United States Patent

Takimoto

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[54] MARINE PROPULSION DEVICE

[72] Inventor: **Syozo Takimoto,** 1-48 Minato Honcho, Aichi-ken, Handa-shi, Japan

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Sept. 2, 1969 Japan.....44/69885

[52] **U.S. Cl.**.....**115/31,** 416/79
[51] **Int. Cl.**.....**B63h 1/32**
[58] **Field of Search** 115/31; 416/79, 81, 83, 64, 416/66, 67; 417/436, 550

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Primary Examiner—Andrew H. Farrell
Attorney—Flynn & Frishauf

[57] **ABSTRACT**

A marine propulsion device comprises a propulsion member reciprocating in a direction in which a ship body is propelled, and a funnel-shaped member attached to the rear end of said reciprocating propulsion member for expelling water backwards. Said funnel-shaped member is backwardly thrust by a strong force applied to said propulsion member.

21 Claims, 11 Drawing Figures

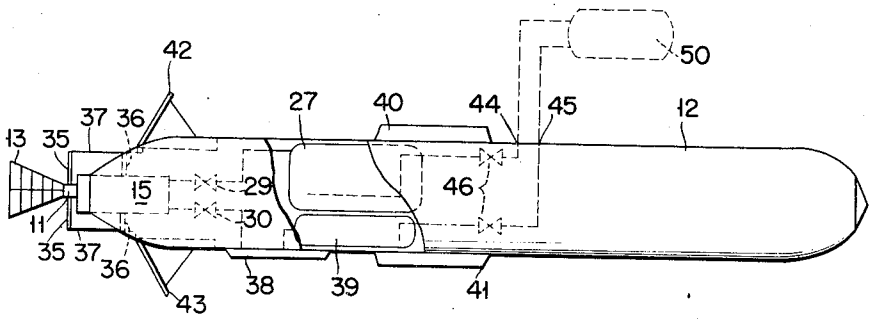

FIG. 1

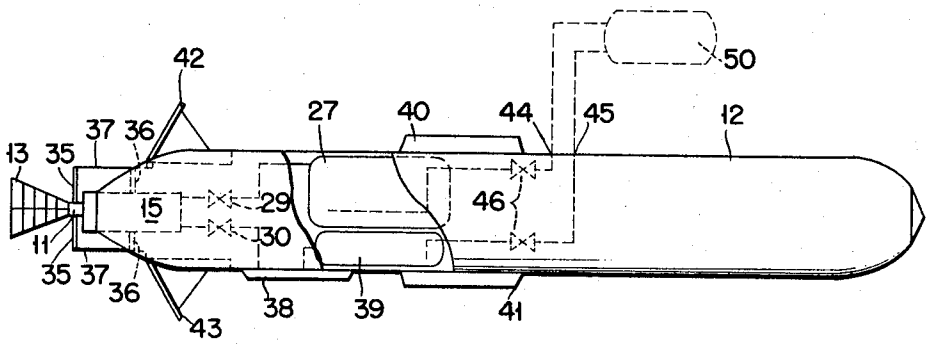
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FIG. 2

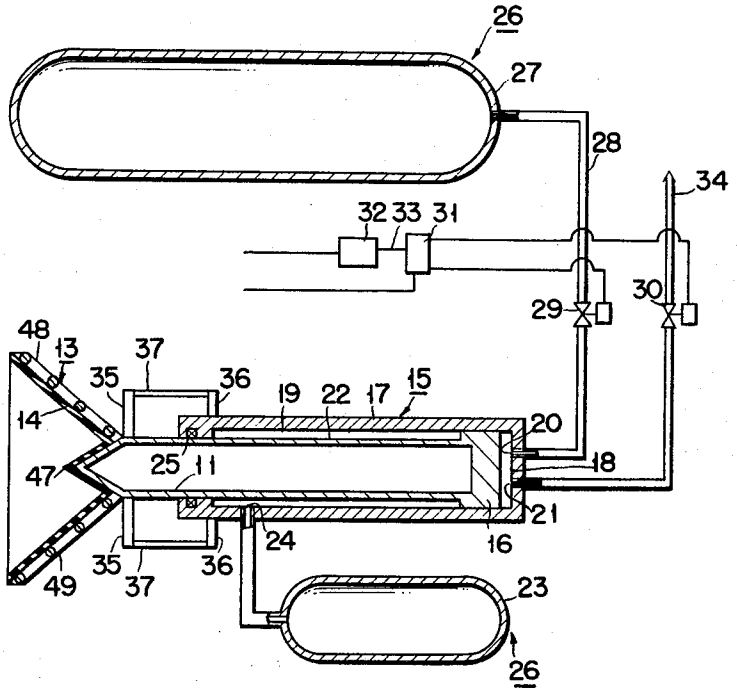
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FIG. 3

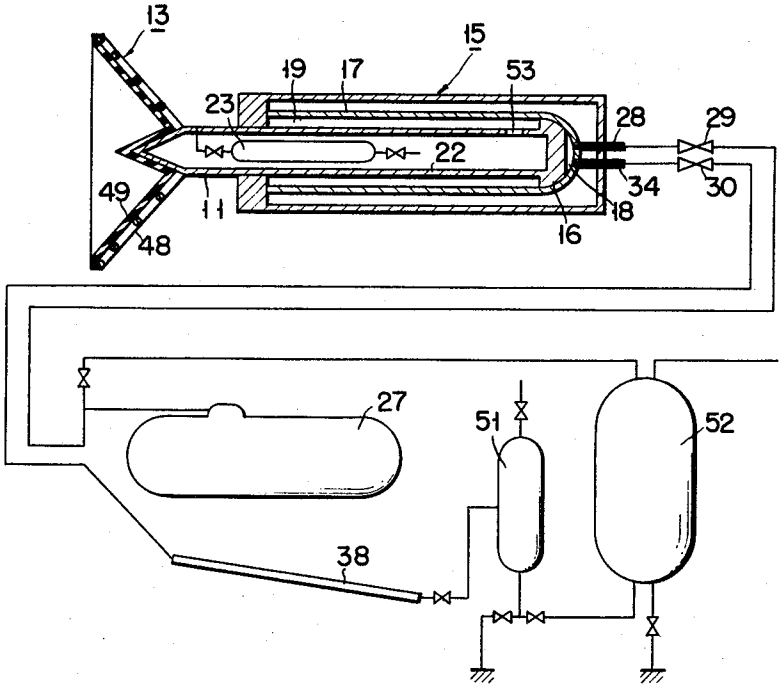
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FIG. 4

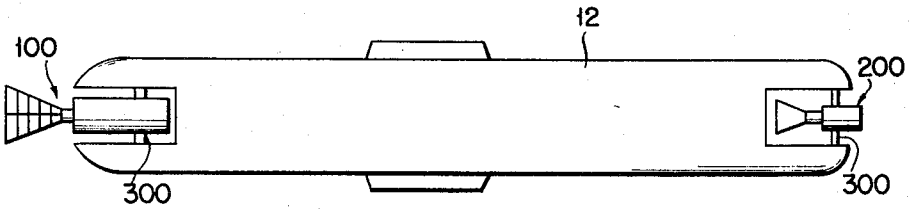
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FIG. 5

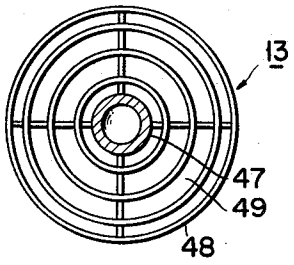


FIG. 6

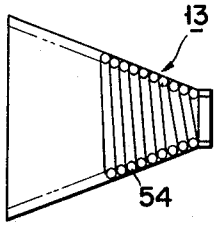


FIG. 7

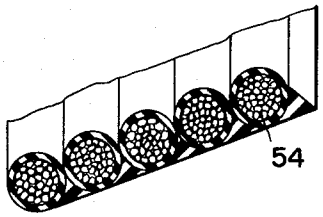
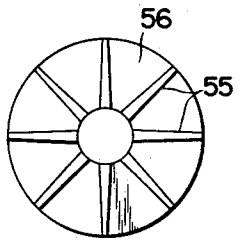


FIG. 8



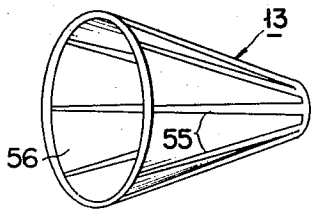


FIG. 9

FIG. 10

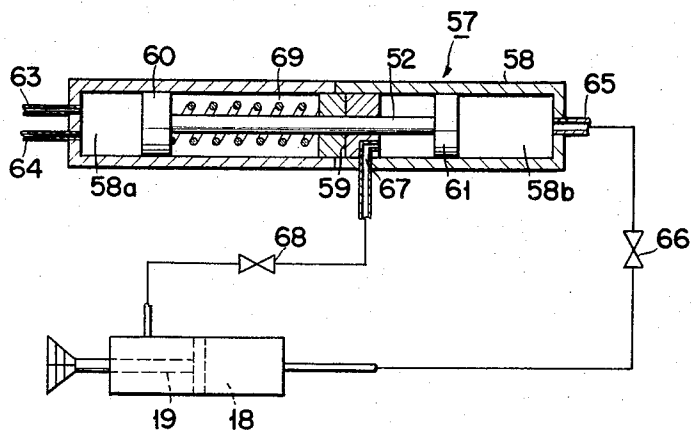

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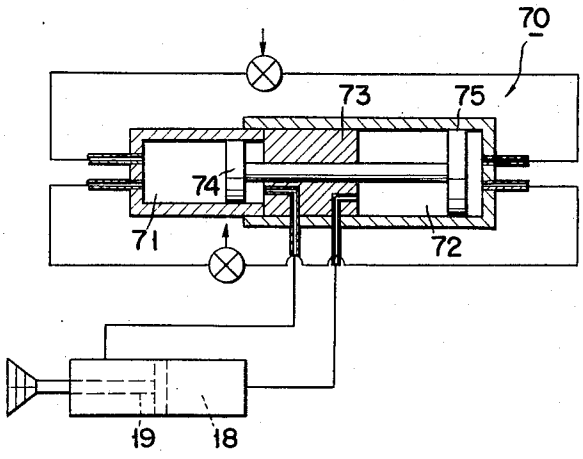
FIG. 11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MARINE PROPULSION DEVICE

The present invention relates to a marine propulsion device of non-screw propeller type for a marine ship, and more particularly to a marine propulsion device having a system for advancing a marine ship in the water by expelling water backwards.

The prior art propulsion device of the general screw-propeller type, notwithstanding its high propulsion efficiency, is unavoidably encountered with the corrosion of the screw-wings resulting from the occurrence of cavitation around the screw shaft and the clinging of floatage to the screw-wings. Furthermore, when applied in military use, the screw-propeller type device has a distinct disadvantage due to its screw noise, which may cause the position of a marine ship involving such device to be easily detected by the enemy.

An object of this invention is to provide a marine propulsion device involving a reciprocating propulsion member so improved as to eliminate the above-mentioned defects and to maintain a high propulsion efficiency.

Another object of this invention is to provide a marine propulsion device in combination with a marine ship involving a reciprocating propulsion member and a piston-cylinder assembly whose piston is connected with said propulsion member and which is contained in a ship body together with other means participating in driving said propulsion member, thereby permitting said marine ship to have a simple contour.

The other features and advantages of this invention will be understood from the following description when taken with reference to the accompanying drawings, in which:

FIG. 1 is a side view of a marine propulsion device in combination with a marine ship embodying the present invention;

FIG. 2 is an illustration of a system for driving a marine propulsion member involved in said device;

FIG. 3 is an illustration of a modification of said driving system of FIG. 2;

FIG. 4 is a side view of a marine propulsion device in combination with a marine ship further embodying the present invention;

FIG. 5 is a forward end view of a funnel-shaped member for expelling water backwards involved in the marine propulsion device;

FIG. 6 is a vertical sectional side view of a funnel-shaped member modified from that of FIG. 5;

FIG. 7 is an enlarged sectional view of part of said funnel-shaped member of FIG. 6;

FIG. 8 is a forward end view of a funnel-shaped member further modified from that of FIG. 5;

FIG. 9 is a perspective view of the funnel-shaped member of FIG. 8;

FIG. 10 is a vertical sectional side view of an actuator for operating a piston-cylinder assembly involved in the marine propulsion device; and

FIG. 11 is a vertical sectional side view of a modification of the actuator of FIG. 10.

FIG. 1 illustrates a marine propulsion device of the invention in combination with a marine ship, for example, a submarine boat for making searches under water.

Referring to FIGS. 1 and 2, a marine propulsion device comprises a propulsion member 11 reciprocating in a direction in which a ship body 12 is propelled, a member 13 attached to said propulsion member 11 for expelling water backwards and having an expelling surface 14 extending substantially perpendicular to the propelling direction, and means for reciprocating the propulsion member 11 to be backwardly extruded with a strong force, which is applied to said propulsion member constantly at high speed. Said expelling surface 14 is expansible upon the backward extrusion of said propulsion member so as to push away large amounts of water, and is shrinkable by water pressure upon the forward retraction of said propulsion member. Said shrinkage may reduce water resistance against the water expelling member 13.

Said reciprocating means involves a piston-cylinder assembly 15 having a piston 16 connected with said propulsion

member 11 and hollow cylinder 17 with two compartments 18 and 19 sealed fluid tight and separated by said piston 16 which is slidably inserted into said cylinder 17. One compartment 18 on the free end side of said piston has an inlet 29 for introducing pressurized fluid into said compartment and an outlet 21 for discharging it therefrom. The other compartment 19, through which is inserted the propulsion member 11 integrally formed with a piston rod 22 of said piston 16, communicates with a high pressure air accumulator 23, which is included in a power source described hereinafter, through a port 24 positioned near the end of said cylinder 17, so as to maintain the pressure in said compartment 19 substantially at the same level as water pressure prevailing on the outside of said ship body. Said propulsion member 11 penetrates the end wall of said cylinder 17 and extends backwards. Said end wall of the cylinder 17 has a sealing member 25, for example, of reinforced rubber.

Said marine propulsion device further comprises a power source 26 including a pressure accumulator 27 provided in said ship body 12 and which communicates through said inlet 20 with said compartment 18 so as to supply a pressurized fluid, for example, pressurized steam, means for transmitting power from said power source 26 to the reciprocating means, i.e., the piston-cylinder assembly 15 and means for causing the motion of said propulsion member 11 to be externally controlled.

In this embodiment, said transmitting means consists of a pass-line 28 communicating with said pressure accumulator 27 and said inlet 20 at respective ends, and said control means consists of two electro-magnetically operable valves 29 and 30, a rotary switch 31 for electrically operating said valves 29 and 30 alternately in open and closed states, and a speed-variable motor 32 for rotating a rotary shaft 33 included in said rotary switch 31. One valve 29 is disposed in said pass-line 28, and the other valve 30 in a pass-line 34 communicating with the outlet 21.

Means for retracting the propulsion member 11 into said cylinder 17 is provided with upper and lower members 35 and 36 protruding perpendicular to the propelling direction attached to the rear end portion of said propulsion member 11 and the rear portion of said cylinder 17 respectively, and elastically extensible tension members 37, for example, of highly flexible rubber extending in the propelling direction and bridging said protruding members 35 and 36.

In this embodiment, there are further provided a condenser 38 (FIG. 1), disposed at the outside of the ship body 12 so as to cause the spent steam to be converted into a drain water by utilizing the ambient water as a coolant, and drain tank 39 for accumulating said drain.

The ship body 12 contains the piston-cylinder assembly 15, pressure accumulator 27 and gas accumulator or bomb 23, as well as other devices participating in driving the propulsion member 11, except for said condenser 38.

The ship body is further provided with dorsal and ventral fins 40 and 41 and upper and lower counter-wing members 42 and 43, which are operable to be moved flush with, or under, the outer surface of the ship body 12 upon the propulsion of the ship, and to be projected out from the ship body 12 upon the braking of the ship movement.

To the outer surface of said ship body 12 are opened an intake port 44 for supplying energized fluid to the accumulator 27, and an exhaust port 45 for discharging fluid used. Each of the ports 44 and 45 has means for example, a valve 46 for normally closing it. FIG. 5 indicates the water-expelling member 13 particularly formed into a funnel-shape and included in the above-mentioned propulsion device. The neck portion 47 of said funnel-shaped member 13 is attached to the rear end portion of the propulsion member 11 and said funnel-shaped member 13 consists of a supporting body 48 ribbed in the form of a funnel, and flexible membrane 49 fitted into the interior of said supporting body 48 and attached to the propulsion member 11 at the neck portion 47.

In operation, the speed-variable motor **32** is driven to rotate the rotary shaft **33** so that the switch **31** acts on the valves **29** and **30** to be alternately operated into their open and closed positions. A pressurized fluid, for instance, steam from the accumulator **27** is intermittently supplied to the compartment **18** upon the opening of the valve **29** and the closing of the valve **30** with a strong force so that the piston **16** together with the propulsion member **11** is thrust or forced out from the rear end of the cylinder **17**, whereby the water-expelling member **13** acts on the water body with its expelling surface **14** pushing the water backwards.

At this point, the displacement of the piston is finished, the valve **29** is closed to prevent the pressurized steam from being supplied into the compartment **18** and the valve **30** is opened to exhaust or discharge the spent steam from said compartment **18** via pass-line **34**.

The forward retraction of the propulsion member **11** and piston **16** resulting from the bias of the tension member **37** is slowly accomplished. Upon the retraction of the piston **16**, the spent steam is forcedly exhausted, so as to prepare for the next introduction of fresh pressurized steam from the inlet **20** through the valve **29**.

Thus is cyclically repeated the reciprocation of the propulsion member **11**.

In this embodiment, fresh steam is supplied to the pressure accumulator **27** through the opened valve **46** with the intake port **44** externally connected with a steam regenerator **50** installed in the roadstead, and the discharged drain is carried from the drain tank **39** to the regenerator **50** through the opened valve **46** with the outlet port **45** externally connected with the regenerator **50**, when the ship is anchored, thereby causing the transmitting means to be cyclically connected with said pressure accumulator **27** with said compartment **18** through the inlet **20** and outlet **21**.

FIG. **3** indicates another system modified from that of FIG. **2** wherein the condenser **38** communicates with a water accumulator **51** so as to cause the spent steam to be supplied to the water accumulator **51** in a condensed state. Said water accumulator **51** communicates with a vacuum tank **52**, whose internal pressure is maintained by suitable means, for example, by vacuum pumps, at a sufficient level to induce the drain water in the condenser **38** through the accumulator **51** into the vacuum tank **52**.

The propulsion member **11** preferably consists of a hollow cylinder wholly combined with a piston rod **22**, and the gas accumulator **23** is contained in the interior of said propulsion member **11** as shown in FIG. **3** which represents another embodiment of the marine propulsion device of the present invention.

Since the hollow portion of the propulsion member **11** communicates with the compartment **19** through an opening **53** drilled in the periphery of the forward end portion of the propulsion member **11** integrally formed with the piston rod **22**, the variation of pressure in the compartment **19** can be as much reduced as possible upon the reciprocation of the piston **16**.

The submarine boat illustrated in FIG. **4** is provided with two propulsion devices **100** and **200**. The propulsion device **100** disposed at the tail portion of said submarine boat is a main water-expelling device, and the other device **200** at the top portion of said submarine boat is an auxiliary water-expelling device. The propulsion devices **100** and **200** each include a steering shaft **300** vertically extending from the upper and lower portions of a cylinder **400** included in a piston-cylinder assembly of the same construction as in the case of FIGS. **1** and **2**.

Upon any slight rotation of the steering shaft **300**, the submarine boat may be propelled along a prescribed curved track.

FIGS. **6** and **7** illustrate a funnel-shaped member **13** for expelling water modified from that of FIG. **5**, wherein said water-expelling member **13** is preferably formed by winding into a funnel-shape an elastically extensible string member **54** with its adjacent turns closely bonded.

FIGS. **8** and **9** illustrate a funnel-shaped member **13** for expelling water further modified from that of FIG. **5**, wherein said water-expelling member **13** preferably is comprised of a plurality of supporting ribs **55** contractively extending from the neck portion in a lengthwise direction of the funnel shaped member **13** to generally define a funnel shape, and a flexible membrane **56** stretched across said ribs, thus assuming the form of an umbrella.

FIG. **10** illustrates an actuator **57** for operating the piston-cylinder assembly **15**. Said actuator **57** is of a free-piston type and is provided with a hollow cylinder **58** having a partition wall **59** formed at the middle portion thereof, and free pistons **60** and **61** slidably disposed in the chambers **58***a* and **58***b* separated by said partition wall **59** in the hollow cylinder **58**. Said pistons **60** and **61** are mutually connected by a piston rod **62** slidably penetrating the partition wall **59** in fluid-tight relationship. One chamber **58***a* has its end provided with an inlet **63** for supply of operating steam and an outlet **64** for its exhaust and the other chamber **58**b has its end provided with a port **65** communicating with the compartment **18** of the cylinder **17** through a control valve **66** disposed in the communicating line, and port **67** formed near the partition wall **59**, said port **65** communicating with the other compartment **19** through a control valve **68** disposed in the communicating line.

A return spring member **69** is compressibly disposed between the piston **60** and the partition wall **59**, so as to return the pistons **60** and **61** to the left as shown in FIG. **10**.

The chamber **58***b*, the compartments **18** and **19** of the cylinder **17**, and the transmitting lines connecting the former chamber with the latter compartments are filled with a non-compressible control material, such as oil as a power transmitting medium. In operation, the supply of pressurized steam to the chamber **58***a* causes the piston **61** to be displaced to the end of the cylinder **58** and in consequence the oil pressure in the forward compartment **18** to be forcedly raised, thereby pushing the propulsion member backwards.

The discharge of the spent steam alternating with the above-mentioned supply of the pressurized steam causes the piston **61** to be displaced toward the partition wall **59** by the bias of the spring **69** and in consequence the oil pressure in the rear compartment **19** to be forcedly raised, thereby returning the propulsion member in the forward direction.

FIG. **11** illustrates an actuator **70** for operating the piston-cylinder assembly **15**. The actuator **70** is of a free-piston type like that of FIG. **10**, but is slightly different from that of FIG. **10** in that the chambers **71** and **72** separated by a partition wall **73** disposed at the middle portion of the cylinder communicate with the compartments **18** and **19** respectively at the inside of the pistons **74** and **75**, and the pressurized steam is supplied alternately to the outside area of the cambers **71** and **72**. Therefore, there is not provided a return spring shown in FIG. **10**.

It will be apparent that the alternate supply of pressurized steam to the chambers results in the reciprocation of the propulsion member **11**.

What is claimed is:

1. A marine propulsion device comprising:

a propulsion member receiprocable in a direction in which a ship body is propelled;

a water-expelling member attached to said propulsion member for expelling water backwards and having an expelling surface extending substantially perpendicular to the propelling direction;

means for reciprocating the propulsion member relative to the ship body and causing the propulsion member to be moved backwardly with a strong force, to thereby cause said water-expelling member to expel water backwards, said reciprocating means comprising a piston-cylinder assembly including a hollow cylinder and a piston slideably disposed therein, said piston being connected with said propulsion member and said piston dividing said hollow cylinder into two sealed, fluid-tight compartments, one compartment being on the free end side of said piston and

having an inlet for introducing pressurized fluid thereinto and an outlet for discharging said fluid therefrom;

a power source provided in said ship body, said power source comprising a pressure accumulator communicating through said inlet with said one compartment so as to supply the pressurized fluid thereto, and a gas accumulator communicating with the other compartment to maintain the pressure in said other compartment at a predetermined pressure; and

means for transmitting power from said power source to the reciprocating means to cause said propulsion member to be reciprocated.

2. The marine propulsion device according to claim 1 wherein said gas accumulator maintains the pressure in said other compartment substantially at the same level as that of the water body prevailing on the outside of said propulsion device.

3. The marine propulsion device according to claim 1 in which said transmitting means includes a pass-line cyclically connecting said accumulator with said one compartment throught said inlet.

4. The marine propulsion device according to claims 1 in which the propulsion member is comprised of a hollow cylinder formed integrally with said piston to comprise a piston rod, and said gas accumulator is contained in the interior of said propulsion member.

5. The marine propulsion device according to claim 1 in which said power transmitting means comprises a control means which includes electro-magnetically operable valves respectively provided in the pass-lines coupled to said inlet and outlet of said one compartment, and a control device for alternately operating said valves in the open and closed states.

6. The marine propulsion device according to claim 1 in which said water-expelling member includes a funnel-shaped member having its neck portion attached to the rear end portion of said propulsion member, said funnel-shaped member including a supporting body comprised of expansible ribs generally in the form of a funnel, and a flexible membrane fitted into the interior of said supporting body and attached to the propelling member at the neck portion.

7. The marine propulsion device according to claim 6 wherein said supporting ribs of the water-expelling member are arranged concentrically with respect to the neck portion.

8. The marine propulsion device according to claim 6 wherein said supporting ribs of the water expelling member extend from the neck portion in the lengthwise direction of the funnel member, the flexible membrane being attached across said ribs.

9. The marine propulsion device according to claim 6 in which said water-expelling member comprises an elastically extensible string member wound into a funnel shape with its adjacent turns closely bonded together.

10. A marine propulsion device comprising:

a propulsion member reciprocable in a direction in which a ship body is propelled;

a water-expelling member attached to said propulsion member for expelling water backwards and having an expelling surface extending substantially perpendicular to the propelling direction;

means for reciprocating the propulsion member relative to the ship body and causing the propulsion member to be moved backwardly with a strong force, to thereby cause said water-expelling member to expel water backwards, said reciprocating means comprising a piston-cylinder assembly including a hollow cylinder and a piston slideably disposed therein, said piston being connected with said propulsion member and said piston dividing said hollow cylinder into two sealed, fluid-tight compartments, one compartment being on the free end side of said piston and having an inlet for introducing pressurized fluid thereinto and an outlet for discharging said fluid therefrom, at least a portion of said propulsion member being surrounded by the other of said two compartments;

a power source provided in said ship body, said power source comprising a pressure accumulator communicating through said inlet with said one compartment so as to supply the pressurized fluid thereto, and a gas accumulator communicating with the other compartment to maintain the pressure in said other compartment at a predetermined pressure; and

means for transmitting power from said power source to the reciprocating means to cause said propulsion member to be reciprocated.

11. The marine propulsion device according to claim 10 wherein said gas accumulator maintains the pressure in said other compartment substantially at the same level as that of the water body prevailing on the outside of said propulsion device.

12. The marine propulsion device according to claim 10 wherein said propulsion member is provided with a hollow interior and an opening for connecting the interior thereof with said other compartment surrounding the propulsion member, and said gas accumulator communicates with said other compartment through the interior of said propulsion member and the opening therein.

13. The marine propulsion device according to claim 10 wherein said gas accumulator is housed in the propulsion member.

14. The marine propulsion device according to claim 10 further comprising a supply pipe line for connecting the inlet of said one compartment of said cylinder with said pressure accumulator, a condenser, an exhaust pipe line connecting the outlet of said one compartment with said condenser, and respective valves in each of said pipe lines, a valve in one pipe line being open or closed while the valve in the other pipe line being conversely closed or open.

15. The marine propulsion device according to claim 10 further comprising a condenser, and a water accumulator and a vacuum tank for storing the liquid condensed in the condenser.

16. A marine propulsion device comprising:

a propulsion member reciprocable in a direction in which a ship body is propelled,

means for reciprocating the propulsion member relative to the ship body,

a water-expelling member attached to said propulsion member for expelling water backwards and having an expelling surface extending substantially perpendicular to the propelling direction, said expelling surface being expansible upon the backward movement of said propulsion member so as to push away large amounts of water, and being shrinkable by water pressure upon the forward retraction of said propulsion member, said water-expelling member including a funnel-shaped member having its neck portion attached to the rear end portion of said propulsion member, said funnel-shaped member including a supporting body comprised of ribs generally in the form of a funnel, said ribs being arranged concentrically with the neck portion, and a flexible membrane fitted into the interior of said supporting body and attached to the propelling member at the neck portion,

a power source provided in said ship body,

means for transmitting power from said power source to said reciprocating means to cause the propulsion member to be reciprocated.

17. A marine propulsion device in combination with a marine ship comprising:

a ship body of fluid-tight construction;

a propulsion member at least partially contained within said ship body and reciprocable in a direction in which said ship body is propelled;

a water-expelling member attached to said propulsion member for expelling water backwards and having an expelling surface extending substantially perpendicular to the propelling direction;

a piston-cylinder assembly disposed within the rear end portion of said ship body and including a hollow cylinder and a piston slideably disposed therein, said piston being connected with said propulsion member and said piston dividing said hollow cylinder into two sealed fluid-tight compartments, one compartment being on the free end side of said piston and having an inlet for introducing pressurized fluid thereinto and an outlet for discharging said fluid therefrom;

a pressure accumulator contained within said ship body and communicating through said inlet with said one compartment so as to supply the pressurized fluid thereto;

a gas accumulator contained within said ship body and communicating with said other compartment so as to maintain the pressure in said other compartment substantially at a predetermined pressure; and

control means contained within said ship body for controlling the motion of said piston, and therefore of said propulsion member, by alternately charging the pressurized fluid into said one compartment and discharging it therefrom.

18. The marine propulsion device according to claim 17 wherein said gas accumulator maintains the pressure in said other compartment substantially at the same level as that of the water body prevailing on the outside of said propulsion device.

19. The marine propulsion device in combination with a marine ship according to claim 17 in which said gas accumulator is contained in the interior of said propulsion member.

20. The marine propulsion device in combination with a marine ship according to claim 19 wherein said propulsion member is provided with a hollow interior and an opening for connecting the interior thereof with the other of said compartments and said gas accumulator communicates with said other compartment through the interior of said propulsion member and the opening therein.

21. The marine propulsion device in combination with a marine ship according to claim 17 in which said water-expelling member includes a funnel-shaped member having its neck portion attached to the rear end portion of said propulsion member.

* * * * *