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HYDRAULIC PRESSURE TRANSMITTING FLUID

Chester M. White, Rochester, N. Y., assignor to Genesee Research Corporation, Rochester, N. Y., a corporation of New York

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The present invention relates to a new and improved hydraulic pressure transmitting fluid which, while not limited thereto, is particularly adapted for use as a hydraulic medium in hydraulic brake systems, hydraulic shock absorbers, hydraulic presses, and other fluid pressure actuated mechanism.

In spite of extended research in an effort to develop substitutes, castor oil is today the most commonly employed base or lubricant in hydraulic pressure transmitting fluids. Possibly the greatest drawback and disadvantage attending the use of castor oil for this purpose is its tendency to oxidize and form a thick and tacky film on the moving parts of the hydraulic pressure system in which it is employed. An almost equally serious disadvantage of castor oil "base" fluids is their comparatively low water tolerance. Straight castor oil fluids may be separated into phases due to the presence of water of condensation.

The foregoing and other disadvantages of castor oil are obviated by the present invention and while, in one sense, the invention may be said to encompass hydraulic pressure transmitting fluids in which a new material is substituted for castor oil, it is not to be construed in such a narrow sense. The compositions of the invention are preferably free from castor oil but, when necessary, they may be readily mixed with commercial castor oil or other "base" fluids in common use in hydraulic systems today.

According to the invention, the improved hydraulic fluids contain tricresyl phosphate as their lubricating base. By "lubricating base" is meant that the tricresyl phosphate comprises a substantial proportion and at least ten per cent of the hydraulic pressure transmitting fluid. It has been found that tricresyl phosphate is stable under heat and will not polymerize or gum up under hydraulic pressure use. Furthermore, it will not break down into its components, phosphoric acid and cresol, and it therefore does not exhibit corrosive tendencies to metals in the hydraulic pressure system. The discovery that tricresyl phosphate could be used as the lubricating "base" in hydraulic pressure transmitting fluids is indeed surprising for this reason. The decomposition of esters is one of the reasons that this class of compounds is generally not employed in brake fluid formulations. As stated above, tricresyl phosphate does not break down under conditions of use. Furthermore, it is quite surprising that this compound does not swell rubber excessively, since it is an aromatic compound, and aromatic compounds are noted for their capacity to cause rubber swelling.

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Broadly stated, the hydraulic pressure transmission fluids of the present invention contain tricresylphosphate as their lubricating base, along with solvents or diluents, and, if necessary or desirable, very small amounts of corrosion inhibitors, such as amine phosphates and nitrites.

As diluents or solvents, there may be employed, either singly or in combination one with the other, a polymerized glycol and/or an aliphatic ether of a polyglycol. As used herein, the term "polymerized glycol" may include the specific compounds diethylene glycol, and triethylene glycol, as well as polymerized ethylene glycols having molecular weights up to 250, and the specific compounds dipropylene glycol and tripropylene glycol as well as polymerized propylene glycol. For the polymerized glycol content, there may be substituted, to the extent of not more than fifty per cent, so-called higher glycols such as butylene glycol, amylene glycol and hexylene glycol.

The alcohol ethers may be methyl, ethyl, propyl, butyl, etc. ethers of ethylene glycol, diethylene glycol, triethylene glycol, tetraethylene glycol, propylene glycol, dipropylene glycol, tripropylene glycol and tetrapropylene glycol. Preferably, mixtures of the foregoing alcohol ethers are employed.

The following general formulation having the range of ingredient proportions indicated embraces a number of highly desirable fluids for use in hydraulic brake systems:

	Per cent by weight
Tricresyl phosphate (Tech.)	10–50
Polymerized glycol (single or mixed)	0–85
Aliphatic ethers of polyglycols (single or mixed)	0–85

As hereinbefore mentioned, the polymerized glycol concentration may be replaced by not more than fifty per cent of butylene, amylene or hexylene glycols, or a mixture of these glycols.

Falling specifically under the foregoing general formulation is the following specific example:

	Per cent by weight
Tricresyl phosphate (Tech.)	20.00
Dipropylene glycol	40.00
Ethyl ether or triethylene glycol	39.10
Diamylamine phosphate	0.05
Diisopropylamine nitrite	0.05

In order to illustrate the desirability of the foregoing specific brake fluid formulation, its critical physical data is given below:

Boiling point	157° C.
Viscosity @ 100° F.	13.1 c. s.
Viscosity @ −40° F.	19,566 c. s.
Rubber swelling	0.030" (heated 5 days @ 158° F.)
Cold test	Clear; flows after 11 days @ −50° F.
Water tolerance	10% water—clear and flows after 11 days @ −50° F.
Miscibility	Castor oil base fluids clear and flow after 11 days @ −50° F.

Corrosion (7 days @ 200° F.):

Cast iron	0.0 mg./sq. cm.
Brass	0.1
Copper	0.1
Steel	0.1
Tin plated steel	0.1
Aluminum alloy	0.0

Another specific example is as follows:

	Per cent by weight
Tricresyl phosphate	18.00
Dipropylene glycol	24.90
Hexylene glycol	15.00
Ethyl ether of triethylene glycol	42.00
Diisopropylamine nitrite	0.05
Diamylamine phosphate	0.05

With respect to the critical physical data, the following may be observed:

Rubber swelling	0.013" (heated 5 days @ 158° F.)
Viscosity @ −40° F.	9026 c. s.

Corrosion (6 days @ 200° F.):

Brass	0.4 mg./sq. cm.
Copper	0.0
Cast iron	0.0
Steel	0.2
Aluminum alloy	0.0
Tin	0.0

A still further specific example is represented by the following formulation:

	Per cent by weight
Tricresyl phosphate (Tech.)	18.00
Dipropylene glycol	20.00
Ethyl ether of triethylene glycol	41.90
Ethyl ether of diethylene glycol	20.00
Diisopropylamine nitrite	0.05
Diamylamine phosphate	0.05

The critical physical data for the foregoing formulation is as follows:

Rubber swelling (5 days @ 158° F.)	0.018"

Corrosion (7 days @ 158° F.):

Steel	0.0 mg./sq. cm.
Brass	0.2
Cast iron	0.3
Copper	0.1
Tin coated iron	0.1
Aluminum alloy	0.0

As stated, the principal advantage of the pressure transmission fluids of the present invention is that there is no possibility of their oxidizing and forming a thick, tacky film on the moving parts of the hydraulic system. In testing the fluids for such tackiness, the following procedure was employed:

A complete wheel cylinder was assembled by lubricating the walls of the wheel cylinder, pistons, springs, and rubber cups with the fluid under test. 5 cc. of the fluid was added to the cylinder with one port open. The cylinder was held at 70° C. for 14 days in a constant temperature oven. Examination of the cylinder and parts at the end of the test shows no residue, gum or corrosion of any of the parts, indicating that there was no oxidation of the ingredients.

A further advantage of the fluids of the present invention resides in their miscibility with other commercial fluids in common use in brake systems today. They also have good low temperature characteristics and are unusually inert as far as "rubber swelling" is concerned. As a matter of fact, they do not swell rubber at all. In test conditions the diameter of a rubber brake cup is increased by such a small amount that it is difficult to measure the change with a micrometer. For all practical purposes it is zero within experimental error.

The fluids have good water tolerance, being miscible with water in all proportions. Corrosion of the various metals in the hydraulic system can be held under control by means of suitable inhibitors. Viscosities at 100° F. and at −40° F. establish a curve with a satisfactory slope.

What is claimed is:

1. A hydraulic pressure fluid consisting essentially of the following ingredients in the approximate percentages indicated:

	Per cent by weight
Tricresyl phosphate	20.00
Dipropylene glycol	40.00
Ethyl ether of triethylene glycol	39.10
Diamylamine phosphate	0.05
Diisopropylamine nitrite	0.05

2. A hydraulic pressure fluid consisting essentially of the following ingredients in the approximate percentages indicated:

	Per cent by weight
Tricresyl phosphate	18.00
Dipropylene glycol	24.90
Hexylene glycol	15.00
Ethyl ether of triethylene glycol	42.00
Diisopropylamine nitrite	0.05
Diamylamine phosphate	0.05

3. A hydraulic pressure fluid consisting essentially of the following ingredients in the approximate percentages indicated:

	Per cent by weight
Tricresyl phosphate	18.00
Dipropylene glycol	20.00
Ethyl ether of triethylene glycol	41.90
Ethyl ether of diethylene glycol	20.00
Diisopropylamine nitrite	0.05
Diamylamine phosphate	0.05

4. A hydraulic pressure fluid consisting essentially of at least 10% tricresyl phosphate as the sole lubricating base and the remainder at least one material effective as a diluent for said tricresyl phosphate and selected from the group consisting of (1) an alkyl ether of a water-soluble glycol where the alkyl group contains 1–4 carbon atoms; (2) a polyethylene glycol containing 2–5 ethylene oxide groups; (3) a polypropylene glycol containing 2–3 propylene oxide

groups; and (4) a water-soluble glycol whose alkylene group contains 4–6 carbon atoms.

5. A hydraulic pressure fluid consisting essentially of approximately 10–50% tricresyl phosphate as the sole lubricating base, approximately 50–90% of a material effective as a diluent for said tricresyl phosphate and selected from the group consisting of (1) an alkyl ether of a water-soluble glycol where the alkyl group contains 1–4 carbon atoms; (2) a polyethylene glycol containing 2–5 ethylene oxide groups; (3) a polypropylene glycol containing 2–3 propylene oxide groups; and (4) a water-soluble glycol whose alkylene group contains 4–6 carbon atoms, and approximately 0.1% of a corrosion inhibitor.

CHESTER M. WHITE.

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