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HYDRAULIC LIQUID HAVING A COMPARATIVELY SMALL CHANGE IN VISCOSITY

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This invention relates to a liquid having a comparatively small change in viscosity with relatively large changes in temperature. More particularly the invention relates to fluids which are used in gun recoil piston cylinders and shock absorbers.

On some of the larger size guns the recoil of the gun is absorbed in cylinders having pistons therein which displace a fluid at a controlled rate. The guns and cylinders are subject to a considerable change in temperature which ranges from —40° F. to 200° F. It is very desirable that the fluid which is to be used in the recoil cylinders should have a substantially uniform viscosity so that the recoil can be equally controlled regardless of the temperature under which it is operated. Such a liquid must have a low freezing point and should change comparatively small amounts in viscosity from the lowest temperature up to the highest temperature. This same principle applies to shock absorbers and such a liquid can advantageously be used in the operation of hydraulic brakes.

A liquid suitable for the purposes outlined above has the following preferred formula:

	Percent by volume
Tributyl phosphate	97.75
Extreme pressure agent (tricresyl phosphite or "Polane")	1.00
Lead naphthenate	1.00
Santolube #261	0.25

In the above formula triethyl phosphate may replace the tributyl phosphate.

It has been found that the tricresyl phosphite, the lead naphthenate and the Santolube #261 are quite soluble in the tributyl phosphate. These ingredients, however, are not so soluble in the triethyl phosphate and it has been desirable, therefore, to replace part of the triethyl phosphate with furnace oil or kerosene to help hold the lead naphthenate, the Santolube #261 and the tricresyl phosphite in stable solution. For example if 75 percent of triethyl phosphate is used with 22.75 percent of furnace oil or kerosene, a liquid having a comparatively uniform viscosity characteristic may be produced. In all of these compounds the lead naphthenate acts as a corrosion resistant agent. The Santolube #261 acts as a corrosion resistant agent, and antioxidizing agent, and a pour point depressant agent. The "Polane" and tricresyl phosphite act to give load carrying capacity to the oil, that is provide extreme pressure lubricating qualities.

It has been found also that dichlorethyl ether

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or amyl acetate may be used with the tributyl phosphate or triethyl phosphate in making up a stable, uniform viscosity fluid.

Santolube #261 is an additive commonly used in modifying lubricating oils, and is a sulfurized tin salt of an alkyl phenol carboxylic acid, manufactured under Patents Nos. 2,197,834; 2,197,835; 2,256,441; and 2,257,751. This product is also referred to as a metallic derivative of an alkylated carboxylic acid containing combined tin and sulfur. The percentage of tin in the additive agent is 3.25 percent by weight and the sulfur is 0.8 percent by weight. This product acts as a pour point depressant and antioxidant, and acts also as an inhibitor for preventing corrosion to metals with which the hydraulic liquid comes in contact. In the liquid of the present invention it is important that the liquid should not corrode the parts in which it operates.

The improved liquid of the present invention which is suitable for use in hydraulic apparatus has a low freezing point of, for example, below minus 50° F. or minus 65° F., and preferably has a Saybolt Universal viscosity in the range of from 300 seconds at minus 40° F. to 35 seconds at 200° F.

Tests on the preferred uniform viscosity fluid having a base of tributyl phosphate show the following Saybolt Universal viscosity characteristics.

	Seconds
—40° F.	278
0° F.	75
100° F.	36
200° F.	30

For the same formula replacing tributyl phosphate with triethyl phosphate, the Saybolt Universal viscosity tests are as follows:

	Seconds
—40° F.	59
0° F.	39
100° F.	32
200° F.	28

In a composition using triethyl phosphate and furnace oil in the above formula for tributyl phosphate the following viscosity characteristics are obtained:

	Seconds
—40° F.	263
100° F.	35
200° F.	30

With a liquid containing tributyl phosphate 75 percent and amyl acetate 22.75 percent in place of the tributyl phosphate of the above formula

the Saybolt Universal viscosity characteristics are:

	Seconds
—40° F.	119
100° F.	33
200° F.	28

Tripropyl or other trialkyl phosphate may be used in place of the tributyl or triethyl phosphate, and it is found that the Santolube #261, lead naphthenate and tricresyl phosphite are more soluble in the tripropyl phosphate than in the triethyl phosphate. In place of the lead naphthenate, lead oleate may be used.

It is to be understood, furthermore, that the formulae above recited are only relative proportions because the proportion of the E. P. agent, the anticorrosion agent and the pour point depressant agent may be varied from one-tenth to one percent without materially changing the physical properties of the liquid. The proportions given above are those proportions which appear to give the most economical mixture of the ingredients which will give the desirable physical characteristics.

"Polane," referred to above, is a commercial product on the market, which is chloromethyl stearate.

The preferred form of the invention having been thus described, what is claimed as new is:

1. A hydraulic liquid having a freezing point below about minus 50° F. and a comparatively small change in viscosity in the temperature range between minus 40° F. and 200° F., consisting substantially entirely of a trialkyl phosphate having dissolved therein about 1% by volume of a corrosion-resisting agent and about 0.25% by volume of a pour point depressant.

2. A hydraulic liquid having a freezing point below about minus 50° F. and a comparatively small change in viscosity in the temperature range between about minus 40° F. and about 200° F., consisting substantially entirely of a trialkyl phosphate having dissolved therein about 1% by volume of a corrosion-resisting agent, about 0.25% by volume of a pour point depressant, and about 1% by volume of an extreme pressure agent.

3. A hydraulic liquid having a freezing point below about minus 50° F. and a comparatively small change in viscosity in the temperature range between about minus 40° F. and about 200° F., consisting substantially entirely of a trialkyl phosphate having dissolved therein about 1% by volume of lead naphthenate and from about 0.1 to about 1% by volume of a sulfurized tin salt of an alkyl phenol carboxylic acid.

4. A hydraulic liquid having a freezing point below about minus 50° F. and a comparatively small change in viscosity in the temperature range between about minus 40° F., and about 200° F., consisting substantially entirely of a trialkyl phosphate having dissolved therein approximately 1% by volume of a corrosion-resisting agent, approximately 1% by volume of an extreme pressure agent, and from about 0.1% to about 1% by volume of a sulfurized tin salt of an alkyl phenol carboxylic acid.

5. A hydraulic liquid having a relatively low freezing point and a comparatively small change in viscosity in the temperature range between about minus 40° F. and 200° F., comprising about 97.75% by volume of tributyl phosphate, about 1% by volume of an extreme pressure agent, about 1% by volume of lead naphthenate, and about 0.25% by volume of a sulfurized tin salt of an alkyl phenol carboxylic acid.

6. A hydraulic liquid having a low freezing point and a comparatively small change in viscosity in the temperature range between about minus 40° F. and about 200° F., comprising about 97.75% by volume of triethyl phosphate, about 1% by volume of tricresyl phosphite, about 1% by volume of lead naphthenate, about 0.25% by volume of a sulfurized tin salt of an alkyl phenol carboxylic acid.

7. A hydraulic liquid, consisting essentially of a trialkyl phosphate having dissolved therein a corrosion-resisting agent in sufficient proportion to prevent corrosion of the metals with which the hydraulic liquid comes in contact.

8. A hydraulic liquid, consisting essentially of a tributyl phosphate having dissolved therein a corrosion-resisting agent in sufficient proportion to prevent corrosion of the metals with which the hydraulic liquid comes in contact.

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