(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
14 November 2019 (14.11.2019)

WIPO | PCT

(10) International Publication Number
WO 2019/217265 A1

(51) International Patent Classification:
F01D 25/16 (2006.01) *F16C 33/10* (2006.01)
F16C 17/04 (2006.01)

(21) International Application Number:
PCT/US2019/030823

(22) International Filing Date:
06 May 2019 (06.05.2019)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
10 2018 207 042.3
07 May 2018 (07.05.2018) DE

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(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN,

(54) Title: TURBOCHARGER FOR AN INTERNAL COMBUSTION ENGINE

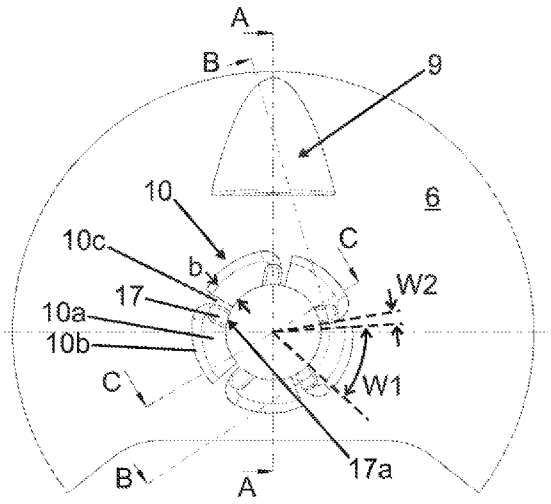


Fig. 4

(57) Abstract: Turbocharger for an internal combustion engine, comprising a housing (2) with a compressor blade (3) on the air side, a shaft (1) driving the compressor blade (3), and at least one radially acting rotary bearing (5) for mounting the shaft (3), wherein the rotary bearing (5) is designed as a hydrodynamic sliding bearing, wherein a stationary bearing element (6) is penetrated by the shaft (1) and a first mounting is formed on one first side of the bearing element (6) and acts axially against a bearing collar (7) rotating with the shaft, wherein, in particular, the bearing element (6) additionally forms a second mounting on an opposite second side which acts axially against a sealing bushing (8) rotating with the shaft (1), wherein an oil supply (9) for supplying the mountings is designed in the bearing element (6), wherein a plurality of flow surfaces (10) with a height (h) varying in the circumferential direction is formed on one surface of the bearing element (6) facing the bearing collar (7) in the axial direction, wherein an individually dimensioned throttle element (11, 12) is designed in the oil supply (9) for each of the two mountings.

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HR, HU, ID, IL, IN, IR, IS, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM, ZW.

(84) **Designated States** *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, 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, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

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))*

Published:

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

TURBOCHARGER FOR AN INTERNAL COMBUSTION ENGINE

Technical Field

[0001] The invention relates to a turbocharger for an internal combustion engine according to the preamble of Claim 1. The invention further relates to a turbocharger for an internal combustion engine according to the preamble of Claim 10.

Background

[0002] WO 2013/169505 A1 describes an axial bearing arrangement for a turbocharger for an internal combustion engine. A bearing element is thereby penetrated in a central hole by a shaft. A plurality of wedge surfaces is formed on side of the bearing element facing in the axial direction, wherein a bearing collar, which rotates with the shaft, contacts the side of the bearing element and projects radially past the wedge surfaces. To supply the mounting, oil feeding holes are provided between the wedge surfaces and are radially located at approximately half the height of the wedge surfaces. The holes completely penetrate the bearing element and also supply a back side of the bearing element, which is supported against a sealing bushing, with oil.

[0003] It is the object of the invention to specify a turbocharger for an internal combustion engine for which a hydrodynamic axial mounting has an effective lubrication.

Brief Summary of the Invention

[0004] This problem is solved according to the invention for a turbocharger of the type listed at the outset with the characterizing features of Claim 1. Due to the individual dimensioning of the throttle elements, an optimal amount of oil and the optimal oil pressure may be guaranteed for each of the two mountings. It is thereby taken into consideration, in particular that while both mountings receive oppositely directed axial support forces during operation depending on instantaneous demands, wherein, however one of the of the mountings is more

continuously loaded and/or receives greater maximum forces. In addition, a heated supply may be optimized by the oil.

[0005] A turbocharger according to the invention comprises a compressor blade driven by the shaft. The turbocharger may preferably have an exhaust gas turbine on the drive side. Alternatively to this, other drives for the shaft are also possible, for example, by an electric motor.

[0006] The oil supply may, in particular, be connected to an oil circuit of the internal combustion engine.

[0007] An axial effect of the rotary bearing is preferably understood in that the bearing element supports at least an overwhelming part, preferably all of the forces acting in the axial direction on the rotating shaft during operation and introduces them into the housing of the turbocharger.

[0008] A bearing element in the meaning of the invention is preferably accommodated stationarily or fixed with respect to the housing. This may be a substantially disk-shaped component, wherein two opposite sides of the disk function as bearing surfaces or support surfaces. These bearing surfaces may have a corresponding shaping or processing of the surfaces in order to facilitate a hydrodynamic mounting. Such a bearing element is preferably manufactured from an alloy that differs from the housing, preferably from a copper alloy.

[0009] A flow surface in the meaning of the invention is understood to be a surface structured in a targeted way, whereby a targeted hydrodynamic pressure distribution of the supplied oil is achieved by the structuring during operation.

[0010] In generally preferred embodiments of the invention, the oil supply for at least one of the mountings, preferably for both mountings, discharges at a minimal radius of the bearing element with respect to the shaft. By this means, it is prevented that a radially inner region of the bearing collar and/or the sealing bushing is not wetted with oil. In particular, due to the oil supply, the shaft itself is wetted with oil from the oil supply, which additionally improves lubrication and cooling. The oil is thereby distributed very uniformly on the different flow

surfaces in the circumferential direction. Each of the flow surfaces thereby receives oil from the radially inner region, and thus at the same, low temperature.

[0011] In a first preferred embodiment of the invention, it is provided that the throttle elements are each designed as an annular gap between the shaft and the bearing element, wherein at least one annular groove, which has a larger maximum diameter than the annular gaps, is designed between the annular gaps in the axial direction. This enables in an easy way a defined distribution of the supplied oil to the first and second mounting, in that the annular gaps function as flow restrictors. The annular groove may advantageously function as a reservoir upstream of the annular gaps and ensure a constant oil flow.

[0012] In a structurally simple and appropriate detailed configuration, the oil supply thereby comprises an oil duct designed in the bearing element and discharging directly into the annular groove. Such an oil duct may, for example, be incorporated as a bore hole.

[0013] In an optimized geometry of the throttle elements, an axial width of at least one of the annular gaps, preferably of each of the annular gaps, is at least 15%, preferably at least 20% of a total width of the bearing element in the area of the annular gap.

[0014] Alternatively or supplementally, it is provided in an optimized geometry that a maximum radial height of the annular groove over a surface of the shaft is at least 15%, preferably at least 20% larger than a largest radial height of the annular gap above the shaft.

[0015] Additionally alternatively or supplementally, it is provided in an optimized geometry that an axial width of the annular groove is at least 20%, preferably at least 25% of a total width of the bearing element in the area of the annular gap.

[0016] In a second preferred embodiment of the invention, the oil supply comprises an oil duct, designed in the bearing element, which branches into a first subduct leading to the first mounting, and into a second subduct leading to the second mounting, wherein the throttle elements are formed by the subducts and a defined dimensioning of the subducts. By this means, a precise oil distribution may be realized in a simple way. The subducts may, for example, be manufactured by bore holes of a defined diameter.

[0017] In a preferred refinement, it is provided that the two subducts branch from the oil duct in a Y-shape and discharge respectively at opposite ends in the axial direction of an annular gap between the shaft and the bearing element. In this way, an oil supply of an inner radial area, including a wetting of the shaft, may be achieved easily and effectively.

[0018] The object of the invention is solved according to the invention for a turbocharger according to the preamble of Claim 10 with the characterizing features of Claim 10. Due to the radial overhang of the flow surfaces, an improved discharge of the oil of the hydrodynamic sliding bearing is achieved. An amount of oil flowing through the mounting may thereby be increased. On the other hand, a better discharge of undesired particles from the region of the mounting may be achieved.

[0019] In particular, the covering parts of the flow surfaces are essentially responsible, with the bearing collar, for the hydrodynamic properties of the mounting. The non-covering parts or the radial overhang are essentially responsible for an improved discharge of oil from the bearing. In the meaning of the invention, the overhang over the bearing collar is understood basically as an overhang over a hydrodynamically effective part of the bearing collar.

[0020] In an optimized dimensioning of the invention, it is thereby provided that a maximum diameter of the flow surfaces is at least 2%, preferably at least 5% greater than a maximum diameter of the bearing collar over/across a hydrodynamically effective area. By this means, a constant discharge of oil across the flow surfaces may be achieved.

[0021] In a generally preferred embodiment, it is provided that the flow surfaces increase monotonically in the circumferential direction across a first angular section, wherein a residual area with a constant height is formed across a second angular section following in the circumferential direction. The constant height of the residual area prevents an undefined break off of the increasing flow surface and reduces wear due to friction.

[0022] In one preferred refinement, the residual area of the second section may project by an offset elevation stepwise above a maximum height of the flow surface of the first section. This step enables a still greater removal of residual area of constant height in the case of inlet

wear or operating wear, without the hydrodynamic properties of the mounting being substantially changed.

[0023] In order to ensure a constant supply of oil, an axial depression like a type of pocket is respectively designed next to each of the flow surfaces in the circumferential direction. The depression preferably has an opening aligned radially to the shaft. Such a depression or pocket functions as an oil reserve and provides oil constantly and without interruption in the area of the flow surfaces.

[0024] In one preferred embodiment, at least one of the flow surfaces has a radially inner wedge surface part and a radially outer drain part connecting thereto, wherein the drain part has a height decreasing radially outward. The wedge surface part is thereby essentially responsible for establishing the hydrodynamic pressure of the mounting. Due to the decreasing shape of the drain part, the radial discharge of the oil may be optimized, wherein primarily a continuous and uninterrupted flow in the radial direction is sought.

[0025] In a geometry optimized with respect to this, it is provided that the drain part has a curved profile in a radially aligned section. This prevents the oil from centrifuging at edges or steps. The radius of curvature of the profile is thereby preferably between 1 times and 4 times, particularly preferably between 1.5 times and 2.5 times a radial width of the wedge surface part. Due to this measurement ratio, a low-wear milling tool may be used in particular to manufacture the flow surfaces of the bearing element. As a whole, the manufacturing of the bearing element is thus less expensive.

[0026] A turbocharger according to one of Claims 10 through 16 may also comprise one or more additional features of Claims 1 through 10 [note, this does not agree with the number of claims]. Conversely, a turbocharger according to one of Claims 1 through 9 may also comprise one or more additional features of Claims 10 through 16. In the interest of improved lubrication, the favorable properties of the oil supply defined by the throttle elements and the favorable properties of the improved oil through flow of the flow surfaces may thereby dovetail. The mounting is by this means more low-wear overall, as an accumulation of particles causing wear in the mounting is reduced.

[0027] Further advantages and features of the invention are derived from the subsequent description of exemplary embodiments and also from the dependent claims.

[0028] Multiple preferred embodiments of the invention are subsequently described and explained in greater detail by way of the appended drawings.

Brief Description of the Drawings

Figure 1 shows a schematic overall view of a turbocharger according to the invention.

Figure 2 shows a top view on a first side of a bearing element with bearing collar and sealing bushing from region Z from Figure 1.

Figure 3 shows a sectional view through the bearing element, bearing collar, and sealing bushing along line A-A from Figure 2.

Figure 4 shows the bearing element from Figure 2 without the bearing collar.

Figure 5 shows a sectional view along line A-A from Figure 1.

Figure 6 shows a sectional view along curved sectional line B-B from Figure 1.

Figure 7 shows a top view on a second side of the bearing element from Figure 2.

Figure 8 shows a part of a sectional view of the bearing element from Figure 4 along sectional line C-C.

Figure 9 shows an enlarged section of region Z from Figure 6.

Figure 10 shows a top view of a second exemplary embodiment of the invention relating to a shaping of the flow surfaces.

Figure 11 shows a sectional view through the bearing element, bearing collar, and sealing bushing of a third exemplary embodiment of the invention.

Detailed Description

[0029] The turbocharger for an internal combustion engine shown in Figure 1 comprises a central shaft 1, which is mounted in a housing 2, and drives a compressor blade 3 on the air side. Shaft 1 is presently driven by an exhaust gas turbine or an exhaust-gas-side turbine blade 4. Alternatively to turbine blade 4, another drive of the shaft is also possible, for example, by an electric motor.

[0030] Shaft 1 is, among others, mounted by an axially acting rotary bearing 5 (see also region Z and Figure 2, Figure 3), which is designed as a hydrodynamic sliding mounting. A stationary bearing element 6 is thereby penetrated by the shaft. A first mounting, acting axially against a bearing collar 7 rotating with shaft 1, is designed on a first side of bearing element 6 (view from Figure 2, Figure 4).

[0031] Bearing element 6 additionally forms a second mounting acting axially against a sealing bushing 8 rotating with shaft 1 on an opposite second side (view from Figure 7).

[0032] An oil supply 9 for supplying the mountings is designed in the bearing element. Oil supply 9 begins in the feed direction with a milled recess 9a in the surface of bearing element 6 formed substantially as a disk. The oil supply is further connected to an oil circuit of the internal combustion engine via ducts in housing 2.

[0033] A plurality of flow surfaces 10 is formed on one surface of the bearing element facing bearing collar 7 in the axial direction. Flow surfaces 10 have a height h, variable in the circumferential direction, across at least one part of their radial extension. Height h is defined as the axially aligned spacing of the flow surfaces with respect to a surface plane of the bearing element. The flow surfaces are formed by a material-removing process (milling) from the planar surface of the bearing element.

[0034] Bearing element 6 is preferably stationarily fixed with respect to the housing. This is a substantially disk-shaped component, wherein two opposite sides of the disk function as bearing surfaces or support surfaces. Flow surfaces 10 represent a molding or processing of the surface in order to enable a hydrodynamic mounting. The bearing element is presently manufactured from an alloy that differs from the housing, in this case, a copper alloy.

[0035] According to the invention, an individually dimensioned throttle element 11, 12 is designed in oil supply 9 for each of the two mountings. In the case of the exemplary embodiment according to Figures 1 through 9, this is an annular gap 11, 12 in each case, which is formed between shaft 1 and bearing element 6. An annular groove 13, which has a larger maximum diameter than the annular gaps, is provided between the annular gaps in the axial direction. This enables in an easy way a defined distribution of the supplied oil to the

first and second mounting, in that the annular gaps function as flow restrictors. In addition, annular groove 13 functions as a reservoir upstream of annular gaps 11, 12 and thus ensures a constant flow of oil.

[0036] Oil supply 9 comprises an oil duct 9b, designed as a bore hole, which begins in milled recess 9a and discharges directly into annular groove 13. Oil supply 9 for supplying the two mountings comprises, within the meaning of the present exemplary embodiment, milled recess 9a, oil duct 9b, annular groove 13, and throttle elements or annular gaps 11, 12.

[0037] Due to the given design of the throttle elements as annular gaps 11, 12, the oil supply 9 for both mountings thus discharges at a minimal radius of bearing element 6 with respect to shaft 1 via annular groove 13. By this means, it is prevented that a radially inner region of the bearing collar and/or the sealing bushing is not wetted with oil. Due to oil supply 9, the shaft itself is wetted with oil from the oil supply, which additionally improves lubrication and cooling. The oil is thereby distributed very uniformly on the different flow surfaces in the circumferential direction. Each of the flow surfaces thereby receives oil from the radially inner region, and thus at the same, low temperature.

[0038] In the present example, the geometry of throttle elements 11, 12 is designed so that an axial width of each of the annular gaps is approximately 27% of the total width of bearing element 6 in the area of annular gaps 11, 12.

[0039] A maximum radial height of annular groove 13 above a surface of shaft 1 is presently approximately 66% greater than a greatest height of annular gaps 11, 12 above shaft 1.

[0040] Furthermore, an axial width of annular groove 13 presently is approximately 46% of a total width of bearing element 6 in the area of annular gaps 11, 12.

[0041] With regards to the design of oil supply 9 with two individually dimensioned throttle elements, Figure 11 shows a second possible exemplary embodiment of the invention. In this case, a milled recess 9a and an oil duct 9b are likewise formed in the bearing element. However, oil duct 9b branches into a first subduct 14 leading to the first mounting and into a second subduct 15 leading to the second mounting. In this embodiment, the throttle elements

are formed by subducts 14, 15 and a defined dimensioning of subducts 14, 15. by this means, a precise oil distribution may be realized in a simple way. Subducts 14, 15 may, for example, be manufactured by bore holes of a defined diameter.

[0042] Just as in the first exemplary embodiment, the partial channels for both mountings discharge at a minimal radius of bearing element 6 with respect to shaft 1. By this means, as in the first example, each of the two sides of bearing element 6 is wetted with oil, starting from shaft 1.

[0043] The two subducts 14, 15 branch from oil duct 9b in a Y-shape and discharge respectively at opposite ends in the axial direction of an annular gap 18 between shaft 1 and bearing element 6. In this way, an oil supply of an inner radial area, including a wetting of the shaft, may be achieved easily and effectively.

[0044] As another subject matter of the invention, flow surfaces 10 in the previously described exemplary embodiments have an overhang 16 past bearing collar 7 in the radial direction. Due to radial overhang 16 of flow surfaces 10, the discharge or drainage of the oil of the hydrodynamic plain bearing is improved. In addition, an amount of oil flowing through the mounting as a whole is improved. In addition, by this means a better discharge of undesired particles from the region of the mounting is achieved.

[0045] Covering parts 17 of flow surfaces 10 are essentially responsible, with the bearing collar, for the hydrodynamic properties of the mounting. The non-covering parts or radial projection 16 are essentially responsible for an improved discharge of oil from the bearing.

[0046] In the case of the first exemplary embodiment according to Figure 1 through Figure 9, a maximum diameter d1 of the flow surfaces is approximately 17% larger than a maximum diameter d2 of bearing collar 7 across a hydrodynamically effective area. By this means, a constant discharge of oil across the flow surfaces may be achieved.

[0047] Individual flow surfaces 10 may each be considered as divided into a radially inner wedge surface part 10a and a drain part 10b connecting radially outwardly thereto. Drain part 10b has a height h that decreases radially outwardly. Wedge surface 10a is thereby essentially

responsible for establishing the hydrodynamic pressure of the mounting. Due to the decreasing shape of drain part 10b, the radial discharge of the oil may be optimized, wherein primarily a continuous and uninterrupted flow in the radial direction is sought.

[0048] Flow surfaces 10 increase monotonically in the circumferential direction across a first angular section W1 (in Figure 4 counter-clockwise or in the direction of rotation of shaft 1). A residual area 10c with a constant height h is formed across a second angular section W2 following in the circumferential direction. The residual area 10c of constant height h prevents an undefined break off of the increasing flow surface and reduces wear due to friction. Presently, the residual area has a height of zero or is part of the planar surface of bearing element 6.

[0049] In the present example (see Figure 9), residual area 10c of second section W2 projects by an offset elevation k stepwise above a maximum height h of the flow surface of the first section. This step 10d enables a still greater removal of residual area 10c of constant height h, without substantially changing the hydrodynamic properties of the mounting.

[0050] In order to ensure a constant supply of oil, an axial depression 17 like a type of pocket is respectively designed next to each of flow surfaces 10 in the circumferential direction. Depression 17 is U-shaped in cross section and has an opening 17a aligned radially to the shaft. Such a depression or pocket 17 functions as an oil reserve and provides oil constantly and without interruption in the area of flow surfaces 10.

[0051] Presently, the geometry is optimized so that drain part 10b of a flow surface 10 has a curved provide in a radially-aligned section (see, for example, Figure 8). This prevents the oil from centrifuging at edges or steps. Presently, a radius of curvature r of the profile is approximately double a radial width b of wedge surface part 10a. Due to this measurement ratio, a low-wear milling cutter may be used for producing flow surfaces 10 of bearing element 6.

[0052] Presently, diameter d2 of bearing collar 7 is equal to its hydrodynamically effective diameter, as oil pressure is applied to the entire axially-aligned surface of bearing collar 7. The periphery of the bearing collar essentially corresponds to a circle which extends on the

boundaries between wedge surface parts 10a and drain parts 10b of flow surfaces 10. Expressed another way, the radius of bearing collar 7 substantially corresponds to the outer radius of wedge surface parts 10a.

[0053] Figure 7 shows the second side of the bearing element or the back side facing the sealing bushing. Flow surfaces 10, which are formed analogously to flow surfaces 10 of the bearing collar side or of the first side are likewise formed here. The increase of wedge surface parts 10a is thus carried out here in the clockwise direction. The only partial radial covering by bearing collar 7 in the case of the first mounting corresponds in the case of the second mounting to an only partial covering by sealing bushing 8. Presently, the two mountings are thus designed identically with respect to flow surfaces 10.

[0054] Figure 10 shows another exemplary embodiment of the invention. Unlike the previously described example according to Figure 1 through Figure 9, no step 10d is provided between the highest end of wedge surface part 10a and residual area 10c lying in the surface of bearing element 6. Correspondingly, in the top view shown, drain parts 10c of the flow surfaces extend into a point in the rising direction of wedge surface parts 10a.

[0055] It is understood that the respective features of the exemplary embodiments (Figure 1 through Figure 9; Figure 10 and Figure 11) may be logically combined with each other depending on the application. In particular, each of the two variants of the flow surfaces (Figure 4 or Figure 10) may be combined with each of the two variants of the oil supply (Figure 3 or Figure 11). In addition, the flow surfaces according to the invention may be combined with conventional oil supply. Furthermore, the oil supplies according to the invention may be combined with conventional flow surfaces.

Reference numerals

1	Shaft
2	Housing
3	Compressor blade
4	Turbine blade
5	Axial rotating bearing
6	Bearing element
7	Bearing collar
8	Sealing bushing
9	Oil supply
9a	Milled recess
9b	Oil duct
10	Flow surfaces
10a	Wedge surface part
10b	Drain part
10c	Residual area
10d	Step
11	First throttle element (annular gap)
12	Second throttle element (annular gap)
13	Annular groove
14	First throttle element (subduct)
15	Second throttle element (subduct)
17a	Pocket, depression
17a	Opening of the depression
18	Annular gap
h	Height of the flow surface
k	Height of step 10d
d1	Maximum diameter of the flow surfaces
d2	Maximum diameter of the bearing collar
W1	First, monotonically increasing angular section

W2 Second angular section with constant height

b Radial width of the wedge surface part

Claims

1. A turbocharger for an internal combustion engine comprising
a housing (2) with a compressor blade (3) on the air side,
a shaft (1) driving the compressor blade (3), and
at least one radially acting rotary bearing (5) for mounting the shaft (3),
wherein the rotary bearing (5) is designed as a hydrodynamic sliding bearing,
wherein a stationary bearing element (6) is penetrated by the shaft (1) and a first mounting is formed on one first side of the bearing element (6) and acts axially against a bearing collar (7) rotating with the shaft,
wherein, in particular, the bearing element (6) additionally forms a second mounting on an opposite second side which acts axially against a sealing bushing (8) rotating with the shaft (1),
wherein an oil supply (9) for supplying the mountings is designed in the bearing element (6),
wherein a plurality of flow surfaces (10) with a height (h) varying in the circumferential direction is formed on one surface of the bearing element (6) facing the bearing collar (7) in the axial direction,
characterized in that
an individually dimensioned throttle element (11, 12) is designed in the oil supply (9) for each of the two mountings.

2. The turbocharger according to Claim 1, characterized in that the oil supply (9) for at least one of the mountings, in particular for both mountings, discharges at a minimum radius of the bearing element (6) with respect to the shaft (1).

3. The turbocharger according to one of the preceding claims, characterized in that the throttle elements (11, 12) are each designed as an annular gap between the shaft (1) and the bearing element (6), wherein at least one annular groove (13), which has a larger maximum diameter than the annular gaps (11, 12), is designed between the annular gaps in the axial direction.

4. The turbocharger according to Claim 3, characterized in that the oil supply (9) comprises an oil duct (9a), formed in the bearing element (6), which discharges directly into the annular groove (13).

5. The turbocharger according to Claim 3 or 4, characterized in that an axial width of at least one of the annular gaps, in particular each of the annular gaps, is at least 15%, in particular at least 20% of a total width of the bearing element (6) in the area of the annular gaps (11, 12).

6. The turbocharger according to one of Claims 3 through 5, characterized in that a maximum radial height of the annular groove (13) above a surface of the shaft (1) is at least 15%, in particular at least 20% greater than a largest radial height of the annular gap (11, 12) above the shaft (1).

7. The turbocharger according to one of Claims 3 through 6, characterized in that an axial width of the annular groove (13) is at least 20%, in particular at least 25% of a total width of the bearing element (6) in the area of the annular gaps (11, 12).

8. The turbocharger according to one of Claims 1 or 2, characterized in that the oil supply (9) comprises an oil duct (9a, formed in the bearing element (6), which branches into a first subduct (14) leading to the first mounting and also into a second subduct (15) leading to the second bearing element, wherein the throttle elements are formed by the subducts (14, 15) and a defined dimensioning of the subducts (14, 15).

9. The turbocharger according to Claim 8, characterized in that the two subducts (14, 15) branch from the oil duct (9b) in a Y-shape and open respectively at opposite ends in the axial direction of an annular gap (18) between the shaft (1) and the bearing element (6).

10. A turbocharger for an internal combustion engine comprising
a housing (2) with a compressor blade (3) on the air side,
a shaft (1) driving the compressor blade (3), and
at least one radially acting rotary bearing (5) for mounting the shaft (1),

wherein the rotary bearing (5) is designed as a hydrodynamic sliding bearing,
wherein a stationary bearing element (6) is penetrated by the shaft (1) and a first mounting is formed on one first side of the bearing element (6) and acts axially against a bearing collar (7) rotating with the shaft (1),
wherein, in particular, the bearing element (6) additionally forms a second mounting on an opposite second side which acts axially against a sealing bushing (8) rotating with the shaft (1),
wherein an oil supply (9) for supplying the mounting is designed in the bearing element (6),
wherein a plurality of flow surfaces (10) with a height (h) varying in the circumferential direction is formed on one surface of the bearing element (6) facing the bearing collar (7) in the axial direction,
characterized in that
the flow surfaces (10) have an overhang (16) over the bearing collar (7) in the axial direction.

11. The turbocharger according to Claim 10, characterized in that a maximum diameter (d1) of the flow surfaces (10) is at least 2%, in particular at least 5% greater than a maximum diameter (d2) of the bearing collar (7) across a hydrodynamically effective range.

12. The turbocharger according to one of Claims 10 through 11, characterized in that the flow surfaces (10) increase monotonically across a first angular section (W1), wherein a residual area (10c) is formed with a constant height (h) across a second angular section (W2) following in the circumferential direction.

13. The turbocharger according to Claim 12, characterized in that the residual area (10c) of the second section projects by an offset elevation (k) stepwise above a maximum height of the flow surface (10a, 10b) of the first section (W1).

14. The turbocharger according to one of Claims 10 through 13, characterized in that an axial depression (17) is formed like a type of pocket in the circumferential direction

adjacent to at least one of the flow surfaces (10), wherein the depression (17) has in particular an opening (17a) aligned radially to the shaft.

15. The turbocharger according to one of Claims 10 through 14, characterized in that at least one of the flow surfaces (10) has a radially inner wedge surface part (10a) and a radially outer drain part (10b) connecting thereto, wherein the drain part (10b) has a height (h) decreasing radially outwardly.

16. The turbocharger according to Claim 15, characterized in that the drain part (10b) has a curved profile in a radially aligned section, wherein in particular a radius of curvature (r) of the profile is between 1 times and 4 times, in particular between 1.5 times and 2.5 times a radial width (b) of the wedge surface part (10a).

17. The turbocharger according to one of Claims 10 through 16, comprising the features according to one of Claims 1 through 9.

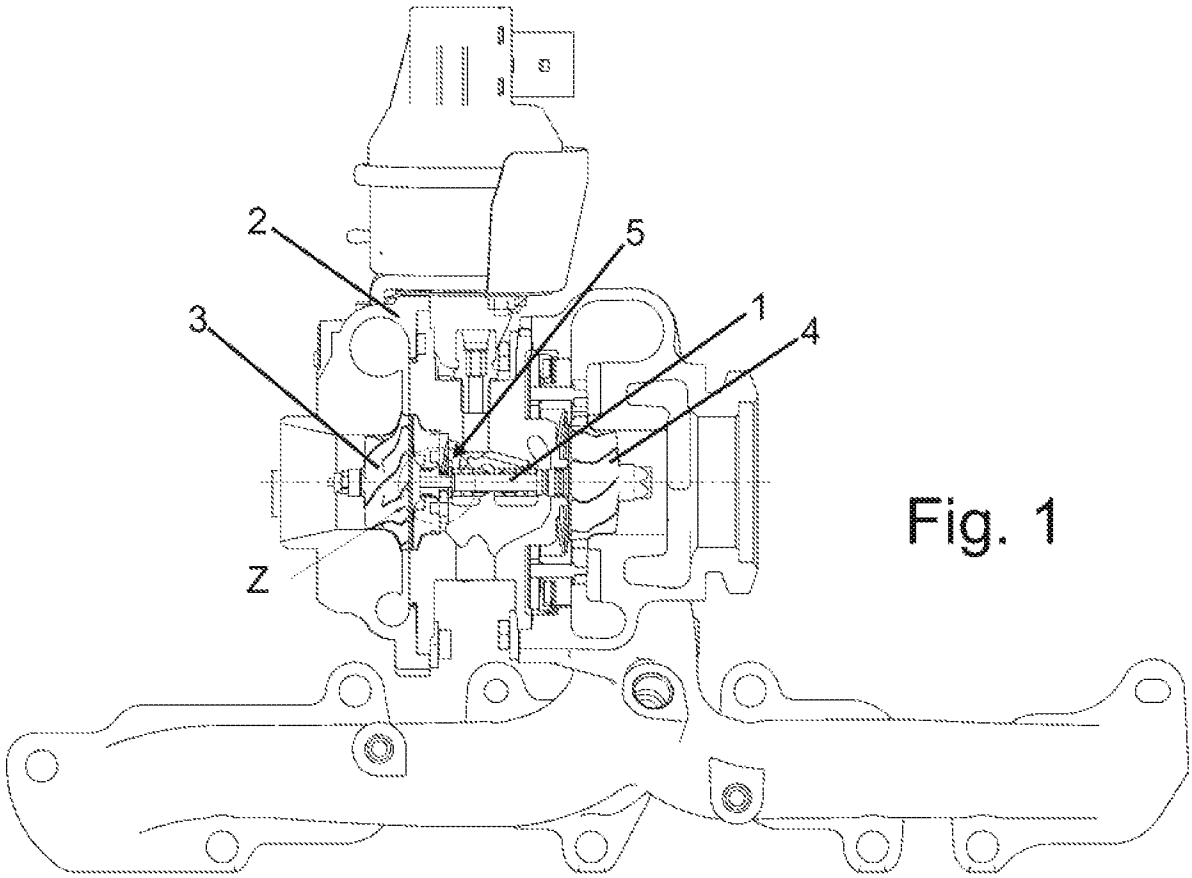


Fig. 1

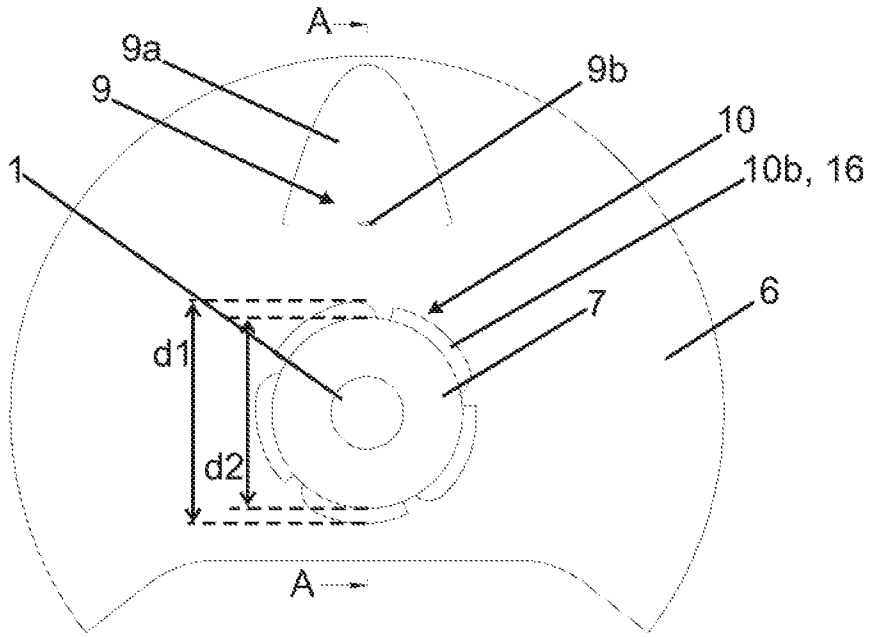


Fig. 2

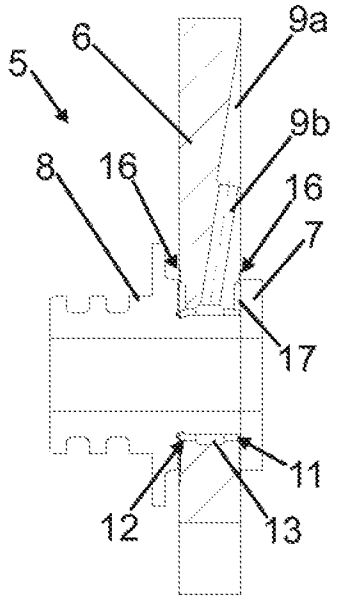


Fig. 3

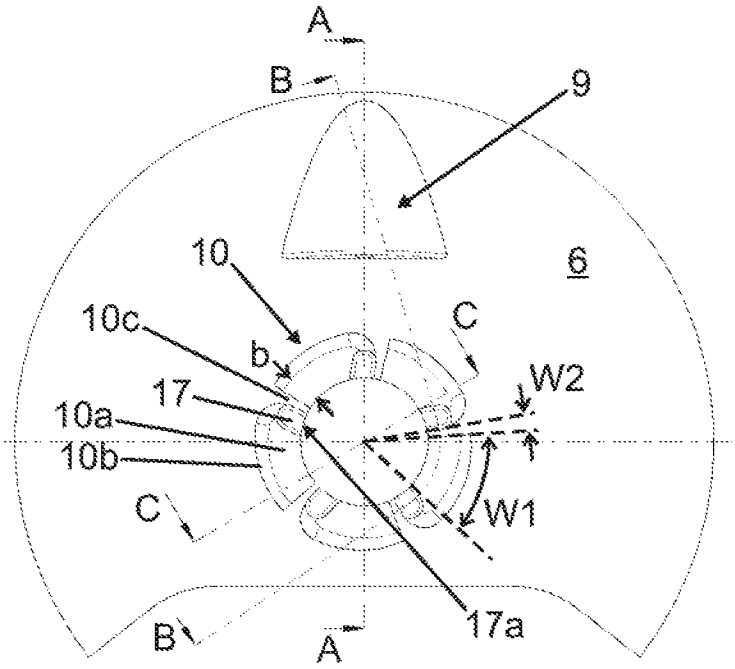


Fig. 4

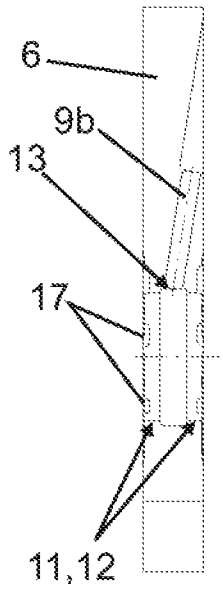


Fig. 5

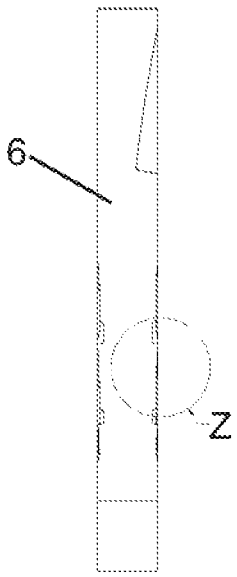


Fig. 6

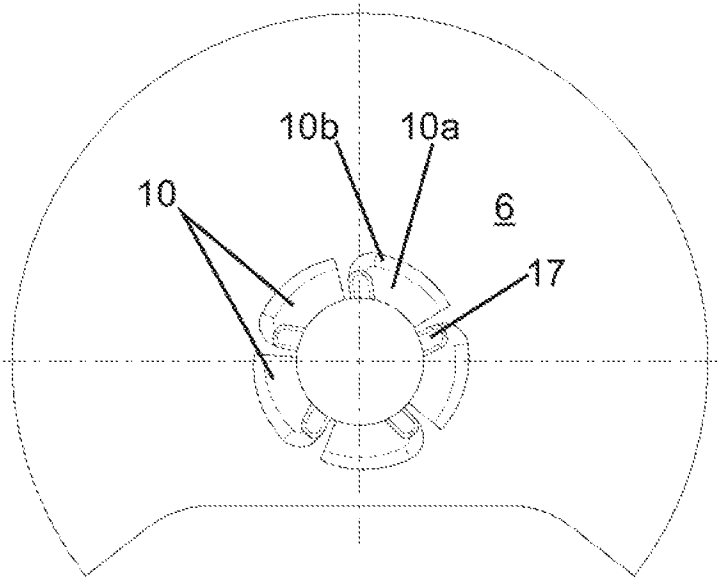


Fig. 7

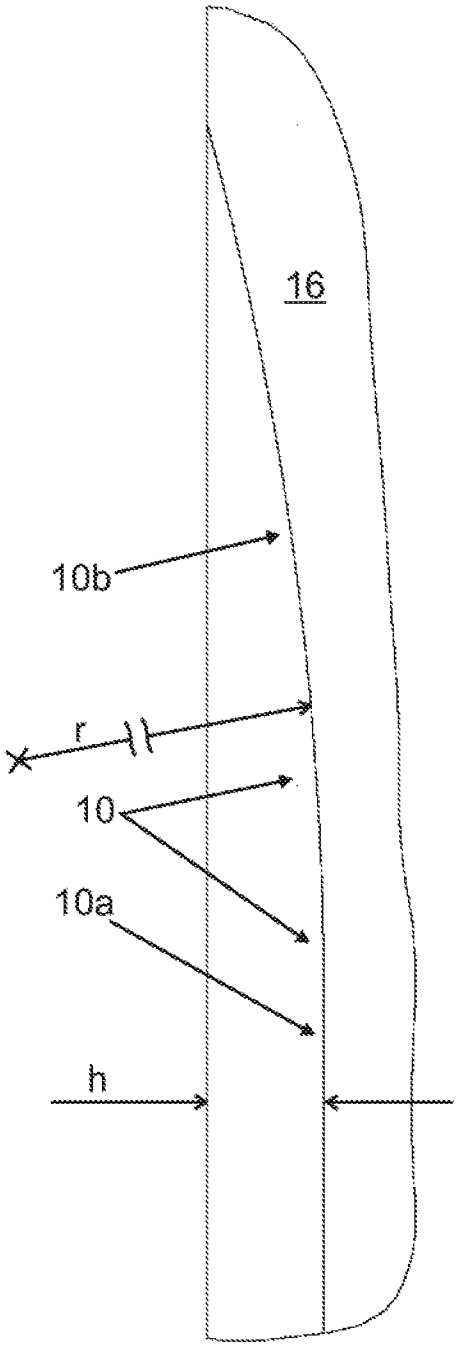


Fig. 8

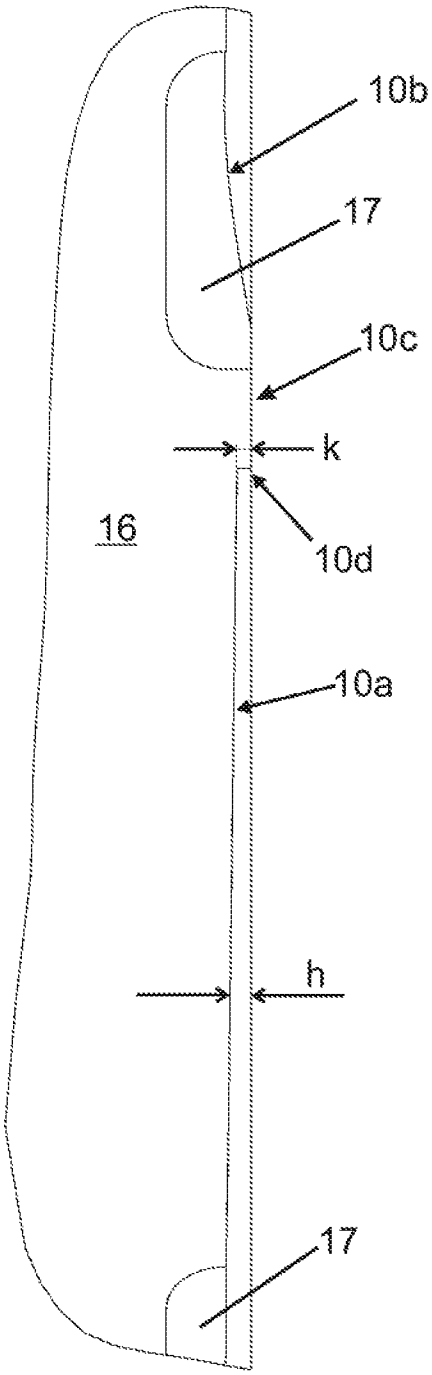


Fig. 9

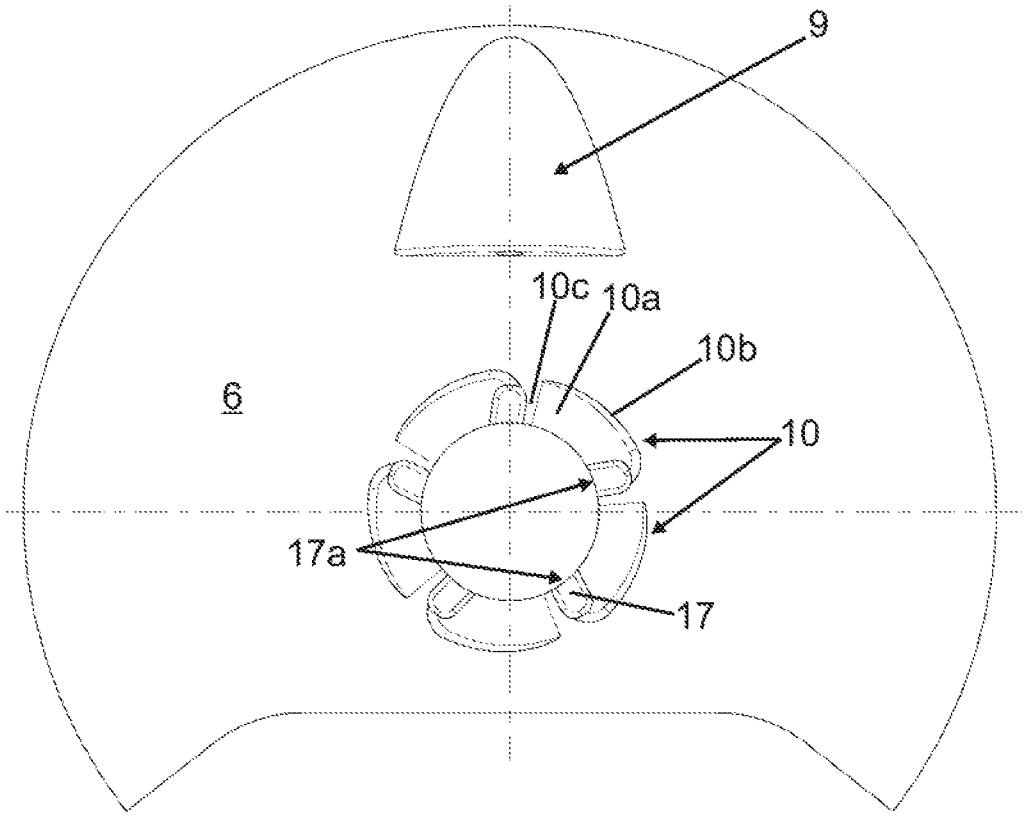


Fig. 10

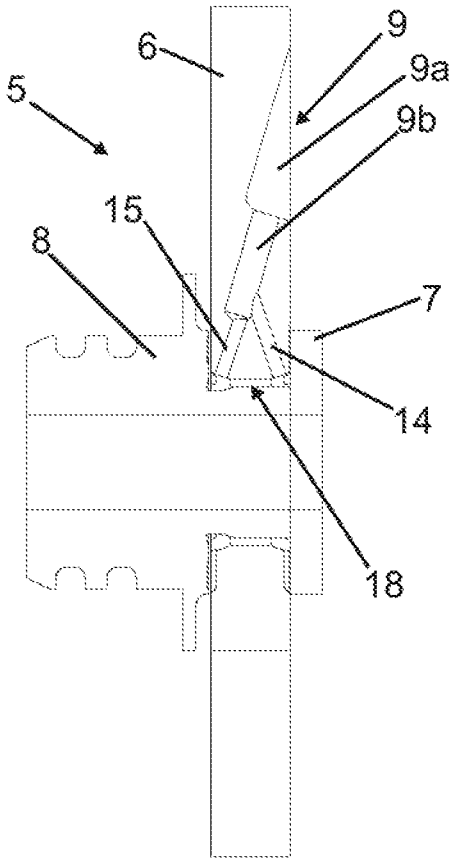


Fig. 11

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/030823

A. CLASSIFICATION OF SUBJECT MATTER
INV. F01D25/16 F16C17/04 F16C33/10
ADD.

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 practicable, 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	GB 2 113 778 A (ISHIKAWAJIMA HARIMA HEAVY IND) 10 August 1983 (1983-08-10)	1
Y	page 2, line 13 - line 40; figure 3	17
A		3-9,13, 14

X	EP 0 881 362 A2 (ISHIKAWAJIMA HARIMA HEAVY IND [JP]) 2 December 1998 (1998-12-02)	10-12
Y	figure 1	15-17

Y	CN 103 912 577 A (CHANGZHOU E & E TURBO POWER CO LTD) 9 July 2014 (2014-07-09) figure 2	15,16

X	JP H05 75519 U (JAPANESE TEXT) 15 October 1993 (1993-10-15) figure 6	1

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

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"P" document published prior to the international filing date but later than the priority date claimed

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"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
4 July 2019	15/07/2019

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Cerva-Pédrin, Sonia

1

Form PCT/ISA/210 (second sheet) (April 2005)

INTERNATIONAL SEARCH REPORT

International application No
PCT/US2019/030823

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

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1

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