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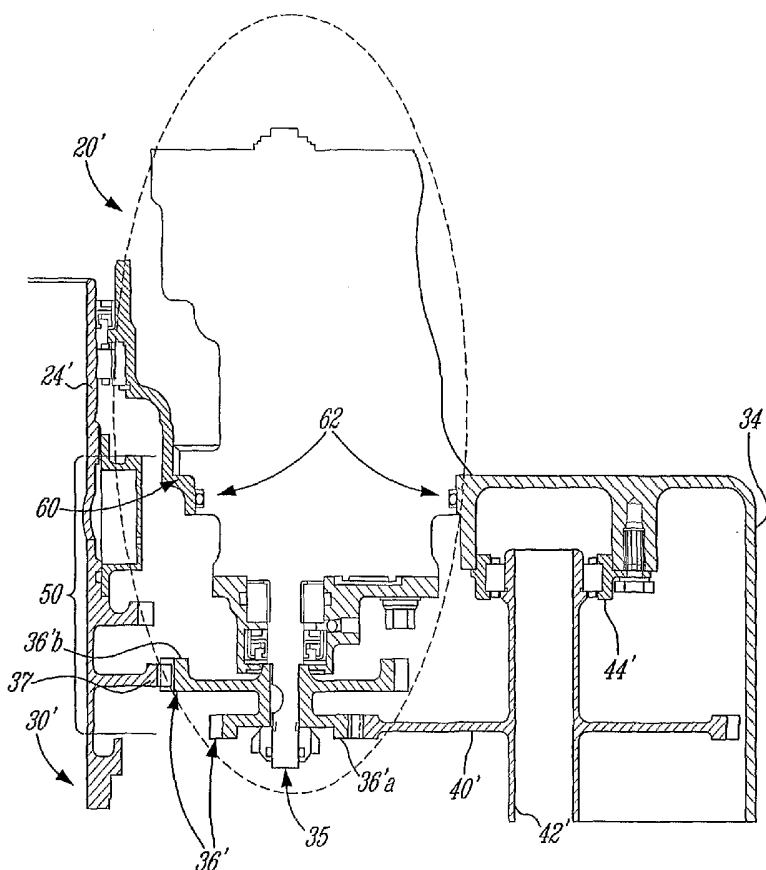
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[Continued on next page]

(54) Title: COMPACT CONFIGURATION FOR ATTACHING A FUEL PUMP OR OTHER ACCESSORY TO AN ACCESSORY
GEARBOX



(57) Abstract: A gas turbine engine accessory (20') is removably mounted to a gearbox (30') of a gas turbine engine (10). The accessory has a drive shaft (35) extending into the gearbox (30'). A driven gear (36'a) is mounted on the drive shaft (35). The driven gear (36'a) is adapted to directly engage a drive gear (40') of the gearbox (30'). The purpose of this improved design is to lighten the overall weight of the gas turbine engine by reducing its number of parts and components.

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COMPACT CONFIGURATION FOR ATTACHING A FUEL
PUMP OR OTHER ACCESSORY TO AN ACCESSORY
GEARBOX

5 BACKGROUND OF THE INVENTION

Field of the Invention

The present invention relates to gas turbine engines and, more particularly, to configurations for connecting fuel pumps or other accessories to accessory gearboxes.

10 Description of the Prior Art

Conventionally, as illustrated in Fig. 3, a fuel-metering unit 20, such as a cartridge fuel pump, is driven off a splined shaft 32 that is housed within an accessory gearbox 30. The accessory gearbox 30 has an enclosed casing 34 which houses a reduction gear set 36. The reduction gear set 36 is driven by a drive gear 40,
15 which is mounted to a starter shaft 42 rotatably secured by a bearing mount 44. The reduction gear set 36 is affixed to the shaft 32 whose internal splines 33 are in meshing engagement with the external splines of a complementarily shaped stub shaft 22 protruding from a casing 24 of the fuel-metering unit 20. To facilitate mounting of the fuel-metering unit 20 to the accessory gearbox 30, the fuel-metering
20 unit 20 has a flanged pad 26 which abuts a corresponding flanged pad 46 on the accessory gearbox 30.

Although the prior-art configuration described above permits removable mounting of an accessory to the accessory gearbox 30, this configuration suffers from certain shortcomings, namely, undesirably high weight and high
25 overhung moment, not to mention the high number of parts involved. Because of these characteristics, the prior-art configuration is suboptimal for light-weight applications.

SUMMARY OF THE INVENTION

It is therefore an aim of the present invention to provide an improved configuration for connecting a fuel-metering unit or other such accessory to an accessory gearbox.

5 Therefore, in accordance with a general aspect of the present invention, there is provided a gas turbine engine accessory in combination with a gearbox of a gas turbine engine, the accessory being removably mounted to the gearbox and having an integral drive shaft extending into the gearbox, and a driven gear mounted on the drive shaft, the driven gear being adapted to directly engage a
10 drive gear of said gearbox.

In accordance with a further general aspect of the present invention, there is provided a gas turbine engine driving arrangement comprising a gas turbine engine accessory integrated to an accessory gearbox, the accessory comprising an open-ended accessory casing, the open-ended accessory casing being adapted to be
15 removably mounted to an accessory gearbox casing having a complementary opening, the accessory casing and gearbox casing mating to form a fully enclosed unit.

In accordance with a still further general aspect of the present invention, there is provided a gas turbine engine comprising at least a compressor, a
20 combustor adapted to receive compressed air from the compressor, a turbine for extracting power from the combustion gases leaving the combustor, an accessory gearbox having at least one drive gear driven by the turbine; and at least one gas turbine engine accessory removably mounted to the accessory gearbox, the accessory having at least one drive shaft with at least one driven gear mounted to the drive
25 shaft, the driven gear meshing with the drive gear of the accessory gearbox.

BRIEF DESCRIPTION OF THE DRAWINGS

Reference will now be made to the accompanying drawings, showing by way of illustration the preferred embodiment thereof, in which:

Fig. 1 is a schematic cross-sectional view of a gas turbine engine to which an embodiment of the present invention is applied;

Fig. 2 is a cross-sectional view of a compact configuration of a fuel-metering unit and accessory gearbox in accordance with an embodiment of the present invention; and

Fig. 3 is a cross-sectional view of a prior-art configuration of a fuel-metering unit and accessory gearbox.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Fig. 1 illustrates 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 multistage compressor 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 turbine section 18 drives various accessories, such as a fuel pump, oil pump, hydraulic pump, air pump, or electric generator, via an accessory gearbox 30' (Fig.2).

Fig. 2 illustrates an embodiment of the present invention in which a fuel-metering unit 20', in this application called a 'cartridge fuel pump', is partially embedded in the accessory gearbox 30'. The fuel-metering unit 20' and the accessory gearbox 30' are partially encased within an accessory casing 24' and a gearbox casing 34', respectively. The accessory casing 24' and the gearbox casing 34' have complementary openings so that a portion of the fuel-metering unit 20 can be inserted, or "embedded", in the accessory gearbox 30' (which acts like a receptacle or socket). A spigot or peripheral portion 60 of the unit 20' is adapted to matingly engage at least one of the casings 24' and 34, and an appropriate seal member 62 is provided to seal the connection (an 'o-ring' type seal 62 is shown, although other suitable seal types, such as face seals or other seals, may be employed). Once embedded, the fuel-metering unit 20' and the accessory gearbox 30' together form a

fully encased unit. The unit 20' is, itself, not fully encased, since its embedded assembly position allows it to become encased as part of an assembly with the gearbox - thus permitting a less-than complete (i.e. non-contiguous) casing for the unit 20' alone, representing a portion of the weight savings achieved, as discussed
5 further below.

As shown in Fig. 2, an embedded portion 50 represents about one half of the length of the cartridge fuel pump, although it should be appreciated that the degree to which the accessory is embedded in the accessory gearbox 30' will vary according to design exigencies, such as the depth inside the accessory gearbox of a
10 drive gear that is to mesh with a driven gear of the accessory. Preferably, a sufficient amount of the accessory is embedded in the gearbox to permit a portion of the accessory casing to be absent, so that the accessory is open casing to be closed by assembly with the gearbox.

The fuel-metering unit 20' (the cartridge fuel pump in this example) is
15 powered by a drive shaft 35. Affixed to the drive shaft 35 is a reduction gear set 36'. As shown, the reduction gear set 36' has a driven gear 36a' and a spacer gear 36b'. The driven gear 36a' meshes with, and is driven by, a drive gear 40' mounted to a starter shaft 42' which is, in turn, rotatably secured by a bearing mount 44'. The spacer gear 36b' is in meshing engagement with a stationary gear 37 provided in the
20 gearbox casing 34' for ensuring proper alignment of the drive shaft 35 so that torque imparted to the driven gear 36a' by the drive gear 40' does not cause the drive shaft 35 to deflect or wobble unduly. As will be appreciated by persons skilled in the art, the drive gear 40' may be connected to any accessory drive shaft that receives torque from the turbine shaft. The drive shaft 35 is preferably not a splined set, but rather a
25 single or integral shaft extending into the unit 20' and to which the gear 36a' is affixed, such that gear set 36 drives the unit 20' directly. This aspect contributes to the weight savings in the concept, as will be discussed further below.

The partial embedding of the fuel-metering unit 20' in the accessory gearbox 30' results in a compact and lightweight configuration. Not only are weight
30 and overhung moment reduced, but so is the number of parts. By embedding the

fuel-metering unit 20' in the accessory gearbox 30', the drive shaft 35 of the unit 20' is directly connected to the reduction gear set 36. The splined shaft 32 (shown in Fig. 3) is thus eliminated, as are the flanged pads 26, 46. Further, since the fuel-metering unit 20' and the accessory gearbox 30' are not individually fully encased, the amount of casing material required is also reduced. As will be appreciated by persons skilled in the art, this compact configuration can be advantageously used on gas turbine engines of all sizes and all types to reduce weight, overhung moment and complexity.

In order to ensure that the driven gear 36a' of the reduction gear set 36' meshes correctly with the drive gear 40' of the accessory gearbox 30' when the unit is assembled, the fuel-metering unit 20' may further be provided with a mounting face (in this case, above the spigot) to abut the casing 34' of the gearbox 30'. Suitable fasteners (not shown) secure the device to the gearbox. The drive shaft 35 and reduction gear set 36' extend below the mounting face by a predetermined distance calculated to ensure that the driven gear 36a' mounted to the drive shaft 35 meshes with the drive gear 40' of the accessory gearbox 30'.

Furthermore, to facilitate connection of the fuel-metering unit 20' to the accessory gearbox 30', the fuel-metering unit 20' may also include a spigot 60 having a circular lip integrally formed with the mounting face for centering the fuel-metering unit 20' with respect to the accessory gearbox 30'.

In operation, when the gas turbine engine 10 is running, the rotation of the turbine shaft drives the accessory gearbox 30' which, in turn, powers the embedded cartridge fuel pump (or other fuel-metering unit) 20. The cartridge fuel pump, or other fuel-metering unit, pumps fuel to a plurality of fuel injectors which inject the fuel into the combustor 16 where the fuel and compressed air from the compressor 14 are combusted to generate hot gases. These hot gases impinge on a plurality of turbine blades which drive the turbine shaft. The rotation of the turbine shaft, as noted earlier, powers the cartridge fuel pump 20' via the accessory gearbox 30'.

Although Fig. 2 illustrates a fuel-metering unit in a compact, “embedded” configuration with an accessory gearbox 30', it should be understood that other accessories may also be embedded in the gearbox 30' in the same compact configuration. Instead of a fuel-metering unit, the embedded accessory could be an
5 oil pump, a hydraulic pump, an air pump, or an electric generator (this is not intended to be an exhaustive list). In each case, the drive shaft of the accessory is provided with a reduction gear set or a driven gear for meshing with a drive gear of the accessory gearbox. Persons skilled in the art will appreciate that other accessories may also be embedded within an accessory gearbox in the manner described.

10 The embodiments of the invention described above are intended to be exemplary. Those skilled in the art will therefore appreciate that the forgoing description is illustrative only, and that various alternatives and modifications can be devised without departing from the spirit of the present invention. Accordingly, the present is intended to embrace all such alternatives, modifications and variances
15 which fall within the scope of the appended claims.

CLAIMS:

1. A gas turbine engine accessory in combination with a gearbox of a gas turbine engine, the accessory being removably mounted to the gearbox and having an integral drive shaft extending into the gearbox, and a driven gear mounted on the drive shaft, the driven gear being adapted to directly engage a drive gear of said gearbox.
2. A combination as defined in claim 1, wherein the accessory is selected from the group consisting of: a fuel pump, an oil pump, a hydraulic pump, an air pump, and an electric generator.
3. A combination as defined in claim 1, wherein the drive gear is mounted to a starter shaft.
4. A combination as defined in claim 1, wherein the accessory includes a seal member around a mid-portion of the accessory, the seal member adapted to sealingly engage the gearbox.
5. A combination as defined in claim 1, wherein said accessory is at least partly embedded in said gearbox.
6. A combination as defined in claim 1, wherein said accessory comprises an open-ended casing, and wherein said open-ended casing is closed by said gearbox when the accessory is mounted thereon.
7. A combination as defined in claim 1, wherein said gearbox has a casing defining an opening for receiving an open end portion of said accessory.
8. A combination as defined in claim 1, wherein said accessory is received in mating engagement in an opening defined in a casing of said gearbox.

9. A combination as defined in claim 1, wherein a spacer gear is mounted on said drive shaft for meshing engagement with a stationary gear in said gearbox.

10. A combination as defined in claim 1, wherein said gearbox has a gearbox casing, and wherein said accessory comprises a mounting face defining a plane transverse to the drive shaft, the mounting face being adapted to abut the gearbox casing to ensure that the driven gear mounted to the drive shaft is positioned at a correct depth within the accessory gearbox for meshing with the drive gear.

11. A gas turbine engine driving arrangement comprising a gas turbine engine accessory integrated to an accessory gearbox, the accessory comprising an open-ended accessory casing, the open-ended accessory casing being adapted to be removably mounted to an accessory gearbox casing having a complementary opening, the accessory casing and gearbox casing mating to form a fully enclosed unit.

12. A gas turbine engine driving arrangement as defined in claim 11, wherein the accessory is selected from the group consisting of: a fuel pump, an oil pump, a hydraulic pump, an air pump, and an electric generator.

13. A gas turbine engine driving arrangement as defined in claim 11, wherein the accessory is partially embedded in the accessory gearbox.

14. A gas turbine engine driving arrangement as defined in claim 11, wherein said accessory comprises a mounting face defining a plane transverse to a drive shaft of the accessory, the mounting face being adapted to abut the gearbox casing to ensure that a driven gear mounted to the drive shaft is positioned at a correct depth within the accessory gearbox for meshing with a drive gear of the accessory gearbox.

15. A gas turbine engine driving arrangement as defined in claim 11, wherein said accessory comprises a drive shaft having a driven gear in meshing engagement with a drive gear of said accessory gearbox.

16. A gas turbine engine driving arrangement as claimed in claim 11, further comprising a spigot having a circular lip for centering the accessory with respect to the accessory gearbox to facilitate mounting and dismantling of the accessory to and from the accessory gearbox.

17. A gas turbine engine driving arrangement as claimed in claim 11, further comprising a seal member circumscribing the open-ended portion, the seal member adapted for sealing the complementary opening when the accessory casing and gearbox casing are mated.

18. A gas turbine engine comprising at least a compressor, a combustor adapted to receive compressed air from the compressor, a turbine for extracting power from the combustion gases leaving the combustor, an accessory gearbox having at least one drive gear driven by the turbine; and at least one gas turbine engine accessory removably mounted to the accessory gearbox, the accessory having at least one drive shaft with at least one driven gear mounted to the drive shaft, the driven gear meshing with the drive gear of the accessory gearbox.

19. A gas turbine engine as defined in claim 18, wherein the accessory is selected from the group consisting of: a fuel pump, an oil pump, a hydraulic pump, an air pump, and an electric generator.

20. A gas turbine engine as defined in claim 19, wherein the fuel pump is a fuel-metering unit for supplying fuel to fuel injectors for injection into the combustor.

21. A gas turbine engine as defined in claim 18, wherein the accessory is partially embedded in the accessory gearbox.

22. A gas turbine engine as defined in claim 18, wherein the drive gear is affixed to a starter shaft within the accessory gearbox.

23. A gas turbine engine as defined in claim 18, wherein said accessory comprises an open-ended casing, and wherein said open-ended casing is closed by said accessory gearbox when the accessory is mounted thereon.

24. A gas turbine engine as defined in claim 17, wherein said gearbox has a casing defining an opening for receiving an open end portion of said accessory.

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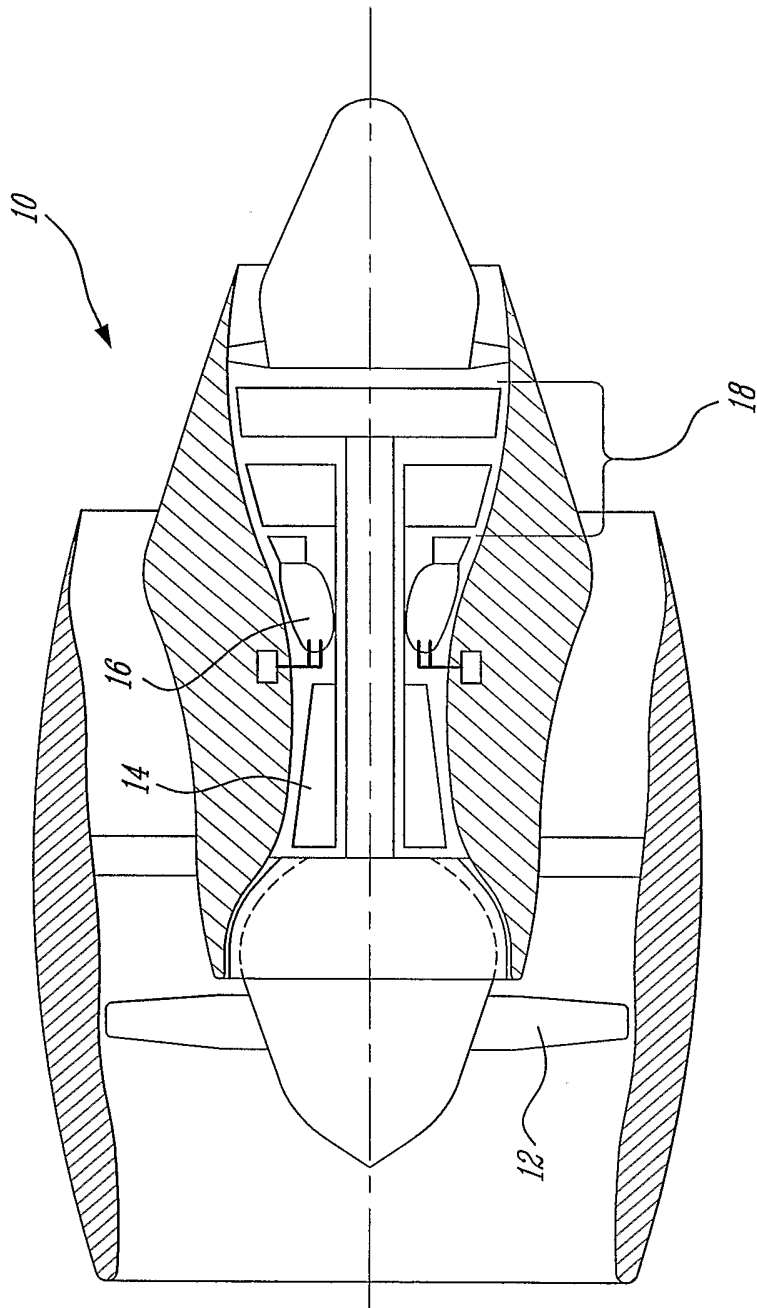


Fig. 1

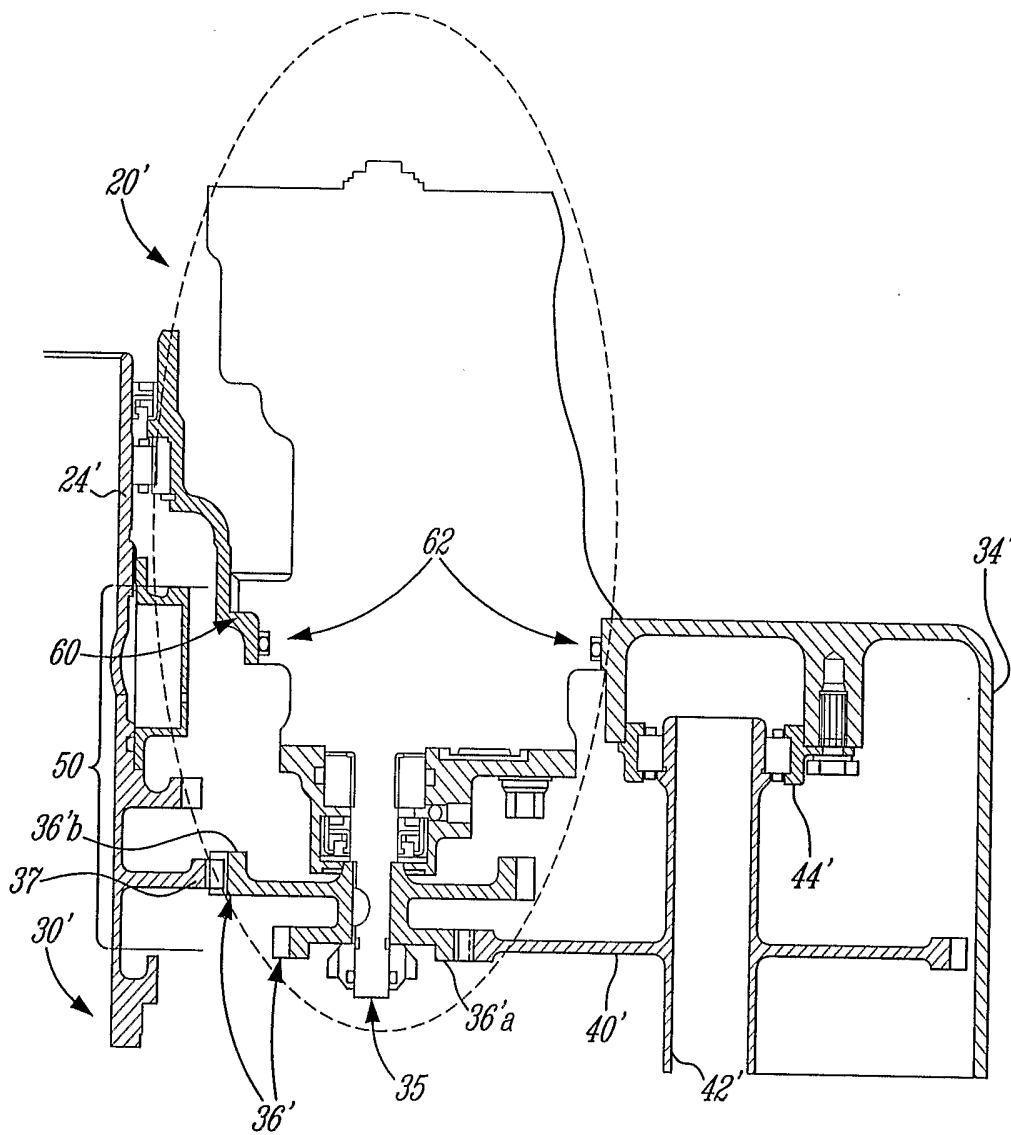


Fig. 2

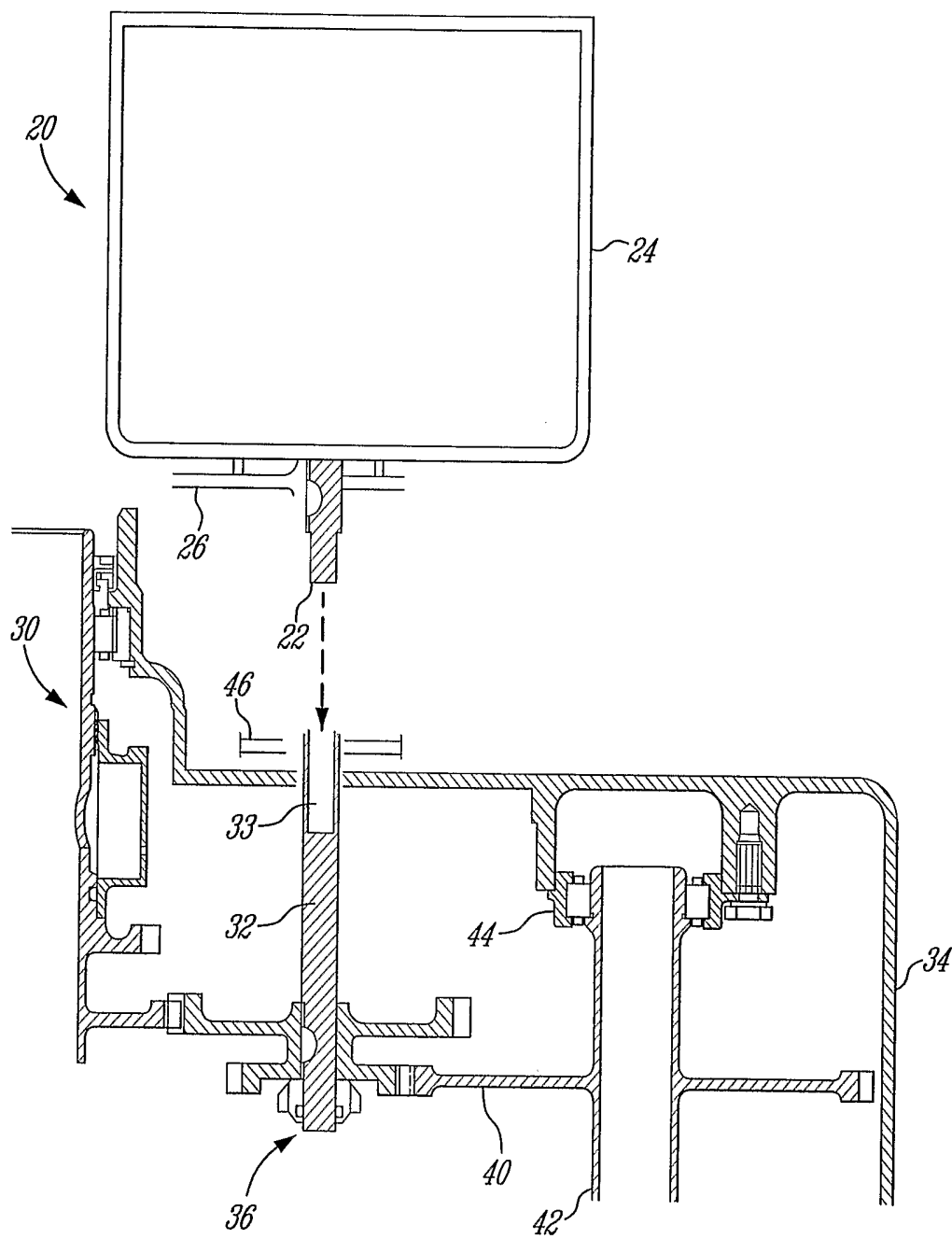


Fig. 3 (PRIOR ART)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2005/000077

A. CLASSIFICATION OF SUBJECT MATTER IPC ⁷ : F02C 7/32, F02C 7/36, F02C 7/22, and F02C 7/28 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 ⁷ : F02C Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched Electronic database(s) consulted during the international search (name of database(s) and, where practicable, search terms used) Delphion and Canadian Patent Database; and search terms used: accessory, gear*, gearbox, shaft, gas, turbine, casing, and AGB		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No(s).
X	EP 0 540 192 A1 (GENERAL ELECTRIC COMPANY) 05 May 1993 (05-05-1993)	1 to 17
Y	Abstract; column 2, line 48 to column 9, line 51; figures 1 to 4; and claims 1 to 8	18 to 24
X	US 4,525,995 A (WILLIAMS INTERNATIONAL CORPORATION) 02 July 1985 (02-07-1985)	1 to 17
Y	Abstract; column 2, line 13 to column 4, line 36; figures 1 to 5; and claims 1 and 2	18 to 24
X	US 6,058,791 A (ALLIED SIGNAL INC.) 09 May 2000 (09-05-2000)	1 to 17
Y	Abstract; column 2, line 8 to column 5, line 56; figures 1 and 2; and claims 1 to 15	18 to 24
Y	JP 2003 269192 A (ISHIKAWAJIMA HARIMA HEAVY IND CO LTD) 25 September 2003 (25-09-2003) Abstract	18 to 24
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> See patent family annex.		
* Special categories of cited documents :	"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	
"A" document defining the general state of the art which is not considered to be of particular relevance	"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	
"E" earlier application or patent but published on or after the international filing date	"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	
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"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		
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Name and mailing address of the ISA/CA Canadian Intellectual Property Office Place du Portage I, C114 - 1st Floor, Box PCT 50 Victoria Street Gatineau, Quebec K1A 0C9 Facsimile No.: 001(819)953-2476	Authorized officer Sylvestre Michael Bishop (819) 953-9813	

INTERNATIONAL SEARCH REPORT

International application No.
PCT/CA2005/000077

Box No. II Observations where certain claims were found unsearchable (Continuation of item 2 of the 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. Claim Nos. :
because they relate to subject matter not required to be searched by this Authority, namely :

2. Claim 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. Claim Nos. :
because they are dependant 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 :

Claims 1 to 10 and 18 to 24 are directed to a gas turbine engine comprising a removably mounted accessory gearbox driven by the turbine engine

Claims 11 to 17 are directed to a gas turbine engine having the accessory casing and gearbox casing mating to form a fully enclosed unit.

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 an additional fee, this Authority did not invite payment of any additional fee.
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 claim 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 claim Nos. :

Remark on Protest The additional search fees were accompanied by the applicant's protest.

No protest accompanied the payment of additional search fees.

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/CA2005/000077

Patent Document Cited in Search Report	Publication Date	Patent Family Member(s)	Publication Date
EP0540192	05-05-1993	JP5214964 A	24-08-1993
US4525995	02-07-1985	None	
US6058791	09-05-2000	WO9947799 A1	23-09-1999
JP2003269192	25-09-2003	None	