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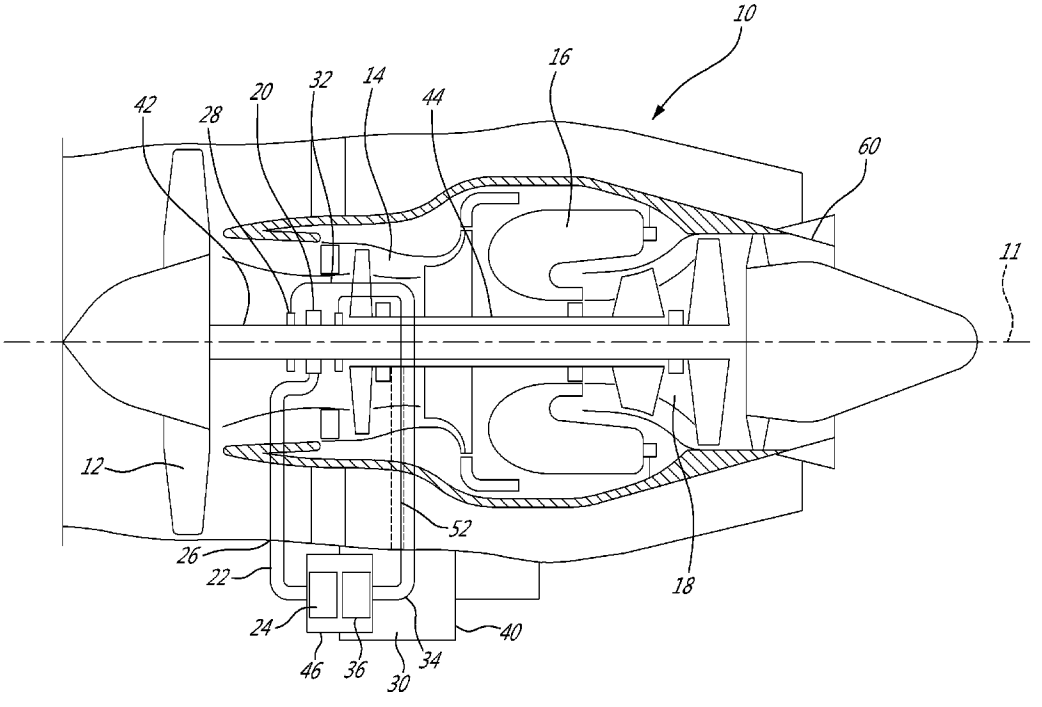
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(54) Titre : MOTEUR D`AERONEF ET SYSTEME DE SEPARATION AIR-HUILE POUR CE DERNIER

(54) Title: AIRCRAFT ENGINE AND AIR-OIL SEPARATOR SYSTEM THEREFORE



(57) Abrégé/Abstract:
The aircraft engine can have an air-oil separator having an air-oil mixture inlet, an oil outlet, an air outlet, and a pressure relief path provided fluidly in parallel with the air-oil separator, between the air-oil mixture inlet and the air outlet, the pressure relief path can have a pressure relief valve for evacuating air-oil mixture to the exhaust duct in the event of excess pressure in the auxiliary gearbox.

ABSTRACT

The aircraft engine can have an air-oil separator having an air-oil mixture inlet, an oil outlet, an air outlet, and a pressure relief path provided fluidly in parallel with the air-oil separator, between the air-oil mixture inlet and the air outlet, the pressure relief path can have a pressure relief valve for evacuating air-oil mixture to the exhaust duct in the event of excess pressure in the auxiliary gearbox.

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AIRCRAFT ENGINE AND AIR-OIL SEPARATOR SYSTEM THEREFORE

TECHNICAL FIELD

The application related generally to gas turbine engines and, more particularly, to air-oil separators thereof.

BACKGROUND OF THE ART

In certain operating conditions, the flow through the air-oil separator can exceed capacity. If the air-oil separator is in an accessory gearbox for instance, this can lead to an undesired increase in pressure in the accessory gearbox. Increasing the capacity of the air-oil separator can alleviate this issue, but at the expense of an increase in weight and/or cost. Accordingly, there remained room for improvement.

SUMMARY

In one aspect, there is provided an aircraft engine comprising an air-oil separator having an air-oil mixture inlet, an oil outlet, an air outlet, and a pressure relief path provided fluidly in parallel with the air-oil separator, between the air-oil mixture inlet and the air outlet, the pressure relief path having a pressure relief valve.

In another aspect, there is provided an air-oil separator for an aircraft engine, the air-oil separator having a rotary shaft configured to be assembled into an accessory gearbox, an annular housing concentric to a rotary shaft, the annular housing having a separator media therein, an air-oil mixture inlet leading into the annular housing, an oil outlet provided radially outwardly through the annular housing, an air outlet provided radially inwardly through the annular housing and leading into an axial conduit formed inside the shaft and leading outside of the accessory gearbox, a bypass conduit formed axially inside the shaft, provided in parallel with the air-oil separator, the bypass conduit communicating with the axial conduit via pressure relief valve.

In a further aspect, there is provided a method of evacuating pressure from an accessory gearbox of a gas turbine engine, the method comprising, simultaneously and in parallel : conveying an air-oil mixture across a separator media of an air-oil separator,

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and out from the accessory gearbox; and conveying the air-oil mixture directly out from the accessory gearbox across a pressure relief valve, against a biasing force of the pressure relief valve; until the pressure becomes weaker than the biasing force of the pressure relief valve.

DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying figures in which:

Fig. 1 is a schematic cross-sectional view of a gas turbine engine;

Fig. 2 is a block diagram of an accessory gearbox having an air-oil separator;

Fig. 3A is a cross-sectional view of an air-oil separator in an accessory gearbox, in accordance with an embodiment;

Fig. 3B is a view similar to Fig. 3A, showing a pressure relief valve in an open configuration, opening a bypass path to the air-oil separator;

Fig. 4 is an oblique cross-section view of the accessory gearbox of Fig 3A, showing the pressure relief valve, in greater detail;

Fig. 5 is an oblique view of the pressure relief valve, shown alone.

DETAILED DESCRIPTION

Fig. 1 illustrated a gas turbine engine 10 of a type preferably provided for use in subsonic flight, generally comprising in serial flow communication a fan 12 through which ambient air is propelled, a compressor section 14 for pressurizing the air, a combustor 16 in which the compressed air is mixed with fuel and ignited for generating an annular stream of hot combustion gases, and a turbine section 18 for extracting energy from the combustion gases.

The compressor 14, fan 12 and turbine 18 have rotating components which can be mounted on one or more shafts. Bearings 20 are used to provide smooth relative rotation between a shaft and casing (non-rotating component), and/or between two

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shafts which rotate at different speeds. An oil lubrication system 22 including an oil pump 24, sometimes referred to as a main pump, and a network of conduits and nozzles 26, is provided to feed the bearings 20 with oil. Seals 28 are used to contain the oil. A scavenge system 30 having cavities 32, conduits 34, and one or more scavenge pumps 36, is used to recover the oil, which can be in the form of an oil foam at that stage, from the bearings 20.

The gas turbine engine also has an accessory gearbox 40 which derives power from a corresponding one of the shafts 42, 44. The accessory gearbox 40 can be positioned in a lower portion of the gas turbine engine 10, and can have a sump 40 lower than the oil level in an oil tank. One or more intermediary shafts and gearing can provide power to the accessory gearbox 40. In this example, a vertical intermediary shaft 52 having gears engaged with corresponding gears on the corresponding compressor/turbine rotor can be engaged, in the accessory gearbox, with a gearbox shaft (see Fig. 2), via appropriate gearing (not shown). The shaft 62 can power various accessories of the gas turbine engine 10, such as electrical generators, oil and fuel pumps, and/or hydraulic pumps through a gear train, or receive power from an engine starter, for instance. The gear train can require oil for lubrication. The oil tank 46 can be external or internal.

The accessory gearbox 40 can be installed under the main engine casing, or at another low point on the engine architecture. The oil tank can be attached to the AGB 40 or mounted above it onto the engine casing, to name two examples. A scavenge pump 36 can be used to pump oil from the sump of the accessory gearbox 40 back into the oil tank 46. The scavenge pump 36 can be powered by the output shaft of the accessory gearbox 40.

Fig. 2 shows a simplified block diagram of an accessory gearbox 40, oil tank 46, scavenge pump 36 and main pump 24, in accordance with an embodiment. An air-oil separator 64 has an annular housing 66 concentric to the rotary shaft 62 and configured to rotate with the shaft 62. The rotation of the shaft 62 can impart centrifugal acceleration in the air-oil separator 64 which can be a factor separating the heavier oil, typically evacuated radially outwardly, from the lighter air, typically evacuated radially

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inwardly via a conduit formed axially in the shaft 62. The annular housing 66 of the air-oil separator 64 can be manufactured as one or more components which are later assembled to the shaft 62, or can be manufactured integrally with the shaft, such as by 3D printing or moulding, for instance. The air-oil separator 64 typically has an air-oil separator media 68, such as a wire mesh for instance, provided inside the annular housing 66, to increase the efficiency of the centrifugal air-oil separating effect. The inlet of the air-oil separator, which can be referred to as the air-oil inlet 70, can be axial, for instance. Some air-oil separators have more complex designs and can include more than one separation stage, for instance.

In the illustrated embodiment, the path formed through the air-oil separator 40, and extending more specifically from the air-oil separator inlet 70 to the air-oil separator outlet 78 can be referred to as the primary air path 75. The air-oil separator can have an radially-outward oil outlet 73. A pressure relief path 72, which can be considered as forming a secondary air path in this embodiment, is provided fluidly in parallel to the primary air path 75. In other words, the pressure relief path 72 can have an inlet 74 open to a first fluidic environment, the air-oil separator inlet 70 also being open to the first fluidic environment. The pressure relief path 72 can have an outlet 76 open to a second fluidic environment, the air outlet 78 of the air-oil separator also being open to the second fluidic environment. It can be preferred, for various reasons, that the air outlet 78 and the pressure relief path outlet 76 lead to an exhaust duct 60 of the gas turbine engine 10, for any remaining oil to be burned. The pressure relief path 72 is distinct, and thus partitioned, from the air-oil separator path (the latter path being between the inlet 70 and the air outlet 78 of the air-oil separator). Fluid flow through the pressure relief path can be controlled by a pressure relief valve 80. Accordingly, during operation, if the flow across the air-oil separator 64 exceeds the air-oil separator's capacity, and the pressure in the auxiliary gearbox 40 increases as a result of this condition, the increasing pressure can become stronger than a bias of the pressure relief valve 80, and force the pressure relief valve 80 into an open configuration. In the open configuration, a mixture of oil and air can directly exit the auxiliary gearbox 40, bypassing the air-oil separator 64, reducing the pressure in the auxiliary gearbox 40. The oil in the mixture of oil and air can be burned in the exhaust duct 60, which can be preferred to the alternative of sustaining the condition of excess pressure in the

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auxiliary gearbox 40. In practice, the outlets 76, 78 of the air-oil separator 64 and of the pressure relief path 72 can be combined into a single conduit or path leading to the exhaust duct 60, or to another location deemed satisfactory in the exact circumstances of use.

Figs. 3A to 5 show a specific example of a possible implementation. Referring first to Fig. 3A, the annular housing 166 of the air-oil separator 164 can have a plurality of apertures 170 in a radially-outer wall, forming a radially outward oil outlet, and a plurality of apertures 184 in a radially-inner wall, forming a radially inward air outlet leading into a hollow cavity 186, forming a conduit, in the rotary shaft 162 to which the air-oil separator 164 is mounted.

In this example, the pressure relief path includes a bypass conduit 188 also formed axially inside the shaft 162, in a distinct, adjacent section of the shaft 162. The bypass conduit 188 communicates with the axial conduit 186 via a pressure relief valve 180. Accordingly, if pressure exceeds a given threshold in the auxiliary gearbox, it will displace a piston head 192 of the valve 180 against the bias exerted by a spring 194, slide a stem 196 of the piston inside a valve body 198 into the configuration shown in Fig. 3B, and allow the mixture of air and oil through the pressure relief valve 180, into the axial conduit 186. Some of these latter components are better shown in Figs. 4 and 5. As more specifically shown in Fig. 5, the valve body 198 can have a plurality of circumferentially interspaced holding members 200 mounted to the shaft , and bypass openings 202 between the holding members 200.

Accordingly, a pressure relief valve can be provided inside the shaft that contains an air-oil separator in the AGB. This can allow an alternate path for the excess air to flow around the blocked air-oil separator. The air/oil mist flowing through this valve can exit to the same point that air/oil normally flowing through the AGB exits, which can avoid having to add a special AGB exhaust. The valve spring can be designed to open the valve at a preset point to avoid excess pressure in the AGB; the oil tank can be vented to the AGB and can thus be protected as well. The valve system can be fully automatic and only function when excess pressure is detected, and re-set when the pressure returns to normal; which can be a relatively quick occurrence, once the excess oil is

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blown out the separator/valve assembly. It will be noted that in the illustrated embodiment, the inlet of both the pressure relief path and of the air-oil separator are in the AGB and are configured to receive a mixture of air and oil therefrom. It will also be noted that in the illustrated embodiment, the outlet paths of both the air-oil separator and of the pressure relief path combine, and are combined in a conduit extending outside the AGB.

The pressure relief path can be retrofit into an existing engines, such as when embodied in a manner similar to the one shown in Figs. 3A to 5, simply by changing a rotary shaft to one which incorporates a bypass conduit with a pressure relief valve. The system can be self-contained within the AGB breather shaft.

The above description is meant to be exemplary only, and one skilled in the art will recognize that changes may be made to the embodiments described without departing from the scope of the invention disclosed. Still other modifications which fall within the scope of the present invention will be apparent to those skilled in the art, in light of a review of this disclosure, and such modifications are intended to fall within the appended claims.

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CLAIMS

1. An aircraft engine comprising an air-oil separator having an air-oil mixture inlet, an oil outlet, an air outlet, a primary air path extending from the air-oil mixture inlet to the air outlet, and a pressure relief path provided fluidly in parallel with the primary air path , the pressure relief path having a pressure relief valve.

2. The aircraft engine of claim 1 wherein the pressure relief path has an outlet fluidly combining with the air outlet of the air-oil separator.

3. The aircraft engine of claim 2 wherein the air outlet of the air-oil separator and the outlet of the pressure relief path are fluidly connected to an exhaust duct of the aircraft engine.

4. The aircraft engine of claim 3 wherein the aircraft engine is a gas turbine engine having in serial flow communication a compressor section, a combustor, a turbine section, and the exhaust duct, the compressor section and turbine section having at least one rotor including compressor blades and turbine blades mounted to a common shaft.

5. The aircraft engine of claim 1 wherein the air-oil separator includes an annular housing concentric to a rotary shaft, the annular housing having a separator media therein, and a separator path extending from the air-oil mixture inlet to the outlets across the separator media.

6. The aircraft engine of claim 5 wherein the air-oil separator includes oil outlets provided radially outwardly of the annular housing and air outlets leading radially inwardly into a cavity extending axially within the rotary shaft.

7. The aircraft engine of claim 1 wherein the air-oil separator is provided inside an accessory gearbox.

8. The aircraft engine of claim 7 wherein the air-oil separator has an annular housing concentric to a starter shaft of the accessory gearbox.

9. The aircraft engine of claim 1 wherein the air-oil separator is mounted annularly around a rotary shaft.

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10. The aircraft engine of claim 9 wherein the oil outlet is radially external to the air-oil separator, and the air outlet is radially internal to the air-oil separator, leading into an axial conduit formed inside the shaft.

11. The aircraft engine of claim 10 wherein the pressure relief path includes a bypass conduit formed axially inside the shaft, the bypass conduit communicating with the axial conduit via pressure relief valve.

12. The aircraft engine of claim 11 wherein the pressure relief valve has a piston head spring-biased against a valve seat, the piston having a stem slidingly mounted in a valve body.

13. The aircraft engine of claim 12 wherein the valve body has a plurality of circumferentially interspaced holding members mounted to the shaft, and bypass openings between the holding members.

14. The aircraft engine of claim 1 wherein the pressure relief path has an inlet open to a first fluidic environment of the air-oil mixture inlet, and an outlet fluidly communicating with a second fluidic environment of the air outlet, the pressure relief path being partitioned from a fluid path extending between the air-oil mixture inlet and the air outlet, across the air-oil separator.

15. An air-oil separator for an aircraft engine, the air-oil separator having a rotary shaft configured to be assembled into an accessory gearbox, an annular housing concentric to a rotary shaft, the annular housing having a separator media therein, an air-oil mixture inlet leading into the annular housing, an oil outlet provided radially outwardly through the annular housing, an air outlet provided radially inwardly through the annular housing and leading into an axial conduit formed inside the shaft and leading outside of the accessory gearbox, a bypass conduit formed axially inside the shaft, provided in parallel with the air-oil separator, the bypass conduit communicating with the axial conduit via pressure relief valve.

16. The aircraft engine of claim 15 wherein the pressure relief valve has a piston head spring-biased against a valve seat, the piston having a stem slidingly mounted in a valve body.

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17. The aircraft engine of claim 16 wherein the valve body has a plurality of circumferentially interspaced holding members mounted to the shaft, and bypass openings between the holding members.

18. A method of evacuating pressure from an accessory gearbox of a gas turbine engine, the method comprising, simultaneously and in parallel :

conveying an air-oil mixture across a separator media of an air-oil separator, and out from the accessory gearbox; and

conveying the air-oil mixture directly out from the accessory gearbox across a pressure relief valve, against a bias of the pressure relief valve;

until the pressure becomes weaker than the bias of the pressure relief valve.

19. The method of claim 18 wherein the air-oil mixture conveyed in parallel across the separator media and across the pressure relief valve are conveyed into an exhaust duct of the gas turbine engine.

20. The method of claim 19 further comprising combining the air-oil mixture conveyed in across the separator media the air-oil mixture conveyed across the pressure relief valve prior to reaching the exhaust duct.

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NORTON ROSE FULBRIGHT

June 30, 2020

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Electronically Submitted

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Our reference
05002993-2598CA

New Canadian Patent Application
Title: AIRCRAFT ENGINE AND AIR-OIL SEPARATOR SYSTEM THEREFORE
Applicant: PRATT & WHITNEY CANADA CORP.

The Applicant, PRATT & WHITNEY CANADA CORP., wishes to file the enclosed Patent application in Canada. The attached Schedule sets out the details of the application and lists our enclosures and payments.

STATEMENT OF ENTITLEMENT

Attached is a statement of entitlement in compliance with section 54 of the *Patent Rules*.

PRIORITY APPLICATION

Pursuant to paragraph 74(1)(b) of the *Patent Rules*, the Applicant informs the Commissioner that the priority patent application is available through the USPTO digital library and that the access code is 1465.

The prescribed fees of **$400.00** are being processed with this submission by credit card using the secure online payment system.

Should the fees submitted be insufficient to cover all of the fees for which payment is explicitly or implicitly requested, the Canadian Intellectual Property Office is authorized to charge the amount of the insufficiency to the Visa account of Norton Rose Fulbright Canada LLP (ending with 2079) as a primary credit card or an alternate VISA (ending with 0777) both on file at CIPO.

Respectfully,

NORTON ROSE FULBRIGHT CANADA LLP/S.E.N.C.R.L., s.r.l.

Norton Rose Fulbright Canada LLP/S.E.N.C.R.L., s.r.l.

Agents for the Applicant

ADA-mm

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SCHEDULE

REGULAR CANADIAN FILING **Applicant: PRATT & WHITNEY CANADA CORP.** **Our Ref.: 05002993-2598CA**	FEE ITEM	INCLUDED
Petition	•	X
Priority Claim		X
Request to Restore Priority		
Certified Copy(ies) of Priority Application(s)		X
Description: Pages 1 to 6		X
Claims: Pages 7 to 9		X
Abstract		X
Drawings: Pages 1 to 4		X
Statement of Entitlement		X
Small Entity Declaration		
Title Document(s)	•	
Sequence Listing in Electronic Form		
Examination Request	•	
Advanced Examination Request	•	
Accelerated Examination Request (PPH)		
FEES PAID		**AMOUNT**
Filing Fee	$	400.00
Title Document Recordal Fee	$	0.00
Examination Fee	$	0.00
Advanced Examination Fee	$	0.00
TOTAL:	$	400.00

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Our Reference: 05002993-2598CA ADA-mm

PETITION FOR GRANT OF A PATENT

1. The applicant, PRATT & WHITNEY CANADA CORP. whose complete address is 1000 Marie Victorin, Longueuil Québec J4G 1A1, Canada, requests the grant of a patent for an invention, entitled AIRCRAFT ENGINE AND AIR-OIL SEPARATOR SYSTEM THEREFORE, which is described and claimed in the accompanying specification.

2. The inventors are:

Inventors	Complete Address
KOSTKA, Richard	15990 Mount Pleasant Rd., Bolton ON L7E 3M5, Canada
MENHEERE, David	10204 Old Pine Crest Road, Norval ON L0P 1K0, Canada

3. The applicant requests priority in respect of the application on the basis of the following previously regularly filed application(s):

Country of filing	Application number	Filing date
United States	16/460,067	July 2, 2019

4. The applicant appoints **NORTON ROSE FULBRIGHT CANADA LLP/S.E.N.C.R.L., S.R.L.**, whose complete address is Suite 2500, 1 Place Ville Marie, Montréal, Québec, H3B 1R1, Tel. 418.640.5182, Fax. 418.640.1500 as the applicant's representative in Canada.

5. The applicant appoints **NORTON ROSE FULBRIGHT CANADA LLP/S.E.N.C.R.L., S.R.L** whose complete address is Suite 2500, 1 Place Ville Marie, Montréal, Québec, H3B 1R1, Tel 418.640.5182, Fax. 418.640.1500, as the applicant's patent agent.

6. The applicant requests that Figure No. 1 of the drawings accompany the abstract when it is open to public inspection under section 10(2) of the *Patent Act* or published.

NORTON ROSE FULBRIGHT CANADA LLP/S.E.N.C.R.L., s.r.l.

Norton Rose Fulbright Canada LLP/S.E.N.C.R.L., s.r.l.

Agents for the Applicant

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Our Reference :05002993-2598CA ADA-mm

STATEMENT OF ENTITLEMENT

TO: The Commissioner of Patents
Canadian Intellectual Property Office
Place du Portage I, Room C-114
50 Victoria Street
Gatineau, Québec K1A 0C9

IN THE MATTER OF a new Canadian Patent application
in the name of PRATT & WHITNEY CANADA CORP.
entitled AIRCRAFT ENGINE AND AIR-OIL SEPARATOR SYSTEM
THEREFORE

Pursuant to paragraph 54(2)(a) of the *Patent Rules*:

The Applicant is entitled to apply for a patent.

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AIRCRAFT ENGINE AND AIR-OIL SEPARATOR SYSTEM THEREFORE

TECHNICAL FIELD

The application related generally to gas turbine engines and, more particularly, to air-oil separators thereof.

BACKGROUND OF THE ART

In certain operating conditions, the flow through the air-oil separator can exceed capacity. If the air-oil separator is in an accessory gearbox for instance, this can lead to an undesired increase in pressure in the accessory gearbox. Increasing the capacity of the air-oil separator can alleviate this issue, but at the expense of an increase in weight and/or cost. Accordingly, there remained room for improvement.

SUMMARY

In one aspect, there is provided an aircraft engine comprising an air-oil separator having an air-oil mixture inlet, an oil outlet, an air outlet, and a pressure relief path provided fluidly in parallel with the air-oil separator, between the air-oil mixture inlet and the air outlet, the pressure relief path having a pressure relief valve.

In another aspect, there is provided an air-oil separator for an aircraft engine, the air-oil separator having a rotary shaft configured to be assembled into an accessory gearbox, an annular housing concentric to a rotary shaft, the annular housing having a separator media therein, an air-oil mixture inlet leading into the annular housing, an oil outlet provided radially outwardly through the annular housing, an air outlet provided radially inwardly through the annular housing and leading into an axial conduit formed inside the shaft and leading outside of the accessory gearbox, a bypass conduit formed axially inside the shaft, provided in parallel with the air-oil separator, the bypass conduit communicating with the axial conduit via pressure relief valve.

In a further aspect, there is provided a method of evacuating pressure from an accessory gearbox of a gas turbine engine, the method comprising, simultaneously and in parallel : conveying an air-oil mixture across a separator media of an air-oil separator,

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and out from the accessory gearbox; and conveying the air-oil mixture directly out from the accessory gearbox across a pressure relief valve, against a biasing force of the pressure relief valve; until the pressure becomes weaker than the biasing force of the pressure relief valve.

DESCRIPTION OF THE DRAWINGS

Reference is now made to the accompanying figures in which:

Fig. 1 is a schematic cross-sectional view of a gas turbine engine;

Fig. 2 is a block diagram of an accessory gearbox having an air-oil separator;

Fig. 3A is a cross-sectional view of an air-oil separator in an accessory gearbox, in accordance with an embodiment;

Fig. 3B is a view similar to Fig. 3A, showing a pressure relief valve in an open configuration, opening a bypass path to the air-oil separator;

Fig. 4 is an oblique cross-section view of the accessory gearbox of Fig 3A, showing the pressure relief valve, in greater detail;

Fig. 5 is an oblique view of the pressure relief valve, shown alone.

DETAILED DESCRIPTION

Fig. 1 illustrated a gas turbine engine 10 of a type preferably provided for use in subsonic flight, generally comprising in serial flow communication a fan 12 through which ambient air is propelled, a compressor section 14 for pressurizing the air, a combustor 16 in which the compressed air is mixed with fuel and ignited for generating an annular stream of hot combustion gases, and a turbine section 18 for extracting energy from the combustion gases.

The compressor 14, fan 12 and turbine 18 have rotating components which can be mounted on one or more shafts. Bearings 20 are used to provide smooth relative rotation between a shaft and casing (non-rotating component), and/or between two

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shafts which rotate at different speeds. An oil lubrication system 22 including an oil pump 24, sometimes referred to as a main pump, and a network of conduits and nozzles 26, is provided to feed the bearings 20 with oil. Seals 28 are used to contain the oil. A scavenge system 30 having cavities 32, conduits 34, and one or more scavenge pumps 36, is used to recover the oil, which can be in the form of an oil foam at that stage, from the bearings 20.

The gas turbine engine also has an accessory gearbox 40 which derives power from a corresponding one of the shafts 42, 44. The accessory gearbox 40 can be positioned in a lower portion of the gas turbine engine 10, and can have a sump 40 lower than the oil level in an oil tank. One or more intermediary shafts and gearing can provide power to the accessory gearbox 40. In this example, a vertical intermediary shaft 52 having gears engaged with corresponding gears on the corresponding compressor/turbine rotor can be engaged, in the accessory gearbox, with a gearbox shaft (see Fig. 2), via appropriate gearing (not shown). The shaft 62 can power various accessories of the gas turbine engine 10, such as electrical generators, oil and fuel pumps, and/or hydraulic pumps through a gear train, or receive power from an engine starter, for instance. The gear train can require oil for lubrication. The oil tank 46 can be external or internal.

The accessory gearbox 40 can be installed under the main engine casing, or at another low point on the engine architecture. The oil tank can be attached to the AGB 40 or mounted above it onto the engine casing, to name two examples. A scavenge pump 36 can be used to pump oil from the sump of the accessory gearbox 40 back into the oil tank 46. The scavenge pump 36 can be powered by the output shaft of the accessory gearbox 40.

Fig. 2 shows a simplified block diagram of an accessory gearbox 40, oil tank 46, scavenge pump 36 and main pump 24, in accordance with an embodiment. An air-oil separator 64 has an annular housing 66 concentric to the rotary shaft 62 and configured to rotate with the shaft 62. The rotation of the shaft 62 can impart centrifugal acceleration in the air-oil separator 64 which can be a factor separating the heavier oil, typically evacuated radially outwardly, from the lighter air, typically evacuated radially

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inwardly via a conduit formed axially in the shaft 62. The annular housing 66 of the air-oil separator 64 can be manufactured as one or more components which are later assembled to the shaft 62, or can be manufactured integrally with the shaft, such as by 3D printing or moulding, for instance. The air-oil separator 64 typically has an air-oil separator media 68, such as a wire mesh for instance, provided inside the annular housing 66, to increase the efficiency of the centrifugal air-oil separating effect. The inlet of the air-oil separator, which can be referred to as the air-oil inlet 70, can be axial, for instance. Some air-oil separators have more complex designs and can include more than one separation stage, for instance.

In the illustrated embodiment, the path formed through the air-oil separator 40, and extending more specifically from the air-oil separator inlet 70 to the air-oil separator outlet 78 can be referred to as the primary air path 75. The air-oil separator can have an radially-outward oil outlet 73. A pressure relief path 72, which can be considered as forming a secondary air path in this embodiment, is provided fluidly in parallel to the primary air path 75. In other words, the pressure relief path 72 can have an inlet 74 open to a first fluidic environment, the air-oil separator inlet 70 also being open to the first fluidic environment. The pressure relief path 72 can have an outlet 76 open to a second fluidic environment, the air outlet 78 of the air-oil separator also being open to the second fluidic environment. It can be preferred, for various reasons, that the air outlet 78 and the pressure relief path outlet 76 lead to an exhaust duct 60 of the gas turbine engine 10, for any remaining oil to be burned. The pressure relief path 72 is distinct, and thus partitioned, from the air-oil separator path (the latter path being between the inlet 70 and the air outlet 78 of the air-oil separator). Fluid flow through the pressure relief path can be controlled by a pressure relief valve 80. Accordingly, during operation, if the flow across the air-oil separator 64 exceeds the air-oil separator's capacity, and the pressure in the auxiliary gearbox 40 increases as a result of this condition, the increasing pressure can become stronger than a bias of the pressure relief valve 80, and force the pressure relief valve 80 into an open configuration. In the open configuration, a mixture of oil and air can directly exit the auxiliary gearbox 40, bypassing the air-oil separator 64, reducing the pressure in the auxiliary gearbox 40. The oil in the mixture of oil and air can be burned in the exhaust duct 60, which can be preferred to the alternative of sustaining the condition of excess pressure in the

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auxiliary gearbox 40. In practice, the outlets 76, 78 of the air-oil separator 64 and of the pressure relief path 72 can be combined into a single conduit or path leading to the exhaust duct 60, or to another location deemed satisfactory in the exact circumstances of use.

Figs. 3A to 5 show a specific example of a possible implementation. Referring first to Fig. 3A, the annular housing 166 of the air-oil separator 164 can have a plurality of apertures 170 in a radially-outer wall, forming a radially outward oil outlet, and a plurality of apertures 184 in a radially-inner wall, forming a radially inward air outlet leading into a hollow cavity 186, forming a conduit, in the rotary shaft 162 to which the air-oil separator 164 is mounted.

In this example, the pressure relief path includes a bypass conduit 188 also formed axially inside the shaft 162, in a distinct, adjacent section of the shaft 162. The bypass conduit 188 communicates with the axial conduit 186 via a pressure relief valve 180. Accordingly, if pressure exceeds a given threshold in the auxiliary gearbox, it will displace a piston head 192 of the valve 180 against the bias exerted by a spring 194, slide a stem 196 of the piston inside a valve body 198 into the configuration shown in Fig. 3B, and allow the mixture of air and oil through the pressure relief valve 180, into the axial conduit 186. Some of these latter components are better shown in Figs. 4 and 5. As more specifically shown in Fig. 5, the valve body 198 can have a plurality of circumferentially interspaced holding members 200 mounted to the shaft , and bypass openings 202 between the holding members 200.

Accordingly, a pressure relief valve can be provided inside the shaft that contains an air-oil separator in the AGB. This can allow an alternate path for the excess air to flow around the blocked air-oil separator. The air/oil mist flowing through this valve can exit to the same point that air/oil normally flowing through the AGB exits, which can avoid having to add a special AGB exhaust. The valve spring can be designed to open the valve at a preset point to avoid excess pressure in the AGB; the oil tank can be vented to the AGB and can thus be protected as well. The valve system can be fully automatic and only function when excess pressure is detected, and re-set when the pressure returns to normal; which can be a relatively quick occurrence, once the excess oil is

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blown out the separator/valve assembly. It will be noted that in the illustrated embodiment, the inlet of both the pressure relief path and of the air-oil separator are in the AGB and are configured to receive a mixture of air and oil therefrom. It will also be noted that in the illustrated embodiment, the outlet paths of both the air-oil separator and of the pressure relief path combine, and are combined in a conduit extending outside the AGB.

The pressure relief path can be retrofit into an existing engines, such as when embodied in a manner similar to the one shown in Figs. 3A to 5, simply by changing a rotary shaft to one which incorporates a bypass conduit with a pressure relief valve. The system can be self-contained within the AGB breather shaft.

The above description is meant to be exemplary only, and one skilled in the art will recognize that changes may be made to the embodiments described without departing from the scope of the invention disclosed. Still other modifications which fall within the scope of the present invention will be apparent to those skilled in the art, in light of a review of this disclosure, and such modifications are intended to fall within the appended claims.

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CLAIMS

1. An aircraft engine comprising an air-oil separator having an air-oil mixture inlet, an oil outlet, an air outlet, a primary air path extending from the air-oil mixture inlet to the air outlet, and a pressure relief path provided fluidly in parallel with the primary air path , the pressure relief path having a pressure relief valve.

2. The aircraft engine of claim 1 wherein the pressure relief path has an outlet fluidly combining with the air outlet of the air-oil separator.

3. The aircraft engine of claim 2 wherein the air outlet of the air-oil separator and the outlet of the pressure relief path are fluidly connected to an exhaust duct of the aircraft engine.

4. The aircraft engine of claim 3 wherein the aircraft engine is a gas turbine engine having in serial flow communication a compressor section, a combustor, a turbine section, and the exhaust duct, the compressor section and turbine section having at least one rotor including compressor blades and turbine blades mounted to a common shaft.

5. The aircraft engine of claim 1 wherein the air-oil separator includes an annular housing concentric to a rotary shaft, the annular housing having a separator media therein, and a separator path extending from the air-oil mixture inlet to the outlets across the separator media.

6. The aircraft engine of claim 5 wherein the air-oil separator includes oil outlets provided radially outwardly of the annular housing and air outlets leading radially inwardly into a cavity extending axially within the rotary shaft.

7. The aircraft engine of claim 1 wherein the air-oil separator is provided inside an accessory gearbox.

8. The aircraft engine of claim 7 wherein the air-oil separator has an annular housing concentric to a starter shaft of the accessory gearbox.

9. The aircraft engine of claim 1 wherein the air-oil separator is mounted annularly around a rotary shaft.

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10. The aircraft engine of claim 9 wherein the oil outlet is radially external to the air-oil separator, and the air outlet is radially internal to the air-oil separator, leading into an axial conduit formed inside the shaft.

11. The aircraft engine of claim 10 wherein the pressure relief path includes a bypass conduit formed axially inside the shaft, the bypass conduit communicating with the axial conduit via pressure relief valve.

12. The aircraft engine of claim 11 wherein the pressure relief valve has a piston head spring-biased against a valve seat, the piston having a stem slidingly mounted in a valve body.

13. The aircraft engine of claim 12 wherein the valve body has a plurality of circumferentially interspaced holding members mounted to the shaft, and bypass openings between the holding members.

14. The aircraft engine of claim 1 wherein the pressure relief path has an inlet open to a first fluidic environment of the air-oil mixture inlet, and an outlet fluidly communicating with a second fluidic environment of the air outlet, the pressure relief path being partitioned from a fluid path extending between the air-oil mixture inlet and the air outlet, across the air-oil separator.

15. An air-oil separator for an aircraft engine, the air-oil separator having a rotary shaft configured to be assembled into an accessory gearbox, an annular housing concentric to a rotary shaft, the annular housing having a separator media therein, an air-oil mixture inlet leading into the annular housing, an oil outlet provided radially outwardly through the annular housing, an air outlet provided radially inwardly through the annular housing and leading into an axial conduit formed inside the shaft and leading outside of the accessory gearbox, a bypass conduit formed axially inside the shaft, provided in parallel with the air-oil separator, the bypass conduit communicating with the axial conduit via pressure relief valve.

16. The aircraft engine of claim 15 wherein the pressure relief valve has a piston head spring-biased against a valve seat, the piston having a stem slidingly mounted in a valve body.

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17. The aircraft engine of claim 16 wherein the valve body has a plurality of circumferentially interspaced holding members mounted to the shaft, and bypass openings between the holding members.

18. A method of evacuating pressure from an accessory gearbox of a gas turbine engine, the method comprising, simultaneously and in parallel :

conveying an air-oil mixture across a separator media of an air-oil separator, and out from the accessory gearbox; and

conveying the air-oil mixture directly out from the accessory gearbox across a pressure relief valve, against a bias of the pressure relief valve;

until the pressure becomes weaker than the bias of the pressure relief valve.

19. The method of claim 18 wherein the air-oil mixture conveyed in parallel across the separator media and across the pressure relief valve are conveyed into an exhaust duct of the gas turbine engine.

20. The method of claim 19 further comprising combining the air-oil mixture conveyed in across the separator media the air-oil mixture conveyed across the pressure relief valve prior to reaching the exhaust duct.

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ABSTRACT

The aircraft engine can have an air-oil separator having an air-oil mixture inlet, an oil outlet, an air outlet, and a pressure relief path provided fluidly in parallel with the air-oil separator, between the air-oil mixture inlet and the air outlet, the pressure relief path can have a pressure relief valve for evacuating air-oil mixture to the exhaust duct in the event of excess pressure in the auxiliary gearbox.

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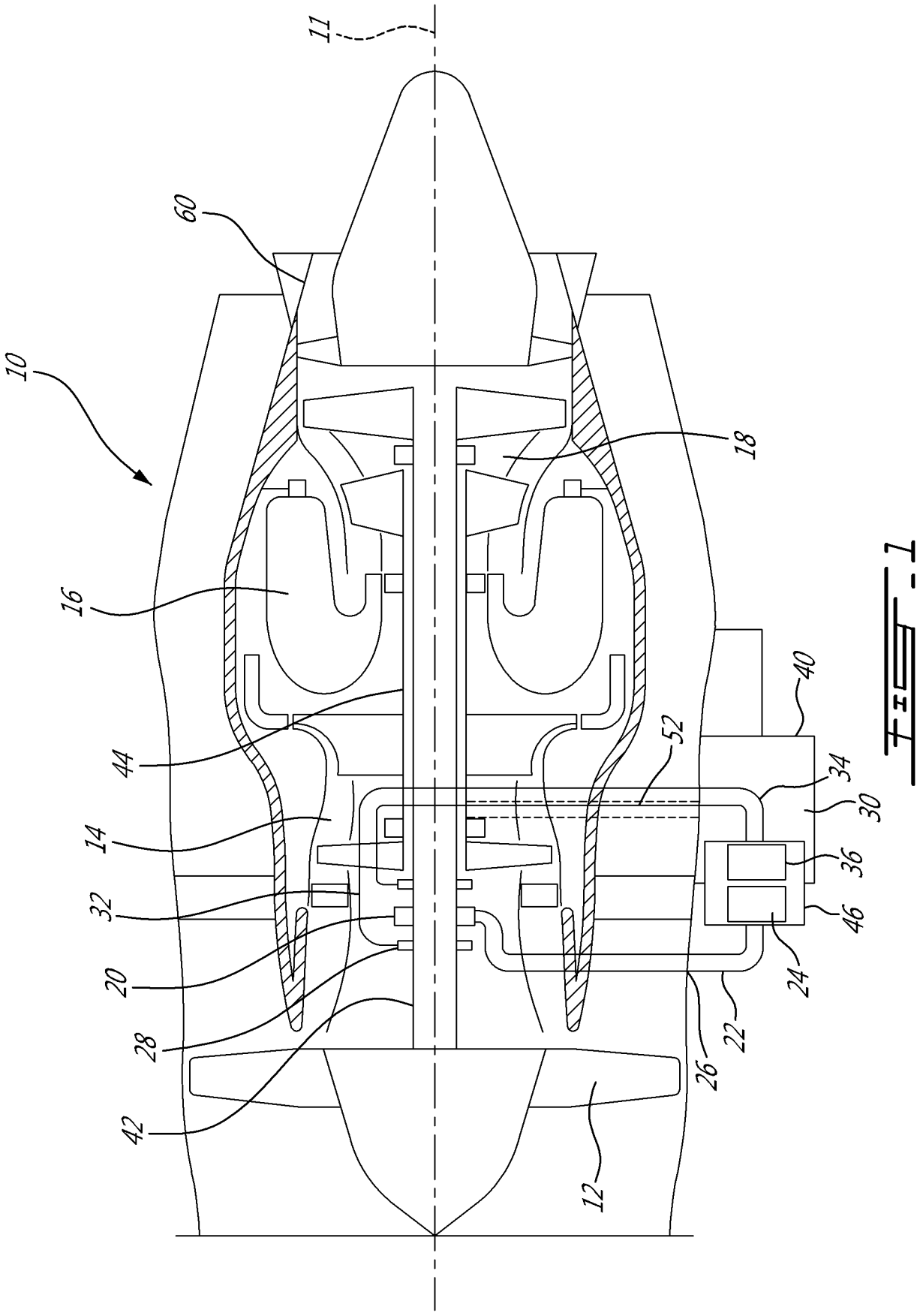


Fig. 1

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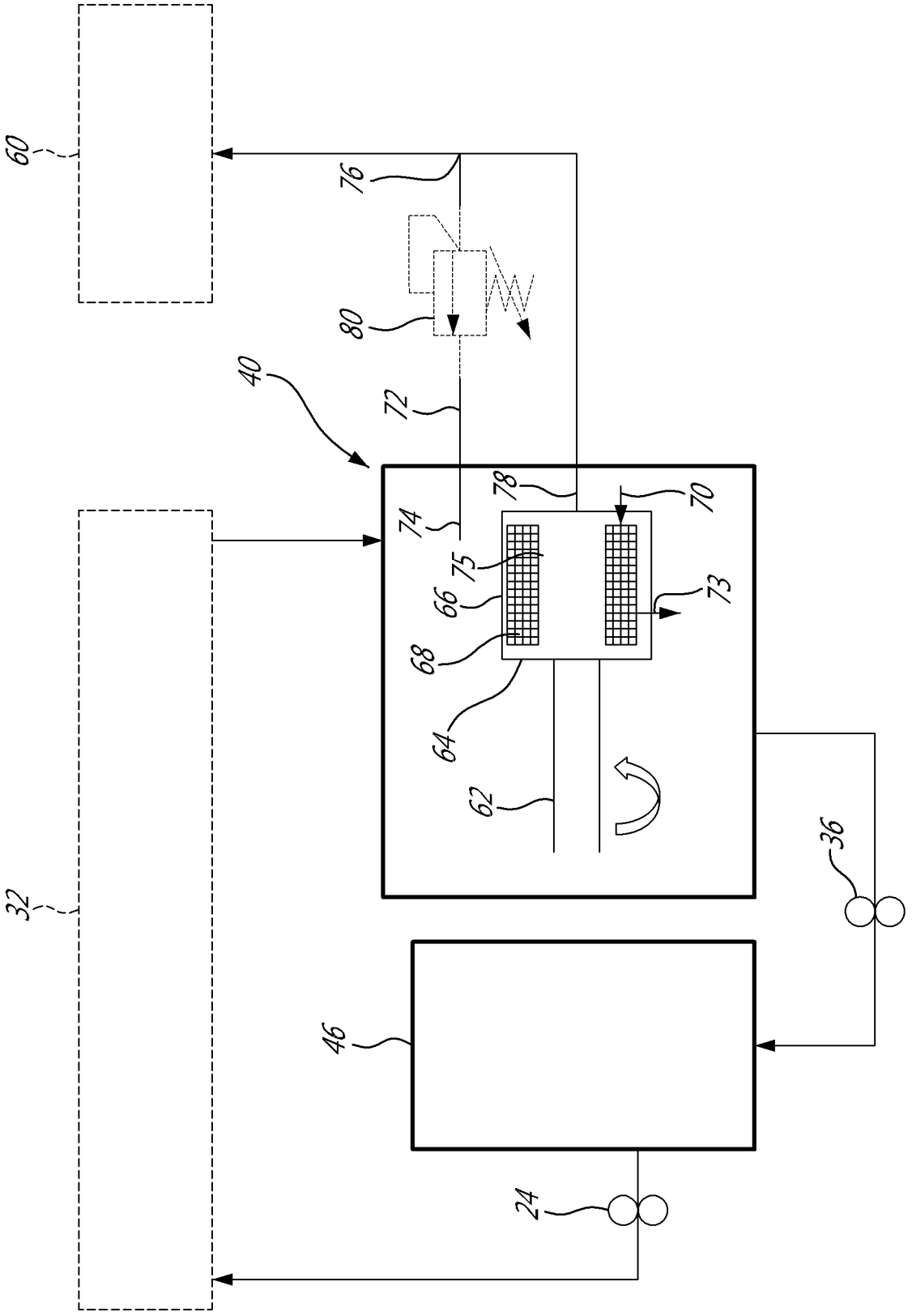


Fig - 2

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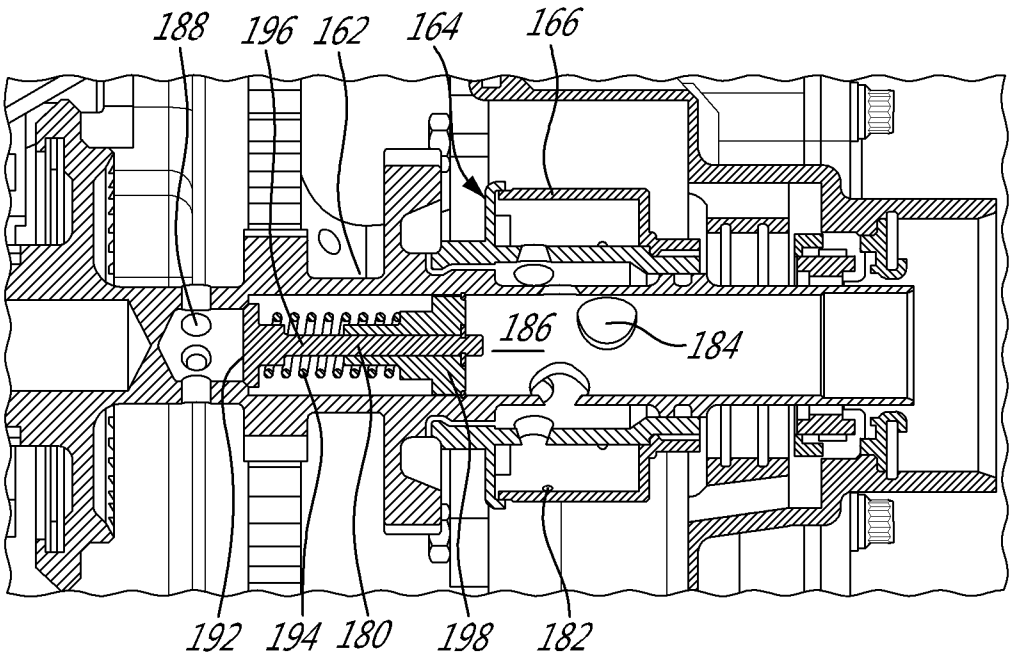


FIG. 3A

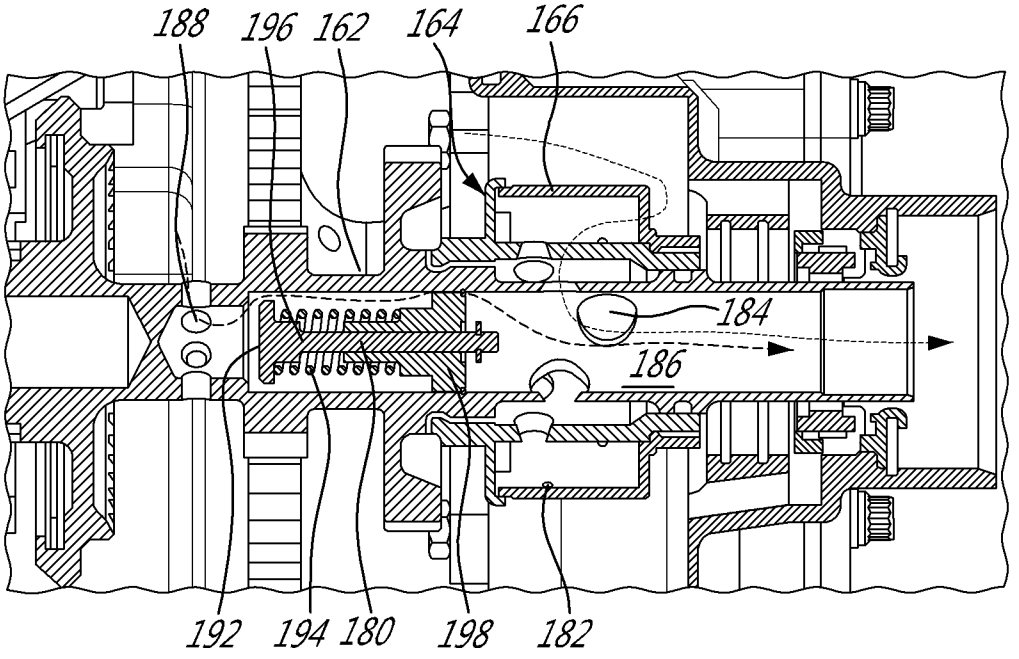


FIG. 3B

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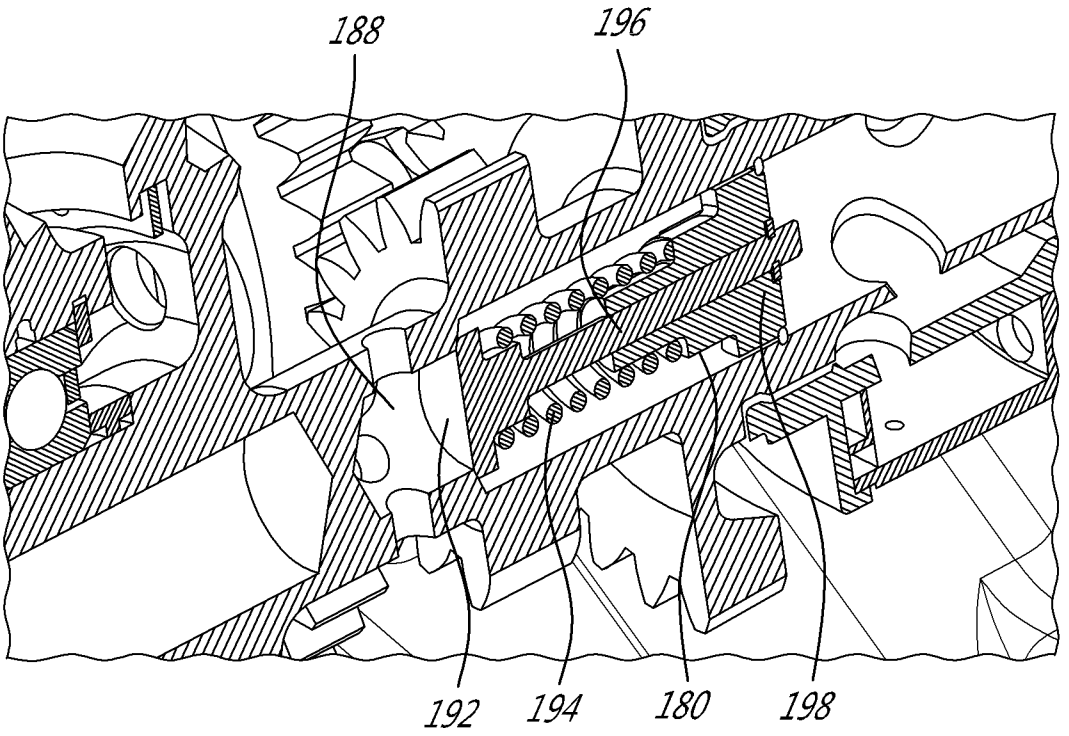


Fig. 4

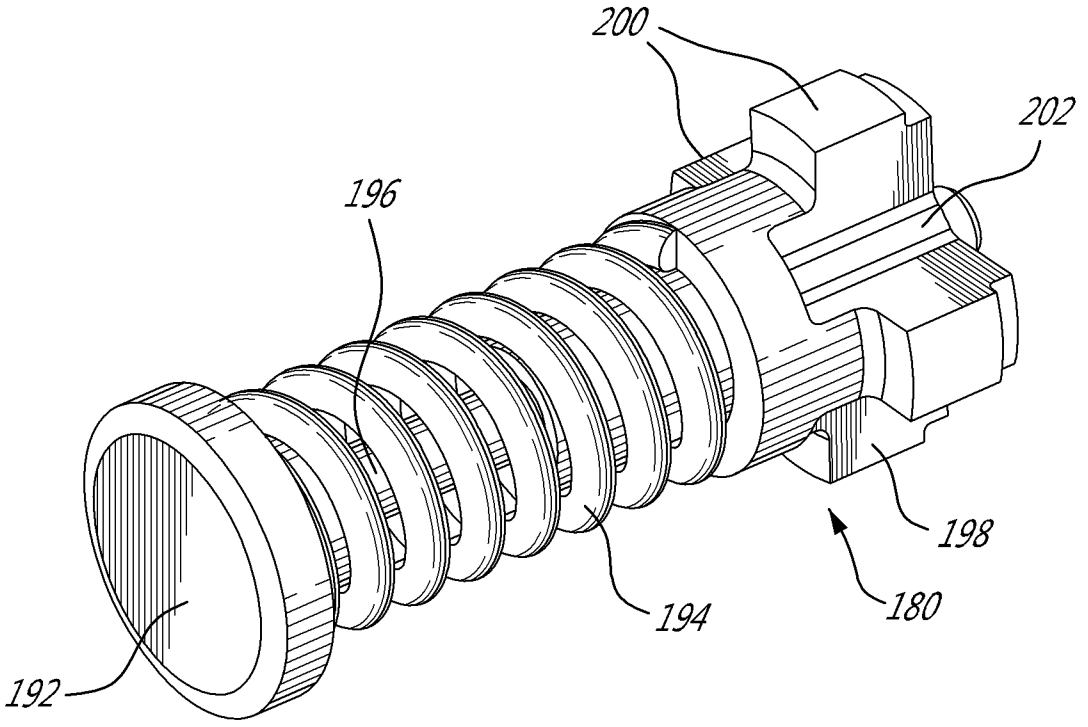


Fig. 5

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