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[Continued on next page]

(54) Title: VARIABLE GEOMETRY TURBINE WITH SHROUD SUPPORT

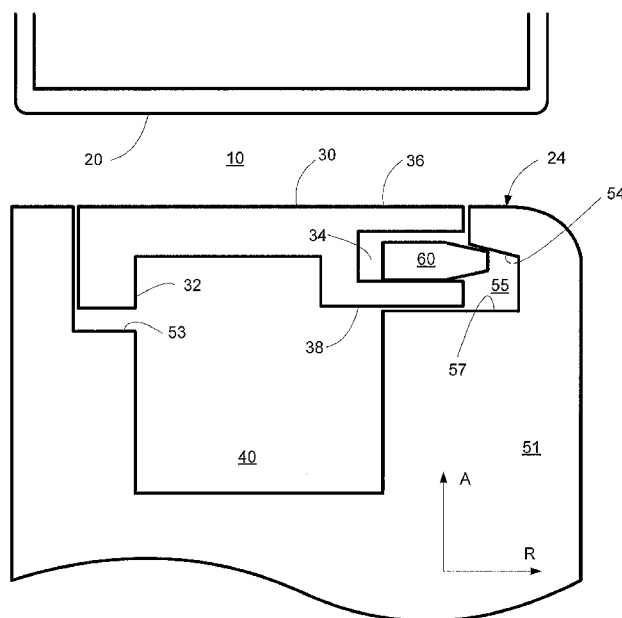


Figure 3

(57) Abstract: A variable geometry turbine includes an axially movable nozzle ring and a stationary shroud. The shroud has at a radially outer edge a groove defined by parallel flanges. The turbine housing defines an inlet gap having an annular vane cavity opposite the movable nozzle ring, the shroud being positioned to cover the cavity. The shroud is secured to the housing by a retaining ring disposed in the groove and acting against a rim at a radially outer edge of the cavity. The retaining ring acts between the rim and a lower flange to secure the lower flange against a ledge formed in the cavity.



EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU,
LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK,
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— *of inventorship (Rule 4.17(iv))*

Published:

— *with international search report (Art. 21(3))*

Declarations under Rule 4.17:

— *as to applicant's entitlement to apply for and be granted
a patent (Rule 4.17(ii))*

Variable Geometry Turbine with Shroud Support

The invention is directed to a variable geometry turbine housing and a shroud plate, and more specifically to an arrangement for supporting a shroud plate in a variable geometry turbine housing.

Background and Summary

5 Turbines may be of a fixed or variable geometry type. Variable geometry turbines differ from fixed geometry turbines in that the size of the inlet passageway can be adjusted to modify inlet gas flow velocities over a range of mass flow rates so that the power output of the turbine can be varied to suit engine demands.

10 In one common type of variable geometry turbine, illustrated in Figure 1, one wall of the inlet passageway 10 includes a movable wall member 20 and the opposing side of the inlet passage is defined by a fixed wall 24. A reference frame in the figures indicates the radial direction R and the axial direction A. The position of the movable wall member 20 relative to the facing fixed wall 24 of the inlet passageway 10 is adjustable to control the width of the inlet passageway, that is, the gap between the movable wall member 20 and the fixed wall 24. As is known in the art, an actuator (not
15 illustrated) is operationally connected to the movable wall to control the position of the movable wall. Exhaust gas passes through the inlet passageway 10 to the turbine wheel 12.

Typically, either the movable wall member or the facing fixed wall is provided with vanes. In such arrangements, the movable wall is referred to as the "nozzle ring." The fixed wall 24 may include an annular cavity 40 covered by a shroud 30. The shroud 30 forms part of the fixed wall 24. In the
20 illustrated example of Figure 1, vanes (one vane 22 is shown) are mounted on the nozzle ring 20. The vanes 22 extend from the nozzle ring 20 into the inlet passageway 10, through slots provided in the shroud 30, and into the annular cavity 40 formed in the turbine housing 50.

Figure 2 is a simplified section view of the portion of the turbine housing 50 of Figure 1 that supports the shroud 30. The vane 22 shown in Figure 1 is removed for clarity. The shroud 30 is a ring-shaped
25 member having on its radially inner margin a foot 32 to contact a first shoulder 52 formed on a radially inner portion of the wall defining the cavity 40. The annular cavity 40 is shaped to provide support for the shroud 30 and includes a first shoulder 52 on a radially inner side and a second shoulder 56 on a radially outer side. A lip or ledge 54 is formed at the radially outer side to provide an annular groove 55 between the lip 54 and the second shoulder 56.

30 The shroud 30 has on its outer margin spaced flanges 36, 38 that define a radially extending groove 34. An upper flange 36 forms part of a surface of the fixed wall 24. A lower flange 38 is spaced from

the upper flange toward the cavity 40. The shroud groove 34 accepts a retaining snap ring 60. The retaining ring 60 contacts the lip 54 formed in the housing 50 and acts between the lip and the lower flange 38 to secure the shroud position in the housing 50. The lower flange 38 is spaced from the second shoulder 56 and the force of the retaining ring 60 acting on the shroud 30 is transmitted to the foot 32, which is supported on the first shoulder 52.

A problem with this arrangement is that the shroud 30 is not secured against rotation relative to the turbine housing. Because the slots in the shroud must align with the vanes to permit free axial movement of the vanes as the movable wall member 20 is positioned to adjust the width of the inlet 10, rotation of the shroud results in contact between the shroud and vanes. Contact causes wear of both the shroud and vanes, and can cause a locking of the vanes on the shroud.

A second problem is that the shroud 30 experiences heat-generated distortion, dishing, with temperature rise. The current arrangement supporting the shroud at its inner margin (at the foot 32) and outer margin (at the flange 38) exaggerates the dishing, leading also to contact between the vanes and the shroud.

The invention provides a solution. According to the invention, a variable geometry turbine includes a turbine housing defining an inlet passage having a first side wall and a second side wall, the second side wall including an annular cavity defined by a radially inner shoulder and a radially outer shoulder and including a radially outer lip overhanging the outer shoulder, a movable annular wall on the first side wall of the inlet passage, the movable wall being moveable relative to the inlet passage to control a width of the inlet passage, an annular shroud plate disposed on the second side wall of the inlet passage and covering the annular cavity, the shroud plate having a radially-extending upper flange and a radially-extending lower flange on a radially outer portion, the upper flange and lower flange defining therebetween a groove, and a retaining ring disposed in the groove and contacting the lip and the lower flange to secure the lower flange against the outer shoulder.

According to another aspect of the invention, the annular shroud plate has a foot at a radially inner portion, the foot being spaced from the inner seat.

Brief Description of the Drawings

Figure 1 is a simplified section view of a turbine housing showing an inlet passage, nozzle ring, and shroud arrangement according to the prior art.

Figure 2 is a simplified section view of the portion of the turbine housing of Figure 1 that supports
5 the shroud 30.

Figure 3 is a section view of a turbine housing showing an arrangement for supporting the shroud according to the invention.

Figure 4 is a section view of a turbine housing showing an alternative arrangement for supporting the shroud according to the invention.

10 Detailed Description

The invention provides a solution in a new arrangement for supporting the shroud in the turbine housing, one embodiment being illustrated in Figure 3. According to the invention, the retaining force on the shroud acts at only the radially outer portion of the shroud. The lower flange 38 of the shroud and the lip 54 and radially outer shoulder 57 of the turbine housing 51 are configured so that
15 the retaining ring 60 acts to secure the lower flange 38 against the radially outer shoulder 57. The radially inner shoulder 53 of the housing and the shroud foot 32 are configured so that the foot is spaced from the radially inner shoulder.

The embodiment according to Figure 3 uses the shroud of Figure 2. According to this embodiment, the housing 51 is shaped so that the relative position of the radially inner shoulder 53 and radially
20 outer shoulder 57 to the fixed wall 24 surface are such that the radially outer shoulder 57 is closer (in the axial direction) to the fixed wall surface than is the first shoulder 53. The retaining ring 60 is received in the groove 34 in the shroud 30 and contacts the lip 54 and acts on the flange 38, however, the flange 38 contacts the second shoulder 57 and the foot 32 at the radially inner margin is allowed to float (not contact the radially inner wall 53 of the cavity). The shroud 30 is thus
25 secured to the housing 51 at its radially outer margin.

According to an alternative embodiment shown in Figure 4, the turbine housing 50 is the same as the current design shown in Figure 2 and the shroud 31 is modified so that axial dimension of the foot 33 is less than the axial dimension of the upper flange 37, groove 34, and lower flange 39. This may be accomplished by making the foot 33 shorter (made less thick in the axial direction), by
30 making the axial dimension of the upper flange 37 and lower flange 39 is greater, by making the lower flange 39 axially thicker, or some combination. The one or more modification arranging the

shroud so that, when installed, the shroud is secured at its outer margin, with the flange 39 between the retaining ring 60 and the second shoulder 56.

The invention has been described in terms of preferred principles and embodiments. The appended claims define the claimed invention and those skilled in the art will understand that substitutions

5 and modifications may be made without departing from scope of the claims.

CLAIMS

1. A variable geometry turbine, comprising:

a turbine housing defining an inlet passage having a first side and a second side, the second side including an annular cavity defined by a radially inner shoulder and a radially outer shoulder and
5 a radially outer lip overhanging the outer seat;

a movable annular wall on the first side of the inlet passage, the movable wall being moveable relative to the inlet passage to control a width of the inlet passage;

an annular shroud plate on the second side of the inlet passage covering the annular cavity, the shroud plate having a radially-extending upper flange and a radially-extending lower flange on a
10 radially outer portion, the upper flange and lower flange defining therebetween a groove; and,

a retaining ring disposed in the groove and contacting the lip and the lower flange to secure the lower flange against the outer shoulder.

2. The variable geometry turbine as claimed in claim 1, the annular shroud plate having a foot at a radially inner portion, the foot being spaced axially from the inner seat.

15 3. The variable geometry turbine as claimed in claim 1, the annular shroud plate having a foot at a radially inner portion, the foot contacting the inner seat.

4. The variable geometry turbine as claimed in claim 1, wherein an axial width of the shroud plate at a radially inner portion is less than an axial width at a radially outer portion.

5. The variable geometry turbine as claimed in claim 1, wherein the radially inner shoulder is at an axial distance from the second side of the inlet passage greater than an axial distance of the radially
20 outer shoulder from the second side.

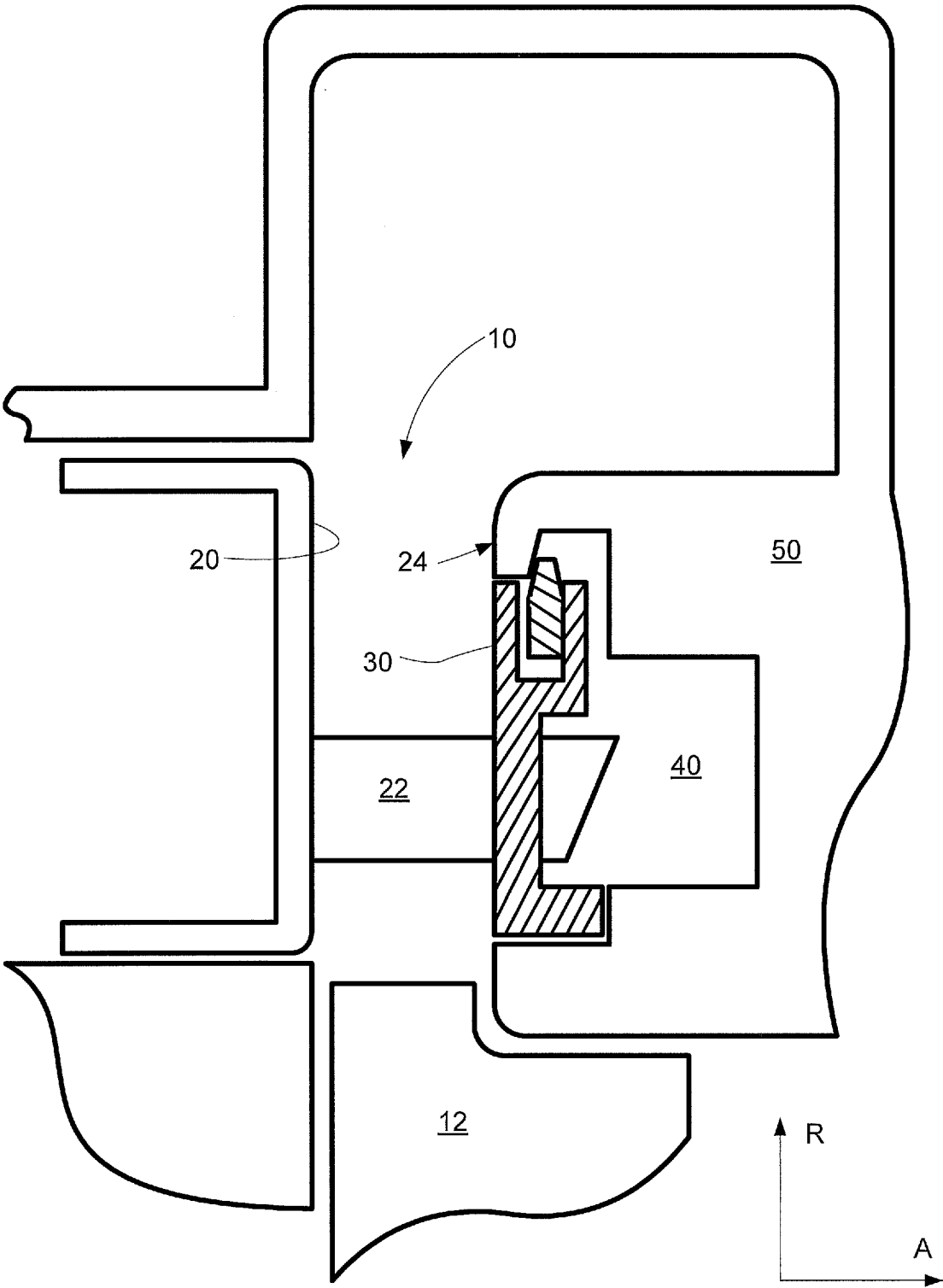


Figure 1

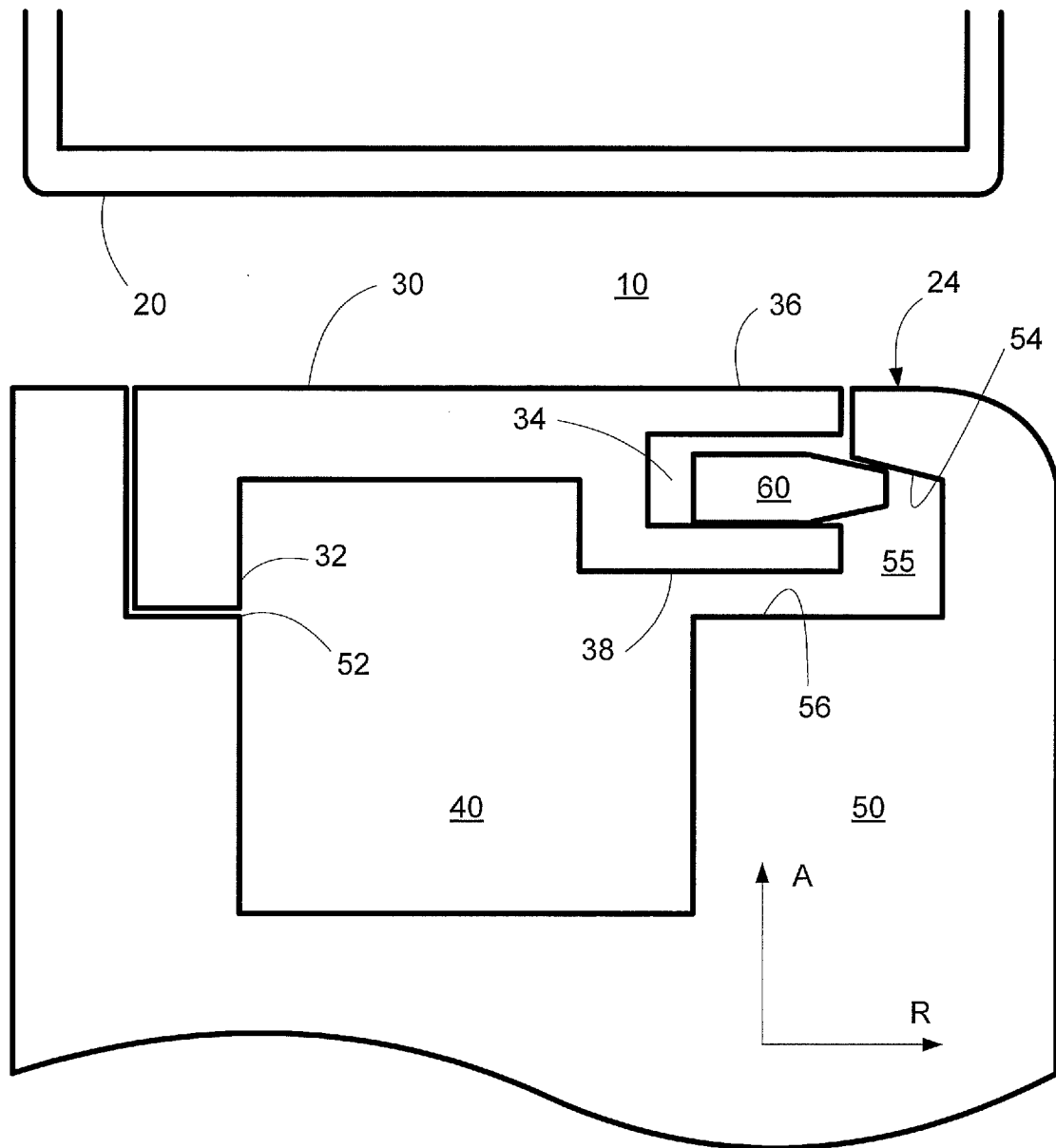


Figure 2

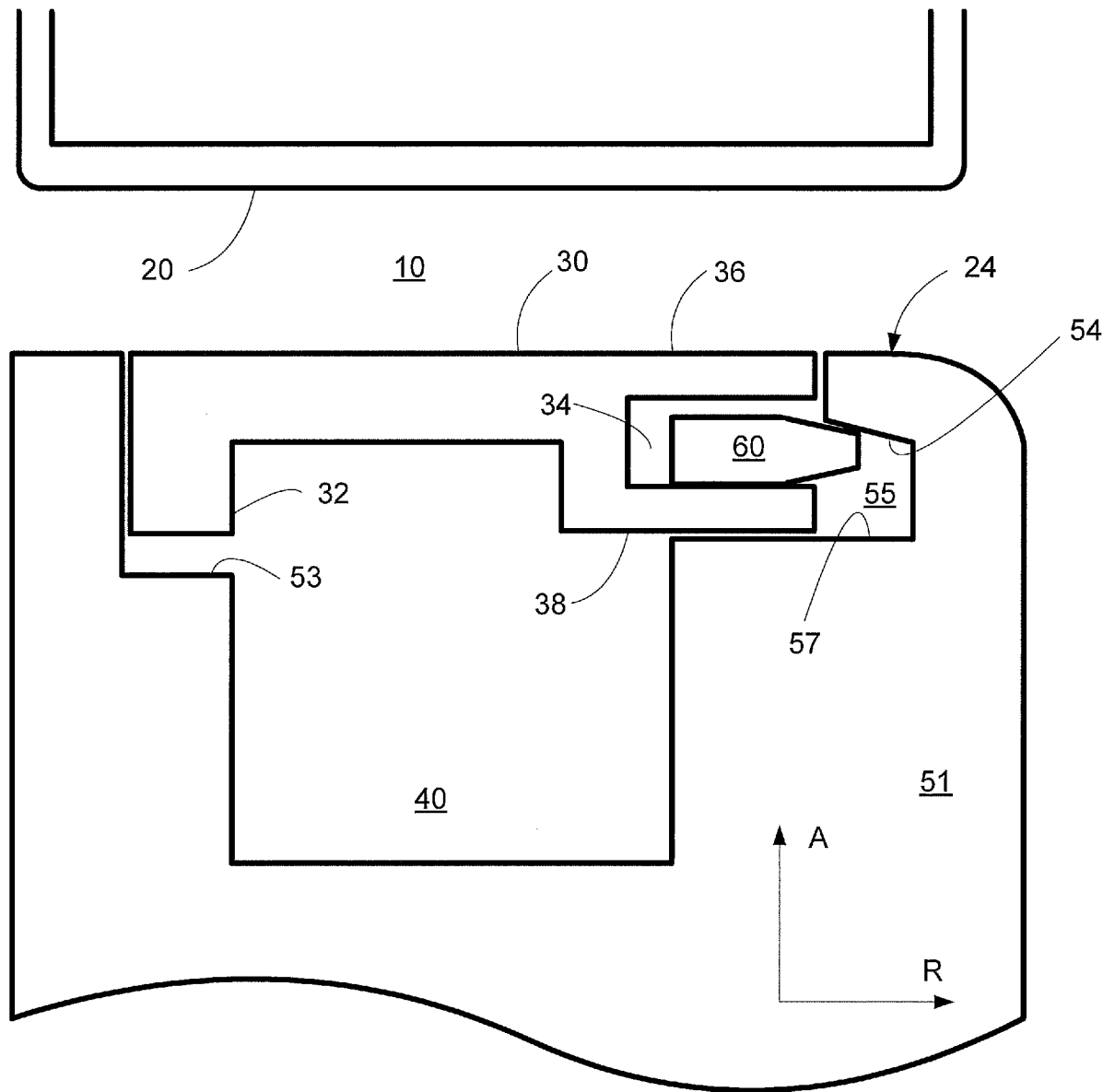


Figure 3

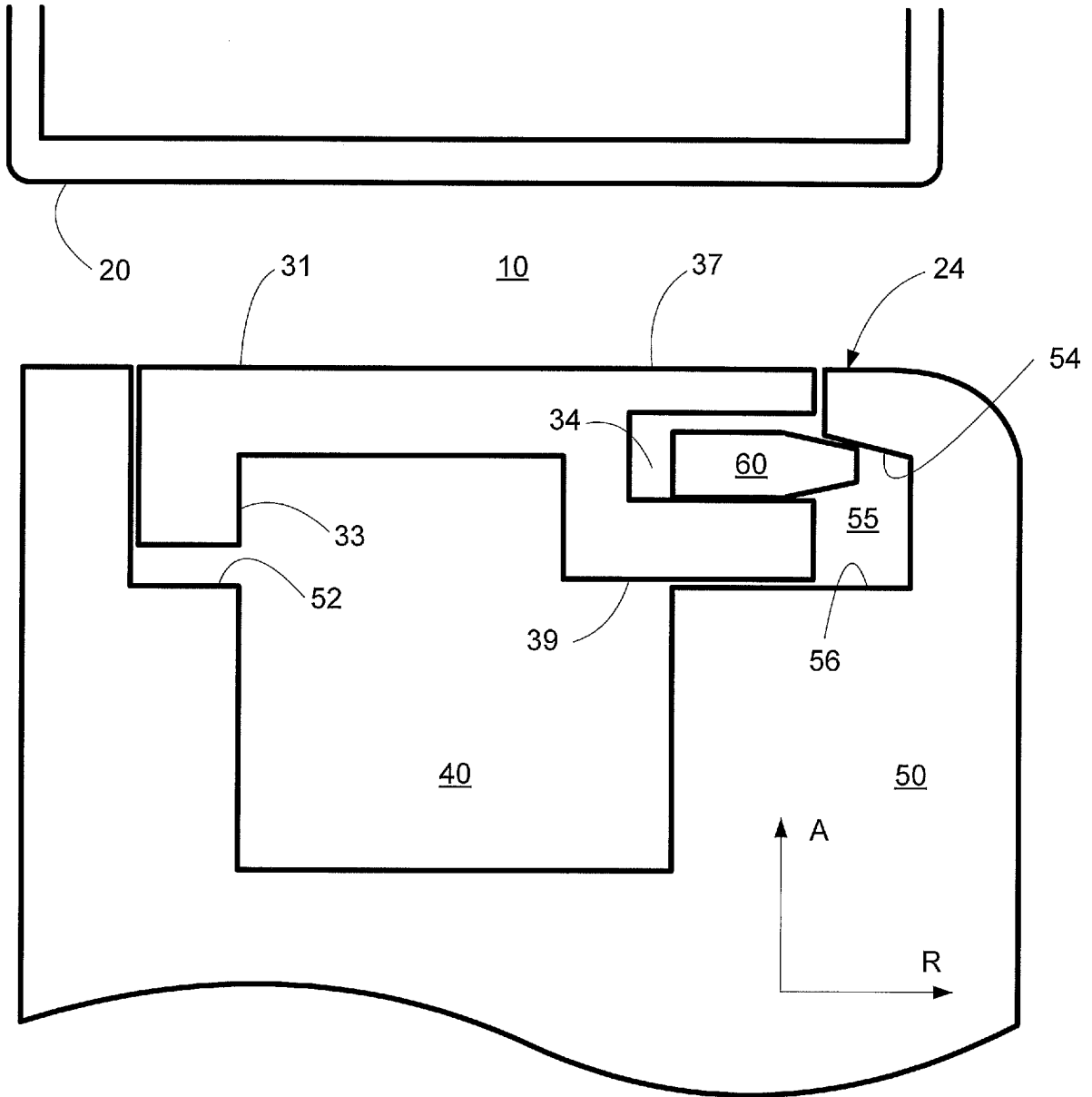


Figure 4

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 13/75654

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - F04D 29/046 (2014.01)

USPC - 415/158, 415/148

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): F04D 29/046, F04D 27/00 (2014.01)

USPC: 415/158, 415/148

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

IPC(8): F04D 29/046, F04D 27/00 (2014.01)

USPC: 415/148, 415/151-166

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

PatBase, Google Patents, Google Web

Keywords: "variable geometry turbine", shroud, shape, geometry, 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 2012/0189433 A1 (Baker et al.) 26 July 2012 (26.07.2012), entire document, especially Figs 1-3, 5	1-5
A	US 4,150,915 A (Karstensen) 24 April 1979 (24.04.1979), entire document	1-5
A	US 7,189,059 B2 (Barton et al.) 13 March 2007 (13.03.2007), entire document	1-5
A	US 2011/0123316 A1 (Roberts et al.) 26 May 2011 (26.05.2011), entire document	1-5

☐ Further documents are listed in the continuation of Box C. ☐

* Special categories of cited documents:

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"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

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Date of the actual completion of the international search

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