April 2, 1946. A. G. FORSYTH 2,397,654

PROPULSION MEANS

Filed May 20, 1942 4 Sheets-Sheet 1

Fig. 1.

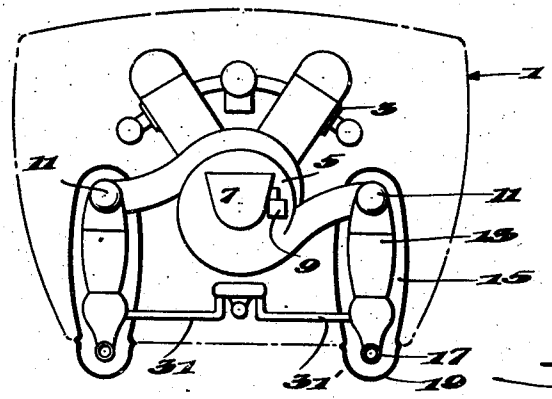


Fig. 1A.

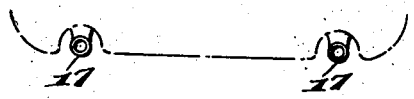


Fig. 2.

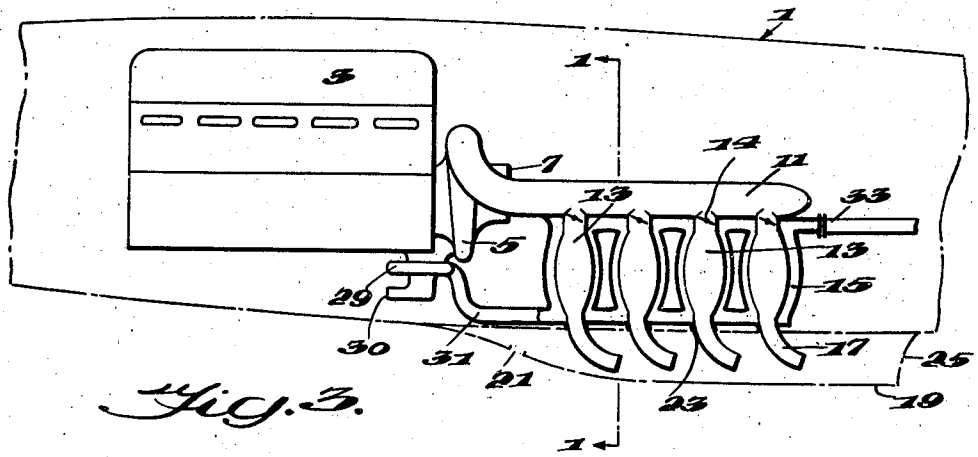


Fig. 3.

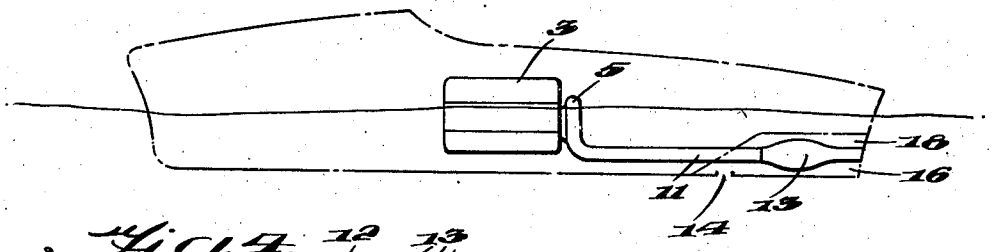
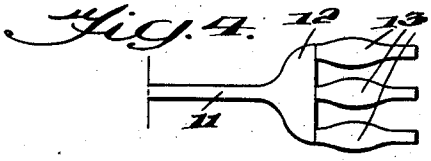


Fig. 4.



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PROPULSION MEANS

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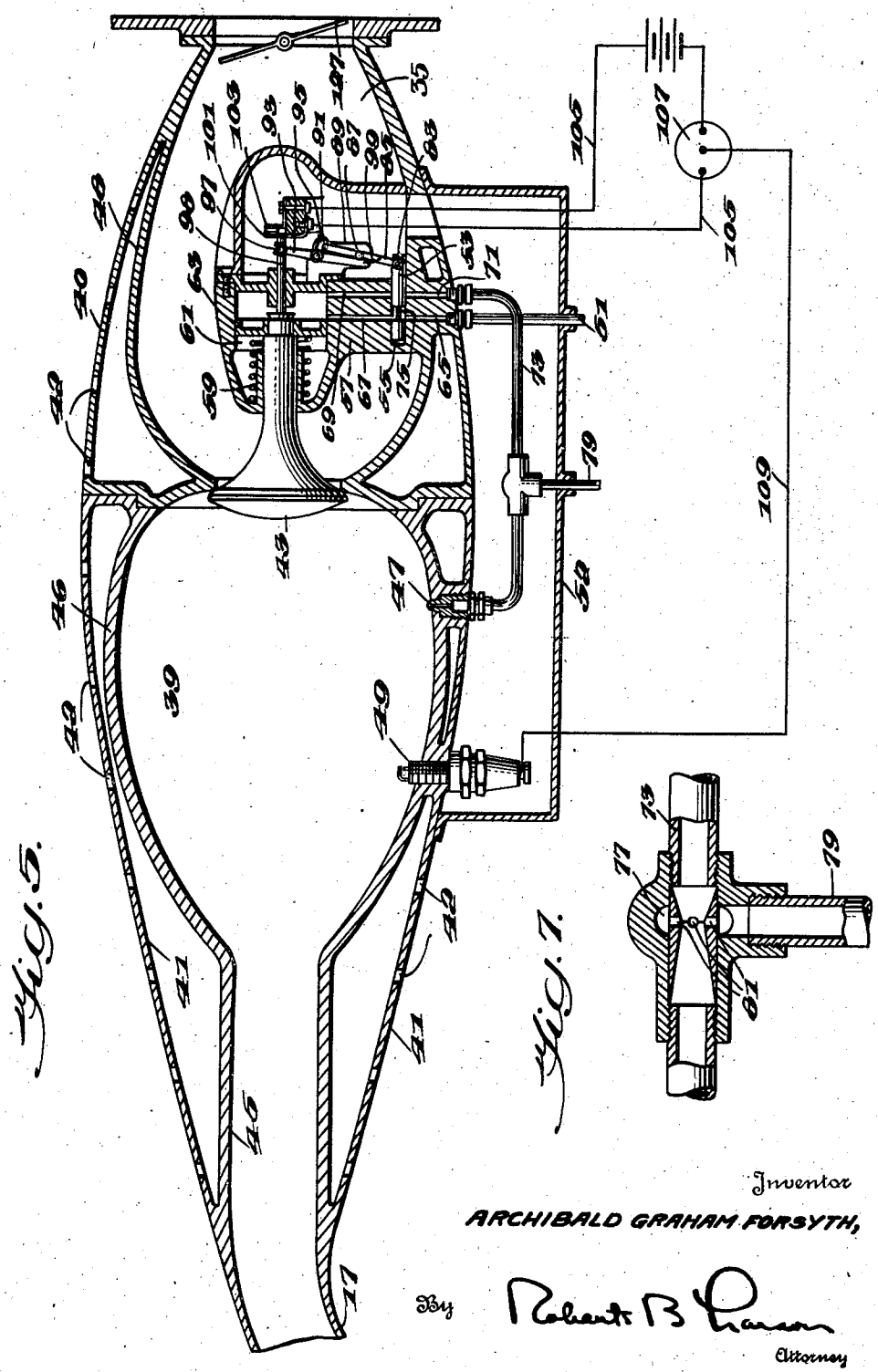


Fig. 5.

Fig. 7.

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PROPULSION MEANS

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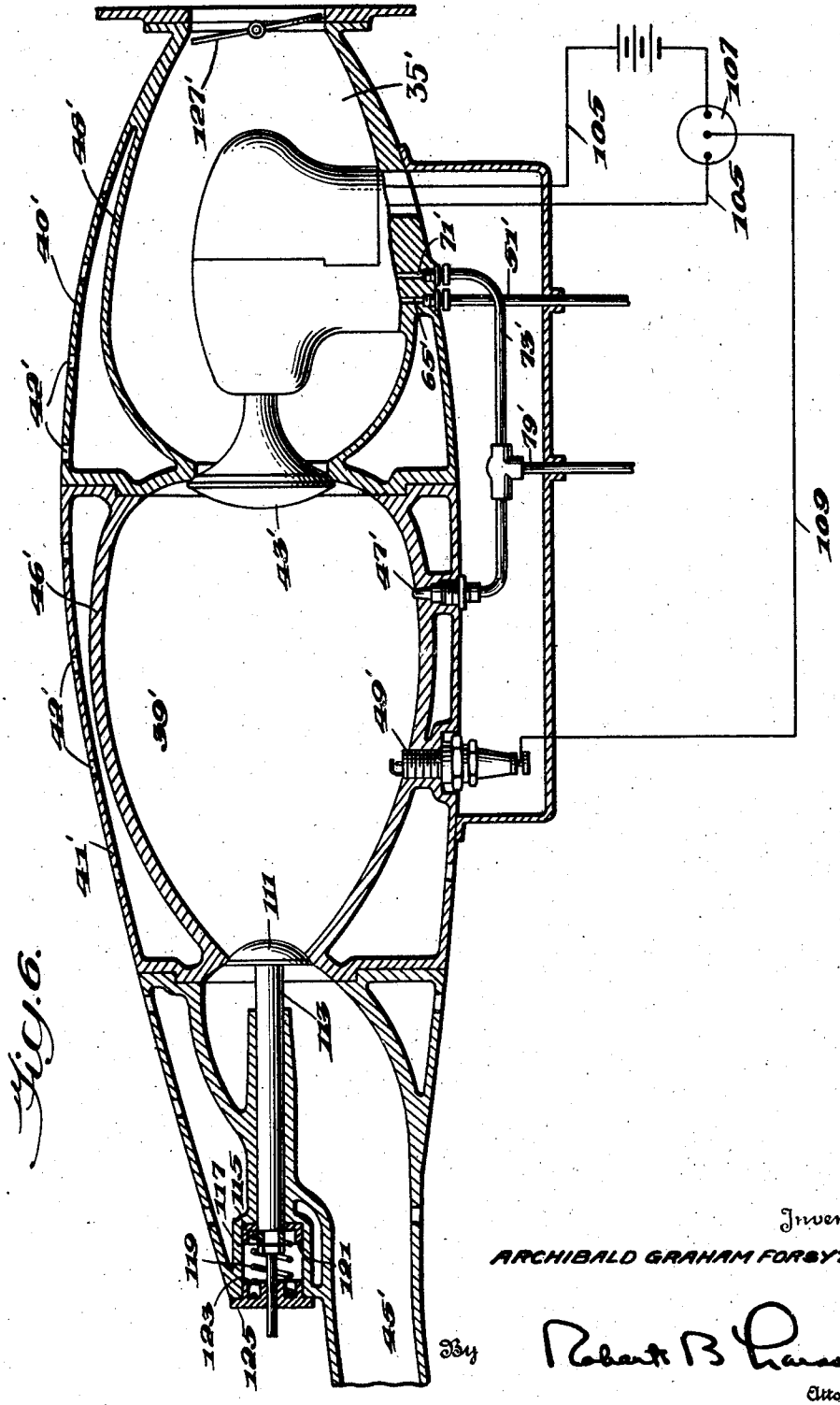


Fig. 6.

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Fig. 8.

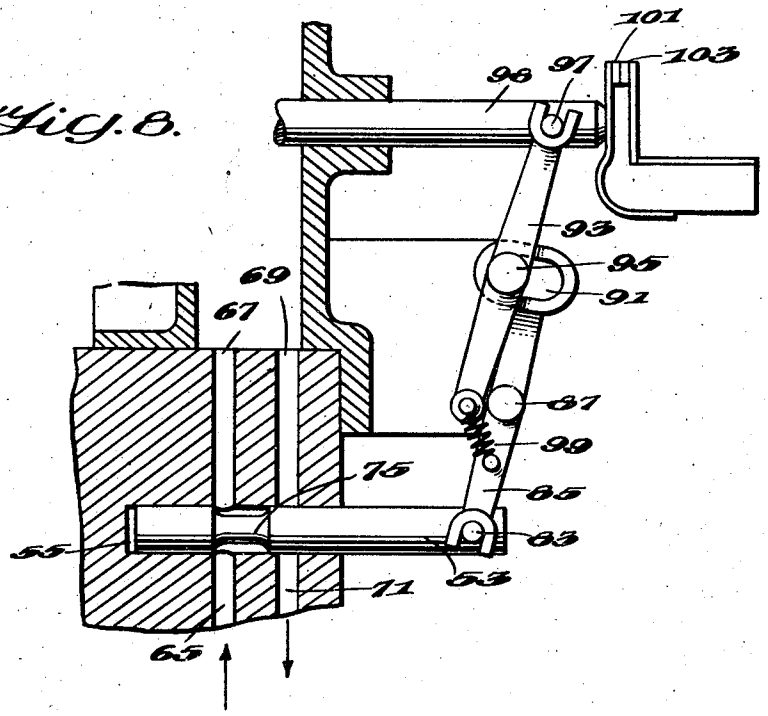
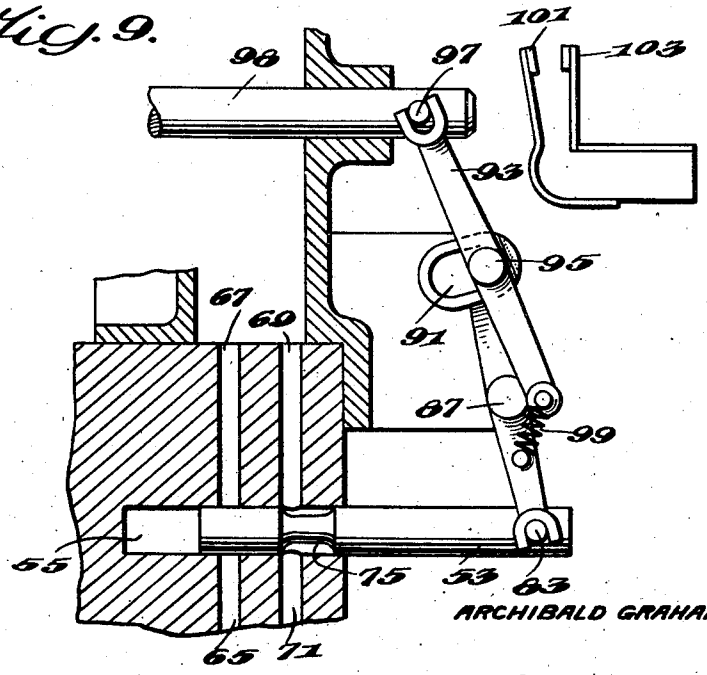


Fig. 9.



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UNITED STATES PATENT OFFICE

2,397,654

PROPULSION MEANS

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Application May 20, 1942, Serial No. 443,785
In Great Britain July 8, 1941

8 Claims. (Cl. 115—13)

This invention relates to shallow draft vessels and more particularly to a marine propulsion device employing the exhaust from combustion units as the effective force producing the propulsion for such vessels.

In present-day warfare, where it is necessary to land an invasion force on the shore of an island or the like, it has been the practice to employ barges or scows. These have been propelled by marine screw propellers or in some instances by airplane propellers. Each of these systems requires the use of a rather large internal combustion engine and consequently the vessels do not, in many instances, have a sufficiently shallow draft to avoid mines and the like which in many cases are anchored only a small distance below the surface of the water. Moreover, with such arrangements, the surprise element is endangered because of the motor throbbing which can be picked up by the sensitive detectors now employed by the defending forces. Also, it has been demonstrated that invasion barges or the like propelled by airplane motors are vulnerable to attack and are easily rendered useless, one well-placed shot being sufficient to put them out of commission.

The present invention has for its principal object the provision of an explosion jet marine propulsion device which will avoid these disadvantages. To accomplish the desired end the invention makes use of one or more combustion units which direct the force of the gases exploded therein against the water to propel the vessel. Being of light weight, the invention makes it possible to propel vessels of very shallow draft, even though such vessels may carry quite a number of men and some armament. Still further, since the invention does not make use of propellers, a vessel constructed with the invention is very silent in operation and is not likely to be detected by the instruments now used for such purpose.

In accordance with another object of the invention a series of combustion units may be connected with means for supplying air thereto, such as, for example, with a supercharger driven from a small internal combustion engine or the like. Means may be provided for maintaining the air supply at a constant predetermined pressure. The combustion units may also be selectively connected or disconnected with the air supply so that one, or any combination of the units may be operated at will.

While it is intended that the combustion units according to the invention should function as the prime mover, it is, of course, possible to employ them as an auxiliary to a main prime mover, where, for example, weight and draft are not of great importance.

Another object of the invention is the provision of an explosion jet marine propulsion device which may be disposed on a shallow draft barge or the like in such manner as to provide considerable space for men, armament, and torpedoes, and in which the men may be well protected.

Other objects of this invention will become more apparent from the following specification and claims when read in the light of the accompanying drawings, in which:

Figure 1 is a cross sectional view taken on the line 1—1 of Figure 2, illustrating one embodiment of the invention.

Figure 1A shows a modified form of hull bottom.

Figure 2 is a side plan view of a preferred arrangement of the propulsion units, supercharger and motor.

Figure 3 is a side plan view of a modification of the invention.

Figure 4 is a top plan view of the arrangement of the propulsion units shown in Figure 3.

Figure 5 is a sectional elevation of one form of the internal combustion unit employed in carrying out this invention.

Figure 6 is a sectional elevation of a modification of the internal combustion unit which may be employed in carrying out the teaching of this invention.

Figure 7 is a cross sectional view of a detail drawn to an enlarged scale.

Figure 8 is an enlarged sectional view of the control valve shown in Figure 6, illustrating automatic operating means for reversing the valve.

Figure 9 is a similar view showing the valve and its operating means in reversed position.

Referring now specifically to the drawings and particularly to Figures 1 and 2, the vessel 1, which is preferably of the flat bottom variety (for example, an invasion barge or scow) is provided with a plurality of combustion units 13, the construction of which will be described hereinafter. At this point it suffices to state that these units are fed periodically with air which is mixed with fuel and then exploded. The exploded gases pass through the lower bent ends of the combustion units and expend their forces on the water to drive the craft.

While the air supplied to the combustion units may be supplied by any number of devices, it is

advantageously supplied by a supercharger 5 driven mechanically by a small internal combustion engine 3. The supercharger has an air intake 7 controlled by a throttle (not shown) which in turn is operated by a boost control 9, thereby providing means for governing the air pressure in the manifold 11 to which the combustion units 13 are joined.

As shown in Figures 1 and 2 two manifolds 11 extend rearwardly from the supercharger, one on each side of the vessel, and a series of combustion units 13 is connected to each manifold so that air under pressure is supplied to the units.

The explosion units 13 preferably are water jacketed as indicated at 15, the bent lower exhaust pipe ends 17 of the units projecting through openings 23 in the water jacket casing. These exhaust ends 17 of the units may in turn be disposed within spaced streamlined longitudinally extending hollow shrouds or casings 19, rigidly mounted upon the bottom of the boat hull 1. Each of these casings is provided with a small opening 21 formed in its forward end portion and each is completely open at its opposite end 25.

Alternatively the boat hull bottom itself may be provided with two longitudinal grooves in which the bent exhaust ends 17 of the explosion units 13 may be disposed.

Water is employed as the cooling medium circulated in the water jacket 15. A motor driven water pump 29 has an inlet port 30 connected to the outside of the hull. The pump 29 circulates water through conduits 31 and 31' to the water jacket, the water finally escaping through the outlet pipe 33.

In Figure 5 I have shown a longitudinal cross sectional view of one type of unit, which is provided with a forwardly opening or intake chamber 35 and a rearwardly opening or explosion chamber 39. The combustion units' outer casings 40, 41 are provided with a plurality of apertures 42 permitting the water which is circulated through the water jacket 15 to contact the outer surface of the inner casings 46, 48, thereby maintaining the unit at a low operating temperature. The chambers 35 and 39 are conjointly shaped to constitute a Venturi tube at the throat of which is a valve 43 by which the intake chamber 35 is separable from the explosion chamber 39. As shown, the air intake chamber 35 is of less diameter at its leading end than at its mid portion and is contracted again towards its rear end, while the explosion chamber 39 has a restricted outlet at 45 or may even be itself shaped to constitute a Venturi tube. A nozzle 47 is provided through which a jet of liquid fuel may be injected into the explosion chamber 29, and a spark plug 49 is used for igniting the explosive mixture. In order to periodically open the valve 43 to admit air from the intake chamber 35 to the explosion chamber 39, to inject liquid fuel into said explosion chamber 39, and to fire the explosive mixture in said chamber 39, compressed air is supplied by a pipe 51 from a suitable source (not shown). The flow of this compressed air is controlled by an automatically operating piston valve 53 slidable in the valve cylinder 55 in a boss 57 situated in the intake chamber 35.

The valve 43 between the intake and explosion chambers 35 and 39 is sodium filled for cooling purposes and is opened automatically against the action of a coiled spring 59 by compressed air admitted from the pipe 51 to a cylinder 61 in the boss 57, the stem of the valve 43 being furnished with a piston 63 which is slidable in the cylinder 61 and constitutes an abutment for one end of the spring 59, the other end of which abuts against a wall at the end of a recess in the boss 57 in which it is housed. In the boss 57 are two pairs of ports 65, 67 and 69, 71 (see also Figures 8 and 9) leading from the valve cylinder 55, of which the ports 65 and 67 are opposite one another and are connected with the compressed air supply pipe 51 and the cylinder 61 respectively, and of which the ports 69 and 71 are opposite one another and are connected, respectively, with the cylinder 61 and with a pipe 73 leading to the fuel injection nozzle 47. The piston valve 53 has a peripheral groove 75 by which, according to the position of the said piston valve 53, the ports 65 and 67 are put in communication with one another, as shown in Figure 8, and hence compressed air is admitted from the pipe 51 to the cylinder 61, moves the piston 63 against the action of the spring 59 and opens the valve 43 between the intake and explosion chambers 35 and 39, or, alternately as shown in Figure 9, the ports 69 and 71 are put into communication with one another, and hence the valve 43 is closed and the air in the cylinder 61 is exhausted therefrom under the influence of the spring 59, and is driven into the pipe 73. Actually, the air thus exhausted from the cylinder 61 is still under pressure, though reduced, and may be used for fuel injection purposes. To this end, as shown in Figure 7, part of the pipe 73 is surrounded by a chamber 77 to which a fuel supply pipe 79 is connected, and said pipe 73 is formed as a Venturi tube at that part thereof which is surrounded by the chamber 77 and has radial openings 81 by which the chamber 77 communicates with said Venturi tube. Hence, when the peripheral groove 75 of the piston valve 53 establishes communication between the ports 69 and 71, as shown in Figure 9, air under pressure flows along the pipe 73 sucking up fuel as it passes through said Venturi tube, and injects a jet of fuel through the nozzle 47 into the explosion chamber 39.

In order that compressed air may be admitted to, and exhausted from, the cylinder 61 to open the valve 43 and allow it to be closed by its spring 59, a cross pin 83 on the piston valve 53 is engaged by the bifurcated end of a lever 85 pivoted at 87 on a lug 89 on the boss 57, and the end of said lever remote from said bifurcation is formed with an arcuate slot 91. On the lug 89 on the boss 57 a second lever 93 is pivoted at 95, the pivot pin 95 passing through the arcuate slot 91 of the lever 85, and the upper end of said lever 93 is bifurcated to engage a cross pin 97 on an extension 98 of the stem of the valve 43, while the lower end of said lever 93 is connected with the lower part of the lever 85 by a torsion spring 99.

When the valve 53 is in the position shown in Figure 8 compressed air is admitted from the pipe 51 to the cylinder 61, and the valve 43 is opened; the opening of the valve 43 moves the cross pin 97 to the left, from the position shown in Figure 9, thus swinging the lever 93 about its pivot 95, relaxing the tension of the spring 99 until after said lever 93 has passed through its dead center position, whereupon the spring 99 is again stressed and, when sufficiently tensioned, acts on the lever 85 and turns the latter about its pivot 87 from the position shown in Figure 8, to the position shown in Figure 9, the extent of movement of said lever being limited by the engagement of the pivot pin 95 in the arcuate slot 91. Thus the position of the valve 53 is reversed and

connection is established between the ports 69 and 71, compressed air is exhausted from the cylinder 61 as the valve 43 closes and fuel is injected into the explosion chamber 39 as set forth above.

In the path of the extension 99 of the stem of the valve 43 is a movable switch blade 101 which, at the moment when the valve 43 seats itself, is forced into contact with the fixed switch blade 103. The switch 101, 103 is arranged in the primary circuit 105 of an ignition coil 107, the secondary of which is connected as at 109 with the spark plug 49. Firing timing means (not shown) is provided to spark the explosion chambers in any desired sequence.

As shown in Figures 5 and 6, a casing 52 is provided which is mounted on the outer casing 41, and secured thereto against water leakage. The casing 52 extends over and includes within its walls the spark plug 49, the conduit 73, and portions of the pipes 51 and 79, and also portions of electrical wires 105 and 109. Obviously, other means may be employed to prevent short circuiting of the spark plug 49 and the switch 103, 103, by water contact. The means shown here is merely illustrative of one form thereof.

The operation of the device is quite apparent. The air which is maintained at a predetermined pressure value in the manifold 11 is passed into the intake chamber 35 when the valve 43 is in closed position. A charge of air under pressure is admitted to the explosion chamber 39 and when the valve 43 is opened, fuel is injected into the air in said explosion chamber 39 and, when the valve 43 is closed, the explosive mixture is fired and the discharge through the restricted outlet 45 produces the propulsive effect.

In the modification of the explosion chamber shown in Figure 6, the explosion chamber 39' is shaped to constitute a Venturi tube at the throat of which is disposed a rearwardly opening spring influenced valve 111 to allow pressure to build up in said chamber 39', and such valve, like the valve 43, may be sodium filled for cooling purposes. In order that valve 111 may be opened as a result of initial movement thereof which takes place when explosion occurs, after which the opening movement is completed positively, the injection discharge taking place through the part 45' of the Venturi tube explosion chamber in rear of the valve 111, said valve being thereafter closed, the stem of the valve has mounted thereon a flange 115 arranged in a cylinder 117 in the rear end of the unit and influenced by a spring 119 which tends, normally, to close said valve. Hence, when the explosion takes place in the forward part of the explosion chamber 39' the valve 111 is forced back slightly against the action of its spring 119, carrying with it the flange 115.

The unseating of the valve 111 permits the exploded gases to pass from chamber 39' through the reduced portion 45' and the tubes 17' to react against the water surrounding them and provides the propelling force for moving the vessel.

In the above description of the modified explosion chamber those elements which correspond to similar elements discussed in the first described explosion chamber have been given identical numeral reference numbers, but are differentiated therefrom by the addition of a prime mark.

While I have shown and described but two types of internal combustion units, other modifications of the units may also be employed, such as, for example, any one of several types of internal combustion devices shown and described in my copending application, Serial No. 437,429, filed April 2, 1942, of which this application is a continuation-in-part.

A further object of my invention is to provide means whereby at the will of the operator, one or more of the explosion units may be rendered effective or ineffective. To accomplish this object I have mounted in the open end of the explosion chamber 35 or 35' the manually operated valve 127 or 127'. This valve comprises a substantially circular disk, mounted on suitable bearings and rotatably secured to the wall of the explosion chamber.

In order to increase or decrease the speed of the boat the operator merely rotates the valve disk, thereby rendering it possible or impossible for the air accumulated in the manifold pipe 11 to pass into the explosion chamber.

In Figures 3 and 4 I have disclosed a modified arrangement of the internal combustion units. As shown therein elongated manifolds 11 extend rearwardly from the engine 3 and are disposed adjacent the bottom of the hull 1. The rear ends of the manifolds 11 are provided with enlarged portions 12 adapted to be coupled to several of the internal combustion units described in detail above. A shroud 18 is also provided which surrounds the units 13 and has an opening 14 at its forward end and a second opening 16 at the opposite end. In this modification no water pump is required, as the water circulates freely about the units. The function and theory of operation of this modification is as has been described above.

I claim:

1. A marine propulsion device adapted to be mounted within a boat and comprising a plurality of spaced combustion units, each of said units having an air intake port, an explosion chamber, and an exhaust pipe, one end of each of said exhaust pipes being connected with its respective explosion chamber, the other end of said exhaust pipes passing through the hull of said boat and being submerged in the water, an air intake port formed in each unit, means for connecting said air intake ports with a supply of air under pressure, an air chamber in each of said units, said air chambers being connected with said air inlet ports, an air control valve in each of said units disposed intermediate the air inlet ports and air chambers, an explosion chamber, means for supplying an ignitable gas to said explosion chamber, means for mixing said air and said gas in said explosition chamber, means for igniting said mixed gases and exhausting the combustion product thereof through said exhaust pipes, against the water.

2. A marine propulsion device adapted to be mounted in a boat, comprising, a plurality of spaced internal combustion units enclosed within a fluid-tight jacket, a pump adapted to circulate a cooling medium through said jacket, each of said units having an air intake port and an exhaust end portion, said exhaust end portions extending through said jacket and the hull of said boat below the water line of said hull, means for maintaining air under constant pressure in a manifold pipe, said air intake ports adapted to be connected with said manifold pipe, an air chamber in each of said units, valves positioned intermediate said air intake ports and said air chambers, means for selectively operating said valves to permit or prevent air from entering said air chambers, combustion chambers in said units, means for supplying an ignitable gas to said com-

bustion chambers, means for mixing said air with said gas in said combustion chambers, means for igniting said mixed gases and exhausting the combustion product thereof through said exhaust end portions.

3. A marine propulsion device adapted to be mounted within a boat, comprising, a plurality of spaced internal combustion units enclosed within a fluid-tight jacket, a pump adapted to circulate a cooling medium through said jacket, each of said units having an air intake port and an exhaust end portion, said exhaust end portions extending through said jacket and the hull of said boat below the water line of said hull, means adapted to maintain air under constant pressure in a manifold pipe, said air intake ports being adapted to be connected with said manifold pipe, an air chamber in each of said units, means for supplying an ignitable gas to said combustion chamber, means for mixing said air with said gas, means for igniting said mixed gases, and exhausting the combustion product thereof through said exhaust end portions, a casing secured to the exterior surface of said boat hull, said casing enclosing said exhaust end portions and being open at at least one of its ends.

4. A marine propulsion device as defined in claim 3, said casing having a relatively small opening in the other end.

5. A marine propulsion device adapted to be mounted within a boat, comprising, a plurality of spaced internal combustion units enclosed within a fluid-tight jacket, a pump adapted to circulate a cooling medium through said jacket, each of said units having an air intake port and an exhaust end portion, said exhaust end portions extending through said jacket and the hull of said boat below the water line of said hull, means adapted to maintain air under constant pressure in a manifold pipe, said air intake ports being adapted to be connected with said manifold pipe, an air intake chamber in each of said units, a valve disposed within each of said units intermediate said air intake port and said air chamber, said valves being operable simultaneously or independently at the will of the operator to permit or prevent air from entering said air chambers, a combustion chamber in each of said units, means for supplying said combustion chambers with an ignitable gas, automatic means within said unit for mixing said gas with said air, means for igniting said mixed gases, and exhausting the combustion product thereof through said exhaust end portions, said exhaust end portions being enclosed within a hollow casing having one of its ends open, the other of said ends having a substantially and relatively reduced opening formed therein, and those portions of said exhaust end portions enclosed within said hollow casing being substantially arcuate shaped and extending longitudinally therein.

6. A marine propulsion device adapted to be mounted within a boat, comprising, a plurality of manifold pipes, means adapted to maintain air under constant pressure in said manifold pipes, said manifold pipes being spaced from each other and disposed on opposite sides of the hull of said boat, a plurality of internal combustion units spaced from each other and disposed in opposite sides of the boat, said units being enclosed within a fluid-tight jacket, a pump adapted to circulate a cooling medium through said jackets, each of said units having an air intake port adapted to be connected with the manifold disposed on the same side of said boat, each of said units having an air intake chamber, a valve in each of said units positioned intermediate said manifold and said air intake chamber, a combustion chamber in each of said units, a valve disposed between said air chamber and said combustion chamber, means for supplying an ignitable gas to said combustion chamber, means for automatically operating said last-said valve to permit the ignitable gas and air to mix, means for igniting said mixed gases and exhausting the combustion products thereof through an exhaust pipe connected with said combustion chamber, said exhaust pipes extending through said jackets and said boat and below the water line of said boat, said exhaust pipes being arcuate shaped and extending rearwardly, those exhaust pipes on each side of the boat being enclosed within a casing secured to the exterior of said hull and below the water line thereof, said casing being open at one of its ends and having a substantially reduced opening at the other of its ends.

7. A marine propulsion device adapted to be mounted within a boat, comprising, means for maintaining air under constant pressure in a plurality of manifold pipes, said manifold pipes being spaced from each other and disposed on opposite sides of said boat, a plurality of combustion units spaced from each other and disposed on opposite sides of the hull of said boat, said units being enclosed within fluidtight jackets, a pump adapted to circulate a cooling medium through said jackets, each of said units having an air intake port adapted to be connected with a manifold disposed on the same side of said boat, each of said units having an air intake chamber, a valve disposed in each of said units and positioned intermediate said manifold and said air intake chamber, a combustion chamber for each of said units, an automatic operating valve disposed between said air chamber and said combustion chamber, means for supplying an ignitable gas to said combustion chamber, means for automatically operating said last said valve to permit the ignitable gas and air to mix, means for igniting said mixed gases and exhausting the combustion product thereof through an exhaust pipe connected with said combustion chamber, a valve disposed intermediate said exhaust pipe and said combustion chamber adapted to only be operated when said mixed gases have been ignited, said exhaust pipes extending through said jackets and the hull of said boat below the water line thereof.

8. A marine propulsion device as defined in claim 1, said internal combustion units having a spring operating valve positioned intermediate the combustion chamber and said exhaust end portions, said valve being normally in closed position, said valve moving to its open position upon ignition of said mixed gases thereby permitting said gases to pass through said exhaust end portions.

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