.5 p. b. w. of tricresyl phosphate, 30 p. b. w. of the trichloro (trifluoromethyl) benzene of boiling range 180° to 210° C. as described above, and 5 p. b. w. of Acryloid 710.

The blend was a clear, somewhat viscous liquid which had a specific gravity $d_{4^\circ}^{20^\circ}$ 1.14, a kinematic viscosity at 130° F. of 9.8 centistokes and at −40° F. of 5,400 centistokes and an autogenous ignition temperature of 480° C. The ignition temperature was determined by the method of ASTM D286–30, according to which samples of the fluid are dropped into a heated flask under standard conditions until a temperature is found at which ignition occurs but at 5° C. below which ignition fails to take place.

Example II

A blend was prepared from 17.5 p. b. w. of tri(2-ethylhexyl) phosphate, 17.5 p. b. w. of tricresyl phosphate, 60 p. b. w. of the trichloro(trifluoromethyl) benzene used in Example I and 5 p. b. w. of Acryloid 710.

A clear blend was obtained which had a specific gravity $d_{4_0}^{20°}$ 1.28, a kinematic viscosity at 130° F. of 6.1 and at −40° F. of 730 centistokes and an autogenous ignition temperature of 505° C.

Example III

A blend was prepared from 55 p. b. w. of tri(2-ethylhexyl) phosphate, 10 p. b. w. of tricresyl phosphate, 30 p. b. w. of the trichloro(trifluoromethyl) benzene used in Example I, and 5 p. b. w. of Acryloid 710.

The blend was a clear, somewhat viscous liquid which had a specific gravity $d_{4°}^{20°}$ 1.08, a kinematic viscosity at 130° F. of 8.4 and at −40° F. of 1,500 centistokes and an autogenous ignition temperature of 422° C.

Example IV

A blend was prepared from 30 p. b. w. of tri(2-ethylhexyl) phosphate, 5 p. b. w. of tricresyl phosphate, 60 p. b. w. of the trichloro(trifluoromethyl) benzene used in Example I and 5 p. b. w. of Acryloid 710.

The blend was a clear, somewhat viscous liquid which had a specific gravity $d_{4°}^{20°}$ 1.22 and a kinematic viscosity at 130° F. of 5.7 and at −40° F. of 478 centistokes and an autogenous ignition temperature of 428° C.

Example V

This blend was prepared from 45.5 p. b. w. of tri(2-ethylhexyl) phosphate, 19.5 p. b. w. of tricresyl phosphate, 30 p. b. w. of the trichloro(trifluoromethyl) benzene used in Example I and 5 p. b. w. of Acryloid 710.

The blend was a clear, somewhat viscous liquid, which had a specific gravity $d_{4°}^{20°}$ 1.10, a kinematic viscosity at 130° F. of 8.4 and at −40° F. of 2,380 centistokes and an autogenous ignition temperature of 440° C.

Example VI

This blend was prepared from 32.5 p. b. w. each of tri(2-ethylhexyl) phosphate and tricresyl phosphate, 30 p. b. w. of the tetrachloro(trifluoromethyl) benzene, boiling range 210° to 250° C. as described above, and 5 p. b. w. of Acryloid 710.

The blend was a clear, somewhat viscous liquid which had a specific gravity $d_{4°}^{20°}$ 1.16, a kinematic viscosity at 130° F. of 11.7 and at −40° F. of 19,000 centistokes, and an autogenous ignition temperature of 455° C.

Example VII

This blend was prepared from 17.5 p. b. w. of tri(2-ethylhexyl) phosphate, 17.5 p. b. w. of tricresyl phosphate, 60 p. b. w. of the tetrachloro(trifluoromethyl) benzene used in Example VI and 5 p. b. w. of Acryloid 710.

The clear blend obtained had a specific gravity $d_{4°}^{20°}$ 1.33, a kinematic viscosity at 130° F. of 8.9 and at −40° F. of 8,000 centistokes, and an autogenous ignition temperature of 470° C.

Example VIII

A blend was prepared from 30 p. b. w. of tri(2-ethylhexyl) phosphate, 5 p. b. w. of tricresyl phosphate, 60 p. b. w. of the tetrachloro(trifluoromethyl) benzene used in Example VI, and 5 p. b. w. of Acryloid 710.

The blend was a clear, somewhat viscous liquid which had a specific gravity $d_{4°}^{20°}$ 1.28, a kinematic viscosity at 130° F. of 8.1 and at −40° F. of 2,600 centistokes, and an autogenous ignition temperature of 425° C.

While the compositions of Examples I to VIII are satisfactory as regards stability, excellent protection against oxidation during prolonged use and the corrosion of metal parts in contact with the fluids is afforded by incorporating about 0.9% by weight of glycidyl phenyl ether and about 0.1% by weight of a wax disulfide prepared as described above, or a normal or basic salt of a metal of group II of the periodic table and of an aromatic carboxylic acid, aromatic hydroxy carboxylic acid or a phenol as described above in amount sufficient to give a metal content of between 0.01 and 1.0% by weight of the finished composition.

We claim as our invention:

1. A substantially non-flammable composition of matter for use as a hydraulic fluid comprising

	Percent by weight
Tri(2-ethylhexyl) phosphate	32.5
Tricresyl phosphate	32.5
A viscosity index-improving polymerized ester of C_{8-14} aliphatic monohydric alcohol and methacrylic acid having an average molecular weight greater than about 25,000	5
Trichloro(trifluoromethyl) benzene	30

2. A substantially non-flammable composition of matter for use as a hydraulic fluid comprising

	Percent by weight
Trioctyl phosphate	30–50
Tricresyl phosphate	5–35
A viscosity index-improving polymerized ester of C_{8-14} aliphatic monohydric alcohol and methacrylic acid having an average molecular weight greater than about 25,000	5–10
Trichloro(trifluoromethyl) benzene	30–60

3. A substantially non-flammable composition of matter for use as a hydraulic fluid comprising

	Percent by weight
A trialkyl phosphate wherein each alkyl radical has from 4 to 9 carbon atoms	30–50
A triarylphosphate containing from 18 to 33 carbon atoms per molecule	5–35
A viscosity index-improving polymerized ester of C_6 to C_{16} aliphatic alcohols and methacrylic acid having an average molecular weight of at least about 25,000	5–10
A chloro(fluoromethyl) benzene having a boiling point above about 75° C. and a pour point below about −5° C.	30–60

4. A substantially non-flammable composition of matter for use as a hydraulic fluid comprising

	Percent by weight
Trioctyl phosphate	30–50
Tricresyl phosphate	5–35
A viscosity index-improving polymerized ester of C_{8-14} aliphatic monohydric alcohol and methacrylic acid having an average molecular weight greater than about 25,000	5–10
Chloro(trifluoromethyl) benzene	30–60

5. A substantially non-flammable composition of matter for use as a hydraulic fluid comprising

	Percent by weight
Trioctyl phosphate	30–50
Tricresyl phosphate	5–35
A viscosity index-improving polymerized ester of C_{8-14} aliphatic monohydric alcohol and methacrylic acid having an average molecular weight greater than about 25,000	5–10
Tetrachloro(trifluoromethyl) benzene	30–60

6. A homogeneous composition of matter for use as a hydraulic fluid comprising

	Percent by weight
A trialkyl phosphate wherein each alkyl radical contains 4 to 9 carbon atoms	15–80
A trihydrocarbyl phosphate, at least one of the hydrocarbyl radicals of which is an aryl radical	0–50
Viscosity index-improving polymerized esters of C_4 to C_{18} alcohols and methacrylic acid having an average molecular weight of at least about 25,000	1–15
A chloro(fluoromethyl) benzene having a boiling point above about 75° C. and a pour point below about —5° C.	10–70

7. A substantially non-flammable composition of matter for use as a hydraulic fluid comprising

	Percent by weight
A trialkyl phosphate wherein each alkyl radical contains 4 to 9 carbon atoms each	30–50
A trihydrocarbyl phosphate containing between about 12 and about 36 carbon atoms per molecule, at least one of the hydrocarbyl radicals being an aryl radical	5–35
Viscosity index-improving polymerized esters of C_4 to C_{18} alcohols and methacrylic acid having an average molecular weight of at least about 25,000	5–10
A chloro(trifluoromethyl) benzene oil, having a boiling point above about 75° C. and a pour point below about —5° C.	30–60

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