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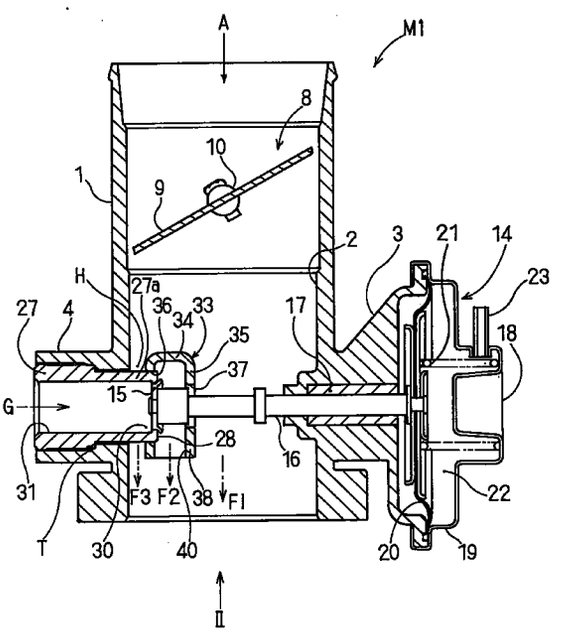
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(54) Exhaust gas recirculation

(57) An exhaust gas recirculator has a throttle valve (8) and an EGR valve (14) positioned on the downstream side of the throttle valve (8) disposed in an air intake passage (2) provided in a body (1) and connected t an internal combustion engine. A valve seat (28) having a recirculation opening (30) opened when a valve member (15) of the EGR valve (14) opens is disposed in an inner peripheral surface of the air intake passage (2). Exhaust gas flows through the recirculation opening (30) into the air intake passage (2) when the EGR valve is open. A recirculation opening sleeve (27) is fitted to a recirculation opening part of the body (1). The recirculation opening sleeve (27) is formed as a tube with the inner periphery of said front end portion (27a) forming the recirculation opening (30) and an end surface of said front end portion (27a) constituting the valve seat (28) of the EGR valve, and is fitted to the body so that said front end portion projects into the air intake passage. A hood (33) is disposed around the front end portion (27a) of the sleeve (27) so as to guide a flow of exhaust gas from the recirculation opening (30) in the downstream direction of the air intake passage (2) and provide an air passage between itself and the inner peripheral surface of the air intake passage (2). With this exhaust gas recirculator it is possible to reduce the adhesion of deposits to the throttle valve and effect cooling of a part around the recirculation opening.

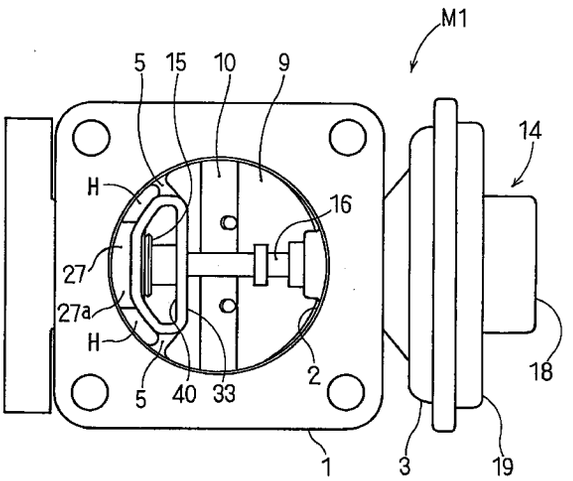
Fig.1



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(Cont. next page)

Fig.2



Description

This invention relates to an exhaust gas recirculator disposed in an air intake passage of an internal combustion engine such as a diesel engine. An exhaust gas recirculator comprises a throttle valve and an EGR (Exhaust Gas Recirculation) valve. An EGR valve is a valve for recirculating exhaust gas into an air intake passage.

Conventional exhaust gas recirculators include those wherein a throttle valve and an EGR valve are integrally assembled to a body (see for example Japanese Utility Model Laid-Open publication No. Sho 57-10455).

In this kind of exhaust gas recirculator, a recirculation opening connected to an exhaust gas recirculation passage opens into an intake passage downstream of (on the intake air downstream side of) a throttle valve. The valve member of the EGR valve is disposed so as to open and close the recirculation opening. That is, opening of the EGR valve causes the recirculation opening to open and disperse exhaust gas in the intake air. The amount of exhaust gas recirculated is adjusted by controlling the EGR valve.

However, in a conventional exhaust gas recirculator, sometimes, as a result of a decelerating operation of the engine, a negative pressure temporarily arises in the downstream side vicinity of the throttle valve. When this kind of negative pressure arises, exhaust gas is entrained into the throttle valve side. As a result, exhaust gas deposits adhere to the valve member and the valve shaft of the throttle valve. Also, this has caused the problem that these deposits gradually accumulate and cause deterioration of the operability of the throttle valve.

The exhaust gas recirculator of the present invention was devised to solve the above-mentioned problems. An object of the invention is to provide an exhaust gas recirculator wherein the adhesion of deposits to the throttle valve is reduced and it is possible to secure stable operability of the throttle valve. Another object of the invention is to provide an exhaust gas recirculator wherein cooling of parts around the recirculation opening is carried out and it is possible to secure stable operability of the EGR valve.

The invention provides an exhaust gas recirculator achieving the above-mentioned objects wherein a throttle valve and an EGR valve positioned on the downstream side of the throttle valve are disposed in an intake air passage provided in a body and connected to an internal combustion engine, a valve seat having a recirculation opening opened when a valve member of the EGR valve opens is disposed in an inner peripheral surface of the intake air passage and exhaust gas flows through the recirculation opening into the intake air passage when the EGR valve is open, characterized in that:

a tubular recirculation opening sleeve is fitted to the body so that a front end portion thereof projects into the intake air passage;

the recirculation opening sleeve is formed with the inner periphery of said front end portion thereof forming the recirculation opening and an end surface of said front end portion constituting the valve seat; and

a hood is disposed around said front end portion of the sleeve so as to guide a flow of exhaust gas from the recirculation opening in the downstream direction of the intake air passage and provide an air passage between the hood and the inner peripheral surface of the intake air passage.

In an exhaust gas recirculator according to the invention, the exhaust gas recirculation opening is provided with a hood and the flow of exhaust gas flowing into the intake air passage is guided by this hood in the downstream direction of the intake air passage. That is, as a result of the presence of the hood the effective distance between the recirculation opening for allowing exhaust gas to flow into the intake air passage and the throttle valve increases and furthermore it is possible to make the direction in which a negative pressure arising on the throttle valve side acts and the direction in which the exhaust gas is guided differ by 180 ° . Consequently, even when a negative pressure temporarily arises in the downstream vicinity of the throttle valve as a result of a decelerating operation of the engine, there is little entrainment of exhaust gas into the throttle valve side.

As a result, it is possible to suppress the adhesion of deposits to the valve member and the valve shaft of the throttle valve and thereby prevent the valve member of the throttle valve from sticking to the body, and stable operability of the throttle valve can be ensured.

Also, by providing an air passage between the hood and the body, it is possible to cool the front end portion of the recirculation opening sleeve with intake air. That is, it is possible to keep the temperature of the part of the body to which the recirculation opening sleeve is fitted lower than the creep temperature of the material constituting the body. Consequently, it is possible to prevent loosening of the recirculation opening sleeve with respect to the body caused by transmission of the high temperature of the exhaust gas to the body. As a result, it is possible to secure stable operability of the EGR valve.

The invention is described further hereinafter, by way of example only, with reference to the accompanying drawings, in which:-

Fig. 1 is a vertical sectional view of an exhaust gas recirculator of a first preferred embodiment of the invention;

Fig. 2 is a view in the direction II of Fig. 1;

Fig. 3 is a vertical sectional view of a first comparison example of an exhaust gas recirculator;

Fig. 4 is a vertical sectional view of a second comparison example of an exhaust gas recirculator;

Fig. 5 is a chart comparing temperatures of parts around recirculation openings;

Fig. 6 is a vertical sectional view of a second preferred embodiment;

Fig. 7 is a view in the direction VII of Fig. 6;

Fig. 8 is a vertical sectional view of an exhaust gas recirculator of a third preferred embodiment;

Fig. 9 is a view in the direction IX of Fig. 8 of the exhaust gas recirculator of the third preferred embodiment;

Fig. 10 is a sectional view on the line X-X of Fig. 9;

Fig. 11 is a vertical sectional view of a fourth preferred embodiment;

Fig. 12 is a view of an experimental apparatus for investigating differences in deposit adhesion states resulting from the difference between the presence and absence of a taper in a downstream end surface of a hood;

Fig. 13 is a view showing the state of a test example in the same experiment;

Fig. 14 is a view showing the state of a third comparison example in the same experiment; and

Fig. 15 is a graph showing results obtained when differences in deposit accumulation height resulting from differences in a tip angle of the lower end surface of a hood were investigated.

An exhaust gas recirculator M1 of a first preferred embodiment shown in Fig. 1 and Fig. 2 comprises a tubular body 1 made of a metal material such as aluminum alloy. The body 1 has an intake air passage 2 connected to an internal combustion engine. The intake air passage 2 passes all the way through the body 1 in the vertical direction of Fig. 1. A throttle valve 8 and an EGR valve 14 are mounted in the body 1. An actuator receiving part 3 and a recirculation opening sleeve receiving part 4 are formed in the body 1 in predetermined positions on the downstream side (the lower side in Fig. 1) of the throttle valve 8 in a flow of intake air A.

The throttle valve 8 has a valve member 9 and a valve shaft 10. The valve member 9 is a disc capable of opening and closing the intake air passage 2 and is held by the valve shaft 10. The valve shaft 10 is rotatably supported on the body 1 by way of bearings such as ball bearings (not shown in the drawings). An accelerator cable not shown in the drawings is connected to one end of the valve shaft 10 and a throttle valve opening angle sensor (not shown in the drawings) is mounted on the other end.

The EGR valve 14 comprises a valve shaft 16 holding a valve member 15 and an actuator 18 for moving the valve shaft 16. The valve member 15 is a disc capable of opening and closing a recirculation opening 30 connected to an exhaust gas recirculation passage. The valve shaft 16 projects into the intake air passage 2 orthogonally with respect to the axis of the intake air passage 2 and has the valve member 15 fixed to its end. The valve shaft 16 is supported by a bearing 17 consisting of a bearing metal or the like so that it can move smoothly in its axial direction.

The actuator 18 is comprises a case 19, a diaphragm 20 and a spring 21. The actuator receiving part 3 constitutes part of the case. The valve shaft 16 is connected to the diaphragm 20. The space enclosed by the case 19 and the diaphragm 20 constitutes a negative pressure chamber 22. The negative pressure chamber 22 is connected to a negative pressure source using a nipple 23.

A cylindrical recirculation opening sleeve 27 made of stainless steel or the like is fixed in the recirculation opening sleeve receiving part 4 by press-fitting. A front end portion 27a of the recirculation opening sleeve 27 projects into the intake air passage 2. The end surface of the front end portion 27a of the recirculation opening sleeve 27 constitutes a valve seat 28 with which the valve member 15 of the EGR valve 14 abuts. The inner periphery of the front end portion 27a of the recirculation opening sleeve 27 forms the recirculation opening 30, through which exhaust gas G flows into the intake air passage 2. The other end of the recirculation opening sleeve 27 constitutes a recirculation port 31 and is connected to an exhaust gas recirculation passage.

A hood 33 is disposed around the front end portion 27a. The hood 33 is disposed so as to cover the throttle valve 8 side of the recirculation opening 30. That is, the hood 33 is made up of a base part 34 and a peripheral wall part 35 extending on the downstream side of the base part 34 so as to block the intake air A on the upstream side and form an opening 40 on the downstream side.

The peripheral wall part 35 is shaped like a substantially elliptical tube and has a connecting hole 36 and a through hole 37. The front end portion 27a of the recirculation opening sleeve 27 is fitted in the connecting hole 36. The valve shaft 16 of the EGR valve 14 passes through the through hole 37. The connecting hole 36 and the through hole 37 are disposed in positions upstream of the downstream end 38 of the hood 33 with respect to the intake air A.

This hood 33 is supported by two stays 5, 5 and formed integrally with the body 1. The stays 5, 5 are of thin plate form extending from the inner circumferential surface of the intake air passage 2 in the body 1. The hood 33 is disposed in the intake air passage 2 and an air passage H enclosed by the stays 5, 5 is provided between the hood 33 and the inner circumferential surface of the body 1. The upstream and downstream ends of the air passage H are both continuous with the intake air passage 2, and the front end portion 27a of the recirculation opening sleeve 27 is exposed in and crosses the air passage H (see Fig. 2).

Next, the operation of the exhaust gas recirculator M1 of the first preferred embodiment will be described.

This exhaust gas recirculator M1 is installed in the air intake system of an internal combustion engine, an exhaust gas recirculation passage is connected to the recirculation port 31 and a negative pressure source (not shown in the drawings) is connected to the negative pressure chamber 22 of the EGR valve 14.

According to the running state of the internal combustion engine, as a result of the valve shaft 10 being rotated, the valve member 9 of the throttle valve 8 opens and closes the intake air passage 2. Also, a negative pressure acts in the negative pressure chamber 22 of the EGR valve 14 and the valve member 15 opens and closes the recirculation opening 30.

In this way, exhaust gas G from the exhaust gas recirculation passage is caused to flow through the recirculation opening 30 into the hood 33. The exhaust gas G has the direction of its flow changed by the hood 33 to the downstream direction of the intake air passage 2 and is delivered through the opening 40 into the intake air passage 2 (see the broken-line arrow F2 in Fig. 1). The exhaust gas G is mixed with the intake air A flowing downstream through the intake air passage 2 and the air passage H (see the dotted-line arrows F1 and F3 in Fig. 1) and sent to the cylinders of the internal combustion engine.

In the exhaust gas recirculator M1 of this first preferred embodiment, even when a temporary negative pressure arises in the downstream vicinity of the throttle valve 8 as a result of a decelerating operation of the internal combustion engine, there is little adhesion of deposits to the valve member 9 and the valve shaft 10 of the throttle valve 8. The reason for this is that in the exhaust gas recirculator M1 of the first preferred embodiment the distance between the opening 40 of the hood 33 and the throttle valve 8 is large and the direction in which the negative pressure on the throttle valve 8 side acts is 180 ° different from the direction in which the exhaust gas G is delivered and entrainment of the exhaust gas G caused by the negative pressure on the throttle valve 8 side is consequently reduced. As a result, it is possible to ensure stable operability of the throttle valve 8.

The high temperature of the exhaust gas G is transmitted from the recirculation opening sleeve 27 via the recirculation opening sleeve receiving part 4 to the body 1. Here, the outer circumferential surface of the front end portion 27a of the recirculation opening sleeve 27 is exposed to the intake air A in the air passage H (see the dotted-line arrow F3 in Fig. 1). The hood 33 is also exposed to the intake air A and the hood 33 acts as a cooling fin of the recirculation opening sleeve 27. As a result, heat is removed from the recirculation opening sleeve 27 by the intake air A flowing through the air passage H and the intake air passage 2 and the recirculation opening sleeve 27 is thereby cooled.

This cooling effect will now be explained by comparison with an exhaust gas recirculator MO1 (see Fig. 3) of a first comparison example and an exhaust gas recirculator MO2 of a second comparison example (see Fig. 4). The exhaust gas recirculator MO1 is one having a hood 53 which simply deflects the flow of the exhaust gas G. The exhaust gas recirculator MO2 is one wherein the recirculation opening 30 is in substantially the same surface as the inner circumferential surface of the intake air passage 2. In Fig. 3 and Fig. 4, constituent elements the same as or equivalent to constituent elements of the exhaust gas recirculator M1 have been given the same reference numerals.

Fig. 5 is a chart showing for comparison the temperature at a temperature measurement point T in the recirculation opening sleeve receiving part 4 of each of the exhaust gas recirculators M1, MO1 and MO2 when the temperature of the recirculated exhaust gas G is for example 500°C in the recirculation port 31. As can be seen from this chart, the temperature of the temperature measurement point T was 190 °C in the exhaust gas recirculator M1 of the first preferred embodiment, reached 250°C in the exhaust gas recirculator MO1 and was 140°C in the exhaust gas recirculator MO2.

As is clear from the results of this comparison, the exhaust gas recirculator M1 and the exhaust gas recirculator MO1 are the same in that introduced exhaust gas G is deflected to the downstream direction before being delivered, but there is a large difference in the effect of cooling the parts around the recirculation opening 30.

The metal material used for the body 1 has a creep temperature of 250°C. Therefore, in the exhaust gas recirculator MO1 the recirculation opening sleeve receiving part 4 reaches the creep temperature and the fixing strength of the press-fitting decreases. As a result, in the exhaust gas recirculator MO1, there is a possibility of the attachment of the recirculation opening sleeve 27 loosening. Of the comparison examples, the one wherein the T point temperature was the highest was the exhaust gas recirculator MO2, which has no hood on the recirculation opening 30. However, in the exhaust gas recirculator MO2, the adhesion of deposits to the valve member 9 and the valve shaft 10 of the throttle valve 8 is not suppressed. In the exhaust gas recirculator M1 of the first preferred embodiment, the adhesion of deposits to the valve member 9 and the valve shaft 10 of the throttle valve 8 is suppressed and also by an effect of cooling the recirculation opening sleeve 27 the temperature measurement point T temperature is reduced to below the creep temperature and the EGR valve 14 can be operated stably.

Fig. 6 and Fig. 7 show an exhaust gas recirculator M2 of a second preferred embodiment of the invention wherein the valve shaft 10 and the valve shaft 16 are disposed in parallel. The invention may alternatively be constructed in this way. The valve shaft 10 is supported by a ball bearings 12, and a throttle valve sensor 11 is mounted at one end of the valve shaft 10.

In an exhaust gas recirculator M3 of a third preferred embodiment shown in Fig. 8, Fig. 9 and Fig. 10, it is possible to suppress the adhesion of deposits to the hood 33. For example, if a deposit adheres to and accumulates on the downstream end surface 39 of the hood 33, it presents a resistance to the flow of the exhaust gas G when the EGR valve 14 is open. This causes the EGR ratio to fluctuate greatly and is therefore not desirable.

The EGR ratio is given by the expression EGR ratio = exhaust gas recirculation flowrate / (intake air flowrate + exhaust gas recirculation flowrate) .

The peripheral wall part 35 of the hood 33 may be formed in a shape such that a part 35a thereof on the side nearer the center of the intake air passage opens out with progress downstream in the intake air A (see fourth embodiment M4 of Fig. 11). If this kind of construction is adopted, it is possible to make the exhaust gas G flowing in through the recirculation opening 30 tend to flow toward the center of the intake air passage 2. As a result, it is possible to contribute to preventing the adhesion of deposits to the inner circumferential surface of the intake air passage 2 on the downstream side of the EGR valve 14.

In the exhaust gas recirculator M3 of the third preferred embodiment, the end surface 39 of the downstream end 38 of the peripheral wall part 35 of the hood 33 is formed tapered so that its cross-section narrows to a point in the downstream direction of the intake air A. In the case of this preferred embodiment, the angle θ of the tip of the tapered end surface 39 is 90 ° .

Also, the downstream end portions 6 of the two stays 5 supporting the hood 33 are disposed upstream of the downstream end 38 of the hood 33 so as to form a step, as shown in Fig. 10.

In this exhaust gas recirculator M3, when the EGR valve 14 opens and a mixture of exhaust gas G and intake air A is supplied into the internal combustion engine, there are the following effects. That is, the downstream end surface 39 of the hood 33 is tapered so that its cross-section narrows to a point pointing downstream. Consequently, as the intake air A and the exhaust gas G flow downstream, turbulence does not readily occur at the downstream end surface 39 of the hood 33. As a result, the intake air A and the exhaust gas G flow smoothly downstream and deposits such as carbon are prevented from adhering to the downstream end surface 39 of the hood 33.

In particular, the hood 33 itself is connected to the recirculation opening sleeve 27 projecting from the inner circumferential surface of the intake air passage 2, the stays 5 and the valve shaft 16 at positions upstream of its downstream end 38. Consequently, the downstream end 38 of the hood 33 is disposed in a floating state in the radial direction of the intake air passage 2 inside the intake air passage 2 and does not directly make contact with the inner circumferential surface of the intake air passage 2. As a result, even if deposits adhere to and accumulate on the inner circumferential surface of the intake air passage 2, the surface of the downstream side of the front end portion 27a or the surface of the downstream side of the valve shaft 16, this does not affect the downstream end surface 39 of the hood 33. Therefore, it is possible to prevent the adhesion of deposits over the whole of the downstream end surface 39 of the hood 33.

When a blow-by gas from the crank case of the engine flows into the intake air passage 2, an oil mist is included in the intake air A. If this oil mist adheres to the downstream end surface 39 of the hood 33, deposits from the exhaust gas G such as carbon readily adhere to the downstream end surface 39 of the hood 33. However, in the third preferred embodiment, the downstream end portions 6 of the stays 5, the sleeve front end portion 27a and the valve shaft 16 of the EGR valve are disposed upstream of the downstream end 38 of the hood 33. That is, the oil mist in the blow-by gas can be caused to adhere to the downstream end portions 6 of the stays 5, the surface of the downstream side of the recirculation opening sleeve front end portion 27a and the valve shaft 16 of the EGR valve before it is allowed to adhere to the downstream end surface 39 of the hood 33. Consequently, it is possible to prevent the adhesion of deposits to the downstream end surface 39 of the hood 33 caused by the oil mist.

Therefore, in the exhaust gas recirculator M3, it is possible to prevent the adhesion of deposits to the downstream end surface 39 of the hood 33 which would obstruct the flow of the exhaust gas G. As a result, with the exhaust gas recirculator M3 it is possible to keep fluctuations in the EGR ratio small and the exhaust gas performance of the engine does not deteriorate even with use over a long period.

If the angle θ of the tip of the downstream end surface 39 of the hood 33 is 60 ° or less, the flow of the intake air A and the exhaust gas G flowing in the vicinity of the downstream end surface 39 of the hood 33 becomes smoother. Therefore, it is possible to further suppress the adhesion of deposits.

The above-mentioned effect was tested by experiment, with the results shown in Fig. 13 and Fig. 14. That is, in a test example shown in Fig. 13 the downstream end surface 39 of the hood 33 was made a tapered surface with a tip angle θ of 60° and in a third comparison example shown in Fig. 14 it was made a flat surface and an experiment was conducted with an experiment apparatus shown in Fig. 12. In the experiment apparatus, a PCV (Positive Crankcase Ventilation) hose was connected to the intake air passage so that oil mist would be mixed into the intake air A and the amount of adhesion of deposits would increase, i.e. so that blow-by gas would be mixed with the intake air A. In the test example and the third comparison example, reference number 25 refers to a cover for preventing the leakage of exhaust gas G through the through hole 37, which is of larger diameter than the valve shaft 16, in the hood 33.

The result was that in the test example shown in Fig. 13 it was possible to suppress the adhesion of deposits more than in the case of the third comparison example shown in Fig. 14.

Also, results obtained when the accumulation height of deposit D when the tip angle θ of the hood downstream end surface 39 was variously changed was investigated are shown in Fig. 15. The test apparatus shown in Fig. 12 was used.

As is clear from this graph, if the tip angle θ is made 60° or less, it is possible to greatly suppress the adhesion of the deposit D. As a lower limit of the tip angle θ , at least 40° is preferable. This is because when the tip angle θ is too small, the length of the hood 33 markedly increases and this results in the exhaust gas recirculator M3 or M4 becoming large and reducing the strength of the downstream end of the hood.

In the first to fourth preferred embodiments, a construction wherein the hood 33 is supported by the stays 5 extend-

ing from the inner circumferential surface of the intake air passage 2 was adopted. However, as a modified example, a construction may be adopted wherein the stays 5, 5 are dispensed with and the hood 33 is held by the recirculation opening sleeve 27 joined to the body 1.

Also, in the preferred embodiments described above, the valve shaft 16 of the EGR valve 14 was disposed so that it passed through the hood 33. However, as a modified example, the heat-resistance and the insulation of the EGR valve 14 can be increased and the valve shaft 16 disposed passing through the inside of the recirculation opening sleeve 27 and the EGR valve 14 mounted on the the body 1 on the recirculation opening sleeve 27 side thereof.

Claims

1. An exhaust gas recirculator wherein a throttle valve (8) and an EGR valve (14), positioned on the downstream side of the throttle valve (8), are disposed in an air intake passage (2) provided in a body (1) and connected, in use, to an internal combustion engine, a valve seat (28) having a recirculation opening (30) opened when a valve member (15) of the EGR valve (14) opens is disposed in an inner peripheral surface of the air intake passage (2) and exhaust gas flows through the recirculation opening (30) into the air intake passage (2) when the EGR valve (14) is open;
characterised in that:
a tubular recirculation opening sleeve (27) is fitted to the body (1) so that a front end portion (27a) thereof projects into the intake air passage (2);
the recirculation opening sleeve (27) is formed with the inner periphery of said front end portion (27a) thereof forming the recirculation opening (30) and an end surface of said front end portion (27a) constituting the valve seat (28); and
a hood (33) is disposed around said front end portion (27a) of the sleeve (27) so as to guide a flow of exhaust gas from the recirculation opening (30) in the downstream direction of the intake air passage (2) and provide an air passage between the hood (33) and the inner peripheral surface of the air intake passage (2).

2. An exhaust gas recirculator according to claim 1 wherein:
the hood (33) is shaped like a bottomed tube closed at its upstream end and open at its downstream end and is connected to the front end portion (27a) of the recirculation opening sleeve (27) at a position upstream of the downstream end, and
the downstream end surface (39) of the hood is tapered so that its cross-section narrows in the downstream direction.

3. An exhaust gas recirculator according to claim 2 wherein:
the angle of a tip in the downstream end surface (39) of the hood (33) is 40° to 60°.

4. An exhaust gas recirculator according to claim 1 or claim 2 wherein:
the hood (33) is supported by a stay (5) extending from the inner circumferential surface of the air intake passage and a downstream end of the stay is disposed upstream of the downstream end of the hood.

5. An exhaust gas recirculator according to claim 1 or claim 2 wherein:
a peripheral wall portion of the hood on a side thereof nearer the center of the air intake passage is formed in a shape such that it opens out with progress downstream.

Fig.1

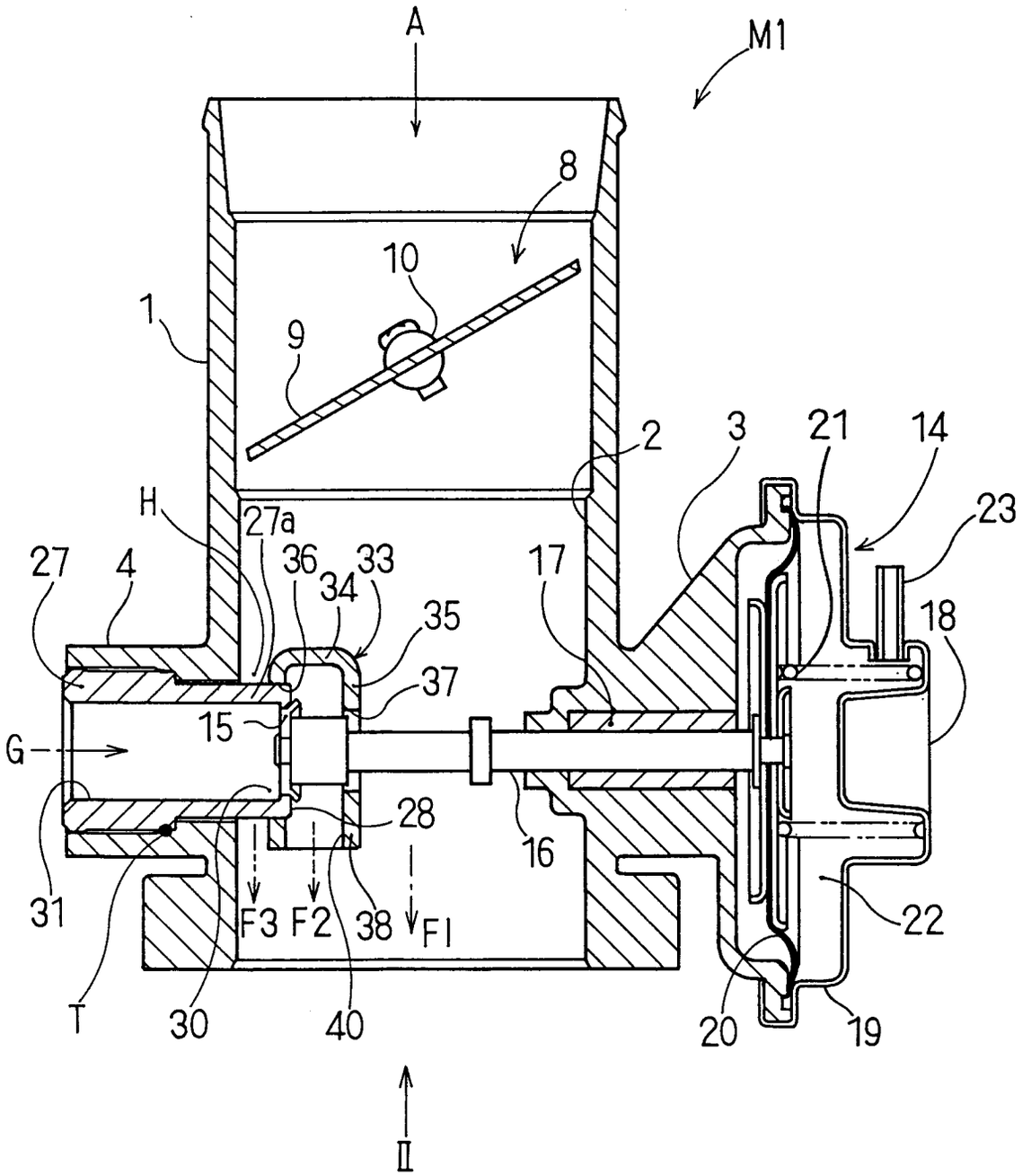

A
M1
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27a
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F3
F2
38
F1
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T
30
40
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19
II

Fig. 2

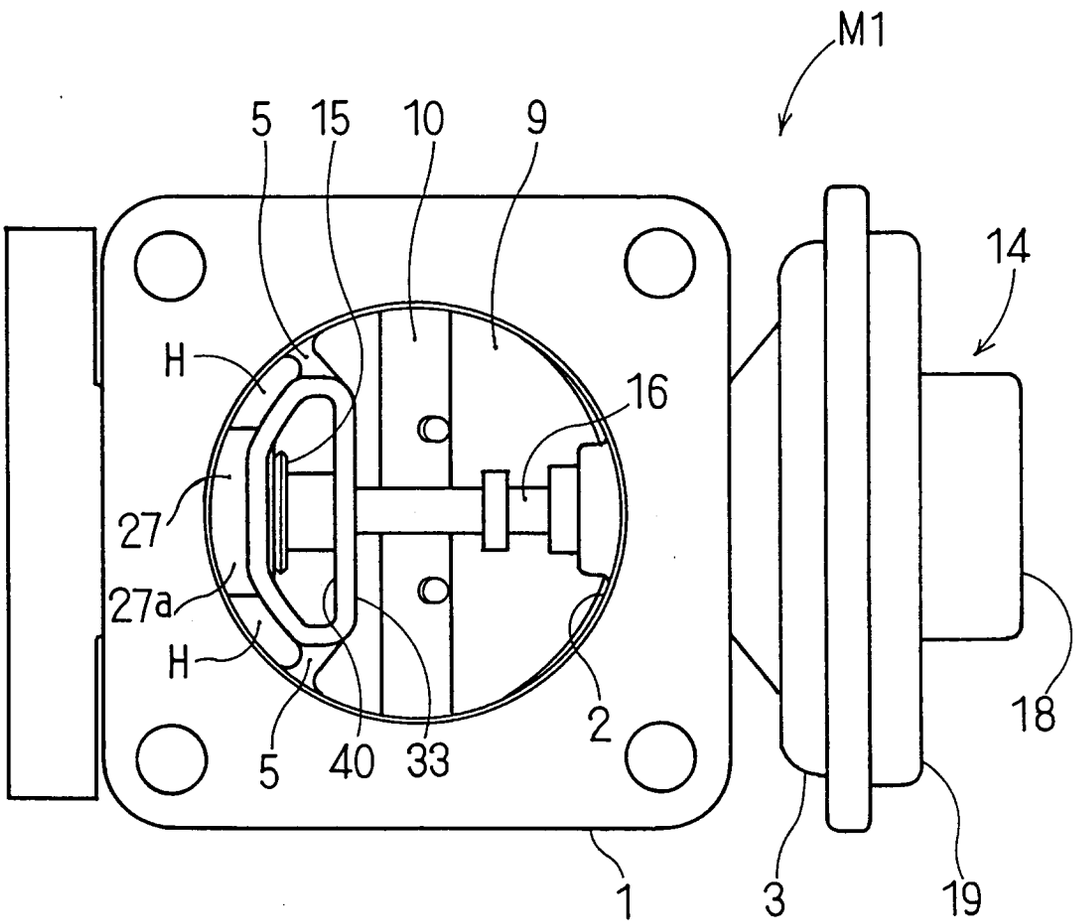


Fig.3

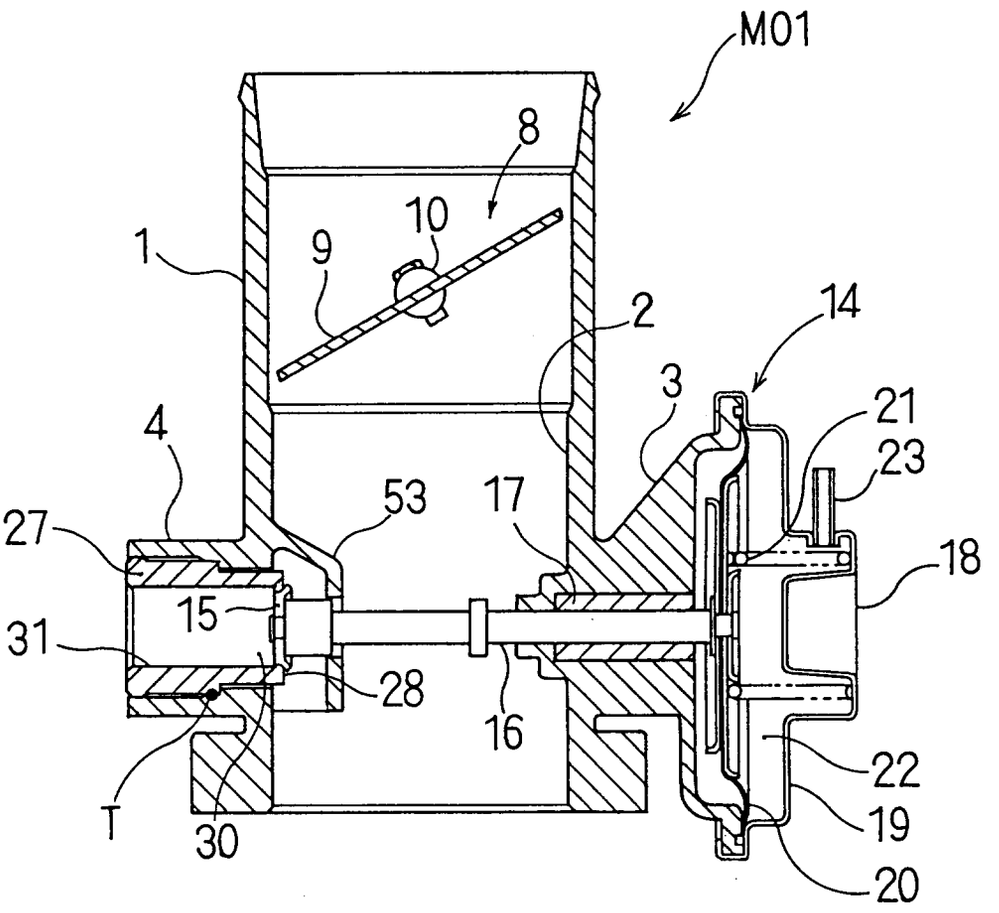


Fig.4

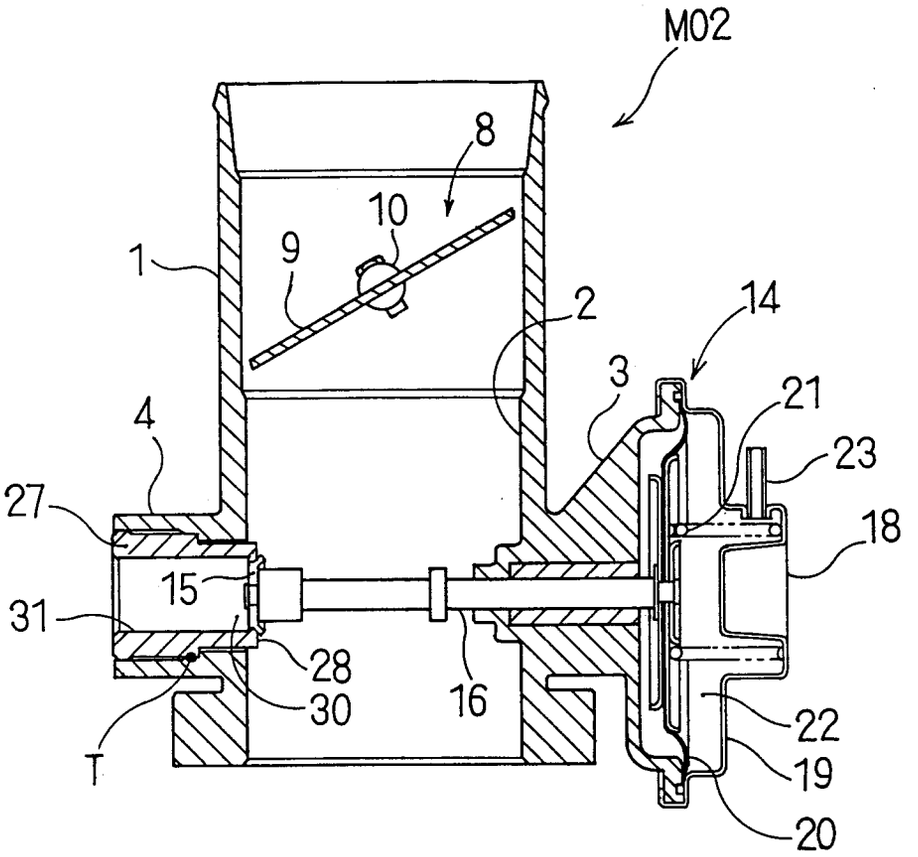

M02
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Fig.5

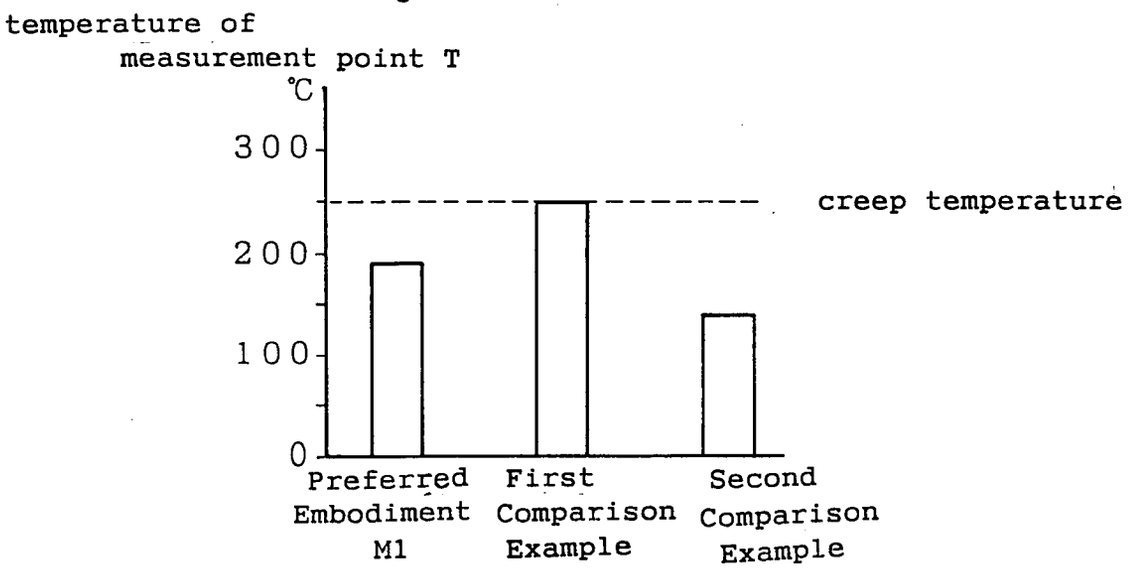

temperature of
measurement point T
℃
300
200
100
0
creep temperature
Preferred Embodiment M1
First Comparison Example
Second Comparison Example

Fig.6

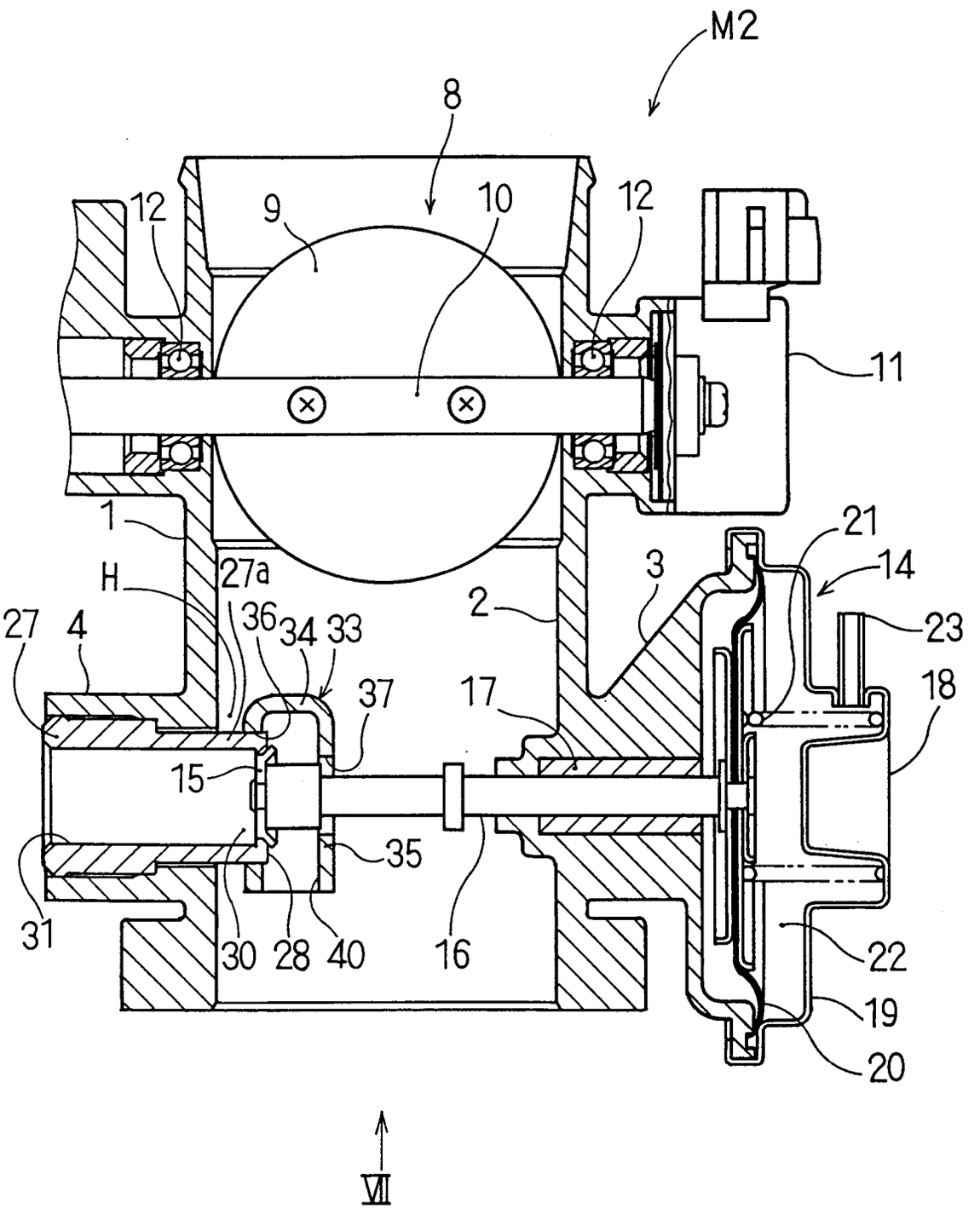

M2
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VII

Fig.7

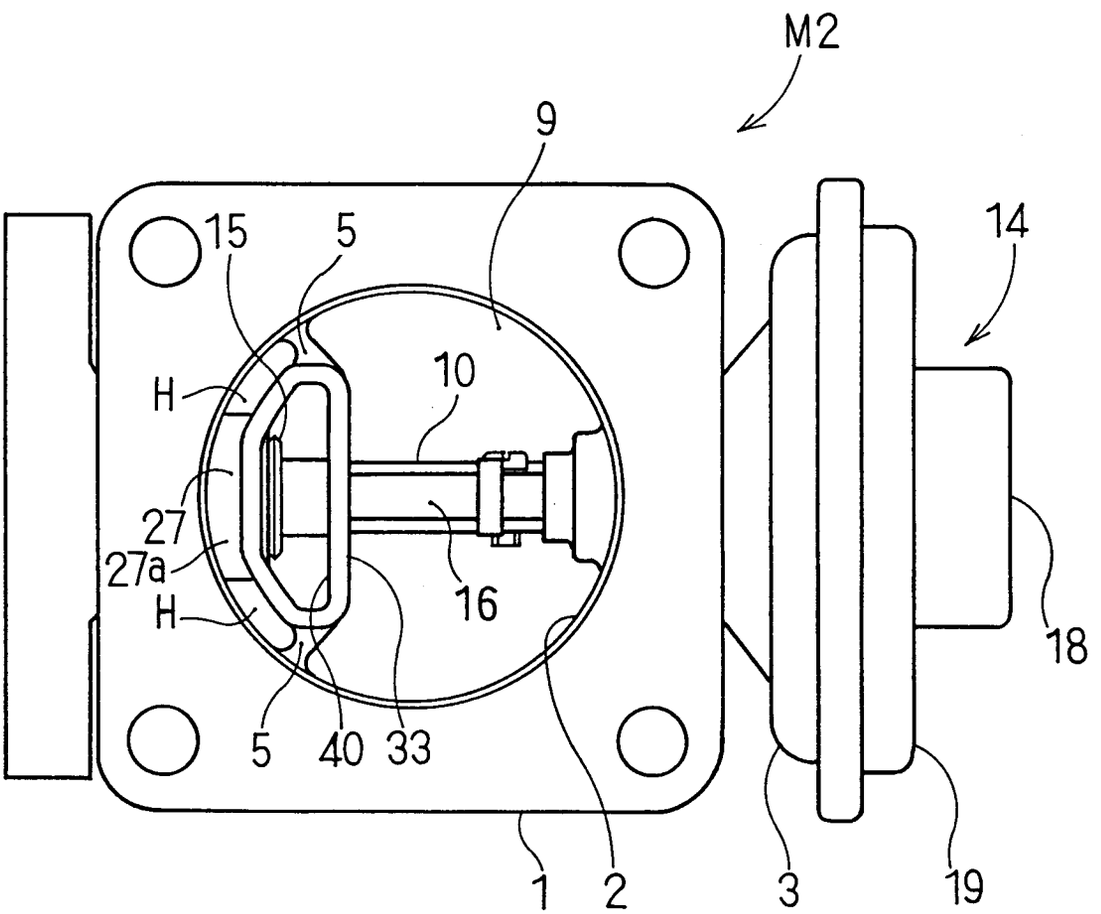


Fig.8

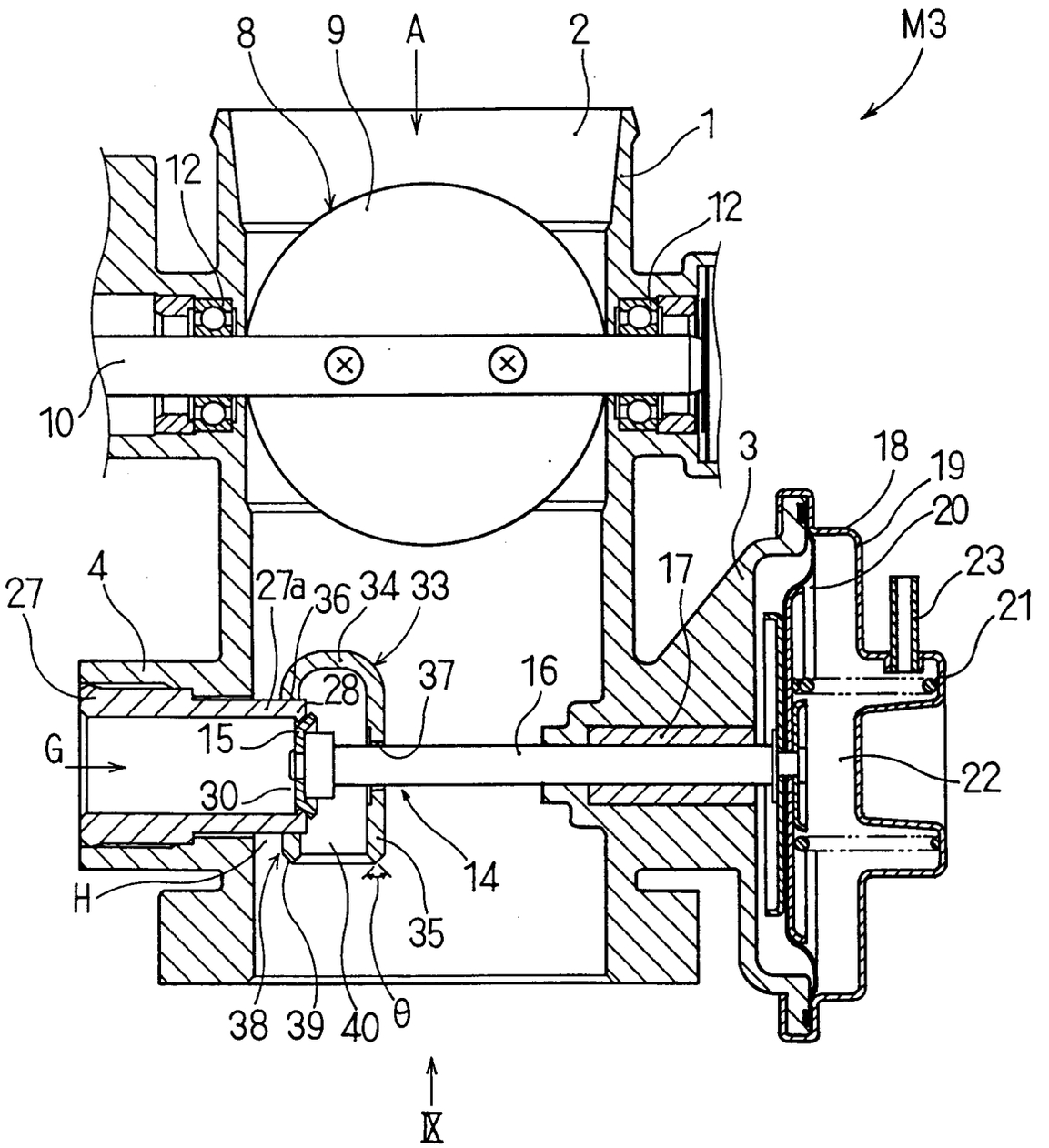

8
9
A
2
M3
1
12
12
10
3
18
19
20
23
21
17
4
27
27a
36
34
33
28
37
16
15
G
30
22
14
H
35
38
39
40
θ
IX

Fig.9

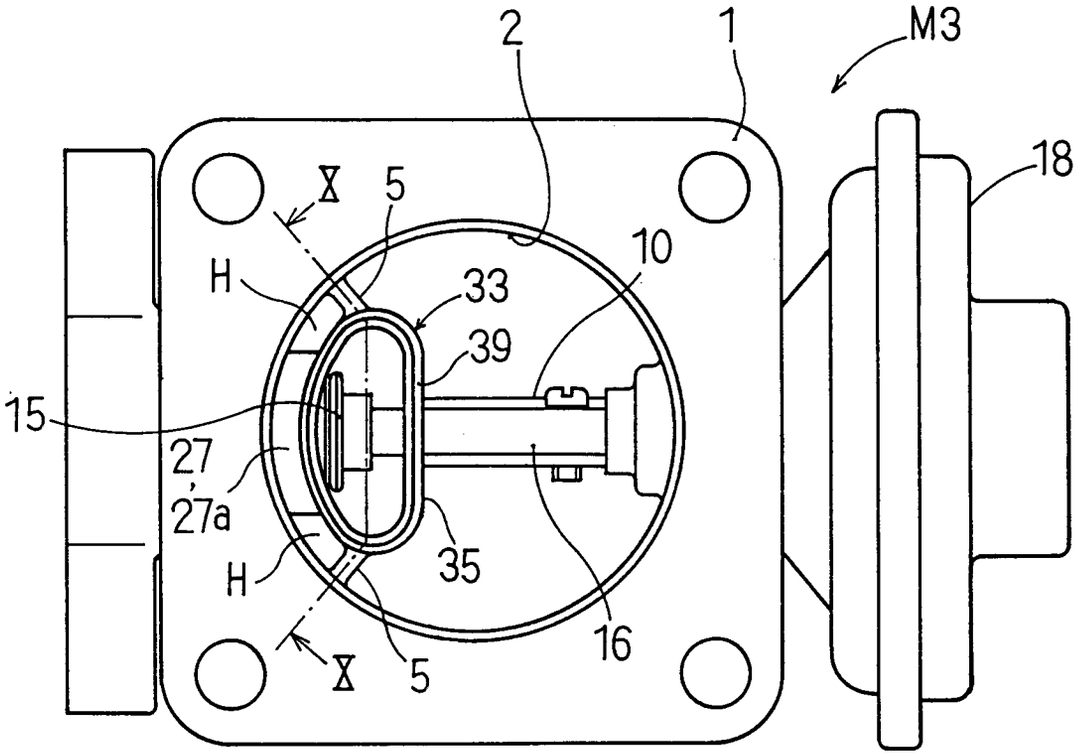


Fig.10

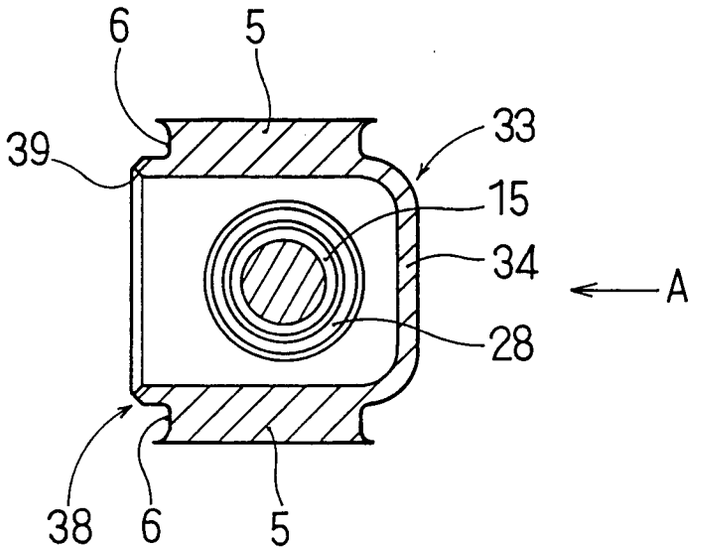


Fig.11

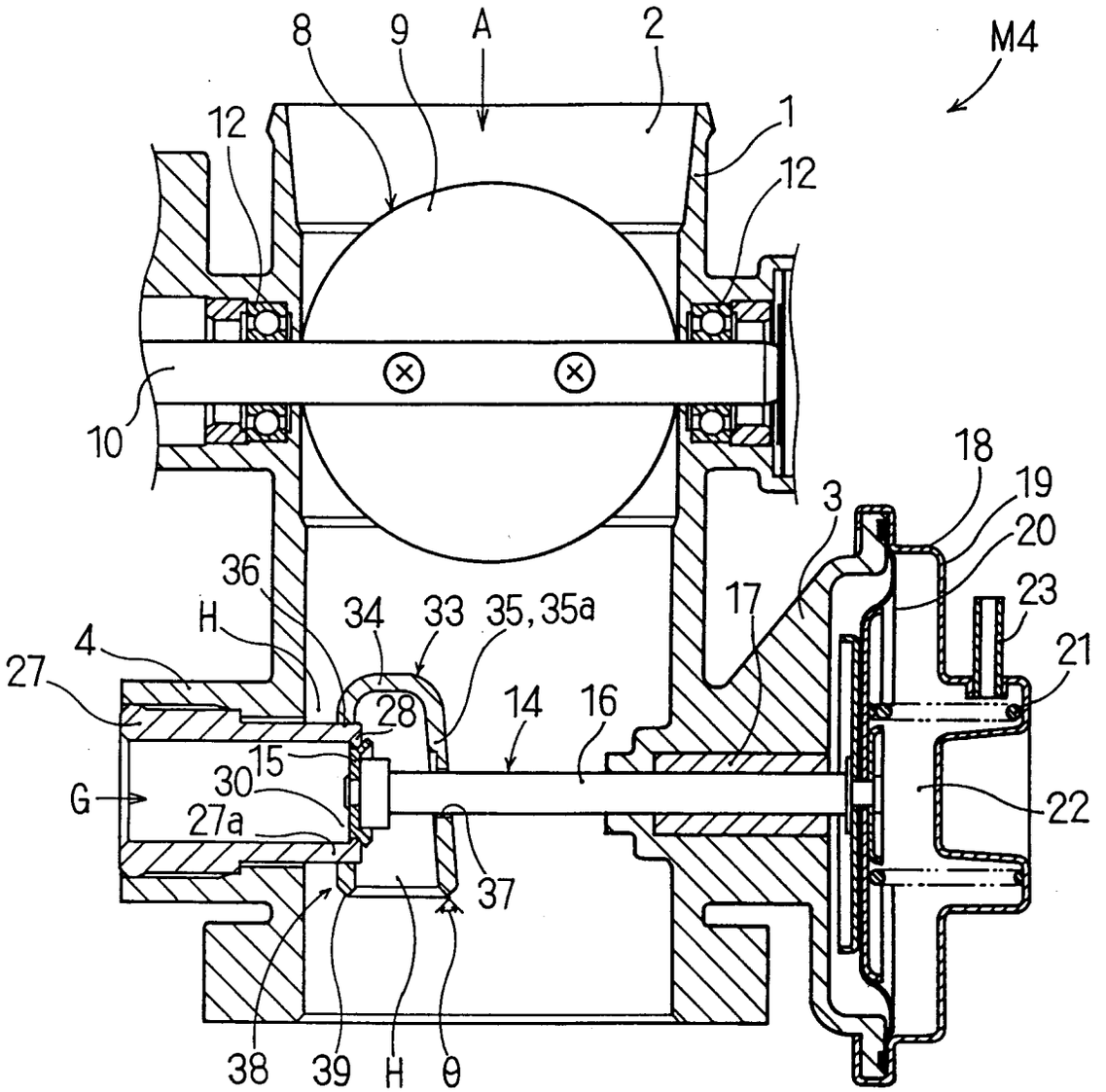

8
9
A
2
M4
12
1
12
10
18
19
3
20
36
H
34
33
35,35a
17
23
4
21
27
28
14
16
15
30
G
27a
22
37
38
39
H
θ

Fig.12

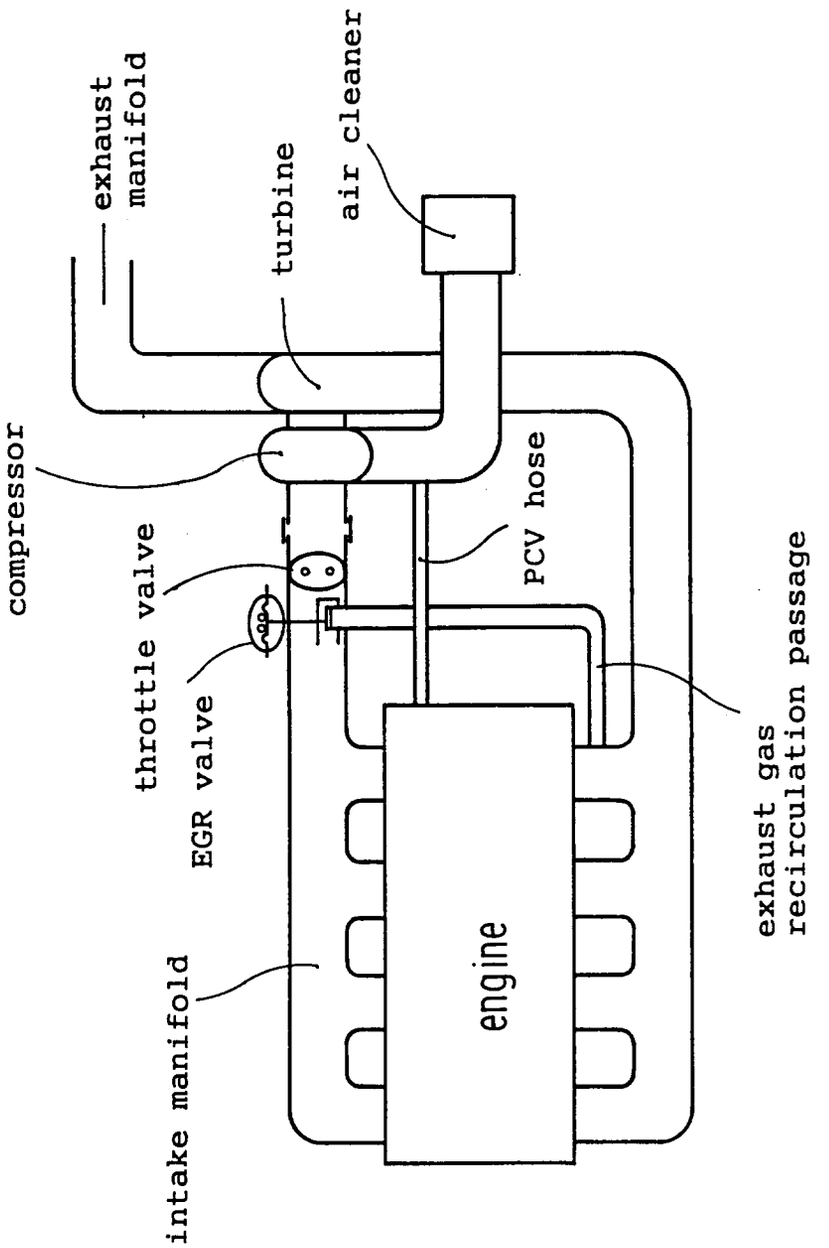

exhaust manifold
turbine
air cleaner
compressor
throttle valve
EGR valve
PCV hose
intake manifold
engine
exhaust gas recirculation passage

Fig. 13

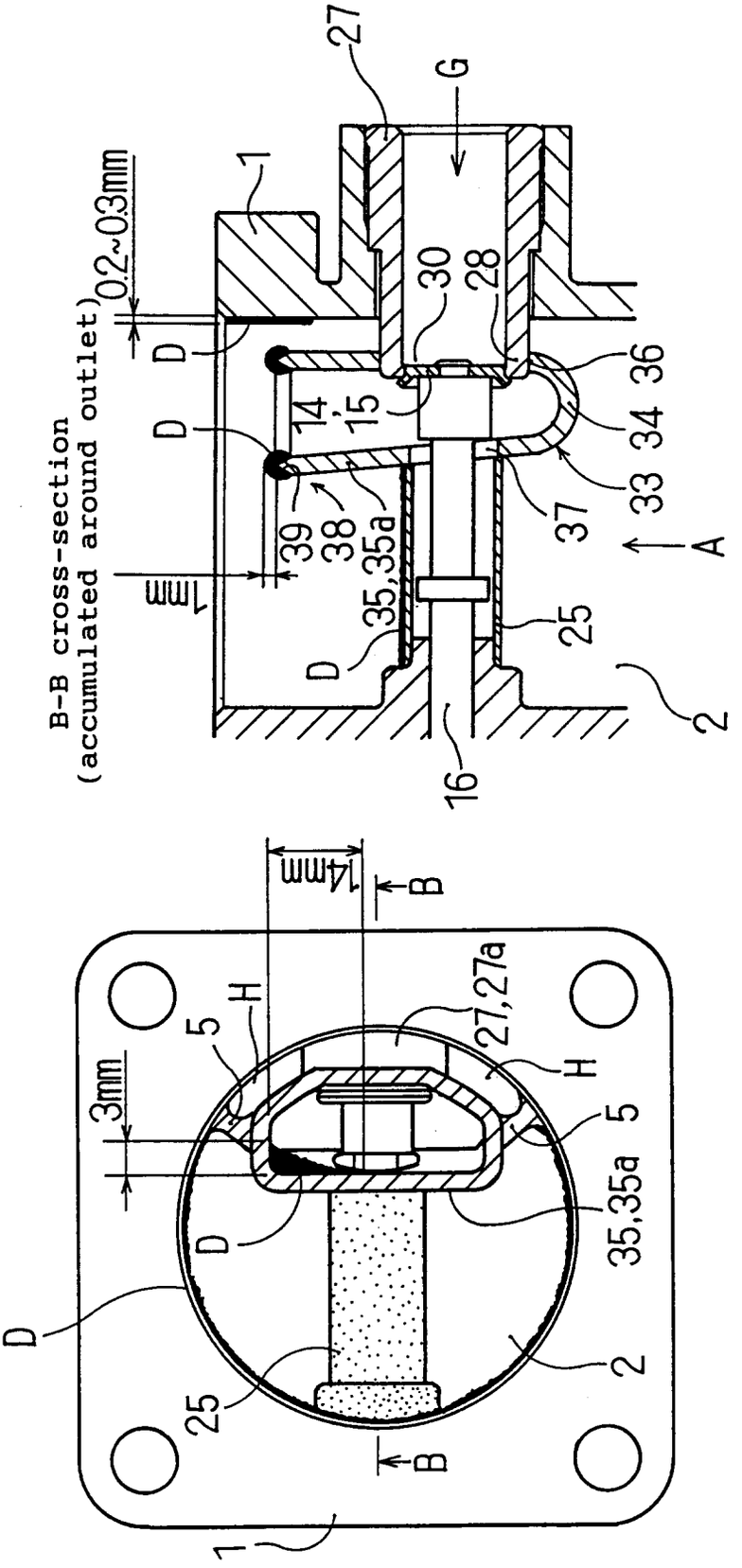

Test Example (hood downstream end surface tip angle θ60°)
Conditions: idling, EGR ratio 45%, smoke density 15%, 30hrs
B-B cross-section
(accumulated around outlet)
0.2~0.3mm
1.4mm
3mm
G
A
B
H
D
1
2
5
14
15
16
25
27
27a
28
30
33
34
35,35a
36
37
38
39

Fig. 14

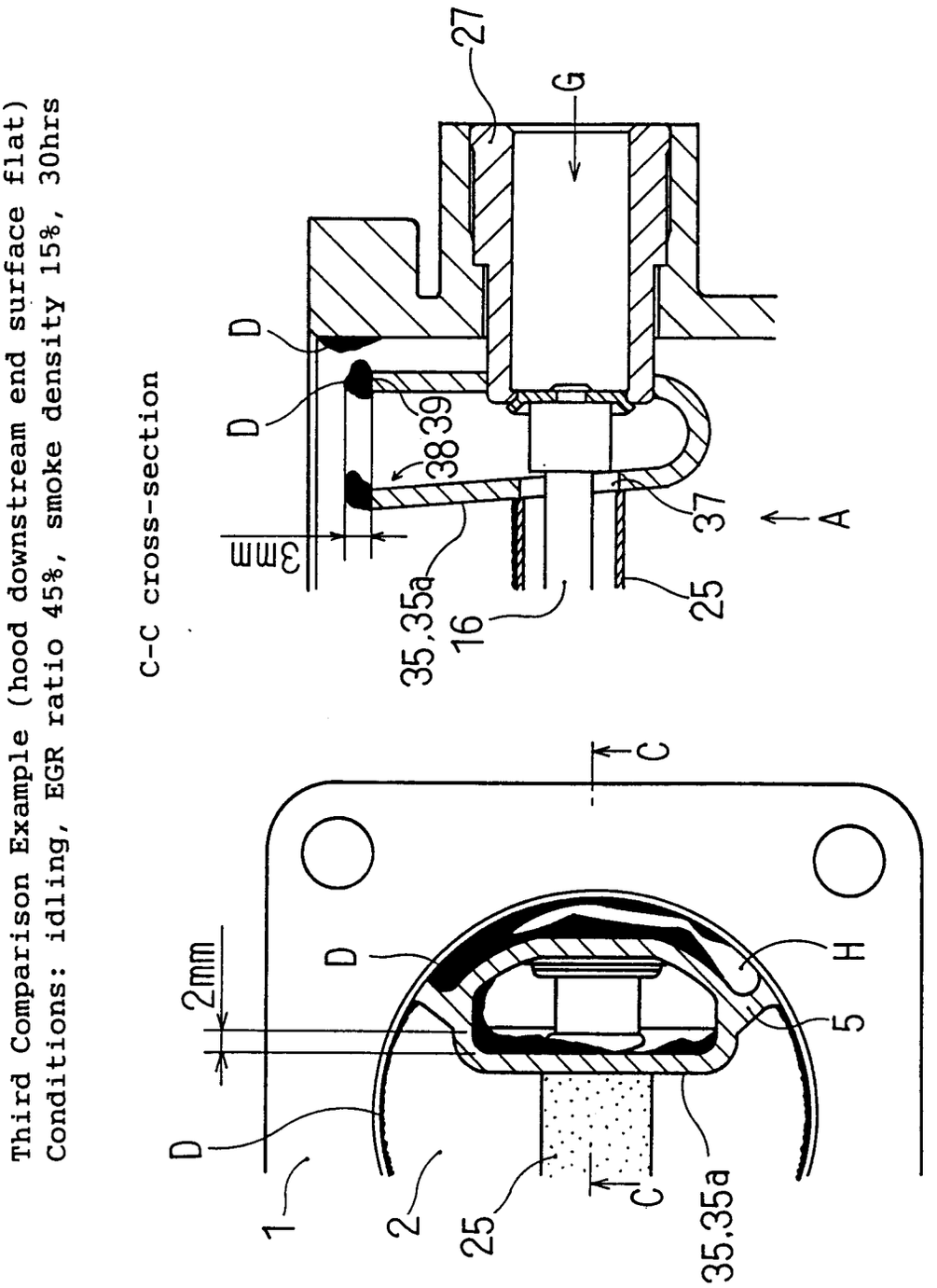
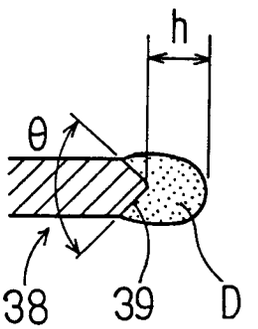
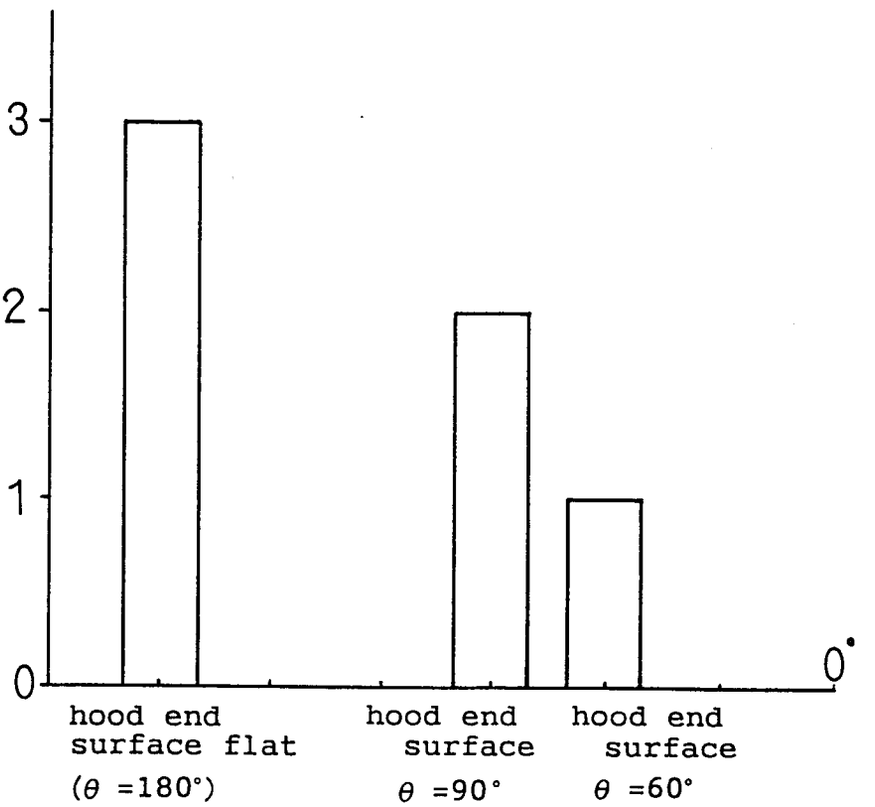

Third Comparison Example (hood downstream end surface flat)
Conditions: idling, EGR ratio 45%, smoke density 15%, 30hrs
C-C cross-section
27
G
D
D
38
39
3mm
35,35a
16
25
37
A
C
2mm
D
D
H
5
1
2
25
C
35,35a

Fig .15



surface deposit accumulation height h (mm) of hood downstream end



European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 96 30 4661

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.6)
A	FR-A-922 202 (P.A. TAILLEBOIS) 3 June 1947 * figure 1 *	1	F02M25/07
A	DE-C-43 25 169 (BAYERISCHE MOTOREN WERKE AG) 22 September 1994 * figure 1 *	1	
P,A	DE-C-44 24 644 (BOSCH GMBH ROBERT) 23 November 1995 * figures *	1	
A	EP-A-0 349 729 (PIERBURG GMBH) 10 January 1990 * figure *	1	
A	DE-A-42 27 739 (BAYERISCHE MOTOREN WERKE AG) 24 February 1994 * figures *	1	
A	EP-A-0 486 338 (PEUGEOT ;CITROEN SA (FR)) 20 May 1992 * figures *	1	TECHNICAL FIELDS SEARCHED (Int.Cl.6) F02M
A	DE-C-44 10 487 (DAIMLER BENZ AG) 2 March 1995 * figure *	1	
A	DE-A-43 38 194 (PIERBURG GMBH) 11 May 1995 * figure *	1	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 October 1996	Alconchel y Ungria,J

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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