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# (54) METHOD AND APPARATUS FOR ENHANCING THE INTERNAL COMBUSTION ENGINE PERFORMANCE FOR SUBMARINES IN SNORKEL RUNNING

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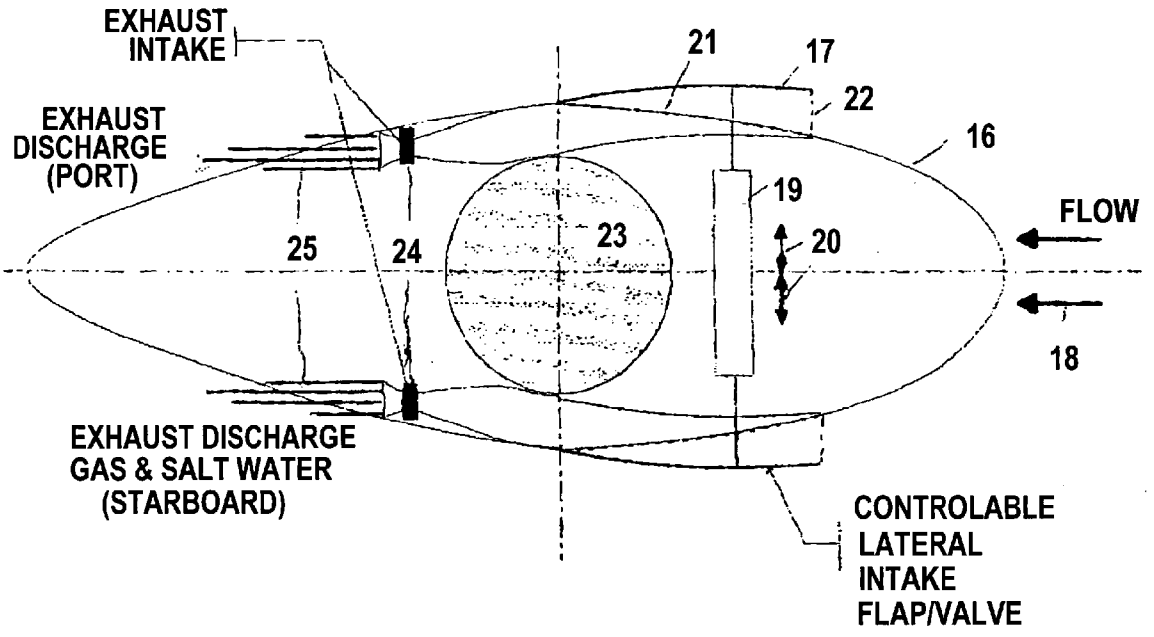
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(57) **ABSTRACT**

A method and apparatus are provided for enhancing the internal combustion engine performance, particularly the performance of charged diesel engines for charging batteries for submarines in snorkel running, whereby the exhaust gasses generated by the internal combustion engines during snorkel running are introduced into the water that surrounds the submarine, and whereby a reduced water pressure is created in at least one region at the submarine via flow-oriented measures by way of the motion of the submarine through the surrounding water, and the exhaust gasses are introduced into this region, for which purpose mechanically actuated flow-directing elements are arranged at the submarine.



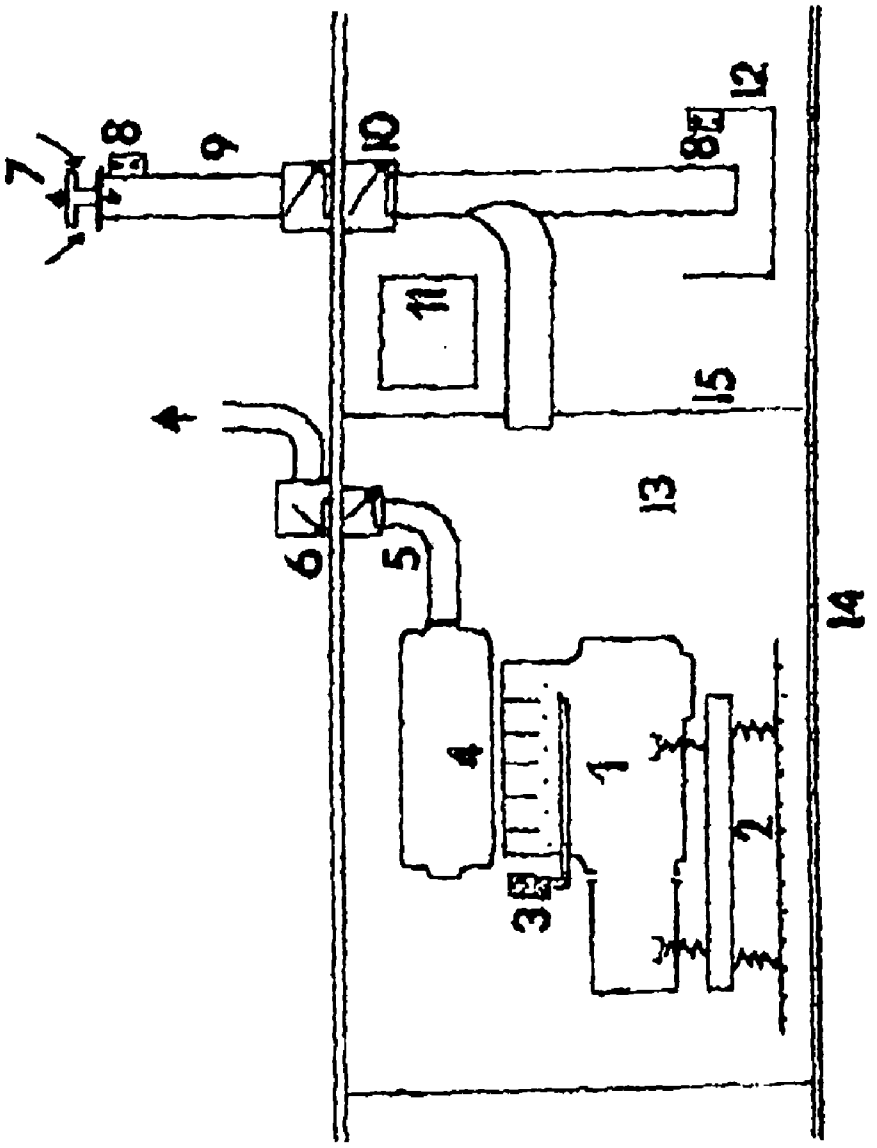



FIG. 1
(PRIOR ART)

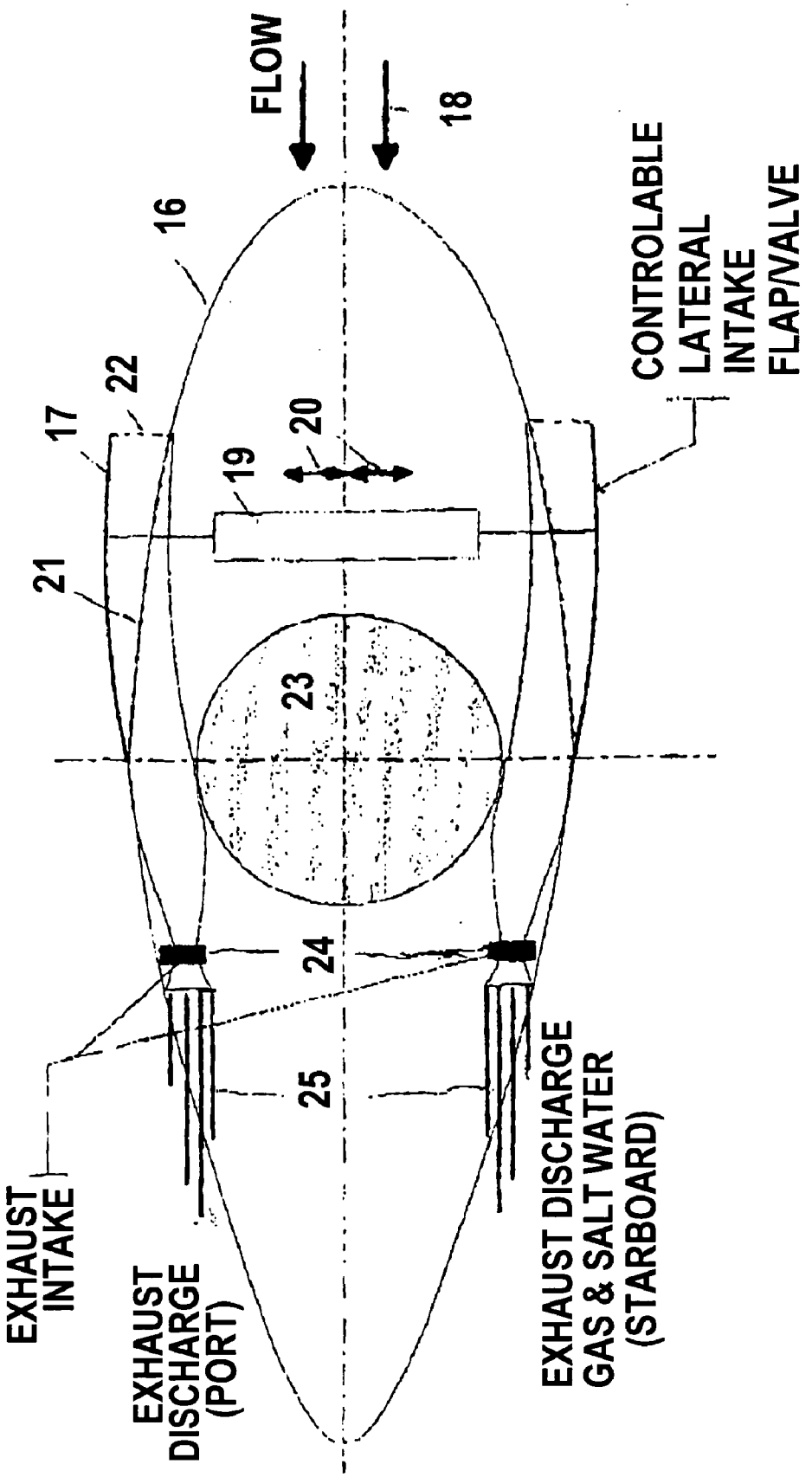

FLOW
18
16
CONTROLABLE
LATERAL
INTAKE
FLAP/VALVE
22
17
20
19
21
23
24
25
EXHAUST
INTAKE
EXHAUST
DISCHARGE
(PORT)
EXHAUST DISCHARGE
GAS & SALT WATER
(STARBOARD)

FIG. 2

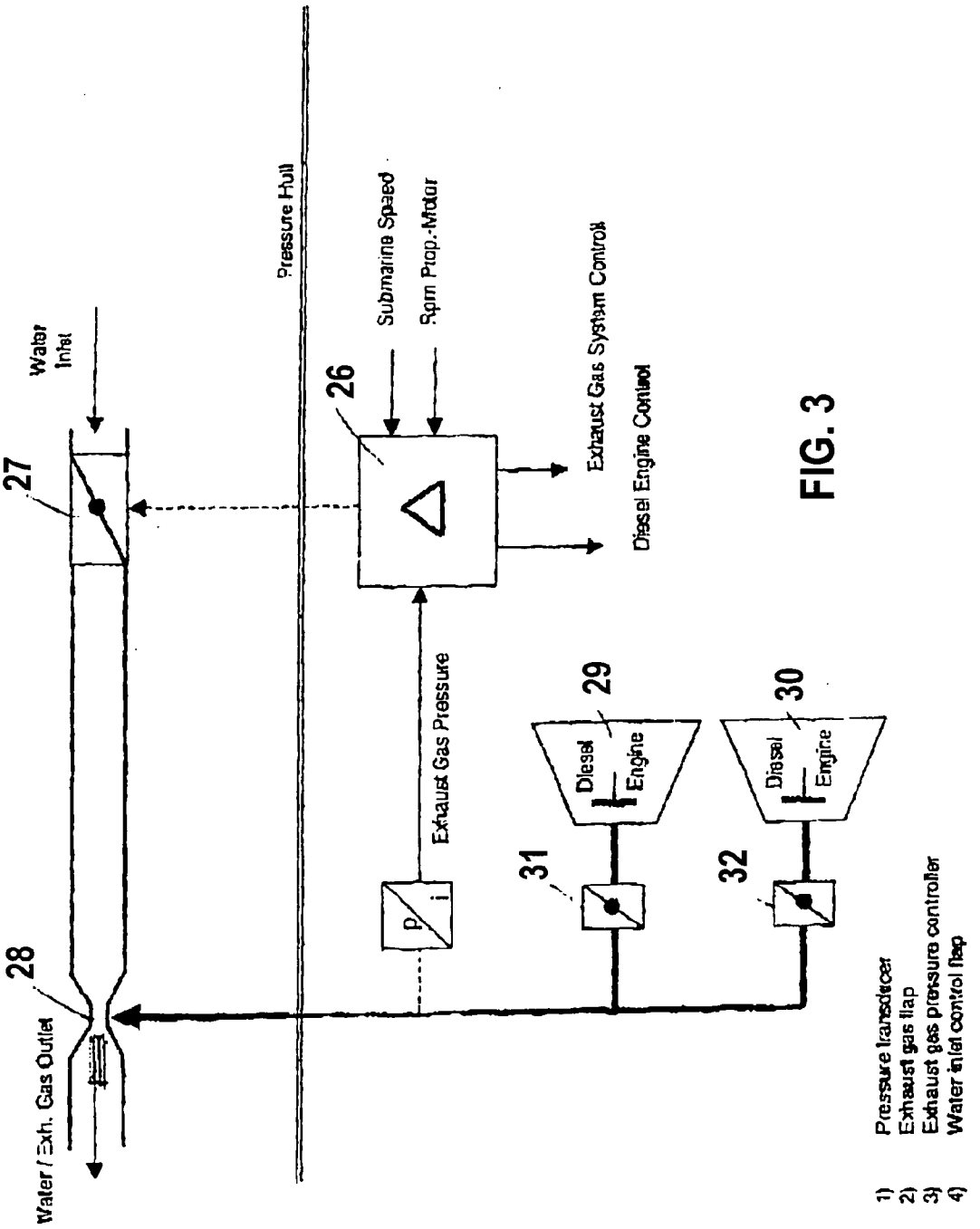
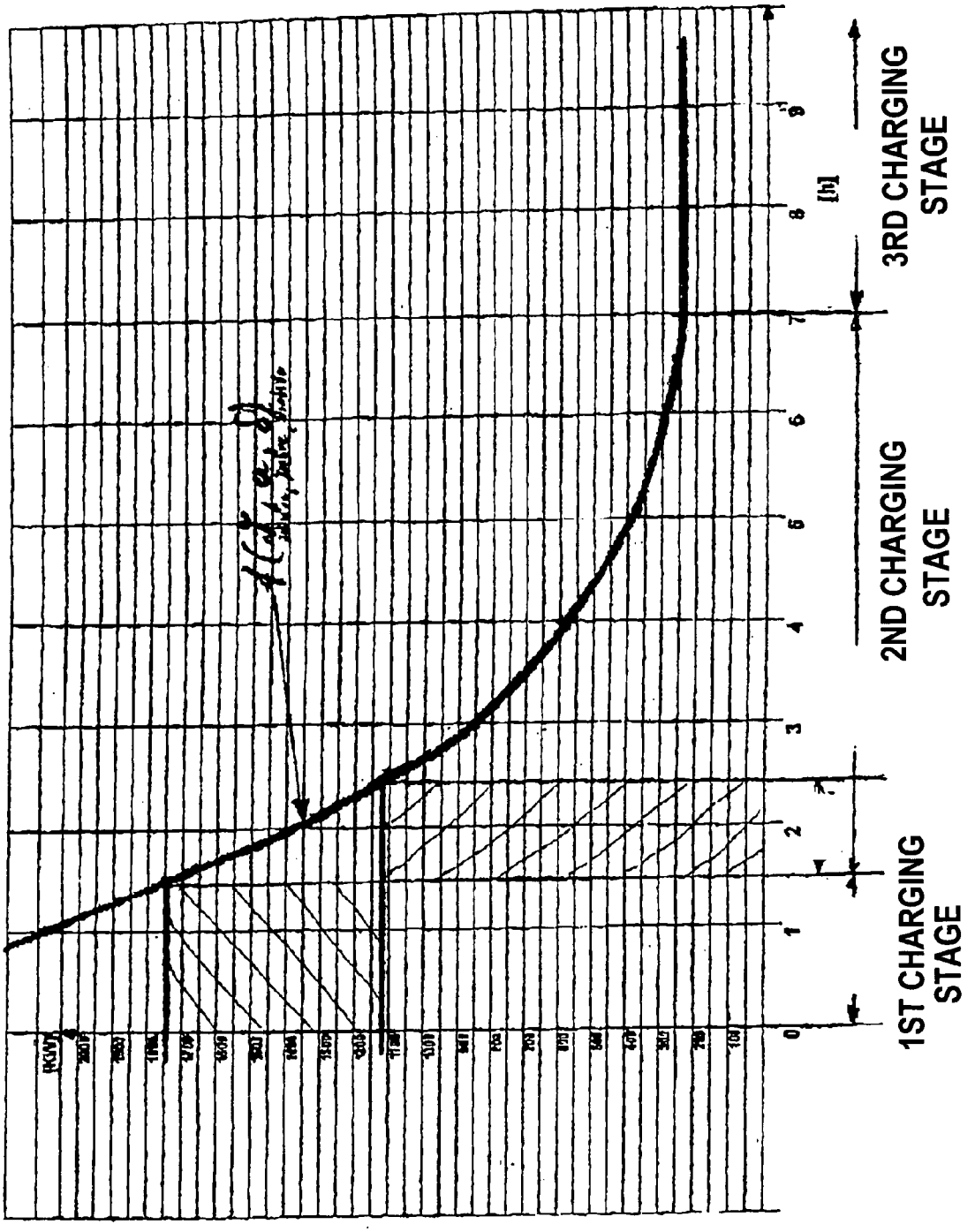

Pressure Hull
Water Inlet
Submarine Speed
Rpm Prop.-Motor
Exhaust Gas System Control
Diesel Engine Control
Exhaust Gas Pressure
Diesel Engine
Diesel Engine
Water / Exh. Gas Outlet
26
27
28
29
30
31
32
p
i
1) Pressure transducer
2) Exhaust gas flap
3) Exhaust gas pressure controller
4) Water inlet control flap

FIG. 3

FIG. 4



# METHOD AND APPARATUS FOR ENHANCING THE INTERNAL COMBUSTION ENGINE PERFORMANCE FOR SUBMARINES IN SNORKEL RUNNING

## BACKGROUND OF THE INVENTION

[0001] 1. Field of the Invention

[0002] The invention is directed to a method and to an apparatus for enhancing an internal combustion engine performance, particularly the performance of charged diesel engines for charging batteries for submarines in a snorkel running mode, whereby the exhaust gasses generated by the internal combustion engines during snorkel running are introduced into the water that surrounds the submarine.

[0003] 1. Description of the Related Art

[0004] The introduction of the exhaust gasses generated by the internal combustion engines into the water that surrounds the submarine is known and the fundamentals thereof are described in the textbook by Ulrich Gabler, *Unterseebootbau,* 3rd Edition, Bernard+Graefe Verlag, Coblence, 1987, pages 72-77.

[0005] The overall scheme is illustrated in Prior Art **FIG. 1**, which shows a diesel generator **1** mounted on a double-elastic foundation **2**. An intake filter **3** and an exhaust gas cooler with noise damper **4** are also shown. Also shown are an exhaust gas conduit **5** and inner or, respectively, outer exhaust gas flaps **6**. Instead of the two exhaust gas flaps that are shown, only one exhaust gas flap can also be provided.

[0006] The air mast **9** (snorkel) with a head valve **7** and a water contact device that serves for opening and closing the air valve **7** serves for intaking the combustion go to the diesel engine **1**. A respective inner and outer air flap **10** are provided in the air mast **10**, in redundant implementation here for security. A monitoring panel **11** for the intake and exhaust air system is also shown. A water collecting tank **12** is also provided under the air mast, this having a water contact **8** allocated to it just as at the head of the air mast **9**.

[0007] An engine room **13** is shown that is bulkheaded off from the interior of the ship by a bulkhead **15**. The bulkhead **15** is arranged within the pressure body of the submarine **14** as a noise-damping bulkhead. According to the Prior Art, the exhaust gas conduit can be conducted upward the inner/outer exhaust gas flap **6** both into the upper part of the submarine tower as well as into a separate exhaust gas mast at the air mast **9**. In both instances, an underwater emergence of the exhaust gasses is provided and an increased counter-pressure with its negative consequences for the efficiency of the internal combustion engines in the submarine derives.

## SUMMARY OF THE INVENTION

[0008] An object of the invention is to design the known exhaust gas systems and, in particular, the introduction of the exhaust gasses into the water surrounding the submarine, such that no reduction of the engine performance ensues given expulsion of the exhaust gasses underwater, i.e., opposite the adjacent hydrostatic pressure.

[0009] An optimally high engine performance during snorkel running is required in order to shorten the charging time of the submarine's batteries. When the charging of the batteries does not ensue with the highest possible available generator power, the time of the submarine in snorkel running, i.e., the time during which the submarine is detectable, is lengthened. The ratio of underwater running to snorkel running is referred to as "indiscretion rate" and should be maximized as much as possible.

[0010] A specific object of the invention is to reduce the "indiscretion rate". A further object of the invention is to boost the performance of the submarine diesel engines, which are limited in performance, i.e., structural size, with or without exhaust gas turbochargers regardless of the depth at which the snorkel running is carried out. What derives from this is that a relatively large submarine can be fitted with relatively small diesel generator units. The optimum diesel generator performance derives from the installed battery capacity and the charging power.

[0011] These objects are primarily achieved in that a reduced water pressure is created in at least one region at the submarine via flow-oriented measures by way of the motion of the submarine through the surrounding water, and the exhaust gasses are introduced into this region. A region of reduced water pressure is created at the submarine and the exhaust gasses are introduced into this region; the disadvantages arising with the increased counter-pressure of the exhaust gas system underwater can be solved.

[0012] Internal combustion engines are substantially dependent on the counter-pressure of the exhaust gas system with reference to their efficiency. As a result of a reduction of this counter-pressure via the inventive measures, it is very advantageously possible to enhance the efficiency of the internal combustion engines given conventional submarine diesel engines without any other measures. The same type of diesel engine can thus be advantageously employed when switching to a larger submarine model. A gas turbine can even be employed when atmospheric pressure is approximately achieved at he exhaust gas muff.

## DESCRIPTION OF THE DRAWINGS

[0013] The invention is explained in greater detail on the basis of drawings from which further details that may be present in preferred embodiments of the invention can be derived.

[0014] **FIG. 1** is a pictorial diagram of a submarine tower according to the Prior Art as derives from the book by Gabler;

[0015] **FIG. 2** is a horizontal section through a submarine tower with laterally arranged gas-mixing chambers shown schematically;

[0016] **FIG. 3** is a block diagram illustrating the regulating principle according to the invention; and

[0017] **FIG. 4** is a graph illustrating the influence of the invention on the charging of the batteries of the submarine.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0018] An embodiment of the invention provides that the region of reduced water pressure may be generated with a water jet formed by flow-directing elements in combination with the motion of the submarine through the water. The employment of a water jet as employed, for example, in the vacuum pumps in the steel industry, makes it possible to

create the inventive region of reduced water pressure in a simple and very operationally dependable way. The region of reduced water pressure can thereby be especially advantageously created without employing outside energy, since the motion of the submarine through the water generates the energy that is required for the formation of the water jet.

[0019] The water jet may be formed using a nozzle effect. By utilizing this nozzle effect, a water jet velocity can be achieved that is multiply higher than the ship velocity. The obtainable pressure reduction is considerable and can even lead to a region of under-pressure at the emergence of the water jet. Compared to known exhaust gas systems, an increased efficiency for the internal combustion engines derives due to the under-pressure that has been generated.

[0020] An especially advantageous embodiment of the invention provides that the nozzle effect is generated at the tower, particularly at the top of the tower. During snorkel running, the upper edge of the tower is not very far below water in conformity with the length of the snorkel (air intake pipe), for which reason a relatively low hydrostatic pressure prevails here. In combination with the nozzle effect and the resultant low pressure at the exhaust gas outlet, an especially beneficial behavior of the exhaust gas discharge with improved efficiency of the diesel engine or of a gas turbine as well—whose employment is inventively enabled—thus derives.

[0021] An embodiment of the invention provides that the nozzle effect is achieved by flow-directing elements acting funnel-like that are open in running direction. Generating the water jet is possible in an especially simple and dependable way by employing flow-directing elements that act funnel-like and are open in running direction. A dependable function of the exhaust gas system with the advantageous lowering of the exhaust gas counter-pressure is assured as long as the flow-directing elements are underwater.

[0022] The height of the reduced water pressure may regulated, for example by influencing the nozzle effect, for instance by regulating the position of the flow-directing elements or, on the other hand, by regulating a nozzle cross-section. An adaptation to the submersion depth that is being run during snorkel running as well as an adaptation to the quantity of exhaust gas as well as to other parameters during snorkel running are thus possible.

[0023] It is especially advantageous that the maximally possible underwater snorkel running speed need not be run for eliminating the maximum exhaust gas quantity generated by the diesel engines, but rather that the positive effect already takes full effect given noticeably lower speeds. The water jet that is formed is in the position of eliminating a multiple of the maximum quantity of exhaust gas generated by the diesels. The normal quantity of diesel exhaust gas can already be completely discharged when running at 3 to 4 knots without having a pressure that exceeds normal atmospheric pressure prevailing at the water jet and its surroundings. When a somewhat elevated exhaust gas counter-pressure can be accepted, the running of the submarine can even be reduced to 2 knots. This design enables unrestricted maneuverability of the submarine in snorkel running given full battery-charging capacity.

[0024] A fine distribution of the exhaust gasses in the water derives as a further advantage compared to the previous standard, undifferentiated underwater expulsion of the exhaust gasses. This results in the detectability of the exhaust gasses and the heat connected therewith being made more difficult.

[0025] Since the exhaust gasses need not necessarily be introduced into the water at the top of the tower but can also be expelled at the topside of the hull, for example behind the tower, it is even possible to achieve a reduction of the frictional drag at the ship by introducing the finely distributed exhaust gasses into the boundary layer of the ship. This advantage contributes to a saving of drive energy given the same ship velocity that can lie in the percent range.

[0026] An implementation of an embodiment of the inventive method is provided that mechanically actuated flow-directing elements are arranged at a submarine, a partial stream being capable of being taken therewith from the water flowing around the submarine. The region of reduced water pressure at the submarine can be very advantageously realized without the use of outside energy via the inventive taking of a partial stream from the water surrounding the submarine. An especially simple fashioning of an apparatus with whose assistance the performance of internal combustion engines during snorkel running can be enhanced thus derives.

[0027] An embodiment of the apparatus provides that the mechanically actuated flow-directing elements form a preferably polygonal, funnel-shaped device whose larger cross-section is arranged at the front in running direction. A simple apparatus for taking a partial stream from the water surrounding the submarine thus derives that leads to an accelerated and, thus, pressure-reduced flow in a region at the submarine.

[0028] The funnel-shaped device may be fashioned mechanically or hydraulically pivotable out from the surface of the submarine. No increased water drag therefore derives at the submarine for normal underwater running. Both in normal surface running as well as in normal underwater running, the funnel-shaped devices may remain pivoted in, and the running behavior of the submarine is not influenced.

[0029] The funnel-shaped device may be fashioned multi-part, particularly bipartite. A multi-part, particularly bipartite fashioning allows the funnel-shaped device to be arranged symmetrically relative to the middle of the submarine or relative to the middle of the submarine tower. It thus derives during snorkel running that the forces that derive from the funnel-shaped device being pivoted out cancel one another. Of course, the funnel-shaped device can also be fashioned of one piece, for example when it is arranged at the topside of the submarine directly over the diesel engines. Forces that would turn the submarine around the longitudinal axis also then do not derive. This is also true when the funnel-shaped device comprises two individual funnels that are respectively arranged at the two sides of the submarine tower.

[0030] This arrangement at the two sides of the submarine tower, particularly at the very top, leads to an especially good bipartite fashioning of the region of diminished pressure, so that work can even be performed with an under-pressure zone in the region of the exhaust gas discharge. The hydrostatic pressure at the upper edge of the tower is lower than the under-pressure that can be achieved with the nozzle and the water jet, so that an exhaust gas discharge derives

that leads to an increase in the efficiency of the internal combustion engine. This is especially advantageous since fuel can thus be saved and, for example, a higher generator power can be achieved underwater with the same diesel engines.

[0031] It is provided in general but particularly in order to achieve the above- described positive effect that the funnel-shaped device may comprise a nozzle at the water discharge side from which the sub-stream water emerges as a water jet having a velocity that is considerably increased compared to the speed of the ship. The under-pressure that is generated by the water jet is all the higher the greater the water jet is accelerated. The effect on the efficiency of the internal combustion engine is correspondingly advantageous.

[0032] An embodiment of the invention provides that a gas mixing chamber may be arranged following the narrowest point of the funnel-shaped device, the exhaust gas conduit of the internal combustion engine discharging into this gas mixing chamber. The gas mixing chamber, which can be fashioned as a simple, coaxially traversed exhaust gas nozzle segment, operates very effectively despite a simple structure.

[0033] Specific gas-guiding elements need not be provided. A simple, potentially tangential introduction of the exhaust gasses into the coaxially traversed exhaust gas nozzle segment suffices in order to achieve a good effect and the provided, fine distribution of the exhaust gasses into the flowing water.

[0034] The cross-section of the generated water jet may be polygonal, particularly rectangular. Due to the rectangular inlet opening of, for example, the lateral funnel plate pivoting out of the submarine tower, a rectangular water jet can be realized in an especially easy way and without greater flow losses and, thus, less creation of noise.

[0035] Another embodiment provides that the cross-section of the water jet is round. An especially good entrainment effect thus derives given a simple tangential inflow of the exhaust gasses into the gas mixing chamber. The flow resistance in the funnel-shaped device, however, is somewhat higher. It is especially advantageous that a simple telescope pipe device can be arranged in the round water jet, whereby the extensible telescope pipe can regulate the cross-section and, thus, the velocity of the water jet independently of the pivoted position of the funnel-shaped device. An additional control possibility for the exhaust gas discharge is thus established, especially advantageously for low ship speeds.

[0036] An especially advantageous embodiment of the invention provides that the device for increasing the performance of internal combustion engines of submarines in snorkel running may comprise a regulator for regulating the reduced water pressure in the exit region of the exhaust gasses, i.e., the exhaust gas counter-pressure. A very advantageous optimization of the operation of the internal combustion engine is thus possible. Differences in the running speed of the submarine can thus be advantageously compensated.

[0037] For regulating the counter-pressure of the exhaust gas, it is thereby advantageously provided that the regulator comprises an interactive connection to the mechanical or hydraulic actuation elements of the funnel-shaped device. A simple regulation of the height of the pressure at the exhaust gas exit point of the exhaust gasses from the ship is thus possible.

[0038] The device may comprise pressure sensors, particularly in the exhaust gas conduit. A reliable function monitoring of the exhaust gas system is thus possible, and the pressure prevailing behind the exhaust gas turbochargers can be monitored, and an optimum regulation of the exhaust gas system can be achieved with the assistance of the regulation of the water jet and of position sensors for the flow-directing elements.

[0039] A further embodiment of the invention provides that the regulator may be fashioned operating in data exchange with the exhaust gas control system (flap system) of the diesel engine and with the controller of the diesel engine. Tthe regulator may be fashioned that considers the submarine speed and the propeller rpm. A complete control of the exhaust gas system thus derives, whereby the running status of the submarine and the respective relative speed of the ship through the water are also considered.

[0040] The employment of the above-described operating method and of the inventive device very advantageously leads to the charging time of the batteries of a submarine in snorkel mode being shortened considerably, for example, by 40%. As a result of the invention, the tactical behavior of the submarine, an advantage that is very significant for snorkeling submarines, is achieved due to a lowered "indiscretion rate" and an improved mixing of exhaust gasses in the sea water.

[0041] Referring to the Figures, **FIG. 2** shows flow arrows **18** that symbolize the flow against the submarine tower **16**. A flow against the submarine tower **16** is always present when the ship is underwater. The funnel-shaped devices **17** at the side of the tower **16**, potentially closed at the front by a course-meshed lattice **22**, have a flow against them in any case and yield a discharge flow **25** in their back end following the exhaust gas introductions **24**. The exhaust gas introductions **24** are connected to exhaust gas mixing chambers (not referenced in detail), or the exhaust gas introductions **24** are integrated into the exhaust gas mixing chambers. Arrows **20** symbolize the mobility of the funnel-shaped devices **17**, this being effected via setting elements **19**. For the normal running conditions of a submarine, the funnel-shaped devices **17** are folded into the tower. This is indicated by the line **21**. The exit shaft and the extension devices **23** (not shown) are located in the inside of the submarine tower, the funnel-shaped devices **17** being conducted past their outsides. For simplifying the illustration, the exhaust gas conduits to the exhaust gas introduction points **24** are not shown. As derives from the schematic illustration, the inventive system is of compelling simplicity with respect to its devices at the outside of the ship and exhibits high efficiency at the same time.

[0042] In **FIG. 3**, a regulating unit **26** for the inventive device acts on the funnel-shaped device for water admission to the exhaust gas discharge **28**. The regulating unit **26** regulates both the position of the funnel-shaped device **27** (the adjustability is symbolically indicated) as well as, potentially, the crossection in the exhaust gas mixing chamber at the exhaust gas discharge **28** and the adjustment elements potentially arranged thereat, for example, a tubing device that can be pushed apart like a telescope and with

which the crossection of the water jet that is formed can be easily and dependably set. Thus, a regulation of the water jet is present here that is independent of the position of the funnel-shaped device **27**.

[**0043**] As a result, a zone of highly reduced pressure, potentially even an under-pressure, can also be achieved given low speeds of the ship through the water. Two diesel generator units **29**, **30** are shown as are normally present in modern submarines. These diesel generator units are followed at their exhaust gas side by exhaust gas valve flaps **31**, **32** of the exhaust side with which the exhaust gas conduits can be closed in a shock-proof manner. These correspond to the shutoff valve flaps as are usually present in a submarine. The regulating unit **26** is provided with signals that relate to the exhaust gas pressure as well as to the position of the funnel-shaped device and the additional gas mixing chamber/water jet regulating unit. Further, signals for the speed of the submarine and the rpm of the propeller motor can also be forwarded to the regulating unit **26**.

[**0044**] A connection both to the internal combustion engines as well as to the control unit for the exhaust gasses of the ship can be set up from the regulating unit **26**. This assures that the respective position of the exhaust gas flaps, of the exhaust gas shunts and the running speed of the submarine matched to the exhaust gas discharge are set when switching between various running modes. The regulating unit, thus, does not only collaborate with the exhaust gas system.

[**0045**] **FIG. 4** shows the influence of the invention on the charging of the submarine batteries. As it turns out and as is illustrated by the hatching for the same energy contents of the batteries, the battery charging characteristic is reached significantly earlier due to the greater charging energy. The gain in time is entered. Given employment of the invention, a charging time reduced by approximately 40% per snorkel run derives in the first charging stage, i.e., the "indiscretion rate" and, thus, the risk of detection of the submarine are considerably reduced. The risk of detection of the submarine is also reduced by the finer distribution of the exhaust gasses in the water; the same occurs due to the elimination of the typical discharge noises of the exhaust gasses underwater from the exhaust gas systems previously employed. The exhaust gas noises, when using the inventive apparatus, are unidentifiably incorporated into the general running noise of the submarine through the water (noise). Overall, thus, a considerable improvement derives with reference to the detectability of traditional, non-nuclear submarines.

[**0046**] Typical details of the battery charging derive from the following example:

[**0047**] The "Piller" generators that are currently often installed in submarines have the following limitations or regulation in the regulator:

[**0048**] a current limiter (set, for example, to: max. current value=3,000 Amps since the generator switches have a maximum breaking capacity of 3,000 Amps);

[**0049**] a voltage limiter (2.45 V×number of partial battery cells, set to the plurality of battery cells per sub-battery) (2.45 is the maximum cell voltage given lead cells and the end of the 2nd charging stage); and

[**0050**] a power regulator that maintains the generator power and, thus, the diesel engine power at a maximum, taking the aforementioned "U" and "i" limitation into consideration. The battery characteristic physically derives from the capacity status (for example, 15-30% residual battery capacity), from the acid temperature, the age, and the acid density.

[**0051**] The charging event of battery charging sequences in the following way:

[**0052**] 1ST CHARGING STAGE

[**0053**] The diesel engine is highly loaded shortly after startup until the generator current limitation that has been set has been reached. The battery charging event is ongoing.

[**0054**] The battery voltage rises up to the end of the 1st charging stage, the cell voltage reaches 2.45 V.

[**0055**] When the max. generator current limitation has responded, the diesel engine would reach the max. power at the end of the 1st charging stage since the battery voltage rises steadily. When the current limitation has not responded—the current limitation can be the generator switch capacity (not the battery)—, the full diesel engine power is required immediately at the start of the 1st charging stage. A plurality of sub-batteries can also be switched parallel in the 1st charging stage, so that a current division per sub-battery ensues.

[**0056**] Submarines often usually only run the 1st charging stage in order to keep the snorkeling time short in the field (detection risk).

[**0057**] 2ND CHARGING STAGE:

[**0058**] The generator voltage is held constant in the 2nd charging stage.

[**0059**] The cell voltage of 2.45 V is reached, the charging current drops, the charging power reaches the characteristic point of the battery characteristic.

[**0060**] The generator voltage of 2.45 V×plurality of sub-battery cells is kept constant in the generator regulator, the charging current drops according to the battery charging characteristic, the aggregate power decreases steadily.

[**0061**] The end of the 2nd charging stage is reached at approximately 250-300 A.

[**0062**] The generator regulator holds the min. charging current that has been set constant in the 3rd charging stage.

[**0063**] For the purposes of promoting an understanding of the principles of the invention, reference has been made to the preferred embodiments illustrated in the drawings, and specific language has been used to describe these embodiments. However, no limitation of the scope of the invention is intended by this specific language, and the invention should be construed to encompass all embodiments that would normally occur to one of ordinary skill in the art.

[**0064**] The present invention may be described in terms of functional block components and various processing steps. Such functional blocks may be realized by any number of hardware and/or software components configured to perform the specified functions. For example, the present invention may employ various integrated circuit components, e.g., memory elements, processing elements, logic

elements, look-up tables, and the like, which may carry out a variety of functions under the control of one or more microprocessors or other control devices. Similarly, where the elements of the present invention are implemented using software programming or software elements the invention may be implemented with any programming or scripting language such as C, C++, Java, assembler, or the like, with the various algorithms being implemented with any combination of data structures, objects, processes, routines or other programming elements. Furthermore, the present invention could employ any number of conventional techniques for electronics configuration, signal processing and/or control, data processing and the like.

[0065] The particular implementations shown and described herein are illustrative examples of the invention and are not intended to otherwise limit the scope of the invention in any way. For the sake of brevity, conventional electronics, control systems, software development and other functional aspects of the systems (and components of the individual operating components of the systems) may not be described in detail. Furthermore, the connecting lines, or connectors shown in the various figures presented are intended to represent exemplary functional relationships and/or physical or logical couplings between the various elements. It should be noted that many alternative or additional functional relationships, physical connections or logical connections may be present in a practical device. Moreover, no item or component is essential to the practice of the invention unless the element is specifically described as "essential" or "critical". Numerous modifications and adaptations will be readily apparent to those skilled in this art without departing from the spirit and scope of the present invention.

**1-27** (currently cancelled).

**28**. A method for enhancing internal combustion engine performance for a submarine in snorkel running, comprising:

generating exhaust gasses by the internal combustion engines during snorkel running;

introducing the exhaust gasses into water that surrounds the submarine;

creating a reduced water pressure in a region at the submarine via flow-oriented measures by a motion of the submarine through the surrounding water; and

introducing the exhaust gasses into this region.

**29**. The method according to claim 28, wherein the internal combustion engine is a charged diesel engine for charging batteries.

**30**. The method according to claim 28, further comprising:

providing flow-directing elements such that the region of reduced water pressure is generated via a water jet formed by the flow-directing elements in combination with the motion of the submarine through the water.

**31**. The method according to claim 30, further comprising:

producing the water jet with a nozzle effect.

**32**. The method according to claim 31, wherein the nozzle effect is generated at a tower of the submarine.

**33**. The method according to claim 32, wherein the nozzle effect is generated at a top of the tower.

**34**. The method according to claim 31, further comprising:

providing flow-directing elements to produce the nozzle effect that operate in a funnel-like manner and are open in a running direction.

**35**. The method according to claim 31, further comprising:

regulating a height of the reduced water pressure.

**36**. The method according to claim 35, wherein the regulation occurs by influencing the nozzle effect.

**37**. The method according to claim 31, further comprising:

regulating a velocity of generated water jet.

**38**. The method according to claim 37, wherein regulating a velocity comprises at least one of:

regulating a position of the flow-directing elements; and

regulating a cross-section of the nozzle.

**39**. The method according to claim 30, further comprising:

producing a fine distribution of the exhaust gasses in the water due to the water jet.

**40**. An apparatus of a submarine for enhancing a performance of internal combustion engines of the submarine in snorkel running, comprising:

mechanically or hydraulically actuated flow-directing elements arranged at the submarine configured to take a partial stream from water flowing around the submarine.

**41**. The apparatus according to claim 40, wherein the internal combustion engine is a charged diesel engine.

**42**. The apparatus according to claim 40, wherein:

the actuated flow-directing elements form a funnel-shaped device whose largest cross-section is arranged at a front in a running direction.

**43**. The apparatus according to claim 42, wherein the funnel- shaped device is polygonal.

**44**. The apparatus according to claim 42, further comprising:

a mechanical or hydraulic pivot mechanism of the funnel-shaped device configured to pivot the funnel-shaped device out of the surface of the submarine.

**45**. The apparatus according to claim 42, wherein:

the funnel-shaped device is fashioned in a multi-part manner, and is symmetrically arranged at the submarine.

**46**. The apparatus according to claim 45, wherein the funnel-shaped device comprises two individual funnels that are respectively arranged at two sides of the submarine tower.

**47**. The apparatus according to claim 42, wherein:

the funnel-shaped device comprises a nozzle at a water exit side from which water of the partial stream emerges as a water jet with a significantly increased velocity.

**48**. The apparatus according to claim 42, further comprising:

a gas mixing chamber into which respective exhaust gas conduits of the internal combustion engines discharge is arranged behind a narrowest point of the funnel-shaped device.

**49**. The apparatus according to claim 48, wherein the exhaust gas mixing chamber is fashioned as an axially traversed exhaust gas nozzle segment.

**50**. The apparatus according to claim 47, wherein a cross-section of the generated water jet is polygonal

**51**. The apparatus according to claim 50, wherein the cross-section of the generated water jet is rectangular.

**52**. The apparatus according to claim 47, wherein a cross-section of the generated water jet is round or oval.

**53**. The apparatus according to claim 40, further comprising:

a regulating unit for regulating a reduced water pressure in an exit region of exhaust gasses, thereby providing for regulating a counter- pressure of the exhaust gas.

**54**. The apparatus according to claim 53, wherein:

the actuated flow-directing elements form a funnel-shaped device whose largest cross-section is arranged at a front in a running direction; and

the regulating unit for regulating the counter-pressure of the exhaust gas comprises an interactive connection to the mechanical or hydraulic actuation elements of the funnel-shaped device.

**55**. The apparatus according to claim 53, further comprising:

pressure sensors connected to the regulating unit, the pressure sensors being located in a least one of an exhaust gas conduit and gas mixing chambers.

**56**. The apparatus according to claim 55, further comprising:

position sensors connected to the regulating unit, the position sensors being located in at least one of the flow-directing elements and the funnel-shaped device.

**57**. The apparatus according to claim 55, further comprising:

a controller of an exhaust gas control system of the internal combustion engines; and

a data exchange mechanism configured to exchange data between the controller and the regulating unit.

**58**. The apparatus according to claim 55, wherein the regulating unit is configured to accept at least one of a submarine speed and a propeller rpm for its calculations.

**59**. A retrofitting kit for a submarine, comprising:

funnel-shaped devices for actuated flow arranged at the submarine configured to take a partial stream from water flowing around the submarine with their gas mixing chambers;

a regulating unit for regulating a reduced water pressure in an exit region of exhaust gasses with the sensors and the mechanical or hydraulic adjustment elements; and

connections of an exhaust gas conduit.

**60**. The retrofitting kit for a submarine according to claim 59, further comprising:

higher-performance diesel generator units.

**61**. A submarine having at least one internal combustion engine, comprising the apparatus according to claim 40 configured for shortening a charging time of its batteries in snorkeling mode.

**62**. A method for operating a submarine, comprising the method according to claim 28 and further comprising shortening a charging time of its batteries in snorkeling mode.

**63**. A submarine having at least one internal combustion engine, comprising the apparatus according to claim 40 configured for charging its batteries in snorkeling mode.

**64**. A method for operating a submarine, comprising the method according to claim 28 and further comprising charging its batteries in snorkeling mode.

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