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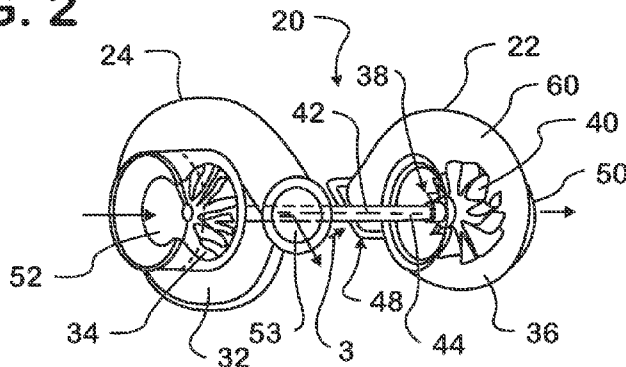
- as to the identity of the inventor (Rule 4.17(i))
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(54) Title: TURBINE OF A TURBOCHARGER

FIG. 2



(57) Abstract: A turbine has a turbine housing having an inlet through which working fluid enters the turbine housing, at least one scroll for conveying working fluid which has entered the inlet to an inner chamber to enable working fluid to spin a turbine wheel and a shaft as working fluid passes through the inner chamber, and an outlet through which working fluid leaves the turbine housing after having passed through the inner chamber. At least one valve element is selectively positionable on the turbine housing for selectively controlling flow through the inlet, and at least one actuator is operable to selectively position the at least one valve element on the turbine housing.



TURBINE OF A TURBOCHARGER

Field

[0001] The present disclosure relates to an internal combustion (IC) engine turbocharger, particularly to a turbine of the turbocharger.

Background

[0002] An IC engine turbocharger comprises a turbine operated by engine exhaust gas (working fluid) flowing through an engine exhaust system and a compressor operated by the turbine to compress intake air and thereby create increased mass flow of air into engine cylinders in comparison to mass flow which would be induced by natural aspiration as engine pistons downstroke within engine cylinders. Increased mass of air in each engine cylinder supports combustion of an increased quantity of fuel in the engine cylinder and consequently allows an engine to produce increased power.

[0003] Turbo lag is a known phenomenon which is characterized by the inability of a turbocharger to instantaneously increase the mass flow of air into engine cylinders in response to a demand for increased engine power.

[0004] Selection of a turbocharger for a particular engine depends on various factors including as examples, the engine's size, how the engine will be used, how much maximum power the engine needs to produce, how much in-cylinder pressure the engine can

withstand, etc. When an engine is used in an automotive application, tailpipe emissions can be a factor, such as when exhaust gas recirculation (EGR) is employed as part of an emissions control strategy.

[0005] Various types of engine turbochargers include wastegate turbochargers and variable geometry turbochargers. Such turbochargers may have either a single stage or two stages.

[0006] A turbine stage typically comprises a turbine housing having an inlet through which exhaust gas enters and a scroll which conveys exhaust gas to an inner chamber within which a turbine wheel is disposed. A shaft to which the turbine wheel is affixed is supported for rotation on the housing. Exhaust gas which has passed through the scroll acts on the turbine wheel to spin it and the shaft. The shaft is common to both the turbine and a compressor which is operated by the turbine. The compressor comprises a compressor housing on which the shaft is also supported for rotation. A compressor wheel is affixed to the shaft within an interior of the compressor housing so that as the shaft is spun by exhaust gas acting on the turbine wheel, the compressor wheel is also spun to produce increased mass flow into engine cylinders.

[0007] Scroll geometry, such as its A/R ratio, is a consideration when a turbocharger is being selected for use on a particular engine. An engine which has a wide operating range and which is subject to transient operation within that range, as is typically the case when a turbocharged IC engine is used to propel a motor vehicle, imposes rather strict constraints on turbocharger

selection. Generally speaking, turbocharger selection may have to compromise turbocharger performance at one portion of an engine's operating range in order to better satisfy turbocharger performance at a different portion of an engine's operating range.

Summary of the Disclosure

[0008] A turbine comprises a turbine housing comprising an inner chamber, a turbine wheel disposed within the inner chamber, and a shaft which is supported on the turbine housing for rotation about an axis and to which the turbine wheel is affixed for rotation with the shaft about the axis.

[0009] The turbine housing further comprises an inlet through which working fluid enters the turbine housing, at least one scroll for conveying working fluid which has entered the inlet to the inner chamber to enable working fluid to spin the turbine wheel and the shaft about the axis as working fluid passes through the inner chamber, and an outlet through which working fluid leaves the turbine housing after having passed through the inner chamber.

[0010] At least one valve element is selectively positionable on the turbine housing for selectively controlling flow through the inlet and at least one actuator is operable to selectively position the at least one valve element on the turbine housing.

[0011] The turbine may be used in a turbocharger of a turbocharged internal combustion which comprises engine cylinders within which combustion occurs to operate the engine, an intake

system through which air which has passed through the intake system enters the engine cylinders to support combustion, and an exhaust system through which exhaust gas resulting from combustion passes after leaving the engine cylinders.

[0012] The turbocharger comprises a turbine operated by exhaust gas passing through the exhaust system and a compressor operated by the turbine for increasing pressure of air passing through the intake system toward the engine cylinders.

[0013] The compressor comprises a compressor housing and a compressor wheel disposed within the compressor housing.

[0014] The turbine comprises a turbine housing having an inner chamber and a turbine wheel disposed within the inner chamber.

[0015] A shaft is supported on the turbine housing and the compressor housing for rotation about an axis, and the compressor wheel and the turbine wheel are both affixed to the shaft.

[0016] The turbine housing further has an inlet through which exhaust gas enters the turbine housing, at least one scroll for conveying exhaust gas which has entered the inlet to the inner chamber to enable exhaust gas to spin the turbine wheel and the shaft about the axis as exhaust gas passes through the inner chamber, and an outlet through which exhaust gas leaves the turbine housing after having passed through the inner chamber;

[0017] At least one valve element is selectively positionable on the turbine housing for selectively controlling flow through the

inlet and at least one actuator is operable to selectively position the at least one valve element on the turbine housing.

[0018] An engine control system controls operation of the at least one actuator.

[0019] The foregoing summary is accompanied by further detail of the disclosure presented in the Detailed Description below with reference to the following drawings which are part of the disclosure.

Brief Description of the Drawings

[0020] Figure 1 is a schematic diagram of a turbocharged internal combustion engine.

[0021] Figure 2 is a perspective view of a turbocharger of the engine.

[0022] Figure 3 is an enlarged view in the direction of arrow 3 in Figure 2.

[0023] Figure 4 is a cross section view in the direction of arrows 4-4 in Figure 3.

[0024] Figure 5 is a cross section view showing internal detail.

[0025] Figure 6 is a cross section view like Figure 5, but showing a different condition of operation.

Detailed Description

[0026] Figure 1 shows an internal combustion engine 10, a diesel engine for example, which may be used as the powerplant of a motor vehicle such as a truck (not shown in the drawing) for propelling the motor vehicle.

[0027] Engine 10 comprises structure defining engine cylinders 12 within which fuel combusts to operate pistons (not shown) which reciprocate within engine cylinders 12 and are coupled by connecting rods (not shown) to a crankshaft (also not shown) through which engine 10 delivers torque to power a load.

[0028] Engine 10 further comprises an intake system 14 through which fresh air enters engine cylinders 12 to support combustion of fuel introduced into engine cylinders 12 by fuel injectors 16 and an exhaust system 18 through which exhaust gas resulting from combustion passes after leaving engine cylinders 12.

[0029] A turbocharger 20 comprises a turbine 22 operated by exhaust gas passing through exhaust system 18 and a compressor 24 operated by turbine 22 for increasing pressure of air passing through intake system 14 toward engine cylinders 12. Turbocharger 20 is an example of a single-stage turbocharger, and it should be understood that certain detail of turbocharger 20 and certain components which may be associated with turbocharger 20 in intake system 14 and/or exhaust system 18 are not specifically shown in Figure 1. Figure 1 however does show an exhaust gas recirculation (EGR) path containing an EGR cooler 26 and an EGR valve 28 for recirculating exhaust gas from exhaust system 18 to intake system 14.

[0030] Engine 10 further comprises an engine control system comprising an electronic engine control unit (ECU) 30 which

controls various aspects of engine operation such as injection of fuel by fuel injectors 16 and EGR by EGR valve 28.

[0031] Figure 2 shows more detail of turbocharger 20. Compressor 24 comprises a compressor housing 32 and a compressor wheel 34 disposed within compressor housing 32. Turbine 22 comprises a turbine housing 36 having an inner chamber 38 and a turbine wheel 40 disposed within inner chamber 38.

[0032] A shaft 42 is supported on both turbine housing 36 and compressor housing 32 for rotation about an axis 44. Compressor wheel 34 and turbine wheel 40 are both affixed to shaft 42.

[0033] Turbine housing 36 has an inlet 48 through which exhaust gas enters turbine housing 36 and an outlet 50 through which exhaust gas leaves turbine housing 36. Compressor housing 32 has an inlet 52 through which fresh intake air enters compressor housing 32 and an outlet 53 through which compressed fresh air leaves compressor housing 32.

[0034] Figures 3, 4, 5, and 6 show further detail of turbine 22.

[0035] Turbine housing 36 comprises a wall 54 (Figures 3 and 4) having a first opening 56 and a second opening 58 forming inlet 48. Openings 56, 58 are arranged laterally side-by-side, and each has the same rectangular shape. Turbine housing 36 further comprises a scroll structure 60 (Figures 2, 5, and 6) for conveying exhaust gas which has entered inlet 48 through openings 56, 58 to inner chamber 38. As exhaust gas passes through inner chamber 38, the exhaust gas spins turbine wheel 40 and shaft 42 about axis 44, thereby spinning compressor

wheel 34 to operate compressor 24. After having passed through inner chamber 38, exhaust gas leaves turbine housing 36 through outlet 50.

[0036] A first valve element 62 and a second valve element 64 are associated with openings 56, 58 respectively. Each valve element 62, 64 is selectively positionable on turbine housing 36 for selectively controlling flow through inlet 48 by selectively controlling flow through the respective opening 56, 58.

[0037] A first hinge 66 mounts first valve element 62 for swinging about an axis 68 of first hinge 66 which is laterally adjacent a first side of inlet 48 over an angular range of swinging, as suggested by arrow 70, between a position at which first valve element 62 maximally occludes opening 56 as shown by the solid line position in Figure 4 and a position at which first valve element 62 does not occlude opening 56 as shown by the broken line position, and a second hinge 72 which mounts second valve element 64 for swinging about an axis 74 of second hinge 72 which is laterally adjacent a second side of inlet 48 laterally opposite the first side of inlet 48 over an angular range of swinging, as suggested by arrow 76, between a position at which second valve element 64 maximally occludes opening 58 as shown by the solid line position in Figure 4 and a position at which second valve element 64 does not occlude opening 58 as shown by the broken line position in Figure 4.

[0038] Turbine housing 36 comprises a first recess 78 which is interior of inlet 48 and within which first valve element 62 is received when first valve element 62 does not occlude opening

56 and a second recess 80 which is interior of inlet 48 and within which second valve element 64 is received when second valve element 64 does not occlude opening 58.

[0039] First valve element 62 comprises a face 82 which is flush with a surface 84 of turbine housing 36 surrounding first recess 78 when first valve element 62 is received within first recess 78, and second valve element 64 comprises a face 86 which is flush with a surface 88 of turbine housing 36 surrounding second recess 80 when second valve element 64 is received within second recess 80.

[0040] Face 82 fits with conformity to first opening 56 to at least substantially close first opening 56 when first valve element 62 is maximally occluding first opening 56, and face 86 fits with conformity to second opening 58 to at least substantially close second opening 58 when second valve element 64 is maximally occluding second opening 58.

[0041] Scroll structure 60 comprises a divider wall 90 separating a first scroll 92 for conveying exhaust gas from inlet 48 to inner chamber 38 and a second scroll 94 for conveying exhaust gas from inlet 48 to inner chamber 38. Opening 56 is in alignment with an entrance to first scroll 92, and opening 58 is in alignment with an entrance to second scroll 94. Scrolls 92, 94 remain separated from each other throughout their lengths so that flow entering first opening 56 is conveyed to inner chamber 38 entirely through first scroll 92 and flow entering second opening 58 is conveyed to inner chamber 38 entirely through second scroll 94.

[0042] Each valve element 62, 64 is independently controlled by ECU 30 via a respective actuator, namely a first actuator 96 and a second actuator 98, so that the position of one valve element doesn't necessarily have to correspond to that of the other. Figure 5 shows a condition where air flows through both scrolls 92, 94 because valve elements 62, 64 are not occluding openings 56, 58 while Figure 6 shows a condition where air flows only through second scroll 94 because valve element 62 is substantially closing first opening 56.

[0043] Figure 3 shows an example of operative couplings of actuators 96, 98 to the respective valve elements 62, 64. First actuator 96 has a coupling with a portion of first hinge 66 attached to first valve element 62 for turning first valve element 62 about first hinge axis 68. Second actuator 98 has a coupling with a portion of second hinge 72 attached to second valve element 64 for turning second valve element 64 about second hinge axis 74.

[0044] Because turbo lag occurs when acceleration is requested, such by a signal from an accelerator position sensor 100 (Figure 1) to ECU 30, a control strategy for valve elements 62, 64 can be useful in mitigating turbo lag. The ability to control flow to inner chamber 38 by controlling opening and closing of valve elements 62, 64 controls the turbine A/R ratio.

WHAT IS CLAIMED IS:

1. A turbine comprising;
a turbine housing comprising an inner chamber;
a turbine wheel disposed within the inner chamber;
a shaft which is supported on the turbine housing for rotation about an axis and to which the turbine wheel is affixed for rotation with the shaft about the axis;

the turbine housing further comprising an inlet through which working fluid enters the turbine housing, at least one scroll for conveying working fluid which has entered the inlet to the inner chamber to enable working fluid to spin the turbine wheel and the shaft about the axis as working fluid passes through the inner chamber, and an outlet through which working fluid leaves the turbine housing after having passed through the inner chamber;

at least one valve element selectively positionable on the turbine housing for selectively controlling flow through the inlet;

and at least one actuator operable to selectively position the at least one valve element on the turbine housing.

2. The turbine as set forth in Claim 1 comprising a hinge which mounts a valve element of the at least one valve element for swinging about an axis of the hinge which is adjacent the inlet over an angular range of swinging between a position at which the valve element of the at least one valve element maximally occludes the inlet and a position at which the valve element of the at least one valve element does not occlude the inlet.

3. The turbine as set forth in Claim 2 in which the turbine housing comprises a recess which is interior of the inlet and within which the valve element of the at least one valve element is received when the valve element of the at least one valve element does not occlude the inlet.

4. The turbine as set forth in Claim 3 in which the valve element of the at least one valve element comprises a face which is flush with a surface of the turbine housing surrounding the recess when the valve element of the at least one valve element is received within the recess.

5. The turbine as set forth in Claim 4 in which the inlet comprises an opening in a wall of the turbine housing and the face of the valve element of the at least one valve element fits with conformity to the opening to at least substantially close the opening when the valve element of the at least one valve element is maximally occluding the inlet.

6. The turbine as set forth in Claim 5 in which the face of the valve element of the at least one valve element has a rectangular shape, the recess has a rectangular shape at the surface of the turbine housing surrounding the recess, the face of the valve element of the at least one valve element fits with conformity to the rectangular shape at the surface of the turbine housing surrounding the recess when the face of the valve element of the at least one valve element is flush with the surface of the turbine housing surrounding the recess, and the opening has a rectangular shape to which the face of the valve element of the at least one valve element fits with conformity when the valve element of the at least one valve element is maximally occluding the inlet.

7. The turbine as set forth in Claim 1 in which the at least one valve element comprises a first valve element and a second valve element each of which is selectively positionable on the turbine housing for selectively controlling flow through the inlet, and the at least one actuator comprises a first actuator operable to selectively position the first valve element and a second actuator operable to selectively position the second valve element.

8. The turbine as set forth in Claim 7 in which the first actuator has its own control input and the second actuator has its own control input to enable the first actuator and the second actuator to operate independently of each other.

9. The turbine as set forth in Claim 8 comprising a first hinge which mounts the first valve element for swinging about an axis of the first hinge which is laterally adjacent a first side of the inlet over an angular range of swinging between a position at which the first valve element maximally occludes the inlet and a position at which the first valve element does not occlude the inlet, and a second hinge which mounts the second valve element for swinging about an axis of the second hinge which is laterally adjacent a second side of the inlet laterally opposite the first side of the inlet over an angular range of swinging between a position at which the second valve element maximally occludes the inlet and a position at which the second valve element does not occlude the inlet.

10. The turbine as set forth in Claim 9 in which the turbine housing comprises a first recess which is interior of the inlet and within which the

first valve element is received when the first valve element does not occlude the inlet and a second recess which is interior of the inlet and within which the second valve element is received when the second valve element does not occlude the inlet.

11. The turbine as set forth in Claim 10 in which the first valve element comprises a face which is flush with a surface of the turbine housing surrounding the first recess when the first valve element is received within the first recess and the second valve element comprises a face which is flush with a surface of the turbine housing surrounding the second recess when the second valve element is received within the second recess.

12. The turbine as set forth in Claim 11 in which the inlet comprises a first opening and a second opening which are laterally spaced apart in a wall of the turbine housing, the face of the first valve element fits with conformity to the first opening to at least substantially close the first opening when the first valve element is maximally occluding the inlet, and the face of the second valve element fits with conformity to the second opening to at least substantially close the second opening when the second valve element is maximally occluding the inlet.

13. The turbine as set forth in Claim 12 in which the at least one scroll comprises first scroll for conveying working fluid from the first opening to the inner chamber and a second scroll for conveying working fluid from the second opening to the inner chamber.

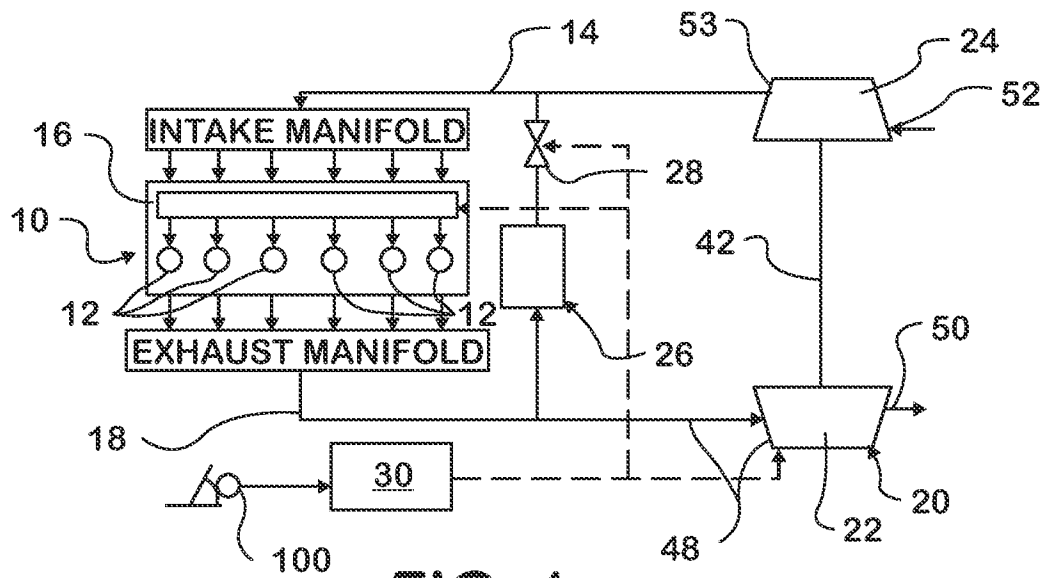


FIG. 1

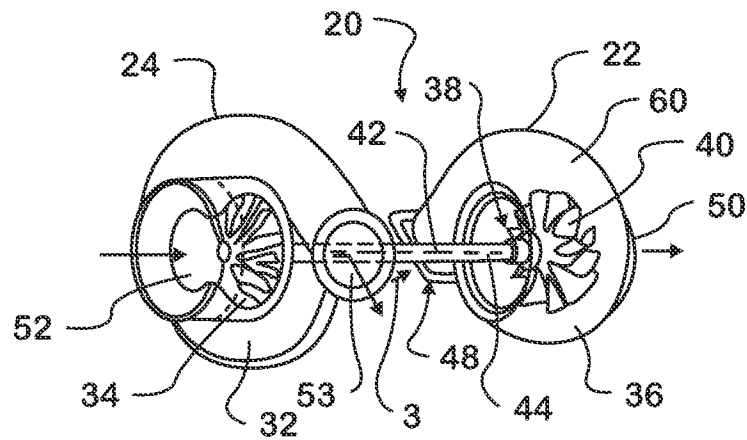


FIG. 2

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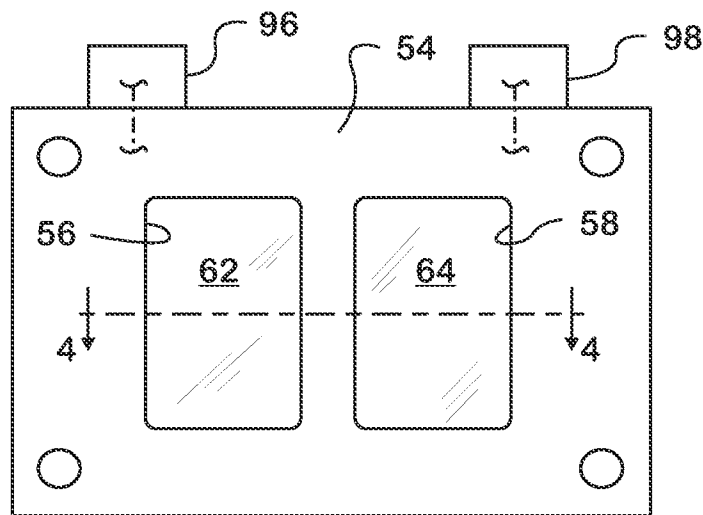


FIG. 3

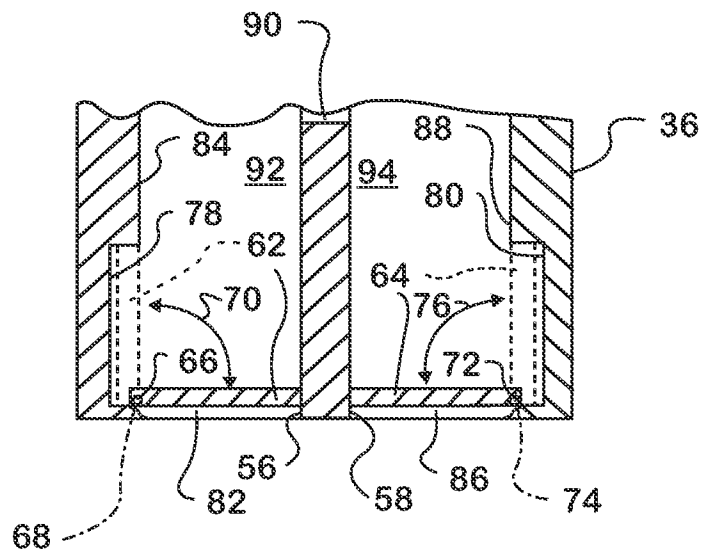


FIG. 4

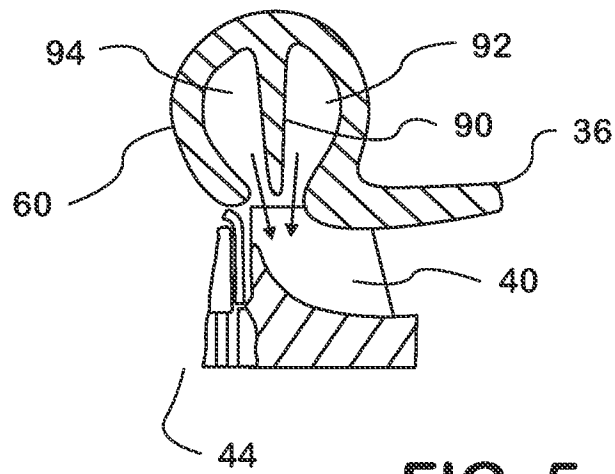


FIG. 5

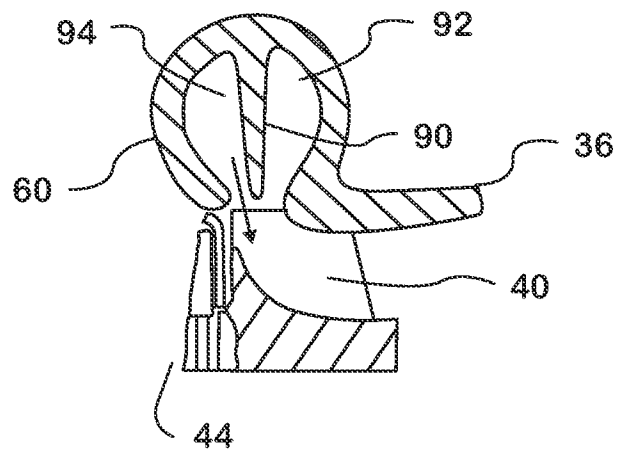


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/042747

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F02B 37/22 (2013.01)

USPC - 415/205

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) - F01D 17/14, 17/18, 25/24; F02B 37/22; F02C 6/12 (2013.01)

USPC - 29/889.2; 60/600, 602, 614, 615; 415/126, 145, 151, 155, 184, 201, 204, 205, 212.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
CPC - F01D 9/026, 17/14, 17/141, 17/143, 17/145, 17/146, 17/148; F02B 37/025; F02C 6/12, 7/054; F05D 2220/40; Y02T10/144 (2013.01)

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

PatBase, Google Patents

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 4,719,757 A (NAKAZAWA et al) 19 January 1988 (19.01.1988) entire document	1-13
A	US 4,893,698 A (SUZUKI) 16 January 1990 (16.01.1990) entire document	1-13
A	US 7,523,736 B2 (RAMMER et al) 28 April 2009 (28.04.2009) entire document	1-13
A	US 2011/0296835 A1 (EBISU) 08 December 2011 (08.12.2011) entire document	1-13

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