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(71) Applicant: **BORGWARNER INC.** [US/US]; Patent Department, 3850 Hamlin Road, Auburn Hills, Michigan 48326 (US).

(72) Inventors: **HENDERSON, Kurt**; 93 Coke Candler Lane, Candler, North Carolina 28715 (US). **VEMULA, Rajendra**; 74 Olde Covington Way, Arden, North Carolina 28704 (US).

(74) Agents: **ASHER, Robin W.** et al.; MILLER, CANFIELD, PADDOCK AND STONE, P.L.C., 150 West Jefferson, Suite 2500, Detroit, Michigan 48226 (US).

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(54) Title: SPLIT NOZZLE RING TO CONTROL EGR AND EXHAUST FLOW

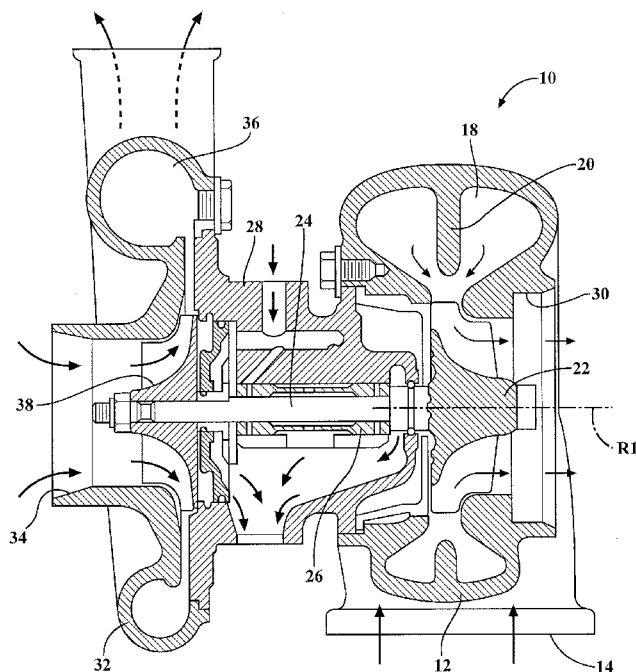


FIG. 1

(57) Abstract: A turbocharger (10) for an internal combustion engine includes a symmetric twin-volute turbine housing (12) having first and second volutes (16, 18). A turbine wheel (22) is disposed within the symmetric twin-volute turbine housing (12) for rotation about a turbocharger axis (R1). A nozzle ring (42, 58) is fixedly secured to the symmetric twin-volute turbine housing (12). The nozzle ring (42, 58) includes a plurality of fixed vanes (44, 62, 66) disposed circumferentially around the turbocharger axis (R1). The plurality of fixed vanes (44, 62, 66) form nozzle passages leading from at least one of the first and second volutes (16, 18) to the turbine wheel (22) for directing exhaust gas against the turbine wheel (22) at an optimum angle.



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Declarations under Rule 4.17:

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

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SPLIT NOZZLE RING TO CONTROL EGR AND EXHAUST FLOW**CROSS-REFERENCE TO RELATED APPLICATION**

This application claims priority to and all benefits of U.S. Provisional Application No. 61/752,007 filed on January 14, 2013, and entitled "Split Nozzle Ring To Control EGR And Exhaust Flow."

BACKGROUND OF THE INVENTION**1. Field of the Invention**

This invention relates to a turbocharger for an internal combustion engine. More particularly, this invention relates to a turbocharger including a symmetric twin-volute turbine housing having a nozzle ring with fixed vanes.

2. Description of Related Art

A turbocharger is a type of forced induction system used with internal combustion engines. Turbochargers deliver compressed air to an engine intake, allowing more fuel to be combusted, thus boosting an engine's power without significantly increasing engine weight. Thus, turbochargers permit the use of smaller engines that develop the same amount of power as larger, normally aspirated engines. Using a smaller engine in a vehicle decreases the mass of the vehicle, increasing performance, and enhancing fuel economy. Moreover, the use of turbochargers permits more complete combustion of the fuel delivered to the engine, which reduces emissions.

Generally, turbochargers use exhaust gas from an exhaust manifold to drive a turbine wheel, which is housed within a turbine housing. The turbine wheel and turbine housing define a turbine or turbine stage of the turbocharger. The turbine wheel is secured to one end of a shaft and a compressor impeller is secured to another end of the shaft such that rotation of the turbine wheel causes rotation of the compressor impeller. The compressor impeller is housed within a compressor housing. The compressor impeller and compressor housing define a compressor or compressor stage of the turbocharger. A bearing housing couples the turbine housing and the compressor housing together. The shaft is rotatably supported in the bearing housing. As the compressor impeller rotates, it draws in ambient air and compresses it before it enters into the engine's cylinders via an intake manifold. This results in a greater mass of air entering the cylinders on each intake stroke. Once the exhaust gas has passed through the turbine wheel, the spent exhaust gas exits the turbine housing and is usually sent to after-treatment devices such as

catalytic converters, particulate traps, and Nitrogen Oxide (NO_x) traps before exiting to atmosphere.

The turbine converts the exhaust gas into mechanical energy to drive the compressor. The exhaust gas enters the turbine housing at an inlet, flows through a scroll or volute, and is directed into the turbine wheel located in the center of the turbine housing. After the turbine wheel, the exhaust gas exits through an outlet or exducer. The exhaust gas, which is restricted by the turbine's flow cross-sectional area, results in a pressure and temperature drop between the inlet and outlet. This pressure drop is converted by the turbine into kinetic energy to drive the turbine wheel. Energy transfer from kinetic energy into shaft power takes place at the turbine wheel, which is designed so that nearly all the kinetic energy is converted by the time the exhaust gas reaches the turbine outlet.

In order to optimize the flow of exhaust gas to the turbine wheel, it is well known to include a nozzle ring which includes a series of curved vanes on a flange which form nozzle passages leading from the volute to the turbine wheel. The nozzle ring is sandwiched between the bearing housing and the turbine housing and the vanes direct the exhaust gas against the turbine wheel at an optimum angle.

Exhaust gas recirculation (EGR) is widely recognized as a significant method for reducing the production of NO_x during the combustion process. The recirculated exhaust gas partially quenches the combustion process and lowers the peak temperature produced during combustion. Since NO_x formation is related to peak temperature, recirculation of exhaust gas reduces the amount of NO_x formed. In order to recirculate exhaust gas into the intake manifold, the exhaust gas must be at a pressure that is greater than the pressure of the intake air. However, if the pressure of the exhaust gas is excessive, the exhaust gas creates backpressure on the engine that is detrimental to overall fuel efficiency and performance.

One approach for ensuring sufficient exhaust gas pressure to promote EGR, while preventing excessive backpressure on the engine, is to use an asymmetric twin-volute turbine housing which incorporates two volutes of different sizes for separate exhaust gas routing of different cylinder groupings. A smaller volute coupled to a first cylinder grouping achieves EGR through higher exhaust gas backpressure built-up in front of the turbine. A larger volute coupled to a second cylinder grouping provides a high turbine output using exhaust gas energy for optimum efficiency without being affected by the EGR. This combination provides optimum engine response and helps the engine to comply with global emissions standards while achieving better fuel economy and improved performance.

It is understood, however, that multiple designs of the asymmetric twin-volute turbine housing are necessary to meet the desired EGR and turbine performance parameters depending on the particular application.

It is desirable, therefore, to provide a symmetric twin-volute turbine housing which can be used with multiple nozzle rings to effectively create an asymmetric twin-volute turbine housing with the desired EGR and turbine performance parameters.

SUMMARY OF THE INVENTION

A turbocharger for an internal combustion engine includes a symmetric twin-volute turbine housing including first and second volutes. A turbine wheel is disposed within the symmetric twin-volute turbine housing for rotation about a turbocharger axis. A nozzle ring is fixedly secured to the symmetric twin-volute turbine housing. The nozzle ring includes a plurality of fixed vanes disposed circumferentially around the turbocharger axis. The plurality of fixed vanes form nozzle passages leading from at least one of the first and second volutes to the turbine wheel for directing exhaust gas against the turbine wheel at an optimum angle.

According to a first embodiment of the invention, the nozzle ring includes a plurality of fixed vanes disposed in a throat of one of the first and second volutes.

According to a second embodiment of the invention, the nozzle ring includes a first side having a plurality of first fixed vanes and a second side having a plurality of second fixed vanes. The plurality of first fixed vanes is disposed in a throat of the first volute and the plurality of second fixed vanes is disposed in a throat of the second volute.

BRIEF DESCRIPTION OF THE DRAWINGS

Advantages of the present invention will be readily appreciated as the same becomes better understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

Figure 1 is a cross-sectional view of a turbocharger with a symmetric twin-volute turbine housing for use with a nozzle ring according to the invention;

Figure 2 is a cross-sectional view of the symmetric twin-volute turbine housing including a nozzle ring according to a first embodiment of the invention;

Figure 3a is a side view of a split nozzle ring for use with the symmetric twin-volute turbine housing according to a second embodiment of the invention;

5 Figure 3b is a perspective view of a first side of the split nozzle ring; and

Figure 3c is a perspective view of a second side of the split nozzle ring.

DETAILED DESCRIPTION OF THE EMBODIMENTS

A cross-section of a turbocharger is illustrated generally at 10 in Figure 1. The turbocharger 10 includes a turbine and a compressor. The turbine includes a turbine housing 12 and is supplied with exhaust gas through a turbine inlet 14 that is connected to an exhaust manifold (not shown). In a first embodiment of the invention, the turbine housing 12 is a symmetric twin-scroll or twin-volute design and includes first and second volutes 16, 18 which are axially adjacent to each other and separated by a divider wall 20. The first and second volutes 16, 18 extend circumferentially within the turbine housing 12 and the divider wall 20 provides separation of the exhaust gas pulsations of individual cylinder groupings. The symmetric twin-volute turbine housing 12 results in equal exhaust gas backpressure for each cylinder grouping and is used to improve low engine speed response by capturing low engine speed exhaust gas pulsations more effectively.

A turbine wheel 22 is disposed within the turbine housing 12 and is mounted on one end of a shaft 24 for rotation about a turbocharger axis R1. The shaft 24 is rotatably supported by a bearing system 26 in a bearing housing 28 that is disposed between the turbine and compressor. The turbine wheel 22 is rotatably driven by exhaust gas supplied from the exhaust manifold and, after driving the turbine wheel 22, the exhaust gas exits the turbine housing 12 through an exducer 30.

The compressor includes a compressor housing 32 and is supplied with ambient air through an inducer 34. The compressor housing 32 includes a compressor volute 36 that extends circumferentially therein. A compressor impeller 38 is disposed within the compressor housing 32 and is mounted to another end of the shaft 24 for rotation about the turbocharger axis R1 in response to rotation of the turbine wheel 22. As the compressor impeller 38 rotates, ambient air is drawn into the compressor housing 18 through the inducer 34 and is compressed by the

compressor impeller 38 to be delivered at an elevated pressure through a compressor outlet 40 to an engine intake manifold (not shown).

Referring to Figure 2, the turbine includes a nozzle ring 42 having a plurality of fixed vanes 44 disposed circumferentially around the turbocharger axis R1. The fixed vanes 44 form nozzle passages leading from the second volute 18 to the turbine wheel 22 and direct the exhaust gas against the turbine wheel 22 at an optimum angle. The nozzle ring 42 is fixedly secured to the turbine housing 12. In the embodiment shown, the nozzle ring 42 is coupled to a contoured surface leading to the exducer 30. It is contemplated that the nozzle ring 42 could partially or completely replace the divider wall 20 without varying from the scope of the invention. The nozzle ring 42 is positioned such that the fixed vanes 44 act on the exhaust gas passing through a throat 46 of the second volute 18. It is appreciated, however, that the nozzle ring 42 may be positioned such that the fixed vanes 44 act on the exhaust gas passing through a throat 48 of the first volute 16 without varying from the scope of the invention. Since the first and second volutes 16, 18 are symmetric, and the fixed vanes 44 only act on the exhaust gas passing through the throat 46 of the second volute 18, the nozzle ring 42 effectively creates an asymmetric twin-volute turbine housing. As such, the second volute 18 and nozzle ring 42 create a higher exhaust gas backpressure for the corresponding cylinder grouping to assist with exhaust gas recirculation while the first volute 16 provides a high turbine output without being affected by the exhaust gas recirculation.

In a second embodiment of the invention, shown in Figures 3a through 3c, the turbine includes a split nozzle ring 58 having a first side 60 with a plurality of first fixed vanes 62 which form nozzle passages leading from the first volute 16 to a turbine wheel 22 and a second side 64 with a plurality of second fixed vanes 66 which form nozzle passages leading from the second volute 18 to the turbine wheel 22. The first and second fixed vanes 62, 66 direct the exhaust gas against the turbine wheel 22 at an optimum angle. In the embodiment shown, the split nozzle ring 58 includes thirteen first fixed vanes 62 and nine second fixed vanes 66, however, it is appreciated that the split nozzle ring 58 may include any number of first and second fixed vanes 62, 66 without varying from the scope of the invention. It is further appreciated that the vane count of the second fixed vanes 66 may be greater than the vane count of the first fixed vanes 62.

The split nozzle ring 58 is fixedly secured to the turbine housing 12 between the first and second volutes 16, 18. It is contemplated that the split nozzle ring 58 could partially or completely replace the divider wall 20. The nozzle ring 58 is positioned such that the first fixed vanes 62 act on the exhaust gas passing through the throat 48 of the first volute 16 and the

second fixed vanes 66 act on the exhaust gas passing through the throat 46 of the second volute 18. The higher vane count of the first fixed vanes 62 create a higher exhaust gas backpressure for the corresponding cylinder grouping to assist with exhaust gas recirculation. In contrast, the lower vane count of the second fixed vanes 66 provide a high turbine output without being
5 affected by the exhaust gas recirculation. As such, the split nozzle ring 58 effectively creates an asymmetric twin-volute turbine housing.

The invention has been described here in an illustrative manner, and it is to be understood that the terminology used is intended to be in the nature of words of description rather than limitation. Many modifications and variations of the present invention are possible in light of
10 the above teachings. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced other than as specifically enumerated within the description.

What is claimed:

1. A turbocharger (10) for an internal combustion engine comprising:

a twin-volute turbine housing (12) including first and second volutes (16, 18);

5 a turbine wheel (22) disposed within said twin-volute turbine housing (12) for rotation about a turbocharger axis (R1); and

a nozzle ring (42, 58) fixedly secured to said twin-volute turbine housing (12), said nozzle ring (42, 58) including a plurality of fixed vanes (44, 62, 66) disposed circumferentially around said turbocharger axis (R1), wherein said plurality of fixed vanes (44, 62, 66) form nozzle passages leading from at least one of said first and second volutes (16, 18) to said turbine
10 wheel (22) for directing exhaust gas against said turbine wheel (22) at an optimum angle.

2. The turbocharger (10) as set forth in claim 1 wherein said first and second volutes (16, 18) are symmetric.

3. The turbocharger (10) as set forth in claim 2 wherein said plurality of fixed vanes (44) form nozzle passages leading from one of said first and second volutes (16, 18) to said
15 turbine wheel (22).

4. The turbocharger (10) as set forth in claim 3 wherein said plurality of fixed vanes (44) promote exhaust gas recirculation.

5. The turbocharger (10) as set forth in claim 4 wherein said nozzle ring (42) is disposed axially between said first and second volutes (16, 18).

20 6. The turbocharger (10) as set forth in claim 2 wherein said nozzle ring (58) includes a first side (60) having said plurality of fixed vanes (62) and a second side (64), opposite said first side (60), having said plurality of fixed vanes (66).

7. The turbocharger (10) as set forth in claim 6 wherein said plurality of fixed vanes (62) form nozzle passages leading from said first volute (16) to said turbine wheel (22), and
25 wherein said plurality of fixed vanes (66) form nozzle passages leading from said second volute (18) to said turbine wheel (22).

8. The turbocharger (10) as set forth in claim 7 wherein a vane count of said plurality of fixed vanes (62) does not equal a vane count of said plurality of fixed vanes (66).

9. The turbocharger (10) as set forth in claim 8 wherein said plurality of fixed vanes (62) promote exhaust gas recirculation, and wherein said plurality of fixed vanes (66) promote a high turbine output.

10. The turbocharger (10) as set forth in claim 9 wherein said nozzle ring (58) is disposed axially between said first and second volutes (16, 18).

11. A turbine housing (12) for a turbocharger (10), said turbine housing (12) comprising:

a pair of symmetric volutes defining a first volute (16) and a second volute (18);

a turbine wheel (22) disposed within said turbine housing (12) for rotation about a turbocharger axis (R1); and

a nozzle ring (42) fixedly secured to said turbine housing (12), said nozzle ring (42) including a plurality of fixed vanes (44) disposed circumferentially around said turbocharger axis (R1), wherein said plurality of fixed vanes (44) form nozzle passages leading from one of said first and second volutes (16, 18) to said turbine wheel (22) for directing exhaust gas against said turbine wheel (22) at an optimum angle.

12. A turbine housing (12) for a turbocharger (10), said turbine housing (12) comprising:

a pair of symmetric volutes defining a first volute (16) and a second volute (18);

a turbine wheel (22) disposed within said turbine housing (12) for rotation about a turbocharger axis (R1); and

a nozzle ring (58) fixedly secured to said turbine housing (12), said nozzle ring (58) including a first side (60) having a plurality of first fixed vanes (62) disposed circumferentially around said turbocharger axis (R1) and a second side (64) having a plurality of second fixed vanes (66) disposed circumferentially around said turbocharger axis (R1), wherein said plurality of first fixed vanes (62) form nozzle passages leading from said first volute (16) to said turbine wheel (22) for directing exhaust gas against said turbine wheel (22) at an optimum angle, and wherein said plurality of second fixed vanes (66) form nozzle passages leading from said second volute (18) to said turbine wheel (22) for directing exhaust gas against said turbine wheel (22) at an optimum angle.

13. The turbine housing (12) as set forth in claim 12 wherein a vane count of said plurality of first fixed vanes (62) does not equal a vane count of said plurality of second fixed vanes (66).

14. The turbine housing (12) as set forth in claim 13 wherein said plurality of first
5 fixed vanes (62) promote exhaust gas recirculation, and wherein said plurality of second fixed vanes (66) promote a high turbine output.

15. The turbine housing (12) as set forth in claim 14 wherein said nozzle ring (58) is disposed axially between said first and second volutes (16, 18).

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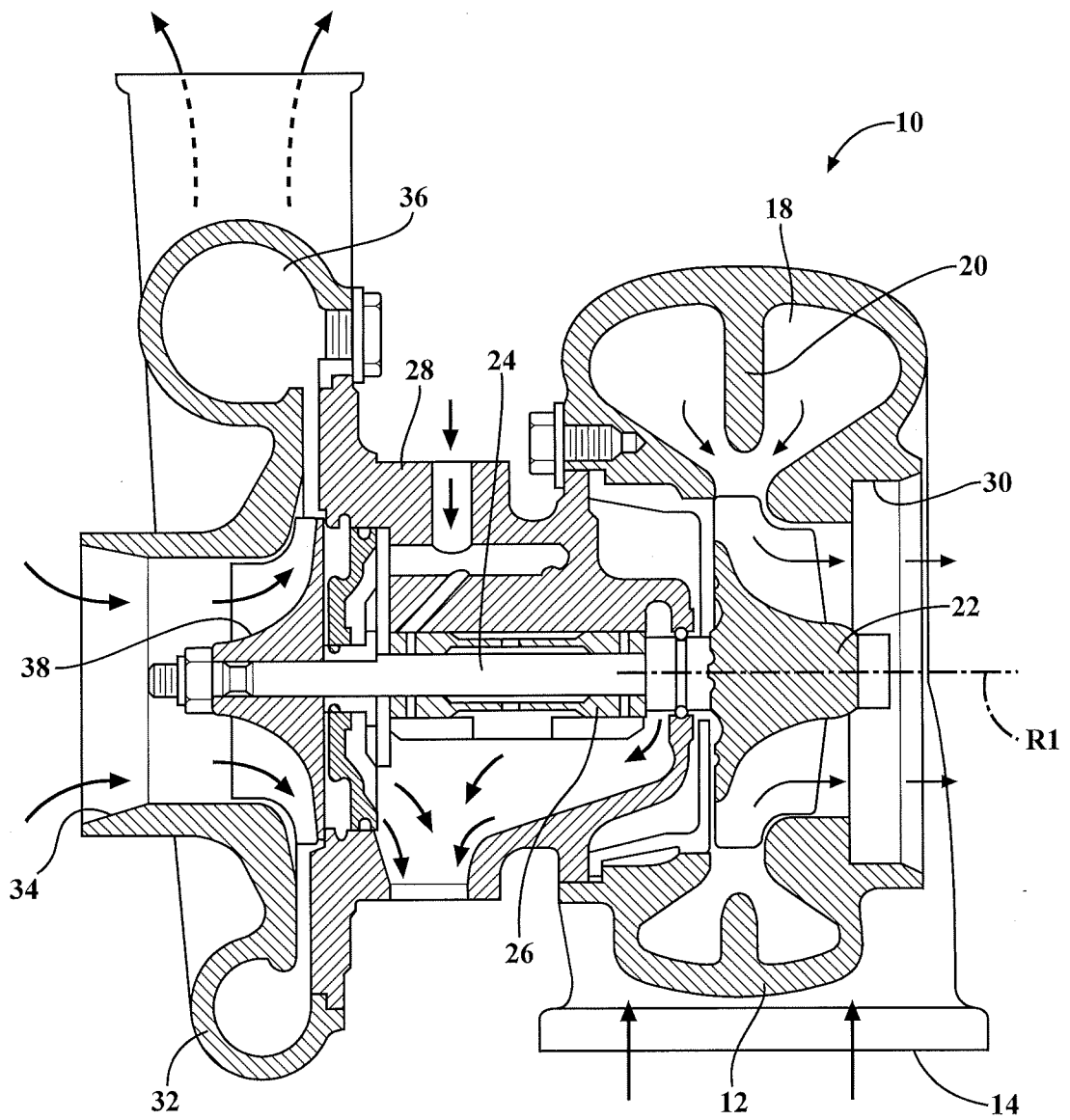


FIG. 1

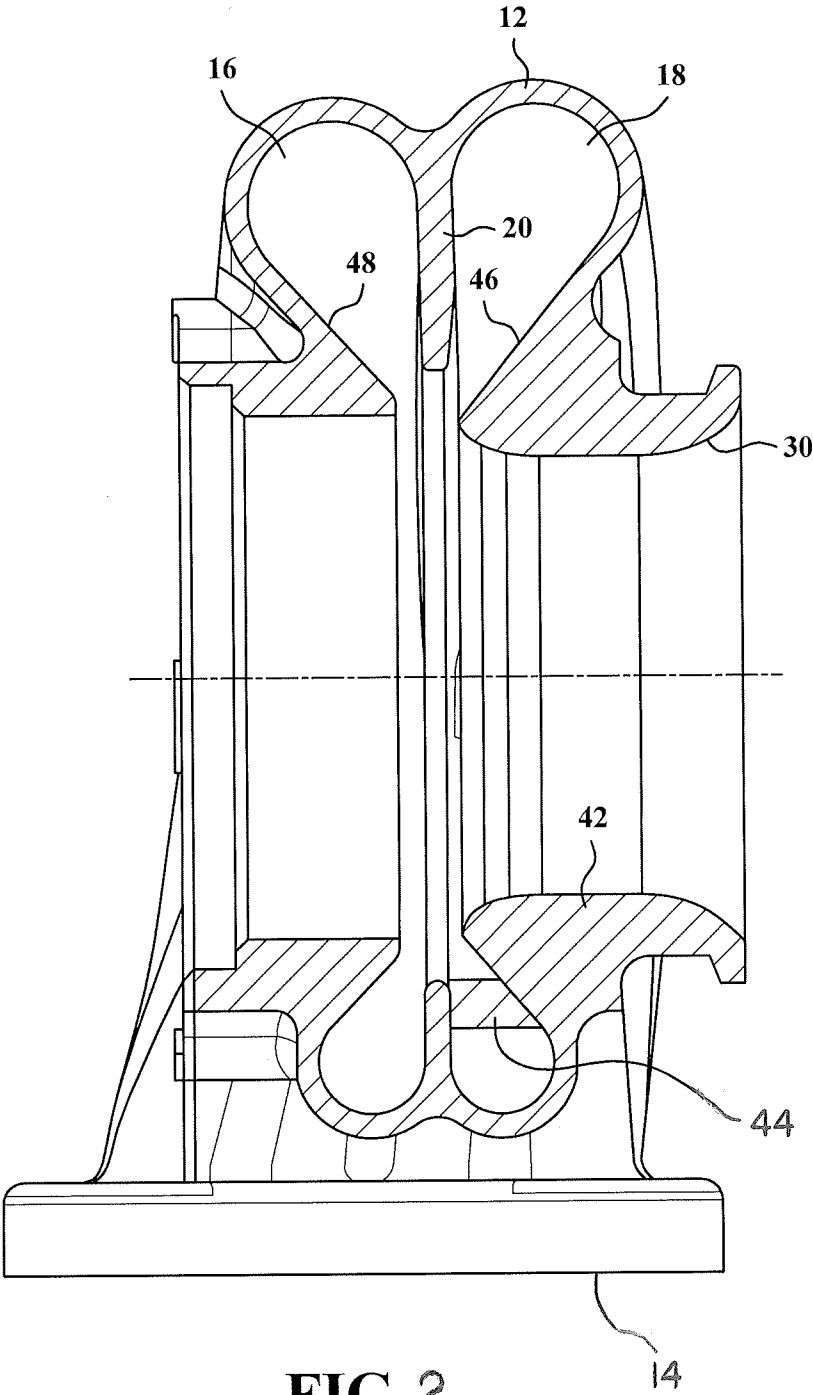


FIG. 2

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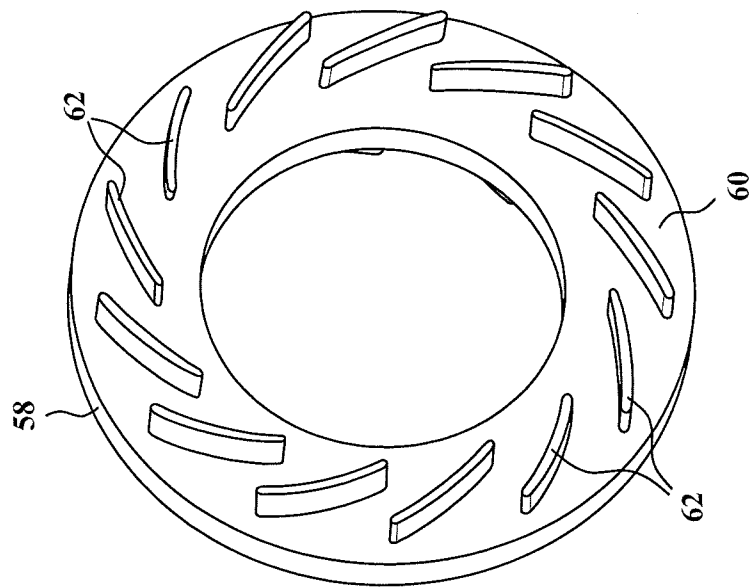


FIG. 3B

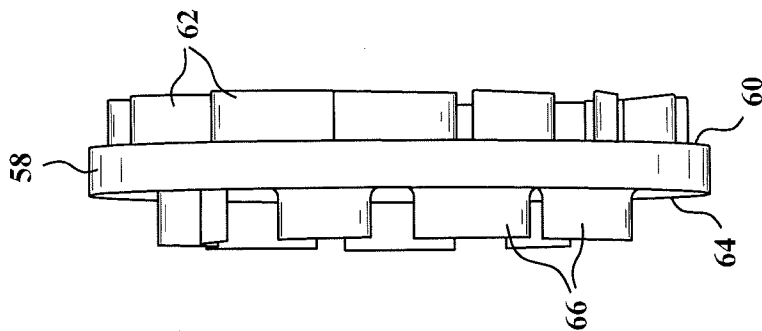


FIG. 3A

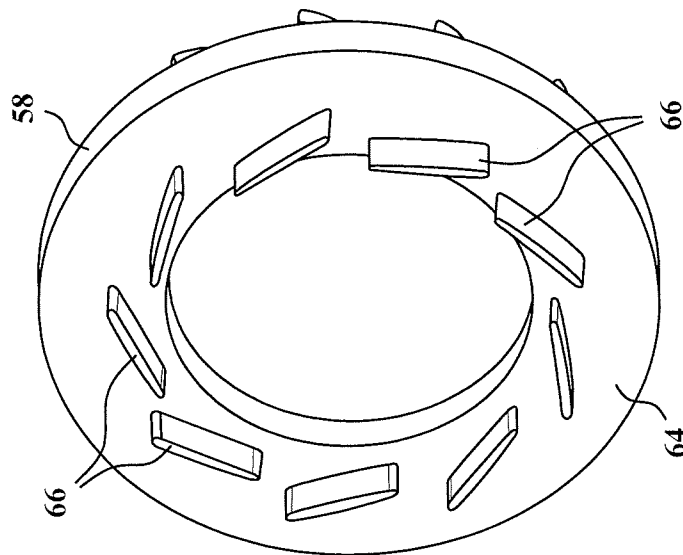


FIG. 3C

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2013/076473**A. CLASSIFICATION OF SUBJECT MATTER****F02B 37/013(2006.01)i, F02B 39/00(2006.01)i, F01D 9/02(2006.01)i**

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)

F02B 37/013; F02B 39/00; F02B 29/04; F02B 33/44; F01D 1/02; F02D 23/00; F02B 37/16; F01D 9/02

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

Korean utility models and applications for utility models

Japanese utility models and applications for utility models

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

eKOMPASS(KIPO internal) & Keywords:turbobocharger, twin, volute, scroll, and nozzle ring

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2009-0041577 A1 (SERRES, NICOLAS) 12 February 2009 See abstract; paragraphs [0023]-[0028]; and figures 1-4,7.	1,11
Y		2-10,12-15
Y	US 2007-0209361 A1 (PEDERSEN et al.) 13 September 2007 See abstract; paragraphs [0010],[0074]-[0079],[0101]-[0103]; and figures 1,2,10-15.	2-10,12-15
A	JP 2008-231993 A (TOYOTA MOTOR CORP. et al.) 02 October 2008 See abstract; paragraphs [0021]-[0023],[0025]; and figures 1-4.	1-15
A	US 2007-0175214 A1 (REISDORF et al.) 02 August 2007 See abstract; paragraphs [0021],[0023],[0024],[0027],[0028]; and figures 2,3.	1-15
A	US 4,809,509 A (HOHKITA, ATSUSHI) 07 March 1989 See abstract; column 2, lines 60-67, column 3, lines 3-34; and figures 1-3.	1-15



Further documents are listed in the continuation of Box C.



See patent family annex.

* Special categories of cited documents:

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

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Date of mailing of the international search report

11 April 2014 (11.04.2014)

Name and mailing address of the ISA/KR

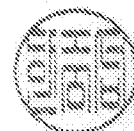
International Application Division
Korean Intellectual Property Office
189 Cheongsa-ro, Seo-gu, Daejeon Metropolitan City, 302-701,
Republic of Korea

Facsimile No. +82-42-472-7140

Authorized officer

HAN, Joong Sub

Telephone No. +82-42-481-5606



INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/US2013/076473

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