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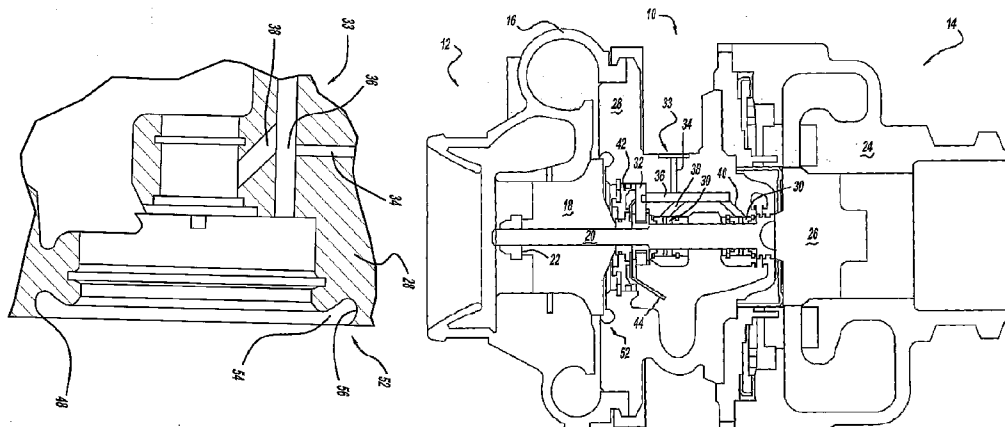
- as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))
- as to the applicant's entitlement to claim the priority of the earlier application (Rule 4.17(iii))
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[Continued on next page]

(54) **Title:** TURBOCHARGER WITH BEARING HOUSING HAVING AN AERODYNAMICALLY ENHANCED COMPRESSOR WHEEL POCKET GEOMETRY



(57) **Abstract:** A turbocharger unit (10) having an aerodynamically enhanced pocket (52), comprising a turbine (14) having a turbine housing (24) and a turbine wheel (26) connected to a shaft (20) along with a compressor (12) having a compressor housing (16) and a compressor wheel (18) mounted on the same shaft (20). There is an intermediate housing (28) disposed between the turbine housing (24) and the compressor housing (16), circumscribing the shaft (20), and having a compressor wheel pocket (50). There is a series of bearings (30) located in the intermediate housing (28) for supporting the shaft (20). There is also a series of fluid passages (33) located in the intermediate housing (28) which provide fluid to lubricate the bearings (30). A seal (42) is used for the prevention of oil from entering the compressor wheel pocket (50). The compressor wheel pocket (50) has an aerodynamically enhanced pocket (52) for the improvement of pressure balance behind the compressor wheel (18), preventing the oil in the intermediate housing (28) from entering the compressor housing (16).

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TURBOCHARGER WITH BEARING HOUSING HAVING AN AERODYNAMICALLY ENHANCED  
COMPRESSOR WHEEL POCKET GEOMETRY

CROSS-REFERENCE TO RELATED APPLICATIONS

- 5           This application claims the benefit of U.S. Patent Application No. 11/242,344, filed October 3, 2005, which claims the benefit of U.S. Provisional Patent Application No. 60/716,016, filed September 9, 2005, the entire specification of which is expressly incorporated herein by reference.

10   FIELD OF THE INVENTION

The present invention relates to turbochargers and the prevention of oil leakage due to insufficient pressure balance across the compressor oil seal.

BACKGROUND OF THE INVENTION

- 15           Turbochargers are a commonly used apparatus for increasing power density in engines. Turbochargers are comprised of a turbine and a compressor. The turbine has a turbine housing and a turbine wheel; the compressor has a compressor housing and a compressor wheel. The compressor wheel and turbine wheel are both mounted on a common shaft.
- 20   Located between the turbine housing and the compressor housing is an intermediate housing, which both the turbine housing and the compressor housing are connected to. The intermediate housing has a compressor wheel pocket; the compressor wheel resides partially in the compressor wheel pocket, and partially in the compressor housing.
- 25           The turbine wheel rotates from the flow of exhaust gas from the engine through the exhaust manifold and into the turbine housing. As the turbine wheel spins, the compressor wheel spins as well. As the compressor wheel spins, fresh air is compressed and forced into the engine's intake manifold. As air flows through the compressor housing, under certain operating conditions,
- 30   the compressor wheel is spinning at a high rotational speed, but the boost pressure is low. This can occur when the vehicle engine is running at high idle speed and can cause a pressure imbalance to occur on the side of the compressor wheel where the intermediate housing is located. This pressure

imbalance occurs in the area between the compressor wheel and the intermediate housing.

The intermediate housing also includes a set of bearings which are used to support the shaft. The turbine wheel and compressor wheel are both  
5 mounted on the shaft, which rotates in the bearings. The bearings are lubricated, and the intermediate housing also has a labyrinth seal which is used to prevent oil from leaking into the compressor housing.

The pressure imbalance results in a lack of pressure against the labyrinth seal and the oil it retains, which can lead to oil leaking into the  
10 compressor wheel pocket and into the compressor housing. Oil leaking onto the compressor wheel and compressor housing can cause fouling and problems with the air intake components leading to the engine.

#### SUMMARY OF THE INVENTION

15 Accordingly, the present invention is directed to the prevention of a pressure imbalance between the compressor wheel and the intermediate housing. The present invention is a turbocharger unit having an aerodynamically enhanced pocket, comprising a turbine having a turbine housing and a turbine wheel connected to a shaft along with a compressor  
20 having a compressor housing and a compressor wheel mounted on the same shaft. There is an intermediate housing disposed between the turbine housing and the compressor housing, circumscribing the shaft, and having a compressor wheel pocket. There is a series of bearings located in the intermediate housing for supporting the shaft. There is also a series of fluid  
25 passages located in the intermediate housing which provide fluid to lubricate the bearings. A seal is used for the prevention of oil from entering the compressor wheel pocket. The compressor wheel pocket has an aerodynamically enhanced pocket for the improvement of pressure balance behind the compressor wheel, preventing the oil in the intermediate housing  
30 from entering the compressor housing.

In a first embodiment, the aerodynamically enhanced pocket is a spoon edge comprised of a rounded recess under a sharp edge at the end of said compressor wheel pocket.

In a second embodiment, the aerodynamically enhanced pocket is a knife edge comprised of an acute angle at the edge of said compressor wheel pocket.

Further areas of applicability of the present invention will become  
5 apparent from the detailed description provided hereinafter. It should be understood that the detailed description and specific examples, while indicating the preferred embodiment of the invention, are intended for purposes of illustration only and are not intended to limit the scope of the invention.

10

#### BRIEF DESCRIPTION OF THE DRAWINGS

The present invention will become more fully understood from the detailed description and the accompanying drawings, wherein:

Figure 1 is a sectional plan view of a turbocharger unit having an  
15 aerodynamically enhanced pocket, according to a first embodiment of the present invention;

Figure 2 is an enlarged sectional plan view of an intermediate housing, partially broken away, having an aerodynamically enhanced pocket according to a first embodiment of the present invention;

20 Figure 3 is a greatly enlarged sectional plan view of an intermediate housing having an aerodynamically enhanced pocket according to a first embodiment of the present invention; and

Figure 4 is an enlarged sectional plan view of an intermediate housing, partially broken away, having an aerodynamically enhanced pocket according  
25 to a second embodiment of the present invention.

#### DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

The following description of the preferred embodiment(s) is merely exemplary in nature and is in no way intended to limit the invention, its  
30 application, or uses.

Referring to Figures 1-3, a turbocharger unit incorporating a first embodiment is generally shown at 10. The turbocharger unit 10 is comprised of a compressor 12 and a turbine 14. The compressor 12 is comprised of a

compressor housing 16, and a compressor wheel 18 held onto a shaft 20 by a retaining nut 22. Turbine 14 is comprised of a turbine housing 24 and a turbine wheel 26 welded onto shaft 22. In between and connected to the turbine housing 24 and the compressor housing 16 is an intermediate housing 28. Located inside the intermediate housing 28 is a set of bearings 30 and a thrust bearing 32. The bearings 30 and thrust bearing 32 receive oil from a series of fluid passages 33. The series of fluid passages 33 are made up of an oil feed passage 34, a main oil passageway 36, a first angled passageway 38 and a second angled passageway 40. The oil feed passage 34 feeds oil into a main oil passageway 36; the main oil passageway 36 delivers oil directly to the thrust bearing 32, and to a first angled passageway 38 as well as a second angled passageway 40. The first angled passageway 38 and the second angled passageway 40 deliver oil to bearings 30. Oil is prevented from coming in contact with the compressor wheel 18 through the use of a seal, shown in Figure 1 as a labyrinth seal 42, and an oil shield 44.

The various embodiments of the present invention will now be described. During normal operation, the exhaust gas from the vehicle engine flows through the turbine 14, and spins the turbine wheel 26 at a high rotational speed. Spinning the turbine wheel 26 at high rotational speed causes the shaft 20 and the compressor wheel 18 to spin at the same speed as the turbine wheel 26. The compressor wheel 18 compresses air in the compressor housing 16, and forces the compressed air into the intake manifold of the engine (not shown). The bearings 30 are lubricated through oil flowing through the first angled passageway 38 and the second angled passageway 40.

A sharp edge 48 is shown in the Figures as part of a compressor wheel pocket 50 located in the intermediate housing 28. In the first embodiment, the compressor wheel pocket 50 is shown as an aerodynamically enhanced pocket 52 having a spoon-shaped recess 54. The spoon-shaped recess 54 includes the sharp edge 48 in the intermediate housing 28, and recesses in a round, spoon-shaped manner to form a rounded recess 56. The spoon-shaped recess 54 reduces the pressure imbalance caused by the compressor wheel 18 when the turbocharger 10 is running at high oil flow conditions, for

example, high engine speed, low engine load operating conditions. The spoon-shaped recess 54 may be comprised of various radii to compensate for various ranges of pressure imbalance due the size of the intermediate housing 28, the size of the compressor wheel 18, and the volume of air flow through the compressor 12.

A second embodiment of the present invention is shown in Figure 4. In this embodiment, the aerodynamically enhanced pocket 52 in the intermediate housing 28 is in the form of a knife-shaped recess 58 defined by the same sharp edge 48 as the spoon-shaped recess 54 of the intermediate housing 28, but then recesses into the housing to form an angled recess 60, set at an angle 62. The knife-shaped recess 58 shown in Figure 4 reduces the pressure imbalance caused by the compressor wheel 18 when the turbocharger 10 is running at high oil flow conditions, for example, high engine speed, low engine load operating conditions. The knife-shaped recess 58 may be comprised of various angles to compensate for various ranges of pressure imbalance due the size of the intermediate housing 28, the size of the compressor wheel 18, and the volume of air flow through the compressor 12.

It should be noted that both the spoon-shaped recess 54 and knife-shaped recess 58 define the sharp edge 48 in the intermediate housing 28. The diameter of the sharp edge 48 is the same in both embodiments described herein.

Reducing the adverse pressure balance between the intermediate housing 28 and the compressor wheel 18 increases the capability of the labyrinth seal 42 to retain oil within the intermediate housing 28 by eliminating any suction force created by compressor wheel 18 spinning at a high rotational speed, while the turbocharger 10 is not under load.

The description of the invention is merely exemplary in nature and, thus, variations that do not depart from the gist of the invention are intended to be within the scope of the invention. Such variations are not to be regarded as a departure from the spirit and scope of the invention.

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## CLAIMS

What is claimed is:

1. A turbocharger, comprising:
  - 5 a turbine having a turbine housing and a turbine wheel connected to a shaft;
  - a compressor having a compressor housing and a compressor wheel mounted on said shaft;
  - an intermediate housing disposed between said turbine housing and
  - 10 said compressor housing, circumscribing said shaft, having a compressor wheel pocket, said compressor wheel extending at least partially into said compressor wheel pocket;
  - one or more bearings located in said intermediate housing, for supporting said shaft;
  - 15 one or more fluid passages located in said intermediate housing for allowing oil to lubricate said bearings;
  - a seal for the prevention of said oil from entering said compressor housing; and
  - an aerodynamically enhanced pocket in said compressor wheel pocket
  - 20 for the prevention of air pressure imbalance around said compressor wheel, and preventing said oil from leaking around said seal entering said compressor housing.
2. The turbocharger of claim 1, wherein said aerodynamically
- 25 enhanced pocket is a spoon-shaped recess.
3. The turbocharger of claim 2, wherein said spoon-shaped recess is comprised of a sharp edge and a rounded recess at the end of said compressor wheel pocket.
- 30 4. The turbocharger of claim 1, wherein said aerodynamically enhanced pocket is a knife-shaped recess.



5. The turbocharger of claim 4, wherein said knife-shaped recess is comprised of a sharp edge having an angled recess at the edge of said compressor wheel pocket.

5 6. The turbocharger of claim 1, wherein said seal is a labyrinth seal.

7. A turbocharger, comprising:

a turbine having a turbine wheel and a turbine housing, said turbine wheel located in said turbine housing and mounted on a shaft;

10 a compressor having a compressor wheel and a compressor housing, said compressor wheel mounted on said shaft and located in said compressor housing;

an intermediate housing positioned between said turbine housing and said compressor housing;

15 a compressor wheel pocket, having a sharp edge, operably associated with said intermediate housing for receiving a portion of said compressor wheel; and

an aerodynamically enhanced pocket in said compressor wheel pocket for balancing the flow of air about said compressor wheel.

20

8. The turbocharger of claim 7, wherein said intermediate housing further comprises one or more bearings for supporting said shaft.

9. The turbocharger of claim 7, wherein said intermediate housing  
25 further comprises one or more fluid passages located in said intermediate housing for providing oil to lubricate said one or more bearings.

10. The turbocharger of claim 7, wherein said intermediate housing further comprises a seal operably associated with said series of fluid passages  
30 for preventing oil from entering said compressor housing.

11. The turbocharger of claim 10, wherein said seal is a labyrinth seal.

12. The turbocharger of claim 7, wherein said aerodynamically enhanced pocket is a spoon-shaped recess, said spoon shaped recess having a rounded recess and said sharp edge positioned in said compressor wheel pocket in proximity to said compressor wheel.

13. The turbocharger of claim 7, wherein said aerodynamically enhanced pocket is a knife-shaped recess comprised of said sharp edge and an angled recess, said sharp edge and said angled recess located in proximity to said compressor wheel.

14. A method for balancing air flow through a compressor housing in a turbocharger unit, comprising:

providing a turbine having a turbine wheel and a turbine housing, said turbine wheel mounted on a shaft and surrounded by said turbine housing;

providing a compressor having a compressor wheel and a compressor housing, said compressor wheel mounted on said shaft and surrounded by said compressor housing;

providing an intermediate housing disposed between and connected to said turbine housing and said compressor housing, and a compressor wheel pocket disposed in said intermediate housing; and

providing an aerodynamically enhanced pocket having a sharp edge, said aerodynamically enhanced pocket disposed within said compressor wheel pocket; and

balancing the airflow around said compressor wheel by reducing the amount of turbulent airflow around said sharp edge with said aerodynamically enhanced pocket and positioning at least a portion of said compressor wheel in said aerodynamically enhanced pocket.

15. The method of claim 14, further providing at least one bearing located in said intermediate housing for supporting said shaft.

16. The method of claim 14, further providing one or more fluid passages located in said intermediate housing.

17. The method of claim 14, further comprising the step of lubricating  
5 said at least one bearing with oil flowing through said one or more fluid passages.

18. The method of claim 17, further comprising the step of preventing said oil from entering said compressor housing by providing a seal  
10 disposed within said intermediate housing.

19. The method of claim 18, further providing the step of preventing oil from leaking around said seal by balancing the airflow around said compressor wheel with said aerodynamically enhanced pocket.  
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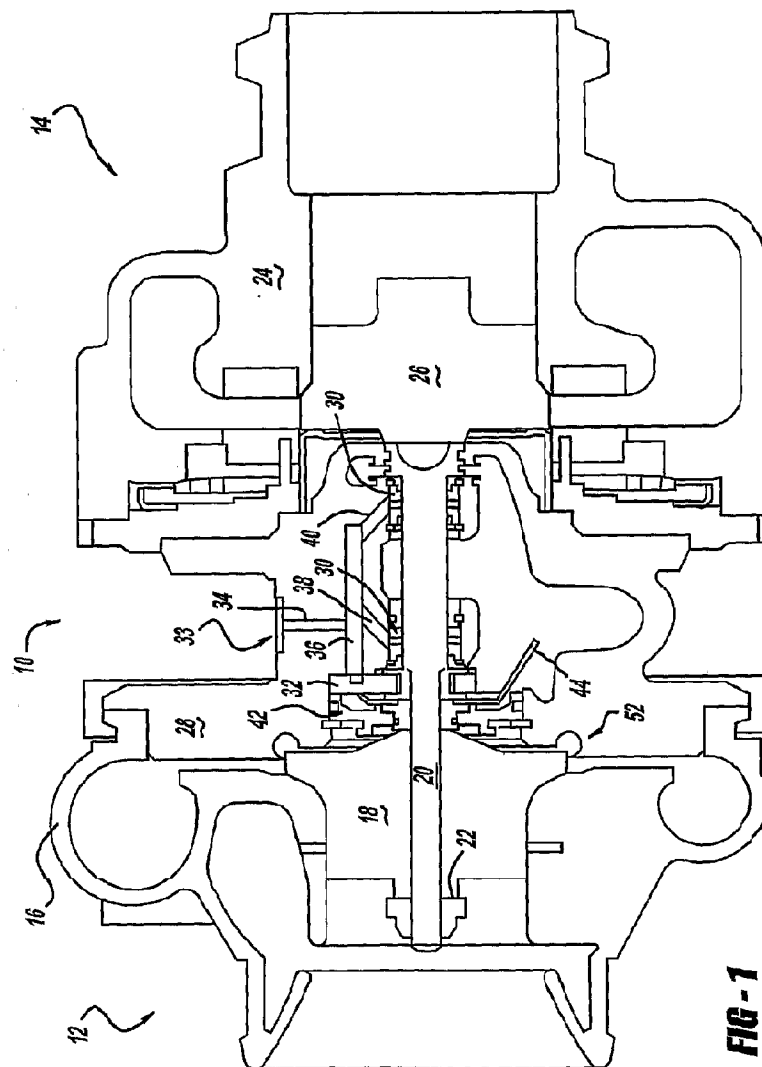
20. The method of claim 14, further providing for said aerodynamically enhanced pocket to be comprised of a spoon-shaped recess.

21. The method of claim 20, further providing for said spoon-shaped  
20 recess to be comprised of said sharp edge and a rounded recess disposed within said compressor wheel pocket.

22. The method of claim 14, further providing for said aerodynamically enhanced pocket to be comprised of a knife-shaped recess.  
25

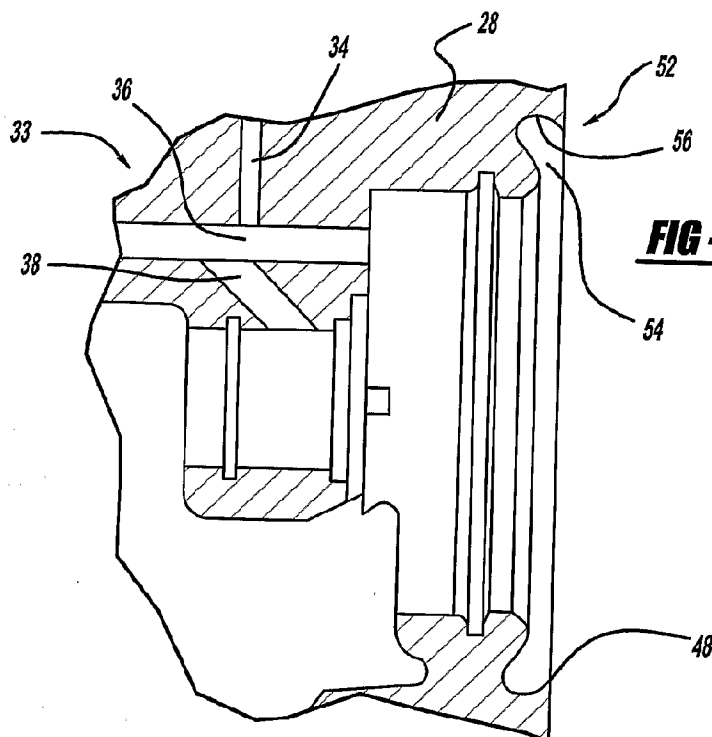
23. The method of claim 22, further providing for said knife-shaped recess to be comprised of said sharp edge and an angled recess disposed within said compressor wheel pocket.

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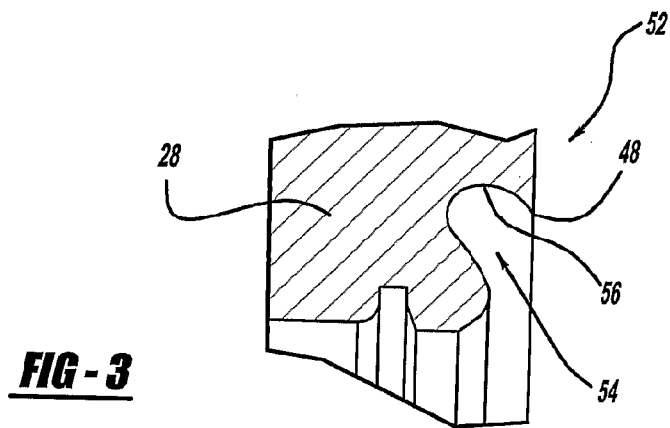
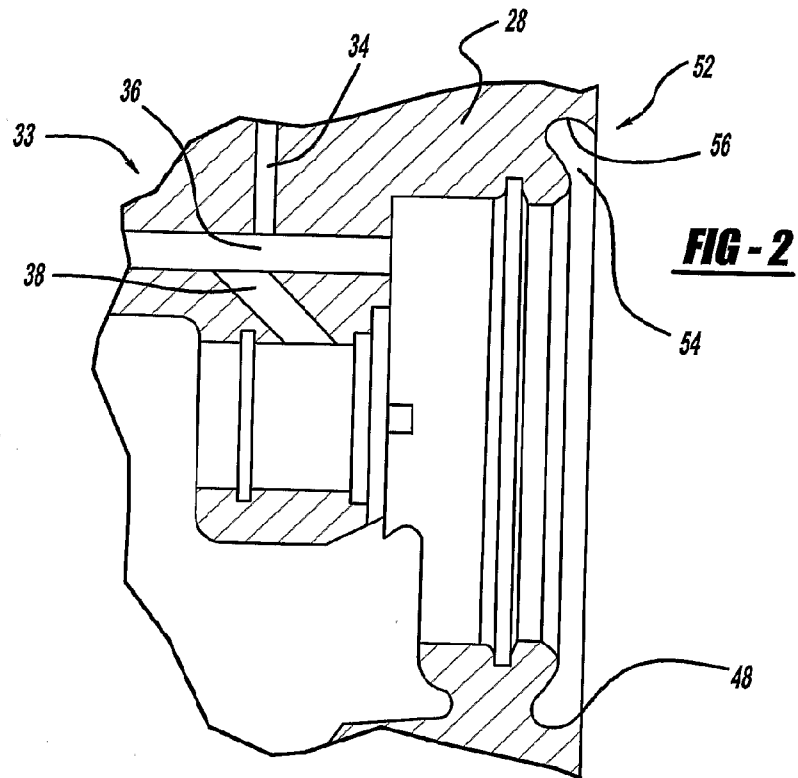


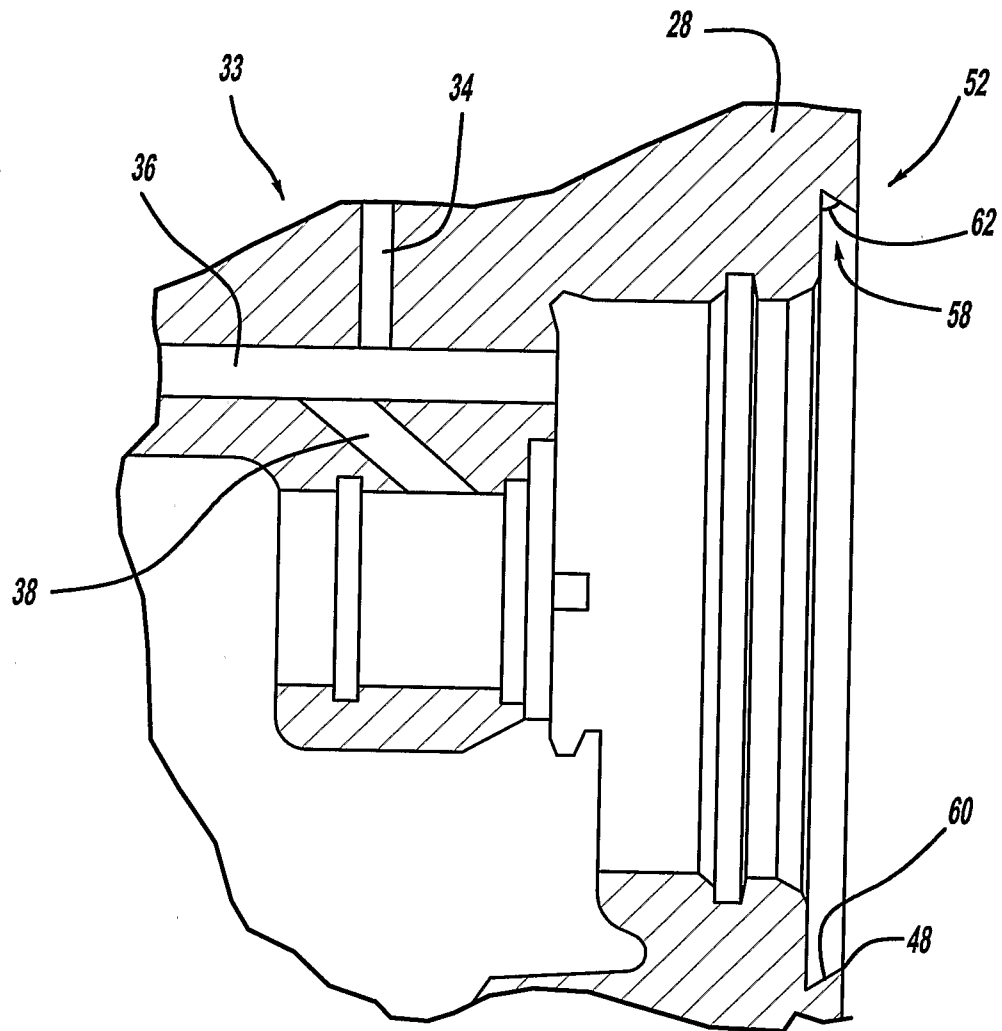
**FIG-1**

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**FIG-2**





**FIG - 4**

# INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2006/033783

A. CLASSIFICATION OF SUBJECT MATTER  
INV. F04D29/08 F01D25/18

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)  
F02C F01D F04D

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 1 193 372 A (GEN MOTORS CORP [US] ELECTRO MOTIVE DIESEL INC [US]) 3 April 2002 (2002-04-03) column 3, paragraph 9 column 4, lines 35-40 column 4, paragraphs 15,16 figures 1,2	1,4-11, 13-19, 22,23
X	US 6 418 722 B1 (ARNOLD STEVEN DON [US]) 16 July 2002 (2002-07-16)  column 2, lines 23-47 figure 1	1-3, 7-10,12, 14-21
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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## INTERNATIONAL SEARCH REPORT

International application No  
PCT/US2006/033783

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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International application No

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