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(71) Applicant: **Hamilton Sundstrand Corporation**
Charlotte, NC 28217-4578 (US)

(72) Inventor: **GAGE, Marc**
Feeding Hills, MA Massachusetts 01030 (US)

(74) Representative: **Dehns**
St. Brides House
10 Salisbury Square
London EC4Y 8JD (GB)

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(54) **AIRCRAFT HYDRAULIC SYSTEM AND HYDRAULIC FLUID**

(57) An aircraft hydraulic system (22) utilizes a hydraulic fluid (24) that includes a heat transfer fluid and a friction modifier additive.

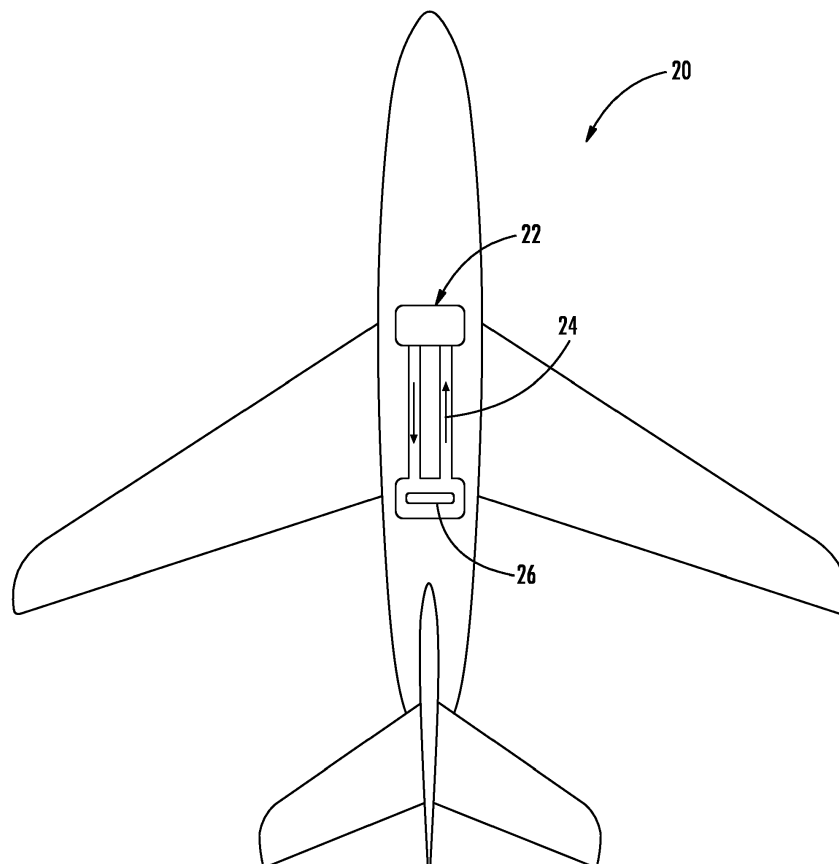


FIG. 1

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Description

BACKGROUND

[0001] The present disclosure relates to a hydraulic system, and more particularly, to an aircraft hydraulic system and the hydraulic fluid used.

[0002] Aircraft hydraulic systems may include systems having a friction plate brake and/or a clutch. Applications of the aircraft hydraulic system may include flight control actuation systems, helicopter hoists, and others. Traditionally, hydraulic fluids are used to provide lubrication between the plates, and friction modifiers are used as an additive to the hydraulic fluid to modify the frictional properties of the fluid in order to prevent stick and/or slip between the friction plates. Unfortunately, the hydraulic fluids typically used in friction plate brake and clutch systems exhibit viscosities at low temperature (e.g., -65°F) that are higher than desired to achieve optimal performance of the friction plate brake and/or clutch systems.

BRIEF DESCRIPTION

[0003] An aircraft hydraulic system according to one, non-limiting, embodiment of the present disclosure includes a hydraulic fluid including a heat transfer fluid and a friction modifier.

[0004] Additionally to the foregoing embodiment, the heat transfer fluid is hydrocarbon-based.

[0005] In the alternative or additionally thereto, in the foregoing embodiment, the aircraft hydraulic system is a friction plate brake system.

[0006] In the alternative or additionally thereto, in the foregoing embodiment, the aircraft hydraulic system is a clutch system.

[0007] In the alternative or additionally thereto, in the foregoing embodiment, the aircraft hydraulic system includes a friction plate exposed to the hydraulic fluid.

[0008] In the alternative or additionally thereto, in the foregoing embodiment, the friction modifier includes a long chain molecule having a polar end associated with the friction plate and a non-polar end associated with the hydrocarbon based heat transfer fluid.

[0009] In the alternative or additionally thereto, in the foregoing embodiment, the friction modifier is a fatty acid.

[0010] In the alternative or additionally thereto, in the foregoing embodiment, the friction modifier is a carboxylic acid.

[0011] In the alternative or additionally thereto, in the foregoing embodiment, the hydrocarbon-based heat transfer fluid is a synthetic hydrocarbon-based heat transfer fluid.

[0012] In the alternative or additionally thereto, in the foregoing embodiment, the synthetic hydrocarbon-based heat transfer fluid is polyalphaolefin.

[0013] In the alternative or additionally thereto, in the foregoing embodiment, the hydrocarbon-based heat transfer fluid is mineral-based.

[0014] In the alternative or additionally thereto, in the foregoing embodiment, the heat transfer fluid has a viscosity of about 0.0011 m²/s (1100 centistokes) or less at 219 Kelvin (negative sixty-five degrees Fahrenheit).

[0015] In the alternative or additionally thereto, in the foregoing embodiment, the heat transfer fluid has a viscosity within a range of about 0.0005 m²/s to 0.0011 m²/s (500 to 1100 centistokes) at 219 Kelvin (negative sixty-five degrees Fahrenheit).

[0016] An aircraft hydraulic fluid according to another, non-limiting, embodiment includes a heat transfer fluid; and a friction modifier.

[0017] Additionally to the foregoing embodiment, the heat transfer fluid is hydrocarbon-based.

[0018] In the alternative or additionally thereto, in the foregoing embodiment, the friction modifier is a fatty acid.

[0019] In the alternative or additionally thereto, in the foregoing embodiment, the friction modifier is a carboxylic acid.

[0020] In the alternative or additionally thereto, in the foregoing embodiment, the heat transfer fluid is polyalphaolefin.

[0021] In the alternative or additionally thereto, in the foregoing embodiment, the heat transfer fluid has a viscosity of about 0.0011 m²/s (1100 centistokes) or less at 219 Kelvin (negative sixty-five degrees Fahrenheit).

[0022] In the alternative or additionally thereto, in the foregoing embodiment, the heat transfer fluid has a viscosity within a range of about 0.0005 m²/s to 0.0011 m²/s (500 to 1100 centistokes) at 219 Kelvin (negative sixty-five degrees Fahrenheit).

[0023] The foregoing features and elements may be combined in various combinations without exclusivity, unless expressly indicated otherwise. These features and elements as well as the operation thereof will become more apparent in light of the following description and the accompanying drawings. However, it should be understood that the following description and drawings are intended to be exemplary in nature and non-limiting.

BRIEF DESCRIPTION OF THE DRAWINGS

[0024] Various features will become apparent to those skilled in the art from the following detailed description of the disclosed non-limiting embodiments. The drawings that accompany the detailed description can be briefly described as follows:

FIG. 1 is a schematic of an aircraft utilizing an aircraft hydraulic system as one exemplary embodiment.

DETAILED DESCRIPTION

[0025] Referring to FIG. 1, an aircraft 20 is illustrated having an aircraft hydraulic system 22 that utilizes a hydraulic fluid (i.e., see arrow 24). Examples of the hydraulic system 22 may include a friction plate brake system, a clutch system, a flight control actuation system, a heli-

copter hoist, and others. The aircraft hydraulic system 22 may include at least one friction plate 26 as is commonly known to one having skill in the art of hydraulic systems. It is contemplated and understood that the aircraft system may further include systems that utilize gear arrangement requiring lubrication.

[0026] Known "hydraulic fluids" that may be hydrocarbon-based, are commonly used in known aircraft hydraulic systems. Such hydraulic fluids may exhibit undesirably high viscosities at low temperatures of, for example, about 219 Kelvin (negative sixty-five degrees Fahrenheit (-65°F)). One example of a traditional hydraulic fluid used in the aviation industry is Castrol Brayco® 795 (manufactured by the BP Corporation headquartered in the UK) having a viscosity of about 0.0024 m²/s (2400 centistokes) at about 219 Kelvin (negative sixty-five degrees Fahrenheit (-65°F)). For aviation applications, the low temperature requirement (i.e., 219 Kelvin (-65°F)) may be a government aviation regulation (e.g., Federal Aviation Authority regulation).

[0027] Hydraulic fluid 24 of the present disclosure includes a low temperature heat transfer fluid and a friction modifier. The low temperature heat transfer fluid may be hydrocarbon-based and traditionally is not used as a hydraulic fluid. For example, the low temperature heat transfer fluid is known to be used as an electrical coolant fluid. The heat transfer fluid may have a viscosity of about 0.0011 m²/s (1100 centistokes), or less, at temperatures of about 219 Kelvin (-65°F), or less. Preferably, the viscosity at 219 Kelvin (-65°F) may be within a range of about 0.0005 m²/s to 0.0011 m²/s (500 to 1100 centistokes). In one embodiment, a preferred viscosity of the heat transfer fluid may be about 0.0005 m²/s (500 centistokes) at about 219 Kelvin (-65°F). Examples of the heat transfer fluid may include a synthetic polyalphaolefin (e.g., Castrol Brayco Micronic 889), a mineral-based hydrocarbon, and others. Castrol Brayco Micronic 889 has a viscosity of about 0.0008 m²/s (800 centistokes) at about 219 Kelvin (negative sixty-five degrees Fahrenheit (-65°F)). In yet another example, the heat transfer fluid may be Royco® 602 (manufactured by the Univar Company headquartered in Redmond, Washington) having a viscosity of about 0.0011 m²/s (1087 centistokes) at about 219 Kelvin (negative sixty-five degrees Fahrenheit (-65°F)).

[0028] The friction modifier provides a uniform friction upon the friction plate(s) 26. The friction modifier may be, or may include, long chain molecules with a polar end associated with, for example, the friction plate 26 of the aircraft hydraulic system 22, and a non-polar end associated with the aircraft hydraulic fluid 24. Examples of a friction modifier may be a fatty acid, a carboxylic acid, and others.

[0029] Advantages and benefits of the present disclosure include aviation friction plate and clutch systems that incorporate hydrocarbon-based heat transfer fluids with improved low temperature fluidity and containing friction modifiers, which results in improved performance

at lower temperatures.

[0030] The term "about" is intended to include the degree of error associated with measurement of the particular quantity based upon the equipment available at the time of filing the application. For example, "about" can include a range of $\pm 8\%$ or 5% , or 2% of a given value.

[0031] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the present disclosure. As used herein, the singular forms "a", "an" and "the" are intended to include the plural forms as well, unless the context clearly indicates otherwise. It will be further understood that the terms "comprises" and/or "comprising," when used in this specification, specify the presence of stated features, integers, steps, operations, elements, and/or components, but do not preclude the presence or addition of one or more other features, integers, steps, operations, element components, and/or groups thereof.

[0032] While the present disclosure has been described with reference to an exemplary embodiment or embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the present disclosure. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the present disclosure without departing from the essential scope thereof. Therefore, it is intended that the present disclosure not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this present disclosure, but that the present disclosure will include all embodiments falling within the scope of the claims.

Claims

1. An aircraft hydraulic system (22) comprising:

a hydraulic fluid (24) including a heat transfer fluid and a friction modifier.

2. The aircraft hydraulic system (22) set forth in claim 1, wherein the heat transfer fluid is hydrocarbon-based.

3. The aircraft hydraulic system (22) set forth in claim 2, wherein the aircraft hydraulic system is a friction plate brake system.

4. The aircraft hydraulic system (22) set forth in claim 2, wherein the aircraft hydraulic system is a clutch system.

5. The aircraft hydraulic system (22) set forth in claim 3, further comprising:

a friction plate exposed to the hydraulic fluid, wherein the friction modifier includes a long

chain molecule having a polar end associated with the friction plate and a non-polar end associated with the hydrocarbon based heat transfer fluid.

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6. The aircraft hydraulic system (22) set forth in any of claims 2 to 5, wherein the friction modifier is at least one of a fatty acid and a carboxylic acid.

7. The aircraft hydraulic system (22) set forth in any of claims 2 to 6, wherein the hydrocarbon-based heat transfer fluid is one of a synthetic hydrocarbon-based heat transfer fluid, a polyalphaolefin, and a mineral-based fluid.

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8. The aircraft hydraulic system (22) set forth in any of claims 2 to 7, wherein the heat transfer fluid has a viscosity of about 0.0011 m²/s (1100 centistokes) or less at negative sixty-five degrees Fahrenheit.

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9. The aircraft hydraulic system (22) set forth in claim 8, wherein the heat transfer fluid has a viscosity within a range of about 0.0005 m²/s to 0.0011 m²/s (500 to 1100 centistokes) at 219 Kelvin (negative sixty-five degrees Fahrenheit).

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10. An aircraft hydraulic fluid (24) comprising:

a heat transfer fluid; and
a friction modifier.

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11. The aircraft hydraulic fluid set forth in claim 10, wherein the heat transfer fluid is hydrocarbon-based.

12. The aircraft hydraulic fluid set forth in claims 10 or 11, wherein the friction modifier is a carboxylic acid.

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13. The aircraft hydraulic fluid set forth in claim 10, wherein the heat transfer fluid is polyalphaolefin.

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14. The aircraft hydraulic fluid set forth in any of claims 10 to 13, wherein the heat transfer fluid has a viscosity of about 0.0011 m²/s (1100 centistokes) or less at 219 Kelvin (negative sixty-five degrees Fahrenheit).

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15. The aircraft hydraulic fluid set forth in claim 14, wherein the heat transfer fluid has a viscosity within a range of about 0.0005 m²/s to 0.0011 m²/s (500 to 1100 centistokes) at 219 Kelvin (negative sixty-five degrees Fahrenheit).

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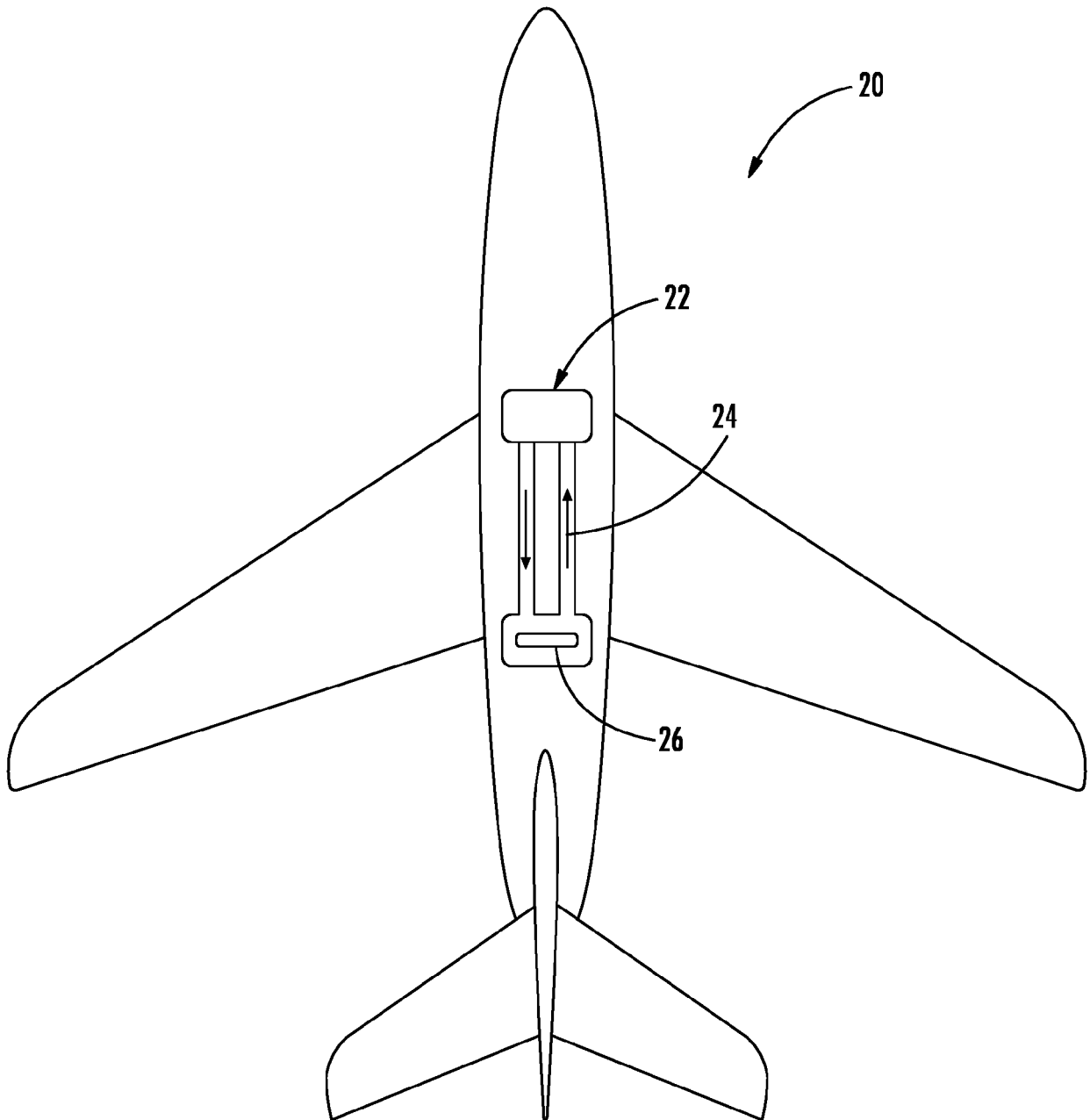


FIG. 1



EUROPEAN SEARCH REPORT

 Application Number
 EP 18 19 9440

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Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
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Y	* claims 1-8; examples II-IV *	1-15	
X	US 3 533 952 A (PRUITT GAIL T ET AL) 13 October 1970 (1970-10-13)	10-12	
Y	* claims 1-4; figure 3; examples 1,5 *	1-15	
Y	US 4 493 509 A (KILNER JEROME R [US] ET AL) 15 January 1985 (1985-01-15)	1-9	
A	US Department Of Defense: "Military Specification Hydraulic Fluid, Petroleum Base; Aircraft , Missile and Ordnance MIL-H-5606G", 9 September 1994 (1994-09-09), pages 1-17, XP055551843, US Retrieved from the Internet: URL:http://www.everyspec.com [retrieved on 2019-02-05] * the whole document *	1-15	TECHNICAL FIELDS SEARCHED (IPC) C10M C10N
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 6 February 2019	Examiner Pöllmann, Klaus
CATEGORY OF CITED DOCUMENTS X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document			

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 EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT
ON EUROPEAN PATENT APPLICATION NO.**

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5 This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.
The members are as contained in the European Patent Office EDP file on
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