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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
13 June 2024 (13.06.2024)

WIPO | PCT

(10) International Publication Number
WO 2024/121823 A1

(51) International Patent Classification:
F02F 11/00 (2006.01) *F01C 19/00* (2006.01)
F01C 19/08 (2006.01) *F01C 1/04* (2006.01)
F01C 19/02 (2006.01)

(21) International Application Number:
PCT/IB2023/062460

(22) International Filing Date:
11 December 2023 (11.12.2023)

(25) Filing Language: Czech

(26) Publication Language: English

(30) Priority Data:
PV 2022-515 09 December 2022 (09.12.2022) CZ

(72) Inventor; and

(71) Applicant: **KNOB, Vaclav** [CZ/CZ]; Ke Strasnicke 2402/15, 10000 Praha 10 (CZ).

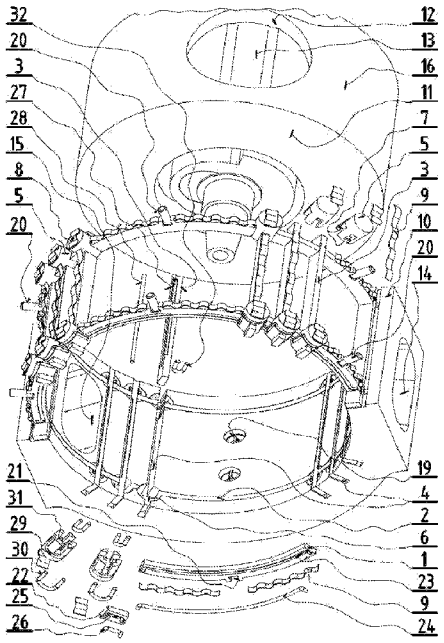
(74) Agent: **PATENT-K S.R.O.**; P.O. Box 26, 29501 Mnichovo Hradiste (CZ).

(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, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, MG, MK, MN, MU, 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, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, CV, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SC, 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,

(54) Title: ROTARY COMBUSTION ENGINE BLOCK SEALING

[Fig. 1]



(57) Abstract: A block sealing of a rotary combustion engine having a rotating block with radially located cylinders and pistons and an outside stationary case is disclosed. Transverse and/or lateral sealings located in the stationary case fit tight to an outer surface of the block. In circular grooves, a lateral sealing of radius sealing strips with springs situated between adjacent transverse sealing strips placed in transverse grooves is located. Couplings with notches and pressure springs are located in bores of the stationary case for inserting radius sealing strips and transverse sealing strips. The radius sealing strip is provided with a cut-out for interlocking of a stop connected with the stationary case. In the side of the radius sealing strip, a longitudinal groove in which a flexible sealing element and/or transverse sealing strip is made, and at its side, it is provided with a groove in which another flexible sealing element is located.

WO 2024/121823 A1

[Continued on next page]

DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, ME, 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 the identity of the inventor (Rule 4.17(i))*

Published:

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

— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments (Rule 48.2(h))*

Rotary Combustion Engine Block Sealing

Technical Field

[001] The disclosure relates to a rotary combustion engine block sealing that comprises a rotating block of a rotational shape, with radially situated cylinders with pistons. Outside the rotating cylinder block there is a stationary case with at least one intake and/or exhaust port. The rotating cylinder block together with the stationary case work like a rotary valve.

Background Art

[002] There have been designed many engines with a rotating block of a rotational shape with radially situated cylinders with pistons and an outer stationary case with an intake and/or exhaust port. The rotating cylinder block together with the stationary case work like a rotary valve. There are well known designs of two-stroke as well as four-stroke engines, two, three and multi-cylinder arrangements. Some engines have been equipped with the crankshaft mechanism and some have been equipped with other known mechanisms for transferring the motion of the piston to the shaft. None of those designs has achieved wider enlargement and utilization despite the undoubted potential.

[003] There are many reasons why these engines were not successful. The main reason is that the seal between the rotating block and the stationary case was not optimally designed. Mostly, the seal between cylinder space and the stationary case was done by means of sealing elements that were placed in the rotating cylinder block. Those sealing elements were then exposed to centrifugal forces that result from rotation of the rotating block. Together with increasing revolutions that leads to significant stress of these sealing elements, to high friction losses and lubrication problems. Such designs are described e. g. in documents DE 2732779, FR2767156A1.

[004] There have been also designs with a seal that is placed in the stationary case of the engine. The most simple is a seal in the form of rings that are placed on both sides of the perimeter of the rotating block. Another seal is done by transverse sealing strips that are placed in the stationary case

in the transverse direction with respect to the motion of the perimeter of the rotating block. Such designs are described e. g. in documents FR2639676A1, US1705130A, WO9823850A1, WO8302642A1, etc.

[005] The most perfect execution of the sealing located in the stationary engine case yet is the solution according to patents CZ304371, US 9366200B2. This solution has the advantage of eliminating the centrifugal forces applied to sealing elements. The sealing set comprises many elements, and the interstices between them are a source of leaks. Another important source of leaks is represented by any minor deformation or inaccuracy of the sealing strip and its groove in the mutual contact of strips and grooves. Then, there is a blow-through provided by the leak around the sealing strip, which is significantly higher than the blow-through in the contact surface of the strip with the surface of the rotating block. In this contact surface, the operation results in running-in and the blow-through is thus minimal. Another issue to be solved is the affect of friction forces to the lateral radius sealing strips. Especially with longer radius sealing strips, the problem lies in the fact that the radius sealing strip is driven by a frictional force, which effects the transverse sealing strip in the coupling of radius and transverse strips. The resultant F of frictional forces is divided into two force components F1 and F2 due to acting on the transverse sealing strip. The F1 force acts perpendicular to the transverse strip and this load results in increasing the resistance for the radial movement of the transverse strip in the groove. This worsens the tightness of the whole strip and coupling set. Another adverse effect is caused by the force component F2, which pushes the radius sealing strip away from the contact surface with the rotating block. This further decreases the tightness between the rotating block and the stationary engine case. When lubricating the sealing by a mixture of oil in the fuel, it is quite difficult to maintain the oil film on the contact surface of radius sealing strips with the outer surface of the rotating block.

Disclosure of Invention

[006] Above mentioned deficiencies are removed to a large extent by the rotary combustion engine block sealing according to example embodiments. The rotary combustion engine comprising a rotating block of a rotational shape with radially situated cylinders with pistons and an outer stationary case with at least one intake port and/or exhaust port. The outer surface of the rotating block is a rotational surface with a straight-line profile curve or a curved line profile curve, on which the transverse and/or side seals, which are placed in the stationary case, sit down. The circular grooves there is a side seal that consists of radius sealing strips with springs that are located between neighbouring transverse sealing strips that are placed in transverse grooves. Those transverse sealing strips go through the circulars grooves across. In the place where the radius sealing strips and transverse sealing strips meet there are joints with notches for inserting the radius sealing strips and transverse sealing strips. Those joints are placed in bores in the outer stationary case and comprise pressure springs. According to example embodiments, the radius sealing strip is provided with a cut-out for fitting the stop connected to the stationary case, and a radius groove is formed in the side of the radius sealing strip, in which a flexible sealing element is placed and/or the transverse sealing strip is provided with a groove on the side. in which another flexible sealing element is placed.

[007] The radius sealing strip and the transverse sealing strip may be located in the notches of a coupling, which on its side has an outer groove in which a coupling flexible sealing element is located and/or an internal groove for another coupling flexible sealing elements is present in the notch.

[008] Between transverse sealing strips, in the transverse groove for example, short radius strips having a short longitudinal groove, where a short flexible sealing element is, are located.

[009] The radius sealing strip may have a side-corrugated contact sealing seating surface.

[010] Flexible sealing elements, short flexible sealing elements, other flexible sealing elements, coupling flexible sealing elements and other coupling sealing elements may have O-shaped and/or X-shaped cross-sections

[011] Rotary combustion engine block sealing enables effective sealing between the rotating block and the stationary case. Placement of the sealing elements in the stationary case ensures that the pressure force of the sealing elements is independent on the engine speed and that allows reaching high engine speed and thus high specific parameters. All transverse sealing strips and radius sealing strips have surface contact with the rotating outer surface of the rotating block.

[012] The radius sealing strip may be provided with a cut-out which leans against the stop in the stationary case. This improves the function of the sealing set since it significantly eliminates the unfavourable effect of the friction forces to the radius sealing strip and the transverse strip as well as the coupling. The high lateral load of the transverse strip and the pushing the radius strip away from the contact surface with the rotating block are eliminated.

[013] The resultant of the frictional forces F is transferred to this stop. If the reaction force R does not act directly against F, also the reaction moment Mr will act on the strip, but this reaction moment will be very low. However, the short radius strip does not need the stop, since its force action on the transverse strip is low. A significant improvement in tightness is provided by flexible sealing elements in lateral grooves in all sealing strips and the coupling. For their production, e.g. fluoro-elastomers (FPM, FKM) can be used. Their cross-section (i.e. of the sealing elements) can be circular, X-shaped or similar. These elements can be placed on the opposite side of the sealing strip from the higher pressures that it is supposed to seal. Then, the gas pressure penetrating to the groove will increase the down-pressure of the sealing strip to the block being sealed. Since the stationary case can be effectively cooled with liquid, the temperature in the sealing strip grooves will be favourable, and flexible sealing elements will not be excessively heat stressed. If strips are lubricated with oil admixture to fuel, it is suitable to form a side-corrugated sealing seating surface being in contact with the rotating

block on radius sealing strips. This way, the lubricant accesses the contact surface more easily.

Brief Description of Drawings

[014] Rotary combustion engine block sealing according to example embodiments may be understood with reference to the enclosed drawings, where in: Fig. 1 illustrates an axonometric view of the seal assembly with a half of the stationary case and the rotating block with cylinders and pistons. The cylinder block with pistons is axially moved from the outer stationary case for better illustration.

[015] Fig. 2 illustrates sealing elements, including grooves and flexible sealing elements in an axonometric view with partial breakdown of the set.

[016] Fig. 3 illustrates a partial section of a rotary piston engine perpendicular to the axis of rotation, where the radius sealing strip and the transverse sealing strip and respective force ratios in the variant without a stop in the stationary case and without a cut-out in the radius sealing strip are depicted.

[017] Fig. 4 illustrates a partial section of a rotary piston engine perpendicular to the axis of rotation, where the radius sealing strip with a cut-out for a stop, the stop in the stationary case and the transverse sealing strip are depicted. Also respective force ratios are shown.

[018] Fig. 5 illustrates the radius sealing strip with a side-corrugated sealing seating surface in an axonometric view.

[019] Fig. 6 illustrate a partial section of a rotary piston engine perpendicular to the axis of rotation, where a section of a transverse sealing strip with a groove and a flexible sealing element with an O-shaped and an X-shaped section variants of these elements is shown.

Description of Embodiments

[020] An example sealing of a rotary combustion engine block sealing according to Fig. 1 is formed by radius sealing strips 1, short radius strips 22, transverse sealing strips 3, couplings 5, pressure springs 8 and springs 9. All these elements are located in a stationary case 10, where a rotating block 11

with radially located cylinders 12, in which pistons 13 move, is located. Its outer surface 16 is made by a rotary cylinder surface. The stationary case 10 is provided with an intake port 14 and an exhaust port 15. Couplings 5 are provided with notches 7, into which radius sealing strips 1 and transverse sealing strips 3 interlock. The radius sealing strips 1 have a cut-out 21 on their outer side, into which a stop 20 located in the stationary case 10 interlocks. The radius sealing strips 1 have a longitudinal groove 23 on their side, where a flexible sealing element 24 is located, and short radius strips 22 have a short longitudinal groove 25 on their side, where a short sealing element 26 is present, and the radius sealing strip 1 and the short radius strip 22 are located in circular grooves 2. Pressure springs 8 and couplings 5 are located in bores 6. The couplings 5 have an outer groove 29 on their side, where a coupling flexible sealing element 30 is located, and an internal groove 31 for another coupling flexible sealing element 32 is made in the notch 7. In the transverse sealing strip 3, a groove 27 for the other flexible sealing elements 28 is provided on the side. The transverse sealing strips 3 are located in transverse grooves 4, and springs 9 are located in transverse grooves 4 and circular grooves 2. Between the spark plug 19 and the intake port 14 and the exhaust port 15, three transverse sealing strips 3 are located.

[021] The embodiment of the rotary combustion engine block sealing according to Fig. 5 is based on the embodiment according to Fig. 1. The difference is in the use of the radius sealing strip 1 provided with a sealing seating surface 36, which is side-corrugated.

[022] The embodiment of the rotary combustion engine block sealing according to Fig. 6 is based on the embodiment according to Fig. 1. The transverse sealing strips 3 have another flexible sealing element 28 having a circular section and an X-shaped sections in the groove 27.

[023] The operation of the rotary combustion engine block sealing is as follows. The radius sealing strips 1 and transverse sealing strips 3 are down-pressed to the outer surface 16 of the rotary block 11 by springs 9. The pressure springs 8 down-press the couplings 5 to the outer surface 16 of the rotary block 11. The gas blow-throughs in the circular groove 2 around the radius sealing strip 1 are prevented by the flexible sealing element 24 in the

longitudinal groove 23. Also in the transverse groove 4, the other flexible sealing element 28 in the groove 27 prevents the blow-throughs around the transverse sealing strip 3. The flexible sealing element 24 and the other flexible sealing element 28 are located on the sides of strips more distant from the area with a higher gas pressure. Then the gas penetrating into the longitudinal groove 24 and the groove 27 increases the down-pressure of the radius sealing strip 1 and the transverse sealing strip 3 to the outer surface 16 of the rotary block 11. The radius sealing strip 1 is provided with a cut-out 21 which leans against the stop 20 in the stationary case 10. Into this groove 20, the resultant F of friction forces is transferred between the radius sealing strip 1 and the rotary block 11, and causes the reaction R with a low reaction moment Mr. Due to the stop 20, the friction forces are not transferred to the transverse sealing strip 3, and do not decrease its sealing properties and the sealing function of the radius strip 1. The flexible sealing element 24 and the other flexible sealing element 28 interlock into the notches 7 in the coupling 5. This improves the tightness in these connections. The coupling 5 is provided with the outer groove 29 with the coupling flexible sealing element 30, which decreases the gas blow-through around the coupling 5. The coupling flexible sealing element 30 is at the side of the coupling 5 away from the place of higher pressure. It does not prevent the penetration of pressure under the coupling, but prevents the gas from escaping further into the lower pressure area. In the notch 7 of the coupling 5, an inner groove 31 with another coupling flexible sealing element 32 preventing the blow-through around the transverse sealing strip 3 passing through the coupling 5 is present. The cross-section of flexible sealing elements can, for example, be circular or X-shaped. For better oil access between the radius sealing strip 1 and the outer surface 16 of the rotating block 11, it is preferred to use the contact sealing seating surface 36, which is side-corrugated.

Industrial applicability

[024] The rotary combustion engine block sealing according to the disclosure can be used, for example, in aircraft engines, motor generators for the production of electricity, motorcycle engines and in other applications of rotary piston engines, where high performance with low weight and engine dimensions is of primary importance. The rotary piston engine can be used for combustion gaseous fuels, including combustion of hydrogen due to their favourable design with absence of particularly hot valves. If the consumption of lubrication oil can be minimized, it can be used in cars as well. For example, as a range extender in electric cars.

Reference Sign List

[025]

1 radius sealing strip
2 circular groove
3 transverse sealing strip
4 transverse groove
5 coupling
6 bore
7 notch (in the coupling)
8 pressure spring
9 spring
10 stationary case
11 rotating block
12 cylinders
13 piston
14 intake port
15 exhaust port
16 outer surface (of the rotating block)
19 spark plug
20 stop (in the stationary case)
21 cut out (for the stop in the stationary case)
22 short radius strip
23 longitudinal groove (in the radius sealing strip)
24 flexible sealing element (for the radius sealing strip)
25 short longitudinal groove (in the short radius sealing strip)
26 short flexible sealing element (for the short radius strip)
27 groove (in the transverse sealing strip)
28 other flexible sealing element (for the transverse sealing strip)
29 outer groove (in coupling)
30 coupling flexible sealing element (for the coupling)
31 internal groove (in the coupling notch)
32 another coupling flexible sealing element (to the internal groove of the coupling)

36 sealing seating surface (of the radius sealing strip)

Claims

1. A rotary combustion engine block sealing consisting of a rotating block (11) having a rotary shape with radially located cylinders (12) with pistons (13) and an outside-located stationary case (10) with at least one intake port (14) and/or an exhaust port (15), wherein the outer surface (16) of the rotating block (11) is formed by a rotating surface with a straight or curved forming curve, on which a transverse and/or a lateral sealing are seated; the sealings are located in the stationary case (10), wherein in circular grooves (2), a lateral sealing consisting of radius sealing strips (1) with springs (9) placed between adjacent transverse sealing strips (3) is located; the transverse sealing strips are located in transverse grooves (4), and these transverse sealing strips (3) pass across circular grooves (2), wherein in the connections of radius sealing strips (1) with transverse sealing strips (3), couplings (5) provided with notches (7) for inserting radius sealing strips (1) and transverse sealing strips (3) are located; and couplings (5) are seated in bores (6) in the stationary case (10) and are provided with pressure springs (8) ***characterized in that*** the radius sealing strip (1) is provided with a cut-out (21) for interlocking of a stop (20) connected with the stationary case (10), and moreover, a longitudinal groove (23) is formed in the side of the radius sealing strip (1), and in the longitudinal groove a flexible sealing element (24) is present, and /or the transverse sealing strip (3) is provided with a groove (27) on its side, where another flexible sealing element (28) is located.

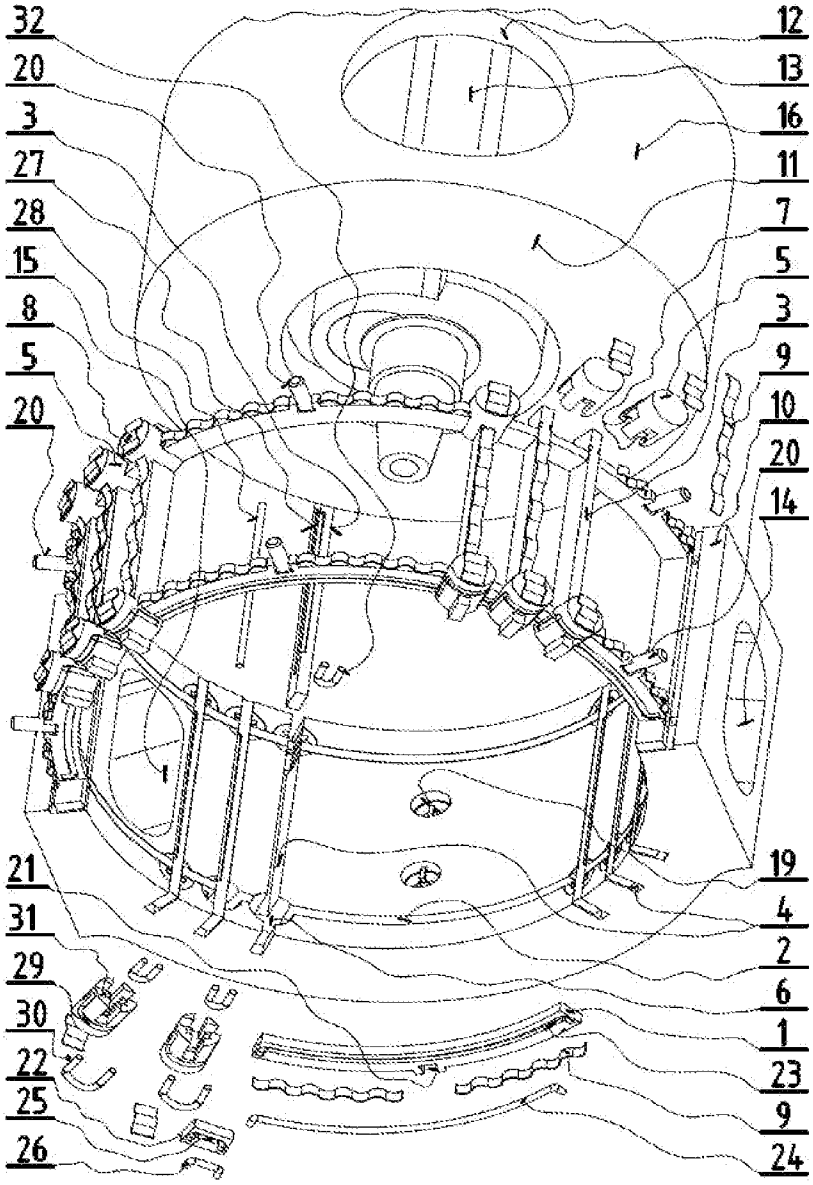
2. The rotary combustion engine block sealing according to Claim 1 ***characterized in that*** the radius sealing strip (1) and the transverse sealing strip (3) are located in the notches (7) of the coupling (5), which on its side has an outer groove (29) in which a coupling flexible sealing element (30) is located and/or an internal groove (31) for another coupling flexible sealing element (32) is present in the notch (7).

3. The rotary combustion engine block sealing according to Claim 1 or 2 ***characterized in that*** between transverse sealing strips (3) in the transverse groove (4), short radius strips (22) having a short longitudinal groove (25), where a short flexible sealing element (26) is located, are located.

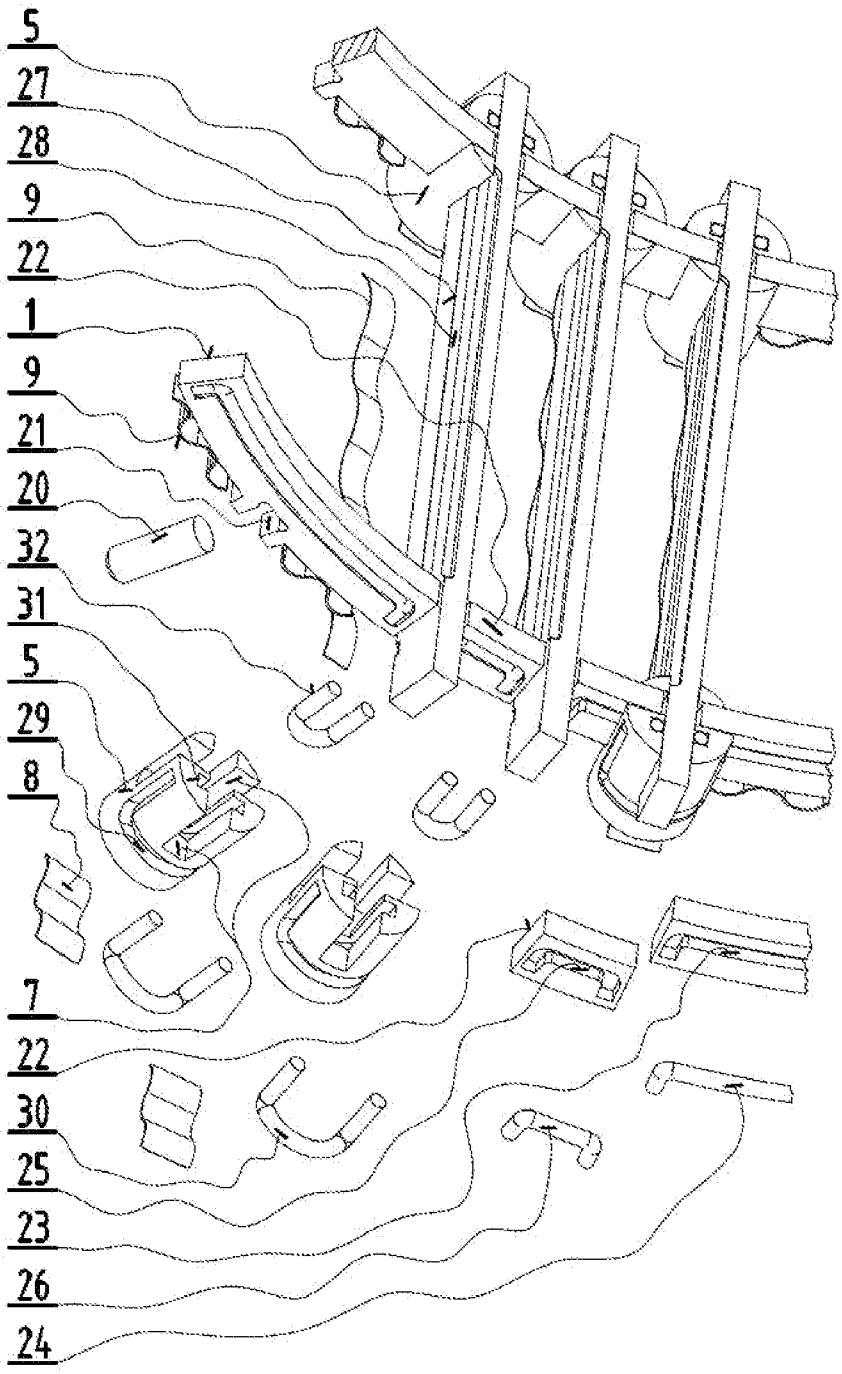
4. The sealing according to any one of Claim 1 to 3 ***characterized in that*** the radius sealing strip (1) has a contact sealing seating surface (36), which is side-corrugated.

5. The sealing according to any one of Claim 1 to 4 ***characterized in that*** the flexible sealing elements (24), short flexible sealing elements (26), other flexible sealing elements (28), coupling flexible sealing elements (30) and other coupling flexible sealing elements (32) have O-shaped and/or X-shaped cross-sections.

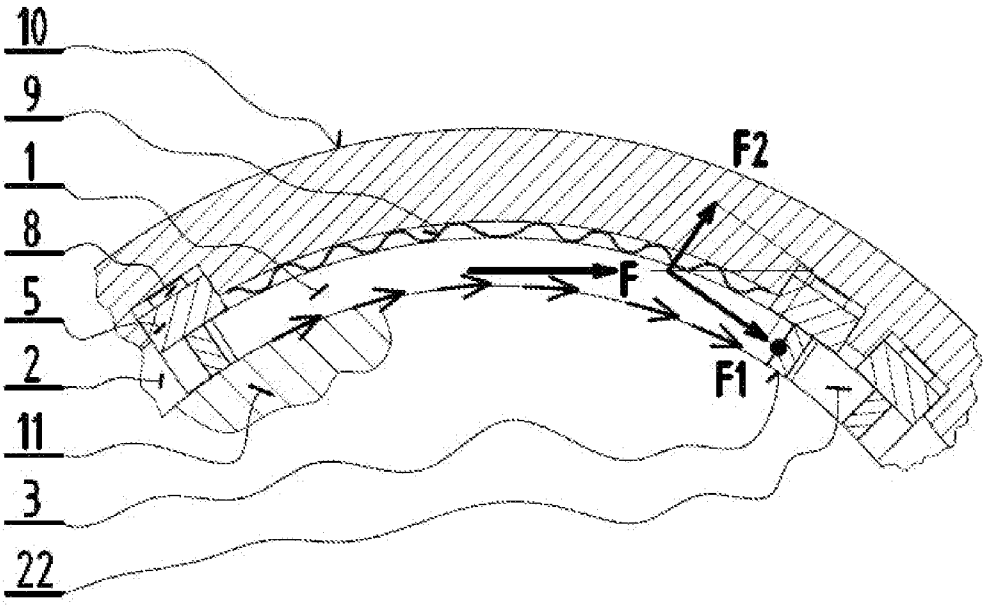
[Fig. 1]


32
20
3
27
28
15
8
5
20
21
31
29
30
22
25
26
12
13
16
11
7
5
3
9
10
20
14
19
4
2
6
1
23
9
24

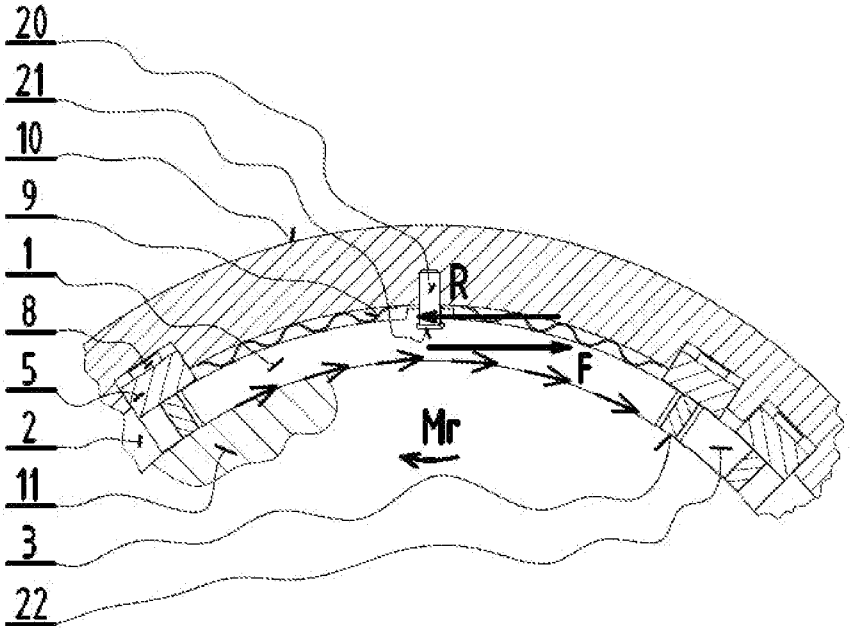
[Fig. 2]



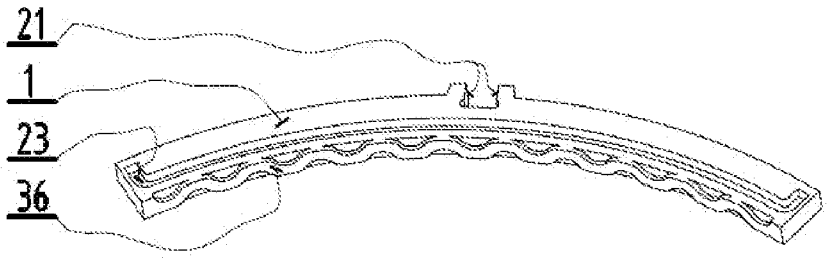
[Fig. 3]



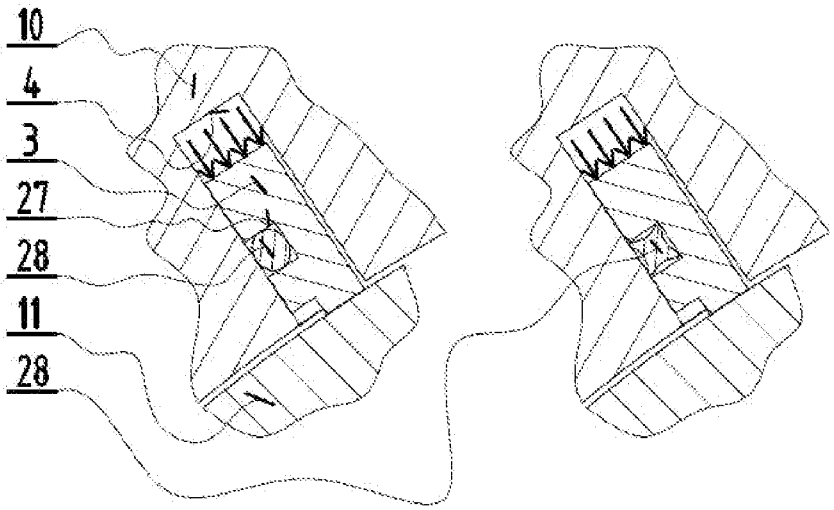
[Fig. 4]



[Fig. 5]



[Fig. 6]



INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2023/062460

A. CLASSIFICATION OF SUBJECT MATTER
INV. F02F11/00 F01C19/08 F01C19/02 F01C19/00 F01C1/04
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)
F02F F01C F01B F02B

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.
Y	US 9 366 200 B2 (KNOB VÁCLAV [CS]; KNOB ENGINES S R O [CZ]) 14 June 2016 (2016-06-14)	1-3,5
A	the whole document figures 1-3 column 2, line 10 - column 3, line 33 column 3, line 54 - column 4, line 43	4
Y	US 4 058 321 A (GAVRUN MICHAEL T ET AL) 15 November 1977 (1977-11-15)	1-3,5
A	the whole document figure 4 column 4, line 65 - column 5, line 17	4

-/--

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

[X] See patent family annex.

* Special categories of cited documents :

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

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

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"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

"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	Date of mailing of the international search report
9 April 2024	22/04/2024

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	Sbresny, Heiko

1

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

INTERNATIONAL SEARCH REPORT

International application No
PCT/IB2023/062460

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 4 308 002 A (DI STEFANO ALFONSO) 29 December 1981 (1981-12-29)	1-3,5
A	the whole document figures 8,9 column 3, line 63 - column 4, line 13 column 4, line 31 - line 53	4
Y	US 3 981 642 A (KAWAMURA KAZUHIRO ET AL) 21 September 1976 (1976-09-21)	1-3,5
A	the whole document figure 3 column 3, line 43 - column 4, line 2	4
Y	CA 2 782 848 A1 (PRATT & WHITNEY CANADA [CA]) 28 January 2013 (2013-01-28)	1-3,5
A	the whole document figures 2,3 page 2, line 20 - line 27 page 6, line 15 - line 33	4

1

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/IB2023/062460

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 9366200 B2	14-06-2016	AU 2013279853 A1	29-01-2015
		BR 112014030753 A2	27-06-2017
		CA 2875723 A1	27-12-2013
		CN 104379872 A	25-02-2015
		CZ 304371 B6	02-04-2014
		DK 2872743 T3	06-11-2017
		EA 201401343 A1	31-03-2016
		EP 2872743 A1	20-05-2015
		ES 2652672 T3	05-02-2018
		HU E037365 T2	28-09-2018
		JP 6190453 B2	30-08-2017
		JP 2015526657 A	10-09-2015
		KR 20150023456 A	05-03-2015
		NO 2872743 T3	17-02-2018
		PL 2872743 T3	31-01-2018
		SI 2872743 T1	28-02-2018
		US 2015144092 A1	28-05-2015
		WO 2013189471 A1	27-12-2013
		ZA 201409216 B	25-11-2015
US 4058321 A	15-11-1977	CA 1056307 A	12-06-1979
		US 4058321 A	15-11-1977
US 4308002 A	29-12-1981	NONE	
US 3981642 A	21-09-1976	DE 2428873 A1	30-01-1975
		GB 1440293 A	23-06-1976
		US 3981642 A	21-09-1976
CA 2782848 A1	28-01-2013	CA 2782848 A1	28-01-2013
		US 2013028771 A1	31-01-2013