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ABSTRACT

[0044] The present invention relates to a hydraulic fluid composition comprising (A) at least one polydiorganosiloxane; (B) a chlorendate diester; and (C) a lubricant compound which is an antimony or lead compound of a dialkyldithiocarbamate or

5 dialkylphosphorodithioate.

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Multipart Description/PDF files in .zip description

Document Description	Start	End
Specification	1	11
Claims	12	15
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Silicone Hydraulic Fluids

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] None.

5 BACKGROUND OF THE INVENTION

[0002] The present invention relates to a hydraulic fluid composition comprising (A) at least one polydiorganosiloxane; (B) a chlorendate diester; and (C) a lubricant compound which is an antimony or lead compound of a dialkyldithiocarbamate or dialkylphosphorodithioate.

10 [0003] Hydraulic systems, in which power is transferred from one place to another, are used extensively in industrial equipment, farm equipment, transportation equipment, and the like. Illustrative of such equipment are lifters, jacks, elevators, mills, presses, and braking, power steering and suspension systems for vehicles.

[0004] High pressures and temperatures, which are frequently present in hydraulic systems, place high demands on the thermal and oxidative stability of the fluid used as the hydraulic medium. In addition, the lubricity of the hydraulic fluid is especially important with hydraulic systems wherein a pump is used to pressurize or move the hydraulic fluid from one place to another.

15 [0005] Polydiorganosiloxanes have been recognized as having exceptional thermal and oxidative stability, compatibility with seal materials, and high viscosity indices, said properties making them potentially useful as hydraulic fluids. Unfortunately, the generally low surface tension of polydiorganosiloxanes tends to cause them to have marginal lubricity on metals. As a result, additives improving the lubricity of polydiorganosiloxanes have been sought.

20 [0006] Although the use of certain silicone materials in hydraulic fluid compositions have been widely accepted, there still exists a need for a silicone hydraulic fluid composition which has better stability to settling at room temperature and at lower and higher temperatures. There is also a need for a hydraulic fluid having improved performance over a wider temperature range and higher oxidation stability.

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BRIEF SUMMARY OF THE INVENTION

[0007] The present invention relates to a hydraulic fluid composition comprising (A) at least one polydiorganosiloxane; (B) a chlorendate diester; and (C) a lubricant compound which is an antimony or lead compound of a dialkyldithiocarbamate or dialkylphosphorodithioate.

[0008] The present invention further relates to a hydraulic fluid composition comprising (A) at least two polydiorganosiloxanes; (B) a chlorendate diester; and (C) a lubricant compound which is an antimony or lead compound of a dialkyldithiocarbamate or dialkylphosphorodithioate.

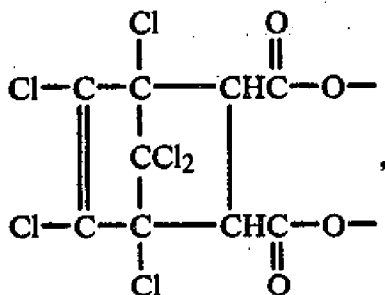
[0009] In yet another aspect of the present invention, a method is provided for transmitting power from one place to another place using the polydiorganosiloxane hydraulic fluid compositions of this invention.

[0010] It is an object of the present invention to provide improved polydiorganosiloxane hydraulic fluid compositions. Another object is to provide polydiorganosiloxane hydraulic fluid compositions having good lubricating properties. A further object is to provide a hydraulic fluid which has settling stability over a wide range of temperature. Another object is to provide an improved process for transmitting power from one place to another place via a hydraulic fluid.

DETAILED DESCRIPTION OF THE INVENTION

[0011] The present invention relates to a composition comprising

(A) 2 to 99 parts of at least one polydiorganosiloxane selected from (A1) 0 to 99 parts of a polydiorganosiloxane having a formula $R'R_2Si-O(Me_2SiO)_wSiR_2R'$ and a viscosity of 1.00×10^{-6} m²/second to 1.00×10^{-4} m²/second at 25° C and (A2) 0 to 99 parts having a formula $R'R_2Si-O(Me_2SiO)_x(MeR^aSiO)_ySiR_2R'$ and a viscosity of 1.00×10^{-5} m²/second to 1.00×10^{-4} m²/second at 25° C, wherein Me represents the methyl radical, each R represents a monovalent radical selected from hydrocarbon radicals containing from 1 to 6 carbon atoms, and halogenated hydrocarbon radicals containing from 1 to 6 carbon atoms, each R' represents a radical selected from R radicals, the hydride radical, and the hydroxy radical, w



and each R'' represents a radical selected from alkyl radicals containing from 4 to 10 carbon atoms, and the tetrahydrofurfuryl radical; and

- 5 (C) 0.1 to 38 parts by weight of a lubricant compound selected from N,N-dialkyldithiocarbamates of lead and antimony and dialkylphosphorodithioates of lead and antimony, the total parts of (A) plus (B) plus (C) being 100 parts by weight.

[0013] The at least one polydiorganosiloxane, component (A) in the compositions of the present invention is selected from (A1) a polydiorganosiloxane having a formula $R'R_2Si-O(Me_2SiO)_zSiR_2R'$ and (A2) a polydiorganosiloxane having a formula $R'R_2Si-O(Me_2SiO)_x(MeR^aSiO)_ySiR_2R'$, wherein Me represents the methyl radical, each R represents a monovalent radical selected from hydrocarbon radicals containing from 1 to 6 carbon atoms, and halogenated hydrocarbon radicals containing from 1 to 6 carbon atoms, each R' represents a radical selected from R radicals, the hydride radical, and the hydroxy radical, R^a represents an aryl hydrocarbon radical having from 6 to 10 carbon atoms, w has an average value from 1 to 70, x has an average value from 5 to 50, and y has an average value from 0.5 to 6.

[0014] Examples of suitable R hydrocarbon radicals containing from 1 to 6 carbon atoms include methyl, ethyl, propyl, isobutyl, pentyl, isopentyl, neopentyl, hexyl, vinyl, and allyl. Halogenated hydrocarbon radicals consist of hydrocarbon radicals as hereinabove delineated in which one or more of the hydrogen atoms has been replaced by a halogen atom, such as fluorine, chlorine, or bromine. Examples of halogenated hydrocarbon radicals include chloromethyl, 3 chloropropyl, and 3,3,3 trifluoropropyl. Alternatively, each R is a hydrocarbon radical containing 1 to 4 carbon atoms. Alternatively, each R is methyl .

[0015] R' represents a radical selected from R radicals, the hydride radical, and the hydroxy radical. The R radicals are as described above. Alternatively, each R' is an R radical. Alternatively, each R' is methyl.

5 [0016] Examples of suitable R^a hydrocarbon radicals containing from 6 to 10 carbon atoms are phenyl, tolyl, mesityl, and naphthyl. Alternatively, each R^a is phenyl.

[0017] Subscript w of Component (A1) has an average value from 1 to 70, alternatively 3 to 42, alternatively 5 to 35.

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[0018] Subscript x of Component (A2) has an average value from 5 to 50, alternatively 11 to 43, alternatively 11 to 37.

15 [0019] Subscript y of Component (A2) has an average value from 0.5 to 6, alternatively 3 to 5, alternatively 3 to 4.

[0020] The viscosity of polydiorganosiloxane component (A1) is from 1.00×10^{-6} m²/second to 1.00×10^{-4} m²/second (1 to 100 centistokes) at 25° C. Alternatively, the viscosity of polydiorganosiloxane component (A1) is from 2.00×10^{-6} m²/second to 5.00×10^{-5} m²/second at 25° C (2 to 50 centistokes). Alternatively, the viscosity of polydiorganosiloxane component (A1) is from 5.00×10^{-6} m²/second to 3.00×10^{-5} m²/second at 25° C. (5 to 30 centistokes).

25 [0021] The viscosity of polydiorganosiloxane component (A2) is from 1.00×10^{-5} m²/second to 1.00×10^{-4} m²/second (10 to 100 centistokes) at 25° C. Alternatively, the viscosity of polydiorganosiloxane component (A2) is from 2.00×10^{-5} m²/second to 7.50×10^{-5} m²/second at 25° C. (20 to 75 centistokes). Alternatively, the viscosity of polydiorganosiloxane component (A2) is from 2.00×10^{-5} m²/second to 5.00×10^{-5} m²/second at 25° C. (20 to 50 centistokes)

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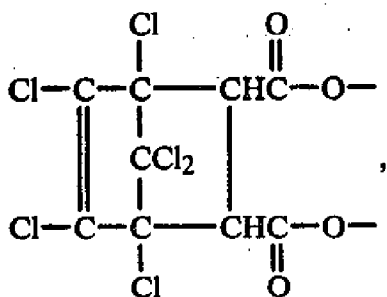
5 [0022] Component (A) may be present in the composition in amounts from 2 to 99 parts based on 100 parts of components (A) plus (B) plus (C). Alternatively, Component (A) is present in amounts from 10 to 97 parts on the same basis. Alternatively, Component (A) is present in amounts from 20 to 96 parts on the same basis. Alternatively, Component (A) is present in amounts from 30 to 95 parts on the same basis. Whether Component (A) is at least one or at least two polydiorganosiloxanes, total parts Component (A) equals parts by weight Component (A1) plus parts by weight Component (A2).

10 [0023] Component (A1) may be present in the composition in amounts from 0 to 99 parts based on 100 parts of components (A) plus (B) plus (C). Alternatively, Component (A1) is present in amounts from 1 to 99 parts on the same basis. Alternatively, Component (A1) is present in amounts from 10 to 67 parts on the same basis. Alternatively, Component (A1) is present in amounts from 20 to 50 parts on the same basis. Alternatively, Component (A1) is present in amounts from 30 to 45 parts on the basis.

15 [0024] Component (A2) may be present in the composition in amounts from 0 to 99 parts based on 100 parts of components (A) plus (B) plus (C). Alternatively, Component (A2) is present in amounts from 1 to 99 parts on the same basis. Alternatively, Component (A2) is present in amounts from 30 to 87 parts on the same basis. Alternatively, Component (A2) is present in amounts from 35 to 76 parts on the same basis. Alternatively, Component (A2) is present in amounts from 50 to 65 parts on the basis.

20 [0025] Suitable methods for synthesis of polydiorganosiloxanes for use as component (A1) and/or (A2) in the compositions of the present invention are well known. Illustrative of
25 suitable synthetic methods is the cohydrolysis and subsequent condensation of appropriately selected diorganodialkoxysilanes or diorganodichlorosilanes, along with desired amounts of $R'R_2SiX$ species, wherein R' and R are as defined above and X represents a hydrolyzable group, such as a halo group, such as chloro, fluoro or bromo; or an alkoxy group, such as methoxy, or ethoxy. Another suitable synthetic method is the acid or base catalyzed
30 equilibration of diorganocyclosiloxanes and an $R'R_2SiX$ species as defined above.

[0026] The chlorendate diester, component (B) in the compositions of the present invention, has the formula $R''O_2CQCO_2R''$, wherein $-O_2C-QCO_2-$ represents the chlorendate residue:



5 and wherein each R'' is independently selected from alkyl radicals containing from 4 to 10 carbon atoms, and the tetrahydrofurfuryl radical. Examples of said alkyl radicals are butyl, pentyl, hexyl, heptyl, octyl, 2-ethylhexyl, nonyl, decyl, and the like. Alternatively, each R'' is butyl or 2-ethylhexyl.

10 [0027] Chlorendate diesters are well-known materials; many are commercially available. The preferred chlorendate diesters are commercially available from, for example, Norquay Technology Chester PA.

15 [0028] Component (B) may be present in the composition in amounts from 0.9 to 60 parts based on 100 parts of components (A) plus (B) plus (C). Alternatively, Component (B) is present in amounts from 3 to 40 parts on the same basis. Alternatively, Component (B) is present in amounts from 3.7 to 30 parts on the same basis. Alternatively, Component (A) is present in amounts from 4.5 to 10 parts on the same basis.

20 [0029] Component (C) in the compositions of the present invention, is selected from the lead and antimony compounds of N,N-dialkyldithiocarbamates and the lead and antimony compounds of dialkyl phosphorodithioates. These compounds have the general formulae:

temperature for a period of time from about 1 minute to about 30 minutes in duration.

Alternatively, mixing can be accomplished by agitation of said components together. For example, said components can be mixed together by means of a high shear mixer, such as an Eppenbach.RTM. mixer. Of course, mixing can be accomplished by heating and agitating.

5 Agitation, with or without heating, is a preferred method for preparation of the polydiorganosiloxane hydraulic fluids of the present invention.

[0034] Small amounts of non-essential components, such as colorants, spray flammability resistance additives, fire retardants, and the viscosity control additives can be added to the
10 polydiorganosiloxane hydraulic fluid compositions of the present invention. Examples of such non-essential additives include dyes, to make the hydraulic fluid more readily identifiable, and highly brominated compounds to reduce flammability.

[0035] The polydiorganosiloxane hydraulic fluid compositions of the present invention are
15 stable hydraulic fluids of excellent lubricity. Accordingly, it is a further object of this invention to provide, in a process of transmitting power from one place to another place, the improvement which comprises using as the hydraulic fluid the composition comprising components (A), (B), and (C) as described above. Said process of transmitting power from one place to another place via a hydraulic fluid is accomplished through use of a hydraulic
20 system.

[0036] While hydraulic systems vary from highly complex control systems to simple presses, they can be characterized as comprising 6 main elements in fluid communication: (1) an hydraulic fluid; (2) a reservoir in which to store said fluid; (3) means to generate pressure
25 in said fluid, such as a pump or the like; (4) piping, to transmit the generated pressure through said fluid; (5) means to convert said pressure into power at a place removed from the place at which the pressure was generated, such as an hydraulic motor, actuator, cylinder, ram, jack, or the like; and (6) pressure control means, such as control valves, relief valves and the like.

30 [0037] In order to utilize the hydraulic principle, of course, it is necessary for the fluid to be within an enclosed volume able to sustain elevated pressures. Some leakage of fluid is

inevitable, and can be tolerated so long as elevated pressures can be sustained.

[0038] The polydiorganosiloxane hydraulic fluid compositions of the present invention can be used as the hydraulic fluid in a system for transmitting power from one place to another place as hereinabove described. Advantageously, the hydraulic fluid compositions of the present invention can be used as the hydraulic fluid in hydraulic systems wherein the fluid is exposed to extremes of temperature and high pressure.

[0039] The following examples are disclosed to further describe, and teach how to practice, the present invention. These examples are not to be construed as limiting the present invention, which is properly delineated by the appended claims. All parts and percentages are by weight unless otherwise stated. Viscosity values were measured in centistokes at 25°C., and converted to m^2 /second by multiplying by $1.00 \times 10^{-6} m^2$ /second/centistoke, and rounding the result of said multiplication to three significant figures.

[0040] Test Procedures

[0041] Viscosity was determined by the general procedure set forth in ASTM D-445.

[0042] Lubricity: Lubricity was determined by the general procedure set forth in ASTM D-4172. Standard 1.27 cm (1/2 inch) AISI-E-52100 chrome alloy steel balls were thoroughly cleaned and placed in a Roxana Four Ball Tester with the appropriate amount of fluid to be tested. Testing conditions were: 1200 r.p.m., 40 kg load, 75°C. Testing was one hour in duration. Results of this testing are reported herein as average scar diameter, determined by microscopic examination of the balls at the conclusion of testing. Results are reported in mm, and are reproducible within a range of approximately +/- 0.1%.

EXAMPLE 1

[0043] A hydraulic fluid of the present invention was prepared by thoroughly mixing 56 parts of dimethyl, phenylmethyl, trimethyl-terminated siloxane having a viscosity of $5.00 \times 10^{-5} m^2$ /second measured at 25°C, 37 parts dimethyl, trimethylsiloxy-terminated siloxane having

a viscosity of 1.00×10^{-5} m²/second measured at 25°C, 5.7 parts di-2-ethylhexyl chlorendate (DEHC) and 0.65 parts antimony tris(o,o-dipropylphosphorodithioate). A low shear mixing apparatus such as a KitchenAide Mixer was utilized until the mixture acquired a uniform appearance and no settling was noted. The mixture exhibited an almost clear appearance.

- 5 Components and amounts as well as viscosity and average wear scar diameters are displayed in Table 1.

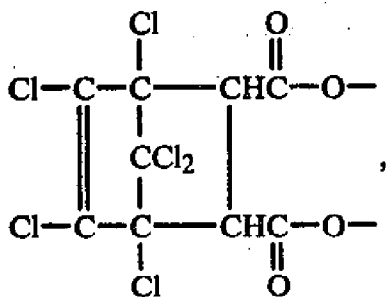
Composition, parts						
Example	Di-methyl silicone	Phenyl-methyl silicone	DEHC	Dithiophosphate	Viscosity, m ² /sec, ASTM D-445	Average scar diameter, mm ASTM D 4172
1	37	56	5.7	0.65	2.7×10^{-5}	1.36

That which is claimed is:

1. A composition comprising

5 (A) 2 to 99 parts of at least one polydiorganosiloxane selected from (A1) 0 to 99 parts of a polydiorganosiloxane having a formula $R'R_2Si-O(Me_2SiO)_wSiR_2R'$ and a viscosity of $1.00 \times 10^{-6} \text{ m}^2/\text{second}$ to $1.00 \times 10^{-4} \text{ m}^2/\text{second}$ at 25°C and (A2) 0 to 99 parts having a formula $R'R_2Si-O(Me_2SiO)_x(MeR^aSiO)_ySiR_2R'$ and a viscosity of $1.00 \times 10^{-5} \text{ m}^2/\text{second}$ to $1.00 \times 10^{-4} \text{ m}^2/\text{second}$ at 25°C , wherein Me represents the methyl radical, each R represents a monovalent radical selected from hydrocarbon radicals containing from 1 to 6 carbon atoms, and halogenated hydrocarbon radicals containing from 1 to 6 carbon atoms, each R' represents a radical selected from R radicals, the hydride radical, and the hydroxy radical, w has an average value from 1 to 70, x has an average value from 5 to 50, and y has an average value from 0.5 to 6;

15 (B) 0.9 to 60 parts by weight of a chlorendate diester having the formula $R''O_2CQCO_2R''$, wherein $-O_2C-QCO_2-$ represents the chlorendate residue,



and each R'' represents a radical selected from alkyl radicals containing from 4 to 10 carbon atoms and the tetrahydrofurfuryl radical; and

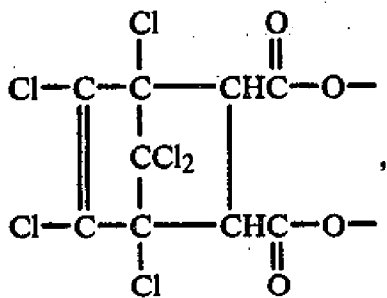
20 (C) 0.1 to 38 parts by weight of a lubricant compound selected from N,N-dialkyldithiocarbamates of lead and antimony and dialkylphosphorodithioates of lead and antimony, the total parts of (A) plus (B) plus (C) being 100 parts by weight.

2. A composition comprising

25 (A) 2 to 99 parts of at least two polydiorganosiloxanes selected from (A1) 1 to 99 parts of a polydiorganosiloxane having a formula $R'R_2Si-O(Me_2SiO)_wSiR_2R'$ and a viscosity of $1.00 \times 10^{-6} \text{ m}^2/\text{second}$ to $1.00 \times 10^{-4} \text{ m}^2/\text{second}$ at 25°C and (A2) 1 to 99 parts of a

polydiorganosiloxane having a formula $R'R_2Si-O(Me_2SiO)_x(MeR^aSiO)_ySiR_2R'$, wherein Me represents the methyl radical, each R represents a monovalent radical selected from hydrocarbon radicals containing from 1 to 6 carbon atoms, and halogenated hydrocarbon radicals containing from 1 to 6 carbon atoms, each R' represents a radical selected from R radicals, the hydride radical, and the hydroxy radical, w has an average value from 1 to 70, x has an average value from 5 to 50, and y has an average value from 0.5 to 6;

(B) 0.9 to 60 parts by weight of a chlorendate diester having the formula $R''O_2CQCO_2R''$, wherein $-O_2C-QCO_2-$ represents the chlorendate residue,



and each R'' represents a radical selected from alkyl radicals containing from 4 to 10 carbon atoms, and the tetrahydrofurfuryl radical; and

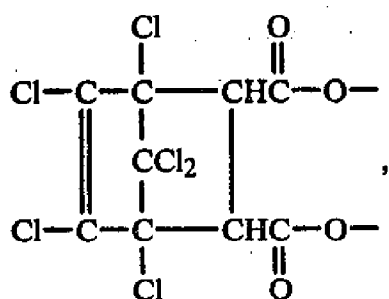
(C) 0.1 to 38 parts by weight of a lubricant compound selected from N,N-dialkyldithiocarbamates of lead and antimony and dialkylphosphorodithioates of lead and antimony, the total parts of (A) plus (B) plus (C) being 100 parts by weight.

3. The composition of Claim 1 or 2 where R is methyl, R' is methyl, R^a is phenyl, R'' is 2-ethylhexyl, R''' is propyl, w has an average value from 3 to 35, x has an average value of from 11 to 37, y has an average value of 3 to 4, 30 to 40 parts of Component (A1) having a viscosity of 5.00×10^{-6} m²/second to 3.00×10^{-5} m²/second at 25° C, 50 to 60 parts of Component (A2) having a viscosity of 2.00×10^{-5} m²/second to 5.00×10^{-5} m²/second at 25° C, 4.5 to 10 parts of Component (B), 0.5 to 10 parts of Component (C) where component (C) is a dipropylphosphorodithioate.

4. In a process of transmitting power from one place to another place via a hydraulic fluid, the improvement which comprises using as the hydraulic fluid a composition comprising

(A) 2 to 99 parts of at least one polydiorganosiloxane selected from (A1) 0 to 99 parts of a polydiorganosiloxane having a formula $R'R_2Si-O(Me_2SiO)_wSiR_2R'$ and a viscosity of 1.00×10^{-6} m²/second to 1.00×10^{-4} m²/second at 25° C and (A2) 0 to 99 parts having a formula $R'R_2Si-O(Me_2SiO)_x(MeR^aSiO)_ySiR_2R'$ and a viscosity of 1.00×10^{-5} m²/second to 1.00×10^{-4} m²/second at 25° C, wherein Me represents the methyl radical, each R represents a monovalent radical selected from hydrocarbon radicals containing from 1 to 6 carbon atoms, and halogenated hydrocarbon radicals containing from 1 to 6 carbon atoms, each R' represents a radical selected from R radicals, the hydride radical, and the hydroxy radical, w has an average value from 1 to 70, x has an average value from 5 to 50, and y has an average value from 0.5 to 6;

(B) 0.9 to 60 parts by weight of a chlorendate diester having the formula $R''O_2CQCO_2R''$, wherein $-O_2C-QCO_2-$ represents the chlorendate residue,



and each R'' represents a radical selected from alkyl radicals containing from 4 to 10 carbon atoms and the tetrahydrofurfuryl radical; and

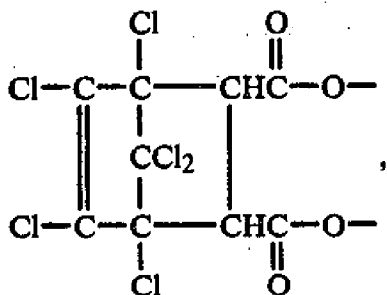
(C) 0.1 to 38 parts by weight of a lubricant compound selected from N,N-dialkyldithiocarbamates of lead and antimony and dialkylphosphorodithioates of lead and antimony, the total parts of (A) plus (B) plus (C) being 100 parts by weight.

5. In a process of transmitting power from one place to another place via a hydraulic fluid, the improvement which comprises using as the hydraulic fluid a composition comprising

(A) 2 to 99 parts of at least two polydiorganosiloxanes selected from (A1) 1 to 99 parts of a polydiorganosiloxane having a formula $R'R_2Si-O(Me_2SiO)_wSiR_2R'$ and a viscosity of 1.00×10^{-6} m²/second to 1.00×10^{-4} m²/second at 25° C and (A2) 1 to 99 parts of a

polydiorganosiloxane having a formula $R'R_2Si-O(Me_2SiO)_x(MeR^aSiO)_ySiR_2R'$, wherein Me represents the methyl radical, each R represents a monovalent radical selected from hydrocarbon radicals containing from 1 to 6 carbon atoms, and halogenated hydrocarbon radicals containing from 1 to 6 carbon atoms, each R' represents a radical selected from R radicals, the hydride radical, and the hydroxy radical, w has an average value from 1 to 70, x has an average value from 5 to 50, and y has an average value from 0.5 to 6;

(B) 0.9 to 60 parts by weight of a chlorendate diester having the formula $R''O_2CQCO_2R''$, wherein $-O_2C-QCO_2-$ represents the chlorendate residue,



and each R'' represents a radical selected from alkyl radicals containing from 4 to 10 carbon atoms, and the tetrahydrofurfuryl radical; and

(C) 0.1 to 38 parts by weight of a lubricant compound selected from N,N-dialkyldithiocarbamates of lead and antimony and dialkylphosphorodithioates of lead and antimony, the total parts of (A) plus (B) plus (C) being 100 parts by weight.

6. The process of Claim 4 or 5 wherein R is methyl, R' is methyl, R^a is phenyl, R'' is 2-ethylhexyl, R''' is propyl, w has an average value from 3 to 35, x has an average value of from 11 to 37, y has an average value of 3 to 4, 30 to 40 parts of Component (A1) having a viscosity of 5.00×10^{-6} m²/second to 3.00×10^{-5} m²/second at 25° C, 50 to 60 parts of Component (A2) having a viscosity of 2.00×10^{-5} m²/second to 5.00×10^{-5} m²/second at 25° C, 4.5 to 10 parts of Component (B), 0.5 to 10 parts of Component (C) where component (C) is a dipropylphosphorodithioate.

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Express Mail Label No. _____

INVENTOR(S)		
Given Name (first and middle [if any])	Family Name or Surname	Residence (City and either State or Foreign Country)
GARY ALLEN	MCINTYRE	BRIGHTON, MICHIGAN USA
Additional inventors are being named on the _____ separately numbered sheets attached hereto.		
TITLE OF THE INVENTION (500 characters max):		
Silicone Hydraulic Fluids		
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