

1/11 © EPODOC / EPO

PN - [GB2577398](#) A 20200325

PR - GB20180014512
20180906; GB20180014530
20180906

AP - GB20190012714 20190904

DT - *; Rep

CT - || STSE (A)
[GB2467947](#) A 20100825 [] (RCV
ENGINES LTD [GB]);
[EP1201883](#) A2 20020502 [] (TECUMSEH PRODUCTS CO [US]);
[US2013180476](#) A1 20130718 [] (ICHIHASHI NAOTO [JP]);
[US2003192493](#) A1 20031016 [] (YUASA TSUNEYOSHI [JP], et al);
[JPS5754666](#) A 19820401 [] (HIRAIZUMI TOKUO);
[JPH0361661](#) A 19910318 [] (HONDA MOTOR CO LTD)

CCI - [F01L7/022](#) ; [F01L7/025](#) ;
[F01L7/028](#)

CCA - [F02B63/02](#)

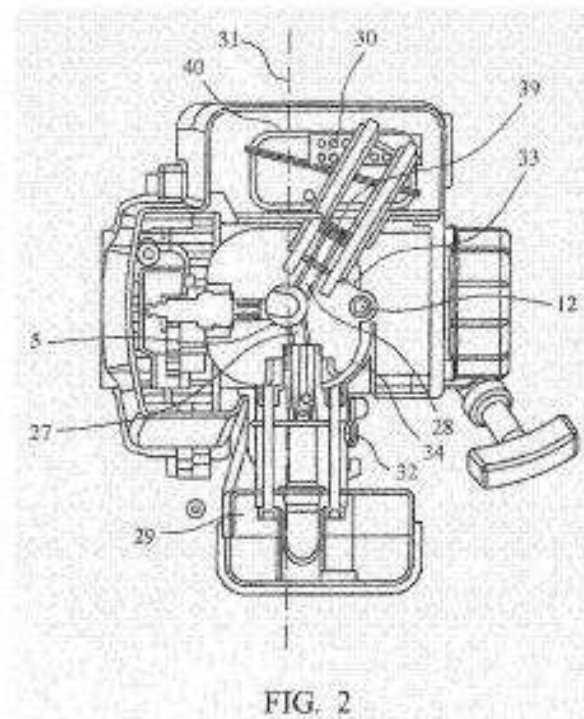
CI - F01L7/021 (GB)
F01L7/022 (EP)
F01L7/025 (EP)
F01L7/028 (EP, GB)
F02B63/02 (GB)
F02M35/10039 (GB)

CA - F02B63/02 (EP)

PA - RCV ENGINES LTD [GB]; KAAZ
CORP [JP]

TI - A **Rotary** valve
internal **combustion** engine

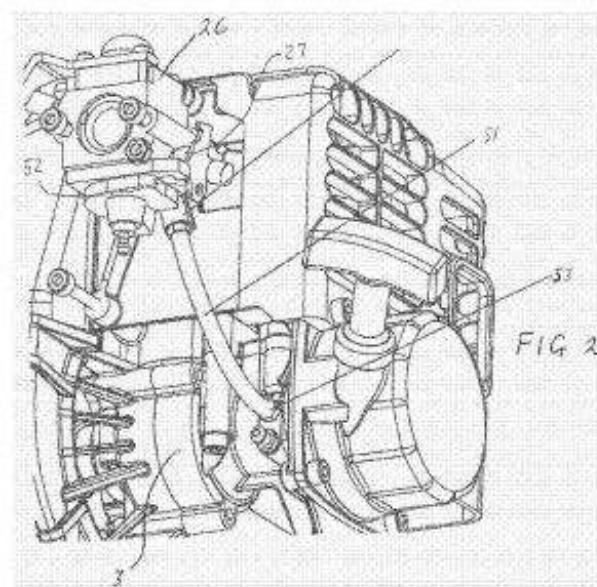
AB - A **rotary** valve
internal **combustion** engine
comprising a **combustion**
chamber defined in part by
the **piston** and the **combustion**
end of the cylinder, a valve
housing (Fig. 1, 8) fixed at an
outer portion of the **combustion**
end of the cylinder and defining
a bore, and a **rotary** valve 5
rotatable about an axis (Fig. 1
5a) in the bore, the valve having



in a wall part thereof a port giving fluid communication to and from the **combustion** chamber via inlet 27 and exhaust 28 ports in the valve housing. The engine has a **carburettor** 29 and an exhaust muffler 30 mounted on opposite sides of the engine, when the engine is at TDC, the valve port is angled towards the **carburettor**, and the centrelines of the inlet and exhaust ports are offset at an angle allowing for the muffler and **carburettor** to be parallel to the crankshaft centreline 31.

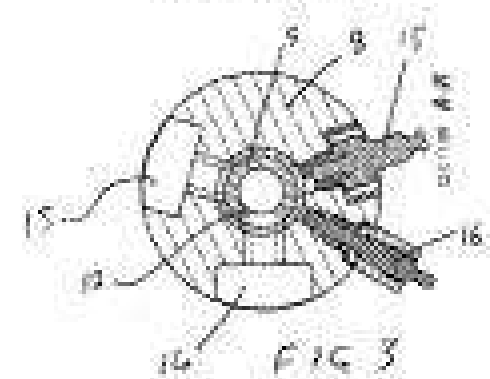
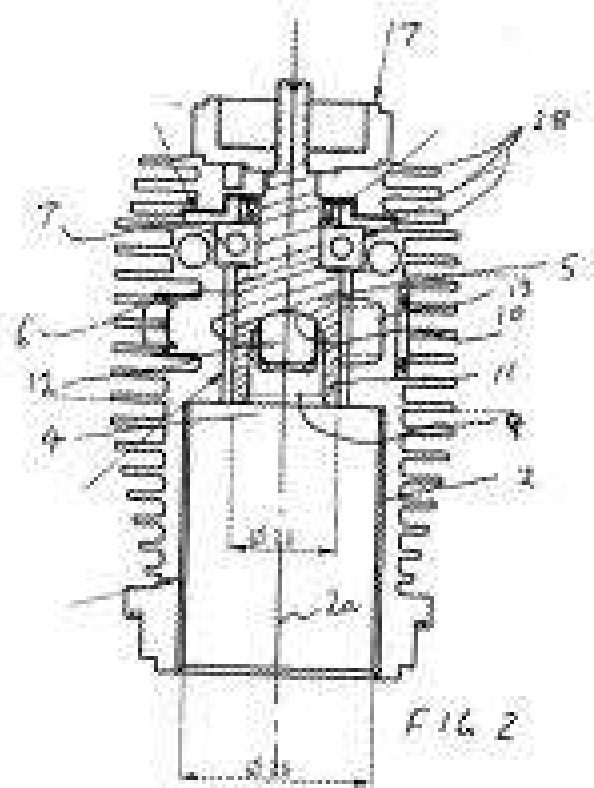
2/11 © EPODOC / EPO

- PN - [GB2576912](#) A 20200311
- PR - GB20180014524 20180906
- AP - GB20180014524 20180906
- DT - *; Rep
- CT - || STSE (A)
[GB2467947](#) A 20100825 [] (RCV ENGINES LTD [GB]);
[GB1530034](#) A 19781025 [] (NISSAN MOTOR);
[JP2015206342](#) A 20151119 [] (TOYOTA BOSHOKU CORP);
[US2011073083](#) A1 20110331 [] (SHIRAISHI KENTARO [JP], et al)
- CCI - [F01L7/023](#) ; [F01L7/028](#) ;
[F01M13/02](#)
- CCA - [F01L2250/06](#) ; [F01M2013/0038](#)
- CI - F01L7/021 (GB)
F01L7/023 (EP)
F01L7/028 (EP)
F01M13/02 (EP, GB)
- CA - F01L2250/06 (EP)
F01M2013/0038 (EP, GB)
- PA - RCV ENGINES LTD [GB]
- TI - A **rotary** valve
internal **combustion** engine
- AB - A **rotary** valve
internal **combustion** engine
operating on the four-stroke



cycle comprising: a **piston** connected to a crankshaft (3, fig. 1) located in a crankcase and reciprocable in a cylinder, a valve housing defining a bore and a **rotary** valve (5, fig.1) rotatable in the bore in the valve housing. The **rotary** valve has a hollow valve body having an interior volume forming a part of the **combustion** chamber, wherein the interior volume of the hollow valve body is subjected to **combustion** gases throughout the **combustion** process. An inlet port being located in an inlet tract downstream of **carburettor** 26, wherein a fluid passage pipe is provided between the inlet tract and the crankcase. The fluid connection between the crankcase and the inlet tract allows blow-by gases in the crankcase caused by leakage past the **piston** during **combustion**, to be vented into the inlet tract and hence to the inlet port.

PN - [GB2467947](#) A 20100825
 PNFP - GB2467947 B 20131009
 PR - GB20090002928 20090220
 AP - GB20090002928 20090220
 DT - *; Rep
 CT - || STSE (A)
 [GB578940](#) A 19460717 [
] (BRIGGS MFG CO);
 [GB1479347](#) A 19770713 [
] (TYLER ROAD ASSOCIATES);
 [DE3239451](#) A1 19840426 [
] (VOLKSWAGENWERK AG [DE]);
 [DE4040936](#) A1 19920625 [
] (KLOECKNER HUMBOLDT DEUTZ
 AG [DE]);
 [EP0194041](#) A1 19860910 [
] (KRIEK GERHARDUS CORNELIUS);
 [US2245743](#) A 19410617 [
] (METCALF ASPIN FRANK);
 [US2331801](#) A 19431012 [
] (RODGERS EDWARD T);
 [US3362391](#) A 19680109 [
] (LINDSAY MAURICE E);
 [US5076219](#) A 19911231 [
] (PELLERIN JACQUES [FR]);
 [WO9523279](#) A2 19950831 [
] (HANSEN ENGINE CORP [US]);
 [WO0019066](#) A2 20000406 [
] (BSA ROCV LIMITED [GB], et al)
 - || STSE (B)
 [GB2195395](#) A 19880407 [
] (HANSEN ENGINE CORP);
 [GB1479347](#) A 19770713 [
] (TYLER ROAD ASSOCIATES);
 [GB578940](#) A 19460717 [
] (BRIGGS MFG CO);
 [EP0194041](#) A1 19860910 [
] (KRIEK GERHARDUS CORNELIUS);
 [WO0019066](#) A2 20000406 [
] (BSA ROCV LIMITED [GB], et al);
 [WO9523279](#) A2 19950831 [
] (HANSEN ENGINE CORP [US]);
 [DE4040936](#) A1 19920625 [
] (KLOECKNER HUMBOLDT DEUTZ
 AG [DE]);
 [DE3239451](#) A1 19840426 [
] (VOLKSWAGENWERK AG [DE]);
 [US5076219](#) A 19911231 [



] (PELLERIN JACQUES [FR]);
[US4494500](#) A 19850122 [
] (HANSEN CRAIG N [US]);
[US3362391](#) A 19680109 [
] (LINDSAY MAURICE E);
[US2331801](#) A 19431012 [
] (RODGERS EDWARD T);
[US2245743](#) A 19410617 [
] (METCALF ASPIN FRANK)

CCI - [F01L7/028](#)

CI - F01L5/04 (KR)
 - F01L7/00 (GB)
 - F01L7/02 (KR)
 - F01L7/021 (GB)
 - F01L7/023 (GB)
 - F01L7/028 (EP, US)
 - F01L7/08 (GB)
 - F01L7/18 (GB)

PA - (A B)
 RCV ENGINES LTD [GB]

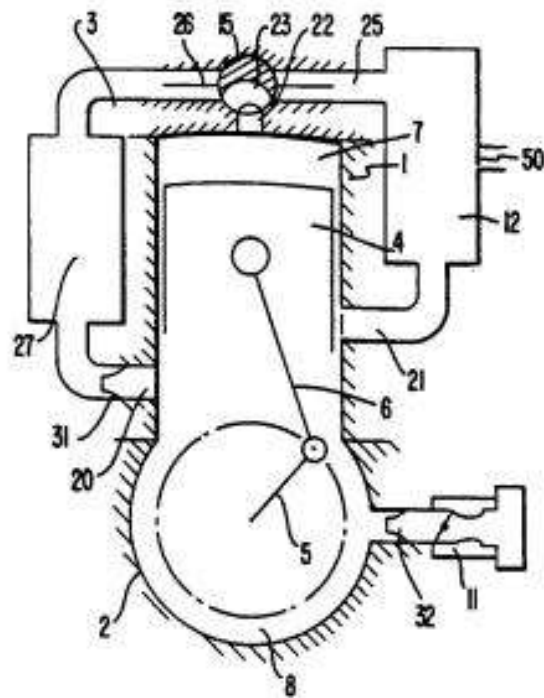
TI - (A)
Rotary valve internal **combustion** engine
 - (B)
 An internal **combustion** engine

AB - (A)
 A **rotary** valve i.c. engine has a **piston** connected to a crankshaft and reciprocable in a cylinder 2, and a **rotary** valve 5 rotatable, eg about the cylinder axis, in a valve housing 8 fixed relative to the cylinder 2. The **rotary** valve 5 has a volume 9 defining, in part, the **combustion** chamber 4 and a port 12 communicating successively, during rotation of the valve 5, with inlet and exhaust ports 13, 14. The valve 5 may have a cylindrical part 6 mounted on a ball bearing 7. Alternatively, the valve member may be conical. The interior volume 9 of the valve may have a hemispherical upper end 10 and a wall 11 with the port 12 which

may be a bore or hole (fig.4a) or a recess in the lower edge of the cylindrical wall 11 (fig.4b). A spark plug 15 and glow plug 16 may be provided. The **rotary** valve 5 may be belt driven via a pulley 17 and may have cooling fins 28. A horizontally opposed twin cylinder flat engine may have **rotary** valves mounted with their axes on the cylinder axes (fig.5) or at right angles thereto (fig.6). The engine may have spark or compression ignition with a **carburettor** of fuel injection.

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- PN - [US5230314](#) A 19930727
- PR - JP19910174812
19910620; JP19920048030
19920204; JP19920086631
19920311; JP19920105216
19920401
- AP - US19920901579 19920619
- DT - **
- CT - || STSE (A)
[JPS4735516](#) A 00000000 [];
[US1825959](#) A 19311006 [] (RENNOSUKE KONDO);
[US3756206](#) A 19730904 [] (GOMMEL D);
[US3945364](#) A 19760323 [] (COOK DANNY G);
[US3973532](#) A 19760810 [] (LITZ HAROLD);
[US4114639](#) A 19780919 [] (CROSS MICHAEL ELLISON, et al);
[US4116189](#) A 19780926 [] (ASAGA RYUZI);
[DE2741649](#) A1 19790315 [] (THIER JOHANN);
[US4169434](#) A 19791002 [] (GUENTHER WILLIAM D [US]);
[FR2467288](#) A1 19810417 [] (QUINIOU HERVE [FR]);
[CH642143](#) A5 19840330 [] (DORIGUZZI RINO [CH]);



[US4473041](#) A 19840925 [
] (LYONS GEORGE A [US], et al);
[US4475499](#) A 19841009 [
] (SHEAFFER BENJAMIN L [US]);
[US4558671](#) A 19851217 [
] (STINEBAUGH DONALD E [US]);
[JPS61200330](#) A 19860904 [
] (HONDA MOTOR CO LTD);
[US4715336](#) A 19871229 [
] (SCHINDLER MANFRED [DE], et
 al);
[US4794895](#) A 19890103 [
] (KRUGER HERMANN [DE])

CCI - [F01L7/022](#) ; [F02B33/26](#) ;
[F02B33/30](#)

CCA - [F02B3/06](#) ; [F02B2075/027](#)

CI - F01L7/022 (EP, US)
 - F02B33/26 (EP, US)
 - F02B33/30 (EP, US)

CA - F02B3/06 (EP, US)
 - F02B2075/027 (EP, US)

PA - MITSUBISHI HEAVY IND LTD [JP]

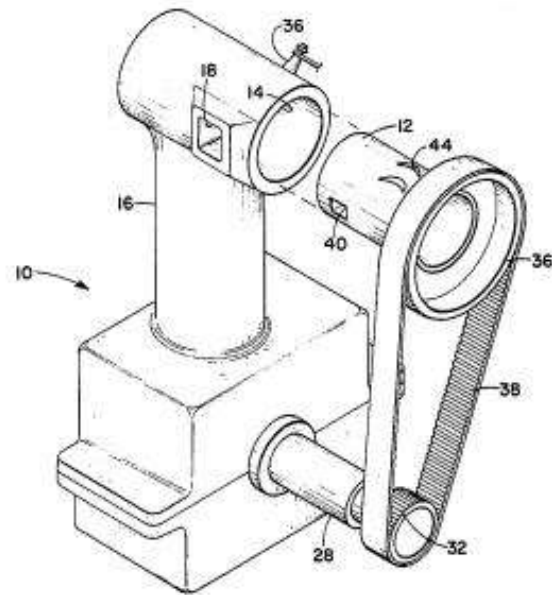
TI - 4-CYCLE ENGINE

AB - A 4-cycle internal **combustion**
 engine including a crankcase, a
 cylinder, a cylinder head,
 a **piston** adapted to reciprocate
 within the cylinder,
 a **combustion** chamber formed
 by the **piston**, the cylinder and
 the cylinder head, and a
 crankshaft connected to
 the **piston** via a connecting rod,
 is improved in order to enhance
 its thermal efficiency, to reduce
 exhaust emissions and to make
 it possible to operate the engine
 while the engine is in any
 attitude. The improvements
 reside in an intake passage and
 an exhaust passage provided in
 the cylinder head, a **rotary** valve
 rotating synchronously with the
 crankshaft at a speed one-half of
 that of the latter for placing the
 intake passage and the exhaust
 passage in communication with

the cylinder during an intake stroke and an exhaust stroke of the **piston**, respectively, a check valve through which the intake passage communicates with the interior of the crankcase so that only flow is allowed from the crankcase towards the intake passage, and a **carburetor** device for feeding a fuel mixture of air, fuel and lubricant oil into the crankcase. The suction of the fuel mixture into the crankcase chamber as well as the feeding of the fuel mixture within the crankcase to the intake passage are made possible by the variation in pressure within the crankcase chamber caused by the reciprocation of the **piston**.

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- PN - [US4658776](#) A 19870421
- PR - US19860825641 19860203
- AP - US19860825641 19860203
- DT - *; Rep
- CT - || STSE (A)
[US1616029](#) A 19270201 [];
[US1616030](#) A 19270201 [] (HERMAN DOCK);
[US1777464](#) A 19301007 [] (EDWARDS WILLIAM M);
[US1977025](#) A 19341016 [] (VANDER ELST JEAN, et al);
[US2249143](#) A 19410715 [] (OSKAR KIESEL, et al);
[US3192914](#) A 19650706 [] (THOMAS KOPCZYK);
[US3871340](#) A 19750318 [] (ZIMMERMAN MERRITT A);
[US4517938](#) A 19850521 [] (KRUEGER HERMANN [DE])
- CCI - [F01L7/021](#)
- CI - F01L7/021 (EP, US)
- PA - COMAN CLYDE R
- TI - **Rotary** valve internal **combustion** engine



AB

- A **rotary** valve internal **combustion** engine including a cylinder block having a cylindrical recess, a cylindrical bore transverse to the cylindrical recess, an exhaust passageway leading from the cylindrical bore, and an intake passageway leading to the cylindrical bore. A cylindrical **piston** sealably reciprocates in the cylindrical recess so that the space defined by the top of the **piston** and the walls of the cylindrical recess forms a **combustion** chamber. An arcuate passageway in the block extends between the cylindrical bore and the **combustion** chamber. A crankshaft is connected to the **piston**. An ignition system is in communication with the **combustion** chamber. A **carburetor** to provide a fuel-air mixture is in communication with the intake passageway. A cylindrical valve, rotatably received in the cylindrical bore, has a hollow body, open ends, two axially aligned intake ports near one end of the cylindrical body, two axially aligned exhaust ports near the opposite end of the cylindrical body, four axially aligned arcuate center openings located between the exhaust ports and the intake ports, and four internal tubes, each tube connecting a center opening with an intake or exhaust port. A sprocket wheel extends from one end of the cylindrical valve and is connected to the crankshaft by a tooth belt. The reciprocating **piston** rotates the valve to first allow the fuel-air mixture to enter the **combustion**

chamber and then allow burnt gases to be expelled from the **combustion** chamber.

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PN - [JPH0874581](#) A 19960319

PR - JP19940267955 19940904

AP - JP19940267955 19940904

DT - I

CCA - - [F02B2075/027](#) ; [F02B2275/32](#) ; [Y02T10/12](#)

CA - - F02B2075/027 (EP)

- F02B2275/32 (EP)

- Y02T10/12 (EP)

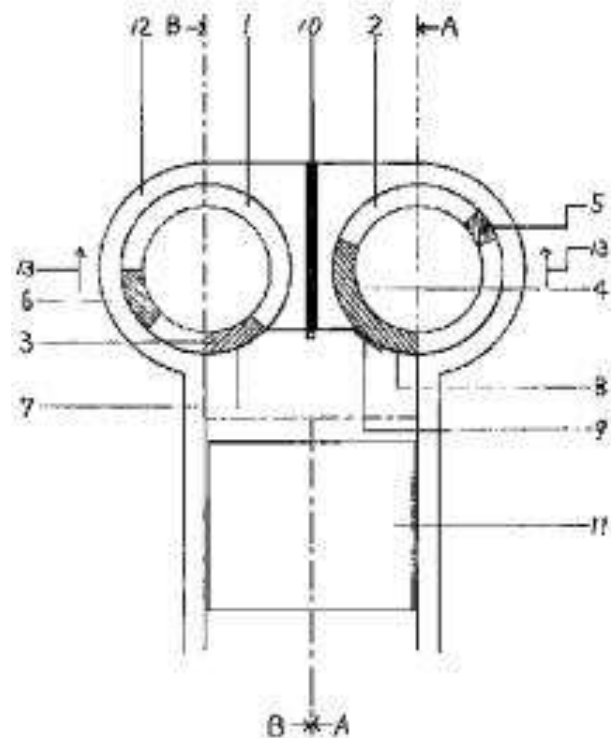
FI - F01L7/02&B; F01L7/02&C;
F02B29/08&G; F02D13/02&L

FT - 3G092/AA01; 3G092/AA07;
3G092/AA12; 3G092/AA13;
3G092/AA16; 3G092/BA01;
3G092/DA01; 3G092/DA02;
3G092/DA14; 3G092/DD01;
3G092/DD03; 3G092/FA24;
3G092/FA25; 3G092/FA50;
3G092/HA01X; 3G092/HA12X;
3G092/HA13X; 3G092/HA14X

PA - NAKADA OSAMU

TI - CORRESPONDENCE TO MIRROR
CYCLE IN TIME OF
HAVING **ROTARY** VALVE USED IN
FOUR-CYCLE GASOLINE ENGINE

AB - PURPOSE: To prevent any reverse
flow to a **carburetor** of a mixer
from occurring by installing this
mixer and both air exclusive
intake and exhaust ports, and in
time of a series of processes up
to intake air, compression and
expansion, setting up an air port
due to both up and down
motions of a **piston** by means of
a crankshaft at angle in the
specified range. CONSTITUTION:
An intake port and an exhaust
port 7 for mixture exclusive use
in a **combustion** chamber are
installed, and further an air port



8 opening simultaneously with the mixture exclusive intake port or somewhere little later in time of an intake process of air-fuel mixture, and rotating a crankshaft as far as 135 degrees from 30 degrees out of the bottom dead center even getting into a compression process, and being opened till a **piston** 11 goes up. Likewise, an air exclusive intake port 9 rotating the crankshaft as far as 160 degrees from 50 degrees out of the top dead center in time of an expansion process and opening while the **piston** 11 goes down, then closing at the bottom dead center, is installed as well. With this constitution, any possible flowing backward of the mixture to a **carburetor** is preventable, so the rate of a ratio of compression ratio < expansion ratio can be taken higher insofar as possible.

PN - [JP560259720](#) A 19851221

PR - JP19840115811 19840606

AP - JP19840115811 19840606

DT - I

CT - || STSE (A)
[JP50094313B](#) B 00000000 []

CCI - [F02B33/26](#) ; [F02B75/34](#)

CCA - [F02B2075/027](#)

CI - F02B33/26 (EP)
F02B75/34 (EP)

CA - F02B2075/027 (EP)

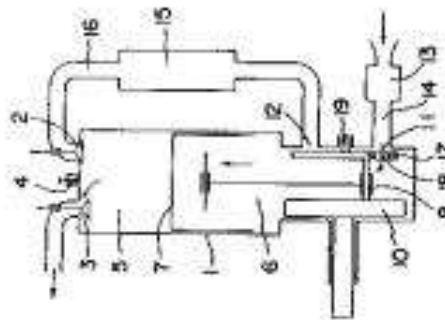
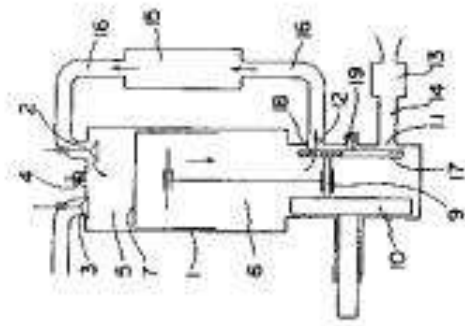
FI - F01L7/02&Z; F01L7/06&Z;
F02B33/30&J

FT - 3G005/BE10

PA - YAMADA NAOHARU

TI - FORCED FEEDING DEVICE OF
MIXTURE IN FOUR-CYCLE
INTERNAL-COMBUSTIONENGINE
FOR MODEL

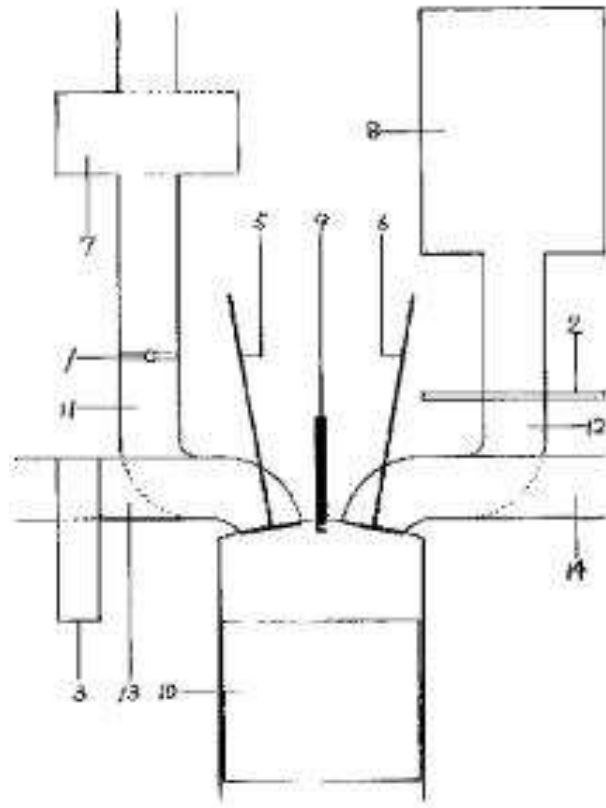
AB - PURPOSE:To increase the
quantity of a mixture in a device
by its simplified mechanism, by
sucking the mixture into a crank
chamber in exhaust and
compression strokes of an
ascending **piston** while forcing
the mixture in the crank chamber
to be fed by pressure into a
mixture tank in explosion and
intake strokes of the
descending **piston** so that the
mixture may be sucked into
a **combustion** chamber at one
time in the intake stroke.
CONSTITUTION:A mixture, being
allowed to flow in a **carburetor**
13, is sucked into a crank
chamber 6 from a valve hole 18
in a **rotary** disc valve 17 in
exhaust and compression
ascending strokes of a **piston**. A
mixture tank 15 is charged with
the mixture in the crank chamber
6 in explosion and intake
descending strokes of the **piston**.
Of the mixtures, the mixture, with



which the tank is charged twice in the explosion and intake strokes, is introduced at one time into a **combustion** chamber 5 from an intake port 2 by opening it in the intake stroke.

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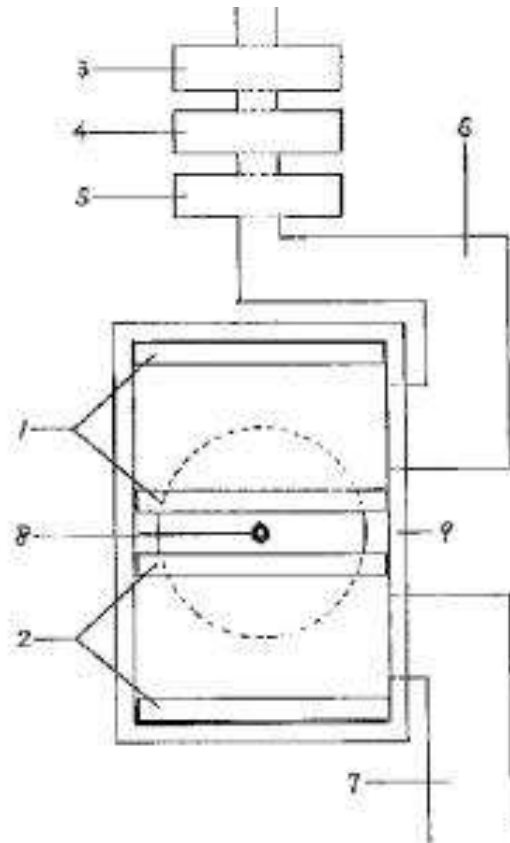
- PN - [JPH08246882](#) A 19960924
- PR - JP19950097346 19950310
- AP - JP19950097346 19950310
- DT - I
- CCI - [F02B75/021](#)
- CCA - [F02B1/04](#) ; [F02B2075/027](#)
- CI - F02B75/021 (EP)
- CA - F02B1/04 (EP)
F02B2075/027 (EP)
- FI - F01L1/00&A; F01L5/04;
F01L7/02&C; F02B29/06&C;
F02B29/08&E; F02B75/02&A;
F02D13/02&L; F02D9/10&A
- FT - 3G016/AA01; 3G016/AA02;
3G016/AA13; 3G016/CA24;
3G065/AA00; 3G065/AA10;
3G065/EA04; 3G065/EA05;
3G065/HA01; 3G065/HA04;
3G065/HA05; 3G092/AA01;
3G092/AA04; 3G092/AA07;
3G092/AA16; 3G092/BA01;
3G092/DA01; 3G092/DA02;
3G092/DA13; 3G092/DC07;
3G092/EA28; 3G092/EA29;
3G092/HA01X; 3G092/HE02Z
- PA - NAKADA OSAMU
- TI - AIR-FUEL MIXTURE EXCLUSIVE
PASSAGE, PASSAGE FROM
NOTHING EXISTENT SPACE,
OPENING-CLOSING OF AIR
EXCLUSIVE PASSAGE AND TYPE OF
THE OPENING-CLOSING DEVICE
WHEN **PISTON** VALVE
AND **ROTARY** VALVE ARE USED IN
4-CYCLE GASOLINE ENGINE AND 6-
CYCLE GASOLINE ENGINE
- AB - PURPOSE: To enhance engine
output by arranging an air-fuel



mixture exclusive intake air passage in which a **piston** valve or a **rotary** valve is interposed, a passage to communicate with a nothing existent space (a chamber) and an air exclusive passage in a **combustion** chamber in a cylinder.

CONSTITUTION: An air-fuel mixture exclusive passage 11 in which a **carburetor** 7 is interposed, a passage 12 extending from a nothing existent space (a chamber) 8 and an air exclusive passage 13 are formed so as to communicated with a **combustion** chamber of a 4-cycle engine or a 6-cycle gasoline engine. A blade type opening-closing device (or a **piston** valve or a **rotary** valve) 1 interposed in the air-fuel mixture exclusive passage 11 is controlled so as to be opened and closed, and engine rotating speed is maintained at desired rotating speed. The passage 12 from the nothing existent space 8 is opened and closed by a slide type opening-closing device 2 or the air exclusive passage 13 is opened and closed by a **piston** type opening-closing device 3, and more proper engine control is realized.

PN	- JPH09189208 A 19970722
PR	- JP19960052186 19960101
AP	- JP19960052186 19960101
DT	- I
CCA	- Y02T10/12
CA	- Y02T10/12 (EP)
FI	- F01L7/02&C; F01L7/02&Z; F02B29/04&R; F02B29/04&S; F02B33/32; F02B37/00&301H; F02B75/02&A
FT	- 3G005/DA00; 3G005/DA02; 3G005/DA03; 3G005/EA04; 3G005/EA05; 3G005/EA16; 3G005/FA05; 3G005/FA35; 3G005/FA45; 3G005/FA54; 3G005/HA13
PA	- NAKADA OSAMU
TI	- ROTARY VALVE INSTALLATION OF SUPERCHARGER SUCH AS TURBO CHARGER AND SUPER CHARGER, AND INSTALLATION OF INTERCOOLER SUCH AS AIR COOLING OR WATERCOOLING, IN USING ROTARY VALVE IN PLACE OF PISTON VALVE WHICH IS USED FOR FOUR CYCLE ENGINE AND SIX CYCLE ENGINE
AB	- PROBLEM TO BE SOLVED: To generate a large power and torque and also improve a combustion efficiency by installing a rotary valve mounted with a super charger such as a turbo-charger and supercharger in an intake port. SOLUTION: In four cycle engine (or six cycle engine), respective rotary valves 1,2 for intaking/exhausting are used instead of respective piston valves for intaking/exhausting. When the rotary valves 1, 2 are used like this, such supercharger 4 as a turbo-charger, supercharger is mounted in the downstream side of a carburetor 3 by an intake passage 6 in the



four cycle engine (the exclusive intake port for a mixed air and the exclusive intake port for air in a six cycle engine). An inter cooler 5 of air cooling or water cooling is mounted in the downstream side of each supercharger 4. Thereby, a larger power and torque can be generated with the same exhaust air amount and number of rotation.

10/11 © EPODOC / EPO

PN - [GB300555](#) A 19291024

PR - BEX300555 19271114

AP - GB19280033211 19281113

DT - *; Rep

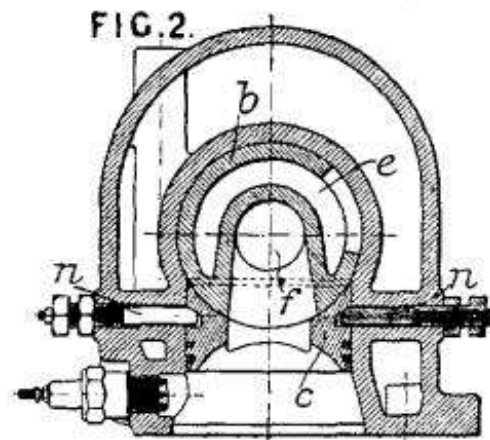
CCI - [F01L7/024](#)

CI - F01L7/024 (EP)

PA - ALFRED FEYENS

TI - Improvements in or relating to **rotary** valves for internal **combustion** engines

AB - 300,555. Feyens, A. Nov. 14, 1927, [Convention date]. Valves.- A **rotary** valve b, having a central exhaust conduit f surrounded by an annular inlet conduit e, is fitted at the cylinder ports with **piston** packing-members c pressed against the valve by the cylinder pressure and adjusted from the outside by means of screwed rods n with bevelled ends. In a modification, the **piston** members c are replaced by annular members fitted in grooves in the valve casing. The bearing at one end of the valve forms a cover to an inlet chamber in communication with the conduit e and with the **carburettor**.



11/11 © EPODOC / EPO

PN - [GB1496281](#) A 19771230

PR - US19740449241
19740308; US19740532391
19741213

AP - GB19750009483 19750307

DT - **

CCI - [F01L7/021](#) ; [F01L7/024](#) ;
[F01L7/026](#) ; [F01L7/18](#) ;
[F02B17/00](#) ; [F02B19/1033](#)

CCA - [F02B2075/027](#) ; [Y02T10/12](#)

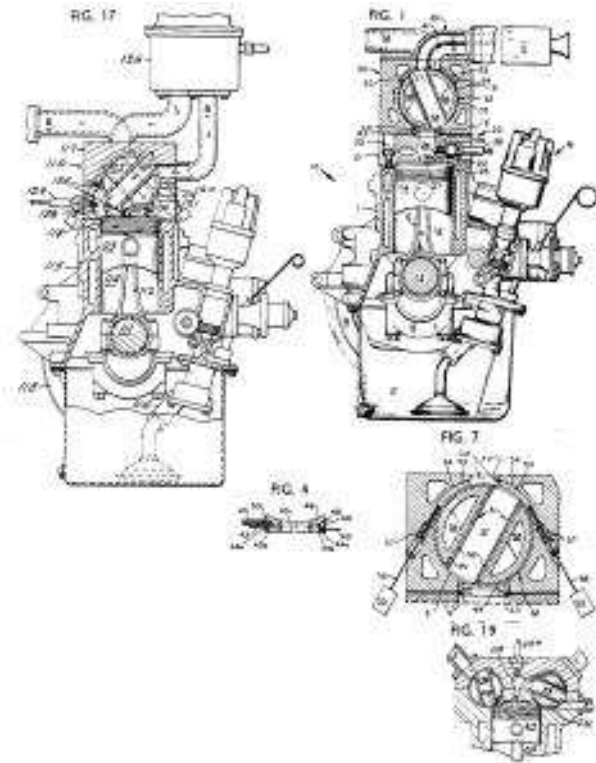
CI - F01L7/021 (EP, US)
F01L7/024 (EP, US)
F01L7/026 (EP, US)
F01L7/18 (EP, US)
F02B17/00 (EP, US)
F02B19/1033 (EP, US)

CA - F02B2075/027 (EP, US)
Y02T10/12 (EP, US)

PA - DANA CORP

TI - INTERNAL COMBUSTION ENGINES

AB - 1496281 **Rotary** valve engines
DANA CORP 7 March 1975 [8
March 1974 13 Dec 1974]
9483/75 Heading F1B An IC
engine of the **rotary** valve type
includes a cylinder in which
a **piston** is axially movable,
a **rotary** valve for controlling the
supply of fuel and air to said
cylinder and at least two
separate inlet ducts, one of the
ducts for supplying air or a lean
fuel/air mixture and the other of
the ducts for supplying a rich
fuel/air mixture, the valve
including at least one passage
which communicates the
respective inlet ducts with the
cylinder to form a stratified
charge within the engine
cylinder. Fig. 1 shows a four-
cylinder four-stroke engine
having a main **combustion**
chamber 24 and a pre-
combustion chamber 26 in which
is a spark plug 29. A **rotary** valve



32 is mounted for rotation in a bore 31 in head 30 and has a diametral passage 36.

A **carburetter** C provides a lean mixture of fuel and air, or air only, to inlet pipe L and a rich mixture to inlet pipe R. Valve 32 rotates clockwise, as seen in Fig. 1, at one-fourth of the crank-shaft speed and is timed so that during the initial part of the intake stroke of the **piston** the passage 36 communicates only with pipe L. During the latter part of the intake stroke, only rich mixture is drawn in, so that there is a layer of lean mixture adjacent the **piston** crown and rich mixture in the upper part of the main **combustion** chamber and in the pre-**combustion** chamber. An exhaust passage 37 is formed in the valve and connects the **combustion** chamber with exhaust pipe 34 during the exhaust stroke. Passages 36 and 37 are provided for each cylinder of the engine. The valve 32 is made of light alloy or cast iron and is fitted with a hard-chrome-plated external sleeve. To protect the bores of exhaust passages 37, heat resistant metal liners 51 e. g. of stainless steel, are fitted, with an air-space 52, Fig. 7, between the liners and the wall of the passage. Cooling liquid passages 38 extend through the valve. A resilient gasket 43, e.g. of stainless steel, is fitted between head 30 and an intermediate plate 21 and has apertures in it in which seals 44 are fitted. Each seal has a peripheral groove, Fig. 4, which receives the gasket, so that the seal is biased towards the valve. The seals are moulded from

carbon, or sintered iron or bronze. Carbon seals are lubricated by the water of **combustion** and metal seals are provided with a pressure oil supply through a pipe 47. The timing of the opening and closing of the inlet and exhaust ports is varied by circumferential movement of arcuate seals 53 which vary the effective width of the ports. The seals 53 are moved by vacuum motors 55 so that the ports are restricted during idling of the engine i.e. when a high degree of vacuum exists in the intake manifold. In a first modification, Fig. 17, the manifolds L and R are spaced angularly by 90 degrees around the valve and two inlet passages 122 and 123 are provided in the valve. Passage 122 admits lean mixture from manifold L and passage 123 conducts rich mixture from manifold R to pre- **combustion** chamber 128. In a second modification, Fig. 19, an inlet valve having two passages is provided, the pre-**combustion** chamber is on the cylinder axis and a separate exhaust valve having a single passage 234 is provided.