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

(11) Publication number: **0 105 934**
A1

(12) EUROPEAN PATENT APPLICATION

(21) Application number: **82107552.0**

(22) Date of filing: **18.08.82**

(51) Int. Cl.³: **F 02 F 1/42**, F 02 M 35/10

(43) Date of publication of application: **25.04.84**
Bulletin 84/17

(84) Designated Contracting States: **GB IT**

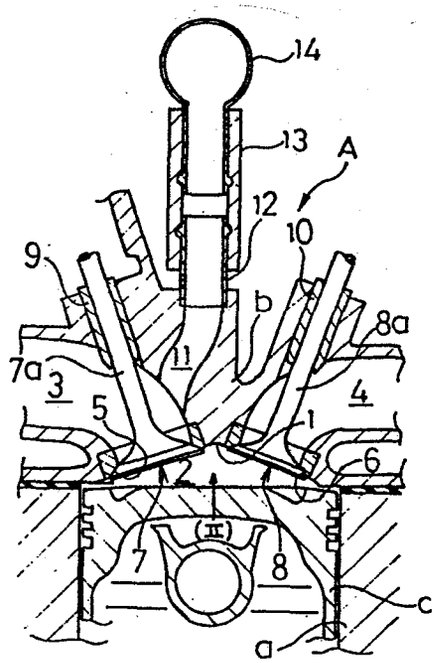
(71) Applicant: **Yamaha Motor Co., Ltd., 2500 Shingai, Iwata-shi Shizuoka-ken (JP)**

(72) Inventor: **Matsumoto, Hiromitsu, 614 Takaoka-cho, Hamamatsu-shi Shizuoka-ken (JP)**
Inventor: **Nagura, Takahiro, 1443-1 Ninomiya, Iwata-shi Shizuoka-ken (JP)**

(74) Representative: **Patentanwälte Grünecker, Dr. Kinkeldey, Dr. Stockmair, Dr. Schumann, Jakob, Dr. Bezold, Meister, Hilgers, Dr. Meyer-Plath, Maximilianstrasse 58, D-8000 München 22 (DE)**

(54) Intake system of an internal-combustion engine.

(57) An internal combustion engine is provided with an auxiliary intake passage (11, 11') which opens into an intake passage (3, 3') immediately downstream of a valve stem (7a, 7a') of an intake valve (7, 7') with respect to the flow direction of the intake air flowing towards a combustion chamber (2, 2'). As a result, the disturbances of the intake air flow immediately downstream of the valve stem are eleminated by the intake air flow coming from said auxiliary intake passage.



EP 0 105 934 A1

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August 18, 1982

GRÜNECKER, KINKELDEY, STOCKMAIR & PARTNER

PATENTANWÄLTE
EUROPEAN PATENT ATTORNEYS

A. GRÜNECKER, DIPL.-ING.
DR. H. KINKELDEY, DIPL.-ING.
DR. W. STOCKMAIR, DIPL.-ING., A.E.E. (CALTECH)
DR. K. SCHUMANN, DIPL.-PHYS.
P. H. JAKOB, DIPL.-ING.
DR. G. BEZOLD, DIPL.-CHEM.
W. MEISTER, DIPL.-ING.
H. HILGERS, DIPL.-ING.
DR. H. MEYER-PLATH, DIPL.-ING.

8000 MÜNCHEN 22
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TITLE MODIFIED
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INTERNAL COMBUSTION ENGINES WITH IMPROVED INTAKE SYSTEM

The invention relates to an internal combustion engine and in particular to an improved intake system for an internal combustion engine.

There are internal combustions engines, for example of four-cycle type, which have their intake valves located in the downstream end of their intake passages such that the respective valve stems are intersecting the flow of intake air. Internal combustion engines of this type experience a phenomenon that the intake air flowing through the intake passage is obstructed in the downstream end of said passage by the stem and guide of said intake valve so that the intake air flow is disturbed immediately downstream of the valve stem with respect to the flow direction.

Said air flow disturbances result in a loss of intake air thereby creating the problem that the intake air amount or intake air pressure within the cylinder to be charged is reduced resulting in a corresponding reduction in the output performance of the internal combustion engine.

The invention as claimed is intended to remedy these drawbacks. It solves the problem of how to design an intake system for internal combustion engines such that the disturbances of the intake air flow immediately downstream of the valve stem of the intake valve with respect to the flow direction are eliminated. This elimination of disturbances causes the charge of the cylinder with the intake air to be enhanced to improve the output performance of the internal combustion engine.

Six ways of carrying out the invention are described in detail below with reference to drawings which illustrate these six specific embodiments, in which:

Fig. 1 is a sectional view showing the intake system according to the present invention;

Fig. 2 is a view taken along arrow II of Fig. 1;

Fig. 3 is a sectional view showing the second embodiment;

Fig. 4 is a sectional view showing the third embodiment;

Fig. 5 is a sectional view showing the forth embodiment;

Fig. 6 is a section taken along line VI-VI of Fig.5;

Fig 7. is a sectional view showing the fifth embodiment;

Fig. 8 is a view taken along arrow VIII of Fig.7; and

Fig. 9 is a sectional view showing the sixth embodiment.

The Figures show an intake system of a four-cycle engine. This four-cycle engine A, A' is equippedwith a plurality of cylinders a, a' of which one is shown in the drawings.

Each cylinder comprises a cylinder head b, b' and a piston (c, c').

Reference numeral 1 denotes a recess which is formed in the upper end of the aforementioned cylinder head b. This recess defines a combustion chamber 2 together with the upper end of the piston c shown at its top dead centre.

Reference numerals 3 and 4 indicate two intake passages and two exhaust passages which are disposed at both the sides of the axis of the cylinder a and which are curved toward the aforementioned combustion chamber 2 to communicate with the combustion chamber 2 through intake ports 5 and exhaust ports 6, respectively.

Reference numeral 7 indicates intake valves for opening and closing the aforementioned intake ports 5, and numeral 8 indicates exhaust valves for opening and closing the exhaust ports 6.

As shown in Fig. 2 in the illustrated embodiment, each cylinder head is provided with two intake valves 7 and with two exhaust valves 8 so that two intake passages 3 and two exhaust passages 4 are required.

These intake and exhaust valves 7 and 8 are so arranged downstream of the intake passages 3 and the exhaust passages 4 as to have their respective valve stems 7a and 8a intersecting the flows of the intake air and the exhaust gas, respectively, and have their lower ends facing the inside of the combustion chamber 2 and corresponding to the intake ports 5 and the exhaust ports 6, respectively, and their valve stems 7a and 8a slidably guided within the wall of the cylinder head b by means of guides 9 and 10, respectively.

The four-cycle engine A so far described now experiences a phenomenon that the flow of the intake air is blocked in the intake passage 3 by the intake valves 7, specifically, by the valve stems 7a and by the guides 9 so that the intake air flow is disturbed immediately downstream of said valve stems 7a with respect to the flow direction. As means for eliminating that phenomenon, there are provided auxiliary intake passages 11.

Each of these auxiliary intake passages 11 has its effective area set smaller than that of the intake passage 3 and opens into said passage 3 immediately downstream of the valve stem 7a with respect to the flow direction, i.e. in the wall which is located downstream of the intake passage 3 and at the outside of the curved direction, that it is directed toward the combustion chamber 2, i.e. toward the outer circumferential portion of the same.

Moreover, the aforementioned auxiliary intake passage 11 extends through the wall of the cylinder head b and is connected through a short pipe 12 and a connecting pipe 13 with a communication pipe 14.

This communication pipe 14 has a length which extends over the respective cylinders of the engine A so that the intake passages 3 of the respective cylinders are allowed to communicate through the auxiliary intake passages 11 of the respective cylinders which are made to communicate by connecting those passages 11 with said pipe 14, as has been described in the above.

Since the respective cylinders of the aforementioned engine A now have different stroke phases, the vacuum of one cylinder in the intake stroke is exerted upon the intake passages 3 of the cylinders in a stroke other than the intake stroke to that the intake air in the

intake passages 3 of the cylinder in the stroke other than the intake stroke is sucked by the vacuum to flow through the auxiliary intake passages 11 and the communication pipe 14 into the auxiliary intake passages 11 of the cylinder in the intake stroke.

Moreover, the intake air coming from those auxiliary intake passages 11 flows at a high rate into the cylinder a via those portions of the intake passages 3, which are located just downstream of the valve stems 7a.

As has been described hereinbefore, the intake air is prevented from residing in the intake passages 3 of each cylinder, and the disturbances of the intake air immediately downstream of the valve stems 7a are settled down and eliminated by the intake air which flows from the auxiliary intake passages 11, thus augmenting the charges of the cylinder a with the intake air.

Other embodiments of the present invention will now be described with reference to Figs. 3 to 9.

Incidentally, in order to simplify the explanation, parts identical to those of the foregoing embodiment are indicated at identical reference characters, and their explanations are omitted.

First of all, in an embodiment shown in Fig. 3 the auxiliary intake passages 11 of each cylinder are connected with a plenum chamber 15.

This plenum chamber 15 has a relatively large capacity and is provided independently for each cylinder. As a result, the plenum chamber 15 performs a function to temporarily reserve the intake air for a time period from the end of the intake stroke to the start of the subsequent intake stroke of the cylinder.

More specifically the vacuum, which has been applied to the plenum chamber 15 via the auxiliary intake passages 11 during the intake stroke, is left active after the end of the intake stroke so that the intake air of the intake passages 3 is sucked by that vacuum and reserved in the plenum chamber 15.

On the other hand, the intake air reserved in the plenum chamber 15 is returned during the subsequent intake stroke from the auxiliary intake passages 11 to the intake passages 3.

As a result, the intake air is allowed to continuously flow without residing in the intake passages 3, the intake air in the plenum chamber 15 merges into the intake air of the intake passages 3 immediately downstream of the valve stems 7a by way of the auxiliary intake passages 11 so that the intake air is prevented from being disturbed just downstream of said valve stems 7a thereby to augment the charge of the cylinder a with the intake air.

Moreover, the intake system of the embodiment under discussion can be attached to a single-cylinder engine because its plenum chamber 15 is provided independently for each cylinder.

Next, in another embodiment shown in Fig. 4 the auxiliary intake passages 11 are connected with the intake passage 3 upstream of the valve stems 7a by way of a by-pass conduit 16 while by-passing said valve stems 7a.

Thus, in this embodiment, the intake air flowing through the intake passages 3 is divided into the by-pass conduit 16 so that the intake air introduced from said conduit 16 into the auxiliary intake passages 11 merges

into the intake air flowing in the intake passages 3 immediately downstream of the valve stems 7a. As a result, the disturbances of the intake air immediately downstream of the valve stems 7a are settled down to augment the intake air the cylinder a is to be charged with.

Incidentally, the intake system of the embodiment thus far described can also be applied to a single-cylinder engine because the bypass conduit is provided for each cylinder.

Moreover, since the two intake passages 3 of each cylinder are made to merge into each other at their upstream portions, the merging portions of the respective cylinders may be made to communicate with a single pipe connected with the by-pass conduit.

With this modification, into the by-pass conduit 16, there flow not only the intake air which is divided from the intake passage 3 but also the intake air which comes from the intake passage 3 of the cylinder in a stroke other than the intake stroke, so that the flow rate of the intake air can be augmented.

Next, another embodiment shown in Figs. 5 and 6 is modified from the foregoing embodiment shown in Fig. 1 and 2 such that there is provided a throttle valve 17 which is made operative to close one of the auxiliary intake passages 11 of each cylinder when the engine A is in a low or intermediate speed running operation.

That throttle valve 17 is disposed in a conduit 18, which connects one of the auxiliary intake passages 11 and the communication pipe 14, and is adapted to be closed when in the low or intermediate speed running operation of the engine A and opened when in a high speed running operation.

Reference numeral 19 indicates a throttle valve which is disposed at the upstream side of the intake passage 3 of each cylinder and which is adapted to be closed similarly to the aforementioned throttle valve 17 when in the low or intermediate speed running operation of the engine A thereby to regulate the flow of the intake air from the intake passage 3 into the cylinder a.

Incidentally, the throttle valve 19 thus far described is used in the embodiment in which the intake air is fed to the respective cylinders by the action of a single carburetor (although not shown). Therefore, the throttle valve 19 can be replaced by the throttle valves of the respective carburetors in the embodiment in which the respective cylinders are independently equipped with the carburetors.

In the embodiment under discussion, too, it is similar to the foregoing embodiments that the disturbances of the intake air in the intake passage 3 immediately downstream of the valve stem 7a can be eliminated. This embodiment can enjoy the following additional operation.

Specifically, during the low or intermediate speed running operation of the engine A, the throttle valves 19 and 17 in the intake passage 3 of each cylinder and in one of the auxiliary intake passages 11 are closed.

As a result, the cylinder a during the intake stroke is fed with the intake air exclusively from the auxiliary intake passage 11 which is open. However, since the auxiliary intake passages 11 are directed toward the outer circumferential portion of the combustion chamber 2 and have the smaller effective area, the intake air coming from one of the auxiliary intake passages 11 flows at a high rate in the tangential direction into the cylinder a so that it can generate a swirling flow in the cylinder a to effect the combustion with the intake air in the combustion chamber 2 at a high rate and in a stable manner thereby to improve the combustion efficiency.

Next, another embodiment shown in Figs. 7 and 8, is different in the type of the engine, specifically, in the intake and exhaust systems of the engine from those of the foregoing embodiments.

More specifically, the engine A' in this embodiment is the so-called "counterflow type multi-cylinder engine", in which an intake passage 3' and an exhaust passage 4' formed in the cylinder head b' of each cylinder are arranged side by side and have their port 5' and 6' respectively in a common plane.

Both the aforementioned two passages 3' and 4' are directed toward the outer circumferential portion of a combustion chamber 2' through their intake and exhaust port 5' and 6', respectively.

Reference numeral 20 indicates a carburetor which is connected to the upstream end of the intake passage 3' of each cylinder so that it feeds the respective cylinders with the intake air.

Moreover, the aforementioned engine A' is equipped similarly to the foregoing embodiments with an auxiliary intake passage 11' which opens the intake passage 3' immediately downstream of an intake valve 7' and in such an outwardly curved portion downstream of the intake passage 3' that it is directed in the opposite direction to the intake passage 3' while intersecting the same.

In other words, the auxiliary intake passage 11' is directed to face the outer circumferential portion of the combustion chamber 2', which is located at the opposite side of the intake passage 3', from the intake port 5' generally in the tangential direction of a cylinder a'.

Moreover, the auxiliary intake passages 11' of the aforementioned respective cylinders are connected to a communication pipe 14' so that they communicate with one another.

Reference numeral 21 indicates a throttle valve which is disposed upstream of the intake valve 7' within the intake passage 3' such that it is closed when in the low or intermediate speed running operation of the engine A'.

Thus, the intake system of this embodiment is similar to the foregoing embodiments in that the possible disturbances of the intake air immediately downstream of valve stems 7a' are eliminated by the intake air coming from the auxiliary intake passages 11' but has the following additional operation.

Specifically, the intake air is made to flow exclusively through the auxiliary intake passages 11' by closing the throttle valve 21 in an upstream portion of the intake passages 3' during the slow or intermediate running operation of the engine A'.

Since the auxiliary intake passage 11' is now directed tangentially to the cylinder a', the intake air from said passage 11' establishes the swirling flow in the cylinder a' so that the combustion in the combustion chamber 2' can be maintained at the high rate and in the stable manner thereby to improve the combustion efficiency.

Next, another embodiment shown in Fig. 9 is modified from the foregoing embodiment of Figs. 7 and 8 such that the communication pipe 14' is connected to the carburetor 20 by way of a conduit 22.

Thus, in this embodiment, the auxiliary intake passage 11' is directly connected to the carburetor 20, while by-passing the throttle valve 21 upstream of the intake passage 3', so that the intake air flows directly from the carburetor 20 into the auxiliary intake passage 11', even if the aforementioned throttle valve 21 and the throttle valve 23 of the carburetor 20 are closed, thereby to establish a more intense swirling flow than those of the foregoing embodiments.

Incidentally, it is similar to the foregoing embodiments that the disturbances of the intake air immediately downstream of the valve stem 7a' are eliminated by the flow of the intake air coming from the auxiliary intake passage 11'.

As has been described hereinbefore, according to the present invention, there is provided the auxiliary intake passage which is so opened in the intake passage immediately downstream of the valve stem with respect to the flow direction that it is directed toward the combustion chamber. As a result, the disturbances of the intake air flow immediately downstream of the valve stem are eliminated by the intake air flow coming from that auxiliary intake passage so that the flow

rate of the intake air the cylinder is to be charged with can be augmented to improve the ouput performance of the internal combustion engine.

CLAIMS:

1. An internal combustion engine of the type having an intake valve (7) which is arranged at the downstream end of an intake passage (3,3') such as to have its valve stem (7a, 7a') intersecting the flow of intake air into a combustion chamber (7), characterized in that an auxiliary intake passage (11, 11') is provided which opens with one end into said intake passage (3,3') immediately downstream of said valve stem (7a, 7a') with respect to the intake air flow direction.

2. Internal combustion engine according to claim 1, characterized in that said auxiliary intake passage (11, 11') extends through the wall of a cylinder head (b, b') and is connected to the respective intake passages (3,3') of each further cylinder (a, a') via a communication pipe (14, 14').

3. Internal combustion engine according to claim 1, characterized in that said auxiliary intake passage (11) is connected to a plenum chamber (15).

4. Internal combustion engine according to claim 1, characterized in that said auxiliary intake passage (11) has its other end connected to a portion of the intake passage (3) which is located upstream of said valve stem (7a).

5. Internal combustion engine according to claim 4, characterized in that a by-pass conduit (16) is provided which by-passes said valve stem (7a).

6. Internal combustion engine according to claim 1, characterized in that a throttle valve (17) is disposed within the auxiliary intake passage (11).

7. Internal combustion engine according to claim 6, characterized in that said throttle valve (17) is disposed in a conduit (18) which connects said auxiliary intake passage (11) with a communication pipe (14').

8. Internal combustion engine according to claim 7, characterized in that said communication pipe (14') is connected to a carburetor (20) while by-passing a throttle valve (21) which is located in the intake passage (3') upstream of said intake valve stem (7a').

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Fig.1

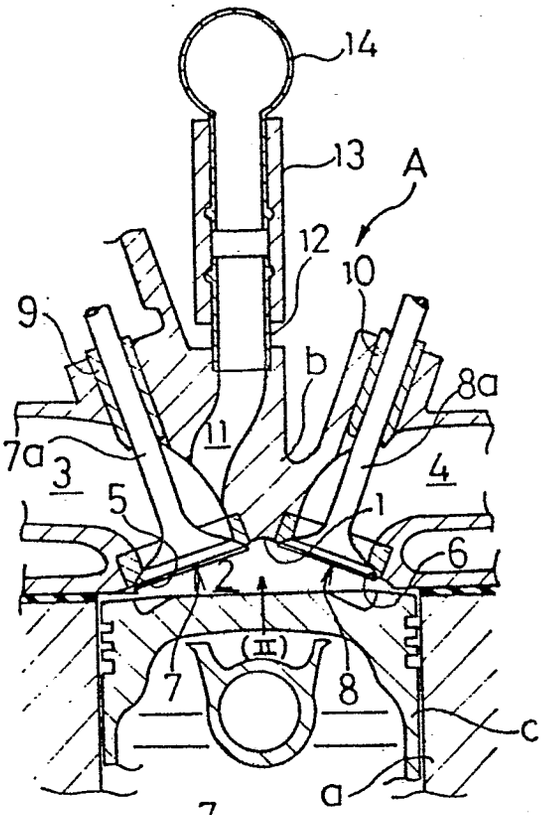

Fig.2

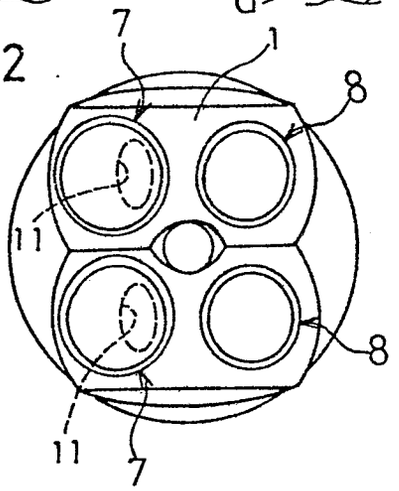

Fig.3

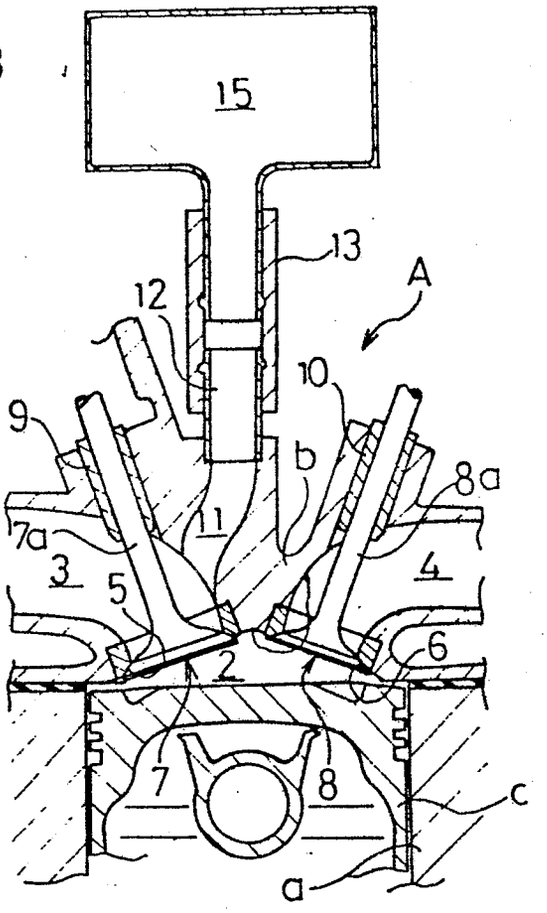

Fig.4

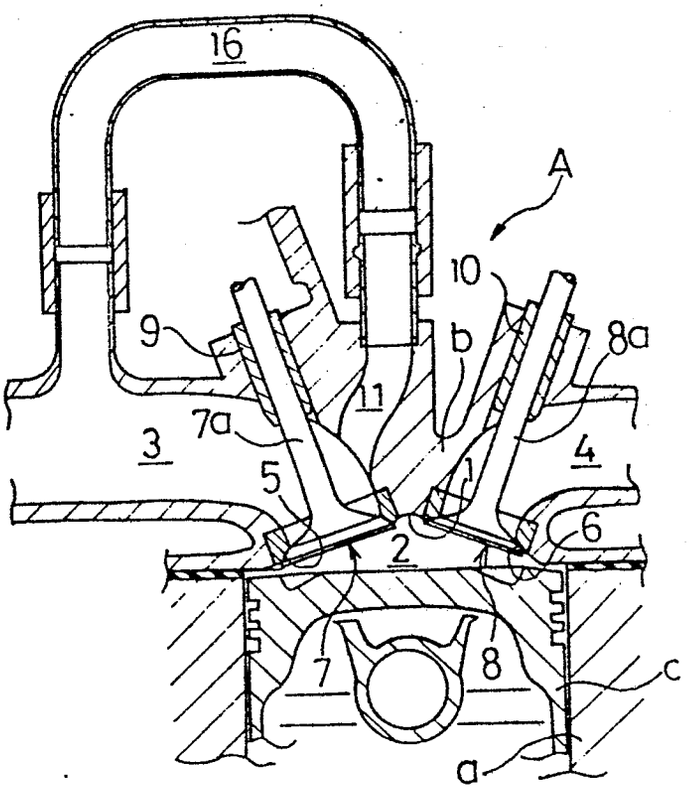

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Fig.5

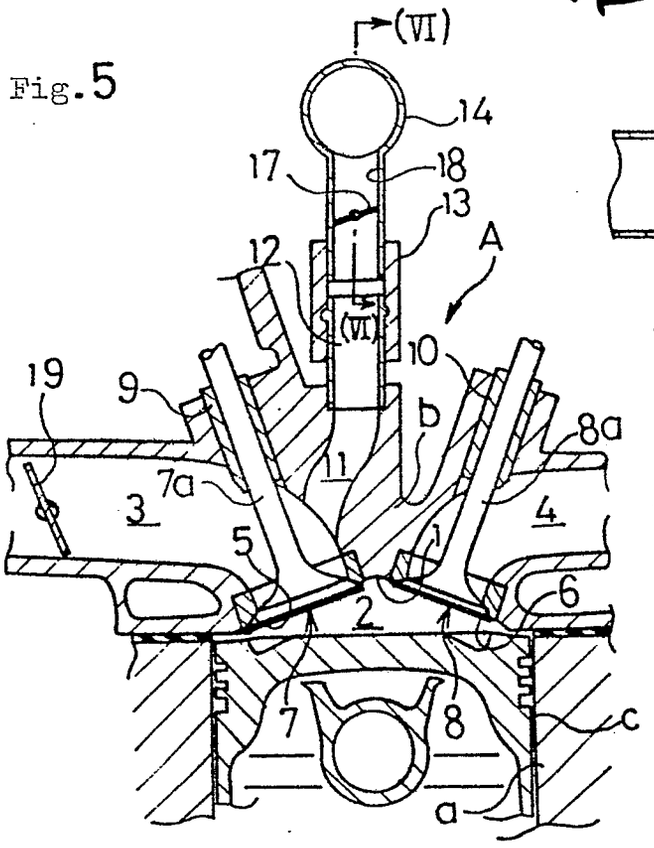

Fig.6

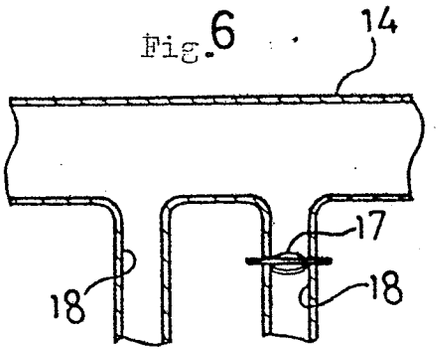

Fig.7

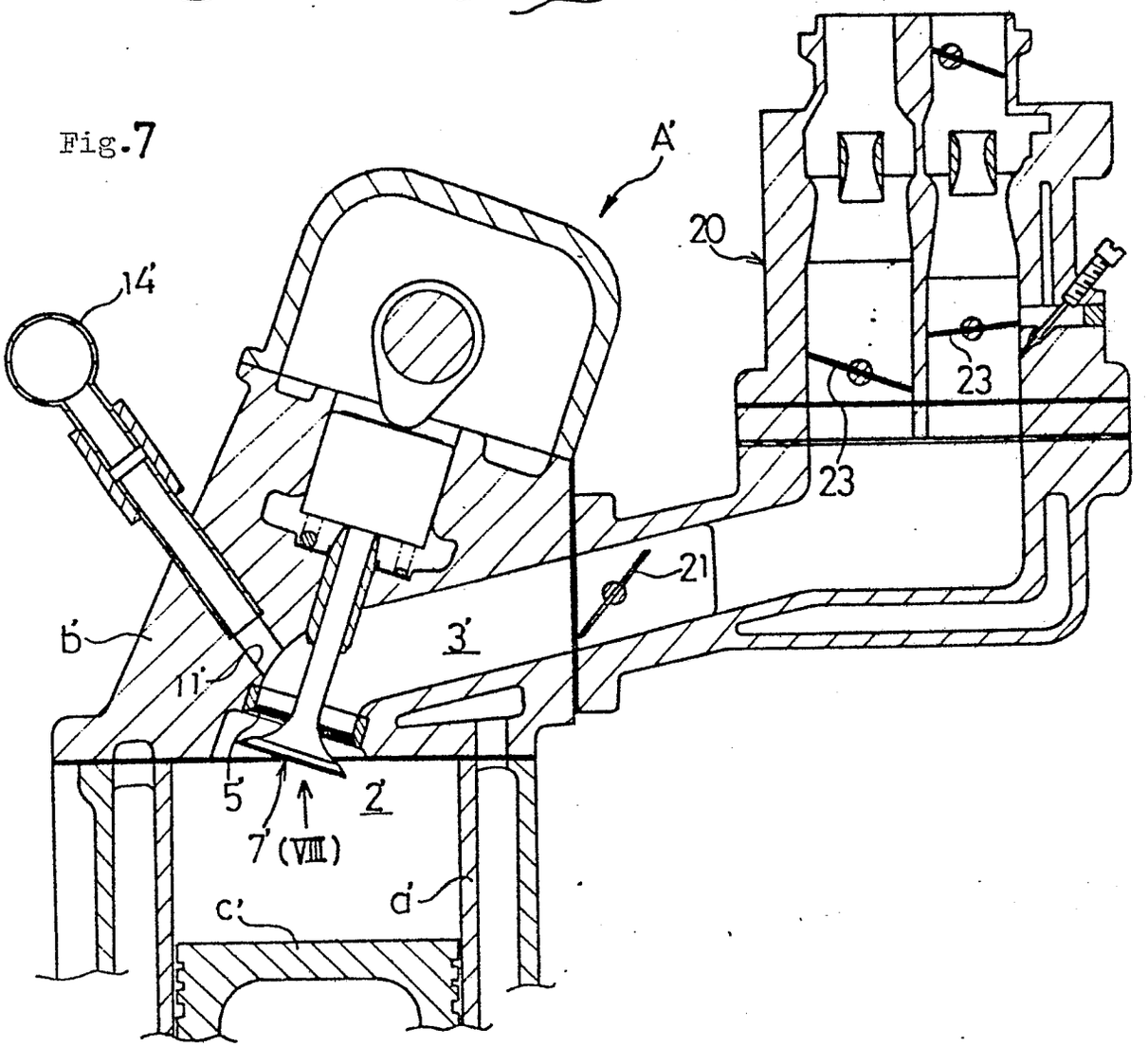

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Fig.8

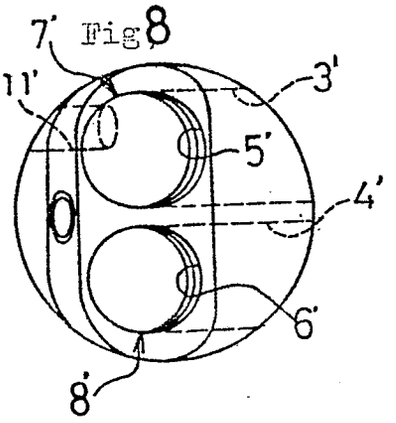
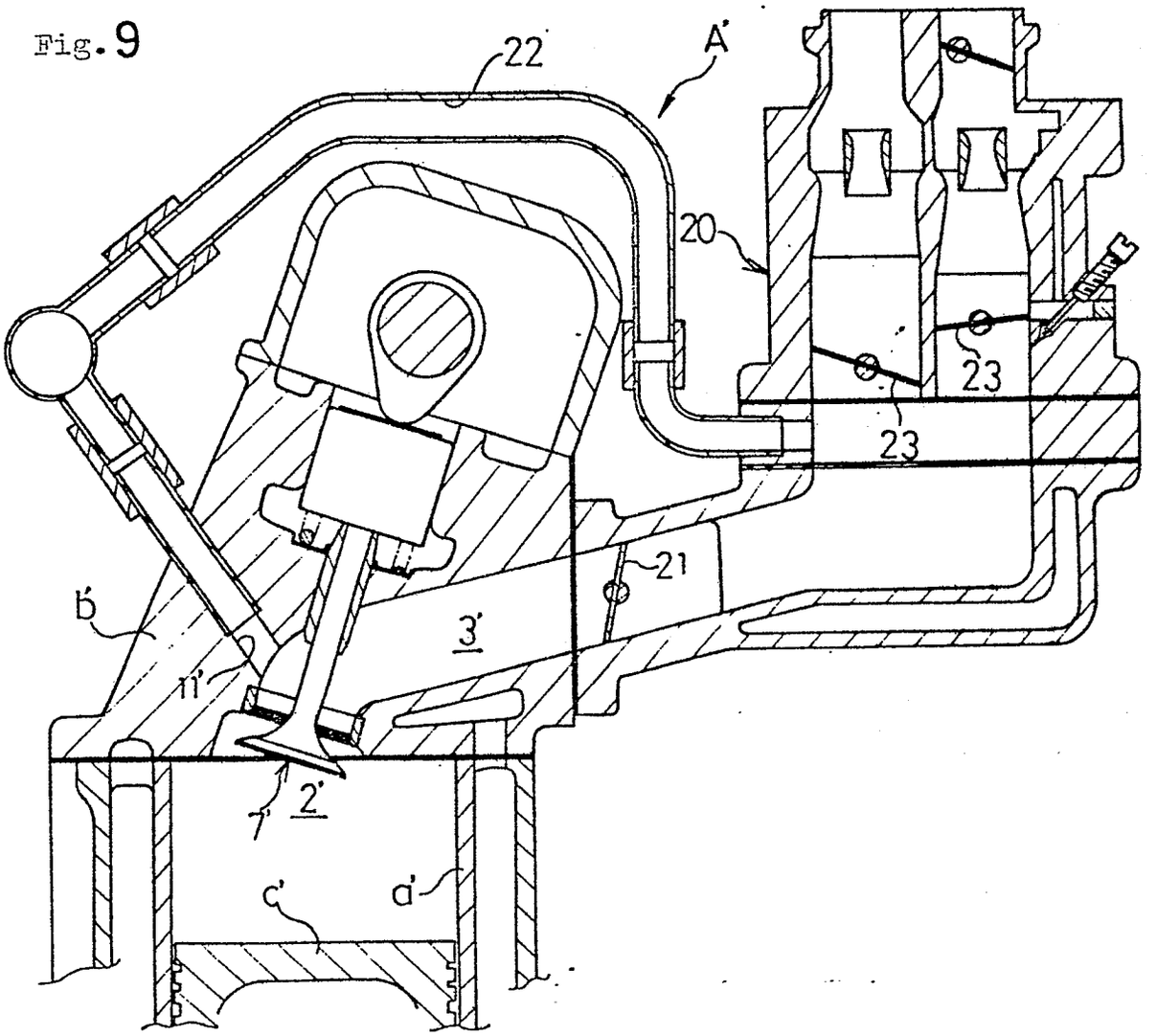


Fig.9



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EUROPEAN SEARCH REPORT

0105934
Application number

EP 82 10 7552

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. ³)
X,Y	GB-A- 971 211 (STARK) *Page 1, lines 12-54; page 2, lines 22-105; page 3, line 120 to page 4, line 7; figures 1-3*	1-8	F 02 F 1/42 F 02 M 35/10
Y	US-A-4 303 046 (TOYOTA) *Column 6, lines 37-51; column 8, lines 8-38; figures 14-16*	3,8	
Y	CH-A- 445 945 (SAUER) *Column 2, lines 1-30; column 3, lines 4-23 - column 4, lines 10-33; figures 1,2*	6,7	
A	US-A-4 304 211 (YAMAHA) *Column 2, line 49 to column 3, line 64; figures 1-4*	1-7	TECHNICAL FIELDS SEARCHED (Int. Cl. ³)
A	FR-A-1 079 530 (DAIMLER-BENZ) *Page 1, left-hand column, paragraph 4; right-hand column, paragraph 2; figures*	1	F 02 F F 02 M
A	US-A-4 186 706 (YAMAHA) *Column 2, line 65 - column 4, line 7; figure 1*	8	

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	30-03-1983	KOOIJMAN F.G.M.

CATEGORY OF CITED DOCUMENTS

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