US005234364A

United States Patent [19]

Ito

[11] Patent Number: 5,234,364

[45] Date of Patent: Aug. 10, 1993

[54] **EXHAUST SYSTEM FOR SMALL PLANING BOAT**

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[21] Appl. No.: **682,136**

[22] Filed: **Apr. 8, 1991**

[30] **Foreign Application Priority Data**

Apr. 12, 1990 [JP] Japan 2-97347

[51] **Int. Cl.**5 .... **B63B 21/32**

[52] **U.S. Cl.** **440/89**; 114/270; 60/310

[58] **Field of Search** 440/89, 47, 38; 114/270; 60/221, 310, 322; 181/212, 221

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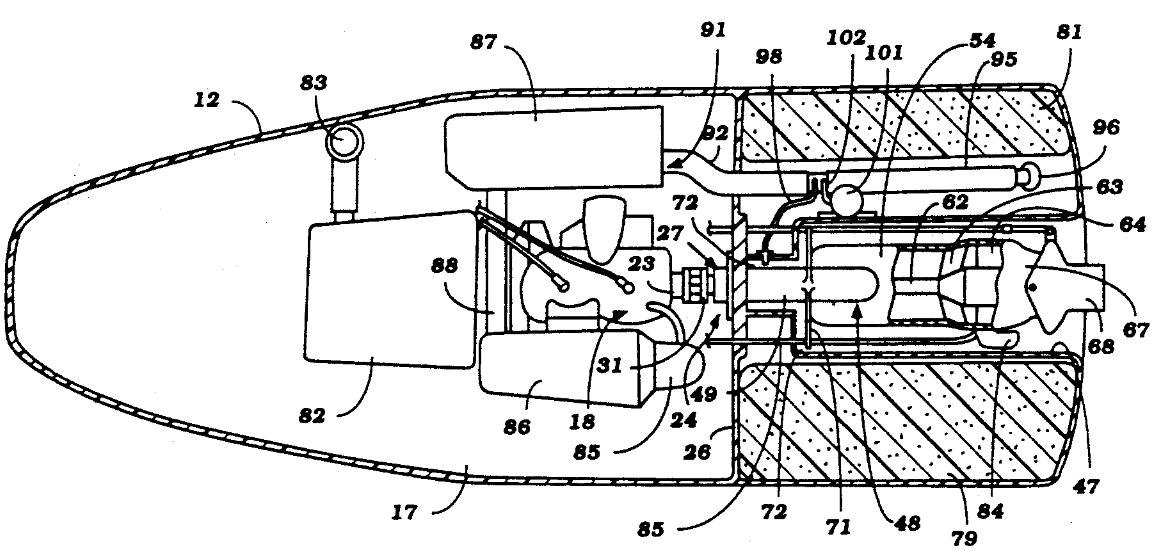
Attorney, Agent, or Firm—Ernest A. Beutler

[57] **ABSTRACT**

A number of embodiments of exhaust systems for marine watercraft, particularly, those of the jet propelled type. The exhaust systems all include an exhaust pipe which terminates in a discharge opening formed in a lower surface of the hull for discharging exhaust gases through the body of water in which the watercraft is operating. In addition, the exhaust pipe has an ascending and descending section with an expansion chamber communicating with the upper portion thereof through an opening so as to accumulate water if the watercraft becomes inverted and to direct the accumulated water back to the exhaust outlet opening when righted so as to preclude water from flowing to the exhaust ports of the engine. The expansion chamber also acts as a silencing device and may comprise a portion of a Helmholtz resonator. Furthermore, a low speed exhaust gas discharge extends from the highest portion of the exhaust pipe to the tunnel in which the jet propulsion unit is contained above the water level therein so as to provide a low speed exhaust gas discharge for discharging exhaust gases when the watercraft is operating at idle or low speeds. Various embodiments show different numbers of Helmholtz resonators and arrangements wherein the low speed exhaust gas discharge communicates with at least one of the Helmholtz resonators.

48 Claims, 9 Drawing Sheets



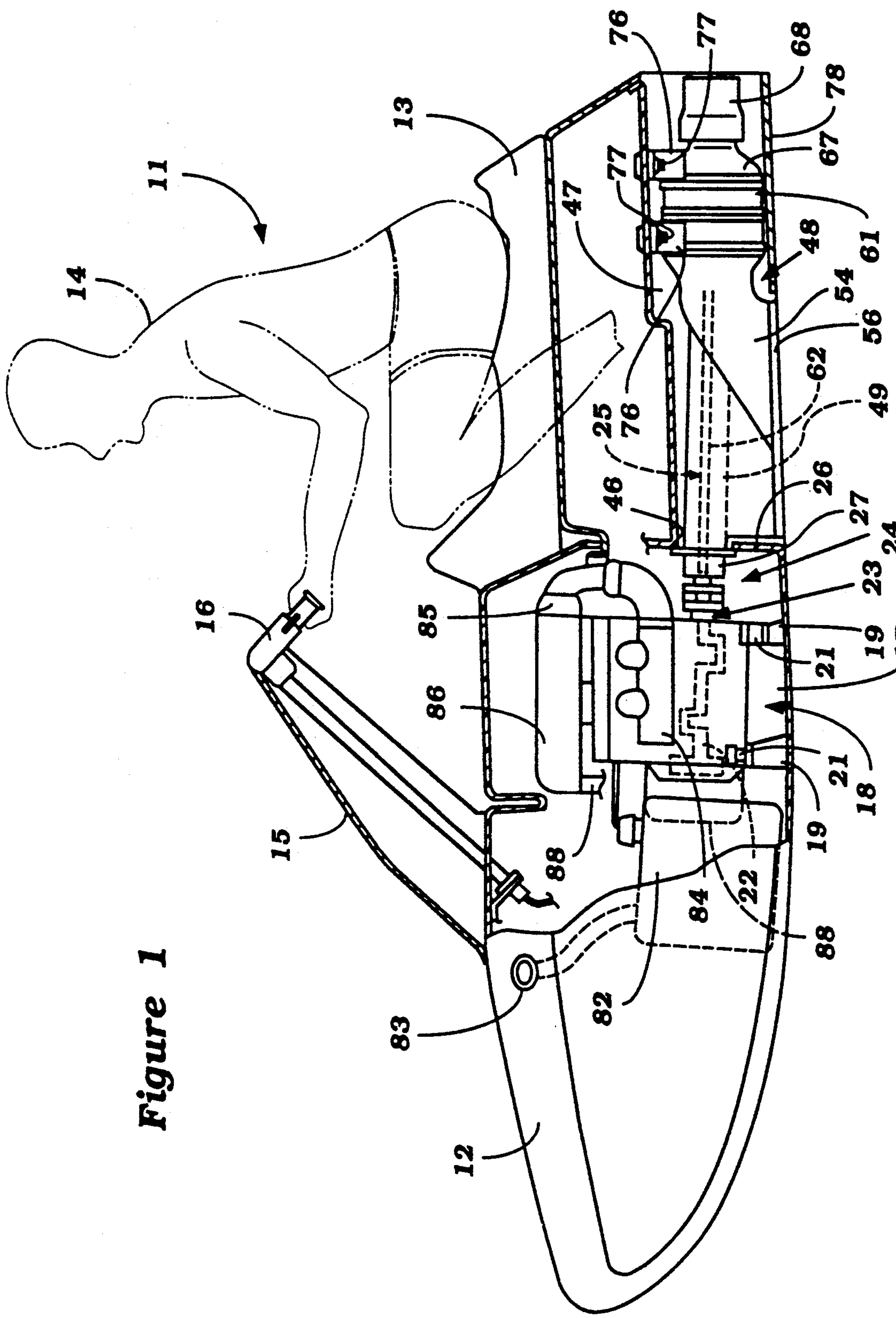

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Figure 1

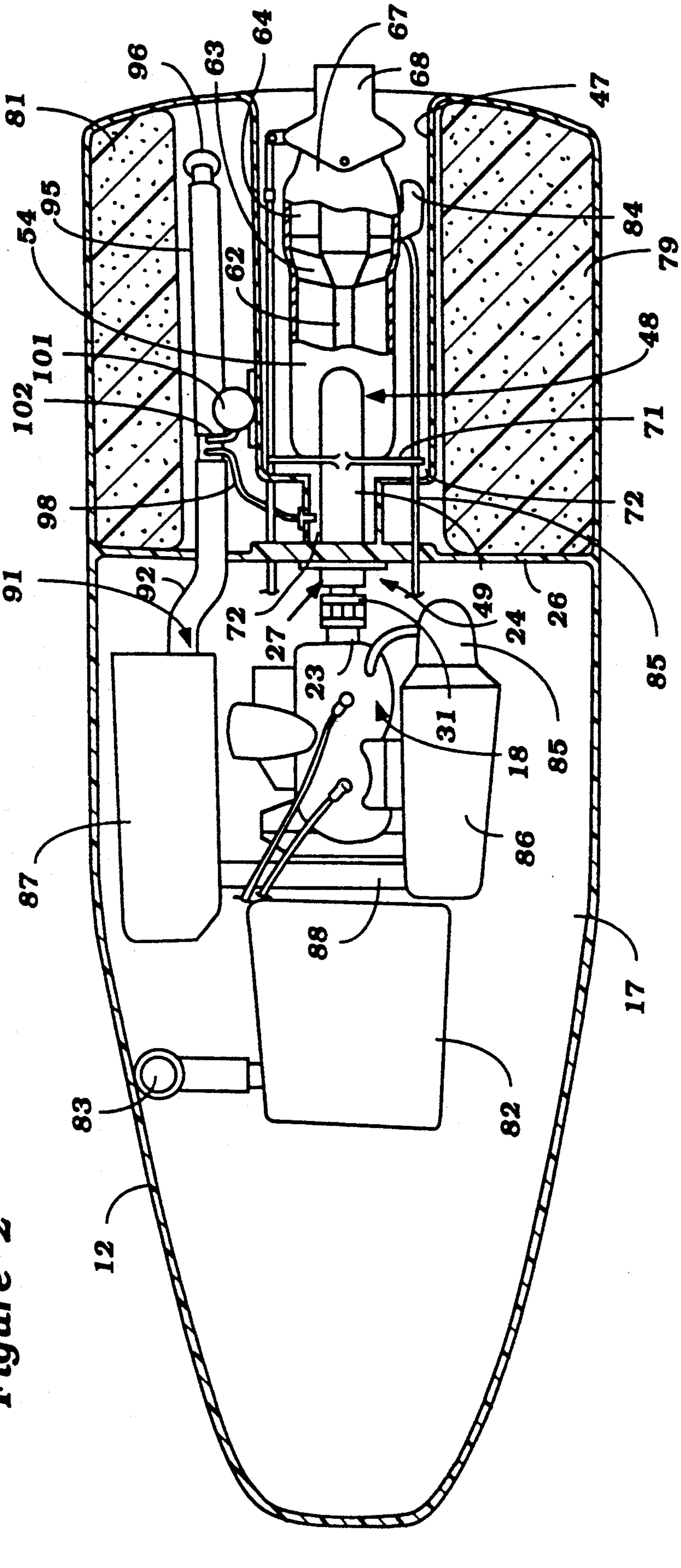

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Figure 2

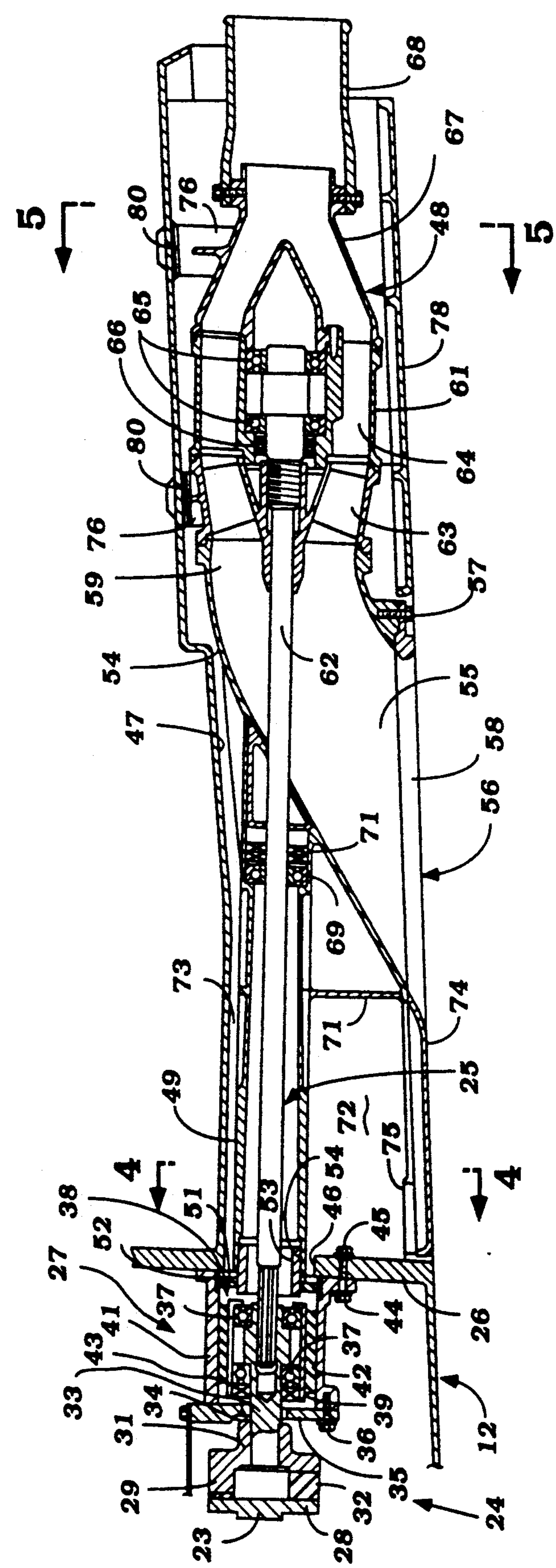
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Figure 3

Figure 4

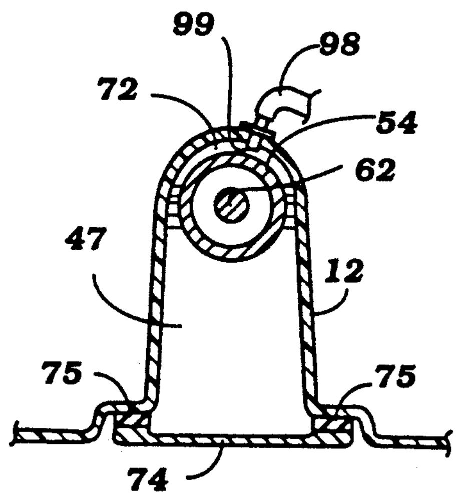


Figure 5

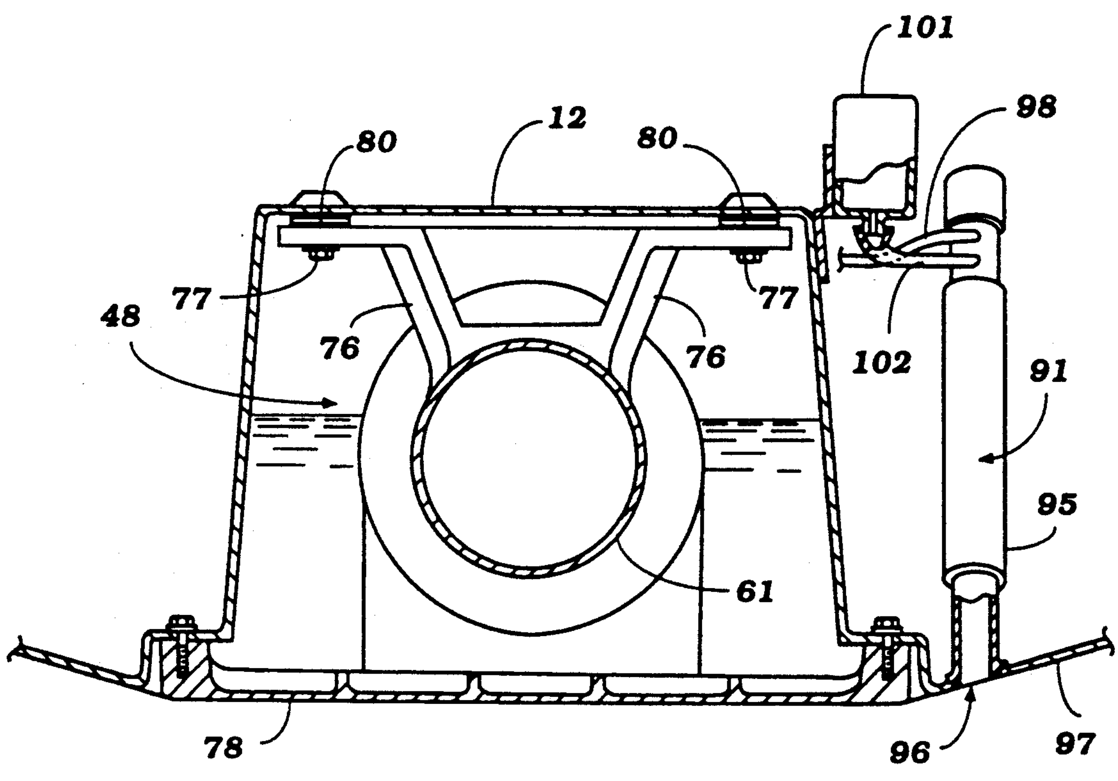
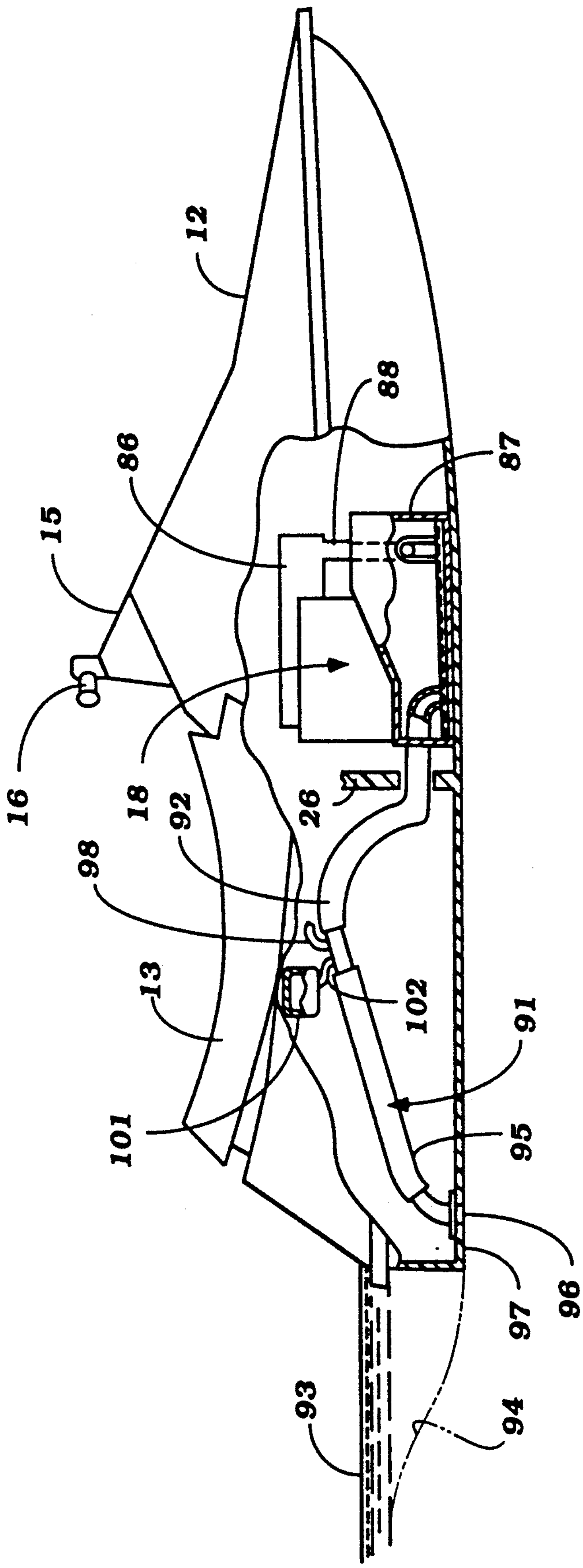


Figure 6



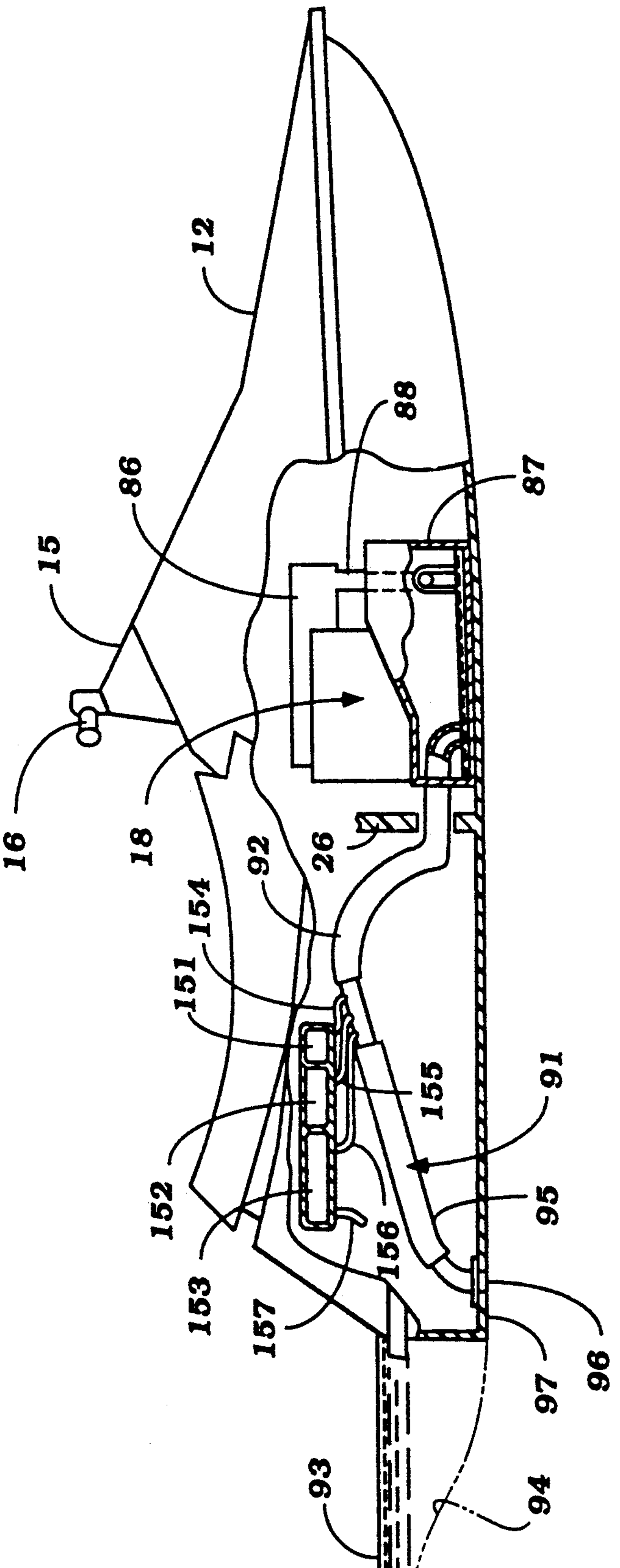

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Figure 7

Figure 8

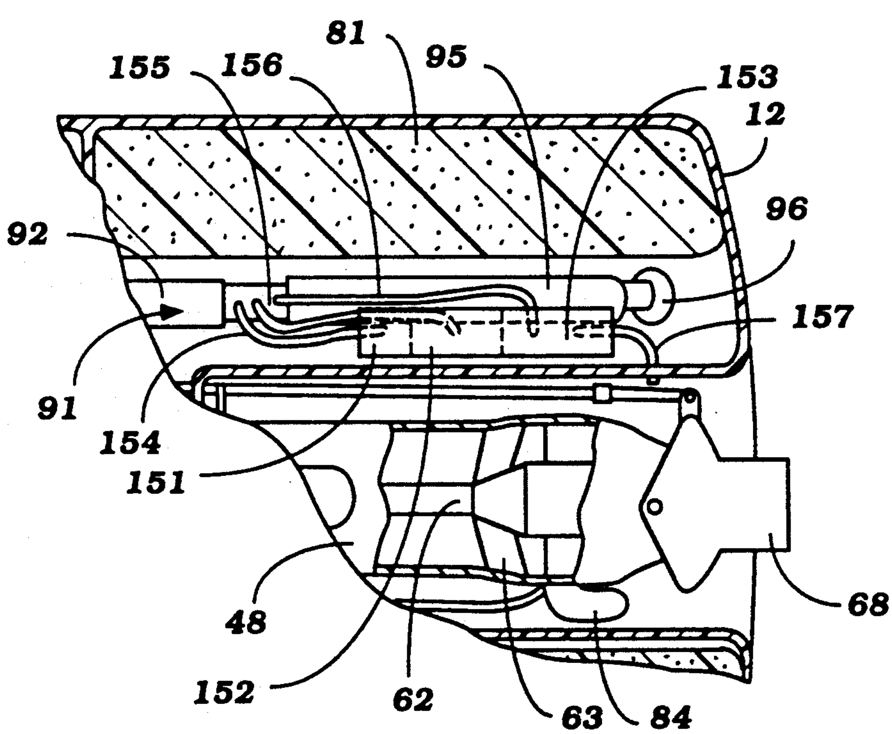


Figure 9

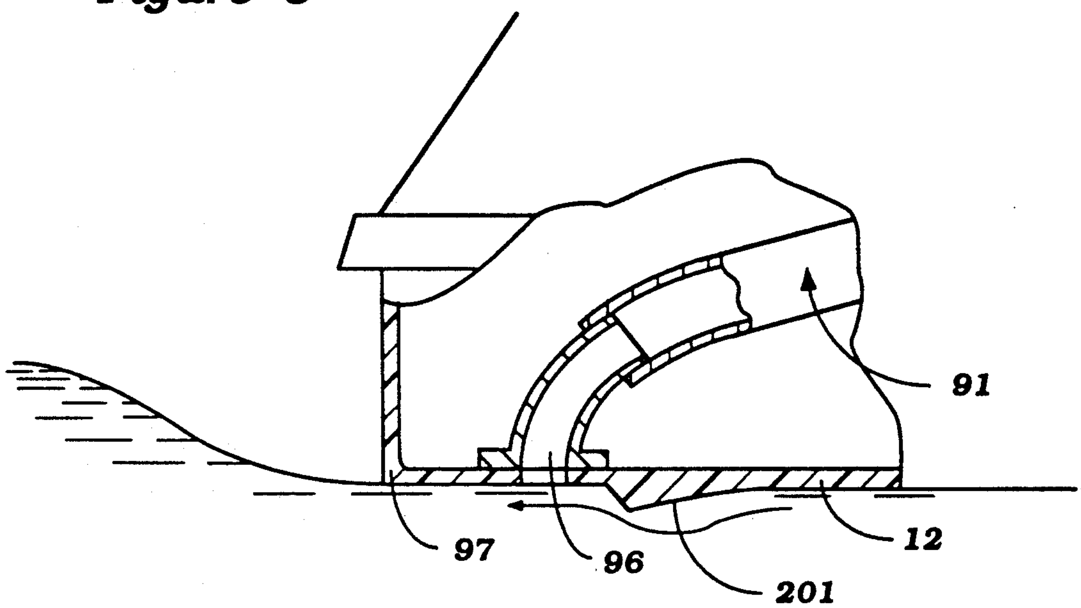
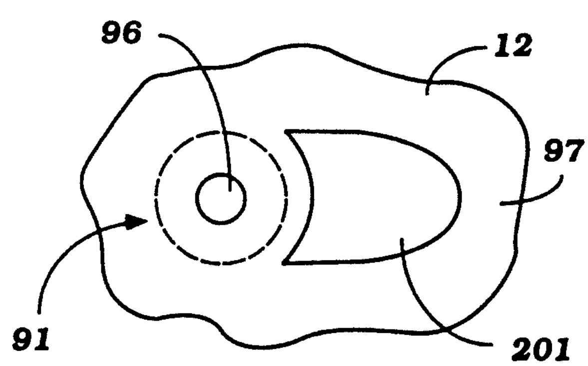


Figure 10



EXHAUST SYSTEM FOR SMALL PLANING BOAT

BACKGROUND OF THE INVENTION

This invention relates to an exhaust system for a small planing boat and more particularly to an improved exhaust system for a watercraft propelled by an inboard engine, such as a jet propelled watercraft.

In marine propulsion units, it is a common practice to employ the cooling water from the body of water in which the watercraft is operating to cool the powering internal combustion engine. In order to facilitate discharge of the cooling water and also to provide silencing, it has been the practice to discharge the cooling water into the exhaust system of the engine. This procedure is used not only with inboard engines, but also with outboard motors that are water cooled.

Although the aforedescribed system is effective to provide silencing, it has some disadvantages. Specifically, because of the addition of water to the exhaust gases, the use of sound deadening materials such as fiberglass packing cannot be employed. Hence, many conventional forms of exhaust silencing utilized with other types of engines cannot be employed with marine propulsion engines.

Another way in which the exhaust gases in a marine propulsion unit are silenced is by discharging the exhaust gases through an underwater exhaust gas discharge. However, this method of silencing has certain disadvantages caused primarily due to the different speeds at which the watercraft may operate. For example, if the exhaust gases are discharged into the body of water in which the watercraft is operating at a low level when the watercraft is operating at low speeds, then the discharge may be too high and above the water when operating at high speeds. Alternatively, the low discharge may give rise to too high a back pressure in the exhaust gases.

With many types of inboard engines, it is the practice to discharge the exhaust gases through the transom of the watercraft. However, this type of discharge presents the problems as noted in the preceding paragraph.

In connection with jet propelled watercraft, it has been proposed to discharge the exhaust gases into the tunnel in which the jet propulsion unit is positioned. This internal discharge of the exhaust gases can improve silencing efficiency. However, the previously proposed discharges of this type have been partially submerged when operating at low speeds and have been above the water and thus provide minimal silencing when at high speeds.

In addition to the problems aforenoted in connection with exhaust gas discharge from a marine propulsion unit, many types of watercraft, because of their sporting nature, frequently may become overturned or capsized. When this occurs, there is a danger that water in the exhaust system may flow into the engine through its open exhaust ports. This presents obvious difficulties upon restarting.

It is, therefore, a principal object of this invention to provide an improved exhaust system for a marine propulsion unit.

It is a further object of this invention to provide an exhaust system for a marine propulsion unit that provides good silencing under all running conditions.

It is a further object of this invention to provide an exhaust system for a jet propulsion unit which will provide excellent silencing under all running conditions.

It is another object of this invention to provide an exhaust system for a small watercraft that embodies a silencing device and which silencing device also acts as a water trap to trap water in the even the watercraft becomes inverted and to prevent the water from flowing to the engine through the exhaust ports either when inverted or when righted.

SUMMARY OF THE INVENTION

A first feature of this invention is adapted to be embodied in an exhaust system for a watercraft having a hull with an under surface which is wetted during all normal operation of the watercraft. An inboard engine is mounted within the hull and drives a propulsion device for propelling the hull through a body of water. An exhaust system is incorporated for receiving exhaust gases from the engine and discharging them to the atmosphere. In accordance with this feature of the invention, the exhaust system terminates at a downwardly facing opening extending through the hull under surface.

Another feature of the invention is also adapted to be embodied in an exhaust system for a watercraft having a hull and an inboard engine mounted within the hull and driving a propulsion device for propelling the hull through a body of water. An exhaust system receives exhaust gases from the engine and discharges them to the atmosphere through an outlet opening. In accordance with this feature of the invention, an expansion chamber is positioned above a portion of the exhaust system in the normal position of the watercraft and communicates with that portion of the exhaust system through an opening to function as a silencing device during normal watercraft operation and to absorb a volume of water entering the watercraft through the outlet opening if the watercraft is inverted for precluding such water from flowing into the engine.

A further feature of this invention is adapted to be embodied in a jet propelled watercraft having a hull with a tunnel in which a jet propulsion unit is positioned and which jet propulsion unit is powered by an internal combustion engine positioned within the hull. The engine has an exhaust system that is comprised of a main exhaust discharge opening formed in the hull below the normal water level during watercraft operation and a restricted opening into the tunnel above the water level therein under all conditions when the watercraft is upright in the body of water.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a side elevational view of a small watercraft constructed in accordance with a first embodiment of the invention, with portions broken away.

FIG. 2 is a top plan view of the watercraft with the hull shown in cross section and certain other portions broken away.

FIG. 3 is a vertical cross sectional view taken through the jet propulsion unit and drive therefor.

FIG. 4 is a cross sectional view taken along the line 4—4 of FIG. 3.

FIG. 5 is a cross sectional view taken along the line 5—5 of FIG. 3.

FIG. 6 is a side elevational view, in part similar to FIG. 1, but shows the watercraft from the opposite side and is broken away to show the exhaust system and the water level when operating at idle and when planing at high speed.

FIG. 7 is a side elevational view, with a portion broken away, similar to FIG. 6, but shows another embodiment of the invention.

FIG. 8 is a partial cross sectional view, in part similar to FIG. 2, but showing the embodiment of FIG. 7.

FIG. 9 is a cross sectional view taken through the exhaust discharge of another embodiment of the invention.

FIG. 10 is a bottom plan view of the embodiment of FIG. 9.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring first to the embodiment of FIGS. 1 through 6, a small watercraft constructed in accordance with this embodiment is identified generally by the reference numeral **11** and includes a hull **12** having a rearwardly mounted seat **13** on which a single rider, shown in phantom and identified by the reference numeral **14**, is adapted to be seated for operating the watercraft. Although the invention is described in conjunction with such a small watercraft, it will be readily apparent to those skilled in the art that the invention may be employed with other types of watercraft. However, certain facets of the invention have particular utility with a small watercraft of this type, due to the fact that this type of small watercraft may frequently become capsized due to its sporting nature.

A mast **15** is positioned in front of the seat **13** and carries a handlebar **16** for operation of the watercraft **11** and particularly for steering it, in a manner to be described. An engine compartment, indicated generally by the reference numeral **17** is formed by the forward portion of the hull **12** and partially extends beneath the mast **15**. An internal combustion engine, indicated generally by the reference numeral **18** is positioned within the engine compartment **17**. In the illustrated embodiment, the engine **18** is of the two cylinder in line, two cycle crankcase compression type. It is to be understood, however, that the invention has utility in conjunction with engines of other types.

The engine **18** is mounted on a pair of engine mounts **19** by means including elastic isolators **21**. The engine **18** has a crankshaft **22** that has a rearwardly extending exposed portion **23** which is coupled by an elastic coupling **24** to an impeller shaft **25** that extends through a bulkhead **26** of the hull **12**. The forward portion of the impeller shaft **25** is contained within a bearing and seal assembly **27**.

This drive construction is shown in greater detail in FIG. 3. As may be seen in this figure, the coupling **24** is comprised of a member **28** that is affixed to or formed integrally with the engine output shaft **23** and which cooperates with interdigitation **29** of a second member **31** with elastomeric elements **32** interposed therebetween so as to provide the flexible coupling. The member **31** is affixed to a stub shaft **33** in a suitable manner and which stub shaft **33** extends through an opening **34** formed in a plate **35** that is affixed to the front of the pilot member **27** by threaded fasteners **36**. The stub shaft **33** is journaled within the pilot member **27** by means of a pair of spaced apart anti-friction bearings **37** which are contained within a cavity **38** defined by the pilot member **27** and end plate **35**. The bearings **37** are supported within a metal sleeve **39** which is, in turn, carried by a cylindrical portion **41** of the pilot part **27** by means of an elastic sleeve **42**. A water seal **43** is interposed between the sleeve **39** and the stub shaft **33** for sealing purposes.

The pilot portion **27** is supported on the bulkhead **26** by a plurality of bolts **44** and nuts **45**. The bulkhead **26** has an opening **46** through which the impeller shaft **25** extends and the impeller shaft has a splined connection to the stub shaft **33** so as to transmit drive therebetween.

A tunnel, indicated generally by the reference numeral **47**, is formed to the rear of the bulkhead **26** and beneath the seat **13**. A jet propulsion unit, indicated generally by the reference numeral **48**, is contained within this tunnel. This jet propulsion unit **48** includes an outer housing having a cylindrical portion **49** that extends through the bulkhead opening **46** and a water seal **51** extends around this and is held in place by a sleeve **52** that is pressed into the pilot member **27** so as to insure against water leakage forwardly of the bulkhead **26**. The seal **51** engages a bushing **53** that is affixed to the interior of the sleeve **49**, as by welds **54**.

Rearwardly of the tubular portion **49**, the jet propulsion unit **48** is provided with a water inlet housing portion **54** having a downwardly facing water inlet opening **55** across which a screen or inlet member **56** is affixed by fasteners **57**. The screen or inlet member **56** has slotted openings **58** that permit water to be drawn from the body of water in which the watercraft is operating and to pass through a delivery section **59** which communicates with an impeller housing, indicated generally by the reference numeral **61**. The impeller shaft **25** has a portion **62** that extends through the delivery section **59** and which is affixed, in a suitable manner, to an impeller **63**. The impeller **63** draws water through the water inlet opening and discharges it past a plurality of straightening vanes **64** formed in the impeller housing **61**.

A bearing assembly **65** is supported within the interior of the impeller housing **61** radially inwardly of the straightening vanes **64** and supports the trailing end of the impeller shaft **25**. Water seals **66** are provided so as to protect the bearings **65** from water damage.

Water is discharged past the straightening vanes **64** to a discharge nozzle **67** which faces rearwardly and upon which a steering nozzle **68** is supported for pivotal movement about a vertically extending steering axis. The steering nozzle **68** is coupled appropriately to the handlebar **16** for steering the watercraft in a well known manner.

Where the tubular portion **49** meets the water inlet housing **54**, there is provided a further support bearing **69** for the impeller shaft **25** and a water seal **71** protects this bearing **69**. Forwardly of the bearing **69**, the jet propulsion unit housing is provided with a vertically extending wall which defines a chamber **72** that is formed forwardly thereof and beneath the lower surface of the tunnel **48** and rearwardly of the bulkhead **26**, for a reason to be described. A restricted opening **73** is formed at the top of the wall **71** so as to communicate the chamber **72** with the area of the tunnel **47** to the rear of the wall **72** and which opens through the rear of the hull **12**.

The jet propulsion unit and particularly the water inlet portion **54** has a horizontally extending wall **74** that forms a lower closure for the chamber **72** and which is engaged by an elastic damper **75** for providing part of the resilient support for the jet propulsion unit **48** within the tunnel **47**.

The impeller housing **61** of the jet propulsion unit is further supported within the tunnel **47** by a cradle **76** that is suitably affixed to the underside of the hull and specifically the tunnel portion **47** by means of fasteners **77** and elastic isolators **80**. A closure plate **78** extends across the rear portion of the tunnel **47** beneath the impeller housing **61** so that the jet propulsion unit is sealed within the tunnel **47** and water will only be drawn through the inlet opening **55** and discharged through the discharge nozzle **67** and steering nozzle **68** without leaking around the outer portion of the jet propulsion unit **48**. This insures good efficiency for the pumping unit.

As may be best seen in FIG. 2, the hull **12** on the sides of the tunnel **47** is filled with bodies **79** and **81** of a buoyant material, such as a foamed plastic or the like. This provides added balance for the watercraft to compensate for the weight of the jet propulsion unit **48**.

Referring now again to the engine **18**, it is provided with a fuel system that includes a forwardly positioned fuel tank **82** which may be filled through a filler neck **83** that is accessible through the forward deck portion of the hull **12**. The fuel tank **82** is positioned on the longitudinal center line of the hull **12** so as to improve the side to side balance and is positioned immediately ahead of the engine **18** in the engine compartment **17**.

The engine **18** is water cooled and is supplied with coolant delivered from a pumping section **84** (FIG. 2) of the jet propulsion unit in proximity to the straightening vanes **64** through a conduit **85**. The engine **18** may be provided with its own internal cooling pump for circulating the coolant through its various cooling jackets. Since this cooling system may be of any conventional type and forms no part of the invention, further description of it is believed to be unnecessary. However, it should be noted that the coolant that has circulated through the cooling jacket of the engine **18** is discharged back into the body of water in which the watercraft is operating through the exhaust system now to be described.

The exhaust gases are discharged from the exhaust ports of the engine into an exhaust manifold **84** (FIG. 1). Cooling water from the engine cooling jacket may also be discharged in an appropriate manner to this exhaust manifold **84**. The exhaust gases and any cooling water then flow through a first exhaust delivery pipe **85** to a first expansion chamber **86** positioned on one side of the engine and which may have a construction as shown in the application for United States Letters Patent entitled "Exhaust System For Small Planing Craft", Ser. No. 593,779, filed Oct. 5, 1990 in my name as co-inventor with Hiroshi Tazaki and Atsushi Sugawara and assigned to the Assignee hereof. The expansion chamber **86**, first exhaust pipe section **85** and exhaust manifold **84** lie on one side of the engine **18**.

Exhaust gases are delivered from the first expansion chamber **86** to a second expansion chamber **87** which, as may be seen in FIG. 2, lies on the opposite side of the engine **18**, through a second exhaust delivery pipe **88**. The pipe **88** has a generally U shaped section and the second expansion chamber **87** is provided with a water trap arrangement so as to avoid the likelihood that water can flow back into the exhaust ports of the engine through the exhaust system. This construction may also be as disclosed in aforenoted copending application for U.S. patent Ser. No. 593,779.

The construction of the exhaust system as thus far described may be considered to be conventional. With

this type of exhaust system and since cooling water is introduced to the exhaust gases from the engine cooling jacket, the type of silencing devices utilized in conjunction with non-marine engines, such as automotive engines, employing such devices as fiberglass packing cannot be employed for silencing purposes and the silencing must be achieved through the use of the water and expansion chambers.

In accordance with the invention, there is provided an arrangement that permits the use of added silencing devices from those conventionally employed with marine propulsion units and which also further insures against the likelihood of water being able to enter the exhaust ports of the engine, even if the watercraft **11** may be inverted and subsequently righted. To this end, there is provided an exhaust pipe, indicated generally by the reference numeral **91** which serves to convey the exhaust gases and coolant from the second expansion chamber **87** to the body of water in which the watercraft is operating in a submerged location and which also incorporates additional silencing and water entry prevention devices.

The exhaust pipe **91** has a first, generally steeply inclined section **92** that runs from the second expansion chamber **87** rearwardly and in a generally upward direction so as to have an upper portion that is disposed above the water level, as seen in FIG. **6**, regardless of whether the watercraft **12** is operating at idle, as shown by the solid line view of the water level **93** or if the watercraft is operating at a planing condition as shown as the dot-dot-dash line **94** in this same figure. From this elevated portion, the exhaust pipe **91** has a gradually downwardly inclined portion **95** that extends toward the rear of the watercraft at one side thereof and which terminates in a downwardly exhaust outlet opening **96** that is formed in the lower surface **97** of the hull. The surface **97** is a surface that is normally wetted under all operating conditions of the watercraft so that the exhaust outlet opening **96** will always be submerged. As a result of this, it will be assured that the exhaust gases will always pass through the body of water in which the watercraft is operating from the outlet **96**. This will add further silencing effect to the exhaust gases.

As may be seen from FIG. **6**, when the watercraft is operating at idle or low speeds, the outlet opening **96** will be relatively deeply submerged. If all of the exhaust gases were forced to exit through this opening **96**, high back pressure in the exhaust system would result in poor engine performance. To avoid this possibility, there is provided a low speed exhaust gas discharge conduit **98** which extends generally from the highest portion of the exhaust pipe **91** and above the water level **93** to a discharge opening in the tunnel **47** and particularly the area **72** thereof formed forwardly of the wall **71**. Hence, the combination of the restricted conduit **98** and the tunnel portion **72** forms an expansion chamber through which the slow speed exhaust gas discharge will be silenced. A restricted opening **99** formed at the end of the conduit **98** will insure that there is good silencing at low speeds and that a large volume of exhaust gases will not exit through this path at high speeds. Hence, good silencing will be achieved under all running conditions.

It should be also noted that from the expansion chamber **72**, the exhaust gases must pass through the restricted passage **73** (FIG. 3) before it can be discharged rearwardly through the transom of the hull **12**. There will hence be a further contraction and expansion of the exhaust gases that adds to the silencing effect.

To further aid in the silencing of the exhaust gases under all running conditions, the exhaust system is also provided with an expansion chamber **101** that communicates with the upper portion of the exhaust pipe **91** through a conduit **102** that functions as a tuning neck so that the expansion chamber **101** and conduit **102** function as a Helmholtz resonator. This Helmholtz resonator may be tuned to silence a more objectionable exhaust frequency and further improve in the silencing.

In addition to providing functioning as Helmholtz resonator, the chamber **101** also will receive water that may enter the exhaust system through the exhaust outlet opening **96** if the watercraft is inverted. It should be noted that the more gradually inclined longer section **95** of the exhaust pipe **91** further insures that more water will be contained in this portion of the exhaust pipe than in the portion **92**. When the watercraft is inverted, water will then tend to flow into the expansion chamber **101** rather than into the exhaust pipe section **92**. As a result, when the watercraft is returned to its normal position, this water will drain from the expansion chamber **101** back to the body of water in which the watercraft is operating through the pipe section **95** rather than return to the expansion chamber **87** through the pipe section **92**. This will offer further insurance that water can never pass back to the exhaust ports of the engine. The device therefore serves a dual purpose.

In the embodiment as thus far described, the low speed exhaust gas discharge is provided separately from the Helmholtz resonator. However, rather than providing separately the conduit **98** and the Helmholtz resonator **101** and conduit **102**, the low speed exhaust gas discharge **98** may be eliminated and a corresponding conduit may be provided between the Helmholtz resonator **101** and the restricted tunnel portion **72** that forms the expansion chamber. When this is done, the Helmholtz resonator can function as a Helmholtz device when running at high speed and as an added expansion chamber for the exhaust gases when running at low speed. Such an arrangement is shown in the embodiment of FIGS. **7** and **8**. In this embodiment, there are also provided additional Helmholtz resonators for providing a wider range of silencing. Because this embodiment differs from the previous embodiment only in that regard, only this portion of the system is illustrated. Components which are the same as those of the previously described embodiment have been identified by the same reference numerals and will be described in detail only insofar as is necessary to understand the construction and operation of this embodiment.

In this embodiment, there are provided three expansion chambers, **151, 152** and **153**, each of which has a different effective volume. The expansion chambers **151, 152** and **153** communicate with the exhaust pipe **91** at approximately its highest point through conduits **154, 155** and **156**. The conduits **154, 155** and **156** may have different lengths and are tuned relative to the volumes of the expansion chambers **152, 153** and **154** so as to provide Helmholtz resonators that will silence different frequencies. In this way, the band of silencing can be further widened from the previously described embodiment.

In addition, the chambers **151, 152** and **153** will provide a larger cumulative volume than the single chamber of the previously described embodiment so as to contain and trap water when the watercraft **11** becomes inverted. Again, this water will drain back through the exhaust pipe section **92** away from the engine rather than back through the section **92** to the engine to further insure against water damage to the engine.

Any one of the expansion chambers **151, 152** and **153** may provide the low speed exhaust gas discharge and in the illustrated embodiment, the chamber **153** is communicated with the tunnel portion **72** by a conduit **157** that has a restricted opening at its end so as to function as a low speed exhaust gas discharge. In addition, the expansion chamber **153** will function as a further expansion chamber under low speed exhaust gas discharge so as to further improve the silencing.

It has been noted that the exhaust gases are discharged, under high speed operation, through the discharge opening **96** in the lower surface **97** of the hull. In order to provide further improvement in the efficiency of the exhaust system, the lower portion of the hull **12** may be provided in proximity with the discharge opening **96** with a device to provide a venturi like action so as to have an extraction force on the exhaust gases. Such an embodiment is shown in FIGS. **9** and **10**. As may be seen in these figures, the hull surface **97** is provided with a somewhat tear drop shaped projection **201** that is formed immediately forwardly of the exhaust discharge opening **96** that will create a flow pattern as shown in FIG. **9** that provides a venturi like effect and a reduced pressure at the exhaust discharge opening **96**. This will improve the ability of the exhaust gases to be discharged and will increase the performance of the engine.

It should be readily apparent from the foregoing description that the several embodiments of the invention disclosed provide an extremely efficient exhaust system for a marine propulsion unit and one which offers greater silencing capabilities than the previously proposed systems for such watercraft. In addition, good silencing will be achieved both at low and high speeds, without restriction in the exhaust gases. The silencing arrangement also has the added advantage of providing a water trap for trapping water if the watercraft becomes inverted and insuring that this water will not flow to the exhaust ports of the engine when the watercraft is righted. Although a number of embodiments of the invention have been illustrated and described, various changes and modifications may be made without departing from the spirit and scope of the invention, as defined by the appended claims.

I claim:

1. An exhaust system for a watercraft having a hull with an undersurface which is wetted during normal operation of said watercraft, an inboard engine mounted within said hull and driving a propulsion drive for propelling said hull through a body of water, an exhaust system for receiving exhaust gases from said engine and discharging the exhaust gases to the atmosphere, said exhaust system terminating in a downwardly facing exhaust outlet extending through said hull under surface, and an expansion chamber communicating with said exhaust system at a point above the water level and devoid of water when the watercraft is operating in the body of water for receiving water which may enter the exhaust system through the exhaust outlet when the watercraft is inverted and to receive any water in said exhaust system when said watercraft is inverted and for draining of such received water back to the body of water in which the watercraft is operating through said exhaust system exhaust outlet when the watercraft is righted for precluding water from entering the exhaust ports of the engine.

2. An exhaust system as set forth in claim 1 wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

3. An exhaust system as set forth in claim 1 wherein the communication of the expansion chamber with the exhaust system is at a point contiguous to the highest point of the exhaust system.

4. An exhaust system as set forth in claim 3 wherein the exhaust system includes an exhaust pipe having a first steeply inclined section running upwardly from a low point in the hull to the highest point and a second portion extending downwardly at a lesser inclined angle from the highest point to the exhaust outlet opening.

5. An exhaust system as set forth in claim 4 wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

6. An exhaust system as set forth in claim 1 further including means for communicating the exhaust system with the atmosphere at a point above the water level regardless of the condition of operation of the watercraft through a restricted opening for providing a low speed exhaust gas discharge when the exhaust gas outlet is deeply submerged.

7. An exhaust system as set forth in claim 6 wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

8. An exhaust system as set forth in claim 6 wherein the communication of the expansion chamber with the exhaust system is at a point contiguous to the highest point of the exhaust system.

9. An exhaust system as set forth in claim 8 wherein the exhaust system incudes an exhaust pipe having a first steeply inclined section running upwardly from a low point in the hull to the highest point and a second portion extending downward at a lesser inclined angle from the highest point to the exhaust outlet opening.

10. An exhaust system as set forth in claim 9 wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

11. An exhaust system as set forth in claim 1 wherein portion of the hull under surface forwardly of the downwardly facing exhaust opening is formed to effect a venturi effect upon the exhaust outlet when the watercraft is traveling through a body of water.

12. An exhaust system for a watercraft having a hull with a tunnel formed at the rear thereof and surrounded on its sides by an undersurface which is wetted during normal operation of said watercraft, an inboard engine mounted within said hull forwardly of said tunnel, a jet propulsion unit contained within said tunnel and driven by said engine for propelling said hull through a body of water, an exhaust system for receiving exhaust gases from said engine and discharging the exhaust gases to the atmosphere, said exhaust system terminating in a downwardly facing exhaust outlet extending through said hull undersurface on one side of said tunnel, and an expansion chamber within said hull communicating with the exhaust system at a point above the water level when the watercraft is operating in the body of water for receiving water which may enter the exhaust system through the exhaust outlet when the watercraft is inverted and for draining of the received water from said expansion chamber back to the body of water in which the watercraft is operating when the watercraft is righted for precluding water from entering the exhaust ports of the engine.

13. An exhaust system as set forth in claim 12 wherein portion of the hull under surface forwardly of the downwardly facing exhaust opening is formed to effect a venturi effect upon the exhaust outlet when the watercraft is traveling through a body of water.

14. An exhaust system as set forth in claim 12 wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

15. An exhaust system as set forth in claim 12 wherein the point of communication of the expansion chamber with the exhaust system is contiguous to the highest point of the exhaust system.

16. An exhaust system as set forth in claim 15 wherein the exhaust system includes an exhaust pipe having a first steeply inclined section running upwardly from a low point in the hull to the highest point and a second portion extending downwardly at a lesser inclined angle from the highest point to the exhaust outlet opening.

17. An exhaust system as set forth in claim 16 wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

18. An exhaust system as set forth in claim 12 further including means for communicating the exhaust system with the atmosphere through the tunnel at a point above the water level regardless of the condition of operation of the watercraft through a restricted opening for providing a low speed exhaust gas discharge when the exhaust gas outlet is deeply submerged.

19. An exhaust system as set forth in claim 18 wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

20. An exhaust system as set forth in claim 18 wherein the point of communication of the expansion chamber with the exhaust system is contiguous to the highest point of the exhaust system.

21. An exhaust system as set forth in claim 20 wherein the exhaust system includes an exhaust pipe having a first steeply inclined section running upwardly from a low point in the hull to the highest point and a second portion extending downward at a lesser inclined angle from the highest point to the exhaust outlet opening.

22. An exhaust system as set forth in claim 21 wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

23. An exhaust system for a watercraft having a hull, an inboard engine mounted within said hull and driving a propulsion device for propelling said hull through a body of water, and an exhaust system for receiving exhaust gases from said engine and delivering the exhaust gases to the atmosphere through an exhaust outlet opening, an expansion chamber positioned above a portion of said exhaust system and above the water level in the normal position of said watercraft and normally devoid of water and communicating with said portion

of said exhaust system through an opening to function as a silencing device during normal watercraft operation and to absorb a volume of water entering said exhaust system through said exhaust outlet opening when said watercraft is inverted for precluding such water from flowing into the engine upon righting to drain said absorbed volume of water through said exhaust outlet opening upon righting.

24. An exhaust system as set forth in claim **23** wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

25. An exhaust system as set forth in claim **23** wherein the point of communication of the expansion chamber with the exhaust system is contiguous to the highest point of the exhaust system.

26. An exhaust system as set forth in claim **25** wherein the exhaust system includes an exhaust pipe having a first steeply inclined section running upwardly from a low point in the hull to the highest point and a second portion extending downward at a lesser inclined angle from the highest point to the exhaust outlet opening.

27. An exhaust system as set forth in claim **26** wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

28. An exhaust system as set forth in claim **23** further including means for communicating the exhaust system with the atmosphere at a point above the water level regardless of the condition of operation of the watercraft through a restricted opening for providing a low speed exhaust gas discharge when the exhaust gas outlet is deeply submerged.

29. An exhaust system as set forth in claim **28** wherein the exhaust system communicates with the atmosphere through the expansion chamber.

30. An exhaust system as set forth in claim **28** wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

31. An exhaust system as set forth in claim **28** wherein the point of communication of the expansion chamber with the exhaust system is contiguous to the highest point of the exhaust system.

32. An exhaust system as set forth in claim **31** wherein the exhaust system includes an exhaust pipe having a first steeply inclined section running upwardly from a low point in the hull to the highest point and a second portion extending downwardly at a lesser inclined angle from the highest point to the exhaust outlet opening.

33. An exhaust system as set forth in claim **32** wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

34. An exhaust system as set forth in claim **23** further including means for communicating the exhaust system with the atmosphere at a point above the water level regardless of the condition of operation of the watercraft through a restricted opening for providing a low speed exhaust gas discharge when the exhaust gas outlet is deeply submerged.

35. An exhaust system as set forth in claim **34** wherein the exhaust system communicates with the atmosphere through the expansion chamber.

36. An exhaust system as set forth in claim **23** wherein the propulsion device comprises a jet propulsion unit contained within a tunnel formed on the underside of the hull.

37. An exhaust system as set forth in claim **36** wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

38. An exhaust system as set forth in claim **23** wherein the point of communication of the expansion chamber with the exhaust system is contiguous to the highest point of the exhaust system.

39. An exhaust system as set forth in claim **38** wherein the exhaust system includes an exhaust pipe having a first steeply inclined section running upwardly from a low point in the hull to the highest point and a second portion extending downwardly at a lesser inclined angle from the highest point to the exhaust outlet opening.

40. An exhaust system as set forth in claim **39** wherein the expansion chamber communicates with the exhaust system through a tuning neck to comprise a Helmholtz resonator when the exhaust system is operating for discharging exhaust gases.

41. A jet propelled watercraft comprising a hull defining a tunnel portion on its undersurface, a jet propulsion unit mounted in said tunnel, an engine mounted within said hull and driving said jet propulsion unit for powering said watercraft, an exhaust system for discharging exhaust gases from said engine to the atmosphere comprising a high speed exhaust gas discharge terminating in a discharge opening in said hull below the level of water in which the watercraft is operating under all normal watercraft operating conditions, and a low speed exhaust gas discharge communicating said exhaust system with said tunnel at a point above the water level therein under all normal running conditions of said watercraft.

42. A jet propelled watercraft as set forth in claim **40** further including an expansion chamber communicating with the exhaust system at a point above the water level in which the jet propelled watercraft is operating.

43. A jet propelled watercraft as set forth in claim **41** wherein the low speed exhaust gas discharge communicates the exhaust system with the tunnel through the expansion chamber.

44. A jet propelled watercraft as set forth in claim **42** further including a restriction positioned between the expansion chamber and the tunnel in the low speed exhaust gas discharge for restricting the flow of exhaust gases into the tunnel.

45. A jet propelled watercraft as set forth in claim **41** wherein the exhaust system includes an exhaust pipe having a first section extending upwardly from a point low in the hull to an elevated position above the water level within the tunnel and a second portion extending down from the upper end of the first portion to the high speed exhaust gas discharge opening and wherein the low speed exhaust gas discharge communicates with the exhaust pipe contiguous to the elevated position.

46. A jet propelled watercraft as set forth in claim **44** further including an expansion chamber contained within the hull and receiving the exhaust gases from the engine and delivering them to the exhaust pipe.

47. A jet propelled watercraft as set forth in claim **45** further including a second expansion chamber and water separator which receives the exhaust gases from the first mentioned expansion chamber and delivers them to the exhaust pipe.

48. A jet propelled watercraft as set forth in claim **46** wherein the first mentioned expansion chamber and the second expansion chamber are positioned on opposite transverse sides of the engine within the hull.

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