



(51) International Patent Classification:

F02M 26/26 (2016.01) F16K 11/052 (2006.01)
F16K 1/22 (2006.01) F16K 1/226 (2006.01)

(21) International Application Number:

PCT/EP2016/057478

(22) International Filing Date:

6 April 2016 (06.04.2016)

(25) Filing Language:

English

(26) Publication Language:

English

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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, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IR, IS, JP, KE, KG, KN, KP, KR, 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).

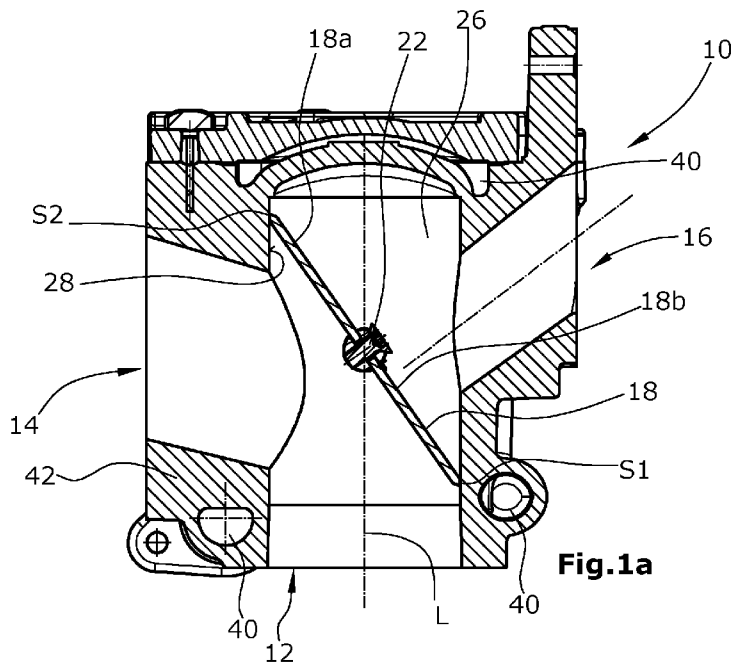
Declarations under Rule 4.17:

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

Published:

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

(54) Title: EXHAUST GAS VALVE DEVICE



(57) Abstract: The invention relates to an exhaust gas valve device (10) for selective recirculating of the exhaust gases of an internal combustion engine, comprising an exhaust gas feed opening (12), a first and a second exhaust gas discharge opening (14, 16), an exhaust gas valve formed as a butterfly flap, which with the aid of a drive means (20) can be pivoted about a pivot axis (22) between a first and a second flap position in such a manner that, in the first flap position, the exhaust gas feed opening (12) is connected to the first exhaust gas discharge opening (14) and, in the second flap position, the exhaust gas feed opening (12) is connected to the second exhaust gas discharge opening (16), and wherein the butterfly flap (18) is of an elliptical design.



D E S C R I P T I O N

Exhaust gas valve device

The invention relates to an exhaust gas valve device.

Exhaust gas valve devices can be used e.g. for selective recirculating of the exhaust gases of an internal combustion engine.

From the state of the art, for instance, exhaust gas valve devices are known which are operative to selectively guide exhaust gases to an exhaust gas cooler or to an air inlet of the internal combustion engine, optionally with an intermediate exhaust gas return valve. The exhaust gases may be redirected to bypass the exhaust gas cooler e.g. during warm-up of the internal combustion engine. An exhaust gas valve device for an internal combustion engine that is formed as butterfly flap is known e.g. from JP 2009-156115 A. The butterfly flap known from this document has the disadvantage that, e.g. in the position in which the bypass duct is closed, the second vane of the butterfly flap will largely project into the opened cooling duct and thus cause a high flow resistance.

It is an object of the invention to provide an exhaust gas valve device for selective recirculating of the exhaust gases of an internal combustion engine wherein said exhaust gas valve device shall have a reduced flow resistance and less leakage in its closed position.

According to the invention, the above object is achieved by the features defined in claim 1.

The exhaust gas valve device for selective recirculating of the exhaust gases of an internal combustion engine as provided according to the invention comprises an exhaust gas feed opening and first and second exhaust gas discharge openings. Via the exhaust gas feed opening, the exhaust gas valve device can be connected to an internal combustion engine on the exhaust side. The first exhaust gas discharge opening can be connected e.g. to an exhaust gas cooler while the second exhaust gas discharge opening can be connected to the air inlet of an internal combustion engine, optionally with interconnection of an exhaust gas return valve.

For selective recirculating of the exhaust gases, the exhaust gas valve device comprises an exhaust gas valve, formed as a butterfly flap, which with the aid of a drive means can be pivoted about a pivot axis in such a manner that, in the first flap position, the exhaust gas feed opening is connected to the first exhaust gas discharge opening and, in the second flap position, the exhaust gas feed opening is connected to the second exhaust gas discharge opening. Preferably, said pivot axis is arranged centrally relative to the two vanes of the butterfly flap. The two vanes of the butterfly flap can have the same length.

According to the invention, the butterfly flap is of an ellipsoidal shape.

Further according to the invention, the butterfly flap in the area of its two main apices along at least a part of its periphery comprises a respective sealing edge.

Said sealing edges can have the largest width on the two main apices and can become smaller, particularly in a continuous manner, starting from the two main apices toward the two secondary apices at the pivot axis of the butterfly flap. The sealing edges are preferably built

monolithically with the butterfly flap, meaning that they are made of the same material and are not a separate part.

According to the invention, in the area of the two secondary apices, the
5 ellipsoidal butterfly flap does not comprise a sealing edge because, starting from its largest width at the two main apices, the sealing edge has become narrower to such an extent that it has a width of 0 at the two secondary apices and preferably in an area around the two secondary apices.

10

By the ellipsoidal shape of the butterfly flap it is rendered possible to fully close an exhaust gas conduit of e.g. circular-cylindrical cross section while the butterfly flap does not need to be arranged at a right angle to the flow direction of the exhaust gases (i.e. to the longitudinal direction
15 of the exhaust gas conduit). Instead, in the first and second flap position, it is possible to arrange the butterfly flap obliquely in the circular-cylindrical exhaust gas conduit and, at the same time, to achieve a good sealing effect on the edges of the ellipsoidal butterfly flap which rest on the inner wall of the exhaust gas conduit. It is preferred that, along its
20 entire periphery, the butterfly flap, when in its first and second flap position (i.e. at its respective maximum angle) is in full abutment on the inner wall of the exhaust gas conduit.

By the oblique arrangement of the butterfly flap in the exhaust gas
25 conduit in the first flap position and in the second flap position, there can be achieved a particularly flow-effective redirection of the exhaust gases of the internal combustion engine to the first and second exhaust gas discharge opening. In this manner, it is possible to select the ellipsoidal shape to the effect that the butterfly flap is arranged in such a manner
30 within the exhaust gas conduit that, in the first flap position, the exhaust gases will already be guided by the butterfly flap in the direction of the

first exhaust gas discharge opening. In the second flap position, in a similar manner, the exhaust gases can be guided by the butterfly flap in the direction of the second exhaust gas discharge opening.

- 5 For instance, in the first flap position, the butterfly flap can be arranged at an angle of 30° to 60° relative to the longitudinal direction of the exhaust gas conduit in which the butterfly flap is situated.

In the second flap position, the butterfly flap can be similarly arranged at
10 an angle of 30° to 60° relative to the longitudinal direction of the exhaust gas conduit.

The first flap position is understood to be that position in which the butterfly flap, by both of its main apices and preferably by the entire rest
15 of its periphery, is in abutment on the inner wall of the exhaust gas conduit and, thus, the exhaust gas feed opening is exclusively connected to the first exhaust gas discharge opening and is sealed toward the second exhaust gas discharge opening. In correspondence thereto, also in the second flap position, the butterfly flap is by both of its main apices
20 and preferably by the entire rest of its periphery in abutment on the inner wall of the exhaust gas conduit so that the exhaust gas feed opening is exclusively connected to the second exhaust gas discharge opening and is sealed toward the first exhaust gas discharge opening.

- 25 According to a preferred embodiment, the sealing edges have a substantially triangular cross section, wherein, in the area of the two main apices, the distal tips of the triangular sealing edges comprise an angle $<X^\circ$, preferably $<Y^\circ$, wherein, in the area of the two main apices, the cross section of the triangular sealing edges comprises an angle
30 between 60° and 120° .

Further, it is preferred that, starting from the two main apices, the sealing edges extend in the peripheral direction of the butterfly flap toward the two secondary apices at angle of at least 75° - 85° in each direction.

5

Further, by the described contour of the sealing edge of the butterfly flap of the invention, there can be achieved a reduced wear and a longer operating life of the exhaust gas valve device. By the ellipsoidal design of the butterfly flap, there can further be reached an improved sealing
10 effect, particularly in case of higher temperatures.

Further, it is preferred that the drive means is an electric motor. Thus, the exhaust gas valve device of the invention is not actuated by a vacuum drive, thus allowing for a higher safeguarding against failure. As
15 compared to a vacuum drive, the omission of a vacuum pump and further components makes it possible to reduce costs.

Further, it is preferred to provide an angle sensor for determining the opening angle of the butterfly flap. The information of this sensor can be
20 used e.g. for the on-board diagnostics of a vehicle, and for testing the functionality of the exhaust gas valve device.

As an angle sensor for determining the opening angle of the butterfly flap, use can be made e.g. of a triaxial Hall sensor which is programmed
25 in such a manner that, for instance, an overall movement of the butterfly flap from the first flap position to the second flap position by 70° will lead to a voltage difference of 3V (with $U_{ref} = 5V$).

For fail-safe operation, a spring can be provided by which, in case of
30 failure of the drive means, the butterfly flap will always be held in the first flap position.

In order to achieve a precise control of the opening angle of the butterfly flap, a closed control circuit can be used.

- 5 Further, the use of an electric motor makes it possible to achieve a faster reaction in comparison with a pneumatic actuator. Also, it is possible to provide a higher moment of rotation for movement of the butterfly flap in both directions.
- 10 The invention further relates to a method for selectively recirculating of the exhaust gases of an internal combustion engine by using the inventive exhaust gas valve device. The method comprises the following steps:
- 15 The butterfly flap is controlled to an intermediate position in which both of the first and second exhaust gas discharge openings are connected to the exhaust gas feed opening. The ratio between the amount of gas flowing from the exhaust gas feed opening to the first exhaust gas discharge opening and the amount of gas flowing from the exhaust gas
- 20 feed opening to the second exhaust gas discharge opening is controlled by the position of the butterfly flap.

This method allows to recirculate some part of the exhaust gas through the exhaust gas cooler, and the remaining exhaust gas to bypass the

25 exhaust gas cooler directly to the intake of the engine. This function can be used, for example, in order to achieve intermediate exhaust gas temperatures at the intake of the combustion engine.

Hereunder, preferred embodiments of the invention will be explained with

30 reference to the Figures.

The following is illustrated:

Figures 1a and 1b show a cross-sectional view of an embodiment of the exhaust gas valve device of the invention in the first and second flap
5 positions.

Figure 2a shows an embodiment of the butterfly flap of the invention in plan view.

10 Figure 2b shows an embodiment of the butterfly flap of the invention in cross-sectional view.

Figure 2c shows an enlarged view of the portion marked in Figure 2b.

15 Figures 2d – 2f show further details of the butterfly flap.

Figure 3 is a sectional view of an embodiment of the exhaust gas valve device of the invention.

20 Illustrated in Figure 1a is an embodiment of the exhaust gas valve device 10 of the invention wherein the butterfly flap 18 is in the first flap position. In this position, the exhaust gas feed opening 12 is exclusively connected to the first exhaust gas discharge opening 14 and is sealed toward the second exhaust gas discharge opening 16. For this purpose,
25 butterfly flap 18 is pivoted fully to the left about the pivot axis 22 and is arranged at an angle of 35° relative to the longitudinal axis I of the exhaust gas conduit 26. Preferably, pivot axis 22 is arranged centrally in the exhaust gas conduit 26 which has a circular cross section.

30 In the first flap position, in the area of the second main apex S_2 , the edge of the first vane 18a of butterfly flap 18 is in abutment on an area of the

inner wall 28 of exhaust gas conduit 26 that is arranged above the first exhaust gas discharge opening 14. At the same time, in the area of the first main apex S_1 , the edge of the second vane 18b of butterfly flap 18 is in abutment on an area of the inner wall 28 of exhaust gas conduit 26 that is arranged below the second exhaust gas discharge opening 16. In these areas in which the butterfly flap is in abutment on the inner wall of exhaust gas conduit 26, there is respectively arranged a sealing edge 24a, 24b by which a sealing effect toward the second exhaust gas discharge opening 16 can be obtained.

10

In Figure 1b, the butterfly flap 18 is in the second flap position so that the exhaust gas feed opening 12 is exclusively connected to the second exhaust gas discharge opening 16 and is sealed toward the first exhaust gas discharge opening 14. Also here, a sealing effect is provided by the two sealing edges 24, 24b which are in abutment on the inner wall 28 of exhaust gas conduit 26. By the preferably triangular design of the sealing edges in cross section, a particularly good sealing effect can be accomplished toward the inner wall 28 of exhaust gas conduit 26 because the sealing edge is in abutment on inner wall 28 via a larger surface area.

20

For achieving a lower flow resistance, it is preferred that the conduits which respectively follow the exhaust gas discharge opening 14 and the exhaust gas discharge opening 16, extend at an acute angle to the longitudinal direction I of the exhaust gas conduit 26. Thus, it can be accomplished that, in the first and respectively second flap position, the exhaust gases do not need to be redirected fully, i.e. for instance by 90° , but merely at an angle smaller than 90° . If the exhaust gas feed conduits are e.g. arranged at an angle of 50° to the longitudinal direction I, the exhaust gases have to be redirected only by 50° so that, in this manner, an improved flow resistance can be achieved.

30

Figure 2a shows an embodiment of the butterfly flap 18 of the invention in plan view. In the Figure, it can be seen that the sealing edges 24a, 24b have their largest width at the first and second main apices S_1 , S_2 and, starting from there, continuously decrease in width in the direction of the secondary apices S_3 , S_4 and do not exist anymore at the secondary apices.

In Figure 2b, the triangular cross-sectional shape of the sealing edges 24a, 24b can be seen. Thus, in the first and second flap position, a particularly good sealing effect against the inner wall 28 of the exhaust gas conduit 26 can be obtained.

In Figure 2c, the angle of the triangular cross section of the sealing edges 24a, 24b is shown. This angle can be in the range between 60° and 120° and depends on the angle of the end position of the butterfly flap compared to the inner wall 28 of the exhaust gas conduit 26.

Figures 2d, 2e and 2f show the construction of the sealing edge 24a, 24b in more detail. As can be seen in figure 2d, in the area between the secondary apex S_3 and point A there is no sealing edge. This area without sealing edge can extend for example over an angle of 15° . Between point A and B there is a sealing zone in which the sealing edge incrementally grows. However, in this sealing zone, the sealing edge does not have a distal tip 25a, 25b which is shown for example in figure 2c. The sealing zone in which the sealing edge has a distal tip extends from point B to the main apex S_1 . Of course, the same features will be present in the other three quarters of the butterfly flap which are not further described in figure 2d.

The area between the two points A is shown in more detail in Figure 2f which shows part F of figure 2e.

By these features, it can be achieved that the sealing edge does not
5 obstruct the rotation of the butterfly flap in the area close to the secondary apices S3 and S4.

Figure 3 shows an exemplary design of an embodiment of the exhaust gas valve device 10 of the invention. The pivot axis 22 is driven by an
10 electric motor 20. For determining the opening angle of butterfly flap 18, an angle sensor 30 in the form of a Hall sensor is provided. Between electric motor 20 and pivot axis 22, a planetary gear 32 can be provided. Above and below butterfly flap 18, the pivot axis 22 is supported in two bearings 34a, 34b.

15

In a second function mode, the butterfly flap can be controlled to intermediate positions between the first and second gas discharge opening 14, 16. Thereby it is possible to selectively control the flow rate ratio through each exhaust conduit. This allows to direct a part of the
20 exhaust gas through the exhaust gas cooler and the remaining exhaust gas to bypass the exhaust gas cooler directly to the intake of the engine. This function can be used in case intermediate exhaust gas temperatures have to be achieved at the intake of the combustion engine.

C L A I M S

- 5 1. An exhaust gas valve device (10) for selective recirculating of the exhaust gases of an internal combustion engine, comprising an exhaust gas feed opening (12),
a first and a second exhaust gas discharge opening (14, 16),
an exhaust gas valve formed as a butterfly flap, which with the aid
10 of a drive means (20) can be pivoted about a pivot axis (22) between a first and a second flap position in such a manner that, in the first flap position, the exhaust gas feed opening (12) is connected to the first exhaust gas discharge opening (14) and, in the second flap position, the exhaust gas feed opening (12) is
15 connected to the second exhaust gas discharge opening (16),

characterized in that

the butterfly flap (18) is of an ellipsoidal design,

20

the butterfly flap (18) in the area of its two main apices S_1 , S_2 comprises a respective sealing edge (24a, 24b) along a part of its periphery,

25

whereby the sealing edges (24a, 24b) have the largest width on the two main apices S_1 , S_2 and become continuously smaller starting from the two main apices S_1 , S_2 toward the two secondary apices S_3 , S_4 at the pivot axis (22) of the butterfly flap.

- 30 2. The exhaust gas valve device (10) according to claim 1,

characterized in that

the sealing edges (24a, 24b) have a substantially triangular cross section and, in the area of the two main apices S_1 , S_2 , the distal tip of the triangular sealing edges comprises an angle, depending on the maximum rotation of the butterfly flap (18) between the inner wall (28) of the exhaust gas conduit (26).

3. The exhaust gas valve device (10) according to claim 2,

characterized in that

the angle of the triangular sealing edge has its minimum at the two main apices S_1 , S_2 and is continuously increased starting from the two main apices S_1 , S_2 towards the two secondary apices S_3 , S_4 , so that at the two secondary apices S_3 , S_4 , the butterfly flap (18) does not comprise a sealing edge.

4. The exhaust gas valve device (10) according to claim 3,

characterized in that

the minimum angle of the triangular sealing edge at the two main apices S_1 , S_2 is between 60° and 120° .

5. The exhaust gas valve device (10) according to any one of claims 1 to 4,

characterized in that,

starting from the two main apices S_1 , S_2 , the sealing edges (24a, 24b) extend in the peripheral direction of the butterfly flap (18) toward the two secondary apices S_3 , S_4 at an angle of at least 75° - 85° in each direction.

6. The exhaust gas valve device (10) according to any one of claims 1 to 4,

characterized in that

the drive means (20) is an electric motor.

7. The exhaust gas valve device (10) according to any one of claims 1 to 6,
characterized by
5 a mechanical lever connection (36) between the pivot axis (22) of the butterfly flap (18) and the planetary gear (32) of the electrical actuator with a return spring (38) function.
8. The exhaust gas valve device (10) according to any one of claims 1 to 7,
10 **characterized by**
an angle sensor for determining the angular position of the butterfly flap (18) between the open and closed position.
- 15 9. The exhaust gas valve device (10) according to any one of claims 1 to 8,
characterized by
an integrated cooling circuit (40) inside the housing for thermal management to protect the electrical actuator system (20, 30 and
20 32) from overheating as well as maintaining an acceptable temperature range for the bearing system (34a and 34b) and housing (42) of the exhaust gas valve device (10).
10. Method for selectively recirculating of exhaust gases of an internal
25 combustion engine by using an exhaust gas valve device (10) according to any one of the claims 1 to 9,
characterized by the steps:
controlling the butterfly flap (18) to an intermediate position, such that both the first and second exhaust gas discharge opening (14,
30 16) are connected to the exhaust gas feed opening (12), whereby the ratio of exhaust gas flowing from the exhaust gas feed opening

(12) to the first exhaust gas discharge opening (14) compared to the gas flowing from the exhaust gas feed opening (12) to the second exhaust gas discharge opening (16) is controlled by the position of the butterfly flap (18).

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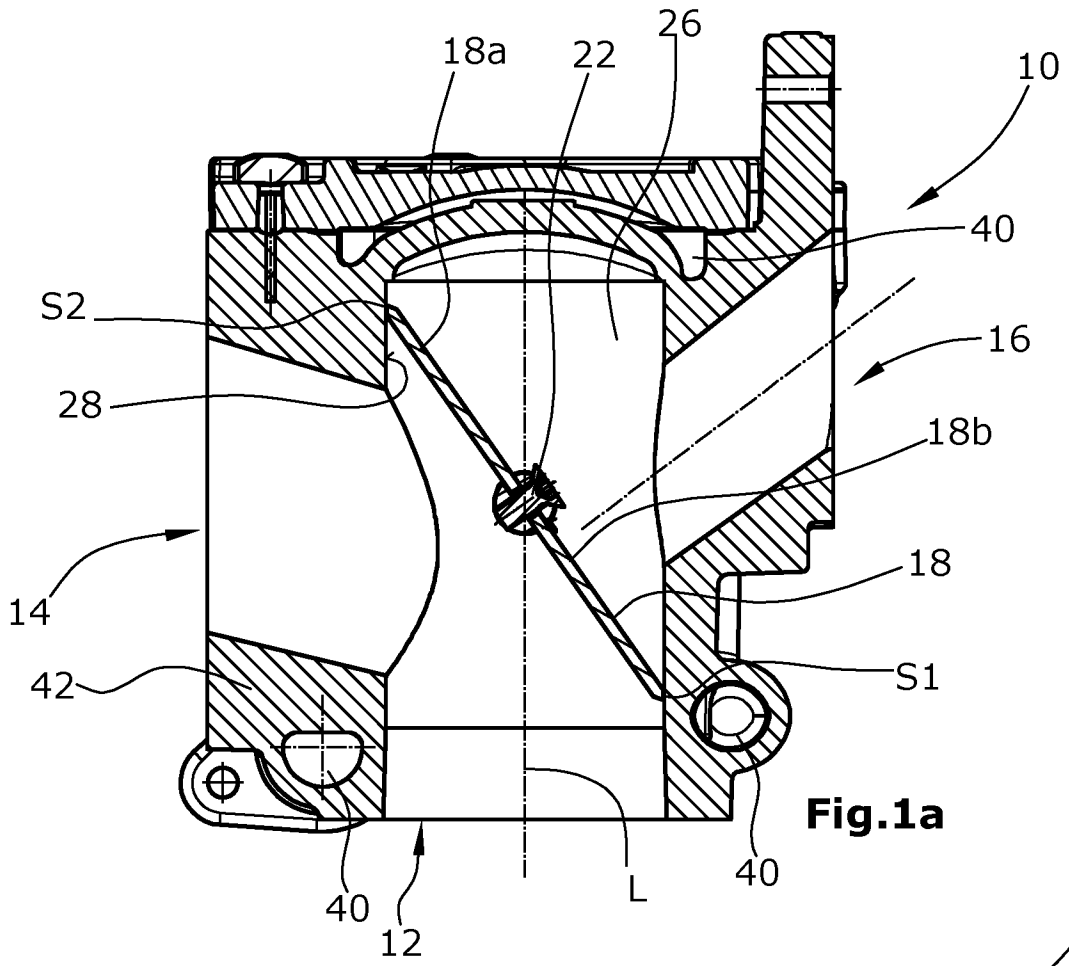


Fig.1a

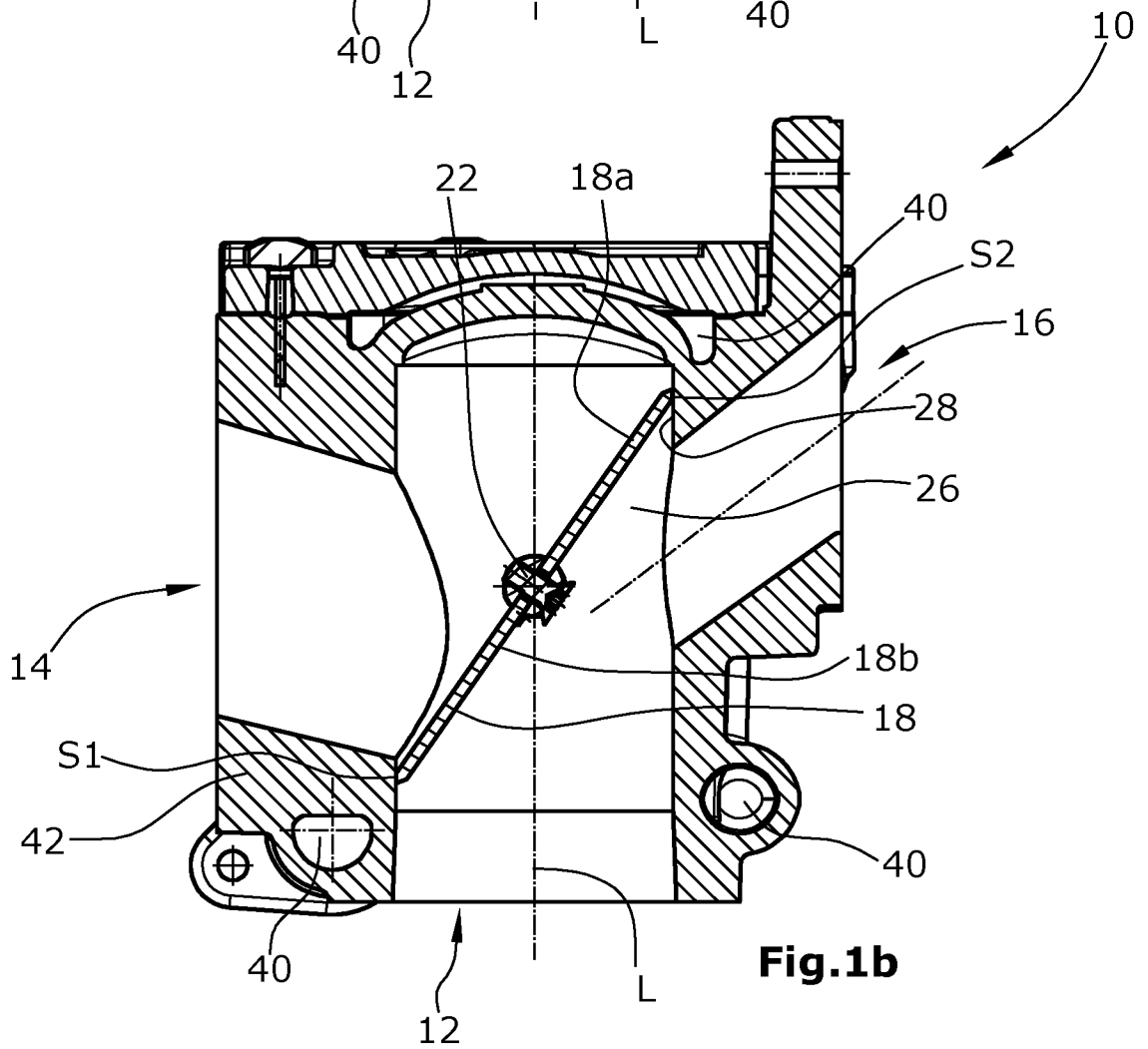


Fig.1b

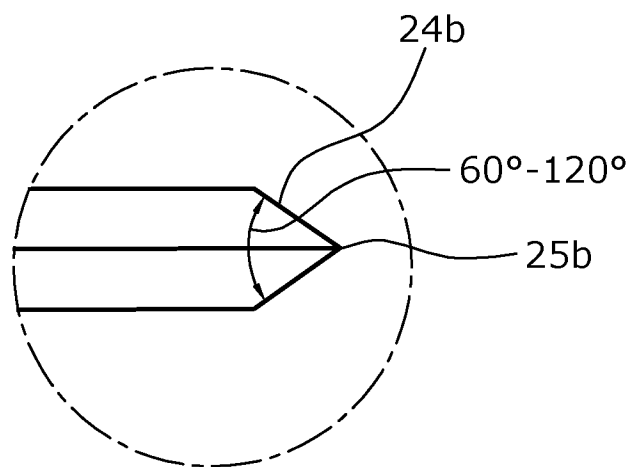
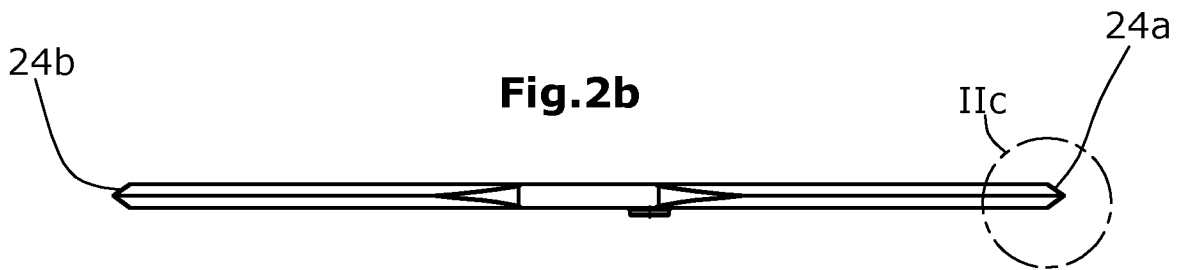
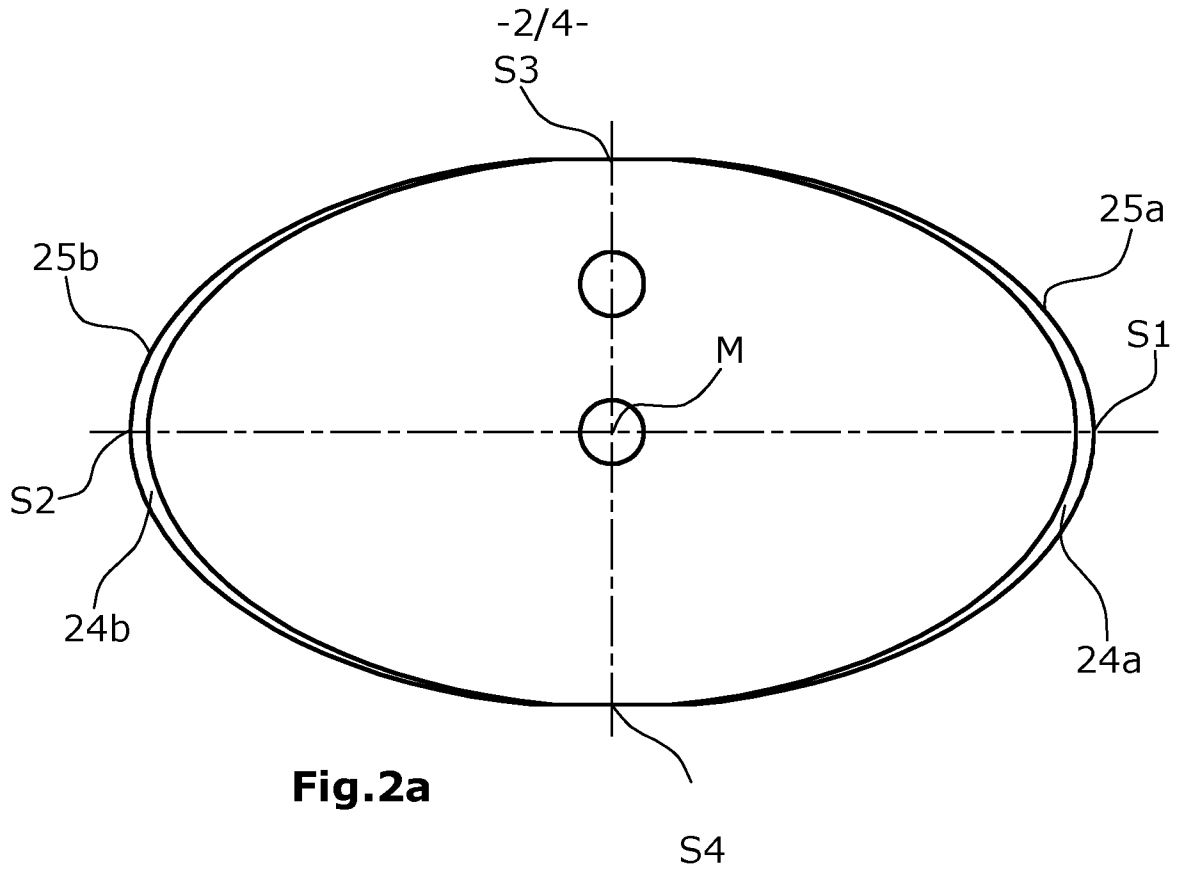


Fig. 2c

-3/4-

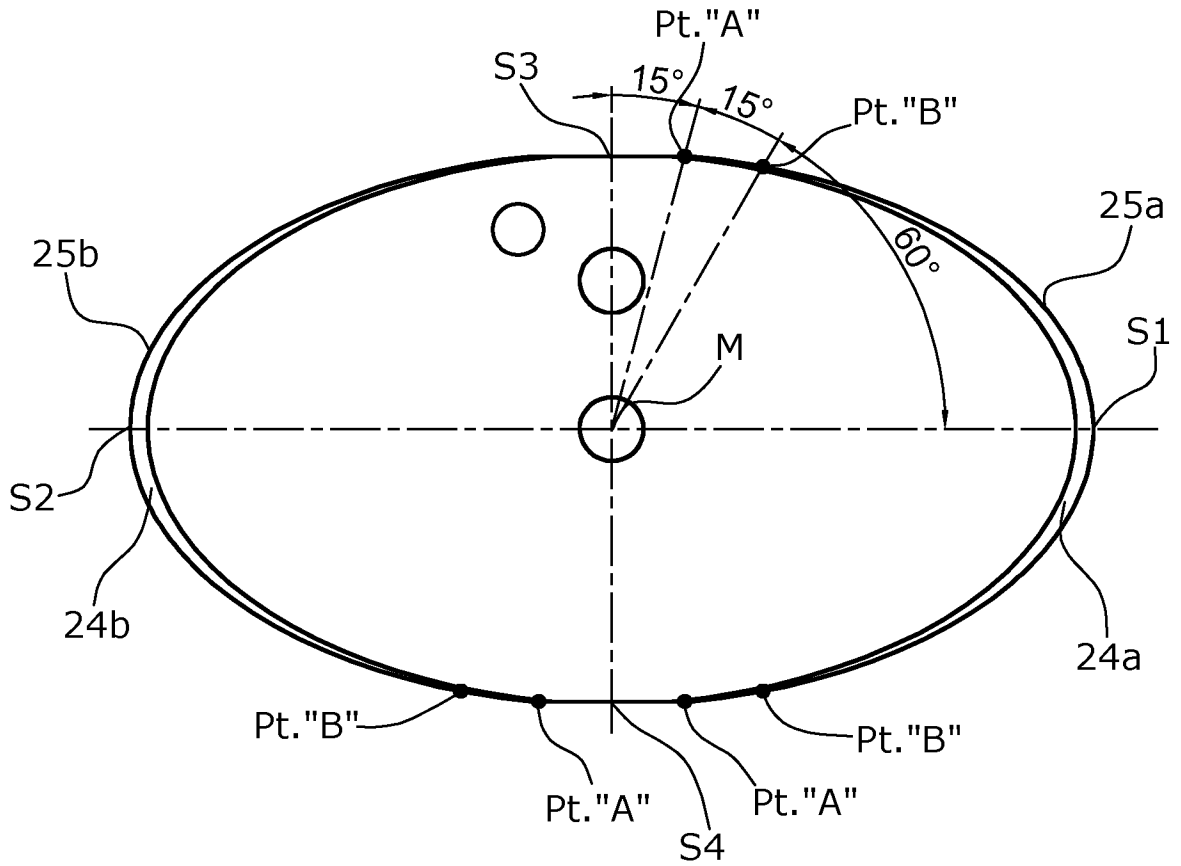


Fig.2d

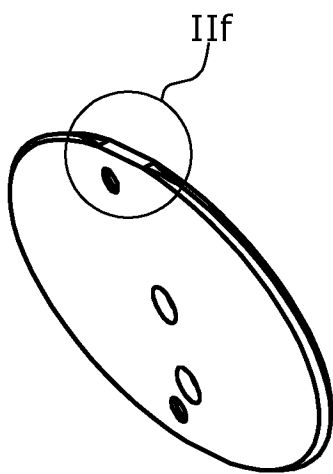


Fig.2e

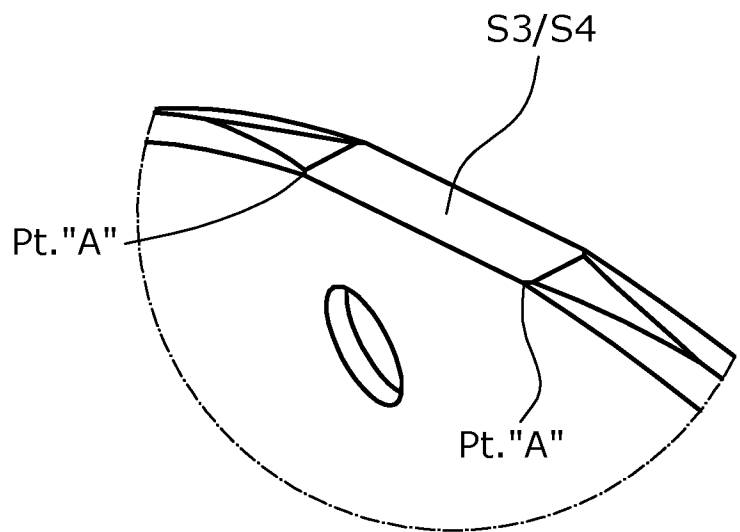


Fig.2f

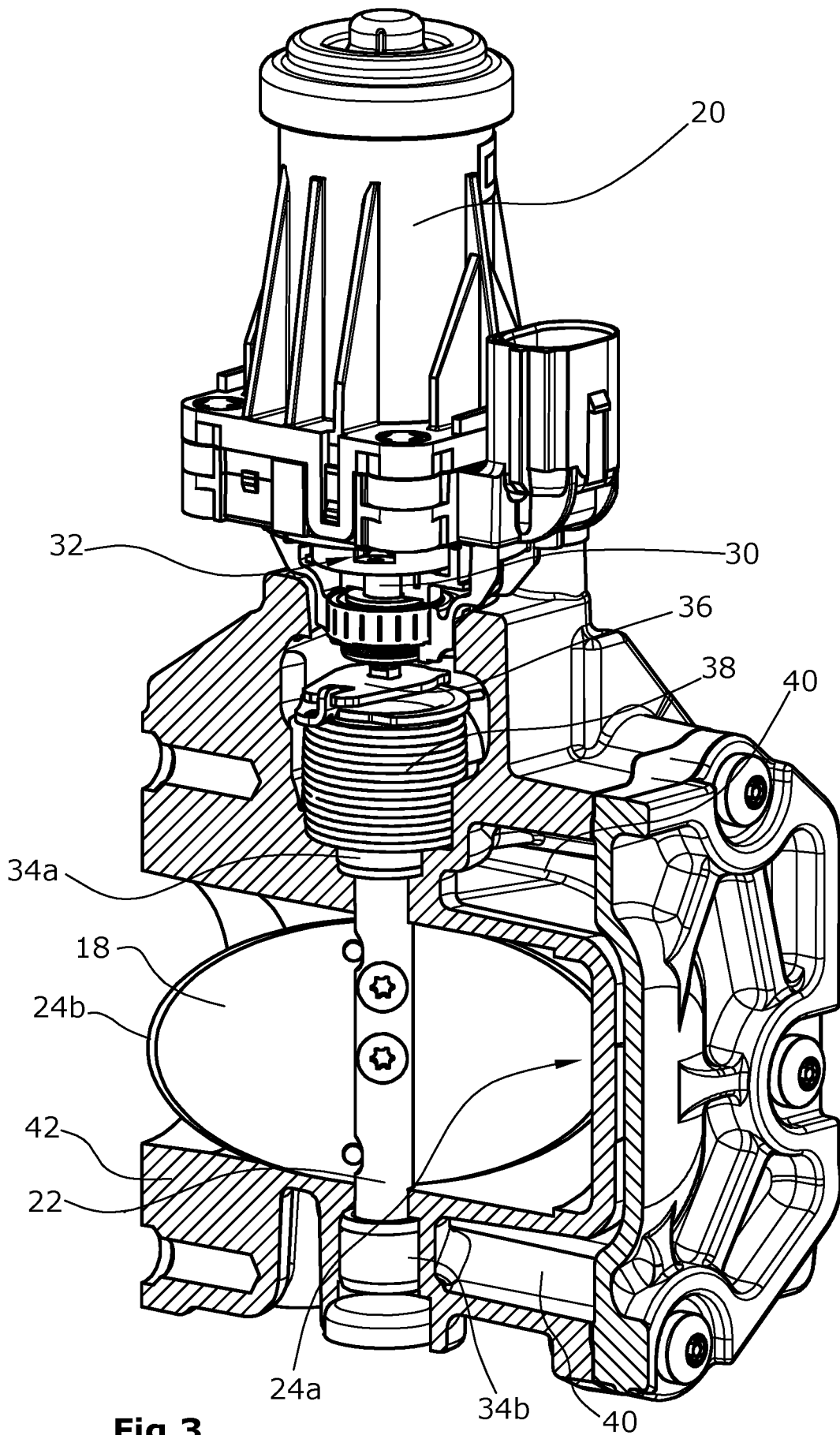


Fig.3

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/057478

A. CLASSIFICATION OF SUBJECT MATTER
INV. F02M26/26 F16K1/22 F16K11/052 F16K1/226
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)
F02M F02B F16K

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, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 2009/151681 A2 (BORGWARNER INC [US]; PETERSON TODD R [US]) 17 December 2009 (2009-12-17) abstract page 8, line 11 - page 11, line 6 figures 1-4	1-10
A	----- US 2 351 613 A (HOPKINS DAVID W) 20 June 1944 (1944-06-20) figures 3-5 column 2, line 33 - line 39	1-10
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Further documents are listed in the continuation of Box C.

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
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Date of the actual completion of the international search 21 December 2016	Date of mailing of the international search report 10/01/2017
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Authorized officer Payr, Matthias

INTERNATIONAL SEARCH REPORT

International application No
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C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No

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