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(71) Applicant (for all designated States except US):

ANSALDO ENERGIA S.P.A. [IT/IT]; Via Nicola Lorenzi, 8, Genova (IT).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **DOTTA, Claudio**

[IT/IT]; Via Teglia, 147, I-17044 S. Martino Stella (IT). **TRAVERSO, Riccardo** [IT/IT]; Via Felice del Canto, 17/9, I-16154 Genova (IT). **MINNITI, Silvia** [IT/IT]; Via Vianson, 18/7, I-16156 Genova (IT). **ROSA, Sergio** [IT/IT]; Via E. Porro, 11/10 scala A., I-16151 Genova (IT).

(74) Agents: **JORIO, Paolo** et al.; c/o Studio Torta S.r.l., Via

Viotti, 9, I-10121 Torino (IT).

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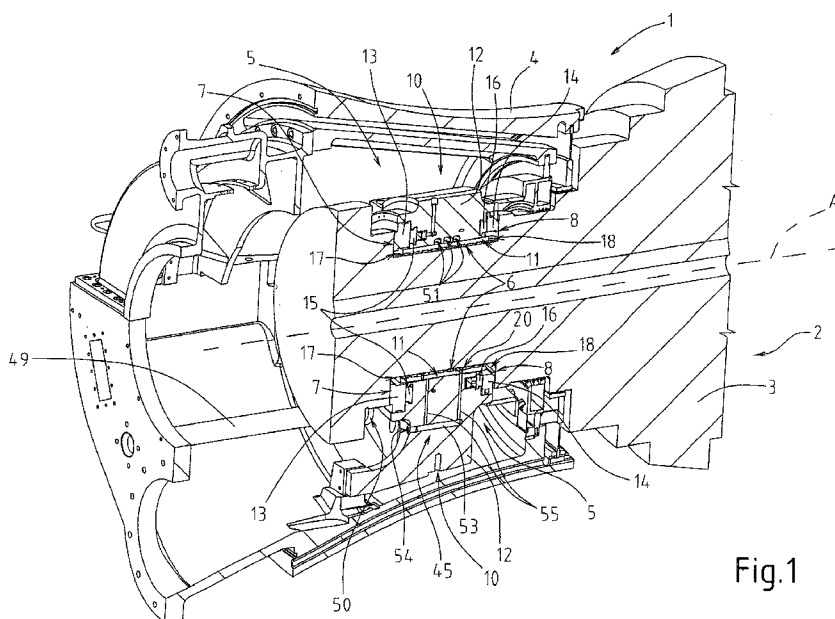


Fig.1

(57) Abstract: A gas turbine has a rotor (2), which is provided with a shaft (3) extending along a longitudinal axis (A) and having at least one annular groove (5), a bearing assembly (10) which may be accommodated into the groove (5) and is provided with a sliding bearing (11) and a cylindrical supporting body (12) arranged about the sliding bearing (11); the sliding bearing (11) axially protrudes with respect to the supporting body (12) in the contact area between the supporting body (12) and the sliding bearing (11).

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BEARING ASSEMBLY FOR A GAS TURBINE

TECHNICAL FIELD

The present invention relates to a bearing assembly
5 for a gas turbine.

BACKGROUND ART

A known type of gas turbine comprises a rotor,
provided with a shaft extending along a longitudinal
10 axis, a cylindrical case, commonly referred to as
bearing stand, which extends about the shaft, and at
least one bearing assembly, which is arranged between
the case and the shaft and is supported by the case.

The bearing assembly of the gas turbine is arranged
15 into an annular groove of the rotor shaft, defined by an
annular surface and two facing annular shoulders.

In small-sized gas turbines, the dimensions of the
annular groove for accommodating the bearing assembly
are obviously smaller than the dimensions of the annular
20 grooves of the larger-sized gas turbines. Specifically,
in small-sized gas turbines, the annular surface and the
shoulders have a shorter axial length and a shorter
radial length, respectively, than those of the larger-
sized gas turbines. However, current bearing assemblies
25 are relatively cumbersome and it is often not possible
to accommodate such bearing assemblies into the annular
grooves of the small-sized gas turbines. This results in
considerable difficulties in making bearing assemblies

which simultaneously are effective and small-sized. Indeed, most of the latest bearing assemblies may not be adapted to the dimensions of the grooves of small-sized turbines.

5

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a bearing assembly which is free from the drawbacks of the known art highlighted herein; specifically, it is an object of the invention to provide a bearing assembly for a small-sized gas turbine which is effective at the same time.

In accordance with such objects, the present invention relates to a bearing assembly for a gas turbine comprising a shaft, which extends along a longitudinal axis and is provided with at least one annular groove delimited by a cylindrical surface, a first annular shoulder and a second annular shoulder facing the first shoulder; the bearing assembly being accommodated into the annular groove and comprising a sliding bearing and a cylindrical supporting body arranged about the sliding bearing; the bearing assembly being characterized in that the sliding bearing axially protrudes with respect to the supporting body in the contact area between the supporting body and the sliding bearing.

In accordance with such objects, the present invention further relates to a gas turbine comprising a

rotor, which is provided with a shaft extending along a longitudinal axis and having an annular groove, a substantially cylindrical case arranged about the shaft, and a bearing assembly accommodated into the groove and supported by the case; the gas turbine being characterized in that the bearing assembly is of the type claimed in any one of the claims from 1 to 17.

BRIEF DESCRIPTION OF THE DRAWINGS

Further features and advantages of the present invention will be apparent from the following description of a non-limitative embodiment thereof, with reference to the figures in the accompanying drawings, in which:

- figure 1 is a perspective section view, with parts removed for clarity, of a portion on a gas turbine according to the present invention;

- figure 2 is a perspective view, with parts in section and parts removed for clarity, of a first detail of the bearing assembly made according to the present invention;

- figure 3 is a perspective section view, on enlarged scale, with parts removed for clarity, of a first detail of the gas turbine in figure 1;

- figure 4 is a perspective section view, on enlarged scale, with parts removed for clarity, of a second detail of the gas turbine in figure 1;

- figure 5 is a schematic side view, with parts

removed for clarity, of a second detail of the bearing assembly made according to the present invention; and

- figure 6 is a schematic side view, with parts removed for clarity, of a third detail of the bearing assembly made according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

In figure 1, numeral 1 indicates as a whole a gas turbine, a portion of which is shown, comprising a rotor 2, provided with a shaft 3, and a case 4.

The shaft 3 extends along a substantially horizontal, longitudinal axis A and rotates about the longitudinal axis A. The case 4 is substantially cylinder-shaped and extends about the shaft 3. The shaft 3 is provided with at least one annular groove 5 delimited by a cylindrical surface 6, one annular shoulder 7 and annular shoulder 8 facing the shoulder 7. Specifically, the groove 5 is arranged close to the inlet of a compressor (not shown in the accompanying figures) of the gas turbine 1.

The gas turbine 1 further comprises at least one bearing assembly 10 adapted to be accommodated into the annular groove 5.

The bearing assembly 10 comprises a sliding bearing 11 arranged about the shaft 3, a supporting body 12 arranged in contact about the sliding bearing 11, a main thrust block 13, a secondary thrust block 14, two main thrust half rings 15, and two secondary thrust half

rings 16.

With reference to figures from 1 to 4, the sliding bearing 11 axially protrudes with respect to the supporting body 12 in the contact area between the supporting body 12 and the sliding bearing 11. Specifically, the sliding bearing 11 has first and second sides 17 and 18, facing shoulder 7 and shoulder 8, respectively, and axially protrudes with respect to the supporting body 12 at the first and second sides 17 and 18.

With reference to figures from 2 to 4, the sliding bearing 11 comprises a cylinder 19 and a lining 20 of the cylinder 19.

The cylinder 19 is fixed to the supporting body 13 by connecting means, preferably connecting pins, not shown in the accompanying figures.

The lining 20 is made of low friction coefficient material, e.g. white metal.

With reference to figure 2, the cylinder 19 and the lining 20 respectively have two outlet holes 21 for the lifting oil of the shaft 3 which are substantially arranged at a substantially vertical, middle plane including the axis A of the shaft 3, and two arrays of holes 22 (only one of which is shown in figure 2) for the lubrication oil outlet, which are arranged on opposite sides of the axis A with respect to the middle plane and preferably comprise three holes 23, e.g. aligned. The lubrication oil is required for the

operation of the bearing assembly 10 because it is used to create an oil film which supports the shaft under hydrodynamic lubrication conditions. The sliding bearing 11 thus made may be advantageously replaced when it shows damages caused by wear; specifically, the sliding bearing 11 may be simply pulled out when required.

With reference to figures from 2 to 4, the supporting body 12 is substantially cylindrically shaped and has a main side 24, substantially facing the shoulder 7, and a secondary side 25, substantially facing the shoulder 8.

The supporting body 12 is provided with a main annular edge 27, which extends from the main side 24 in the axial direction, and a secondary annular edge 28, which extends from the secondary side 25 in the axial direction. The main edge 27 and the secondary edge 28 define a preferably cylindrical, main annular seat 30 for accommodating the main thrust block 13, and a preferably cylindrical, secondary annular seat 31 for accommodating the secondary thrust block 14, respectively.

With reference to figures 2 and 3, on the main side 24, at the main annular seat 30, the supporting body 12 is provided with two substantially semi-circular, main grooves 32a (only one of which is shown in figures 2 and 3) for accommodating the main thrust half rings 15.

At the main grooves 32a, the supporting body 12 is further provided with a plurality of cylindrical main

seats 33 adapted to be engaged by respective main pistons 34 (figure 3) being substantially cylindrically shaped and provided with main thrust surfaces of center B1.

5 With reference to figure 5, the primitive obtained by joining the centers B1 of each main piston 34 is substantially a circumference of radius R1.

With reference to figure 4, on the secondary side 25, at the secondary annular seat 31, the supporting
10 body 12 is provided with two substantially semicircular, secondary grooves 32b for accommodating the secondary thrust half rings 16.

At the secondary grooves 32b, the supporting body 12 is further provided with a plurality of cylindrical
15 secondary seats 35 adapted to be engaged by respective secondary pistons 36 being substantially cylindrically shaped and provided with secondary thrust surfaces of center B2.

With reference to figure 6, the primitive obtained
20 by joining the centers B2 of each secondary piston 36 is substantially a circumference of radius R2.

In the non-limitative example shown and described herein, there are sixteen cylindrical main seats 33, and therefore sixteen respective main pistons 34, while
25 there are fourteen cylindrical secondary seats 35, and therefore fourteen respective secondary pistons 36.

With reference to figures 3 and 4, each cylindrical main seat 33 and each cylindrical secondary seat 35 is

connected by means of respective main holes 38 (figure 3) and secondary holes 39 (figure 4) to a hydraulic circuit 40, provided inside the main body 12. A pressurized fluid, generally oil, which moves the main
5 pistons 34 and the secondary pistons 36 in the axial direction to compensate for the dimensional variations of the shaft 3 due to temperature variations, flows into the hydraulic circuit 40.

With reference to figure 2, the supporting body 12
10 is connected to the case 4 by cylindrical coupling means. Specifically, the cylindrical coupling means comprise two cylinders 42 of the supporting body 12, which extend in a direction orthogonal to axis A and are arranged on opposite sides of the axis A with respect to
15 the middle plane, and two rings of the case 4 (not shown in the accompanying figures), which are engaged by the respective cylinders 42. This type of cylindrical coupling allows the bearing assembly 10 to easily comply with the movements of the shaft 3 during the operation
20 of the turbine 1. In such a manner, possible offsets between the shaft 3 and the main and secondary thrust blocks 13 and 14, which may cause overloads on the same main and secondary thrust blocks 13 and 14, are avoided.

With reference to figures from 1 to 4, the
25 supporting body 12 further comprises a circuit 44 for feeding lubricant oil to the sliding bearing 11, a circuit 45 for feeding shaft-lifting oil, a circuit 46 for feeding lubricant oil to the main thrust block 13

and a circuit 47 for feeding lubricant oil to the secondary thrust block 14.

Specifically, the circuit 44 for feeding lubricant oil to the sliding bearing 11 comprises a manifold (not shown in the accompanying figures), which communicates with a feeding pipe 49 (figure 1) through a hole 50 (figures 1 and 2), and a plurality of pipes 51 (figures 2, 3 and 4), preferably three, connected to the holes 23 (figure 2) of the sliding bearing 11.

With reference to figure 1, the circuit 45 for feeding shaft-lifting oil comprises a pipe 53, which receives the oil through a hole 54 from a feeding pipe (not shown in the accompanying figures), and two branches 55 which communicate with the interior of the sliding bearing 11 by means of the holes 21 (figure 2). The circuit 45 for feeding shaft-lifting oil mainly intervenes during the steps of starting the gas turbine 1 in which the shaft 3 is either static or is at low revolutions.

The circuit 46 for feeding lubricant oil to the main thrust block 13 and the circuit 47 for feeding lubricant oil to the secondary thrust block 14 comprise a lubrication pipe 56 (figures 3 and 4) of the main thrust block 13 and a lubrication pipe 57 (figures 3 and 4) of the secondary thrust block 14, respectively, and are fed by the same feeding pipe (not shown in the accompanying figures) through the hole 58 (figure 2).

With reference to figure 3, the main thrust block

13 is substantially ring-shaped and comprises a frame 60 and an array of main slides 61.

The frame 60 is substantially ring-shaped and substantially arranged in abutment with the main edge 27 of the supporting body 12 close to the main side 24 of the supporting body 12 and with the main thrust half rings 15.

The main slide array 61 is annular and comprises a plurality of main slides 63, specifically nineteen, each of which has a surface 64 substantially in contact with the main shoulder 7 and is coupled to respective main leverages 65 of kinematic load transmission of known type (diagrammatically shown in figure 3 by a section block).

The main leverages 65 are in contact with the main thrust half rings 15 at contact points C1. Such contact points C1 coincide with the load transmission points between the main thrust half rings 15 and the main leverages 65, which, in turn, exchange them with the respective main slides 63.

With reference to figure 5, the primitive obtained by joining the contact points C1 of the main thrust half ring 15 is substantially a circumference of radius R3.

With reference to figure 4, the secondary thrust block 14 is substantially ring-shaped and comprises a frame 66 and an array of secondary slides 67.

The frame 66 is substantially ring-shaped and substantially arranged in abutment with the secondary

edge 28 of the supporting body 12 close to the secondary side 25 of the supporting body 12 and with the secondary thrust half rings 16.

The secondary slide array 67 is annular and
5 comprises a plurality of secondary slides 69,
specifically thirty, each of which has a surface 70
substantially in contact with the secondary shoulder 8
and is coupled to respective secondary leverages 71 of
kinematic load transmission of known type
10 (diagrammatically shown in figure 3 by a section block).

The secondary leverages 71 are in contact with the
secondary thrust half rings 15 at contact points C2.
Such contact points C2 coincide with the load
transmission points between the secondary thrust half
15 rings 16 and the secondary leverages 71, which, in turn,
exchange them with the respective secondary slides 69.

With reference to figure 5, the primitive obtained
by joining the contact points C2 of the secondary thrust
half ring 16 is substantially a circumference of radius
20 R4.

With reference to figure 3, the two main thrust
half rings 15 are adapted to be accommodated into the
respective main grooves 32a between the supporting body
12 and the main thrust block 13 and have a given axial
25 length A1.

Specifically, the main thrust half rings 15 have
one face in contact with the main pistons 34 of center
B1 and one face in contact with the main leverages 65 at

the points C1.

With reference to figure 5, the centers B1 and the contact points C1 are radially and circumferentially misaligned due to design constraints.

5 The radial misalignment may generate a non-uniform distribution of the thrusts generated by the main pistons 34 in the main thrust half rings 15.

Specifically, the radial misalignment is equal to the difference between the radius R1 of the primitive of centers B1 of the main pistons 34 and the radius R3 of
10 the primitive of contact points C1 between the main leverages 65 and the main thrust half rings 15.

The effects of the radial misalignment are strongly mitigated by using main thrust half rings 15 having an
15 axial length A1 equal to at least the radial misalignment.

On the other hand, the circumferential misalignment may cause damages to the main leverages 65. The effects of the circumferential misalignment are considerably
20 mitigated by an adequate distribution of the main pistons 34 with respect to the main thrust half rings 15 so as to minimize the circumferential misalignment between the centers B1 and the contact points C1.

With reference to figure 4, the two secondary
25 thrust half rings 16 are adapted to be accommodated into the respective secondary grooves 32a between the supporting body 12 and the secondary thrust block 14 and have a given axial length A2.

Specifically, the secondary thrust half rings 16 have one face in contact with the secondary pistons 36 of center B2 and one face in contact with the secondary leverages 71 at the points C2.

5 With reference to figure 6, the centers B2 and the contact points C2 are radially and circumferentially misaligned due to design constraints.

The radial misalignment may generate a non-uniform distribution of the thrusts generated by the secondary
10 pistons 34 in the secondary thrust half rings 16.

Specifically, the radial misalignment is equal to the difference between the radius R2 of the primitive of centers B2 of the secondary pistons 36 and the radius R4 of the primitive of contact points C2 between the
15 secondary leverages 71 and the secondary thrust half rings 16.

The effects of the radial misalignment are strongly mitigated by using secondary thrust half rings 16 having an axial length A2 equal to at least the radial
20 misalignment.

On the other hand, the circumferential misalignment may cause damages to the secondary leverages 71. The effects of the circumferential misalignment are considerably mitigated by an adequate distribution of
25 the secondary pistons 36 with respect to the secondary thrust half rings 16 so as to minimize the circumferential misalignment between the centers B2 and the contact points C2.

It is finally apparent that changes and variations may be made to the bearing assembly and gas turbine described herein, without departing from the scope of the appended claims.

CLAIMS

1. A bearing assembly for a gas turbine (1) comprising a shaft (3), which extends along a longitudinal axis (A) and is provided with at least one annular groove (5) delimited by a cylindrical surface (6), a first annular shoulder (7) and a second annular shoulder (8) facing the first shoulder (7); the bearing assembly (10) being able to be accommodated into the annular groove (5) and comprising a sliding bearing (11) and a cylindrical supporting body (12) arranged about the sliding bearing (11); the bearing assembly (10) being characterized in that the sliding bearing (11) axially protrudes with respect to the supporting body (12) in the contact area between the supporting body (12) and the sliding bearing (11).

2. A bearing assembly according to claim 1, characterized in that the sliding bearing (11) has first and second sides (17, 18) facing the first and second shoulders (7, 8), respectively, and axially protrudes with respect to the supporting body (12) at the first and second sides (17, 18).

3. A bearing assembly according to claim 1 or 2, characterized in that the sliding bearing (11) is defined by a cylinder (19) and a lining (20) of the cylinder (19) made of low friction coefficient material.

4. A bearing assembly according to any one of the preceding claims, characterized in that it comprises a main thrust block (13), which is substantially ring-

shaped and arranged between the supporting body (12) and the first shoulder (7) of the groove (5) of the rotor (2).

5 5. A bearing assembly according to any one of the preceding claims, characterized in that it comprises a secondary thrust block (14), which is substantially ring-shaped and arranged between the supporting body (12) and the second shoulder (8) of the groove (5) of the rotor (2).

10 6. A bearing assembly according to claim 4 or 5, characterized in that the main thrust block (13) slides in the axial direction with respect to the supporting body (12).

15 7. A bearing assembly according to claim 5 or 6, characterized in that the secondary thrust block (14) slides in the axial direction with respect to the supporting body (12).

20 8. A bearing assembly according to claim 6 or 7, characterized in that the supporting body (12) is provided with an annular main seat (30) defined by an annular main edge (27); the main thrust block (13) being substantially arranged in abutment with the main edge (27) of the supporting body (12) and being guided by the main edge (27).

25 9. A bearing assembly according to claim 7 or 8, characterized in that the supporting body (12) is provided with an annular secondary seat (31) defined by an annular secondary edge (28); the secondary thrust

block (14) being substantially arranged in abutment with the secondary edge (28) of the supporting body (12) and being guided by the secondary edge (28).

10. A bearing assembly according to claim 8 or 9,
5 characterized in that it comprises two main thrust half rings (15) having an axial length (A1); the supporting body (12) being provided, at the annular main seat (30), with two main grooves (32a) for accommodating the respective main thrust half rings (15) between the
10 supporting body (12) and the main thrust block (13).

11. A bearing assembly according to claim 9 or 10, characterized in that it comprises two secondary thrust half rings (16) having an axial length (A2); the supporting body (12) being provided, at the annular
15 secondary seat (31), with two secondary grooves (32a) for accommodating the respective secondary thrust half rings (16) between the supporting body (12) and the secondary thrust block (14).

12. A bearing assembly according to claim 10 or 11,
20 characterized in that the main thrust block (13) is substantially ring-shaped and comprises a plurality of main slides (63); each main slide (63) being substantially arranged in contact with the first shoulder (7) and being coupled to respective main
25 leverages (65) of kinematic load transmission, which are in contact with the main thrust half rings (15) at first contact points (C1).

13. A bearing assembly according to claim 11 or 12,

characterized in that the secondary thrust block (14) is substantially ring-shaped and comprises a plurality of secondary slides (69); each secondary slide (69) being substantially arranged in contact with the second
5 shoulder (8) and being coupled to respective secondary leverages (71) of kinematic load transmission, which are in contact with the secondary thrust half rings (16) at second contact points (C2).

14. A bearing assembly according to claim 12 or 13,
10 characterized in that it comprises a plurality of substantially cylindrically shaped, main pistons (34), which are provided with main thrust surfaces having a center (B1) and adapted to be arranged in contact with the main thrust half rings (15); the supporting body
15 (12) being provided with a plurality of cylindrical main seats (33) adapted to be engaged by respective main pistons (34).

15. A bearing assembly according to claim 13 or 14,
characterized in that it comprises a plurality of
20 substantially cylindrically shaped, secondary pistons (36), which are provided with secondary thrust surfaces having a center (B2) and adapted to be arranged in contact with the secondary thrust half rings (16); the supporting body (12) being provided with a plurality of
25 cylindrical secondary seats (35) adapted to be engaged by respective secondary pistons (36).

16. A bearing assembly according to claim 14 or 15, characterized in that the main thrust half rings have an

axial length (A1) equal to at least the difference between the radius (R1) of a first primitive obtained by joining the centers (B1) of the main pistons (34) and the radius (R3) of a second primitive obtained by joining the first contact points (C1).

17. A bearing assembly according to claim 15 or 16, characterized in that the secondary thrust half rings (16) have an axial length (A2) equal to at least the difference between the radius (R2) of a third primitive obtained by joining the centers (B2) of the secondary pistons (36) and the radius (R4) of a fourth primitive obtained by joining the second contact points (C2).

18. A gas turbine comprising a rotor (2), which is provided with a shaft (3) extending along a longitudinal axis (A) and having an annular groove (5), a substantially cylindrical case (4) arranged about the shaft (3), and a bearing assembly (10) accommodated into the groove (5) and supported by the case (4); the gas turbine (1) being characterized in that the bearing assembly (10) is of the type claimed in any one of the preceding claims.

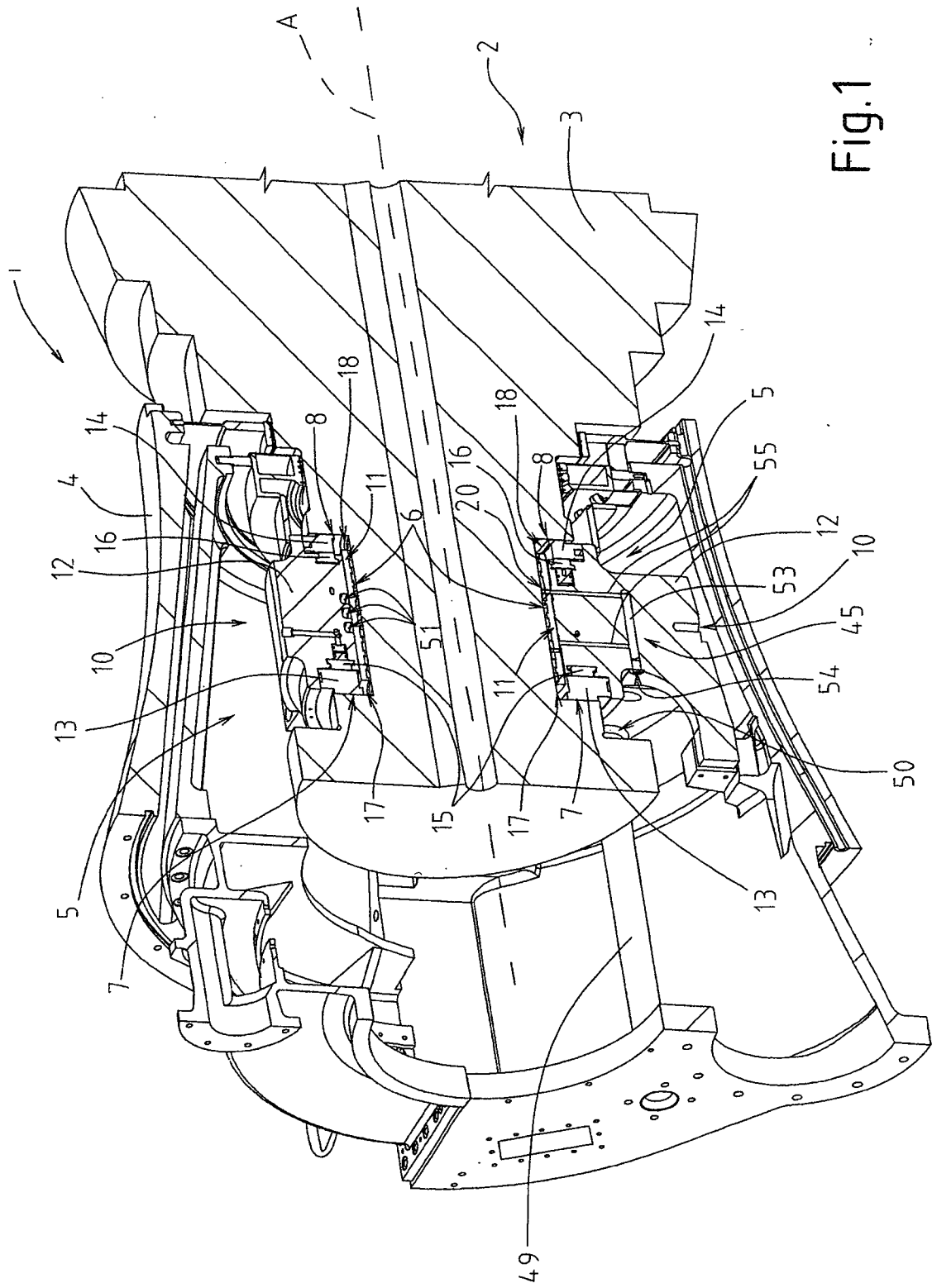


Fig.1

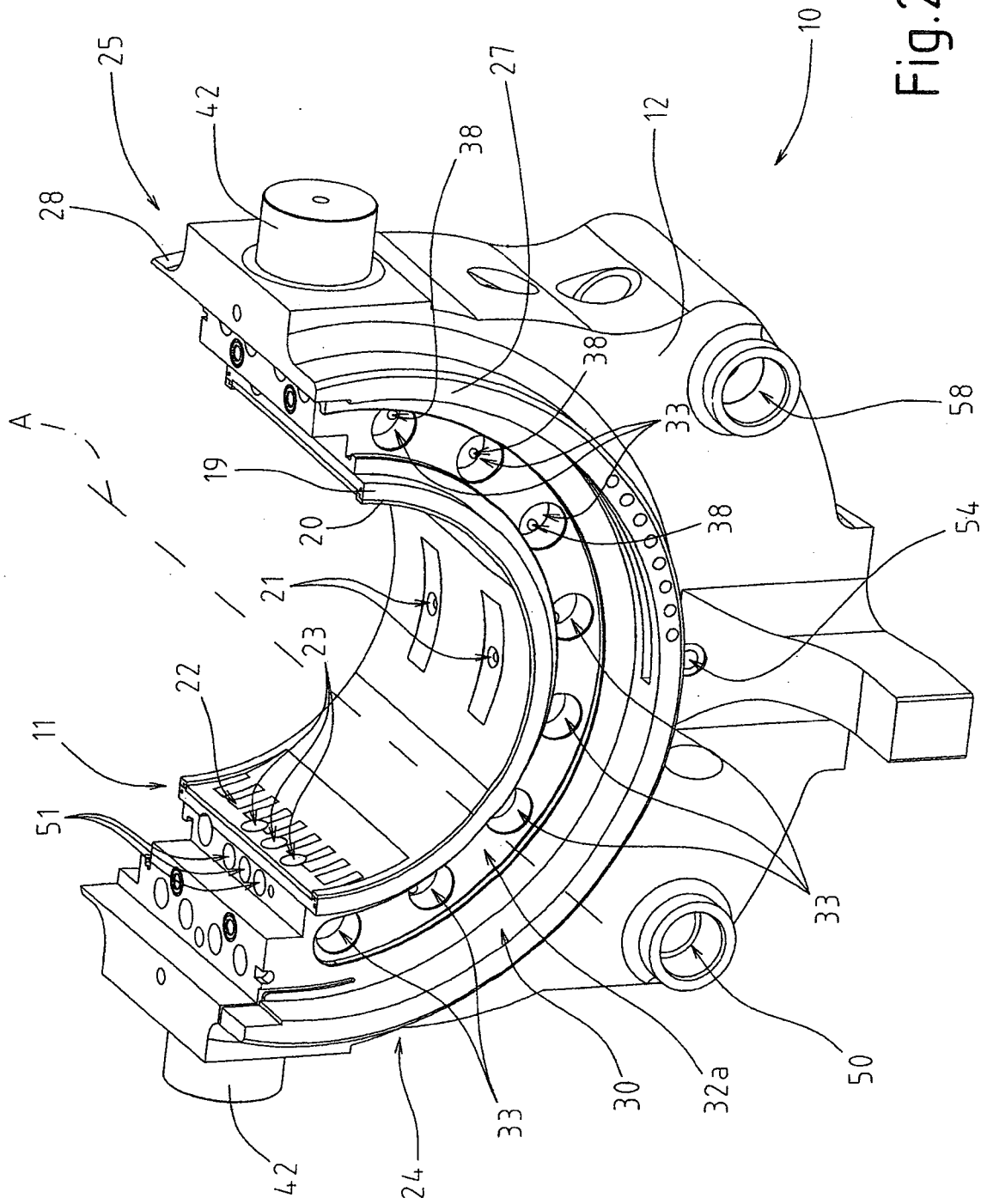
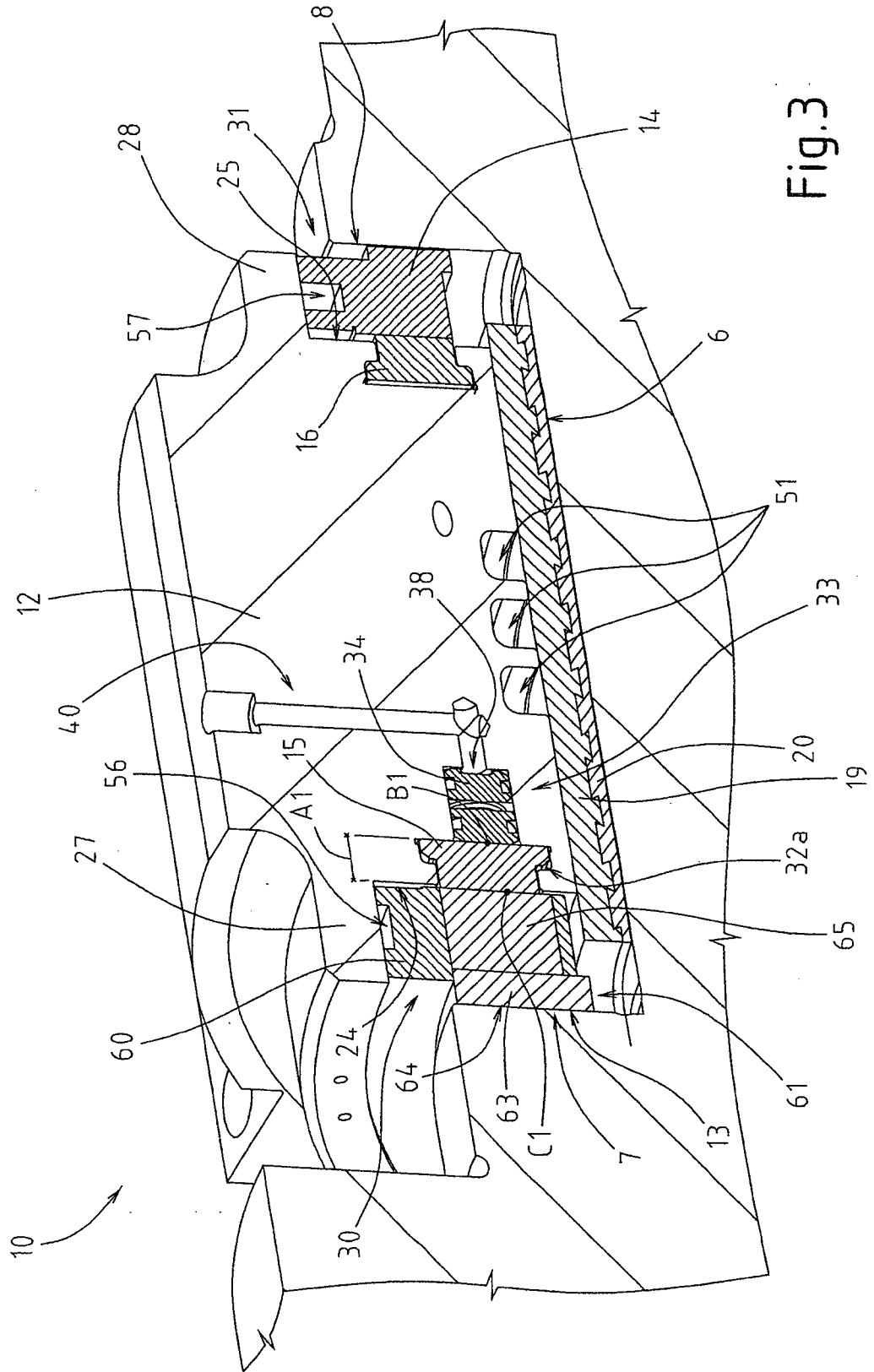


Fig.2



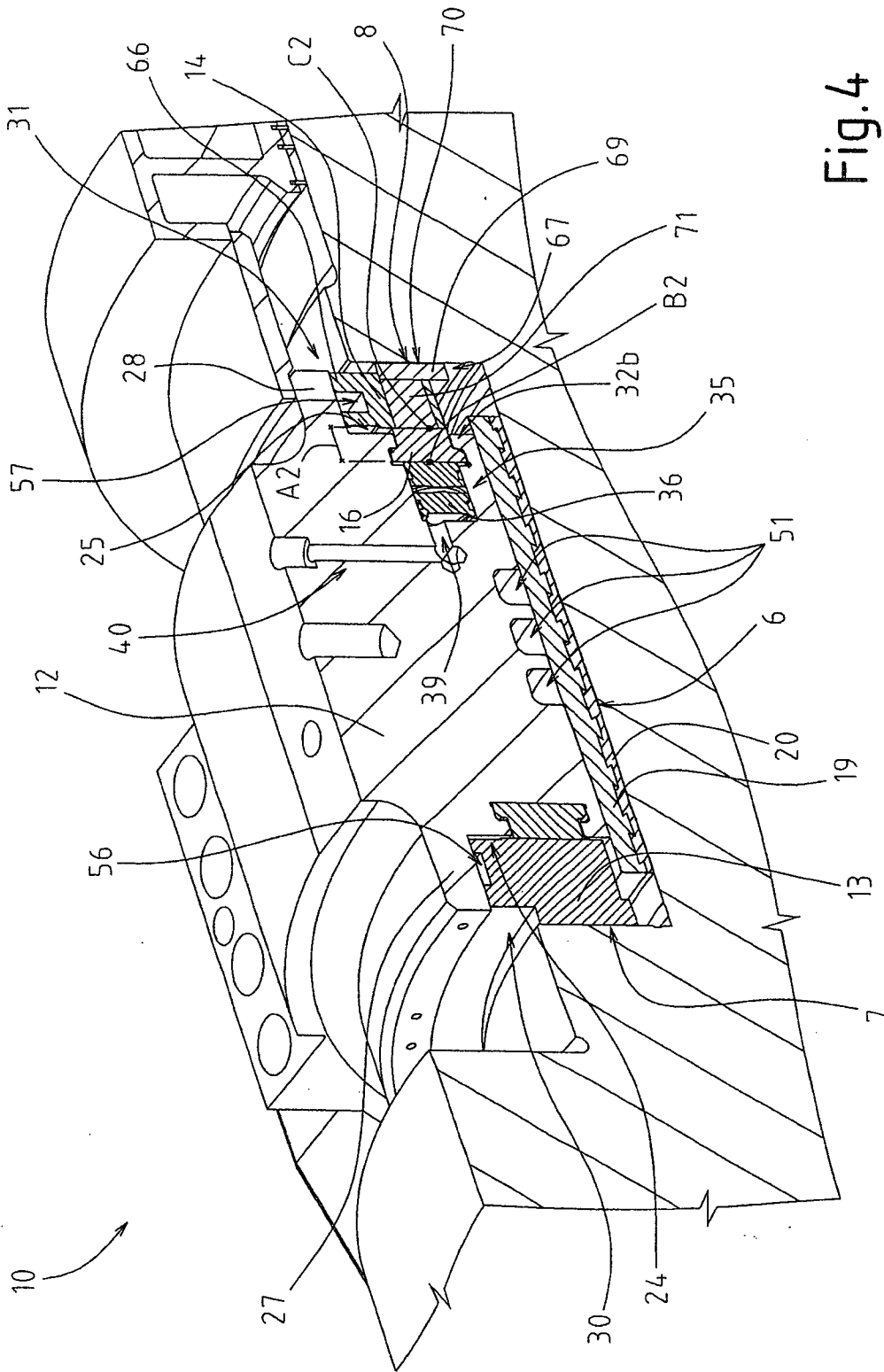


Fig.4

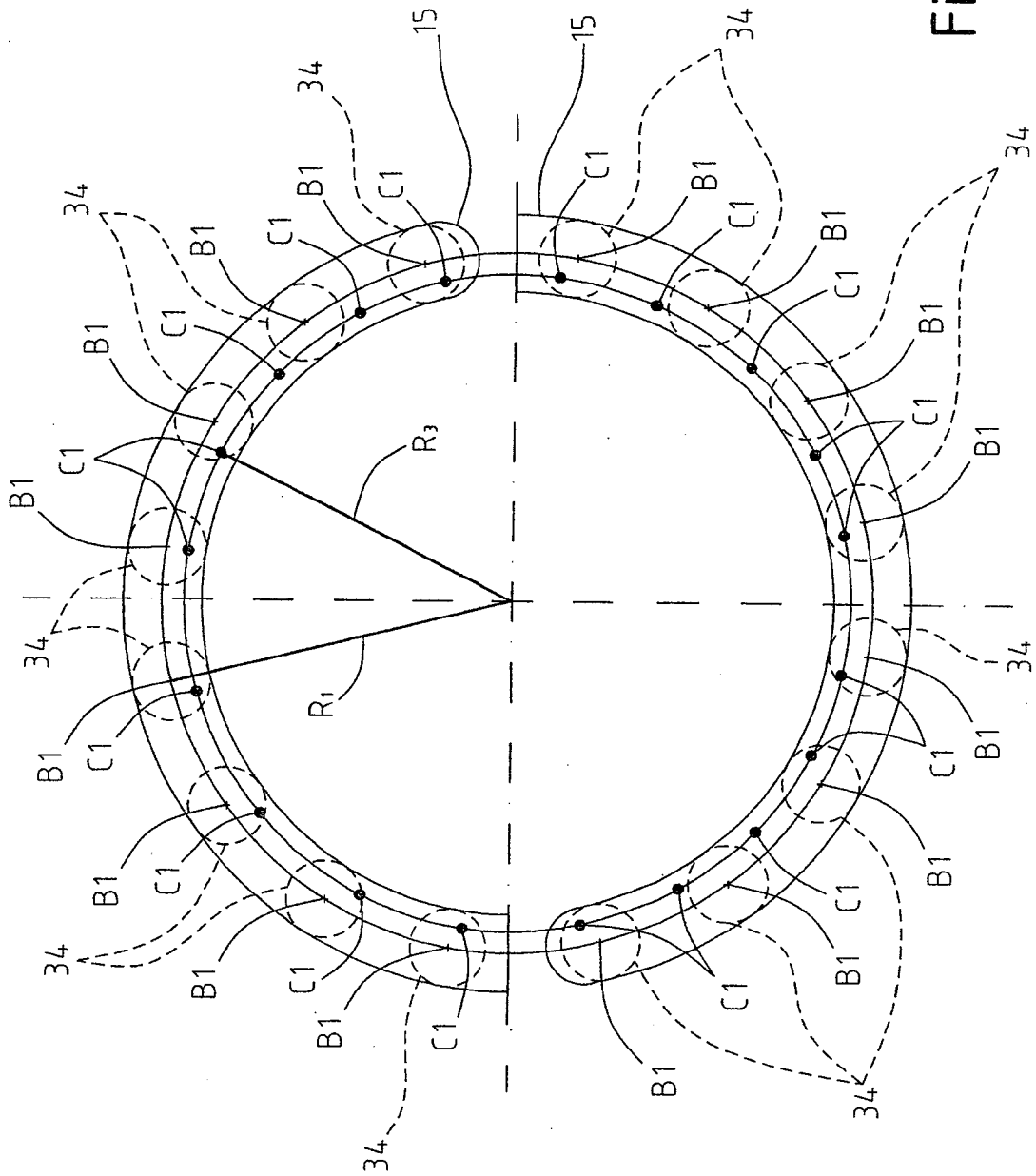


Fig.5

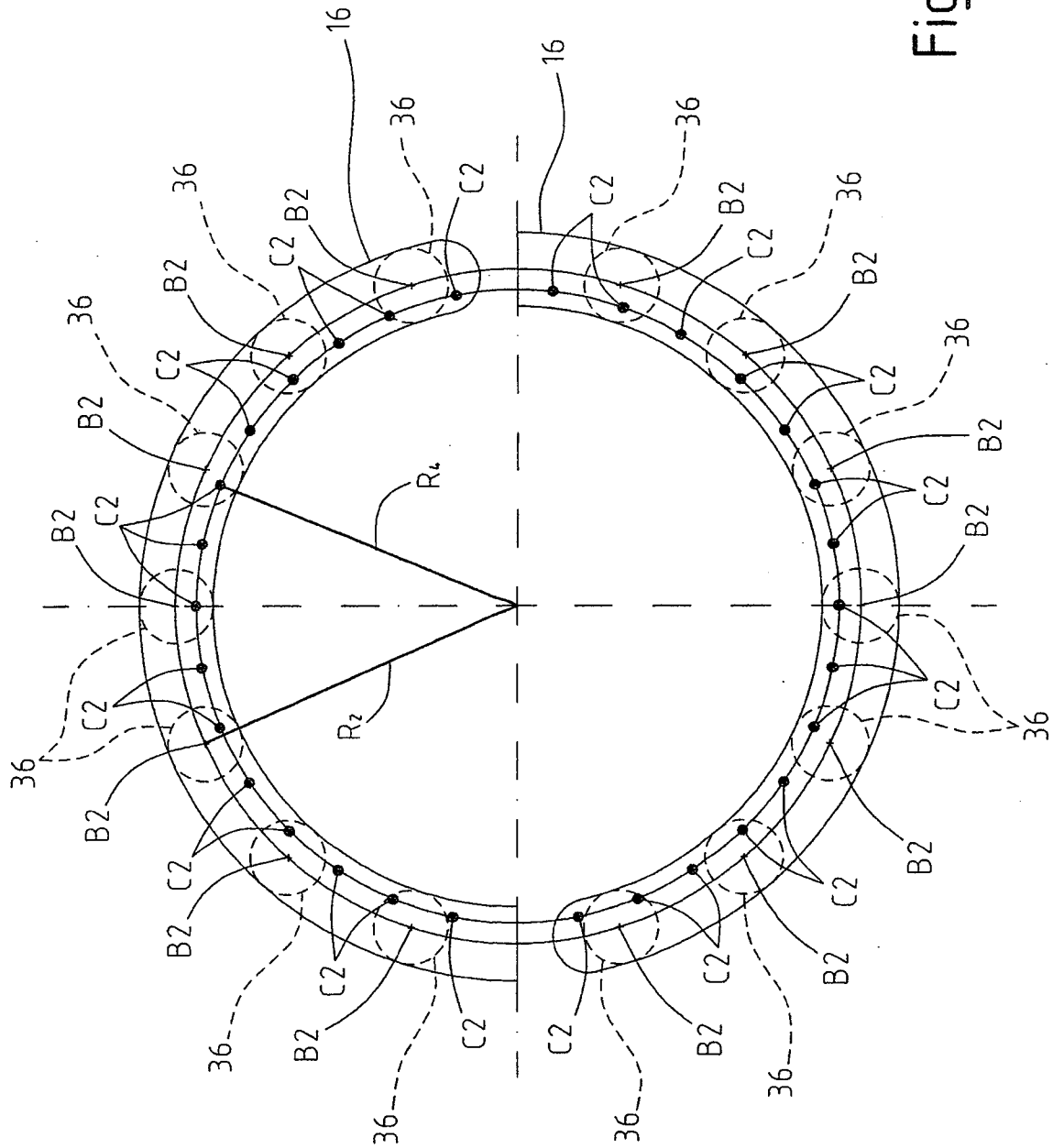


Fig.6

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2008/003642

A. CLASSIFICATION OF SUBJECT MATTER

INV. F01D25/16 F01D3/04 F16C17/22 F16C33/10 F16C17/10
F16C25/02

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)

F01D F16C

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 1 479 875 A (SIEMENS AG [DE]) 24 November 2004 (2004-11-24) abstract paragraph [0015] figure 1	1,3-18
X	EP 0 028 424 A (BBC BROWN BOVERI & CIE [CH]) 13 May 1981 (1981-05-13) abstract page 6, line 14 - line 15 figures 4,5	1-13,18
X	DE 805 336 C (JOSEF WOLFENSTETTER DIPL ING) 15 May 1951 (1951-05-15) column 1, line 7 - line 8 column 2, line 59 - line 62 column 2, line 79 - line 81 figures 1,2	1-9,18
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Further documents are listed in the continuation of Box C.

See patent family annex.

* Special categories of cited documents :

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European Patent Office, P.B. 5818 Patentlaan 2
NL - 2280 HV Rijswijk
Tel. (+31-70) 340-2040,
Fax: (+31-70) 340-3016

Authorized officer

Rapenne, Lionel

INTERNATIONAL SEARCH REPORT

International application No

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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	FR 2 449 820 A (WALLACE MURRAY CORP [US]) 19 September 1980 (1980-09-19) abstract page 1, line 20 - line 22 page 6, line 15 figure 2	1-3, 18
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A	WO 00/28190 A (SIEMENS AG [DE]; REICHERT ARND [DE]; BECKER BERNARD [DE]) 18 May 2000 (2000-05-18) the whole document	1-18

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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