(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 4 368 822 A1**

(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:
15.05.2024 Bulletin 2024/20

(21) Application number: **22206614.4**

(22) Date of filing: **10.11.2022**

(51) International Patent Classification (IPC):
F02B 53/02 *(2006.01)* ***F01C 1/063*** *(2006.01)*
F01C 1/07 *(2006.01)* ***F01C 1/077*** *(2006.01)*
F02B 55/16 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
F02B 53/02; F01C 1/063; F01C 1/07; F01C 1/077; F02B 55/16

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(71) Applicant: **Knevel, Andries Hendrik**
7948 DL Nijeveen (NL)

(72) Inventor: **Knevel, Andries Hendrik**
7948 DL Nijeveen (NL)

(74) Representative: **'t Jong, Bastiaan Jacob**
Inaday Patent B.V.
Hengelosestraat 141
7521 AA Enschede (NL)

(54) TWO-STROKE COMBUSTION ENGINE

(57) The invention relates to a two-stroke combustion engine comprising:
- a first and second toroid sector shaped combustion chamber having a common main axis of revolution and toroidal axis, wherein the first and second combustion chamber are arranged mirror symmetrical relative to a plane through the main axis of revolution, wherein each combustion chamber has on one end an inlet port arranged in the toroidal wall and on the other end an outlet port arranged in the toroidal wall;
- two pairs of piston heads coaxially arranged with the toroidal axis of the first and second combustion chamber, wherein the two piston heads of each pair are mounted fixedly on opposite sides of an arc-shaped base element, which base element is mounted fixedly with a center part to one end of a lever, which is rotatable around the main axis;
and wherein of the first pair one piston head is positioned in the first end of the first combustion chamber and the other piston head is positioned in the first end of the second combustion chamber and wherein of the second pair one piston head is positioned in the second end of the first combustion chamber and the other piston head is positioned in the second end of the second combustion chamber, such that the piston heads are movable in the respective combustion chamber and along the toroidal direction;
- a crankshaft mechanism and two drive rods rotatably connected with one end to the crankshaft mechanism and with the other end to one of the levers for transforming the reciprocating movement of the pair of piston heads into a rotating motion of the crankshaft mechanism; and
- at least two spark plugs each extending into one of the first and second combustion chambers.

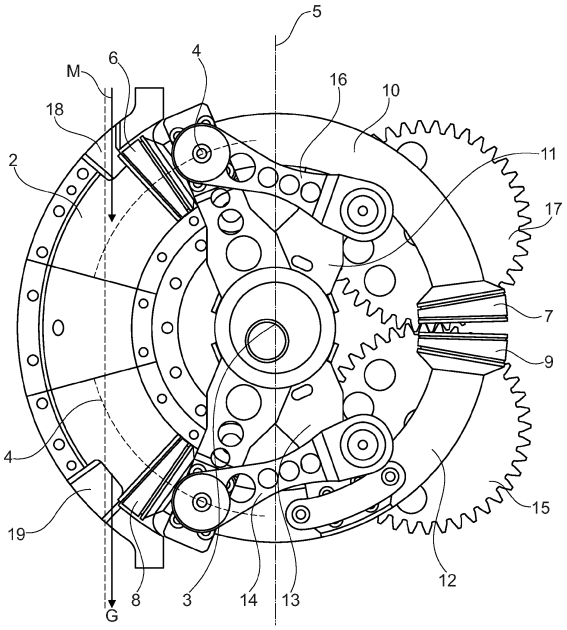

Fig. 1

EP 4 368 822 A1

Description

[0001] The invention relates to a two-stroke combustion engine.

[0002] A typical two-stroke combustion engine has a cylindrical combustion chamber, which is closed on one end by a cylinder head, in which at least a spark plug is arranged.

[0003] Inside the combustion chamber, a piston is movable up and down by a drive rod, which is rotatably arranged between the piston and a crankshaft. On opposite sides of the combustion chamber, an inlet port and an outlet port are arranged.

[0004] By movement of the piston, a mixture of air and fuel is sucked into the combustion chamber, compressed by the stroke of the piston, ignited by the spark plug. The air and fuel mixture then combusts and expands driving the crankshaft via the piston and drive rod. Finally, the combustion gases are expelled through the outlet port, which also causes the suction of a new mixture of air and fuel.

[0005] A disadvantage of this known two-stroke engine is that the inlet port and outlet port are positioned near the bottom dead center of the piston. At that position of the piston, the expanding combustion gases need to flow out of the combustion chamber and a fresh mixture of air and fuel enters the combustion chamber. Due to this arrangement of inlet and outlet ports, a part of the combustion gases remain in the combustion chamber near the cylinder head.

[0006] Another disadvantage of the known two-stroke combustion engine is that the drive rod is connected to the piston via a bearing. Due to the combustion in the combustion chamber, the piston becomes hot and as a result the bearing is also subjected to substantial heat. This requires sufficient lubrication and cooling to reduce resistance in the bearing, which will reduce the efficiency of the engine.

[0007] It is an object of the invention to reduce or even remove the above mentioned disadvantages.

[0008] This object is achieved according to the invention with a two-stroke combustion engine comprising:

- a first and second toroid sector shaped combustion chamber having a common main axis of revolution and toroidal axis, wherein the first and second combustion chamber are arranged mirror symmetrical relative to a plane through the main axis of revolution, wherein each combustion chamber has on one end an inlet port arranged in the toroidal wall and on the other end an outlet port arranged in the toroidal wall;
- two pairs of piston heads coaxially arranged with the toroidal axis of the first and second combustion chamber, wherein the two piston heads of each pair are mounted fixedly on opposite sides of an arc-shaped base element, which base element is mounted fixedly with a center part to one end of a lever, which is rotatable around the main axis; and wherein of the first pair one piston head is positioned in the first end of the first combustion chamber and the other piston head is positioned in the first end of the second combustion chamber and wherein of the second pair one piston head is positioned in the second end of the first combustion chamber and the other piston head is positioned in the second end of the second combustion chamber, such that the piston heads are movable in the respective combustion chamber and along the toroidal direction;
- a crankshaft mechanism and two drive rods rotatably connected with one end to the crankshaft mechanism and with the other end to one of the levers for transforming the reciprocating movement of the pair of piston heads into a rotating motion of the crankshaft mechanism; and
- at least two spark plugs each extending into one of the first and second combustion chambers.

[0009] With the engine according to the invention two pistons are provided in each combustion chamber. These pistons move towards each other and away from each other to compress an air and fuel mixture and to expand the combustion gasses.

[0010] Because the inlet port and outlet port are provided on opposite sides of the each combustion chamber, the combustion chamber can be fully flushed with a new mixture when both pistons are at their most distant position relative to each other. This ensures for a more efficient combustion of the fuel.

[0011] Furthermore, with the combustion engine according to the invention, the toroid sector shaped combustion chambers allow for the pistons to rotate around the main axis, while moving in the combustion chambers to compress the mixture and let the combustion gases to expand. By combining the two toroid sector shaped combustion chambers it is possible to directly convert the combustion forces in one chamber to the compression in the other chamber, without having to transfer these forces via bearings, drive rods and crankshaft, such as with known conventional two-stroke engines. As a result of the lack of a bearing, lubrication is also no longer necessary. Furthermore, due to the lack of a bearing, the friction between the piston and the cylinder wall is reduced as the piston cannot tilt relative to the cylinder wall.

[0012] Also the mass inertia of the pistons at an expansion is used for the pistons at a compression in the other combustion chamber. This increases the efficiency of the two-stroke combustion engine according to the invention.

[0013] The toroid sector shaped combustion chambers furthermore allow for any bearings to be positioned well outside of the combustion chamber, compared to conventional two stroke engines, in which a bearing is required in the piston.

[0014] A toroid is a surface of revolution of a circle. The surface of revolution has a hole in the middle. The main

axis of revolution passes through the hole and so does not intersect the surface. A toroid sector is the surface of a part of the revolution of the circle.

[0015] The term toroidal direction refers to a direction relative to a torus of reference. The toroidal direction follows a large circular path around the main axis of the torus.

[0016] In a preferred embodiment the two-stroke combustion engine according to the invention, the inlet port and outlet port of a combustion chamber are positioned on an axis, such that a linear channel is formed through the inlet port, through the combustion chamber and through the outlet port.

[0017] By positioning the inlet port and outlet port such that they form part of a linear channel, the inflowing mixture and the outflowing combustion gases experience as little resistance as possible, which is beneficial for the efficiency of the engine according to the invention.

[0018] In a further embodiment of the engine according to the invention the distance between the spark plug and the inlet port of a combustion chamber is larger than the distance between the spark plug and the outlet port of said combustion chamber.

[0019] This positioning ensures, that the outlet port is opened by the respective piston earlier than that the inlet port is opened by its respective piston. As a result the expanding combustion gases leave the combustion chamber via the outlet port somewhat earlier than the fresh air and fuel can enter the combustion chamber via the inlet port. The expanding gases also cause an airflow from the inlet port to the outlet port ensuring a good flushing of the combustion chamber.

[0020] In a preferred embodiment of the two-stroke combustion engine according to the invention a fuel injector is arranged adjacent to each spark plug, which fuel injector extends into the respective combustion chamber. With a fuel injector, the amount of fuel can easily be controlled depending on varying circumstances and be optimized on the amount of air flowing into the combustion chamber via the inlet port.

[0021] In still a further embodiment of the two-stroke combustion engine according to the invention the crankshaft mechanism comprises a main axle arranged parallel to and at a distance of the main axis and a gear set of at least three gears engaging in series on each other, wherein a first gear is arranged on the main axle, wherein a second gear is arranged on a secondary axle parallel to the main axle and wherein one of the two drive rods is rotatably arranged near the circumference of the second gear, and wherein a third gear is arranged on a third axle parallel to the main axle and wherein the other of the two drive rods is rotatably arranged near the circumference of the third gear.

[0022] The gear set ensures that the movements of the first pair of pistons and second pair of pistons is synchronized and that in one combustion chamber the compression stroke is performed, while in the other combustion chamber the power stroke takes place.

[0023] In order to further balance the forces, it is possible to embody the crankshaft mechanism double, such that on both sides of the first and second toroid sector shaped combustion chambers a gear set is provided, of which the first gears are arranged on the same main axle.

[0024] In still a further embodiment of the two-stroke combustion engine according to the invention the second and third gear are provided with an identical number of teeth.

[0025] These and other features of the invention will be elucidated in conjunction with the accompanying drawings.

Figure 1 shows a schematic view of an embodiment of the two-stroke combustion engine according to the invention in the intake position.

Figure 2 shows the engine of figure 1 in the compression motion.

Figure 3 shows the engine of figure 1 in the combustion position.

[0026] Figure 1 shows a schematic view of an embodiment of a two-stroke combustion engine 1 according to the invention. The engine 1 has a first toroid sector shaped combustion chamber 2 having a main axis of revolution 3 and toroidal axis 4. Mirror symmetrical relative to a plane 5 through the main axis of revolution 3 is a second toroid sector shaped combustion chamber, which is not shown for clarity.

[0027] The engine 1 has further two pairs of piston heads (6, 7; 8, 9) coaxially arranged with the toroidal axis 4. The piston heads 6, 7 are mounted on opposite sides of an arc-shaped base 10, which is fixedly mounted with a center part to one end of a lever 11, which is rotatable around the main axis 3. Also the second pair of pistons 8, 9 has an arc-shaped base 12 mounted onto a lever 13.

[0028] The lever 11 is on the other end connected to a drive shaft 14, which is also rotatably connected to a gear 15. The lever 13 is connected to a drive shaft 16, which is rotatably connected to a gear 17. The gears 15, 17 engage on each other to synchronize the movement of both pairs of pistons (6, 7; 8, 9) and to drive a third gear connected to an output shaft (not shown).

[0029] The toroid sector shaped combustion chamber 2 has on one end an inlet port 18 and on the opposite end an outlet port 19. These inlet port 18 and outlet port 19 are arranged on an axis such that a mixture M can flow straight into the combustion chamber 2 and the combustion gases G of a previous cycle can flow straight out. This improves the efficiency.

[0030] Figure 2 shows the engine 1 in a compression motion for the first toroid sector shaped combustion chamber 2, wherein the piston 6 and piston 8 move towards each other. This is assisted by an expansion movement in the second toroid sector shaped combustion chamber, which drives the piston 7 and piston 9 away from each other.

[0031] Due to this movement the gears 15, 17 are ro-

tated and a output shaft engaging via a third gear on one of the gears 15, 17 is driven.

[0032] Figure 3 shows the engine 1 in the compression position, in which the piston 6 and piston 8 are brought into the closest position. In this position a mixture of air and fuel is fully compressed, or only air is compressed and fuel is injected between the two pistons 6, 8 via hole 20. The pistons 7, 9 are at the most distant position relative to each other, similar to the intake position of pistons 6, 8 as shown in figure 1.

[0033] A spark plug is also positioned inside hole 20 to ignite the fuel and air mixture, such that the combustion causes the pistons 6 and 8 to move away from each other, while the pistons 7, 9 perform a compression motion in the second toroid sector shaped combustion chamber as described in relation to figure 2.

[0034] By repeating the steps shown in figures 1 - 3 the engine 1 will run and drive an output shaft through the gears 15, 18.

Claims

1. Two-stroke combustion engine comprising:

- a first and second toroid sector shaped combustion chamber having a common main axis of revolution and toroidal axis, wherein the first and second combustion chamber are arranged mirror symmetrical relative to a plane through the main axis of revolution, wherein each combustion chamber has on one end an inlet port arranged in the toroidal wall and on the other end an outlet port arranged in the toroidal wall;
- two pairs of piston heads coaxially arranged with the toroidal axis of the first and second combustion chamber, wherein the two piston heads of each pair are mounted fixedly on opposite sides of an arc-shaped base element, which base element is mounted fixedly with a center part to one end of a lever, which is rotatable around the main axis;
and wherein of the first pair one piston head is positioned in the first end of the first combustion chamber and the other piston head is positioned in the first end of the second combustion chamber and wherein of the second pair one piston head is positioned in the second end of the first combustion chamber and the other piston head is positioned in the second end of the second combustion chamber, such that the piston heads are movable in the respective combustion chamber and along the toroidal direction;
- a crankshaft mechanism and two drive rods rotatably connected with one end to the crankshaft mechanism and with the other end to one of the levers for transforming the reciprocating movement of the pair of piston heads into a rotating motion of the crankshaft mechanism; and
- at least two spark plugs each extending into one of the first and second combustion chambers.

2. Two-stroke combustion engine according to claim 1, wherein the inlet port and outlet port of a combustion chamber are positioned on an axis, such that a linear channel is formed through the inlet port, through the combustion chamber and through the outlet port.

3. Two-stroke combustion engine according to claim 1 or 2, wherein the distance between the spark plug and the inlet port of a combustion chamber is larger than the distance between the spark plug and the outlet port of said combustion chamber.

4. Two-stroke combustion engine according to any of the preceding claims, wherein a fuel injector is arranged adjacent to each spark plug, which fuel injector extends into the respective combustion chamber.

5. Two-stroke combustion engine according to any of the preceding claims, wherein the crankshaft mechanism comprising a main axle arranged parallel to and at a distance of the main axis and a gear set of at least three gears engaging in series on each other, wherein a first gear is arranged on the main axle, wherein a second gear is arranged on a secondary axle parallel to the main axle and wherein one of the two drive rods is rotatably arranged near the circumference of the second gear, and wherein a third gear is arranged on a third axle parallel to the main axle and wherein the other of the two drive rods is rotatably arranged near the circumference of the third gear.

6. Two-stroke combustion engine according to claim 5, wherein the second and third gear are provided with an identical number of teeth.

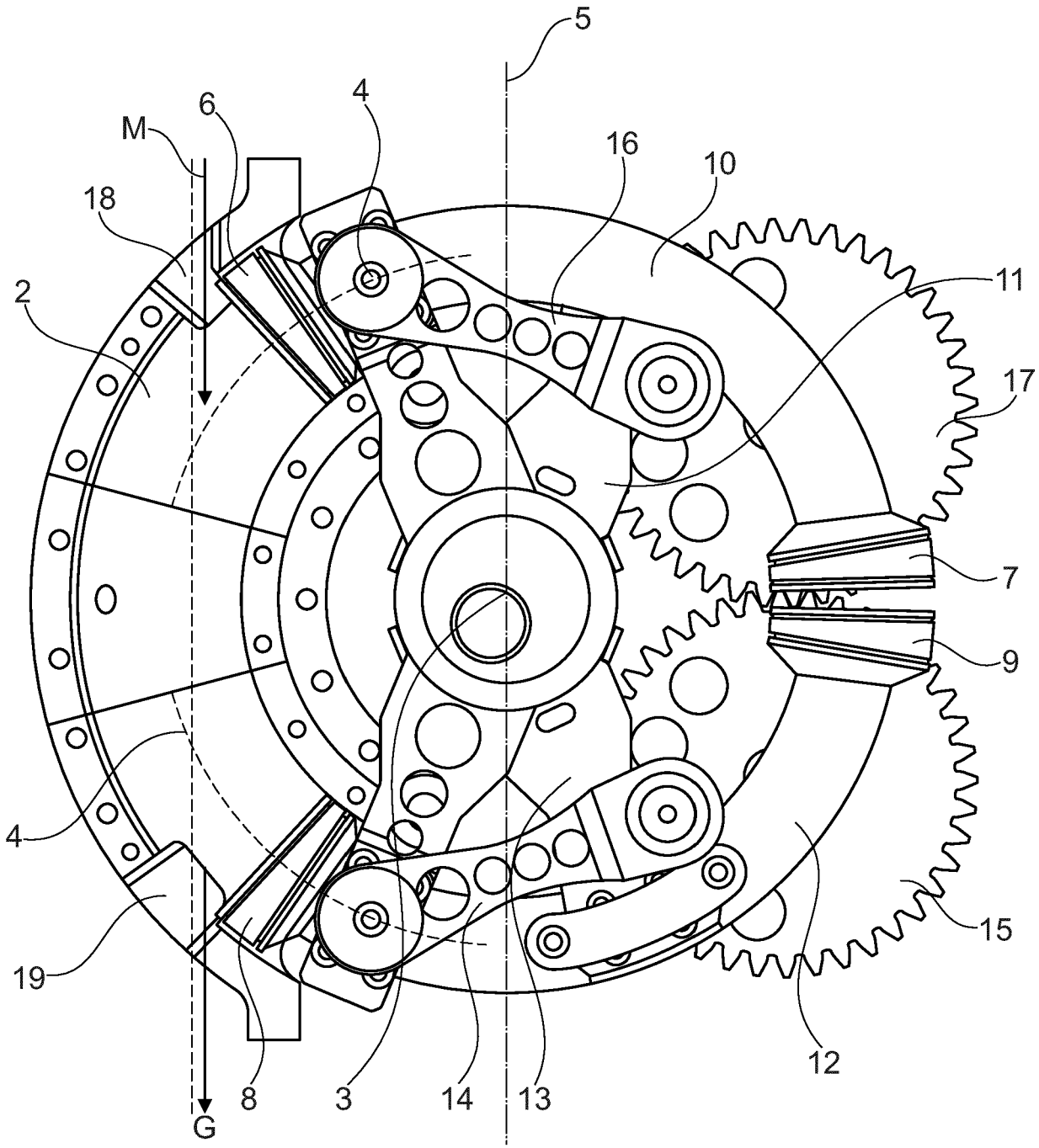

Fig. 1

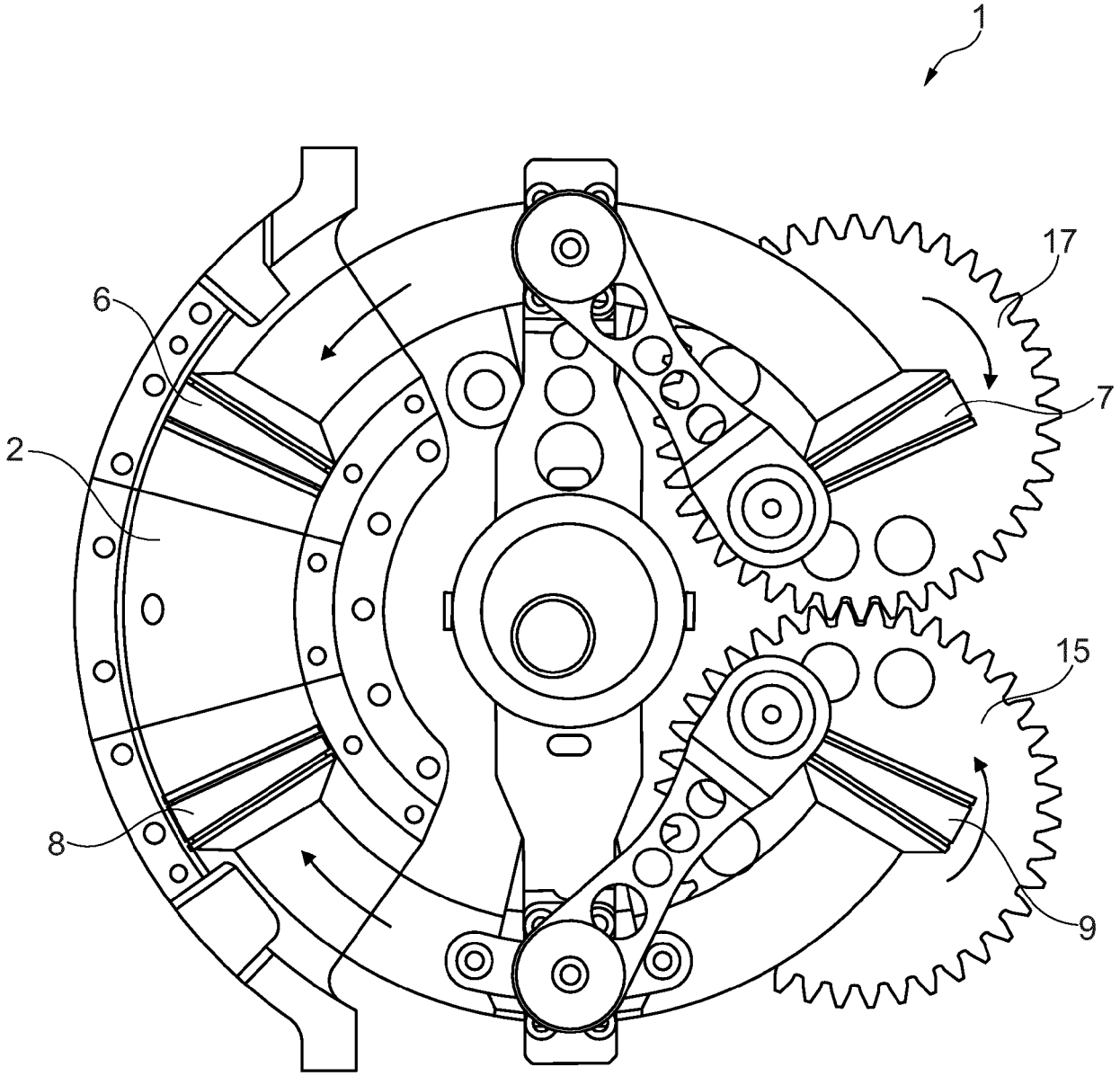

Fig. 2

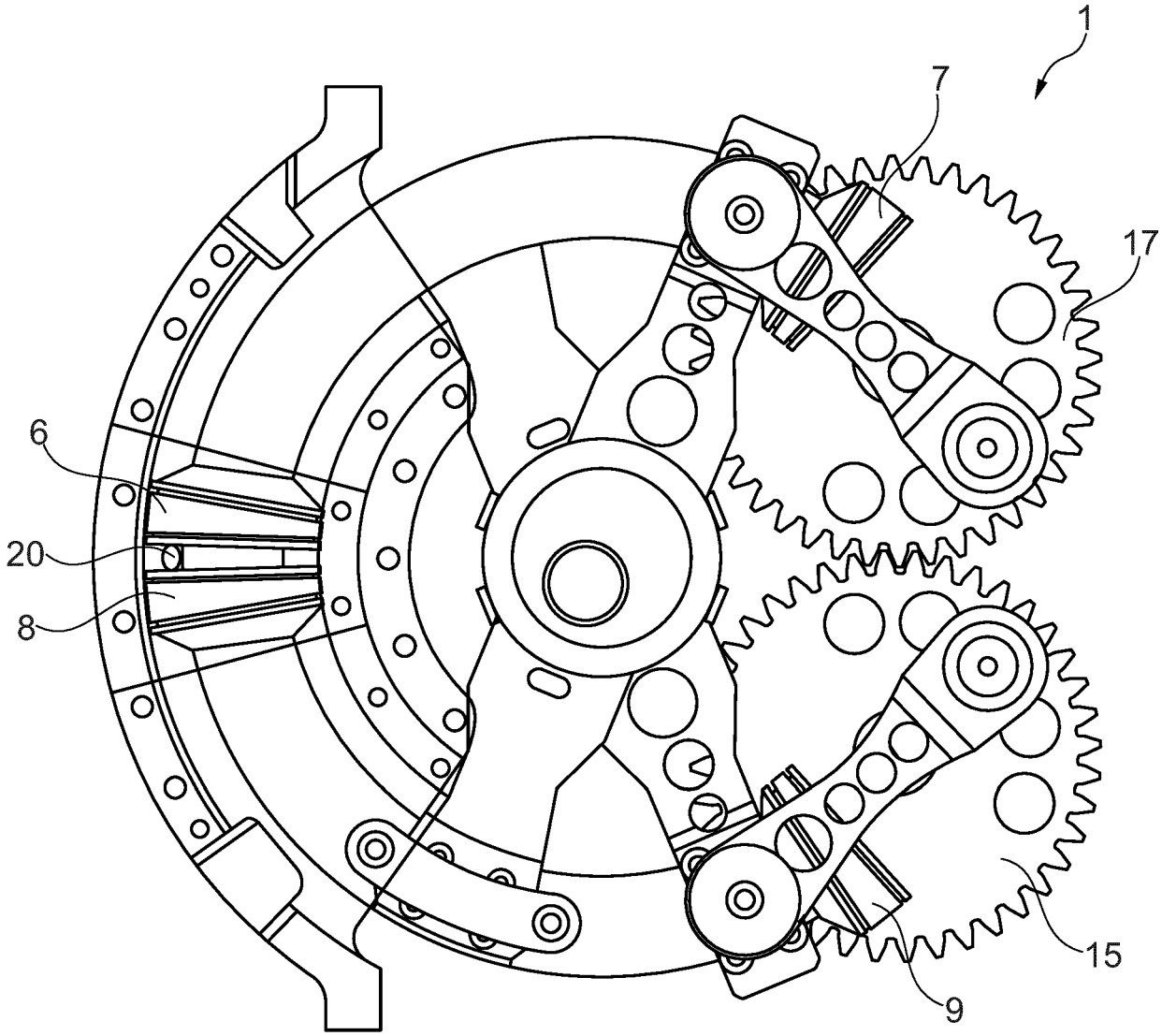

Fig. 3

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 22 20 6614

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	DE 292 633 C (JOHN THOMAS KEMPER) 20 June 1916 (1916-06-20) * page 1, line 31 - page 2, line 79; figures 1-3 *	1-4	INV. F02B53/02 F01C1/063 F01C1/07 F01C1/077
X	US 2006/150949 A1 (KOVALENKO VYACHESLAV I [UA]) 13 July 2006 (2006-07-13) * paragraph [0023] - paragraph [0025]; figures 2,5-8 *	1,5,6	F02B55/16
X	US 2012/134860 A1 (DRACHKO YEVGENIY FEDOROVICH [UA]) 31 May 2012 (2012-05-31) * paragraph [0221] - paragraph [0235]; figures 2-26 *	1	
A	WO 88/08921 A1 (GAMBARO GIANFRANCO [IT]) 17 November 1988 (1988-11-17) * abstract; figures 1-3 *	1-6	
A	US 226 527 A (FREDERIC W. LINK) 13 April 1880 (1880-04-13) * page 1, line 25 - page 2, line 93; figures 1-3 *	1-6	

TECHNICAL FIELDS SEARCHED (IPC)

F02B
F01C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	4 April 2023	Tietje, Kai

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

EPO FORM 1503 03.82 (P04C01)

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO. EP 22 20 6614

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

04-04-2023

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
DE 292633 C	20-06-1916	NONE	
US 2006150949 A1	13-07-2006	EP 1681437 A1	19-07-2006
		RU 2343290 C2	10-01-2009
		US 2006150949 A1	13-07-2006
US 2012134860 A1	31-05-2012	EP 2458145 A1	30-05-2012
		RU 2012101836 A	27-08-2013
		UA 93603 C2	25-02-2011
		US 2012134860 A1	31-05-2012
		WO 2011010978 A1	27-01-2011
WO 8808921 A1	17-11-1988	AU 1722088 A	06-12-1988
		ES 2008484 A6	16-07-1989
		IT 1230665 B	29-10-1991
		KR 890701874 A	22-12-1989
		WO 8808921 A1	17-11-1988
US 226527 A	13-04-1880	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82