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(54) marine outboard engine
     Aussenbord-Brennkraftmaschine
     Moteur à hors-bord

(56) References cited:
     GB-A- 2 055 422
     US-A- 3 431 882
     US-A- 4 588 385

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The present invention relates to a marine outboard engine having an engine unit being vertically arranged with respect to a driving direction of a boat, said engine unit comprising a cylinder block having at least one cylinder, and a cylinder head connected to said cylinder block and defining at least one combustion chamber, said cylinder block further comprising an exhaust passage for collecting exhaust gases from the combustion chamber and for expelling said exhaust gases downward beneath the engine unit, said marine outboard engine further having a cooling structure for cooling said at least one cylinder and said at least one combustion chamber by means of a fresh coolant water, whereas said coolant water first is directed to the exhaust passage for firstly cooling said exhaust passage and then is directed to said at least one cylinder and respective combustion chamber.

Such an engine is known from GB-A-2 055 422.

The general structure for marine outboard engines that are mounted in small boats that is known to the art is one whereby, in order for the crankshaft to be disposed in the vertical direction, the engine unit in which the cylinders are arrayed in the vertical direction has been housed inside the top cowling at the top of the outboard engine. In such engines, in order to house such engines compactly, an exhaust passage is integrally formed in the cylinder block of the engine unit in order to convey the exhaust gases collected from the combustion chambers of the cylinders to the area beneath the engine unit.

In this type of marine outboard engine that has an exhaust passage integrally formed in the engine unit, there are additionally a coolant passage around the cylinders and a coolant passage around the exhaust passages in order to cool the areas around the cylinders and combustion chambers of the engine unit and around the exhaust passage using coolant water drawn up from below.

Figure 11 shows a conventional arrangement of these respective coolant passages in the engine unit. First, after the coolant water has been introduced through the inlet that opens on the lower end of the coolant passage 71 and around the exhaust passage on the cylinder block side, it branches off [severally] midway into the coolant passage 72 running around the exhaust passage and also continues on to cause the coolant to flow in from the bottom coolant passage 71 around the exhaust passage upward, from where it is directly sent to the bottom of the coolant passage 74 around the cylinders. The coolant flows upward from the bottom of said coolant passage 74, and it subsequently flows upward where the coolant is then [severally] branched off, and in addition, the coolant that is flowing through the coolant passage 71 around the exhaust passage in the cylinder block is gradually diverted midway, and then the coolant flowing through the coolant passage 72 proceeds through the coolant passage 73 around the combustion chambers and merges with the coolant passage 74 around the cylinders, and then finally, the various flows of coolant water around the cylinders are expelled through the outlet at the top of coolant passage 74 to the outside of the cooling circuit.

With regard to the overall cooling circuit for marine outboard engines, normally it is the case that outside water introduced into the lower case is used as the coolant, and this coolant water is drawn up by means of a water pump that is linked to the rotational drive of the engine. Midway in the coolant transmission piping, while cooling inside the upper case, the coolant is transmitted to the engine unit inside the top cowling. After the engine unit has been cooled by means of coolant passage through the above described cooling circuit, it is returned to the upper case where, after cooling the oil pan and muffler, the coolant is sent through the lower case and expelled to the outside of the unit.

However, with regard to marine outboard engine cooling structures such as described above for the coolant passages of the engine, the coolant is circulated in the coolant passage around the cylinders, applying a direct coolant flow without first circulating around the exhaust passage. In addition, since this coolant is merged with a flow of coolant that was heated by passing around the exhaust passage, in some areas, a temperature variation will develop in the coolant temperature flowing around the cylinders; this can cause uneven temperatures around the cylinders.

The result is the development of a significant deformation of the cylinders while the engine is running, which increases the resistance on the sliding motion of the pistons, and which can cause them to seize, increase the amount of blowby gas, promote higher oil consumption, and in addition, impair the combustion stability during low speed operations due to the coolant that is directly circulated around the cylinders and combustion chambers lowering the temperature of those combustion chambers.

Accordingly, it is an objective of the present invention to provide an improved marine outboard engine comprising a cooling system facilitating an always reliable cooling of the engine and simultaneously enhances the longevity of this marine outboard engine.

According to the present invention, this objective is solved for a marine outboard engine as indicated above in that a pressure valve being provided close to a downstream end of a coolant passage around the exhaust passage.

According to a preferred embodiment of the present invention, said coolant water is fed into the engine unit from its lower area and first is passing through a coolant passage around the exhaust passage and then is passing through a further coolant passage around the at least one cylinder and the respective combustion chamber.
In some cases, it is advantageous to control the temperature dependent amount of coolant expelled. In these cases, a thermostatic valve may be provided at the top of the engine unit close to the end of said coolant passage.

Furthermore, with regard to the above described marine outboard engines of the prior art that employed an exhaust passage integrally formed in the cylinder block, and that had a water jacket formed around the cylinders, because the heat from the exhaust gases was transmitted to the area around the cylinders on the exhaust passage side, a very large temperature difference would develop between the exhaust side and the air intake side of the engine.

Increasing the size of the water jacket around the cylinders on the exhaust passage side could be considered a way to insulate them from the heat from the exhaust gases, but if the size of the water jacket were varied between the intake side and the exhaust side, the effect of the coolant would differ between the exhaust side and the air intake side. In the final analysis, temperature differences would develop between the exhaust side and air intake side of the engine unit in the region around the cylinders.

As a result, when the temperature is not uniform around the cylinders in the cylinder block, problems would arise from the resulting deformation of the cylinders during engine operation, such as increased sliding resistance of the pistons that could result in seizing or increases in blow-by gases, and additionally, increased oil consumption.

Another solution of the afore-mentioned objective, according to the present application, is given by providing a heat insulating space between the exhaust passage and the coolant passage surrounding said at least one cylinder. This solution is an independent one but it can also be applied simultaneously with the solution of claim 1.

According to a further preferred embodiment of the present invention, four coolant passages are provided, a first coolant passage around the exhaust passage in the cylinder block, a second coolant passage around the exhaust passage in the cylinder head, a third coolant passage around the respective combustion chamber of the cylinder, and a fourth coolant passage around the cylinder in the cylinder block.

In that case, it may be advantageous that the first and second coolant passages are connected in series and that the third and fourth coolant passages are both connected in parallel to the second coolant passage or that the second and first coolant passages are connected in series and that third and fourth coolant passage are both connected in parallel to the first coolant passage.

Other preferred embodiments of the present invention are laid down in further dependent claims.

In the following, the present invention is explained in greater detail with respect to several embodiments thereof in conjunction with the accompanying drawings, wherein:

Figure 1 is a diagram seen from the starboard side of a marine outboard engine having the cooling structure of this invention.

Figure 2 is a partial sectional diagram for purposes of explanation of the internal structure of the marine outboard engine shown in Figure 1.

Figure 3 is a partial sectional diagram for purposes of explanation of the internal structure of the engine in the top cowling area.

Figure 4 is a side view for purposes of explanation of the upper case area showing the internal structure of the marine outboard engine shown in Figure 2.

Figure 5 is a top sectional view for purposes of explanation of the top cowling area internal structure of the marine outboard engine shown in Figure 2.

Figure 6 is an enlarged, top sectional view for purposes of explanation of the engine shown in Figure 5.

Figure 7 is a rear surface view of the cylinder block when viewed from the direction of arrow A in Figure 6.

Figure 8 is a block diagram showing an embodiment of the cooling circuit for a marine outboard engine cooling structure according to this invention.

Figure 9 is a block diagram showing another embodiment of the cooling circuit for a marine outboard engine cooling structure according to this invention.

Figure 10 is a block diagram showing yet another embodiment of the cooling circuit for a marine outboard engine cooling structure according to this invention, and

Figure 11 is a block diagram showing an example of a conventional cooling circuit for marine outboard engines.

Implementation embodiments of cooling structures for marine outboard engines will be described below for marine outboard engines according to the present invention.

Figure 1 is a starboard side external view of a marine outboard engine equipped with the cooling structure of this invention. The various parts of the marine engine 1 are housed inside a housing composed of a top cowling 2, upper case 3 and lower case 4. The top cowling 2 is composed of the upper cowling 2a, a lower cowling 2b and the air duct cover 2c, while the upper case 3 is covered at its top by the apron 5, and the propeller 6 is attached opposite the lower case 4. The engine is attached to the stern of the boat 8 by an attachment member 7 which allows it to be raised or lowered and turned left and right.

Figures 2 through 5 show the positioning of the various parts of the marine engine 1 inside the housing. Figure 2 is a view of the internals of the engine 1 from
the starboard side; Figure 3 shows the region under the
top cowling 2; Figure 4 shows the upper casing region;
and Figure 5 shows a top view of the inside of the top
cowling 2.

[0024] The various cylinders of the marine engine 1
are arrayed vertically in the 4-cycle, 4-cylinder, L-type
engine 10, to which an exhaust guide 11 is affixed be-
tween the bottom cowling 2b and the upper case 3. A
cover member 12 is affixed to and covers the upper sur-
face of the exhaust guide and is contained within the top
cowling 2.

[0025] The air intake and exhaust valves 17, 18 for
the various cylinders are attached to the cylinder head
14, and the camshafts 20, 21 that drive the respective
valves 17, 18 are positioned with their respective rota-
tional axes disposed in the vertical direction; they are
axially supported by the cam caps 22 that cover the
head cover and by the bearing area of the cylinder head
14. Cam pulleys 23, 24 are attached to the respective
top ends of each camshaft 20, 21.

[0026] The crankshaft 26 is axially supported with its
rotational axis in the vertical direction in the crank cham-
ber 25, which is the space bounded by the front of the
cylinder block 15 and the crankcase 16. A flywheel 27
is attached to the upper end of the crankshaft 26 and a
timing pulley 30 is attached under the flywheel 27. The
timing belt 28 spans the timing pulley 30 and the cam
pulleys 23, 24 in a manner such that the rotation of the
crankshaft is transmitted to the camshafts 20, 21 to drive
the air intake and exhaust valves 17, 18.

[0027] A tensioner 29 engages the timing belt 28 to
prevent it from slackening. This tensioner 29 constantly
pushes the timing belt 28 toward the inside by means of
a gas filled cylinder (not shown).

[0028] The surge tank 31 is positioned on the front left
side of the engine and it integrally connects with the front
face of the crankcase 16. The air intake passage 32 that
extends from the surge tank 31 connects, via the throt-
tle, with the air intake ports 34 of the cylinders at ver-
tically disposed intervals on the left side of the cylinder
head 14.

[0029] The exhaust ports 35 on the right side of the
engine connect at vertically disposed intervals with the
combustion chambers of the cylinders. An exhaust pas-
sage 36, which is integrally formed in the cylinder block
at the right of the cylinders 37, collects the exhaust gas-
es expelled from the exhaust ports 35 and expels that
gas to the area beneath the engine unit. This exhaust
passage 36 that extends vertically inside the cylinder
block 15 is connected at its lower end to the exhaust
passage 11a of the exhaust guide 11.

[0030] The foregoing engine 10 is further equipped
with an oil pump located near the lower end of the crank-
shaft 26 and drawing-in lubricating oil from an oil pan
located beneath the exhaust guide 11 and delivering it
via an oil passage inside the engine unit. A thermostat
valve 41 controls the outflow of the coolant according to
the temperature around the cylinders and combustion
chambers, and a pressure valve 42 is further mounted
inside the coolant passage that allows coolant to escape
when the pressure in said coolant passage exceeds a
certain level.

[0031] There are also a fuel tank (not shown) mounted
in the boat and a fuel pump 43 that is located on the air
intake side which pumps fuel to the engine 10. Also, at-
tached to the exhaust side of the engine unit is a pilot
water pipe to which a part of the coolant from the coolant
passage in the engine is diverted and discharged from
the water discharge opening 45 of the top cowling as
pilot water.

[0032] As is shown in Figure 4, the coolant returning
from the engine 10 is temporarily pooled in a water res-
ervoir 50 that is positioned under the top cowling 2
in the upper case 3. Said water reservoir 50 is isolated
from the vertically disposed drive shaft 51 that connects
to the top end of the crankshaft 26 of the engine 10, and
its bottom end extends to the inside of the lower case 4.

[0033] There is a water pump 52 that is driven by
the drive shaft 51 and located near the lower case 4 crossed
by the drive shaft 51 that passes through the upper case
3. While not shown in the Figures, the water intake of
said water pump 51 is connected with a coolant water
intake pipe that extends downward inside the lower case
and with a coolant transport pipe 53 that extends upward
to the engine 10 through the upper case 3.

[0034] On the other hand, an oil pan 54 bottom mem-
ber is tightly attached to the lower surface of the exhaust
guide 11 at the water reservoir 50 of the upper case 3
in a manner such that its upper opening is closed off by
the bottom surface of the exhaust guide 11. Integrially
attached at the center of the bottom member of said oil
pan 54 is an exhaust pipe insert member 54a that is
pipe-shaped and passes above and below the air space
inside the oil pan 54.

[0035] Further, a muffler (exhaust gas expansion
chamber) 55 is attached to the exhaust gas outlet 55a
located in the lower wall of the oil pan 54 and covers the
exhaust gas pipe insert member 54a of the bottom sur-
face of the oil pan 54 beneath the water reservoir 50.
The space inside said muffler 55 connects by means of
an exhaust gas outlet 55a to an exhaust passage formed
inside the lower case (not shown).

[0036] An exhaust pipe 56 is attached to the exhaust
gas pipe insert member 54a of the oil pan 54 which con-
nects it to the exhaust passage 11a of the exhaust guide
11. The bottom end of the exhaust pipe 56 projects
downward from the oil pan 54 and opens inside the muff-
ner 55. The exhaust passage 11a formed by the exhaust
pipe 56 and the exhaust guide 11 connect the space in-
side the muffler 55 to the exhaust passage 36 of the en-
geine.

[0037] There is a suction pipe 57 that projects down-
ward from the bottom surface of the exhaust guide 11,
drawing oil residing in the oil pan 54 into the oil pump
38 for the engine 10.

[0038] There is a water pipe 58 integrally formed in
the perimeter wall of the oil pan 54 that permits the over-
flow of water from the water reservoir 50 surrounding
the oil pan 54. The water passage composed of the wa-
ter pipe 58 fitted with a water inlet opening inside the
water reservoir 50 connects via the water passage 55b,
that is integrally formed on the top outer wall of the muf-
fler 55, to the water drain opening 3a of the upper case 3.

[0039] The water drain passage 59 that continues
from the water drain opening 3a in the upper case to the
lower case divides at its lower end and further divides
above the idle expansion chamber that passes through
the muffler 55 and opens into the drain hole 61 and the
drain hole 62 which connect with the outside of the en-
gine at the idle expansion chamber 60.

[0040] While not shown in the figures, the drive shaft
51, which passes through the upper case, is axially sup-
ported in the lower case 4 beneath the upper case 3.
The lower end of said drive shaft 51 is attached to the
rotating shaft of the propeller 6 via a shiftable gear unit.

[0041] Also omitted from the figures is a cold water
inlet mounted on the lower case 4 that draws in cold wa-
ter from the water pump, and, in addition, an exhaust
passage that is attached to the muffler 55 and allows
expelling exhaust gases underwater in conjunction with
the rotation of the propeller 6, and this passage is par-
titioned into a coolant drain passage allowing to expel
to the engine-outside the coolant water that drops down
from the upper case.

[0042] With regard to the exhaust route for the marine
outboard engine 1 with the various members located as
described above, the exhaust gases, which are expelled
downward from the exhaust passage 36 formed in the
engine unit, pass through the exhaust passage 11a of
the exhaust guide 11 and the exhaust pipe 56 into the
muffler 55, and then pass through the idle expansion
chamber 60 through the exhaust hole and 61 are ex-
pelled into the atmosphere, while in addition, when the
engine is running and the propeller 6 is turning, the ma-
jority of the exhaust gases pass from the exhaust outlet
55a in the muffler 55 and pass through the exhaust pas-
sage in the lower casing 4, and are expelled underwater
in conjunction with the rotation of the propeller 6.

[0043] With regard to the cooling circuit of the marine
outboard engine 1, the coolant water drawn up by the
water pump 52 though the water inlet of the lower case
4 cools inside the upper case 3 while flowing through
the coolant conduit 53 into the engine 10 fitted with an
integrated exhaust passage 36 in the cylinder block 15. As is shown in Figure 6, formed in the cylinder
head 14 are a coolant passage (water jacket) 73 which
runs around the combustion chambers, and a coolant
passage (water jacket) 72 which runs around the ex-
haust passage (exhaust ports 29); and in addition,
formed in the cylinder block, are a coolant passage (wa-
ter jacket) 74 around the cylinders and a coolant pas-
sage (water jacket) 71 around the exhaust passage 36,
respectively.

[0044] With a marine outboard engine as described
above, the water pump 52 transmits the coolant through
the coolant conduit 53 into the engine 10 fitted with an
integrated exhaust passage 36 in the cylinder block 15. As is shown in Figure 6, formed in the cylinder
head 14 are a coolant passage (water jacket) 73 which
runs around the combustion chambers, and a coolant
passage (water jacket) 72 which runs around the ex-
haust passage (exhaust ports 29); and in addition,
formed in the cylinder block, are a coolant passage (wa-
ter jacket) 74 around the cylinders and a coolant pas-
sage (water jacket) 71 around the exhaust passage 36,
respectively.

[0045] In addition to the coolant passages 71, 74,
there is also an insulating space 76 formed in the cylin-
der block 15, which prevents exhaust heat from the ex-
haust passage 26 from being transmitted to the side of
the cylinders 37, while a coolant return passage formed
in the cylinder block returns coolant that has passed
through the thermostat valve 41 and was expelled
through the cooling circuit back to inside of the upper
case 3.

[0046] As is shown in Figure 7, because of the vertical
array of the cylinders, the various coolant passages 71,
72, 73 and 74 are all vertically disposed coolant pas-
sages, and coolant water that passes from the coolant sup-
ply pipe 53 through the exhaust guide 7, passes through
the coolant passages 71, 72, 73 and 74, and because
these coolant passages 71, 72, 73 and 74 all connect
to form one cooling circuit, the coolant thereby may be
expelled from the top of the engine unit (cylinder block
15).

[0047] Figure 8 shows the cooling structure for the
present embodiment with its constituent coolant pas-
sages 71, 72, 73 and 74 that were described above. In
this engine cooling circuit formed by these coolant pas-
sages 71, 72, 73 and 74, the water pump 52 pumps wa-
ter through the coolant transmission pipe 53 and the ex-
haust guide 11 in a manner such that it first flows from
the bottom to the cylinder block 15 side, and enters the
coolant passage 71 that lies around the exhaust pas-
sage.

[0048] Then the coolant is circulated in the vertical di-
rection from the coolant pipe 72 around the exhaust pas-
sage in the cylinder head 14 through the cooling circuit,
in the cylinder block 15, formed around the exhaust pas-
sage, and then it circulates from bottom to top respec-
tively through the coolant passage 73 around the comb-
bustion chambers in the cylinder head 14 and through
the coolant passage 74 around the cylinders in the cy-
inder block 15, and then it is expelled from the cooling
circuit at the top of the coolant passage 74 around the
cylinders in the cylinder block 15.

[0049] To wit, the engine cooling structure in the
present embodiment connects the coolant passages 71,
72 around the exhaust passages in series with the cool-
ant passages 73, 74 around the cylinders and combus-
tion chambers in forming the cooling circuit for the en-
gine unit.

[0050] Furthermore, with regard to the cooling circuit
in the present embodiment, there is a thermostat valve 41 to control the amount of coolant expelled according to the temperature around the cylinders and combustion chambers; it is located at the top of the engine unit at the outlet for the coolant in the cooling circuit. In addition, there is also a pressure valve 42 that allows the coolant to escape from said cooling circuit when the water pressure inside the cooling circuit rises above a certain level, and it is located in the downstream end of the coolant passages 71, 72 formed around the exhaust passage.

The coolant that is expelled through the thermostat valve 41 passes through the coolant return passage 77 in the engine unit and the exhaust guide 11 and returns to the inside the upper case 3; the coolant that escapes from the pressure valve 42 passes through the coolant return pipe 78, the exhaust guide 11, and is returned to inside of the upper case 3.

Comparing the above described cooling structure for marine outboard engines of the present embodiment and forming a cooling circuit as described above, with the engine cooling structure of the prior art, that has the cooling circuit as shown in Figure 11, because in this invention, the coolant is sent only through the circuit composed of the coolant passages 73, 74 around the combustion chambers and the cylinders, and the coolant passages 71, 72 around the exhaust passage, no localized variations develop in the coolant temperature around the cylinders 37, thereby maintaining temperature uniformity around the cylinders, further making it possible to inhibit the deformation of the cylinders 37 during engine operations, to prevent piston-seizing or increases in the amount of blowby gases and, at the same time, to hold down oil consumption.

Furthermore, since all the coolant taken into the engine unit 10 has first been circulated through the coolant passages 71, 72 around the exhaust passage without being branched off, there is an enhanced cooling efficiency in the high temperature exhaust passage, and then the coolant that has been adequately heated around the exhaust passage is supplied to the coolant passages 73, 74 around the combustion chambers and cylinders, thereby improving the combustion stability of the engine during low speed operations.

Further, as shown for the prior art engine cooling structure in Figure 11, the pressure valve 42 for returning the coolant is positioned near the cooling circuit inlet, but in the present embodiment, that pressure valve 42 is located near the downstream end of the coolant passages 71, 72 around the exhaust passages, so even when the thermostat valve 41 is closed, coolant is circulated through the coolant passages 71, 72 around the exhaust passages, thereby assuring cooling the high temperature exhaust passages 35, 36.

The foregoing explanation has described but one embodiment of the engine cooling structure for marine outboard engines according to this invention, but the present invention is not confined to this embodiment. Figures 9 and 10, for example, show other possible cooling circuits, and it goes without saying that the design can be modified appropriately.

As described above, the present invention's cooling structure for marine outboard engines provides, through the same circuit, coolant at a uniform temperature that has flowed around the exhaust passage, to the bottom of the coolant passages around the cylinders and combustion chambers, thereby minimizing the temperature difference between the top and bottom cylinders and making it possible to maintain a uniform temperature distribution around the cylinders, to maximize the cooling provided to around the exhaust passage, and to allow the efficient absorption of heat around the exhaust passage.

As a result, it is possible to decrease the amount of cylinder deformation during engine operations, to prevent seizing, to improve or reduce the amount of blowby gases, and to inhibit increases in oil consumption, and, at the same time, to improve combustion stability during low speed operations.

Claim 1. Marine outboard engine (1) having an engine unit (10) being vertically arranged with respect to a driving direction of a boat (8), said engine unit (10) comprising a cylinder block (15) having at least one cylinder (37), and a cylinder head (14) connected to said cylinder block (15) and defining at least one combustion chamber, said cylinder block (15) further comprising an exhaust passage (36) for collecting exhaust gases from the combustion chamber and for expelling said exhaust gases downward beneath the engine unit (10), said marine outboard engine (1) further having a cooling structure for cooling said at least one cylinder (37) and said at least one combustion chamber by means of a fresh coolant water, whereas said coolant water first is directed to the exhaust passage (36) for firstly cooling said exhaust passage (36) and then is directed to said at least one cylinder (37) and respective combustion chamber, characterized in that a pressure valve (42) being provided close to a downstream end of a coolant passage (71,72) around the exhaust passage (36).

2. Marine outboard engine (1) as claimed in claim 1, characterized in that said coolant water is fed into the engine unit (10) from its lower area and first is passing through a coolant passage (71,72) around the exhaust passage (36) and then is passing through a further coolant passage (73,74) around the at least one cylinder (37) and the respective combustion chamber.

3. Marine outboard engine as claimed in claims 1 or
2. characterized in that the coolant in the coolant passage (73,74) and the cylinder (37) and respective combustion chamber is fed to flow from the bottom to the top of said engine unit (10) and is expelled out of the coolant passage (73,74) at the top of the engine unit (10).

4. Marine outboard engine as claimed in at least one of claims 1 to 3, characterized in that a thermostatic valve (41) being provided at the top of the engine unit (10) close to the end of said coolant passage (73,74) for controlling the temperature dependent amount of coolant expelled.

5. Marine outboard engine, as claimed in at least one of claims 1 to 4, characterized by a heat insulating space (76) between the exhaust passage (36) and the coolant passage (74) surrounding said at least one cylinder (37).

6. Marine outboard engine as claimed in at least one of claims 2 to 5, characterized in that four coolant passages (71,74) are provided, a first coolant passage (71) around the exhaust passage (36) in the cylinder block (15), a second coolant passage (72) around the exhaust passage (35) in the cylinder head (14), a third coolant passage (73) around the respective combustion chamber of the cylinder (37), and a fourth coolant passage (74) around the cylinder (37) in the cylinder block (14).

7. Marine outboard engine as claimed in claim 6, characterized in that the first and second coolant passages (71,72) are connected in series and that the third and fourth coolant passages (73,74) are both connected in parallel to the second coolant passage (72) or that the second and first coolant passages (72,71) are connected in series and that third and fourth coolant passage (73,74) are both connected in parallel to the first coolant passage (71).

8. Marine outboard engine as claimed in claim 7, characterized in that a waterpump (52) is connected to the first or to the second coolant passage (71,72).

9. Marine outboard engine as claimed in claims 7 or 8, characterized in that the third and fourth coolant passages (73,74) comprising passages interconnecting the respective combustion chamber coolant passage with the respective cylinder (37) coolant passage.

10. Marine outboard engine as claimed in one of claims 1 to 9, characterized in that the coolant expelled at the top of the engine unit (10) is returned via a first coolant return pipe (27).

11. Marine outboard engine as claimed in one of claims 1 to 10, characterized in that the coolant expelled at the pressure valve (42) is returned via a second coolant return pipe (78).

12. Marine outboard engine as claimed in one of claims 1 to 11, characterized in that said exhaust passage (36) being integrally formed in the cylinder block (15).

Patentansprüche

1. Außenbordmotor (1), der eine Motoreinheit (10) hat, die senkrecht in Bezug zu einer Fahrtrichtung eines Bootes (8) angeordnet ist, wobei die Motoreinheit (10) einen Zylinderblock (15) aufweist, der zumindest einen Zylinder (37) und einen Zylinderkopf (14), verbunden mit dem Zylinderblock (15) hat und der zumindest eine Brennkammer begrenzt, der Zylinderblock weist außerdem einen Auslaßkanal (36) zum Sammeln von Auslaßgas von der Brennkammer und für das Ausweisen des Auslaßgases abwärts auf, wobei die Außenbordmotor (1) außerdem einen Kühlrauabau zum Kühlen des zumindest eines Zyliner (37) und der zumindest einer Brennkammer mittels eines frischen Kühlwassers hat, wobei das Kühlwasser zuerst zu dem Auslaßkanal (36) und dann zu dem zumindest einen Zylinder (37) und die jewelige Brennkammer gerichtet ist, dadurch gekennzeichnet, daß ein Druckventil (42) nahe eines stromabwärtigen Endes eines rund um den Auslaßkanal (36) vorgesehenen Kühlkanals (71, 72) vorgesehen ist.

2. Außenbordmotor (1), wie in Anspruch 1 beansprucht, dadurch gekennzeichnet, daß das Kühlwasser in die Motoreinheit (10) von ihrem unteren Bereich zugeführt wird und zuerst durch einen Kühlkanal (71, 72) um den Auslaßkanal (36) durchgeht und dann durch einen weiteren Kühlkanal (73, 74) um zumindest einen Zylinder (37) und die jeweilige Brennkammer hindurchgeht.

3. Außenbordmotor (1), wie in Anspruch 1 oder 2 beansprucht, dadurch gekennzeichnet, daß das Kühlmittel in dem Kühlkanal (73, 74) und dem Zylinder (37) und die jeweilige Brennkammer so zugeführt wird, um von dem Boden zu der Oberseite der Motoreinheit (10) zu fließen und von dem Kühlkanal (73, 74) an der Oberseite der Motoreinheit (10) ausgewiesen wird.

4. Außenbordmotor (1), wie zumindest in einem der Ansprüche 1 bis 3 beansprucht, dadurch gekennzeichnet, daß ein Thermostatventil (41) an der Oberseite der Motoreinheit (10) vorgesehen ist, na-
he dem Ende des Kühlkanales (73, 74), zum Steuern des temperaturabhängigen Betrages des ausgeworffenen Kühlmittels.

5. Außenbordmotor (1), wie zumindest in einem der Ansprüche 1 bis 4 beansprucht, gekennzeichnet durch einen Wärmeisolierraum (76) zwischen dem Ausläßkanal (36) und dem Kühlkanal (74), der den zumindest einen Zylinder (37) umgibt.

6. Außenbordmotor (1), wie zumindest in einem der Ansprüche 2 bis 5 beansprucht, dadurch gekennzeichnet, daß vier Kühlkanäle (71, 74) vorgesehen sind, ein erster Kühlkanal (71) um den Ausläßkanal (36) in dem Zylinderblock (15) herum, ein zweiter Kühlkanal (72) um den Ausläßkanal (35) in dem Zylinderkopf (14) herum, ein dritter Kühlkanal (73) um die jeweilige Brennkammer des Zylinders (37) herum und ein vieter Kühlkanal (74) um den Zylinder (37) in dem Zylinderblock (14) herum.

7. Außenbordmotor, wie in Anspruch 6 beansprucht, dadurch gekennzeichnet, daß der erste und zweite Kühlkanal (71, 72) in Reihe verbunden sind und daß der dritte und vierte Kühlkanal (73, 74) beide parallel mit dem zweiten Kühlkanal (72) verbunden sind, oder daß der zweite und erste Kühlkanal (71, 72) in Reihe verbunden sind und daß der dritte und vierte Kühlkanal (73, 74) beide parallel mit dem ersten Kühlkanal (71) verbunden sind.

8. Außenbordmotor, wie in Anspruch 7 beansprucht, dadurch gekennzeichnet, daß eine Wasserpumpe (52) mit dem ersten oder mit dem zweiten Kühlkanal (71, 72) verbunden ist.


10. Außenbordmotor, wie in einem der Ansprüche 1 bis 9 beansprucht, dadurch gekennzeichnet, daß das Kühlmittel, ausgeworfen an der Oberseite der Motoreinheit (10), mittels einer ersten Kühlmittel- Rückführleitung (27) zurückgeführt wird.

11. Außenbordmotor, wie in einem der Ansprüche 1 bis 10 beansprucht, dadurch gekennzeichnet, daß das Kühlmittel, ausgeworfen an dem Druckventil (42) mittels einer zweiten Kühlmittel- Rückführleitung (78) zurückgeführt wird.

12. Außenbordmotor, wie in einem der Ansprüche 1 bis 11 beansprucht, dadurch gekennzeichnet, daß der Ausläßkanal (36) einstückig in dem Zylinderblock (15) ausgebildet ist.

**Revendications**

1. Moteur à combustion interne hors-bord marin (1), ayant une unité de moteur à combustion interne (10) agencée verticalement par rapport à une direction de propulsion d'un bateau (8), ladite unité de moteur à combustion interne (10) comprenant un bloc-cylindre (15) ayant au moins un cylindre (37) et une culasse (14) reliée audit bloc-cylindre (15) et définissant au moins une chambre de combustion, ledit bloc-cylindre (15) comprenant en outre un passage d'échappement (36) pour collecter des gaz d'échappement venant de la chambre de combustion et pour expulser lesdits gaz d'échappement vers le bas, au-dessous de l'unité à moteur à combustion interne (10), ledit moteur à combustion interne hors-bord marin ayant en outre une structure de refroidissement, pour refroidir ledit au moins un cylindre (37) et au moins une chambre de combustion, au moyen d'eau de refroidissement neuve, tandis que ladite eau de refroidissement est d'abord dirigée sur le passage d'échappement (36) pour d'abord refroidir ledit passage d'échappement (36) puis dirigée sur ledit au moins un cylindre (37) et la chambre de combustion respective, caractérisé en ce qu'une valve de pression (42) est prévue proche d'une extrémité aval d'un passage de refroidissement (71, 72) autour du passage d'échappement (36).

2. Moteur à combustion interne hors-bord marin (1) selon la revendication 1, caractérisé en ce que la dite eau de refroidissement est fournie dans l'unité à moteur à combustion interne (10) depuis sa surface inférieure et d'abord est passée par un passage à fluide de refroidissement (71, 72) ménagé autour du passage d'échappement (36), puis est passée par un autre passage à fluide de refroidissement (73, 74) autour du au moins un cylindre (37) et de la chambre de combustion respective.

3. Moteur à combustion interne hors-bord marin selon la revendication 1 ou 2, caractérisé en ce que le fluide de refroidissement, passant dans le passage à fluide de refroidissement (73, 74) et le cylindre (37) et la chambre de combustion respective, est mis en écoulement depuis le bas vers le haut de ladite unité de moteur à combustion interne (10) et expulsé du passage à fluide de refroidissement (73, 74) en partie haute de l'unité du moteur à combustion interne (10).

4. Moteur à combustion interne hors-bord marin selon au moins l'une des revendications 1 à 3, caractérisé en ce qu'une valve thermostatique (41) est prévue en partie haute de l'unité à moteur à combustion interne (10), près de l'extrémité dudit passage à fluide de refroidissement (73, 74), pour commander la
température en fonction de la quantité de fluide de refroidissement expulsé.

5. Moteur à combustion interne hors-bord marin selon au moins l'une des revendications 1 à 4, caractérisé par un espace d'isolation thermique (76), prévu entre le passage d'échappement (36) et le passage à fluide de refroidissement (74) entourant ledit au moins un cylindre (37).

6. Moteur à combustion interne hors-bord marin (1) selon au moins l'une des revendications 2 à 5, caractérisé en ce que quatre passages à fluide de refroidissement (71, 74) sont prévus, un premier passage à fluide de refroidissement (71), autour du passage d'échappement (36) dans le bloc-cylindre (15), un deuxième passage à fluide de refroidissement (72), autour du passage des gaz d'échappement (35) dans la culasse (14), un troisième passage à fluide de refroidissement (73), autour de la chambre de combustion respective du cylindre (37), et un quatrième passage à fluide de refroidissement (74) autour du cylindre (37) dans le bloc-cylindre (14).

7. Moteur à combustion interne hors-bord marin selon la revendication 6, caractérisé en ce que les premier et deuxième passages à fluide de refroidissement (71, 72) sont reliés en série, et en ce que les troisième et quatrième passages à fluide de refroidissement (73, 74) sont, les deux, reliés en parallèle au deuxième passage à fluide de refroidissement (72), ou bien les deuxième et premier passages à fluide de refroidissement (71, 72) sont reliés en série et les troisième et quatrième passages à fluide de refroidissement (73, 74) sont, les deux, reliés en parallèle au premier passage à fluide de refroidissement (71).

8. Moteur à combustion interne hors-bord marin selon la revendication 7, caractérisé en ce qu'une pompe à eau de refroidissement (52) est reliée au premier ou au deuxième passage à fluide de refroidissement (71, 72).

9. Moteur à combustion interne hors-bord marin selon la revendication 7 ou 8, caractérisé en ce que les troisième et quatrième passages à fluide de refroidissement (73, 74) comprennent des passages interconnectant le passage à fluide de refroidissement de chambre à combustion respective au passage à fluide de refroidissement de cylindre (37) respectif.

10. Moteur à combustion interne hors-bord marin selon l'une des revendications 1 à 9, caractérisé en ce que le fluide de refroidissement expulsé en partie haute de l'unité à moteur à combustion interne (10) est retourné via un premier tuyau de retour de fluide de refroidissement (27).

11. Moteur à combustion interne hors-bord marin selon l'une des revendications 1 à 10, caractérisé en ce que le fluide de refroidissement expulsé à la valve de pression (42) est retourné via un deuxième tuyau de retour de fluide de refroidissement (78).

12. Moteur à combustion interne hors-bord marin selon l'une des revendications 1 à 10, caractérisé en ce que ledit passage d'échappement (36) est formé d'une seule pièce dans le bloc-cylindre (15).
FIGURE 1
FIGURE 8

Around combustion chambers in the cylinder head

Around exhaust passage in the cylinder head

Around the cylinders in the cylinder block

Around exhaust passage in the cylinder block

to upper case

WP
Figure 9

Around combustion chambers in the cylinder head

Around the cylinders in the cylinder block

Around exhaust passage in the cylinder head

Around exhaust passage in the cylinder block
FIGURE 10

Around combustion chambers in the cylinder head

Around exhaust passage in the cylinder head

Around the cylinders in the cylinder block

Around exhaust passage in the cylinder block

to upper case
Around combustion chambers in the cylinder head

Around exhaust passage in the cylinder head

Around the cylinders in the cylinder block

Around exhaust passage in the cylinder block

to upper case

FIGURE 11

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