United States Patent [19]

Sawyer et al.

[11] **3,711,410**

[45] **Jan. 16, 1973**

[54] **LOW WATER-SENSITIVE HYDRAULIC FLUIDS CONTAINING BORATE ESTERS**

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[22] Filed: **April 12, 1971**

[21] Appl. No.: **133,452**

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 717,996, April 1, 1968, Pat. No. 3,625,899, which is a continuation-in-part of Ser. No. 653,338, July 14, 1967, abandoned.

[52] **U.S. Cl.**.....**252/78,** 252/49.6

[51] **Int. Cl.** **C09k 3/00,** C10m 3/48

[58] **Field of Search**.....252/74, 75, 77, 78, 49.6

[56] **References Cited**

UNITED STATES PATENTS

3,625,899 12/1971 Sawyer et al. 252/75

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[57] **ABSTRACT**

A low water-sensitive hydraulic fluid composition which contains from about 20 to about 96 percent by weight of at least one borate ester as the base fluid. Such low-water sensitive hydraulic fluids are high boiling compositions particularly useful as brake fluids.

25 Claims, No Drawings

LOW WATER-SENSITIVE HYDRAULIC FLUIDS CONTAINING BORATE ESTERS

This application is a continuation-in-part of co-pending application Ser. No. 717,996 filed Apr. 1, 1968 and now U.S. Pat. No. 3,625,899, which in turn was a continuation-in-part of application Ser. No. 653,338 filed July 14, 1967 and now abandoned.

This invention relates to new and improved, low water-sensitive hydraulic pressure transmission fluids for use in fluid pressure operating devices such as hydraulic brake systems, hydraulic steering mechanisms, hydraulic transmissions, hydraulic jacks, hydraulic lifts, etc. More particularly, this invention relates to hydraulic fluids having a low sensitivity to water which employ as the base fluid one or more borate esters of glycol monoethers. The term "base fluid" as used throughout the specification and claims means the major active ingredient (not necessarily present in the major or largest proportion) of the hydraulic fluid, i.e. that ingredient which is most active in maintaining the desired properties of the hydraulic fluid especially in the face of aqueous contamination.

A great number of hydraulic fluid compositions have been suggested in the art. Commonly, the hydraulic pressure transmission fluids, such as brake fluids are made up of three principal units. The first is a base or lubricant for the system which may include heavy bodied fluids such as polyglycols, castor oil, mixtures of these materials, etc. Diluents, which are employed for the purpose of controlling the viscosity of the fluid as represented by glycol ethers, glycols, alcohols, etc., form the second basic unit. Finally, the third basic unit is represented by an additive or inhibitor package comprising small quantities of materials which are added to control or modify various chemical and physical properties of the fluid, e.g. to reduce oxidation, to improve wetting and flow and to maintain the pH of the hydraulic system above 7 in order to minimize corrosion. By varying the composition, particularly desired properties can generally be attained. However, hydraulic fluids have been subject to increasingly stringent requirements with regard to many properties, e.g. boiling point, viscosity, corrosiveness, lubricity, pour point and rubber swell. This has made it extremely difficult to produce a desirable fluid since very often a change in composition which improves one or more of these or other essential properties will detrimentally effect some other property. This problem is magnified when water gets into the hydraulic fluid since many of the properties are effected, some to a substantial extent.

Hydraulic fluids, as exemplified by the commercial motor vehicle brake fluids, are hydroscopic by nature and therefore, absorb moisture from ambient atmospheres with resulting degradation of their boiling point. This effect that water has on the boiling point of hydraulic fluids has been studied extensively and a great deal of public interest has been generated concerning the safety qualities of hydraulic fluids especially brake fluids as is pointed out, for example by C. F. Pickett in an article entitled "Automotive Hydraulic Brake Fluids" published as part of the 51st Mid-Year Meeting Proceedings of the Chemical Specialties Manufacturing Association, Inc., N.Y. (1965). As indicated in the above-noted article, when a small amount of water, e.g. 3.5 percent by weight was added to various commercial brake fluids, some having initial boiling points of 500°F., the resulting fluid compositions exhibited boiling points below 300°F. In contrast, the hydraulic fluid compositions of this invention generally maintain boiling points of greater than 320°F. and more often greater than 350°F. after the addition of 3.5 percent water.

The importance of having a hydraulic fluid which has a low sensitivity to water and thus can maintain the boiling point at levels above those previously found in available commercial fluids is more readily understood when the following facts are considered. First of all, it is known that hydraulic brake fluid temperatures can reach rather high levels and often approach and even exceed the 300°F. level. This is substantiated by the results of field studies in 1966 by the Society of Automotive Engineers (See SP-338, "Automotive Brake Evaluation Under Customer Usage Conditions", pp.1 and 2, 1968) wherein it was shown that brake fluid temperatures approached 270°F. under typical driving conditions of vehicles which were loaded only to their manufacturer's recommended limit. It could reasonably be assumed from these results, that when abnormal conditions are encountered temperatures would exceed 270°F. and approach and even pass 300°F.

It is also known that so-called conventional type motor vehicles often accumulate small amounts of moisture in their hydraulic fluids during usage. This is substantiated by results disclosed in a meeting of the SAE Hydraulic Brake Systems Actuating Committee in 1966 (See minutes of meeting of October 26–27, 1966) and further by the report of Charles B. Jordan, "Effect of Water on Hydraulic Brake Fluid", U.S. Army Coating and Chemical Laboratory, May, 1966. These articles clearly show that amounts of water have been accumulated in hydraulic brake fluids under use conditions in varying proportions and have often reached levels of up to 3.5 percent and even have been as high as 5 percent by weight. The fact that hydraulic fluids do accumulate some water during usage is further supported by the SAE Standard J-1703 which requires certain water tolerance tests to be passed after the addition of 3.5 percent by weight water and also, requires a corrosion test to be passed after the addition of 5 percent by weight water to the brake fluid.

From the above discussion, it can readily be understood that hydraulic fluids can under certain conditions approach temperatures of the magnitude of 300°F. and higher and furthermore such fluids can accumulate small amounts of moisture during usage. Thus, hydraulic fluids which have low dry boiling points and are sensitive to water to a large degree can encounter problems such as vapor lock which can result in the failure of a hydraulic brake system and consequently cause an accident. This clearly illustrates the advantage of the hydraulic fluids of this invention which possess a high degree of water tolerance and are able to maintain their boiling points at higher and safer levels.

The seriousness of the problem of water accumulation and its effects on the hydraulic fluid system is further signified by the fact that the U.S. Department of Transportation presently is considering acceptance of standards for motor vehicle brake fluids which would for the first time include a minimum wet reflux boiling

point (equivalent to approximately 3.5 percent by weight of water added). The proposed standards include one for a fluid having a minimum dry reflux boiling point of 401°F. and a minimum wet reflux boiling point of 284°F. and another for a fluid having a minimum dry reflux boiling point of 446°F. and a minimum wet reflux boiling point of 320°F. The term "dry reflux boiling point" as used herein is defined as the boiling point of the hydraulic fluid as delivered to the consumer or distributors (i.e. fluid ready for use). Wet reflux boiling point is the boiling point of the hydraulic fluid after a discrete amount of water has been added thereto.

The above considerations clearly point out the need for a hydraulic fluid which has a low sensitivity to water and can maintain certain properties and characteristics when amounts of water commonly encountered during use are present.

There are various hydraulic fluids known in the art as shown for example in Introduction to Hydraulic Fluids by Roger E. Hatton, Reinhold Publishing Corp. (1962); U.S. Pat. No. 2,998,389 issued to Chester M. White on August 29, 1961 and U.S. Pat. No. 3,377,288 issued to Arthur W. Sawyer on Apr. 9, 1968. Generally, these fluids do not have the low water sensitivity that is required to maintain their original properties after there is an accumulation of moisture.

One of the basic objects of this invention is to provide hydraulic pressure transmission fluids for use in hydraulic systems which retain to a high degree, their original properties when water is accumulated, i.e. they have a low sensitivity to water.

Another object of this invention is to provide hydraulic pressure transmission fluids which are extremely high boiling compositions and which maintain relatively high boiling points even when water is accumulated in the hydraulic fluid composition.

Another object of this invention is to provide a hydraulic pressure transmission fluid having an initial dry reflux boiling point of at least about 450°F. and a wet reflux boiling point of at least about 320°F. when about 3.5 percent by volume of water (equivalent to about 3.4 percent by weight) is present.

A further object of this invention is to provide a hydraulic pressure transmission fluid having a high degree of lubricity while maintaining desired viscosities within a predetermined range under a wide variation of temperature conditions.

These and other objects of this invention are accomplished with the hydraulic fluids of this invention which generally comprise from about 20 to about 96 percent by weight, based on the total hydraulic fluid weight, of at least one borate ester of a glycol monoether as the base fluid. Generally the remainder of the fluid is comprised of diluent and one or more additives.

The hydraulic fluids of this invention are especially desirable because they have a low water sensitivity and are particularly useful as brake fluids since they can retain to a high degree the original properties of the fluid after water is accumulated. Additionally, the hydraulic fluids of this invention are of low cost, possess a high boiling point, are essentially odorless and colorless, possess a high degree of compatibility with other fluids and exhibit a very low rate of corrosivity.

Another feature of this invention is the highly satisfactory rubber compatibility of the novel fluids as shown in tests carried out according to SAE Standard J70c (see Table I). Fluids previously employed have utilized more expensive materials such as 2-ethylhexanol, heptanols, butyl ethers of glycols, or diethers of glycols in an amount from about 10 to about 30 percent by weight of the total composition to achieve the desired rubber swelling characteristics whereas the hydraulic fluids of this invention provide satisfactory rubber swelling properties without the addition of a component for this purpose. The importance of the rubber swelling properties of the fluid cannot be overlooked since too little swelling will result in leakage of the fluid passed the rubber cup sealing means and passed the piston in hydraulic cylinders with corresponding loss of power. On the other hand fluids which cause too much rubber swelling are not desirable in that they destroy the structural properties of the rubber sealing cups in hydraulic cylinders, which in turn results in malfunction or inoperativeness of the unit.

The hydraulic fluids of this invention generally comprise three principal units: (1) base fluid, (2) diluents and (3) additives. The components of these units and the proportions thereof are described in detail below.

BASE FLUID

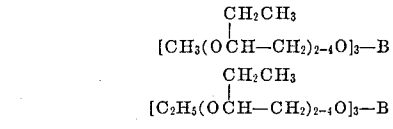
The base fluid employed in the novel hydraulic fluids of this invention generally comprises at least one borate ester of a glycol monoether. More particularly, the hydraulic fluids of this invention will comprise from about 20 to about 96 percent by weight, based on the total hydraulic fluid weight, of at least one borate ester of a glycol monoether. Preferably, the amount of borate ester will vary from about 30 to about 92 percent and more preferably from about 54.5 to about 92 percent by weight, based on the total hydraulic fluid weight. When using hydraulic fluids which can safely operate under somewhat lower temperature conditions, the range of borate ester used may vary from about 20 to about 55.4 percent and preferably from about 30 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid. Generally, when 54.5 percent borate ester is used, the hydraulic fluid can maintain a wet boiling point (≈3.5 percent by volume water added — equivalent to about 3.4 percent by weight) of at least about 350°F. When 20 and 30 percent borate ester is used, a wet boiling point of at least about 320°F. and 330°F. respectively can be maintained.

Although a wide variety of borate esters can be employed as the base fluid in the novel hydraulic fluids of this invention, an especially useful class of borate esters are the so-called tri borate esters of glycol monoethers having the general formula

$$[R_1(O-R_a)_y-O]_3-B \qquad (I)$$

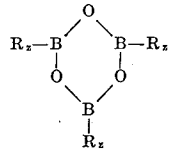
wherein R_1 is a lower alkyl radical containing from one to four carbon atoms, preferably one to two, R_a is alkylene of from two to four carbon atoms, preferably two to three, and y is an integer from two to four inclusive. The R_1 and R_a groups may be either straight or branched chain structures. Borates of the above-mentioned type include, for example: $[CH_3(OCH_2CH_2)_2O]$

$_3$-B, $[C_2H_5(OCH_2CH_2)_3O]_3$—B, $[C_3H_7(OCH_2CH_2)_4O]_3$—B, $[CH_3(OCH_2CHCH_3)_2O]_3$—B, $[CH_3(OCH_2CHCH_3)_3CQ]_3$—B, $[CH_3(OCH_2CHCH_3)_4O]_3$—B, $[C_2H_5(OCH_2CHCH_3)_2O]_3$—B, $[C_2H_5(OCH_2CHCH_3)_3O]_3$—B, $[C_2H_5(OCH_2CHCH_3)_4O]_3$—B, $[C_3H_7(OCH_2CHCH_3)_2$—$_4O]_3$—B, $[C_4H_9(OCH_2CHCH_3)_2$—$_4O]_3$—B, $[CH_3O(OCHCH_3CH_2)_2$—$_4O]_3$—B, $[C_2H_5(OCHCH_3CH_2)_2$—$_4O]_3$—B, $[CH_3(OCHCH_3CHCH_3)_2$—$_4O]_3$—B, $[C_2H_5(OCHCH_3CHCH_3)_2$—$_4O]_3$—B, $[CH_3(OCHCHCH_2CH_3)_2$—$_4O]_3$—B, $[C_2H_5(OCH_2CHCH_2CH_3)_2$—$_4O]_3$—B,



While any of the borate esters defined by formula (I) may be used, the following borate esters are particularly useful: $[CH_3(OCH_2CH_2)_3O]_3$—B, $[C_2H_5(OCh_2CH_2O]_3$—B, $[C_2H_5(OCH_2CH_2)_3O]_3$—B, $[C_2H_5(OCH_2Ch_2]_3$—B, $[C_3H_7(OCH_2CH_2)_3O]_3$—B, $[C_4H_9(OCH_2CH_2c\text{-}2O]_3$—B and $[C_4H_9(OCH_2CH_2)_3O]_3$—B.

Borates of the above-mentioned type can be conveniently prepared by reacting orthoboric acid and the glycol monoether while in the presence of a water-azeotrope forming solvent. Water formed in the esterification reaction is continuously removed as the azeotrope. At first, the temperature of the reaction mixture is maintained between about 0°C. and about 190°C. and desirably at the distillation temperature of the water-solvent azeotrope. After essentially complete removal of the water formed during esterification, the excess solvent is conveniently removed from the reaction mixture by distillation. The borate ester product, which is left in a residue, may then be recovered by distilling under reduced pressure or by extraction with a suitable solvent followed by evaporation of the solvent. For example, the compound $[C_2H_5(OCH_2CH_2)_2O]_3$—B can be prepared by reacting two moles of $C_2H_5(OCHCH_2)_2OH$, 0.67 mole of orthoboric acid and 700 ml. of ethylbenzene with heating and mixing to yield 198 grams of the ester, a water-white liquid boiling at 222°–223° C. (5 mm. Hg). It is noted that in the preparation of these esters, a small proportion of concomitant reaction products may be formed and other minor impurities may also be present. Generally, the predominant portion of such other reaction products formed is a boroxine type compound having the following general structure:



wherein R_z is derived from the particular glycol ether being used, e.g. $CH_3(OCH_2CH_2)_2O$—, $C_2H_5(OCH_2CH_2)_2O$, etc. The amount of such concomitant reaction products formed and other impurities present may be up to about 10 percent by weight if the reacted mixture is not distilled. Distillation will reduce the amount of other reaction products and impurities to about 1 percent or less, however, either the distilled or undistilled product can be used provided the reaction medium or solvent is stripped off. The term "borate ester" as used in the specification and claims is intended to include relatively pure borate ester as well as crude borate ester which contains impurities and other by-products formed during preparation as described above. The preparation of the tri-borate esters per se is more completely described in U.S. Pat. No. 3,080,412 issued to D. M. Young on Mar. 5, 1963. It is of interest to note that this patent (U.S. Pat. No. 3,080,412) discloses the use of tri-borate esters, such as tris [2-(2-ethoxyethoxy)ethyl] borate, as stabilizers and corrosion inhibitors for lubricants and non-aqueous hydraulic fluids. However, use of these esters for such purposes, i.e. as a stabilizer or corrosion inhibitor, would not impart satisfactory low water sensitivity to the hydraulic fluid since such usage would generally be in very small or minor proportions (e.g. from 0.5 to 2 percent) in accordance with the generally accepted practice in the art (e.g. see U.S. Pat. No. 3,403,104 issued to P. B. Sullivan on Sept. 24, 1968).

A second highly useful class of borate esters includes compounds of the general formula: $[R_1(OCH_2CHR_2)_m$—$(OCH_2CHR_3)_nO]_3$—B (II)

wherein R_2 and R_3 are independently selected from the group consisting of hydrogen and methyl, *m* and *n* are positive integers whose sum is from 2 to 20 and R_1 is alkyl of from one to four carbon atoms and with proviso that one of R_2 and R_3 is methyl and one of R_2 and R_3 is hydrogen. R_1 may be straight chain or branched alkyl. Borate esters of Type II can be prepared in the general way as those esters previously described (Type I) above, utilizing the so-called block type glycol monoethers. The preparation of esters of Type II is described in detail in U.S. Pat. No. 3,316,287 issued to L. G. Nunn, Jr. et al. on Apr. 25, 1967. **Type II borate esters useful in preparing the novel fluids of this invention include, for example:**

$[CH_3(OCH_2CH_2)$—$(OCH_2CHCH_3)O]$c-3—B
$[C_2H_5(OCH_2CHCH_3)$—$(OCH_2CH_2)O]_3$—B
$[C_3H_7(OCH_2CHCH_3)_2$—$(OCH_2CH_2)O]_3$—B
$[C_4H_9(OCH_2CH_2)_5$—$(OCH_2CHCH_3)O]_3$—B
$[CH_3(OCH_2CH_2)_8(OCH_2CHCH_3)_5O]_3$—B
$[C_2H_5(OCH_2CHCH_3)_{12}$—$(OCH_2CH_2)_8O]_3$—B
$[C_3H_7(OCH_2CHCH_3)_{10}$—$(OCH_2CH_2)_{10}O]$—B

Another class of borate esters useful in the fluid compositions of this invention include esters having heteric oxyalkylene chains, that is, oxyalkylene chains in which oxyethylene and oxypropylene units are distributed randomly throughout the chain. These Type III esters have the general formula:

$$(R_1[Rg]O)_3\text{—B}, \quad \text{(III)}$$

Rg represents a heteric oxyalkylene chain having the formula:

$$[-(OCH_2CH_2)_r, (OCH_2CHCH_3)_s-]$$

where the sum of *r* and *s* is not more than 20 and wherein the weight percent of oxyethylene units in the said chain is not less than 20 based on the total weight of all the oxyalkylene units in the chain and R_1 is alkyl

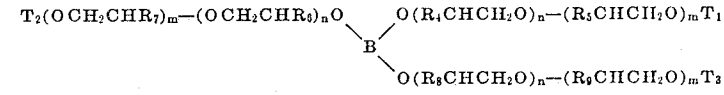
of from one to four carbon atoms and may be straight or branched chain. The preparation of Type III esters can be accomplished in the same general manner as the preparation of Types I and II described above by reacting orthoboric acid in the presence of toluene with a heteric glycol monoether of the formula:

$$R_1[Rg]OH,$$

where R_1 and Rg have the same meaning as previously set forth. Glycol monoethers of this class can be conveniently prepared by methods well known in the art such as the process described in U.S. Pat. No. 2,425,845 issued to W. J. Toussaint et al. on Aug. 19, 1947.

A fourth type of borate esters suitable for use in the fluid compositions of this invention have the general formula:

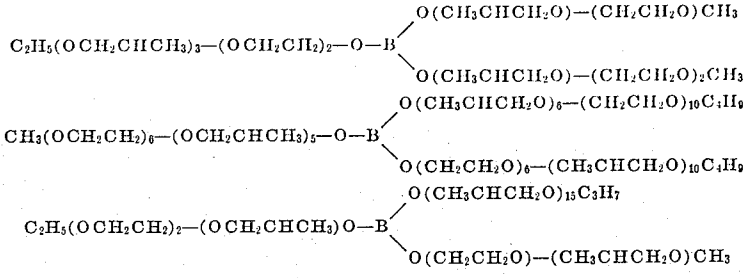
(IV)



wherein T_1, T_2 and T_3 are each an independently selected alkyl group having from one to four carbon atoms, R_4, R_5, R_6, R_7, R_8 and R_9 are independently selected from the group consisting of hydrogen and methyl, *n* and *m* are positive integers independently selected in each chain and whose sum in each chain is from 2 to 20, and with the proviso that in no more than two of the chains is the sum of *n* and *m* the same. It is also noted that T_1, T_2 and T_3 may be a straight or branched chain alkyl group.

Borate esters of this type can be prepared in the same way as the process described for Type I esters previously mentioned.

Type IV borate esters suitable for use in the fluids of this invention include, for example:



It is further noted that borate esters of Types II, III and IV may include concomitant reaction products and other impurities of the type as described above for Type I esters. Reference to these types of borate esters in the specification and claims is intended to include relatively pure borate ester as well as crude borate ester which contains impurities and other by-products formed during preparation as described above for Type I.

DILUENTS

This diluent portion of the hydraulic fluid composition of this invention generally will comprise one or more compounds selected from the group consisting of (a) glycol monoethers or diethers (b) glycols and polyglycols and (c) aliphatic saturated alcohols.

More particularly, the glycol monoethers or diethers have the formula:

$$R[O—R'']_yOR' \qquad (V)$$

wherein R is alkyl of from one to four carbon atoms, preferably one to two, R' is hydrogen or alkyl of from one to four carbon atoms, preferably one to two, R'' is alkylene of two to four carbon atoms, preferably two to three, and *y* is two to four. The R, R' and R'' groups may be straight chained or branched. It is also intended that the alkylene oxide group (O—R'') in the above formula (V) include mixtures of said alkylene oxides.

Illustrative of the diluents of this type (V) are the following compounds: diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monoisopropyl ether, diethylene glycol monoisobutyl ether, triethylene glycol monomethyl ether, triethylene glycol monoether ether, triethylene glycol mono-n-butyl ether, tetraethylene glycol monomethyl ether, tetraethylene glycol monoethyl ether, dipropylene glycol monomethyl ether, dipropylene glycol monoethyl ether, tripropylene glycol monomethyl ether, tripropylene glycol monoethyl ether, tripropylene glycol mono-n-butyl ether, tetrapropylene glycol monomethyl ether, tetrapropylene glycol monoethyl ether, dibutylene glycol monomethyl ether, dibutylene glycol monoethyl ether, tributylene glycol monomethyl ether, tributylene glycol monoethyl ether, tributylene glycol mono-n-propyl ether, tetrabutylene glycol monomethyl ether, tetrabutylene glycol monoethyl ether, tetrabutylene glycol mono-n-butyl ether and the corresponding diethers thereof. It is further noted that the above diluents include the various isomers of the respective compounds and mixtures thereof.

While any of the above glycol ethers defined by formula (V) may be used, the following glycol ethers are particularly useful: diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monobutyl ether, triethylene glycol monomethyl ether, triethylene glycol monoethyl ether, triethylene glycol monobutyl ether, tetraethylene glycol monomethyl ether, tetraethylene glycol monoethyl ether and tetraethylene glycol monobutyl ether.

The glycol ethers are the most preferred diluent since their use will result in a fluid having a desirably high boiling point with good viscosity and water solubility properties. Most preferred of the glycol ethers are the ethylene glycols.

The second group of useful diluents are the glycols and polyglycols, including alkylene, polyalkylene and polyoxyalkylene glycols, having a molecular weight of from about 60 to about 450 and preferably from about 100 to about 300. Illustrative of such type diluents are the following compound: ethylene glycol, propylene glycol, hexylene glycol, diethylene glycol, dipropylene

glycol, triethylene glycol, tripropylene glycol, polyethylene glycol and polypropylene glycol.

The use of the glycols and polyglycols as diluents is not as desirable as the glycol ethers since their use may result in some loss of fluidity at very low temperatures, however, they may be used in conditions where the requirements are not as demanding.

The third type of useful diluents are aliphatic, saturated, monohydric alcohols containing from six to 13 carbon atoms, preferably from eight to 10. Illustrative of such diluents are the following alcohols: hexanol, octanol, isooctanol, decanol, isodecanol, dodecanol, and tridecanol.

Since the use of the aliphatic alcohols in a high boiling hydraulic fluid may result in some loss of water solubility, they are not as desirable as the glycol ethers. However, they may be used in conditions where the requirements are not as stringent.

The diluent portion of the hydraulic fluids of this invention generally will comprise from 0 to about 80 percent by weight, preferably from about 3 to about 70 and more preferably from about 3 to about 45 percent by weight, based on the total weight of the hydraulic fluid composition.

While the above diluents, especially the glycol ethers, are particularly preferred, other diluents may be used if the desired properties and characteristics of the hydraulic fluid can be attained. For example, certain diesters derived from organic aliphatic acids and aliphatic alcohols might be usefully employed. Examples of diesters which might be used include dibutyl adipate, bis(methoxyethyl) azelate, diisopropyl succinate, dipropylene glycol diproprionate and triethylene glycol dibutyrate.

ADDITIVES

When desired, various additives may be added to the hydraulic fluids of this invention to control or modify various chemical and physical properties of the fluids. Among the various types of additives which can be added to the hydraulic fluids of this invention are included: inhibitors for pH and corrosion control, antioxidants, rust inhibitors, viscosity index improvers, pour point depressants, lubricity agents, antifoamants, stabilizers, demulsifiers dyes and odor suppressants. Generally, the total amount of additives which may be incorporated into the fluid composition will vary depending on the particular composition and the desire properties. More particularly, the total amount of additives will comprise from 0 to about 10 percent and preferably from about 0.1 to about 8.0 percent by weight based on the total weight of the hydraulic fluid composition.

For example, inhibitors for pH and corrosion control, such as alkaline inhibitors as exemplified by the alkali metal borates, can be employed in an amount sufficient to maintain alkaline conditions in the fluid compositions, e.g. a pH value of from about 7.0 to about 11.5. These inhibitors are generally added in an amount of from 0 to about 8.0 percent by weight based on the total weight of the hydraulic fluid composition and preferably from about 0.2 to about 6.0 percent by weight on the same basis. Useful inhibitors include alkali metal borates, such as sodium borate, potassium tetraborate, etc.; sodium meta arsenite; alkali metal salts of fatty acids, such as potassium oleate, the potassium soap of rosin or tall oil; alkylene glycol condensates with alkali metal borates, such as the ethylene glycol condensate of potassium tetraborate; amines, for example, ethanolamine, methyl diethanolamine, diethanolamine, isopropanolamines(mono, di and tri), di(2-ethylhexyl) amine, di-N-butyl amine, monoamyl amine, diamylamine, dioctylamine, salicylal monoethanolamine, di-β-naphthyl-p-phenylene diamine, N,N′-disalicylidene-1,2-propanediamine, N,N′-disalicylal ethylene diamine, dicyclohexylamine, and amine salts such as mono or dibutyl ammonium borate; phosphites, such as triphenyl phosphite, tri(tertamylphenyl) phosphite, diisopropyl phosphite, etc.; mercaptobenzotriazole; morpholine compounds including alkyl morpholines having from one to four carbon atoms in the alkyl group such as N-ethyl morpholine, N-isopropyl morpholine, N-butyl morpholine; N-phenyl morpholine, N-(2-aminoethyl) morpholine, N-(2-hydroxyethyl) morpholine, etc.; phosphates, including the alkali metal phosphates, dibutyl amine phosphates, the dialkyl acid o-phosphates and amine salts thereof; triazoles including benzotriazole, 1,2-naphthotriazole, 4-nitrobenzotriazole, tolutriazole, aminobenzotriazoles such as 5-acylaminobenzotriazole, and alkyl triazoles having one to 10 carbon atoms in the alkyl group as exemplified by methyl triazole, ethyl triazole, n-propyl triazole, tertiary butyl triazole, hexyl triazole, isodecyl triazole, etc. Other useful corrosion inhibitors include adenine, 4-methylimidazole, 3,5-dimethyl pyrazole, 6-nitroidazole, imidazole, benzimidazole, quaninie, indazole, ammonium dinonylnaphthaline sulfonate, dioleyl thiodipropionate, ethylbenzoate, ethyl-p-aminobenzoate, cyclohexyl ammonium nitrite, diisopropyl ammonium nitrite, butynediol, glycerin, 1,3,5-trimethyl-2,4,6-tris (3,5-di-tert. butyl-4-hydroxybenzoyl), 4,4′-methylene bis(2,6-di tert. butylphenol), 4-hydroxymethyl-2,6-di-tert. butylphenol, 4,4′-methylene bis (4-methyl-6-tert. butylphenol), salicylal-o-aminophenol, 2,6-di-tert. butyl-2-dimethylamino-p-cresol, 4,4′-thio bis-(6-tert. butyl-o-cresol). Mixtures of the above-mentioned inhibitors can be employed if desired.

An antioxidant may be used as an additive in the hydraulic fluid compositions of this invention if desired. Generally the amount of antioxidant used will vary from 0 to about 2 percent and preferably will be from about 0.001 to about 1.0 percent by weight based on the total weight of the fluid composition. Typical antioxidants include phenolic compounds, such as 2,2-di-(4-hydroxyphenyl) propane, phenothiazine, phenothiazine carboxylic acid esters, N-alkyl or N-arylphenothiazines, such as N-ethyl phenothiazine, N-phenyl phenothiazine, etc.; polymerized trimethyldihydroquinoline; amines, such as phenyl-alpha-naphthylamine, phenyl-beta-naphthylamine, dioctyl diphenylamine, N,N-di-β-naphthyl-p-phenylene diamine, p-isopropoxy diphenylamine, N,N-dibutyl-p-phenylene diamine, diphenyl-p-phenylene diamine, N,N′-bis(1,4-dimethylpentyl)-p-phenylene diamine, N,N′-diisopropyl-p-phenylene diamine, p-hydroxydiphenylamine, etc.; hindered phenols such as dibutyl cresol, 2,6-dimethyl-p-cresol, butylated 2,2-di-(4-hydroxyphenyl propane, n-butylated aminophenol, butylated hydroxyanisoles, such as 2,6dibutyl-p-hydroxyanisole; anthraquinone, dihydroxyanthraquinone, hydroquinone, 2,5-di-tertiarybutylhydroquinone, 2-tertiary butylhydroquinone, quinoline, p-hydroxydiphenylamine, phenyl benzoate, 2,6-dimethyl p-cresol, p-

hydroxyanisole, nordihydroquaiaretic acid, pyrocatechol, styrenated phenol, polyalkyl polyphenols, sodium nitrite, etc. Mixtures of the above-mentioned antioxidants can be employed, if desired. It should be emphasized that with a variety of the fluids of this invention, which are suitable for a wide range of industrial application, a separate antioxidant is not required.

The above-noted inhibitors and additives are merely exemplary and are not intended as an exclusive listing of the many well-know materials which can be added to hydraulic fluid compositions to obtain various desired properties. Numerous additives useful in hydraulic fluids are disclosed in Introduction to Hydraulic Fluids by Roger E. Hatton, Reinhold Publishing Corp., (1962).

Formulation of the novel fluid of this invention is accomplished by blending the components to a homogeneous stage in a mixing vessel. The preferable blending temperature is from about 50°–125°F. It is preferable to warm the solution during preparation to facilitate dissolution. The blending of the compounds is conveniently conducted at atmospheric pressure in the absence of moisture.

In general, any suitable method can be used in preparing the liquid compositions of this invention. The components can be added together or one at a time, in any desired sequence. It is preferable, however, to add the antioxidant and alkaline inhibitor as a solution in the glycol ether component. All components are mixed until a single phase composition is obtained.

The following examples which illustrate various embodiments of this invention are to be considered not limitative.

EXAMPLE 1

A hydraulic fluid having the following composition was prepared:

	Percent by Weight
$[CH_3(OCH_2CH_2)_2O]_3$-B	67.39
Triethylene glycol monomethyl ether	23.20
Diethanolamine	1.78
Polyethylene glycol (Mol. wt. 300)	7.62
Sodium Nitrite	0.01
Total	100.00

The fluid composition of this example was tested according to the procedures set forth in Hydraulic Brake Fluid — SAE Standard J70c for heavy duty types 70R1 and 70R3 hydraulic brake fluid. Pertinent data relating to these tests, which illustrates the outstanding properties of this novel fluid, is shown in Table 1. The fluid of Example 1 was found to satisfy completely the requirements for SAE heavy duty type 70R3 hydraulic brake fluid. Table 2 illustrates the effect of added water on the hydraulic fluid of Example 1 and compares it with the effect of water on a conventional or commercially available fluid.

TABLE 1.—PROPERTIES OF WATER INSENSITIVE BRAKE FLUID OF EXAMPLE 1

(Tests conducted according to procedures set forth in Society of Automotive Engineers Standard J70c)

Test	SAE 70R3 specification	Test results water insensitive fluid of Example 1
Boiling point (min.)	374° F	497° F.
Flash point (min.)	179.6° F	330° F.
Viscosity:		
−40° F. (max.)	1,800 cs	1,790 cs.
122° F. (min.)	4.2 cs	7.34 cs.
212° F. (min.)	1.5 cs	2.71 cs.
pH	7–11.5	7.70.
Stability at high temperature:		
Boiling point (min.)	374° F	495° F.
Boiling point change (max.)	±9.0° F	−2° F.
Corrosion test (wt. change mg./sq. cm.):		
Copper	0.4	−0.18.
Brass	0.4	−0.14.
Cast iron	0.2	+0.01.
Aluminum alloy	0.1	0.00.
Steel	0.2	0.00.
Tinned iron	0.2	0.00.
Sedimentation, percent by vol. (max.)	0.10 percent	<0.01 percent.
Gelling fluid/water mixture	None	None.
Crystalline deposit jar walls or strips	do	Do.
pH fluid/water mixture	7–11.5	7.50.
Rubber cups:		
Swelling (max.)	0.055″	0.007″.
Softening (max.)	−15°	−3°.
Fluidity and appearance:		
(Cold test) −40° F. six days:		
Black contrast lines, HP chart	Clearly discernible	Clear.
Stratification-sedimentation	None	None.
Air bubble travel time (max.)	10 sec	2 sec.
−58° F., six hours:		
Black contrast lines, HP chart	Clearly discernible	Clear.
Stratification-sedimentation	None	None.
Air bubble travel time (max.)	35 sec	5 sec.
Evaporation test:		
Percent loss (max.)	80 percent	69 percent.
Gritty or abrasive reside	None	None.
Pour point (max.)	23° F	23° F.
Water tolerance:		
−40° F., 24 hours:		
Black contrast lines, HP chart	Clearly discernible	Clear.
Stratification-sedimentation	None	None.
Air bubble travel time (max.)	10 sec	3 sec.
140° F., 24 hours:		
Stratification	None	None.
Sedimentation, percent by vol. (max.)	0.05 percent	0.01 percent.

Table I—Continued

Test	SAE 70R3 specification	Test results water insensitive fluid of Example 1
Compatibility:		
—40° F., 24 hours:		
Black contrast lines, HP chart	Clearly discernible	Clear.
Stratification-sedimentation	None	None.
140° F., 24 hours:		
Stratification	None	Do.
Sedimentation, percent by vol. (max.)	0.05 percent	0.01 percent.
Resistance to oxidation (peroxide test):		
Pitting of metal strips:		
Aluminum	None	None.
Cast iron	do	Do.
Weight loss in mg./sq. cm.:		
Aluminum alloy (max.)	0.05	0.00.
Cast iron (max.)	0.30	+0.01.
Effect on rubber —158° F.:		
Hardness decrease:		
Natural (max.)	10°	2°.
SBR (max.)	10°	3°.
Base diameter increase:		
Natural	0.006"-0.055"	0.013".
SBR	0.006"-0.055"	0.019".

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Disintegration rubber cups	None	None.
Effect on SBR rubber —248° F.:		
Hardness decrease (max.)	15°	4°.
Base diameter increase	0.006"-0.055"	0.033".
Disintegration rubber cups	None	None.
Specific gravity 60/60° F		1.085.
Pounds per gallon 60° F		
Color		Straw.
Simulated Service Performance Procedure No. 2 (85,000 strokes; 248° F./1,000 p.s.i.)		
Corrosion of metal parts as evidenced by discernible pitting	None	None.
Change in initial diameter of any cylinder or piston (max.)	0.005"	Do.
Lip diameter interference set of rubber cups:		
Wheel cylinder cups (max.)	65 percent	7.2 percent.
Master cylinder cups:		
Primary (max.)	do	15.4 percent.
Secondary (max.)	do	0.0 percent.
Hardness decrease of rubber cups:		
Wheel cylinder cups (max.)	15°	4°.
Master cylinder cups:		
Primary (max.)	15°	6°.
Secondary (max.)	15°	5°.
Operating condition of rubber cups as evidence by excessive tackiness, scoring, scuffing, blistering, cracking, chipping, or change in shape.	Satisfactory	Satisfactory.
Fluid loss during any 24,000 stroke period (max.)	36 ml	7 ml.
Freezing or malfunction of cylinder pistons	None	None.
Gum deposited on metal parts of cylinder walls that are abrasive or cannot be removed with ethanol	Trace	Do.
Deposits formed or adhering to cylinder walls that are abrasive or cannot be removed with ethanol	None	Do.
Fluid loss during 100 strokes at end of test (max.)	36 ml	5 ml.
Condition of fluid and brake cylinders by evidence of sludging, gelling or grittiness likely to cause improper brake action.	None	None.
Percent sediment in fluid drained from wheel cylinders 72 hours equilibrium (max.)	1.5 percent	0.05 percent.
Percent sediment in fluid drained from master cylinder 72 hours equilibrium (max.)	do	Do.
Decrease in base diam. of rubber cups:		
Wheel cylinder cups (max.)	0.035"	0.020 percent.
Master cylinder cups:		
Primary (max.)	0.035"	0.025 percent.
Secondary (max.)	0.035"	0.035 percent.

TABLE 2.—EFFECT OF ADDED WATER ON BOILING POINT OF HYDRAULIC FLUID OF EXAMPLE 1

Water	Reflux boiling point, ° F.	
	Conventional fluid A	Low water sensitive fluid of Example 1
0.0 percent by vol. (dry)	484	497
1.0	380	450
3.38*	294	373

*3.5 ml. H_2O/100 ml. fluid.

The composition of Conventional Fluid A was as follows:

	Weight percent
A 50-50 weight percent ethylene oxide-propylene oxide random addition reaction product with butyl alcohol (avg. mol. wt. 1,000)	20.0
Triethylene glycol monomethyl ether	19.0
Triethylene glycol monoethyl ether	40.2
Triethylene glycol monobutyl ether	19.0
Ethylene glycol	1.5
Diphenylol propane	0.1
Condensate of 7 moles of ethylene glycol with 1 mole of potassium tetraborane	0.2
Total	100.0

EXAMPLE 2

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	89.48
Triethylene glycol monomethyl ether	6.68
Polyethylene glycol (Mol. wt. 300)	1.83
Methyldiethanolamine	1.99
Sodium Nitrite	0.02
Total	100.00

The reflux boiling point (dry)[1] of the above fluid was measured and found to be 552°F. at atmospheric pressure. To test the low water sensitivity of the fluid composition of Example 2 a composition consisting of 100 parts by volume of the fluid plus 3.5 parts by volume of water was prepared and it was found to have a reflux boiling point (wet) at atmospheric pressure of 402°F. indicating that the fluid has an exceptional low water sensitivity. For example, when a conventional brake fluid which boils above 550°F. is tested in the same manner, the reflux boiling point drop is about 250°F. or more.

The fluid composition of this example was also tested according to the procedures of SAE Standard J70c for water tolerance and evaporation and was found to pass both of these tests. [1] - All reflux boiling point measurements in this example and in the other examples of this specification were conducted in accordance with the procedure of SAE Standard J70c.

EXAMPLE 3

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	66.0
Triethylene glycol monomethyl ether	21.9
N-ethyl morpholine	4.4
Polyethylene glycol (Mol. wt. 300)	7.7
Total	100.0

The reflux boiling point (dry) of this fluid was measured and found to be 440°F. at atmospheric pressure. On addition of 3.5 parts by volume of water to 100 parts by volume of the fluid there was obtained a fluid having a reflux boiling point (wet) at atmospheric pressure of 353°F. When tested according to the procedure of SAE Standard J70c, this fluid passed the evaporation requirement for SAE heavy duty type 70R3 brake fluid.

EXAMPLE 4

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	67.04
Triethylene glycol monomethyl ether	21.72
N-phenyl morpholine	1.89
Diethanolamine	0.85
Polyethylene glycol (Mol. wt. 300)	8.50
Total	100.00

Properties:

Reflux boiling point (dry) at atmospheric pressure 498°F.

Reflux boiling point (wet) at atmospheric pressure of 3.5 parts by volume of water and 100 parts by volume of fluid of Example 4 367°F.

EXAMPLE 5

	Percent by Weight
$[C_4H_9(OCH_2CH_2)_2O]_3$-B	44.68
$[CH_3(OCH_2CH_2)_3O]_3$-B	31.63
Diethylene glycol monobutyl ether	3.81
Triethylene glycol monomethyl ether	11.05
Diethanolamine	1.83
Polyethylene glycol (Mol. wt. 300)	6.98
Sodium nitrite	0.02
Total	100.00

Properties:

Reflux boiling point (dry) at atmospheric pressure 510°F.

Reflux boiling point (wet) at atmospheric pressure of 3.5 parts by volume of water and 100 parts by volume of fluid of Example 5 372°F.

Viscosity

−40°F. = 1620 cs.

212°F. = 2.74 cs.

Water Tolerance Test

Passed water tolerance test at −40°F. and 140°F. according to procedure of SAE J70c.

EXAMPLE 6

	Percent by Weight
$[C_2H_5(OCH_2CH_2)_3O]_3$-B	82.78
Triethylene glycol monoethyl ether	10.00
Methyldiethanolamine	2.20
Polyethylene glycol (Mol. wt. 300)	5.00
Sodium nitrite	0.02
Total	100.00

Properties:

Reflux boiling point (dry) at atmospheric pressure 554°F.

Reflux boiling point (wet) at atmospheric pressure of 3.5 parts by volume of water and 100 parts by volume of fluid of Example 6 383°F.

Viscosity

−40°F. = 1910 cs.

212°F. = 2.82 cs.

Water Tolerance Test

Passed −40°F. and 140°F. water tolerance test according to procedure of SAE J70c.

EXAMPLE 7

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	70.13
Triethylene glycol monomethyl ether	20.00
Diethanolamine	1.86
Triethylene glycol (Mol. wt. 150)	8.00
Sodium nitrite	0.01
Total	100.00

Properties:

Reflux boiling point (dry) at atmospheric pressure 500°F.

Reflux boiling point (wet) atmospheric pressure of 3.5 parts by volume of water and 100 parts by volume of fluid of Example 7 381°F.

Viscosity

−40°F. = 2050 cs.

212°F. = 2.80 cs.

Corrosion Test

Passed corrosion test according to procedure of SAE J70c.

Water Tolerance Test

Passed water tolerance test at −40°F. and 140°F. according to procedure of SAE J70c.

EXAMPLE 8

	Percent by Weight
$[C_4H_9(OCH_2CH_2)_3O]_3$-B	28.29
$[CH_3(OCH_2CH_2)_3O]_3$-B	55.58
Triethylene glycol monomethyl ether	8.05
Polyethylene glycol (Mol. wt. 300)	6.11
Methyldiethanolamine	1.94
Sodium nitrite	0.03
Total	100.00

Properties:

Reflux boiling point (dry) at atmospheric pressure 562°F.

Reflux boiling point (wet) at atmospheric pressure of 3.5 parts by volume of water and 100 parts by volume of fluid of Example 8 400°F.

Viscosity

−40°F. = 2540 cs.

212°F. = 3.27 cs.

Water Tolerance Test

Passed water tolerance test at −40°F. and 140°F. according to procedure of SAE J70c.

EXAMPLE 9

	Percent by Weight
Borate Ester D (Described below)	80.46
Triethylene glycol monobutyl ether	11.40
Diethanolamine	2.04
Polyethylene glycol (Mol. wt. 300)	6.08
Sodium nitrite	0.02
Total	100.00

Properties:

Reflux boiling point (dry) at atmospheric pressure 500°F.

Reflux boiling point (wet) at atmospheric pressure of 3.5 parts by volume of water and 100 parts by volume of fluid of Example 9 385°F.

Viscosity

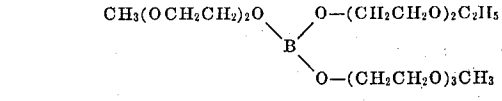
40°F. = 1470 cs.

212°F. = 2.64 cs.

Water Tolerance Test

Passed water tolerance test at −40°F. and 140°F. according to procedure of SAE J70*c*.

Borate Ester D employed in the above fluid, which is an example of a Type IV ester, was prepared in the following manner: One mole (61.8 grams) of orthoboric acid was added to a solution of one mole (164 grams) of triethylene glycol monomethyl ether and 50 ml. of toluene. The mixture was heated to the boiling point and one mole (18 ml.) of water was removed as the azeotrope with toluene. The solution was cooled slightly below the boiling point and one mole (134 grams) of diethylene glycol monoethyl ether was added. Heating was resumed until another mole (18 ml.) of water was removed from the reaction mixture. Again the solution was cooled below the boiling point and one mole (120 grams) of diethylene glycol monomethyl ether was added. The solution was heated to boiling and a third mole (18 ml.) of water was removed following which the toluene remaining in the reaction mixture was removed to yield a tri borate ester of the formula:



The reflux boiling pint (dry) of the ester was 610°F. at atmospheric pressure and it exhibited a viscosity of 775 cs. at −40°F.

	Percent B
Analysis:	
Calculated:	2.58
Found:	2.83

EXAMPLE 10

	Percent by Weight
Borate Ester E (Described below)	29.18
$[CH_3(OCH_2CH_2)_3O]_3$-B	55.48
Triethylene glycol monomethyl ether	11.90
Diethanolamine	0.91
Polyethylene glycol (Mol. wt. 300)	2.52
Sodium nitrite	0.01
Total	100.00

Properties:

Reflux boiling point (dry) at atmospheric pressure 555°F.

Reflux boiling point (wet) at atmospheric pressure of 3.5 parts by volume of water and 100 parts by volume of fluid of Example 10 383°F.

Viscosity

−40°F. = 2380 cs.

212°F. = 3.38 cs.

Water Tolerance Test

Passed water tolerance test at −40°F. and 140°F. according to procedure of SAE J70*c*.

Borate Ester E employed in the above fluid composition, which is a Type III borate ester, was prepared as follows: One mole (354 grams) of a random addition product of ethylene oxide and propylene oxide with butyl alcohol, prepared by reaction a mixture containing 50 weight percent ethylene oxide and 50 weight percent propylene oxide with the alcohol, and 60 ml. of toluene were mixed with one-third mole (20 grams) of orthoboric acid. The mixture was heated to its boiling point and one mole (18 ml.) of water was removed as the azeotrope with toluene after which the toluene remaining in the reaction mixture was removed under vacuum. The resulting tris borate ester (Borate Ester E) was clear, water-white liquid having a reflux boiling point (dry) of approximately 625°- 30°F.

EXAMPLE 11

	Percent by Weight
$[C_2H_5(OCH_2CH_2)_3O]_3$-B	80.00
Triethylene glycol monoethyl ether	12.78
Methyldiethanolamine	2.20
Polyethylene glycol (Mol. wt. 300)	5.00
Diisopropyl ammonium nitrite	0.02
Total	100.00

EXAMPLE 12

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	70.30
Triethylene glycol monomethyl ether	19.95
Diethanolamine	1.85
Polyethylene glycol (Mol. wt. 300)	7.85
Di(2-ethylhexyl) ammonium nitrite	0.05
Total	100.00

EXAMPLE 13

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	66.00
Triethylene glycol monomethyl ether	25.90
Diethanolamine	1.85
Polyethylene glycol (Mol. wt. 300)	6.00
Benzotriazole	0.25
Total	100.00

EXAMPLE 14

	Percent by Weight
$[C_2H_5(OCH_2CH_2)_3O]_3$-B	80.00
Triethylene glycol monoethyl ether	15.0
Polyethylene glycol (Mol. wt. 300)	5.0
Total	100.00

EXAMPLE 15

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	67.40
Triethylene glycol monomethyl ether	25.81
Diethanolamine	1.78
Polyethylene glycol (Mol. wt. 300)	5.00
Sodium Nitrite	0.01
Total	100.00

EXAMPLE 16

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	75.00
Triethylene glycol monomethyl ether	6.20
Tetraethylene glycol monoethyl ether	17.00
Diethanolamine	1.68
Sodium Nitrite	0.02
Tolutriazole	0.10
Total	100.00

The fluid composition of Example 16 was tested according to the procedures set forth in Motor Vehicle Brake Fluid — SAE Standard J1703. Pertinent data which illustrates the outstanding properties of this fluid is shown below:

Properties of Water Insensitive Brake Fluid of Example 16

Test	SAE J 1702	Test Results
Reflux boiling point (dry)	374°F. min.	532°F.
Flash point	179.6°F. min.	320°F.
Viscosity at 212°F.	1.5 cs. min.	2.5 cs.
Viscosity at −40°F.	1800 cs. max.	1530 cs.
pH	7.0 to 11.5	7.5
Evaporation loss	80 percent max.	62 percent

EXAMPLE 17

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	70.00
Tetraethylene glycol monoethyl ether	21.00
Triethylene glycol monomethyl ether	7.20
Diethanolamine	1.68
Tolutriazole	0.10
Sodium Nitrite	0.02
Total	100.00

Reflux boiling point (dry) at atmospheric pressure 528°F.

Viscosity at −40°F. 1447 cs.

pH 7.3

EXAMPLE 18

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	70.00
Tetraethylene glycol monoethyl ether	25.00
Triethylene glycol monomethyl ether	3.20
Diethanolamine	1.68
Tolutriazole	0.10
Sodium Nitrite	0.02
Total	100.00

Reflux boiling point (dry) at atmospheric pressure 528°F.

Viscosity at −40°F. 1552 cs.

pH 7.35

EXAMPLE 19

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	66.00
Tetraethylene glycol monoethyl ether	29.00
Triethylene glycol monomethyl ether	3.20
Diethanolamine	1.68
Tolutriazole	0.10
Sodium Nitrite	0.02
Total	100.00

Reflux boiling point (dry) at atmospheric pressure 526°F.

Viscosity at −40°F. 1501 cs.

pH 7.5

EXAMPLE 20

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	75.00
Tetraethylene glycol monoethyl ether	23.20
Diethanolamine	1.68
Tolutriazole	0.10
Sodium Nitrite 0.02	
Total	100.00

Reflux boiling point (dry) at atmospheric pressure 535°F.

Viscosity at −40°F. 1663

EXAMPLE 21

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	75.00
Triethylene glycol monomethyl ether	11.25
Tetraethylene glycol monomethyl ether	12.00
Diethyl amino ethoxyethanol	1.75
	100.00

EXAMPLE 22

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	70.00
Triethylene glycol monomethyl ether	13.25
Tetraethylene glycol monomethyl ether	15.00
Methyl diethanolamine	1.75
Total	100.00

EXAMPLE 23

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	72.00
Triethylene glycol monoethyl ether	16.25
Tetraethylene glycol monoethyl ether	10.00
Hydroxyethyl hydrazine	1.75
Total	100.00

EXAMPLE 24

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	66.00
Triethylene glycol monoethyl ether	5.00
Triethylene glycol monomethyl ether	17.00
Tetraethylene glycol monomethyl ether	10.00
Diethyl amino ethanol	2.00
Total	100.00

EXAMPLE 25

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	73.00
Diethylene glycol monoethyl ether	5.00
Triethylene glycol monomethyl ether	10.00
Tetraethylene glycol monomethyl ether	10.00
Dimethyl amino ethoxyethanol	2.00
Total	100.00

EXAMPLE 26

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	73.20
Triethylene glycol monomethyl ether	10.00
Tetraethylene glycol monomethyl ether	15.00
Diethanolamine	1.78
Sodium Nitrite	0.02
Total	100.00

EXAMPLE 27

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	75.00
Triethylene glycol monomethyl ether	6.00
Triethylene glycol monoethyl ether	7.00
Tetraethylene glycol monoethyl ether	10.00
Hydroxyethyl hydrazine	1.90
Tolutriazole	0.10
Total	100.00

EXAMPLE 28

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	71.00
Triethylene glycol monomethyl ether	18.00
Tetraethylene glycol monomethyl ether	9.00
Diethanolamine	1.93
Sodium Nitrite	0.02
Benzotriazole	0.05
Total	100.00

EXAMPLE 29

	Percent by Weight

$[C_3H_7(OCH_2CH_2)_3O]_3$-B	75.00
Triethylene glycol monomethyl ether	6.00
Triethylene glycol monoethyl ether	7.00
Tetraethylene glycol monoethyl ether	10.00
Hydroxyethyl hydrazine	1.90
Tolutriazole	0.10
Total	100.00

EXAMPLE 30

	Percent by Weight
$[C_2H_5(OCH_2CH_2)_3O]_3$-B	75.00
Triethylene glycol monomethyl ether	6.00
Triethylene glycol monoethyl ether	7.00
Tetraethylene glycol monoethyl ether	10.00
Hydroxyethyl hydrazine	1.90
Tolutriazole	0.10
Total	100.00

EXAMPLE 31

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	65.0
Tripropylene glycol dimethyl ether	22.9
N-ethyl morpholine	4.4
Polyethylene glycol (Mol. wt. 250)	7.7
Total	100.0

EXAMPLE 32

	Percent by Weight
$[C_2H_5(OCH_2CH_2)_3O]_3$-B	51.0
$[C_2H_5(OCH_2CH_2)_4O]_3$-B	18.2
Triethylene glycol monoethyl ether	14.35
Triethylene glycol monomethyl ether	10.0
Mixed isopropanolamines (10–15% mono, 40–50% di, 40–50% tri)	3.0
Glycerin	2.0
Butynediol	0.5
Dioctyl diphenylamine	0.1
Sodium nitrite	0.05
Total	100.00

Properties:

Reflux boiling point (dry)	493°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	343°F.
Viscosity at −40°F.	1961 cs.

EXAMPLE 33

	Percent by Weight
$[C_2H_5(OCH_2CH_2)_3O]_3$-B	51.8
$[C_2H_5(OCH_2CH_2)_4O]_3$-B	18.2
Triethylene glycol monoethyl ether	14.35
Diethylene glycol monomethyl ether	10.0
Mixed isopropanolamines (10-15% mono, 40-50% di, 40-50% tri)	3.0
Glycerin	2.0
Butynediol	0.5
Dioctyl diphenylamine	0.1
Sodium nitrite	0.05
Total	100.00

Properties:

Reflux boiling point (dry)	466°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	342°F.
Viscosity at −40°F.	1542 cs.

EXAMPLE 34

	Percent by Weight
$[C_2H_5(OCH_2CH_2)_3O]_3$-B	51.8
$[C_2H_5(OCH_2CH_2)_4O]_3$-B	18.2
Triethylene glycol monoethyl ether	14.35
Diethylene glycol monoethyl ether	10.0
Mixed isopropanolamines (10–15% mono, 40–50% di, 40–50% tri)	3.0
Glycerin	2.0
Butynediol	0.5
Dioctyl diphenylamine	0.1
Sodium nitrite	0.05
	100.00

Properties:

Reflux boiling point (dry)	472°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	340°F.
Viscosity at −40°F.	1684 cs.

EXAMPLE 35

	Percent by Weight
$[C_2H_5(OCH_2CH_2)_3O]_3$-B	44.4
$[C_2H_5(OCH_2CH_2)_4O]_3$-B	15.6
Triethylene glycol monoethyl ether	24.35
Triethylene glycol monomethyl ether	10.0
Mixed isopropanolamines (10–15% mono, 40–50% di, 40–50% tri)	3.0
Glycerin	2.0
Butynediol	0.5
Dioctyl diphenylamine	0.1
Sodium nitrite	0.05
Total	100.00

Properties:

Reflux boiling point (dry)	480°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	334°F.
Viscosity at −40°F.	1585 cs.

EXAMPLE 36

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	40.0
Tetraethylene glycol monoethyl ether	9.4
Triethylene glycol monomethyl ether	50.01
Monoethanolamine	0.5
Benzotriazole	0.03
Diisopropanolamine nitrite	0.06
Total	100.00

Properties:

Reflux boiling point (dry)	470°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	340°F.
Viscosity at −40°F.	584 cs.

EXAMPLE 37

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	30.0
Tetraethylene glycol monoethyl ether	7.0
Triethylene glycol monomethyl ether	62.56
Monoethanolamine	0.38
Benzotriazole	0.02
Diisopropanolamine nitrite	0.04
Total	100.00

Properties:

Reflux boiling point (dry)	467°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	332°F.
Viscosity at −40°F.	456 cs.

EXAMPLE 38

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	20.00
Tetraethylene glycol monoethyl ether	4.70
Triethylene glycol monomethyl ether	75.01
Monoethanolamine	0.25
Benzotriazole	0.01
Diisopropanolamine nitrite	0.03
Total	100.00

Properties:

Reflux boiling point (dry)	464°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	323°F.
Viscosity at −40°F.	373 cs.

EXAMPLE 39

	Percent by Weight
$[C_2H_5(OCH_2CH_2)_3O]_3$-B	51.8
$[C_2H_5(OCH_2CH_2)_4O]_3$-B	18.2
$[C_2H_5(OCH_2CH_2)_2O]_3$-B	24.35
Mixed isopropanolamine (10–15% mono, 40–50% di, 40–50% tri)	3.0
Glycerin	2.0
Butynediol	0.5
Dioctyl diphenylamine(Van Lube 81 produced by R.T.Vanderbilt Co.)	0.1
Sodium nitrite	0.05
Total	100.00

Properties:

Reflux boiling point (dry)	506°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	373°F.
Viscosity at −40°F.	2453 cs.

EXAMPLE 40

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	54.5
Triethylene Glycol monomethyl ether	36.09
Diethanolamine	1.78
Polyethylene glycol (M.W. 300)	7.62
Sodium nitrite	0.01
Total	100.00

Properties:

Reflux boiling point (dry)	479°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	350°F.

EXAMPLE 41

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	50.00
Triethylene glycol monomethyl ether	40.59
Diethanolamine	1.78
Polyethylene glycol (M.W. 300)	7.62
Sodium nitrite	0.01
Total	100.00

Properties:

Reflux boiling point (dry)	473°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	347°F.

EXAMPLE 42

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	40.00
Triethylene glycol monomethyl ether	50.59
Diethanolamine	1.78
Polyethylene glycol (M.W. 300)	7.62
Sodium nitrite	0.01
Total	100.00

Properties:

Reflux boiling point (dry)	463°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	336°F.

EXAMPLE 43

A hydraulic fluid having the following composition was prepared:

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	79.0
Isoctanol	20.0
Monoethanolamine	1.0
Total	100.0

Properties:

Reflux boiling point (dry)	463°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	310°F.
Viscosity at −40°F.	816 cs.

EXAMPLE 44

A hydraulic fluid having the following composition was prepared:

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	79.0
Hexylene glycol	20.0
Monoethanolamine	1.0
Total	100.0

Properties:

Reflux boiling point (dry)	489°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	343°F.
Viscosity at −40°F.	982 cs.

EXAMPLE 45

A hydraulic fluid having the following composition was prepared:

	Percent by Weight
$[CH_3(OCH_2CH_2)_3O]_3$-B	89.0
Diethylene glycol	10.0
Monoethanolamine	1.0
Total	100.0

Properties:

Reflux boiling point (dry)	522°F.
Reflux boiling point (wet) (3.5 ml. water + 100 ml. fluid)	392°F.
Viscosity at −40°F.	3050 cs.

What is claimed is:

1. A hydraulic fluid composition consisting essentially of (A) from about 20 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid composition of at least one base fluid or lubricant selected from the group consisting of (a) a borate ester of the formula:

$$[R_1(O—R_a)_y—O]_3—B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_a is alkylene of from two to four carbon atoms and y is an integer of from two to four; (b) a borate ester of the formula:

$$[R_1—(OCH_2CHR_2)_m—(OCH_2CHR_3)_nO]_3—B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_2 and R_3 are independently selected from the group consisting of hydrogen and methyl, m and n are positive integers whose sum is from 2 to 20, and with the proviso that one of R_2 and R_3 is methyl and one of R_2 and R_3 is hydrogen; (c) a borate ester of the formula:

$$(R_1[Rg]O)_3—B,$$

wherein R_1 is alkyl of from one to four carbon atoms, Rg is a heteric oxyalkylene chain of the formula:

$[-(OCH_2CH_2)_r, (OCH_2CHCH_3)_s-]$,

wherein the sum of r and s is not more than 20 and wherein the weight percent of the oxyethylene units is not less than 20 based on the total weight of all the oxyalkylene units; and (d) a borate ester of the formula:

$$B-O(R_4CHCH_2O)_n-(R_5CHCH_2O)_mT_1$$
$$B-O(R_6CHCH_2O)_n-(R_7CHCH_2O)_mT_2$$
$$B-O(R_8CHCH_2O)_n-(R_9CHCH_2O)_mT_3$$

wherein T_1, T_2 and T_3 are each an independently selected alkyl group having from one to four carbon atoms; R_4, R_5, R_6, R_7, R_8 and R_9 are independently selected from the group consisting of hydrogen and methyl, n and m are positive integers independently selected in each chain and whose sum in each chain is from 2 to 20, and with the proviso that in no more than two of the chains is the sum of n and m the same; and the remainder of the hydraulic fluid composition comprising: (B) from 0 to about 80 percent by weight, based on the total weight of the fluid composition, of at least one diluent selected from the group consisting of: (i) glycol ethers having the formula:

$$R[O-R'']_yOR',$$

wherein R is alkyl of from one to four carbon atoms, R' is selected from the group consisting of hydrogen and alkyl of from one to four carbon atoms, R'' is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (ii) glycols and polyglycols having a molecular weight of from about 60 to about 450 and (iii) aliphatic saturated, monohydric alcohols having from six to 13 carbon atoms.

2. A hydraulic fluid composition consisting essentially of (A) from about 20 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid composition of at least one base fluid or lubricant selected from the group consisting of (a) a borate ester of the formula:

$$[R_1(O-R_a)_y-O]_3-B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_a is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (b) a borate ester of the formula:

$$[R_1-(OCH_2CHR_2)_m-(OCH_2CHR_3)_nO]_3-B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_2 and R_3 are independently selected from the group consisting of hydrogen and methyl, m and n are positive integers whose sum is from 2 to 20, and with the proviso that one of R_2 and R_3 is methyl and one of R_2 and R_3 is hydrogen; (c) a borate ester of the formula:

$$(R_1[Rg]O)_3-B,$$

wherein R_1 is alkyl of from one to four carbon atoms, Rg is a heteric oxyalkylene chain of the formula:

$$[-(OCH_2CH_2)_r, (OCH_2CHCH_3)_s-],$$

wherein the sum of r and s is not more than 20 and wherein the weight percent of the oxyethylene units is not less than 20 based on the total weight of all the oxyalkylene units; and (d) a borate ester of the formula:

$$B-O(R_4CHCH_2O)_n-(R_5CHCH_2O)_mT_1$$
$$B-O(R_6CHCH_2O)_n-(R_7CHCH_2O)_mT_2$$
$$B-O(R_8CHCH_2O)_n-(R_9CHCH_2O)_mT_3$$

wherein T_1, T_2 and T_3 are each an independently selected alkyl group having from one to four carbon atoms; R_4, R_5, R_6, R_7, R_8 and R_9 are independently selected from the group consisting of hydrogen and methyl, n and m are positive integers independently selected in each chain and whose sum in each chain is from 2 to 20, and with the proviso that in no more than two of the chains is the sum of n and m the same; and the remainder of the hydraulic fluid composition comprising: (B) from 0 to about 80 percent by weight, based on the total weight of the fluid composition, of at least one diluent selected from the group consisting of: (i) glycol ethers having the formula:

$$R[O-R'']_yOR',$$

wherein R is alkyl of from one to four carbon atoms, R' is selected from the group consisting of hydrogen and alkyl of from one to four carbon atoms, R'' is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (ii) glycols and polyglycols having a molecular weight of from about 60 to about 450 and (iii) aliphatic saturated, monohydric alcohols having from six to 13 carbon atoms and (C) from 0 to about 10.0 percent by weight, based on the total weight of the hydraulic fluid, of at least one inhibitor for pH and corrosion control.

3. A hydraulic fluid composition consisting essentially of (A) from about 20 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid composition of at least one base fluid or lubricant selected from the group consisting of (a) a borate ester of the formula:

$$[R_1)O-R_a)_y-O]_3-B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_a is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (b) a borate ester of the formula:

$$[R_1-(OCH_2CHR_2)_m-(OCH_2CHR_3)_nO]_3-B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_2 and R_3 are independently selected from the group consisting of hydrogen and methyl, m and n are positive integers whose sum is from 2 to 20, and with the proviso that one of R_2 and R_3 is methyl and one of R_2 and R_3 is hydrogen; (c) a borate ester of the formula:
$(R_1[Rg]biO)_3-B,$
wherein R_1 is alkyl of from one to four carbon atoms, Rg is a heteric oxyalkylene chain of the formula:

$$[-(OCH_2CH_2)_r, (OCH_2CHCH_3)_s-],$$

wherein the sum of r and s is not more than 20 and wherein the weight percent of the oxyethylene units in not less than 20 based on the total weight of all the oxyalkylene units; and (d) a borate ester of the formula:

$$B-O(R_4CHCH_2O)_n-(R_5CHCH_2O)_mT_1$$
$$B-O(R_6CHCH_2O)_n-(R_7CHCH_2O)_mT_2$$
$$B-O(R_8CHCH_2O)_n-(R_9CHCH_2O)_mT_3$$

wherein T_1, T_2 and T_3 are each an independently selected alkyl group having from one to four carbon atoms; R_4, R_5, R_6, R_7, R_8 and R_9 are independently selected from the group consisting of hydrogen and methyl, n and m are positive integers independently selected in each chain and whose sum in each chain is from 2 to 20, and with the proviso that in no more than

two of the chains is the sum of *n* and *m* the same; and the remainder of the hydraulic fluid composition comprising: (B) from 0 to about 80 percent by weight, based on the total weight of the fluid composition, of at least one diluent selected from the group consisting of: (i) glycol ethers having the formula:

$$R[O\text{-}R'']_yOR',$$

wherein R is alkyl of from one to four carbon atoms, R' is selected from the group consisting of hydrogen and alkyl of from one to four carbon atoms, R'' is alkylene of from 2 to 4 carbon atoms and *y* is an integer of from 2 to 4; (ii) glycols and polyglycols having a molecular weight of from about 60 to about 450 and (iii) aliphatic saturated, monohydric alcohols having from six to 13 carbon atoms and (C) from 0 to about 10.0 percent by weight, based on the total weight of the hydraulic fluid, of at least one antioxidant.

4. A hydraulic fluid composition consisting essentially of (A) from about 20 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid composition of at least one base fluid or lubricant selected from the group consisting of (a) a borate ester of the formula:

$$[R_1(O\text{—}R_a)_y\text{—}O]_3\text{—}B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_a is alkylene of from two to four carbon atoms and *y* is an integer of from 2 to 4; (b) a borate ester of the formula:

$$[R_1\text{—}(OCH_2CHR_2)_m\text{—}(OCH_2CHR_3)_nO]_3\text{—}B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_2 and R_3 are independently selected from the group consisting of hydrogen and methyl, *m* and *n* are positive integers whose sum is from 2 to 20, and with the proviso that one of R_2 and R_3 is methyl and one of R_2 and R_3 is hydrogen; (c) a borate ester of the formula:

$$(R_1[Rg]O)_3\text{-}B,$$

wherein R_1 is alkyl of from one to four carbon atoms, Rg is a heteric oxyalkylene chain of the formula:

$$[-(OCH_2CH_2)_r,(OCH_2CHCH_3)_s-],$$

wherein the sum of *r* and *s* is not more than 20 and wherein the weight percent of the oxyethylene units is not less than 20 based on the total weight of all the oxyalkylene units; and (d) a borate ester of the formula:

$$\begin{array}{l} \diagup O(R_4CHCH_2O)_n\text{—}(R_5CHCH_2O)_mT_1 \\ B\text{—}O(R_6CHCH_2O)_n\text{—}(R_7CHCH_2O)_mT_2 \\ \diagdown O(R_8CHCH_2O)_n\text{—}(R_9CHCH_2O)_mT_3 \end{array}$$

wherein T_1, T_2 and T_3 are each an independently selected alkyl group having from one to four carbon atoms; R_4, R_5, R_6, R_7, R_8 and R_9 are independently selected from the group consisting of hydrogen and methyl, *n* and *m* are positive integers independently selected in each chain and whose sum in each chain is from 2 to 20, and with the proviso that in no mere than two of the chains is the sum of *n* and *m* the same; and the remainder of the hydraulic fluid composition comprising: (B) from 0 to about 80 percent by weight, based on the total weight of the fluid composition, of at least one diluent selected from the group consisting of: (i) glycol ethers having the formula:

$$R[O\text{—}R'']_yOR',$$

wherein R is alkyl of from one to four carbon atoms, R' is selected from the group consisting of hydrogen and alkyl of from one to four carbon atoms, R'' is alkylene of from two to four carbon atoms and *y* is an integer of from 2 to 4; (ii) glycols and polyglycols having a molecular weight of from about 60 to about 450 and (iii) aliphatic saturated, monohydric alcohols having from six to 13 carbon atoms and (C) from 0 to about 10.0 percent by weight, based on the total weight of the hydraulic fluid, of at least one rust inhibitor.

5. A hydraulic fluid composition consisting essentially of (A) from about 20 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid composition of at least one base fluid or lubricant selected from the group consisting of (a) a borate ester of the formula:

$$[R_1(O\text{—}R_a)_y\text{—}O]_3\text{—}B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_a is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (b) a borate ester of the formula:

$$[R_1\text{—}(OCH_2CHR_2)_m\text{—}(OCH_2CHR_3)_nO]_3\text{—}B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_2 and R_3 are independently selected from the group consisting of hydrogen and methyl, *m* and *n* are positive integers whose sum is from 2 to 20, and with the proviso that one of R_2 and R_3 is methyl and one of R_2 and R_3 is hydrogen; (c) a borate ester of the formula:

$$(R_1[Rg]O)_3\text{—}B,$$

wherein R_1 is alkyl of from one to four carbon atoms, Rg is a heteric oxyalkylene chain of the formula:

$$[-(OCH_2CH_2)_r,(OCH_2CHCH_3)_s-],$$

wherein the sum of *r* and *s* is not more than 20 and wherein the weight percent of the oxyethylene units is not less than 20 based on the total weight of all the oxyalkylene units; and (d) a borate ester of the formula:

$$\begin{array}{l} \diagup O(R_4CHCH_2O)_n\text{—}(R_5CHCH_2O)_mT_1 \\ B\text{—}O(R_6CHCH_2O)_n\text{—}(R_7CHCH_2O)_mT_2 \\ \diagdown O(R_8CHCH_2O)_n\text{—}(R_9CHCH_2O)_mT_3 \end{array}$$

wherein T_1, $T_2$and T_3 are each in independently selected alkyl group having from one to four carbon atoms; R_4, R_5, R_6, R_7 , R_8 and R_9 are independently selected from the group consisting of hydrogen and methyl, n and m are positive integers independently selected in each chain and whose sum in each chain is from 2 to 20, and with the proviso that in no more than two of the chains is the sum of *n* and *m* the same; and the remainder of the hydraulic fluid composition comprising: (B) from 0 to about 80 percent by weight, based on the total weight of the fluid composition, of at least one diluent selected from the group consisting of: (i) glycol ethers having the formula:

$$R[O\text{—}R'']_yOR',$$

wherein R is alkyl of from one to four carbon atoms, R' is selected from the group consisting of hydrogen and alkyl of from one to four carbon atoms, R'' is alkylene of from two to four carbon atoms and *y* is an integer of from 2 to 4; (ii) glycols and polyglycols having a molecular weight of from about 60 to about 450 and (iii) aliphatic saturated, monohydric alcohols having

from six to 13 carbon atoms and (C) from 0 to about 10.0 percent by weight, based on the total weight of the hydraulic fluid, of at least one viscosity index improver.

6. A hydraulic fluid composition consisting essentially of (A) from about 20 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid composition of at least one base fluid or lubricant selected from the group consisting of (a) a borate ester of the formula:

$$[R_1(O-R_a)_y-O]_3-B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_a is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (b) a borate ester of the formula:

$$[R_1-(OCH_2CHR_2)_m-(OCH_2CHR_3)_nO]_3-B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_2 and R_3 are independently selected from the group consisting of hydrogen and methyl, m and n are positive integers whose sum is from 2 to 20, and with the proviso that one of R_2 and R_3 is methyl and one of R_2 and R_3 is hydrogen; (c) a borate ester of the formula:

$$(R_1[Rg]O)_3-B,$$

wherein R_1 is alkyl of from one to four carbon atoms, Rg is a heteric oxyalkylene chain of the formula:

$$[-(OCH_2CH_2)_r,(OCH_2CHCH_3)_s-],$$

wherein the sum of r and s is not more than 20 and wherein the weight percent of the oxyethylene units is not less than 20 based on the total weight of all the oxyalkylene units; and (d) a borate ester of the formula:

$$\begin{array}{l} \diagup O(R_4CHCH_2O)_n-(R_5CHCH_2O)_mT_1 \\ B-O(R_6CHCH_2O)_n-(R_7CHCH_2O)_mT_2 \\ \diagdown O(R_8CHCH_2O)_n-(R_9CHCH_2O)_mT_3 \end{array}$$

wherein T_1, T_2 and T_3 are each an independently selected alkyl group having from one to four carbon atoms; R_4, R_5, R_6, R_7, R_8 and R_9 are independently selected from the group consisting of hydrogen and methyl, n and m are positive integers independently selected in each chain and whose sum in each chain is from 2 to 20, and with the proviso that in no more than two of the chains is the sum of n and m the same; and the remainder of the hydraulic fluid composition comprising: (B) from 0 to about 80 percent by weight, based on the total weight of the fluid composition, of at least one diluent selected from the group consisting of: (i) glycol ethers having the formula:

$$R[O\text{-}R'']_yOR',$$

wherein R is alkyl of from one to four carbon atoms, R' is selected from the group consisting of hydrogen and alkyl of from one to four carbon atoms, R'' is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (ii) glycols and polyglycols having a molecular weight of from about 60 to about 450 and (iii) aliphatic saturated, monohydric alcohols having from six to 13 carbon atoms and (C) from 0 to about 10.0 percent by weight, based on the total weight of the hydraulic fluid, of at least one pour point depressant.

7. A hydraulic fluid composition consisting essentially of (A) from about 20 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid composition of at least one base fluid or lubricant selected from the group consisting of (a) a borate ester of the formula:

$$[R_1(O-R_a)_y-O]_3-B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_a is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (b) a borate ester of the formula:

$$[R_1-(OCH_2CHR_2)_m-(OCH_2CHR_3)_nO]_3-B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_2 and R_3 are independently selected from the group consisting of hydrogen and methyl, m and n are positive integers whose sum is from 2 to 20, and with the proviso that one of R_2 and R_3 is methyl and one of R_2 and R_3 is hydrogen; (c) a borate ester of the formula:

$$(R_1[Rg]O)_3-B,$$

wherein R_1 is alkyl of from one to four carbon atoms, Rg is a heteric oxyalkylene chain of the formula:

$$[-(OCH_2CH_2)_r,(OCH_2CHCH_3)_s-],$$

wherein the sum of r and s is not more than 20 and wherein the weight percent of the oxyethylene units is not less than 20 based on the total weight of all the oxyalkylene units; and (d) a borate ester of the formula:

$$\begin{array}{l} \diagup O(R_4CHCH_2O)_n-(R_5CHCH_2O)_mT_1 \\ B-O(R_6CHCH_2O)_n-(R_7CHCH_2O)_mT_2 \\ \diagdown O(R_8CHCH_2O)_n-(R_9CHCH_2O)_mT_3 \end{array}$$

wherein T_1, T_2 and T_3 are each an independently selected alkyl group having from one to four carbon atoms; R_4, R_5, R_6, R_7, R_8 and R_9 are independently selected from the group consisting of hydrogen and methyl, n and m are positive integers independently selected in each chain and whose sum in each chain is from 2 to 20, and with the proviso that in no more than two of the chains is the sum of n and m the same; and the remainder of the hydraulic fluid composition comprising: (B) from 0 to about 80 percent by weight, based on the total weight of the fluid composition, of at least one diluent selected from the group consisting of: (i) glycol ethers having the formula:

$$R[O-R'']_yOR',$$

wherein R is alkyl of from one to four carbon atoms, R' is selected from the group consisting of hydrogen and alkyl of from one to four carbon atoms, R'' is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (ii) glycols and polyglycols having a molecular weight of from about 60 to about 450 and (iii) aliphatic saturated, monohydric alcohols having from six to 13 carbon atoms and (C) from 0 to about 10.0 percent by weight, based on the total weight of the hydraulic fluid, of at least one lubricity agent.

8. A hydraulic fluid composition consisting essentially of (A) from about 20 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid composition of at least one base fluid or lubricant

selected from the group consisting of (a) a borate ester of the formula:

$[R_1(O—R_a)_y—O]_3—B$, wherein R_1 is alkyl of from one to four carbon atoms, R_a is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (b) a borate ester of the formula:

$$[R_1—(OCH_2CHR_2)_m—(OCH_2CHR_3)_nO]_3—B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_2 and R_3 are independently selected from the group consisting of hydrogen and methyl, m and n are positive integers whose sum is from 2 to 20, and with the proviso that one of R_2 and R_3 is methyl and one of R_2 and R_3 is hydrogen; (c) a borate ester of the formula:

$$(R_1[Rg]O)_3—B,$$

wherein R_1 is alkyl of from one to four carbon atoms, Rg is a heteric oxyalkylene chain of the formula:

$[—(OCH_2CH_2)_r, (OCH_2CHCH_3)_s—]$, wherein the sum of r and s is not more than 20 and wherein the weight percent of the oxyethylene units is not less than 20 based on the total weight of all the oxyalkylene units; and (d) a borate ester of the formula:

$$\begin{array}{l} \diagup O(R_4CHCH_2O)_n—(R_5CHCH_2O)_mT_1 \\ B—O(R_6CHCH_2O)_n—(R_7CHCH_2O)_mT_2 \\ \diagdown O(R_8CHCH_2O)_n—(R_9CHCH_2O)_mT_3 \end{array}$$

wherein T_1, T_2 and T_3 are each an independently selected alkyl group having from one to four carbon atoms; R_4, R_5, R_6, R_7, R_8 and R_9 are independently selected from the group consisting of hydrogen and methyl, n and m are positive integers independently selected in each chain and whose sum in each chain is from 2 to 20, and with the proviso that in no more than two of the chains is the sum of n and m the same; and the remainder of the hydraulic fluid composition comprising: (B) from 0 to about 80 percent by weight, based on the total weight of the fluid composition, of at least one diluent selected from the group consisting of: (i) glycol ethers having the formula:

$$R[O—R'']_yOR',$$

wherein R is alkyl of from one to four carbon atoms, R' is selected from the group consisting of hydrogen and alkyl of from one to four carbon atoms, R'' is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (ii) glycols and polyglycols having a molecular weight of from about 60 to about 450 and (iii) aliphatic saturated, monohydric alcohols having from six to 13 carbon atoms and (C) from 0 to about 10.0 percent by weight, based on the total weight of the hydraulic fluid, of at least one dye.

9. The hydraulic fluid composition of claim **2** which contains from 0 to about 8.0 percent by weight of at least one said inhibitor for pH and corrosion control and from 0 to about 2.0 percent by weight of at least one antioxidant.

10. The hydraulic fluid composition of claim **2** wherein said base fluid or lubricant is at least one borate ester of type (a).

11. The hydraulic fluid composition of claim **10** wherein said diluent is of type (i).

12. The hydraulic fluid composition of claim **11** which contains from about 0.2 to about 6.0 percent by weight, based on the total weight of the hydraulic fluid, of at least one said inhibitor for pH and corrosion control.

13. The hydraulic fluid composition of claim **12** which contains from about 0.001 to about 1.0 percent by weight, based on the total weight of the hydraulic fluid, of at least one said antioxidant.

14. The hydraulic fluid composition of claim **2** wherein said base fluid or lubricant consists essentially of from about 30 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid composition.

15. The hydraulic fluid composition of claim **14** wherein said base fluid or lubricant is at least one borate ester of type (a).

16. The hydraulic fluid composition of claim **15** wherein said borate ester of type (a) has an R_1 alkyl group of one to two carbon atoms and an R_a alkylene group of 2 to 3.

17. The hydraulic fluid composition of claim **15** wherein said borate ester of type (a) is selected from the group consisting of $[CH_3(OCH_2CH_2)_3O]_3—B$, $[C_2H_{ax}{}^{(OCH}{}_2CH_2)_2O]_3—B$, $[C_2H_5(OCH_2CH_2)_3O]_3—B$, $[C_2H_{ax}{}^{(OCH}{}_2CH_2)_4O]_3—B$, $[C_3H_7(OCH_2CH_2)_3O]_3—B$, $[C_4H_{ax}{}^{(OCH}{}_2CH_2)_2O]_3—B$, and $[C_4H_9(OCH_2CH_2)_3O]_3—B$.

18. The hydraulic fluid composition of claim **15** wherein said diluent is at least one glycol ether of type (i).

19. The hydraulic fluid composition of claim **18** wherein said glycol ether of type (i) has an alkyl R group of one to two carbon atoms, an R' selected from the group consisting of hydrogen and alkyl of one to two carbon atoms and an alkylene R'' group of from two to three carbon atoms.

20. The hydraulic fluid composition of claim **18** wherein said glycol ether is selected from the group consisting of diethylene glycol monomethyl ether, diethylene glycol monoethyl ether, diethylene glycol monobutyl ether, triethylene glycol monomethyl ether, triethylene glycol monoethyl ether, triethylene glycol monobutyl ether, tetraethylene glycol monomethyl ether and tetraethylene glycol monobutyl ether.

21. The hydraulic fluid composition of claim **18** which contains from about 0.2 to about 6.0 percent by weight, based on the total weight of the hydraulic fluid of at least one inhibitor for pH and corrosion control.

22. The hydraulic fluid composition of claim **21** which contains from about 0.001 to about 1.0 percent by weight, based on the total weight of the hydraulic fluid, of at least one antioxidant.

23. In the operation of a fluid pressure operating device which uses hydraulic pressure transmission fluid, the improvement comprising using as said hydraulic pressure transmission fluid a composition consisting essentially of from about 20 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid composition, of at least one borate ester base fluid or lubricant selected from the group consisting of (a) a borate ester of the formula:

$$[R_1(O—R_a)_y—O]_3—B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_a is alkylene of from two to four carbon atoms and y is an integer of from 2 to 4; (b) a borate ester of the formula:

$$[R_1—(OCH_2CHR_2)_m—(OCH_2CHR_3)_nO]_3—B,$$

wherein R_1 is alkyl of from one to four carbon atoms, R_2 and R_3 are independently selected from the group consisting of hydrogen and methyl, *m* and *n* are positive integers whose sum is from 2 to 20, and with the proviso that one of R_2 and R_3 is methyl and one of R_2 and R_3 is hydrogen; (c) a borate ester of the formula:

$$(R_1[Rg]O)_3—B,$$

wherein R_1 is alkyl of from one to four carbon atoms, Rg is a heteric oxyalkylene chain of the formula:

$$[—(OCH_2CH_2)_r,(OCH_2CHCH_3)_s—]$$

wherein the sum of *r* and *s* is not more than 20 and wherein the weight percent of the oxyethylene units is not less than 20 based on the total weight of all the oxyalkylene units; and (d) a borate ester of the formula:

$$B\begin{cases}—O(R_4CHCH_2O)_n—(R_5CHCH_2O)_mT_1\\—O(R_6CHCH_2O)_n—(R_7CHCH_2O)_mT_2\\—O(R_8CHCH_2O)_n—(R_9CHCH_2O)_mT_3\end{cases}$$

wherein T_1, T_2 and T_3 are each an independently selected alkyl group having from one to four carbon atoms; R_4, R_5, R_6, R_7, R_8 and R_9 are independently selected from the group consisting of hydrogen and methyl, *n* and *m* are positive integers independently selected in each chain and whose sum in each chain is from 2 to 20, and with the proviso that in no more than two of the chains is the sum of *n* and *m* the same.

24. The process of claim **23** wherein there is from about 30 to about 54.4 percent by weight, based on the total weight of the hydraulic fluid composition, of said base fluid or lubricant.

25. The process of claim **24**, wherein said base fluid or lubricant includes at least one borate ester of type (a).

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