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POWER TRANSMISSION FLUIDS

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8 Claims. (Cl. 252—79)

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This invention relates to power transmission fluid of the type comprising castor oil and a diluent such as a glycol ether.

In patent application Serial No. 552,820, now Patent No. 2,517,044, there is described and claimed a process for the preparation of a fluid for transmission of power which comprises treating castor oil or glyceryl tri-ricinoleate in the presence of a glycol monoether, such as diethylene glycol monoethyl ether, with an alkali or alcoholate in excess of that required to neutralise the free acidity of the tri-ricinoleate. In making up a fluid according to the said specification the alkali was dissolved in a small proportion of the glycol monoether desired in the final fluid and the amount of excess alkali was determined by previous trial, allowing the mixture to stand until substantial neutrality was attained and then determining the water tolerance of the mixture. In this way optimum proportions could be determined, and when the point of substantial neutrality was reached, the remainder of the glycol ether was added. Working in this way it was found possible to produce a fluid containing approximately 35% oil and 65% glycol monoether with a setting point of minus 60° C. to minus 70° C.

It has now been found that an essential feature of the fluid produced according to this prior patent was the presence of an ester of ricinoleic acid and the glycol monoether, and that comparable fluids could be made by mixing together glyceryl tri-ricinoleate, a glycol monoether and the ester of ricinoleic acid obtained by esterifying a glycol monoether with ricinoleic acid.

Further investigation has shown that the ricinoleic acid ester of a glycol monoether is a good substitute for castor oil quite apart from whether or not castor oil forms a constituent of the mixture, and consequently this ricinoleic acid ester will form a satisfactory fluid for transmission of power when diluted with any of the diluents which have been employed for making up fluids for transmission of power hitherto.

According to the present invention, therefore, in its broadest aspect a fluid for transmission of power comprises a ricinoleic acid ester of a glycol monoether and a diluent.

As above stated any of the diluents which have been employed in this type of fluid may be employed according to the invention, but it has been found advantageous to employ a glycol monoether as the diluent, and conveniently the glycol monoether may be the same glycol ether as that employed for forming the ricinoleic acid ester. The monoethyl or butyl ethers of ethylene glycol or diethylene glycol have been found to be particularly suitable, but other mono-alkyl ethers of glycol and polyglycols may be employed according to the conditions which the fluid is required to stand up to. Thus, where very low temperatures are likely to be met with, as in the case of fluids for aircraft purposes, the lower alkyl ethers of ethylene glycol or diethylene glycol will be chosen rather than the higher alkyl ethers and the monoethers of the mono- or di-glycols in preference to higher polyglycols. If castor oil is employed as an ingredient of the fluid it may be employed in the form of neutralised castor oil or in the form of synthetic glyceryl tri-ricinoleate.

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A fluid according to the invention may be prepared by adding the esterified glycol monoether to the standard 35-65 castor oil-Cellosolve brake fluid (monoethyl ether of ethylene glycol is sold under the registered trade-mark "Cellosolve"), but in this case the viscosity may have to be adjusted by adding more of the glycol monoether because the proportion of glyceryl tri-ricinoleate will be higher than in a fluid prepared according to patent application Serial No. 552,820, now Patent No. 2,517,044, to which no claim is made herein.

It is preferred when making up a fluid with castor oil to start with the constituent materials, which may conveniently be ethylene glycol monoethyl ether ("Cellosolve"), glyceryl tri-ricinoleate, which may or may not contain saponified acids obtained by neutralising castor oil and the ricinoleic acid ester of ethylene glycol monoethyl ether, which will be referred to hereinafter as "Cellosolve ricinoleate." The effective range of the fluid may be increased by employing, instead of Cellosolve, the higher boiling point diethylene glycol monoethyl ether sold under the registered trade-mark "Carbitol" as the diluent, and in this case either Cellosolve ricinoleate may be employed as the ricinoleic acid ester or the ester of the corresponding diglycol ether which will be referred to hereinafter as "Carbitol ricinoleate."

Table I given hereinafter shows inter alia the

effect of reducing the proportions of castor oil in a castor oil-Cellosolve ricinoleate-Cellosolve fluid, the flow at low temperatures being particularly good with mixtures containing as low as 5% castor oil. Further investigation has shown that a comparably good low temperature fluid can be obtained by eliminating the castor oil entirely. Thus a fluid consisting of:

	Percent
Cellosolve ricinoleate	30
Cellosolve	70

was found to have a viscosity of 35 secs. (Redwood No. 1) at 100° F. and to have an appreciable flow at −70° C.

The following Tables I to IV give particulars including physical constants of fluids prepared in accordance with the invention in comparison with the standard castor oil-Cellosolve fluid and a fluid according to patent application Serial No. 552,820, now Patent No. 2,517,044. In these tables the fluids marked AA were prepared in accordance with the standard procedure for preparing castor oil Cellosolve brake fluids in which pharmaceutical grade castor oil and Cellosolve are mixed and sufficient caustic potash dissolved in Cellosolve added to neutralise the free acidity. The fluids marked BB were prepared in accordance with the process described in our prior application Serial No. 552,820, now Patent No. 2,517,044. The fluids CC, DD and EE were prepared by mixing pharmaceutical grade castor oil with the other ingredients without neutralising the free acidity of the castor oil and the fluid FF1 by simply mixing Cellosolve ricinoleate with Cellosolve. The fluids CC and EE would show even better low temperature qualities if the free acidity of the castor oil used had been neutralised with caustic potash as in the case of fluid AA.

Table I shows a comparison between the standard castor oil-Cellosolve fluid and a fluid made according to patent application Serial No. 552,820, now Patent No. 2,517,044, with fluids made in accordance with the present invention with varying proportions of castor oil and no castor oil in respect of viscosity and flow qualities at low temperatures the amount of diluent (Cellosolve) being constant. Table II shows the same comparison with the amount of Cellosolve adjusted to give constant viscosity. Table III shows the effect on viscosity and flow characteristics of substituting in fluid EE1 of Table I (*a*) Carbitol ricinoleate and Carbitol (EE2) and (*b*) Carbitol only (EE3) for the corresponding Cellosolve constituents. While the low temperature flow characteristics are not unduly impaired the high temperature range is extended on account of the higher boiling point of Carbitol. Table IV shows the effect of the introduction of different proportions of Cellosolve ricinoleate into castor oil-Cellosolve fluids on the rubber swelling properties and other constants of these fluids. The higher swelling action on rubber of Cellosolve ricinoleate may, of course, be compensated in known manner by the introduction of an inhibitor.

The flow tests were made in accordance with the procedure laid down in the British Air Ministry specification D. T. D. 391 of the Director of Technical Development. According to this specification the fluid to be tested is contained in a glass U-tube having a bore 3.4 mm. to 3.6 mm. diameter, the radius of the bend being such that the distance between the limbs of the U-measured from wall to wall is 10 mm. The bend of the tube must be such as to allow a steel ball of diameter within the specified limits of the bore of the tube to pass from one end of the tube to the other.

In carrying out the test the tube is filled to a depth of 10 cm. in each limb and placed in a freezing mixture adapted to give the required temperature, such as solid carbon dioxide and alcohol. One limb of the tube is attached to pressure apparatus through a cock which may be opened when the flow test is made to give an air pressure equal to 12" head of water. The other limb is attached to a graduated horizontal capilliary to measure the flow of fluid in the U-tube, which is observed by the movement of a bubble in the graduated capilliary which is calibrated for each U-tube used. Before applying the pressure and making the flow test the freezing mixture is maintained at the required temperature plus or minus 0.5° C. for two hours.

Table I.—Comparison of fluids made with equal proportions of solvent

	Composition by volume	Viscosity	Flow in cms. in U-tube			
			at −40° C.	at −50° C.	at −60° C.	at −70° C.
Fluid AA1	Castor Oil, 30% Cellosolve, 70% KOH to neutralise	40 seconds Redwood No. 1 at 100° F.	(1) No flow in 60 secs.	(1) No flow in 60 secs.		
Fluid BB1	Castor Oil, 30% Cellosolve, 70% KOH reacted according to application Serial No. 552,820.	38 seconds at 100° F.	(1) 1 cm. flow in 20 secs.	(1) 0.75 cm. in 60 secs. (2) 0.75 cm. in 60 secs.		
Fluid CC1	Castor Oil, 20% Cellosolve Ricinoleate, 10% Cellosolve, 70%	38 secs. at 100° F.	(1) 1 cm. flow in 1 sec. (2) 1 cm. flow in 1 sec.	(1) Meniscus change only on 60 secs.		
Fluid DD1	Castor Oil, 10% Cellosolve Ricinoleate, 20% Cellosolve, 70%	36 seconds at 100° F.		(1) 1 cm. in 2 secs. (2) 1 cm. in 3 secs.	(1) Meniscus change only in 60 secs.	
Fluid EE1	Castor Oil, 5% Cellosolve Ricinoleate, 25% Cellosolve, 70%	35.5 secs. at 100° F.			(1) 1 cm. in 3 secs. (2) 1 cm. in 3 secs.	(1) 1 cm. in 4½ secs. (2) 1 cm. in 6 secs.
Fluid FF1	Cellosolve Ricinoleate, 30% Cellosolve, 70%	35 secs. at 100° F.			(1) 1 cm. in 4 secs. (2) 1 cm. in 6 secs.	(1) 1 cm. in 11 secs. (2) 1 cm. in 23 secs.

Table II.—Comparison of fluids made to equal viscosity

	Composition by volume	Viscosity	Flow in cms. in U-tube			
			@−40° C.	@−50° C.	@−60° C.	@−70° C.
Fluid AA	Castor Oil, 27.3% Cellosolve, 72.7% KOH to neutralise	38 seconds Redwood No. 1 @ 100° F.	(1) No flow in 60 seconds.	(1) No flow in 60 seconds. (2) No flow in 60 seconds.		
Fluid BB	Castor Oil, 30% Cellosolve, 70% KOH reacted according to application Serial No. 552,820.	38 seconds @ 100° F.	(1) 1 cm. flow in 20 seconds.	(1) 0.75 cm. flow in 60 secs. (2) 0.75 cm. in 60 secs.		
Fluid CC	Castor Oil, 19% Cellosolve Ricinoleate, 10%.	38 seconds @ 100° F.	(1) 1 cm. flow in 1 sec. (app.). (2) 1 cm. flow in 1 sec. (App.).	(1) No flow in 60 seconds. (2) No flow in 60 seconds.		
Fluid DD	Castor Oil, 12.5% Cellosolve Ricinoleate, 20.5%. Cellosolve, 67.0%	38 seconds @ 100° F.		(1) 1 cm. flow in 36 secs.		
Fluid EE	Castor Oil, 6% Cellosolve Ricinoleate, 31%. Cellosolve, 63%	38 seconds @ 100° F.		(1) 1 cm. flow in 5 secs.	(1) 1 cm. flow in 9 secs.	

Table III.—Comparison of fluids made with equal proportions of Carbitol as solvent

	Composition by volume	Viscosity	Flow in cms. in U-tube			
			at −40° C.	at −50° C.	at −60° C.	at −70° C.
Fluid AA2	Castor Oil, 30% Carbitol, 70% KOH to neutralise	50 seconds, Redwood No. 1 at 100° F.	(1) No flow in 60 seconds.			
Fluid EE2	Castor Oil, 5% Carbitol Ricinoleate, 25%. Carbitol, 70%	42 seconds at 100° F.		(1) 0.25 cm. flow in 60 sec. (2) 0.25 cm. flow in 60 secs.	(1) No flow in 60 secs. (2) Meniscus change in 60 secs.	(1) No flow in 60 secs. (2) Meniscus change in 60 secs.
Fluid EE3	Castor Oil, 5% Cellosolve Ricinoleate, 25%. Carbitol, 70%	42 seconds at 100 °F.		(1) 1 cm. flow in 7 secs. (2) 1 cm. flow in 5 secs.	(1) 1 cm. flow in 15 secs. (2) 1 cm. flow in 18 secs.	(1) 0.5 cm. in 60 secs.

Table IV.—Other experimental data obtained on fluids of Table I

	Rubber Swelling Tests [1]	Organic Acidity	pH	Water Tolerance
	Percent			*Percent*
Fluid AA1	7.2	0.08 mgm. KOH/gm	9.41	12
Fluid BB1	9.3	0.14 mgm. KOH/gm	9.63	22.4
Fluid DD1	11.13	0.38 mgm. KOH/gm	6.74	10.0
Fluid EE1	11.60	0.28 mgm. KOH/gm	7.43	10.0

[1] Per cent volume increases after 24 hours at 70° C.

What we claim is:

1. A fluid for transmission of power consisting of 30 volumes of the ricinoleic acid ester of the monoethylether of ethylene glycol, and 70 volumes of the monoethyl ether of ethylene glycol.

2. A fluid for transmission of power consisting of about 30 volumes of a ricinoleic acid ester of a glycol monoether and about 70 volumes of a glycol monoether.

3. A fluid for transmission of power consisting of 30 volumes of a liquid selected from the group consisting of ricinoleates of the glycol monoethers and mixtures of the latter with castor oil and 70 volumes of a glycol monoether.

4. A fluid for transmission of power consisting of 30 volumes of a liquid selected from the group consisting of ricinoleates of the glycol monoethers and mixtures of the latter with castor oil and 70 volumes of the monoethyl ether of ethylene glycol.

5. A fluid for transmission of power consisting of 30 volumes of a liquid selected from the group consisting of ricinoleates of the glycol monoethers and mixtures of the latter with castor oil and 70 volumes of the monoethyl ether of diethylene glycol.

6. A fluid for transmission of power consisting of 30 volumes of the ricinoleic acid ester of ethylene glycol monoethyl ether and 70 volumes of the monoethyl ether of diethylene glycol.

7. A fluid for transmission of power as claimed in claim 4, wherein the ricinoleate liquid selected consists of 5 to 20 volumes of castor oil and the remainder is the monoethyl ether of ethylene glycol.

8. A fluid for transmission of power as claimed in claim 5, wherein the ricinoleate liquid selected

consists of 5 to 20 volumes of castor oil and the remainder is the monoethyl ether of diethylene glycol.

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