Sept. 4, 1962 E. C. KIEKHAEFER ETAL 3,052,086

TUNED EXHAUST FOR OUTBOARD MOTORS

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Fig. 1.

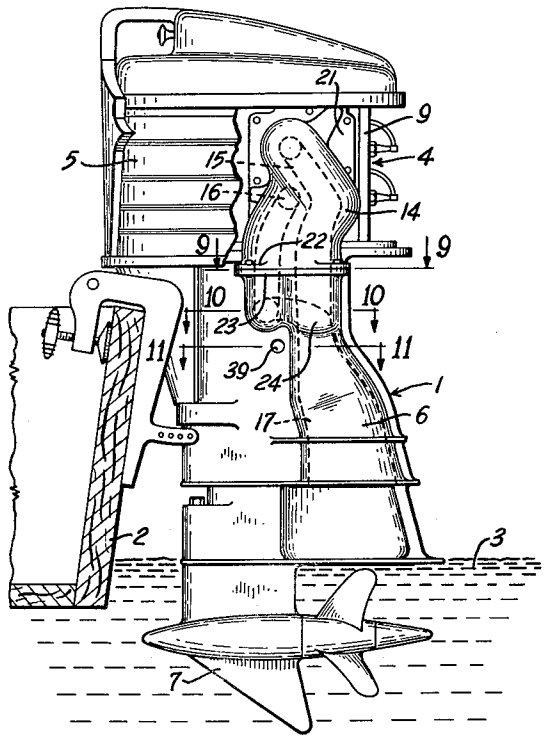
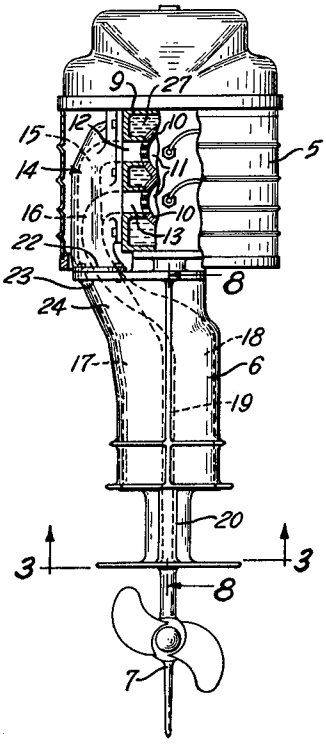


Fig. 2.



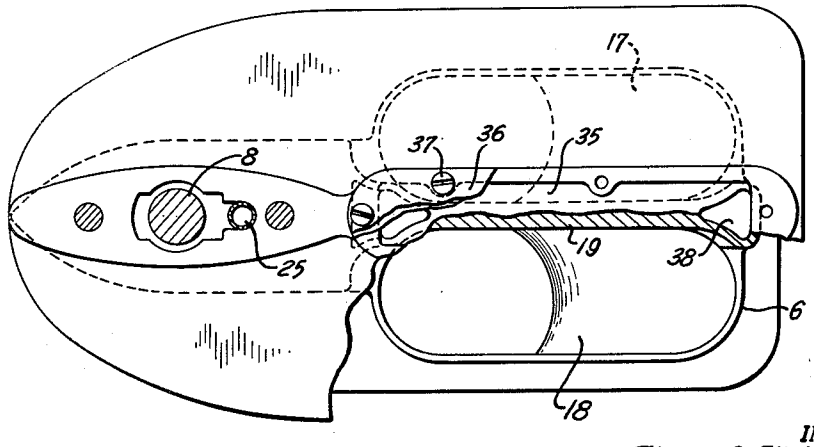


Fig. 3.

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Fig. 5.

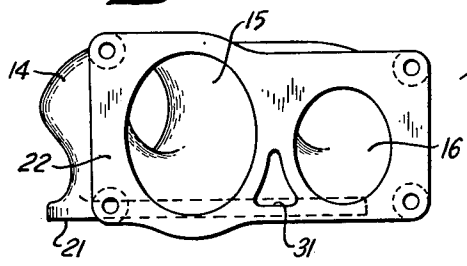


Fig. 4.

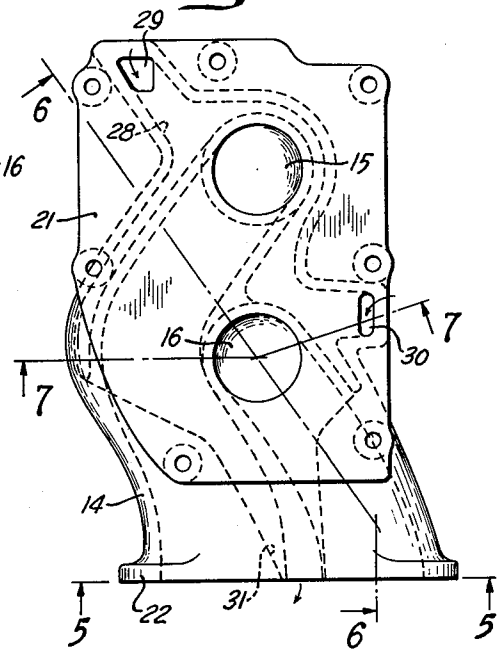


Fig. 6.

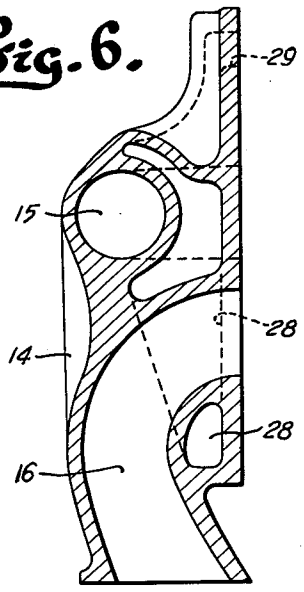
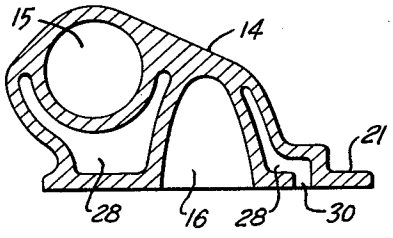


Fig. 7.



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Fig. 8.

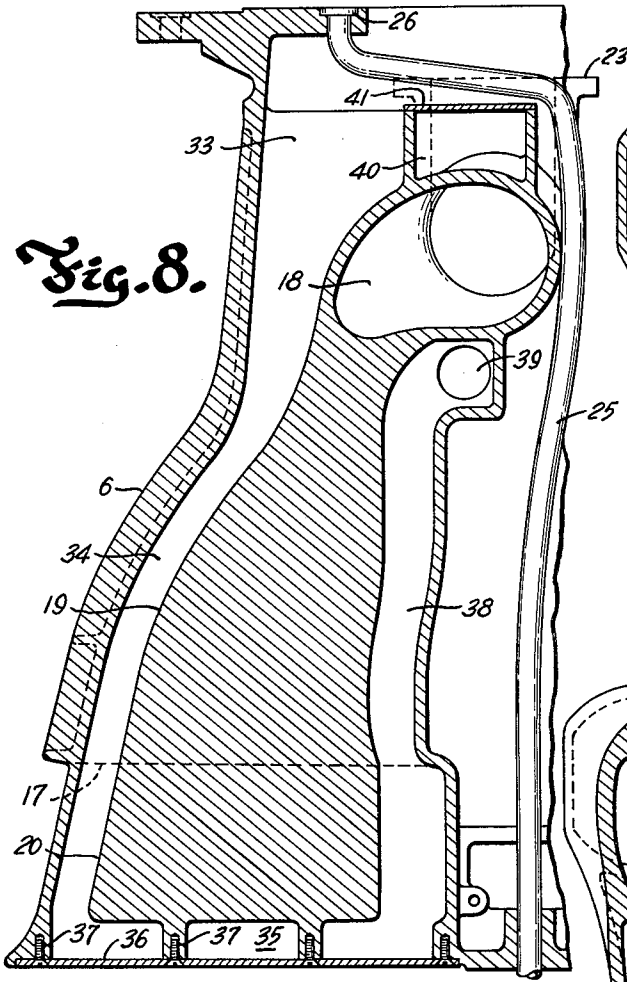
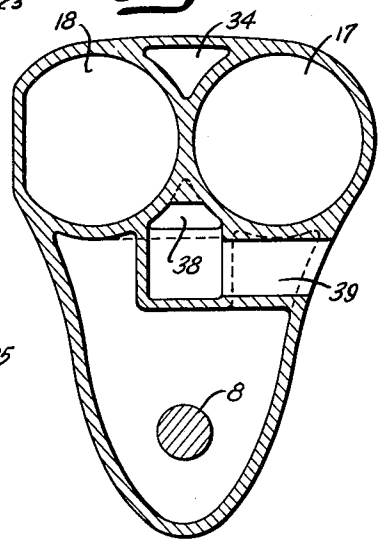


Fig. 11.



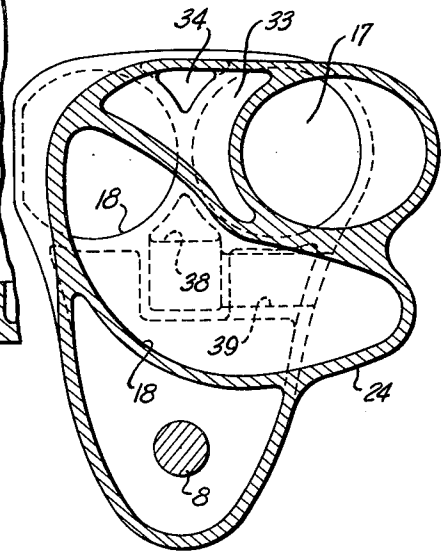


Fig. 10.

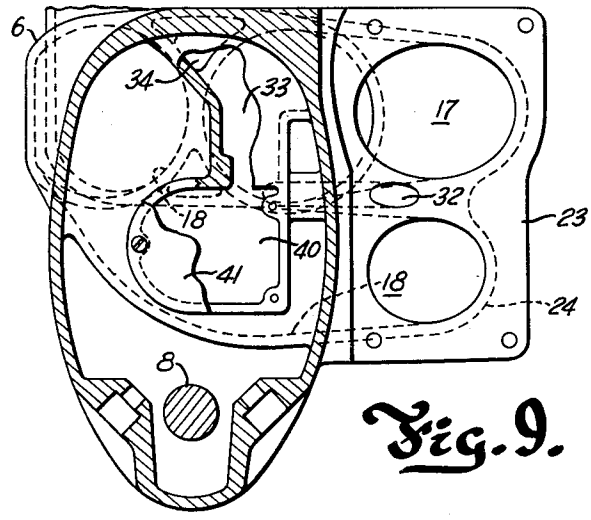


Fig. 9.

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TUNED EXHAUST FOR OUTBOARD MOTORS

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9 Claims. (Cl. 60—31)

This invention relates to a tuned exhaust system incorporated into an outboard motor and particularly to a tuned exhaust system integrally formed with the drive shaft housing of the outboard motor.

Tuned exhaust systems have been employed to improve the scavenging of internal combustion engines of the two cycle variety in motorcycles and the like. A separate exhaust pipe of a predetermined length and varying cross sections is provided to establish pressure waves during the exhaust cycle which improve the scavenging of the cylinders. Thus, in racing motorcycles it has been conventional to add a separate distinct exhaust pipe which is affixed to each cylinder to increase the scavenging effect and to thereby increase the speed of the engine.

The present invention is particularly directed to an outboard motor having a drive shaft housing incorporating an integral tuned exhaust system for the internal combustion outboard motor. In accordance with the present invention, a manifold couples the exhaust passages in a motor block to individual exhaust passages integrally formed within the lower drive shaft housing. The manifold and the drive shaft housing are internally divided to establish a series of tuned exhaust stacks. For most efficient operation, the tuned exhaust passages or stacks terminate immediately above the water surface with the motor mounted upon the aft end of a boat in operating position.

In accordance with another aspect of the present invention, a water cooling jacket is provided adjacent the passages in the manifold and the passages in the drive shaft housing. The jacket is preferably serially connected to the water jacket for the cylinder block to provide a simple and efficient cooling system.

The present invention thus provides an improved racing outboard motor which is adapted to be operated at a given maximum speed with improved exhaust or scavenging of the cylinders to increase the efficiency of the motor.

The drawings furnished herewith illustrate the best mode presently contemplated for carrying out the invention.

In the drawings:

FIG. 1 is a side elevational view of an outboard motor with parts of the upper cowling broken away to show inner details of construction;

FIG. 2 is a rear end view of the motor shown in FIG. 1 with parts broken away to show details of the exhaust passages;

FIG. 3 is a bottom view taken on broken line 3—3 of FIG. 2 with parts broken away;

FIG. 4 is an enlarged side elevational view of a manifold shown in FIG. 1;

FIG. 5 is a bottom view of the manifold taken on line 5—5 of FIG. 4;

FIG. 6 is a sectional view of the manifold taken on broken line 6—6 of FIG. 4;

FIG. 7 is a sectional view taken on the broken line 7—7 of FIG. 4;

FIG. 8 is a vertical fragmentary section taken on line 8—8 of FIG. 2;

FIG. 9 is a horizontal section taken on line 9—9 of FIG. 1;

FIG. 10 is a horizontal section taken on line 10—10 in FIG. 1; and

FIG. 11 is a view taken on line 11—11 in FIG. 1.

Referring to the drawings and particularly to FIGS. 1 and 2, an outboard motor 1 is shown mounted upon the aft end of a boat 2 with the lower end of the motor 1 immersed in water 3.

The outboard motor 1 includes an internal combustion engine or power head 4 shown with two cylinder construction. A decorative cowling 5 encloses the power head 4 and is shown broken away in FIGS. 1 and 2 to show the power head. A drive shaft housing 6 is secured to power head 4 and the cowling 5 and projects downwardly therefrom terminating in a propeller assembly 7. A drive shaft 8, shown only in FIG. 3, extends vertically upwardly through the forward portion of the drive shaft housing 6 and is coupled to the crankshaft, not shown, of the motor power head 4. Connection of the drive shaft 8 is conventional and therefore no illustration or further description thereof is given.

The power head 4 includes a water-cooled block 9 having a pair of vertically spaced cylinders 10. Pistons 11 are slidably journaled within the cylinders 10 in accordance with conventional practice. Similar exhaust ports 12 and 13 are formed in block 9 in vertically spaced relation and in communication with the respective upper and lower cylinder to allow exhaust movement of the exploded gases from within the cylinders. The inlet ports through which the gases are initially introduced into the cylinders are not shown. A manifold 14 constructed in accordance with the present invention is bolted or otherwise secured to the side of the water-cooled block 9 immediately adjacent the exhaust ports 12 and 13. The manifold 14 is provided with manifold exhaust passages 15 and 16 having vertically spaced openings or inlets which are precisely aligned with the exhaust ports 12 and 13 with the manifold 14 bolted to the cylinder block 9, as shown in FIG. 2. The manifold 14 is also bolted to the drive shaft housing 6 and the manifold exhaust passages 15 and 16 terminate in openings aligned and communicating with a pair of tuned exhaust passages 17 and 18 which are formed in the drive shaft housing 6 by a partition wall 19 which extends vertically upwardly centrally through the housing, to form exhaust passages of predetermined configuration, as more fully described hereinafter. The tuned exhaust passages 17 and 18 terminate above the normal level of the water 3 to discharge the exhaust gases to the atmosphere and provide readily constructed tuned exhaust systems.

An extension 20 of the partition wall 19 extends downwardly and is integrally secured to the lower propeller unit to maintain the exhaust gases separate from each other.

Referring particularly to FIGS. 4–7, an enlarged illustration of the manifold 14, shown in FIGS. 1 and 2 is given. Generally, the manifold 14 includes a vertical mounting flange 21 having suitable openings to receive bolts by which the manifold is securely attached to the block 9 with the manifold exhaust passages 15 and 16 in precise communication with the exhaust ports 12 and 13 in the block 9.

The upper cylinder manifold exhaust passage 15 extends outwardly from block 9 and rearwardly around the inlet to the lower exhaust passage 16 and then downwardly into communication with the tuned exhaust passage 17 in the drive shaft housing 6. The lower cylinder manifold exhaust passage 16 extends outwardly from the block and then forwardly and downwardly terminating within the lower portion of the manifold 14 in alignment with the tuned exhaust passage 18 in the drive shaft housing.

Each of the manifold exhaust passages 15 and 16 gradually increases in cross-sectional area as the length

of the passage increases, in accordance with known design procedure, and in cooperation with passages 17 and 18 provide a tuned exhaust system which results in rapid scavenging of cylinders 10. The manifold exhaust passage 15 which is connected to the upper cylinder is somewhat longer than the exhaust passage 16 in the manifold and consequently, as most clearly shown in FIG. 5, the discharge end of the passage 15 is somewhat larger than the discharge end of the passage 16.

The manifold terminates in a mounting flange 22 which is bolted to a similar mounting flange 23 integrally formed on the one side of drive shaft housing 6.

Referring particularly to FIGS. 8–11, an enlarged series of views of the drive shaft housing 6 is given more clearly illustrating the exhaust passages 17 and 18. The mounting flange 23 is somewhat below the upper plane of the housing 6 and constitutes the upper plane of a protruding housing portion 24 of the housing 6. The exhaust passages 17 and 18 begin in portion 24 and extend into the main portion of housing 6 in the illustrated embodiment of the invention, as follows.

The tuned exhaust passage 17 extends laterally through the housing portion 24 and then laterally and downwardly upon one side of the partition wall 19 as shown in FIGS. 10 and 11. The generally vertical portion of exhaust passage 17 in housing 6 includes a relatively constant diameter passage adjacent the plane shown in FIG. 9 and then expands gradually within housing 6 and terminates in a generally elliptical opening above the water level as shown in FIGS. 1 and 3.

The tuned exhaust passage 18 for the lower cylinder of the engine power head 4 curves laterally through the protruding portion 24 forwardly of the corresponding passage 17 to the opposite side of the partition wall 19 by a curved elliptically shaped passage shown in FIG. 10. Tuned exhaust passage 18 on the opposite side of the partition wall 19 substantially corresponds to the corresponding portion of exhaust passage 17 and extends downwardly terminating in a generally elliptical opening above the level of water 3.

The tuned exhaust system integrally formed within the drive shaft housing 6 and connected through the separate manifold 14 provides tuned exhaust system without sacrificing the streamlined construction of the drive shaft housing 6 and without the necessity for separate, individually attached exhaust pipes.

In accordance with the illustrated embodiment of the present invention, cooling water is circulated through the block 9, the manifold 14 and the drive shaft housing 6 to reduce the temperature of the exhaust gases.

Referring particularly to FIG. 8, which is a fragmentary vertical section through the drive shaft housing 6 taken on line 8—8 in FIG. 2 and to FIG. 3, a cooling water inlet tube 25 is secured within the propeller assembly 7 and the drive shaft housing 6 in a known manner and extends upwardly through the drive shaft housing 6 with the drive shaft 8. A pump assembly, not shown, is normally incorporated in propeller assembly 7 to force cooling water upwardly through tube 25. The tube 25 terminates in a coupling 26 in the top mounting surface of the housing 6 upon which block 9 is secured. When the engine block 9 is secured to the drive shaft housing 6, the coupling 26 automatically connects the inlet tube 25 to a cooling chamber 27 conventionally encircling cylinders 10 within the block 9.

Referring particularly to FIGS. 4–7, the manifold 14 also includes a water cooling chamber 28 including a pair of spaced water inlets 29 and 30 in the block mounting flange 21. When the manifold is mounted in place the inlets 29 and 30 are aligned with suitable discharge openings, not shown, in the water cooling chamber 27 of the block 9 and the water flows from block 9 into chamber 28 through the manifold 14. The cooling chamber 28 in the manifold 14 is substantially coextensive with the exhaust passages 15 and 16 to cool the discharging exhaust gases. Manifold 14 includes a single water outlet 31 in the lower mounting flange 22. As shown in FIG. 9, mounting flange 23 on the drive shaft housing 6 includes a water discharge passage 32 which projects laterally and downwardly between the tuned exhaust passages 17 and 18 into the drive shaft housing and terminates in communication with a connecting chamber 33 within the upper portion of the drive shaft housing. A vertical passage 34 is formed in the drive shaft housing 6 extending downwardly from chamber 33 at the trailing edge of the partition wall 19, as most clearly shown in FIG. 8. The passage 34 extends to the lower end of the partition wall 19 including the extension 20 which is recessed to form a horizontal passage 35 longitudinally extending from the passage 34 to the leading end of drive shaft housing 6, as most clearly shown in FIGS. 3 and 8. A lower cover 36 is secured over the horizontal recess as by screws 37 to define the horizontal passage 35. A vertical passage 38 communicates with the opposite end of passage 35 and projects upwardly at the forward end of the partition wall 19. The vertical passage 38 terminates immediately below the protruding portion 24 of housing 6 in a laterally extending discharge opening 39 as shown in FIGS. 1 and 8–11.

In summary, cooling water is pumped upwardly through the inlet tube 25 in a conventional manner and after being circuated through the chamber 27 in cylinder block 9 is discharged into chamber 28 in manifold 14. From the manifold chamber 28, the water is discharged downwardly into the passage 32 in housing 6 and circulated through the vertical and horizontal passages 34, 35 and 38 adjacent the partition wall 19 to further cool the exhaust gases and increase the efficiency of operation of the power head 4. The cooling water is finally discharged.

As shown particularly in FIGS. 8 and 9, a casting chamber 40 is formed within the upper portion of the drive shaft housing 6 adjacent the connecting chamber 33 for purposes of convenient casting of the exhaust passage. A cover 41 is secured over the chamber 40 to seal the chamber.

The operation of the illustrated embodiment of the invention is summarized as follows. After an explosion within a cylinder 10, piston 11 moves down and uncovers the corresponding port 12 or 13. The exhaust gases pass outwardly through the exhaust port and through the exhaust paths formed either by passages 15 and 17 or 16 and 18 depending upon which of the cylinders 10 is being considered and then discharge into the atmosphere. Each of the exhaust paths increases in cross-sectional area as it extends away from the cylinder 10 and is so designed to resonate the exhaust system at a preselected speed of the motor 7. At the resonant frequency, pressure waves are established within the exhaust cycle which improves the scavenging of the cylinders 10 and thus the removal of the exhaust gases from the cylinders and the introduction of fresh gas into the cylinder. The cooling water circulates through the block 9, manifold 14 and then through the inner portion of housing 6 adjacent partition wall 19 to provide cooling of the exhausted gases. The atmospheric air adjacent the outer surfaces of housing 6 defining the tuned exhaust passages 17 and 18 eliminate the necessity of cooling chambers therein.

The present invention thus provides a compact, tuned exhaust system for outboard motors providing maximum efficiency of operation of the outboard motor at a preselected speed.

Various modes of carrying out the invention are contemplated as being within the scope of the following claims particularly pointing out and distinctly claiming the subject matter which is regarded as the invention.

We claim:

1. An outboard motor including an internal combus-

tion engine power head mounted on a drive shaft housing, which comprises internal exhaust passage walls integrally formed with said housing and defining with the outer wall of the drive shaft housing at least two separate exhaust passageways resonating at a predetermined engine speed to provide a tuned exhaust system for the engine power head.

2. In an outboard motor including an internal combustion engine power head having a series of cylinders and being mounted on a drive shaft housing, internal wall means within the drive shaft housing and defining with the outer wall of the drive shaft housing a plurality of exhaust passages, and a manifold having individual exhaust passages connecting an exhaust port from each cylinder to an exhaust passage in said housing, the connected exhaust passages in said manifold and said drive shaft housing being designed to resonate at a predetermined engine speed to provide a tuned exhaust system for the engine power head.

3. In an outboard motor including an internal combustion engine power head with a plurality of in-line cylinders and with a water cooling chamber for the cylinders and having a drive shaft housing with the engine power head mounted thereon, vertical partition wall means in the drive shaft housing establishing a plurality of tuned exhaust passages corresponding in number to the cylinders in the engine power head, a manifold having a similar number of exhaust passages connecting an exhaust port of each cylinder to an individual exhaust passage in the housing, a cooling chamber in the manifold having an opening connected to a discharge opening from the cooling chamber for the cylinders and having a discharge opening, and a cooling chamber in the drive shaft housing in heat exchange relation with the partition wall means and having an inlet opening connected to the discharge opening in the manifold.

4. In an outboard motor including a power head with a plurality of in-line internal combustion engine cylinders and mounted on a drive shaft housing, vertical partition walls in the trailing end of the drive shaft housing establish a plurality of tuned exhaust passages corresponding in number to the cylinders of the engine, said exhaust passages terminating above the submergible portion of the motor to discharge the exhaust gases to the atmosphere, and a manifold having individual exhaust passages connecting the exhaust ports of the cylinders to the exhaust passages.

5. In an outboard motor including a power head with a plurality of in-line internal combustion engine cylinders and mounted on a drive shaft housing having a lower submergible portion, vertical partition wall means in the trailing end of the drive shaft housing establishing a plurality of tuned exhaust passages corresponding in number to the cylinders of the power head and including an extension connected to the submergible portion, said passages terminating above the submergible portion of the drive shaft housing and the extension of the vertical partition wall means, and means to individually connect the passages to the cylinders of the power head.

6. In an outboard motor, a drive shaft housing having a forward connecting portion and a trailing exhaust portion and having a cooling water passage means terminating in the upper surface of the housing, an engine block secured to the upper end of the housing adjacent the exhaust portion with a series of in-line vertically arranged cylinders with individual exhaust ports, said block including a cooling chamber having an inlet aligned with said cooling water passage and having an outlet adjacent the exhaust ports, a manifold secured to the side of the block covering the exhaust ports and having individual exhaust passages terminating in the lower end of the manifold, a lateral protrusion on the housing aligned to support the lower end of the manifold and having exhaust passages aligned with the manifold exhaust passages and extending laterally into the housing,

vertical partition wall means within the housing defining exhaust passages at the outer surface of the housing and as an extension of the exhaust passages in the protrusion, the exhaust passages in the housing terminating above the water line to discharge the exhaust gases to the atmosphere, said exhaust passages being continuously enlarged the further the passage is removed from the cylinder and each exhaust path defined by said passages being designed to resonant at the same frequency, said manifold having a cooling chamber with an inlet aligned with the outlet from the cylinder block and having an outlet adjacent the lower end of the manifold, and said housing having a cooling passage extending from the manifold outlet downwardly adjacent the partition wall means and across the bottom thereof terminating in a lateral opening adjacent the upper portion of the housing.

7. In an outboard motor, a drive shaft housing having a forward power connecting portion and a trailing exhaust portion and having a cooling water passage terminating in the upper surface of the housing, an engine block secured to the upper end of the housing with a pair of in-line vertically arranged cylinders generally aligned with the exhaust portion, said block including a cooling chamber having an inlet aligned with the cooling water passage in the drive shaft housing, said cylinders having vertically aligned exhaust ports, a manifold secured to the side of the block covering the exhaust ports and having individual exhaust passages terminating in the lower end of the manifold, a lateral enlargement of the housing coincident with the lower end of the manifold and having individual housing exhaust passages aligned with the manifold individual exhaust passages, said housing exhaust passages extending laterally into the main portion of the housing and then downwardly through the exhaust portion with a vertical partition wall defining the vertical portions of the exhaust passages, the lower end of the exhaust portion of the housing terminating above the submergible portion of the motor to discharge the exhaust gases to the atmosphere, the vertical partition wall extending downwardly to the submergible portion to maintain separation of the exhaust gases, said exhaust passages being continuously enlarged and each being designed to resonant at the same frequency, said manifold having a cooling chamber with a plurality of inlets aligned with the outlets from the cylinder block and having an outlet adjacent the lower end of the manifold, and said housing having a cooling passage extending from the manifold outlet downwardly adjacent the trailing end of the partition wall across the bottom thereof and then upwardly adjacent the forward end of the partition wall, and terminating in a lateral opening adjacent the underside of the lateral enlargement of the housing.

8. In an outboard motor, a drive shaft housing having a forward connecting portion and a trailing exhaust portion, an engine block secured to the upper end of the housing with a series of in-line vertically arranged cylinders generally aligned with the exhaust portion, and having vertically aligned exhaust ports, a manifold secured to the side of the block covering the exhaust ports and having individual exhaust passages terminating in the lower end of the manifold, a lateral enlargement formed in the housing coincident with the lower end of the manifold and having individual housing exhaust passages aligned with the manifold individual exhaust passages, said housing exhaust passages extending laterally into the main portion of the housing and then downwardly through the exhaust portion of the housing, the lower end of the exhaust portion of the housing terminating above the water line to discharge the exhaust gases to the atmosphere, and said exhaust passages similarly progressively enlarging the further removed from said cylinder exhaust ports to resonant at the same frequency.

9. In an outboard motor, a drive shaft housing having a forward connecting portion and a trailing exhaust por-

tion and having a cooling water passage means terminating in the upper surface of the housing, an engine block secured to the upper end of the housing adjacent the exhaust portion with a pair of in-line vertically arranged cylinders with individual exhaust ports in one side of the block, said block including a cooling chamber having an inlet aligned with said cooling water passage and having an outlet adjacent the exhaust ports, a manifold secured to the side of the block covering the exhaust ports and having a first exhaust passage aligned with the upper exhaust port and extending rearwardly and downwardly about the lower exhaust port and terminating in the lower end of the manifold and having a second exhaust passage aligned with the lower exhaust port and extending rearwardly and downwardly and terminating in the lower end of the manifold, a lateral protrusion on the housing aligned to support the lower end of the manifold and having first and second exhaust passages aligned with the first and second manifold exhaust passages, the first exhaust passage in the housing extending laterally into the housing, vertical partition wall means within the housing defining a continuation of the first exhaust passage, the second exhaust passage in the housing extending laterally across the partition wall means and into a continuation passage defined by the partition wall means, the exhaust passages in the housing terminating above the water line to discharge the exhaust gases to the atmosphere, the exhaust paths so defined by said passages being continuously enlarged the further the path is removed from the cylinder to resonant at the same frequency, said manifold having a cooling chamber with an inlet aligned with the outlet from the cylinder block and having an outlet adjacent the lower end of the manifold, and said housing having a cooling passage extending from the manifold outlet downwardly adjacent the trailing edge of the partition wall means and across the bottom thereof and upwardly adjacent the forward edge of the partition wall means and terminating in a lateral opening immediately adjacent the lateral protrusion of said housing.

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