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Declarations under Rule 4.17:

- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
- of inventorship (Rule 4.17(iv))

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(54) Title: FLUID DISTRIBUTION ASSEMBLY HAVING ANTI-CLOG INLET HOUSING

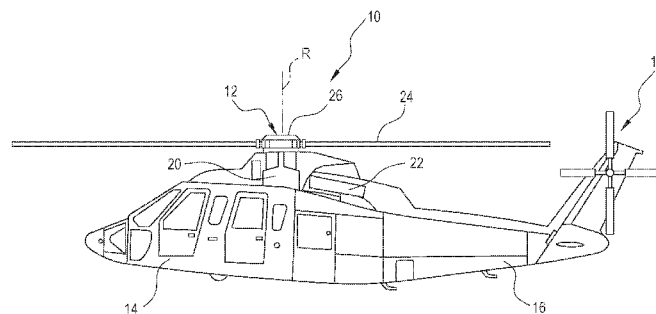
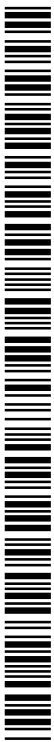


FIG. 1

(57) Abstract: A fluid distribution assembly for distributing a fluid, the fluid distribution assembly includes an inlet housing including a first conduit and a bypass conduit; a chip detector cavity in fluid communication with the first conduit such that the fluid can pass through the first conduit into the chip detector cavity; and an outlet housing in fluid communication with the chip detector cavity and the bypass conduit such that the fluid can pass into the outlet housing through the chip detector cavity and/or the bypass conduit.



FLUID DISTRIBUTION ASSEMBLY HAVING ANTI-CLOG INLET HOUSING

BACKGROUND

[0001] The subject matter disclosed herein relates generally to fluid distribution, and in particular, to a lubricant distribution assembly that having an anti-clog inlet housing for distributing lubricant in a rotary wing aircraft.

[0002] Existing rotary wing aircraft employ a lubricant distribution assembly to convey lubricant to one or more gearboxes. An existing lubricant distribution assembly has a single inlet housing with a chip detector sensor and chip detector screen. The chip detector sensor and chip detector screen capture and detect contaminants in the lubricant that is traveling to the lubricant pumps. A drawback to the existing lubricant distribution assembly is that excessive debris may clog the chip detector screen or the inlet housing and prevent lubricant from passing through the inlet housing to the lubricant pumps.

SUMMARY

[0003] In one exemplary embodiment, a fluid distribution assembly for distributing a fluid, the fluid distribution assembly includes an inlet housing including a first conduit and a bypass conduit; a chip detector cavity in fluid communication with the first conduit such that the fluid can pass through the first conduit into the chip detector cavity; and an outlet housing in fluid communication with the chip detector cavity and the bypass conduit such that the fluid can pass into the outlet housing through the chip detector cavity and/or the bypass conduit.

[0004] In addition to one or more of the features described above, or as an alternative, further embodiments could include a screen positioned between the first conduit and the bypass conduit, the screen to pass fluid between the first conduit and the bypass conduit.

[0005] In addition to one or more of the features described above, or as an alternative, further embodiments could include a filter in the chip detector cavity between the first conduit and the outlet housing.

[0006] In addition to one or more of the features described above, or as an alternative, further embodiments could include wherein when fluid flow through the first conduit and the chip detector cavity is unblocked, fluid flows in the first conduit, the chip detector cavity and the bypass conduit to the outlet housing.

[0007] In addition to one or more of the features described above, or as an alternative, further embodiments could include wherein when fluid flow through the first conduit or the chip detector cavity is blocked, fluid flows in the bypass conduit to the outlet housing.

[0008] In addition to one or more of the features described above, or as an alternative, further embodiments could include wherein the inlet housing includes an inlet; the inlet housing including a vortex reducer located adjacent the inlet which can reduce vortices created at an opening between the first conduit and the bypass conduit.

[0009] In addition to one or more of the features described above, or as an alternative, further embodiments could include wherein the vortex reducer includes a lip extending from one wall of the inlet housing towards the inlet.

[0010] In another exemplary embodiment, a rotary wing aircraft includes a rotor; a gearbox coupled to the rotor; an engine coupled to the gearbox; and a lubricant distribution system providing lubricant from a sump to the gearbox, the lubricant distribution system including an inlet housing including a first conduit and a bypass conduit; a chip detector cavity in fluid communication with the first conduit such that the fluid can pass through the first conduit into the chip detector cavity, the chip detector cavity housing a chip detector; and an outlet housing in fluid communication with the chip detector cavity and the bypass conduit such that the fluid can pass into the outlet housing through the chip detector cavity and/or the bypass conduit.

[0011] In addition to one or more of the features described above, or as an alternative, further embodiments could include a screen positioned between the first conduit and the bypass conduit, the screen passing fluid between the first conduit and the bypass conduit.

[0012] In addition to one or more of the features described above, or as an alternative, further embodiments could include a filter in the chip detector cavity between the first conduit and the outlet housing.

[0013] In addition to one or more of the features described above, or as an alternative, further embodiments could include wherein when fluid flow through the first conduit is unblocked, fluid flows in the first conduit and the bypass conduit to the outlet housing.

[0014] In addition to one or more of the features described above, or as an alternative, further embodiments could include wherein when fluid flow through the first conduit is blocked, fluid flows in the bypass conduit to the outlet housing.

[0015] In addition to one or more of the features described above, or as an alternative, further embodiments could include wherein the inlet housing includes an inlet; the inlet housing including a vortex reducer located adjacent the inlet.

[0016] In addition to one or more of the features described above, or as an alternative, further embodiments could include wherein the vortex reducer includes a lip extending from one wall of the inlet housing towards the inlet.

[0017] In addition to one or more of the features described above, or as an alternative, further embodiments could include a pump coupled to the outlet housing, the pump directing lubricant through inlet housing.

[0018] Other aspects, features, and techniques of the invention will become more apparent from the following description taken in conjunction with the drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] Referring now to the drawings wherein like elements are numbered alike in the several FIGURES, in which:

[0020] FIG. 1 illustrates a rotary wing aircraft in an exemplary embodiment;

[0021] FIG. 2 depicts a gearbox and rotor shaft in an exemplary embodiment;

[0022] FIG. 3 depicts a lubricant distribution assembly with a first fluid path unblocked in an exemplary embodiment;

[0023] FIG. 4 depicts the lubricant distribution assembly with the first fluid path blocked in an exemplary embodiment; and

[0024] FIG. 5 depicts lubricant flow in the lubricant distribution assembly with the first fluid path blocked in an exemplary embodiment.

DETAILED DESCRIPTION

[0025] FIG. 1 illustrates a rotary-wing aircraft 10 having a main rotor assembly 12. The aircraft 10 includes an airframe 14 having an extending tail 16, which mounts a tail rotor system 18, such as an anti-torque system, a translational thrust system, a pusher propeller, a rotor propulsion system, and the like. The main rotor assembly 12 is driven about an axis of rotation R through a main gearbox 20 by one or more engines 22. The main rotor assembly 12 includes a multiple of rotor blades 24 mounted to a rotor hub 26. Although a particular helicopter configuration is illustrated and described in the disclosed embodiment, other configurations and/or machines, such as high speed compound rotary wing aircraft with supplemental translational thrust systems, dual contra-rotating, coaxial rotor system aircraft, turbo-props, tilt-rotors and tilt-wing aircraft, will also benefit from embodiments of the invention.

[0026] FIG. 2 depicts a gearbox assembly 20 and main rotor shaft 21 in an exemplary embodiment. A fluid (e.g., lubricant) distribution assembly 30 is positioned in a lubricant sump 32. Lubricant pumps 34 draw lubricant (e.g., oil) from the sump 32, through the lubricant distribution assembly 30 and supply lubricant to gearbox assembly 20. A chip detector assembly 36 may be mounted to the lubricant distribution assembly 30. While described as a lubricant in the context of gearbox assembly 20, it is understood that, in other aspects, the lubricant is only one type of fluid usable with embodiments of the invention. By way of example, the fluid could be fuel where the sump 32 is a gas tank and the fluid distribution assembly 30 distributes fuel to an engine. By way of another example, the fluid could be coolant where the sump 32 is a coolant reservoir and the fluid distribution assembly 30 distributes coolant to cool an engine. Further, while shown with two pumps 34, it is understood that a single pump 34, or other numbers of pumps 34 could be used in other aspects.

[0027] FIG. 3 depicts a lubricant distribution assembly 30 in an exemplary embodiment. Lubricant distribution assembly 30 includes an inlet housing 40. Inlet housing 40 is a hollow member for placement in the sump 32 (See Fig. 2). The inlet housing 40 is in fluid communication with an outlet housing 42. An outlet of outlet housing 42 is in fluid communication with the lubricant pump(s) 34 (See FIG. 2). Interposed between inlet housing 40 and outlet housing 42 is a chip detector cavity 44 in fluid communication with inlet housing 40 and outlet housing 42. Chip detector cavity 44 is a generally cylindrical member, having a hollow interior to receive a portion of chip detector assembly 36. A filter 46 captures contaminants in lubricant traveling from the inlet housing 40 to the outlet housing 42. Lubricant traveling from the inlet housing 40 to the outlet housing 42 passes through filter 46. Filter 46 may be implemented using a metal screen or other filter media. Filter 46 may be part of the chip detector assembly 36.

[0028] Inlet housing 40 includes a first conduit 50 fluidly coupled to the chip detector cavity 44. First conduit 50 is part of a first fluid path including an inlet 52, first conduit 50, chip detector cavity 44, and outlet housing 42. Inlet housing 40 also includes a bypass conduit 54 extending from inlet 52 to outlet housing 42. Bypass conduit 54 is part of a bypass fluid path including inlet 52, bypass conduit 54, and outlet housing 42. A screen 56 is positioned between first conduit 50 and bypass conduit 54, and allows fluid flow between the first conduit 50 and bypass conduit 54. Screen 56 may be implemented using a metal screen or other filter media. Screen 56 may have the same or a different porosity as filter 46. Bypass conduit 54 allows fluid to bypass the chip detector cavity 44 and filter 46. As

shown, the screen 56 is relatively large as compared to filter 46, and extends substantially along a length of the connection between the bypass conduit 54 and the inlet 52 and having a same width as the connection. The screen 46 acts to prevent chips from flowing into the bypass conduit 54 while also allowing sufficient lubricant from flowing through the bypass conduit 54 when there is a blocked condition as described below. However, it is understood that other geometries for the screen 56 can be used.

[0029] FIG. 3 depicts lubricant flow in the lubricant distribution assembly 30 with the first fluid path unblocked. Blocked, as used herein, refers to a condition where the flow of lubricant through the first fluid path is below a threshold. During unblocked operation, some lubricant also flows in the bypass fluid path, that is, through bypass conduit 54 and around the chip detector assembly 36. In an exemplary embodiment, about 60% of the lubricant flows in the first fluid path and 40% of the lubricant flows in the bypass fluid path, in an unblocked condition.

[0030] FIG. 4 depicts the lubricant flow in the lubricant distribution assembly 30 with the first fluid path blocked. This blocked condition may be due to a buildup of debris on filter 46, by way of example. The blocked condition does not require complete blockage or total interruption of lubricant flow in first fluid path. The blocked condition may also be a result of debris buildup in the first conduit 50.

[0031] During blocked operation of FIG. 4, lubricant enters inlet 52, passes through screen 56, along bypass conduit 54 and to outlet housing 42. The amount of lubricant flow through bypass conduit 54 may be below a certain level, such that a low pressure signal is generated by a lubricant monitoring system in the aircraft. FIG. 5 depicts lubricant flow when the first fluid path is blocked. Lubricant enters first conduit 50, passes through screen 56, through bypass conduit 54 and to outlet housing 42.

[0032] Referring to FIG. 3, the inlet housing 40 includes a vortex reducer 60 located adjacent the inlet 52. Inlet 52 is located on a bottom wall 51 of the inlet housing 40. Vortex reducer 60 includes a lip 62, extending downwardly from a top wall 53 of the inlet housing 40. Lip 62 terminates prior to bottom wall 51. Lip 62 serves to disrupt a vortex formed in the lubricant.

[0033] Embodiments of the lubricant distribution assembly provide a bypass fluid path to an outlet housing in the event first fluid path is blocked. During normal, unblocked operation, lubricant flows through the chip detector assembly 36 to allow for chip detection. When lubricant pumps 34 are shut off, lubricant flows from outlet housing 42 back to inlet 52, and passes through screen 56. This reverse flow of lubricant removes particles from

screen 56. During unblocked or blocked operation, particles in the lubricant are trapped by screen 56, thereby reducing the debris that travels to screen 46 and reducing the likelihood of clogging screen 46. If the first fluid path is blocked, the bypass fluid path provides a restricted flow rate which will result in low fluid pressure indication to the operator of the aircraft.

[0034] The terminology used herein is for the purpose of describing particular embodiments only and is not intended to be limiting of the invention. While the description of the present invention has been presented for purposes of illustration and description, it is not intended to be exhaustive or limited to the invention in the form disclosed. Many modifications, variations, alterations, substitutions, or equivalent arrangement not hereto described will be apparent to those of ordinary skill in the art without departing from the scope and spirit of the invention. By way of example, while described in terms of use on an aircraft, aspects can be used in automobiles, other types of aircrafts beyond rotorcraft, ships, industrial machinery, pipelines, septic or sewer systems, or any other system where fluid flow needs to be maintained. Additionally, while various embodiment of the invention have been described, it is to be understood that aspects of the invention may include only some of the described embodiments. Accordingly, the invention is not to be seen as limited by the foregoing description, but is only limited by the scope of the appended claims.

CLAIMS

What is claimed is:

1. A fluid distribution assembly for distributing a fluid, the fluid distribution assembly comprising:
 - an inlet housing including a first conduit and a bypass conduit;
 - a chip detector cavity in fluid communication with the first conduit such that the fluid can pass through the first conduit into the chip detector cavity; and
 - an outlet housing in fluid communication with the chip detector cavity and the bypass conduit such that the fluid can pass into the outlet housing through the chip detector cavity and/or the bypass conduit.
2. The fluid distribution assembly of claim 1 further comprising:
 - a screen positioned between the first conduit and the bypass conduit, the screen to pass fluid between the first conduit and the bypass conduit.
3. The fluid distribution assembly of any preceding claim further comprising:
 - a filter in the chip detector cavity between the first conduit and the outlet housing.
4. The fluid distribution assembly of any preceding claim wherein:
 - when fluid flow through the first conduit and the chip detector cavity is unblocked, fluid flows in the first conduit, the chip detector cavity and the bypass conduit to the outlet housing.
5. The fluid distribution assembly of any preceding claim wherein:
 - when fluid flow through the first conduit or the chip detector cavity is blocked, fluid flows in the bypass conduit to the outlet housing.
6. The fluid distribution assembly of any preceding claim wherein:
 - the inlet housing includes an inlet;
 - the inlet housing including a vortex reducer located adjacent the inlet which can reduce vortices created at an opening between the first conduit and the bypass conduit.
7. The fluid distribution assembly of claim 6 wherein:
 - the vortex reducer includes a lip extending from one wall of the inlet housing towards the inlet.
8. A rotary wing aircraft comprising:
 - a rotor;
 - a gearbox coupled to the rotor;
 - an engine coupled to the gearbox; and

a lubricant distribution system providing lubricant from a sump to the gearbox, the lubricant distribution system including:

an inlet housing including a first conduit and a bypass conduit;

a chip detector cavity in fluid communication with the first conduit such that the fluid can pass through the first conduit into the chip detector cavity, the chip detector cavity housing a chip detector; and

an outlet housing in fluid communication with the chip detector cavity and the bypass conduit such that the fluid can pass into the outlet housing through the chip detector cavity and/or the bypass conduit

9. The rotary wing aircraft of claim 8 further comprising:

a screen positioned between the first conduit and the bypass conduit, the screen passing fluid between the first conduit and the bypass conduit.

10. The rotary wing aircraft of any preceding claim further comprising:

a filter in the chip detector cavity between the first conduit and the outlet housing.

11. The rotary wing aircraft of any preceding claim wherein:

when fluid flow through the first conduit is unblocked, fluid flows in the first conduit and the bypass conduit to the outlet housing.

12. The rotary wing aircraft of any preceding claim wherein:

when fluid flow through the first conduit is blocked, fluid flows in the bypass conduit to the outlet housing.

13. The rotary wing aircraft of any preceding claim wherein:

the inlet housing includes an inlet;

the inlet housing including a vortex reducer located adjacent the inlet.

14. The rotary wing aircraft of claim 13 wherein:

the vortex reducer includes a lip extending from one wall of the inlet housing towards the inlet.

15. The rotary wing aircraft of any preceding claim further comprising:

a pump coupled to the outlet housing, the pump directing lubricant through inlet housing.

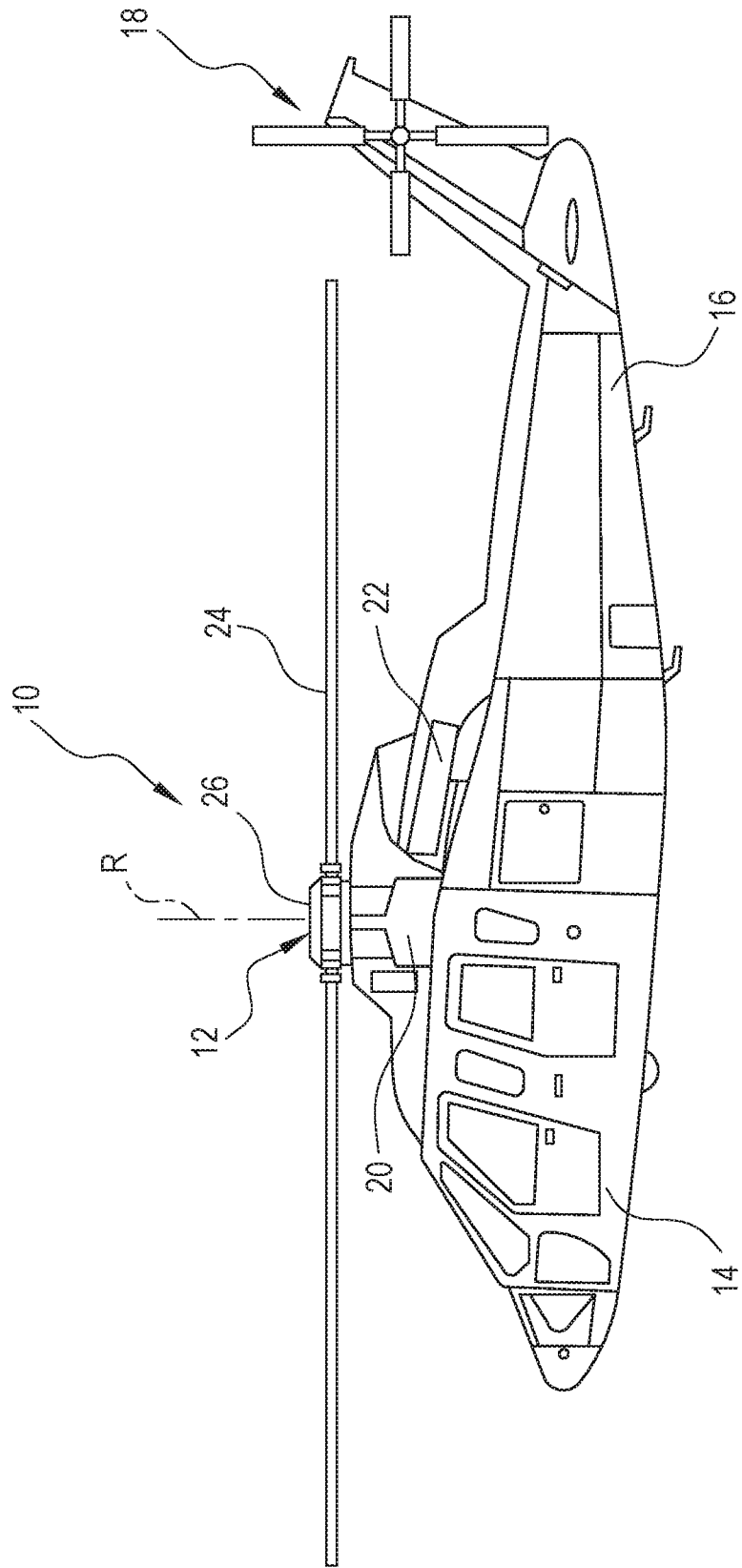


FIG. 1

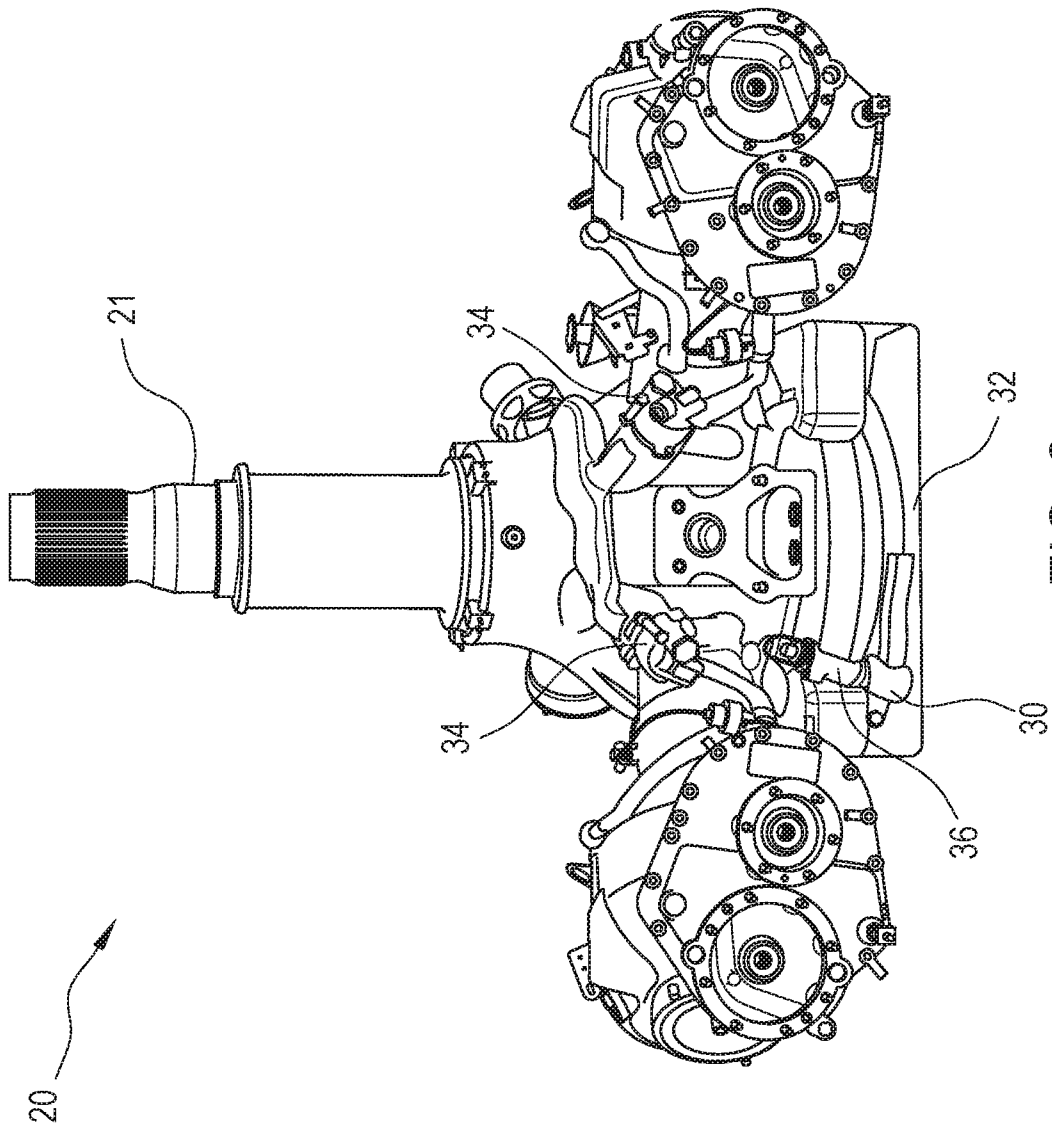


FIG. 2

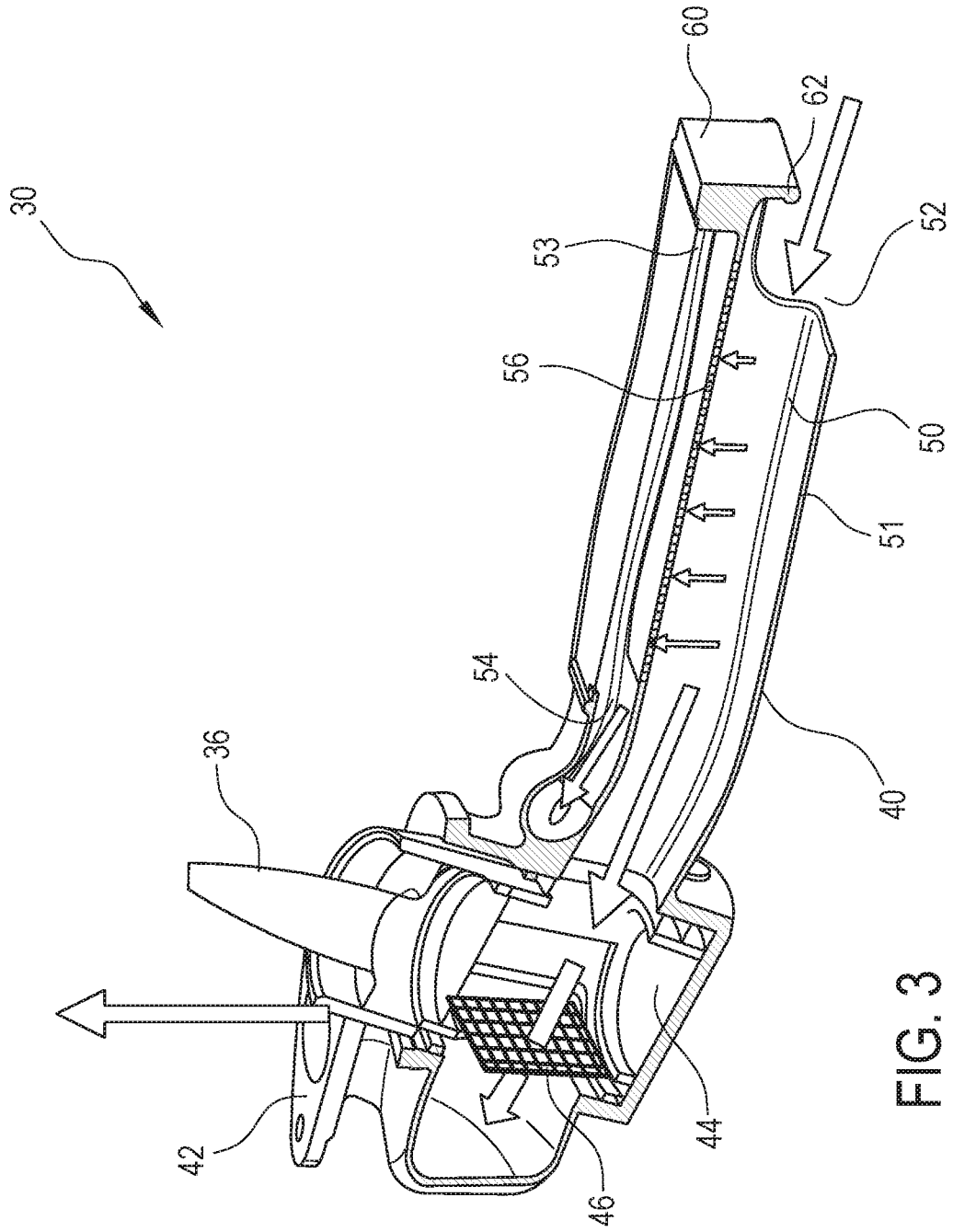


FIG. 3

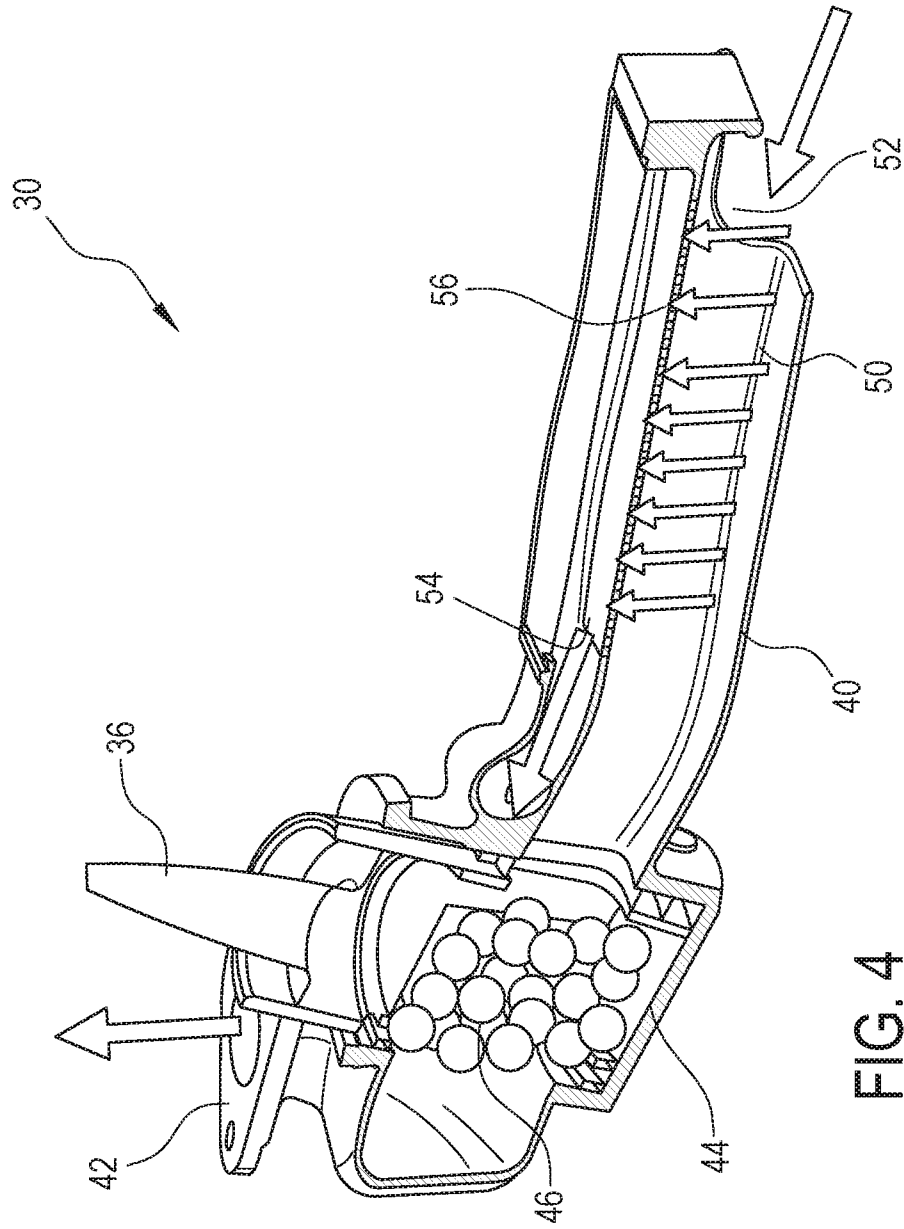


FIG. 4

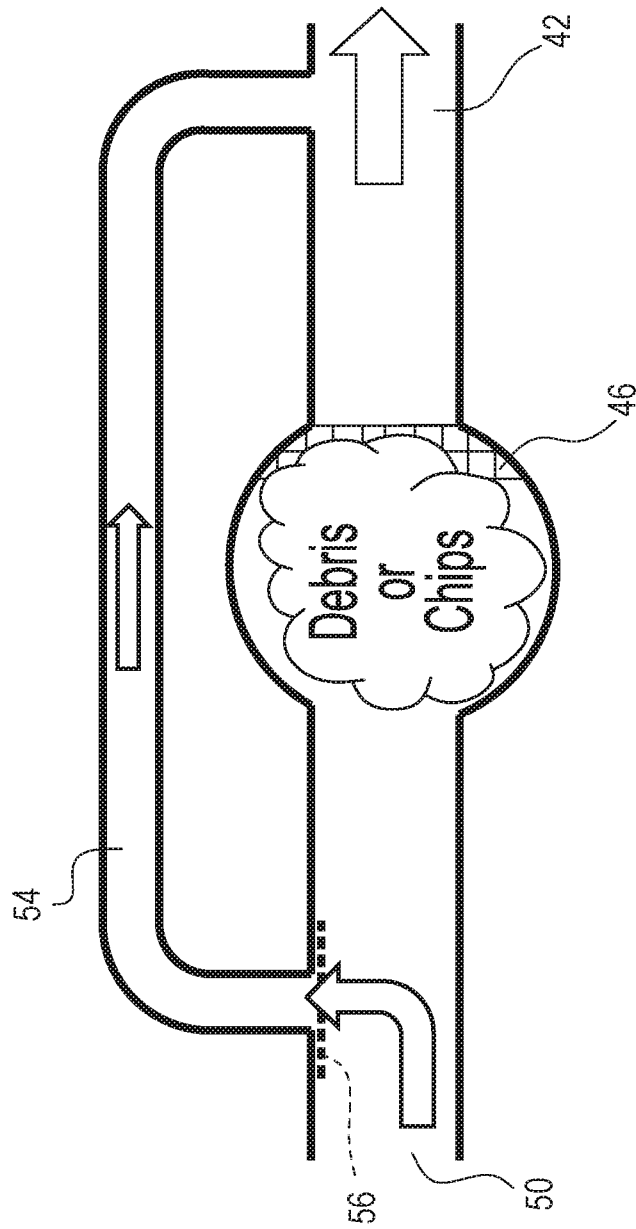


FIG. 5

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2016/017379

A. CLASSIFICATION OF SUBJECT MATTER IPC(8) - F01M 11/02 (2016.01) CPC - F01M 11/02 (2016.02) According to International Patent Classification (IPC) or to both national classification and IPC		
B. FIELDS SEARCHED Minimum documentation searched (classification system followed by classification symbols) IPC(8) - B64C 27/12; B64D 45/00; F01M 1/10, 5/00, 11/02, 11/03, 11/10; F16N 39/06 (2016.01) CPC - B64C 27/12; B64D 45/00; F01M 1/10, 5/00, 11/02, 11/03, 11/10; F16N 39/06, 2210/08 (2016.02)		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched USPC - 184/6, 6.24, 6.4, 7.3 (keyword delimited)		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) PatBase, Google Patents, Google Scholar, Google Search terms used: fluid distribution, conduit, oil, lubricant, inlet, outlet, housing, bypass, chip detector, cavity, rotary wing aircraft		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X ---	US 4,707,165 A (TAUBER et al) 17 November 1987 (17.11.1987) entire document	1-3
Y		8, 9
Y	US 2010/0025159 A1 (GMIRYA et al) 04 February 2010 (04.02.2010) entire document	8, 9
A	US 2009/0183950 A1 (BROUILLET et al) 23 July 2009 (23.07.2009) entire document	1-3, 8, 9
A	US 5,411,116 A (KISH et al) 02 May 1995 (02.05.1995) entire document	1-3, 8, 9
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
* Special categories of cited documents: "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier application or patent but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art "&" document member of the same patent family		
Date of the actual completion of the international search 22 March 2016		Date of mailing of the international search report 11 APR 2016
Name and mailing address of the ISA/ Mail Stop PCT, Attn: ISA/US, Commissioner for Patents P.O. Box 1450, Alexandria, VA 22313-1450 Facsimile No. 571-273-8300		Authorized officer Blaine R. Copenheaver PCT Helpdesk: 571-272-4300 PCT OSP: 571-272-7774

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US2016/017379

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of first sheet)

This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. Claims Nos.:
because they relate to subject matter not required to be searched by this Authority, namely:

2. Claims Nos.:
because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. Claims Nos.: 4-7, 10-15
because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a).

Box No. III Observations where unity of invention is lacking (Continuation of item 3 of first sheet)

This International Searching Authority found multiple inventions in this international application, as follows:

1. As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.:

4. No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.:

Remark on Protest

- The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.
- The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.
- No protest accompanied the payment of additional search fees.