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

72 Inventor: Yoshikawa, Masaaki
 2822 Nishikaizuka
 Iwata-shi Shizuoka-ken(JP)

74 Representative: Patentanwälte Grünecker, Dr.
 Kinkeldey, Dr. Stockmair, Dr. Schumann, Jakob, Dr.
 Bezold, Meister, Hilgers, Dr. Meyer-Plath
 Maximilianstrasse 43
 D-8000 München 22(DE)

54 Four-cycle internal combustion engine.

57 In a four-cycle combustion engine of the type having a plurality of intake valves and of exhaust valves provided in each cylinder, at least an additional intermediate intake valve (5') is arranged in order to enlarge the number of intake valves. Said intermediate intake valve is arranged to face the combustion chamber of the cylinder at a smaller angle (α_1) of inclination with respect to the axis (ℓ_1) of the cylinder than that of the remaining intake valves (5) which are arranged at both sides of said intermediate intake valve. As a result, any interference between said valves can be avoided.

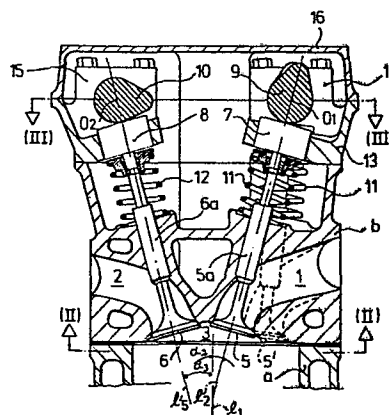


Fig.1

GRÜNECKER, KINKELDEY, STOCKMAIR & PARTNER

PATENTANWÄLTE
S. 1000 MÜNCHEN 22

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L. GRÜNECKER, DPL. ING.
 J. H. KINKELDEY, DPL. ING.
 J. W. STOCKMAIR, DPL. ING., DPL. RECHT.
 J. A. SCHUMANN, DPL. RECHT.
 J. H. JAKOB, DPL. ING.
 J. G. BEZOLD, DPL. RECHT.
 J. VEISTER, DPL. ING.
 J. HILGERS, DPL. ING.
 J. H. MEYER-PLATH, DPL. ING.

5

5000 MÜNCHEN 22
 MAXIMILIANSTRASSE 43

10

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15 YAMAHA MOTOR CO. LTD.

2500 Shingai, Iwata-shi, Shizuoka-ken, Japan

20 FOUR-CYCLE INTERNAL COMBUSTION ENGINE

The present invention relates to a four-cycle internal combustion engine. In order to improve the output performance of a four-cycle internal combustion engine
 25 at its high speed running range, it is a current practice to increase the number of intake valves and the number of exhaust valves for each cylinder of the internal combustion engine.

30 This is partly because the sum of the areas to be occupied in a combustion chamber by the intake and exhaust valves, i.e., the so-called "valve area" is increased to improve the charge and discharge efficiencies in accordance with increases in the intake and exhaust valves and partly
 35 because the respective valves themselves can have their sizes and weights reduced so that their followabilities at a high speed can be improved.

1 However, there exist restrictions in that the area of
the combustion chamber to be faced by the respective
valves is limited and that the plural valves have to be
arranged within that limited area without any inter-
5 ference among the plural valves.

In case the number of the valves is increased, there
arises another problem in providing a suitable system
for driving said valves.

10 Specifically, in the structure having its valves driven
by the cam shafts which are located just above them,
a valve or valves may occasionally fail to be aligned
with the corresponding cam shaft if the valve number is
15 too large.

In this case, connecting means for connecting the mis-
aligned valve or valves and its or their cam shaft is
newly required for driving it or them, thus raising
20 another problem that the construction of the valve driving
system is complicated.

From the reasons thus far discussed, according to the
prior art, the respective numbers of the intake and
25 exhaust valves are two and are not increased further.

The invention as claimed has been conceived in order to
remedy these drawbacks and solves the problem to provide
a four-cycle engine which is enabled to have at least
30 three intake valves of the intake and exhaust valve
without detrimental interferences in a combustion chamber
and to drive the three pairs of valves without rendering
their driving system too complicated.

35 One way of carrying out the invention is described in
detail below with reference to drawings which illustrate
merely one specific embodiment, in which:-

1 Figure 1 is a longitudinal section showing the engine
according to the present invention; Figure 2 is a section
taken along line II - II of Figure 1; Figure 3 is a section
taken along line III - III of Figure 1; and Figure 4 is a
5 section taken along line IV - IV of Figure 2.

These drawings illustrate one cylinder of a four-cycle
engine, in which reference letters a and b indicate a
cylinder and a cylinder head, respectively, and reference
10 numerals 1 and 2 indicate an intake passage and an exhaust
passage, respectively.

Numeral 3 indicates a combustion chamber which is formed
below the afore-mentioned cylinder head b and into which
15 the intake and exhaust passages 1 and 2 are opened.

Numeral 4 indicates a threaded hole for mounting an
ignition plug, which is opened at the center portion of
the upper side of the afore-mentioned combustion chamber 3.
20

Numeral 5 indicates intake valves for opening and closing
the afore-mentioned intake passage 1, and numeral 6
indicates exhaust valves for opening and closing the exhaust
passage 2.

25 Said intake and exhaust valves 5 and 6 have their respective
lower ends facing the combustion chamber 3 to close the
open ends of the intake passage 1 and the exhaust passage 2,
respectively. Their respective intermediate portions are
slidably supported in the wall of the cylinder head b
30 through guides 5a and 6a.

Numerals 7 and 8 indicate lifters which are formed to extend
from the upper ends of both the afore-mentioned valves 5
and 6 and through which both the valves 5 and 6 are connected
35 to corresponding cam shafts 9 and 10 just thereabove so
that they are driven by said shafts 9 and 10.

1 Numerals 11 and 12 indicate springs which are made operative to bias the intake and exhaust valves 5 and 6 in their closing directions.

5 Furthermore, the afore-mentioned cam shafts 9 and 10 are rotatably supported above the cylinder head 3 through a cam carrier 13 and cam caps 14 and 15.

10 Numeral 16 indicates a cover which covers the afore-mentioned cam shafts 9 and 10 and the cam caps 14 and 15 and which is formed to extend from the upper end of the cam carrier 13.

The four-cycle engine thus constructed is equipped, so as 15 to improve its output performance, with a plurality of intake valves 5 and a plurality of exhaust valves 6 for each cylinder, of which at least the intake valves 5 are three in number.

20 Incidentally, it is quite natural that the numbers of the intake passage 1 and the exhaust passage 2 be increased in accordance with the respective numbers of the valves 5 and 6.

25 The afore-mentioned three intake valves 5 are arranged and constructed such that the intermediate one 5' faces the combustion chamber 3 at a smaller angle of inclination with respect to the axis \mathcal{L}_1 of the cylinder than that of the remaining two outer intake valves 5, 5.

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Specifically, if the angle of inclination of the intermediate intake valve 5' is designated at α_1 whereas the angle of inclination of the two outer intake valves 5 is indicated at α_2 , then a relation of $\alpha_1 < \alpha_2$ exists.

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On the other hand, the afore-mentioned intake valves 5 are further arranged and constructed such that all their respective axes \mathcal{L}_2 extend through the center O_1 of the

1 cam shaft 9.

Thus, the afore-mentioned intake valves 5 are arranged, as shown in Figure 2, such that the intermediate one 5' is more offset to the outside with respect to the center line ℓ_3 , which divides the combustion chamber 3 into intake and exhaust portions, than the two intake valves 5,5 at both sides, whereby the entirety of intake valves 5 does not interfere with one another.

10 Moreover, since the respective intake valves 5 have their axes ℓ_2 extending through the center O_1 of the cam shaft 9, nothing is newly required except the lifters 7 acting as means for connecting the intake valves 5 with said shaft 9.

15 On the contrary, the exhaust valves 6 provided are two in number and are arranged in the combustion chamber 3 on a plane ℓ_4 which is parallel to the afore-mentioned center line ℓ_3 .

20 Moreover, the exhaust valves 6 are arranged to have their respective axes ℓ_5 extending through the center O_2 of the cam shaft 10 and are set with an equal angle of inclination α_3 with respect to the axis ℓ_1 of the cylinder a.

25 Thus, since the afore-mentioned exhaust valves provided are two in number, they are prevented from interfering with each other, even if they are in the combustion chamber 3 on the straight line, and nothing is newly required except the 30 lifters 8 acting as means for connecting the exhaust valves 6 with the cam shaft 10.

Incidentally, although the intake valves 5 provided in the embodiment thus far described are three in number, three 35 exhaust valves 6 may be provided if they adopt the arrangement and construction similar to those of the intake valves 5.

1 As has been described hereinbefore, according to the
present invention, the intermediate intake valve 5' is
arranged to face the combustion chamber at a smaller
angle α_1 of inclination with respect to the axis ℓ_1 of
5 the cylinder than that of the remaining two intake valves 5
when the three intake valves are to be provided. As a
result, the intermediate intake valve 5' is more offset
to the outside than the intake valves at both sides so that
said three intake valves can be arranged in the combustion
10 chamber without any interference among them.

Moreover, said three intake valves are so arranged that
their respective axes extend through the center O_1 of their
cam shaft 9. The positional relationship between the
15 respective valves and their cam shaft is not changed from
that of the prior art, and no new one is required as the
means for connecting the respective valves with their cam
shaft so that the valve driving system is not necessarily
made complicated.

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CLAIMS:

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1. A four-cycle internal combustion engine of the type having for each of its cylinders a plurality of intake valves and a plurality of exhaust valves, both types of valve being driven by respective cam shafts as are provided just above said intake and exhaust valves, respectively, characterized in that at least of said intake valves (5) are provided three in number such that the intermediate intake valve (5') is arranged to face a combustion chamber (3) at a smaller angle (α_1) of inclination with respect to the axis (ℓ_1) of said cylinder (a) than the angle (α_2) of inclination of the remaining intake valves (5) at both sides of said intermediate intake valve (5'); and in that said three intake valves (5,5'5) have their respective axis (ℓ_2) extending to intersect the axis (O_1) of a cam shaft (9) driving said intake valves.

2. Engine according to claim 1, characterized in that the intermediate intake valve (5') is more offset to the outside with respect to a centerline (ℓ_3), which divides the combustion chamber (3) into intake and exhaust portions, than the two intake valves (5,5) at both sides of said intermediate valve (5').

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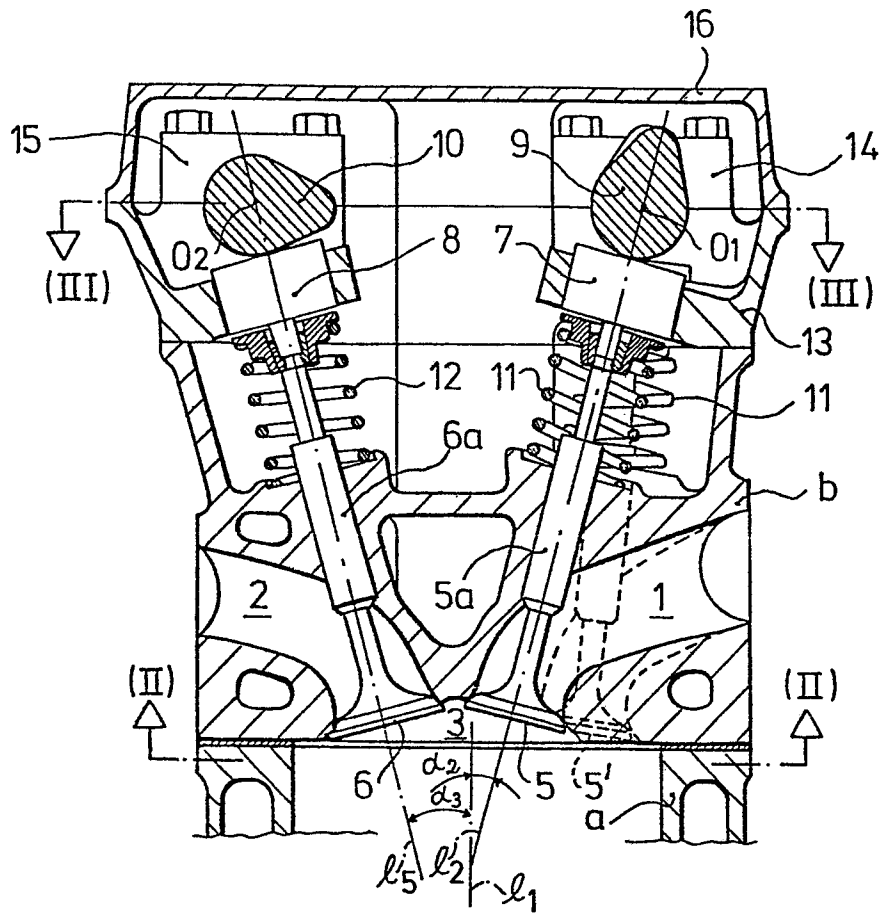


Fig. 1

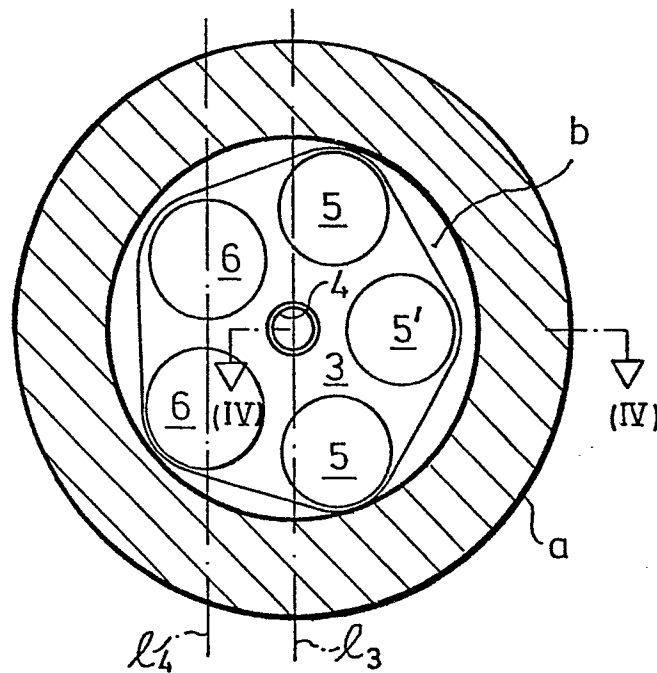


Fig. 2

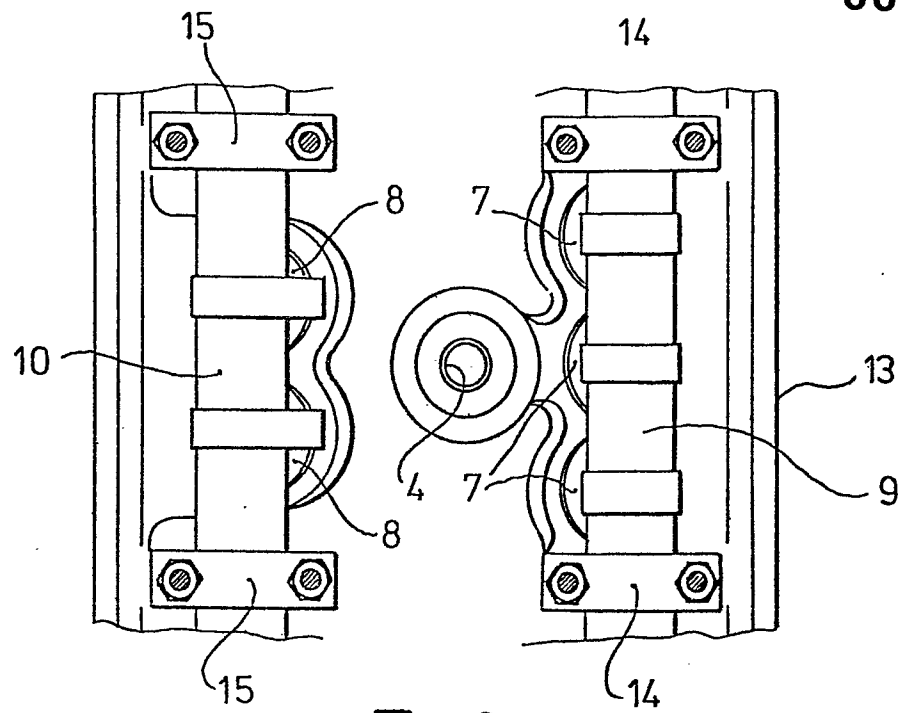


Fig. 3

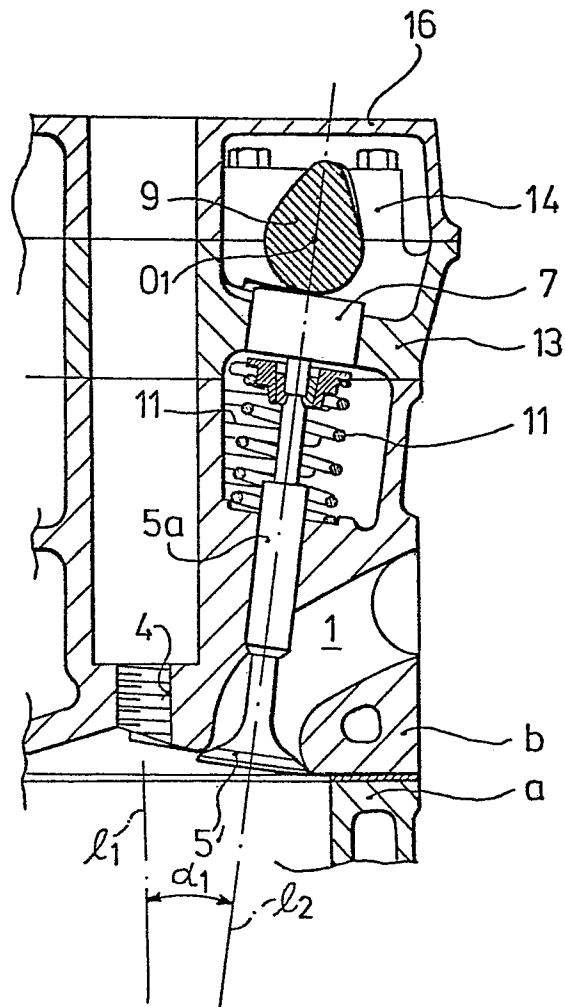


Fig. 4