Sept. 19, 1950 C. A. GONGWER ET AL 2,522,945

APPARATUS FOR JET PROPULSION THROUGH WATER
BY COMBUSTION OF CARBURETED FUEL

Filed March 28, 1947 3 Sheets-Sheet 1

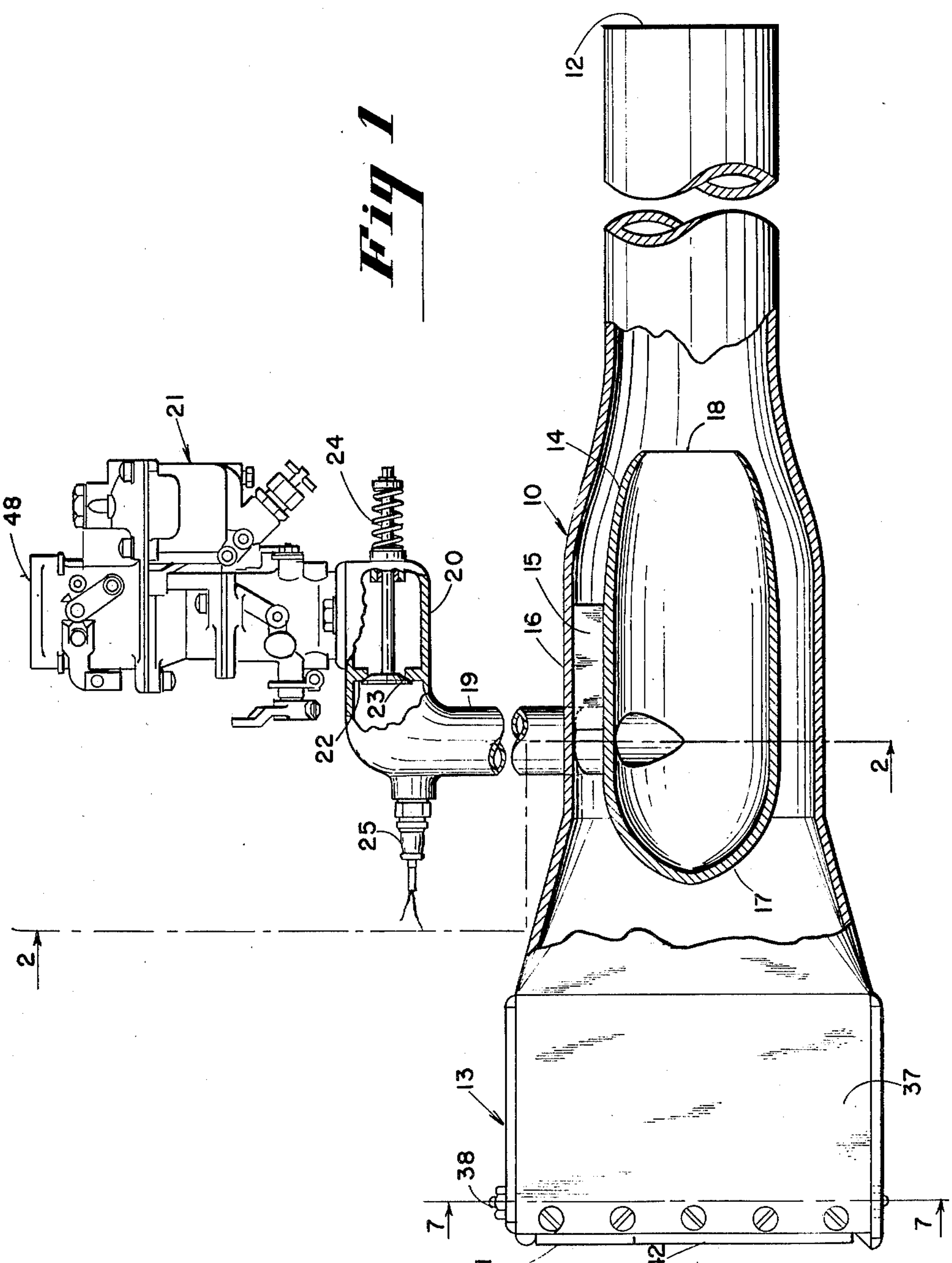

Fig 1

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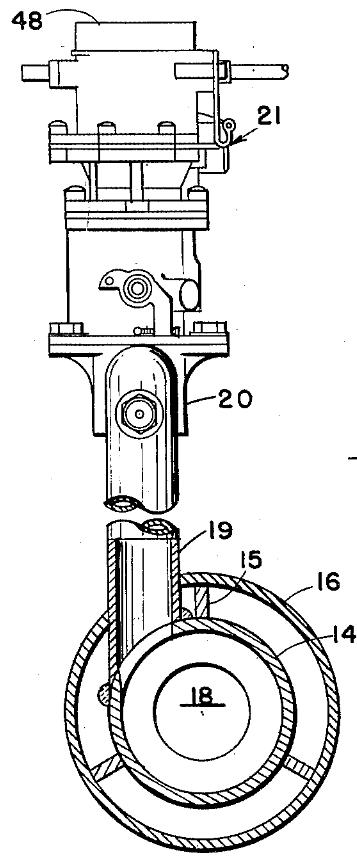

Fig. 2

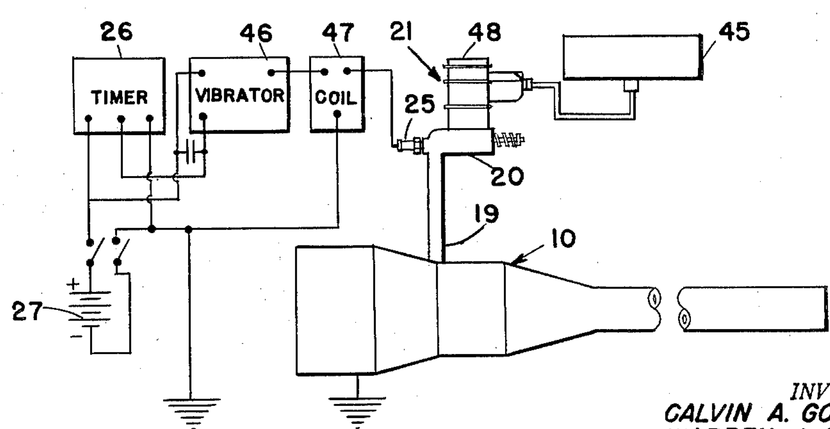

Fig 3

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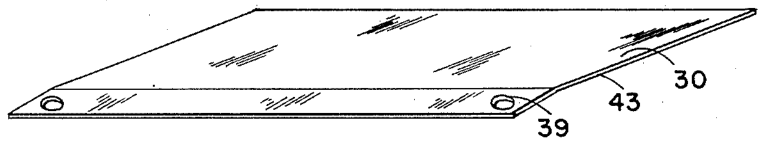

Fig. 4

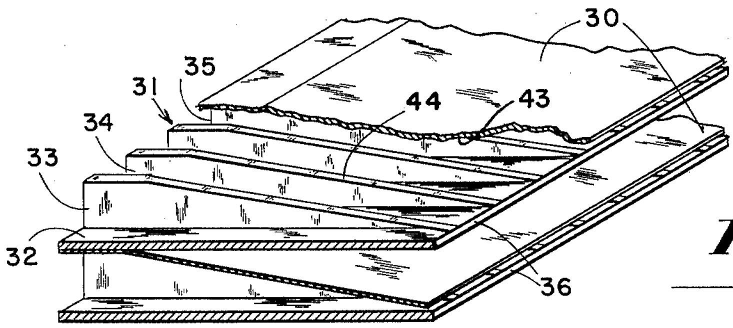

Fig. 5

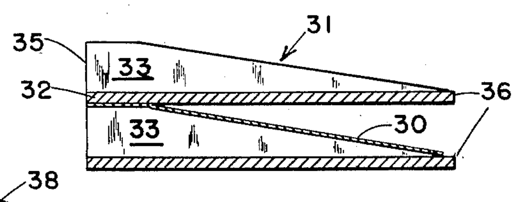

Fig. 6

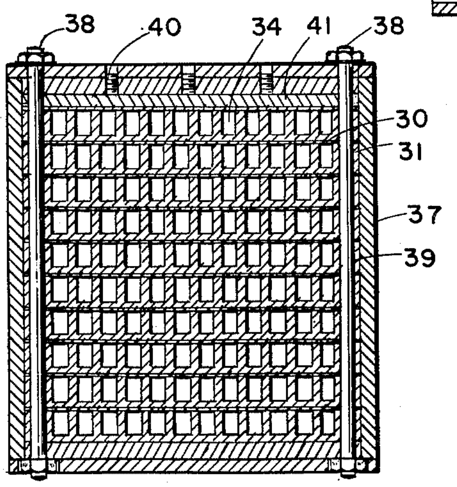

Fig. 7

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2,522,945

APPARATUS FOR JET PROPULSION THROUGH WATER BY COMBUSTION OF CARBURETED FUEL

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5 Claims. (Cl. 60—35.6)

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This invention relates to jet propulsion and more particularly to jet propulsion of a device in liquid medium.

The principal object of this invention is to provide a simple and inexpensive apparatus employing a minimum number of moving parts and capable of operating craft through water by jet propulsion.

Heretofore several jet propulsion devices have been disclosed for propelling by reaction various types of water craft. One specific group employs a simple duct into which water reacting materials are injected and serve as propellants by reacting with water flowing through the duct developing gases which supply the motive force. While these devices possess particular advantages for underwater operation, where the oxidizer would otherwise have to be carried, their use for surface craft is not warranted due to the excessive cost of the materials employed as propellants.

Our present invention is based on the discovery of a simple jet propulsion device which makes use of easily available materials, such as gasoline, to develop the gases necessary for energizing the column of water flowing through the duct.

In accordance with our present invention we provide an efficient yet relatively simple jet propulsion device capable of operating through water and making use of easily available and relatively cheap fuel, such as gasoline, to develop the gases necessary for sending the column of water through the duct. We carry out our invention by the provision of a duct through which the water flows into the inlet opening and out the exhaust opening. The duct is provided with a valve through which the water flows; and a combustion chamber discharges its combustion products into the duct back of the valve in a manner to act on the water and project it through the exhaust opening while the valve is closed. We inject into the combustion chamber a carbureted mixture, for example, gasoline and air, and this is drawn into the chamber by the vacuum effect created in the duct after each explosion. Ordinarily, a timed ignition device such as a spark plug will be used to time the explosion.

At each explosion, the gases of combustion created in the combustion chamber produce pressure in the duct closing the inlet valve and pushing a piston of water out through the exhaust

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opening. In the operation of pushing this piston of water, the rearward movement of the gases sends the pressure much lower back at the combustion chamber, generally below atmospheric, which will have the effect of drawing more fuel from the carburetor, and opening the main valve in the duct to let in more water. The new charge exploding in the chamber will create a new water piston which will be sent rearwardly through the duct and will tend to overtake the previous piston. This action will be repeated with subsequent explosions.

We prefer to use a relatively long pipe between the combustion chamber and the exit from the duct in order to obtain the best possible effect of the piston action. During the initial overtaking of one piston of water by a subsequent piston of water, a pressure will build up in this long pipe; and this pressure is of special advantage in the efficiency of the operation. As at least two substantial water pistons should be kept in the pipe for efficient operation, the pipe should preferably be relatively long.

A preferred feature of the construction is the provision of a fuel inlet valve at the carbureter which automatically opens each time a vacuum is created to admit the proper amount of the fuel mixture into the combustion chamber.

A further feature of our invention is the provision of a specially designed chamber and induction pipe arrangement which permits rapid mixing of the fuel and air mixture in the firing chamber and insures rapid scavenging of the products of combustion from the firing chamber after each explosion.

A related feature is the symmetrical confluence of the water duct and combustion chamber outlet nozzle which permits efficient engagement of the liquid passing through the duct by the hot gases escaping the combustion chamber after each explosion.

Another feature is the lack of complicating moving parts required in the above device.

The foregoing and other features of our invention will be better understood from the following detailed description and the accompanying drawings of which:

Fig. 1 is a longitudinal view partly in cross section showing an assembled motor;

Fig. 2 is a view of the device partly in cross section taken on the line 2—2 of Fig. 1;

Fig. 3 is a schematic view showing a motor and the electrical circuit;

Fig. 4 is a perspective view of a valve blade;

Fig. 5 is a perspective view partially broken taken from above showing the manner in which the valve blades cover the channels;

Fig. 6 is an end plan view partly in cross section showing the valve blade interleaved between two valve channels; and

Fig. 7 is a cross section view of the valve assembly taken on the line 7—7 of Fig. 1.

The jet motor shown in the drawings comprises a duct 10 having an inlet opening or mouth 11, an exhaust opening or nozzle 12. Within the inlet opening there is located a valve assembly 13 and between the valve and exhaust opening there is provided a firing chamber 14. The duct portion 16 surrounding the firing chamber 14 is larger in diameter than the outer diameter of the firing chamber starting at the end of valve assembly 13 and continuing at uniform diameter to a point just short of exhaust end 18 of the firing chamber 14. Rearwardly from this point the diameter of the duct gradually reduces ultimately to conform with the diameter of nozzle member 12. The firing chamber 14 is supported within the enlarged section of the duct 16 by a series of fins 15 which centrally affix the firing chamber 14 therein. Firing chamber 14 is preferably cylindrical in shape throughout the major portion of its length; and the forward end 17 is closed by a streamlined cap while the rear portion tapers in diameter, terminating in an exhaust opening 18 which is considerably smaller in cross section than the principal cross section of the firing chamber 14.

An induction pipe 19 is provided near the forward end of the combustion chamber and enters the firing chamber at an off-center position as shown in Fig. 2. The upper portion of induction pipe 19 is fitted to one end of a Z-shaped valve housing 20 while the other end of the Z-shaped valve housing is provided with means for attaching thereto a conventional fuel-air carburetor 21 of the type employed in internal combustion engines. Housing 20 is provided with an internal valve seat 22 on which is seated a poppet valve 23 which is normally held in a closed position against the seat by a coil spring 24. The lower leg of the valve housing 20 is provided with a suitable ignition device such as a spark plug 25.

The sparking of plug 25 is controlled by a timing device 26 placed in series with a vibrator 46 and a coil 47. The timer, vibrator and coil are located between plug 25 and a standard source of electrical energy such as a battery 27 as shown in the schematic drawing Fig. 3. Both the spark plug 25 and the negative terminals of the batteries are grounded thus completing the circuit.

The construction of valve assembly 13, which is located in the entrance to the duct, is described in detail with reference to Figs. 4, 5, 6 and 7. The valve is of the flutter or blade type and is built up of an assembly of alternating flexible blades 30 and rigid channel members 31. Each channel member 31 comprises a rectangular plate 32 the upper surface of which is provided with a series of partition members 33, which are preferably integral with the plate 32 and run parallel to each other as shown. These partition members form a series of channels 34 preferably tapering in depth. They are deeper at the leading edge 35 and diminish as they approach the rear end 36 to coincide with the thickness of rear edge of blade 30.

In assembling the valve unit 13 several flexible blades 30 are alternatively interleaved between the several channel members 31 and are firmly held near their leading edge 35 by the channel plate 32 of one channel member and the upper edge of partitions 33 of the adjacent channel member.

These valves and rigid channel members are securely held together in a valve housing 37 by bolts 38 which pass through the holes 39 provided in both the flexible blades 30 and the rigid channel members 31 as shown in Fig. 7. The central span of the valve assembly is placed in compression by a series of compression bolts 40 which press against a bearing plate 41. Valve housing 37 is shown as rectangular for convenience only and may be of any other suitable shape.

When a series of these valves and channel members are formed in the housing to form a complete valve assembly 13 they completely fill the inlet space just preceding the firing chamber 14. For purpose of assembly the completed valve slides into the housing 37 and is clamped into position by bolts 38, compression bolts 40 and a pair of shoulder shaped retainers 42 which are attached to the forward portion of the sides of duct opening 11.

Figs. 5 and 6 are views illustrating the means by which one of the valve blades is sandwiched between two of the channel members.

Fig. 5 shows a cutaway view looking into the channel member 31 showing its relationship to valve blade 30. The arrangement is such that the lower face 43 of each flexible blade is able to vibrate alternately contacting and moving away from the top edge 44 of partition 33. This creates the valve action placing the valve in a closed position whenever the pressure on the downstream side of the valve assembly exceeds the pressure acting from the upstream side and permitting flow of liquid through the valve when the pressure on the upstream side of the valve exceeds that of the downstream side pushing the blade away from the top of channel partition 33.

The operation of the unit will be understood with reference to Fig. 3 which schematically shows the apparatus. When the apparatus is at rest it may be started by introducing compressed air from a storage source (not shown) into the air inlet 48 of the carburetor 21 thus displacing any water which may be standing in firing chamber 14 and induction pipe 19. The stream of air passing through the carburetor air intake 48 picks up the fuel such as, for example, gasoline, which is supplied to carburetor 21 from a storage tank 45 forming a combustible mixture which fills induction pipe 19 and firing chamber 14. After the initial firing the fuel from the carburetor 21 continues to form a combustible mixture by dispersing in the stream of air sucked in through the Venturi-tube of the carburetor whenever the pressure within the firing chamber 14 drops below the pressure of the atmosphere.

Poppet valve 23 is lightly loaded to permit it to open whenever the pressure in firing chamber 14 drops slightly below atmospheric pressure. When the pressure in the firing chamber is subatmospheric, poppet valve 23 remains open allowing a charge of the combustible fuel-air mixture to flow through induction tube 19 and into firing chamber 14.

The firing periods are controlled by a timer 26 which times the flow of electricity entering vibrator 46, coil 47 and spark plug 25 initiating the explosion of the combustible mixture in the firing chamber. The timing is preferably regulated to approach the natural resonating frequency of the duct; however, this may be varied depending on the performance desired. The gases and the energy developed by the explosion in the firing chamber escape through exhaust opening 18 which serves as a nozzle, pushing ahead of them the water that is present within the duct in the region downstream from the opening 18 of firing chamber 14 and forcing the column of water to escape through duct nozzle 12 thereby generating the reactive force.

When the gases escape from the firing chamber 14 through nozzle 18 all of the liquid within the duct 10 is temporarily placed under pressure forcing shut valve 13 and making any flow of water in the duct take place in the direction of exhaust nozzle 12. The gases escaping from the firing chamber in effect get behind a piston of water in the exhaust pipe and push it out toward the exhaust nozzle, with considerable velocity. This creates a considerable momentum of the piston of water which has the effect of creating vacuum within the duct and combustion chamber after the water piston moves a distance towards the exhaust nozzle, and this vacuum has the effect of again opening the inlet valve to admit another mass of water and opening the poppet valve to draw another charge of the fuel mixture to the combustion chamber. The firing of this latter charge of fuel mixture then takes place just in time for the exhaust gases from the combustion chamber to get behind the mass or piston of water which has just been let in through the inlet valve; and the pressure built up by the explosion pushes this piston on toward the next preceding water piston and causing it to overtake said preceding piston. The reason each piston or slug of water tends to be overtaken by the next succeeding piston of water is that after the gaseous pressure behind each piston is relieved, the velocity of the piston in the tail pipe pulls the vacuum in the duct, accompanied by a slowing down of the piston. Then when the next firing occurs, the next succeeding piston is moved at a much higher velocity than the said preceding piston so that the space between the pistons closes up during the travel down the tail pipe. As the explosions occur in rapid succession, this action of creating alternate vacuum and pressure with the combustion gases pushing pistons out the exhaust opening takes place continuously with continuous exhaust of water.

The function of the inlet valve 13 will be apparent from the foregoing explanation. The valve placed at the entrance to the duct prevents back flow of water out through the mouth of the duct and acts as a back stop against which the intermittent pressurizations can act to force the pistons or slugs of water out through the tail pipe.

Each of the intermittent firings is started at the spark plug in the induction pipe and extends down into the combustion chamber 14; accordingly what appears at the outlet 18 of the combustion chamber is a series of gaseous pressurizations behind pistons or slugs of water passing down the tail pipe. Each pressurization at the chamber outlet acts in all directions on the water in the duct tending to push the water both frontwards and backwards; and this tendency exists even though it is probable that the rearward tend-

ency is greater than the forward tendency. Accordingly, during normal operation, the flutter valve 13 will be alternately opened and closed in accordance with the pressurizations due to the firing and the alternate vacuums due to the velocity of the slugs of water travelling down the tail pipe after a firing.

It has been found that for the best efficient operation the length of the pipe from the combustion chamber back to the exhaust opening 12 should be relatively long, that is, it should be about 5 to 15 diameters long. This relatively great length of pipe enables at least two pistons of water to be in the pipe, thereby creating the foregoing piston effect with a substantial mass of water in each piston and thereby obtaining high efficiency.

It has been found that the positioning of the induction pipe 19 at the forward end of the firing chamber in an off-center position produces rapid mixing of the combustible mixture, causing it to circulate in a spiral manner throughout the entire length of the firing chamber. On exploding the resulting gases acquire the same swirling motion maintaining their spiralling motion until they leave the firing chamber. This causes a more positive displacement of the burnt gases by new mixture with a minimum of mixing between the two. Rapid scavenging is desirable since it clears the firing chamber of all inert material quickly enough to permit a new combustible charge to enter without interfering with the natural frequency of the duct.

A feature is the symmetrical confluence of the wall of the duct with the pattern of the exhaust from the firing chamber. This insures efficient engagement of water in the duct by hot gases escaping from the firing chamber.

A particular advantage of this type of apparatus is its simplicity of construction, efficient operation, absence of intricate moving parts and ease of repair.

We claim:

1. A jet propulsion motor adapted for operation through water, said motor comprising a duct having an inlet opening and an exhaust opening, an automatic pressure operable valve located within the duct for intermittently blocking and passing water entering the duct from the inlet opening, a combustion chamber located within the duct at the downstream side of said valve, said combustion chamber being in the general form of a hollow cylinder closed at the forward end and having an opening at the rearward end, and being streamlined at both ends with side walls substantially parallel to the walls of the duct within which it is placed, and being symmetrically located within said duct walls, whereby the water flowing through the duct flows past and along the side walls of the combustion chamber, a fuel mixing carburetor having an outlet, an induction pipe leading from the carburetor outlet and into the combustion chamber through the side walls of the duct and of the combustion chamber, an automatic pressure operable outlet valve located at the carburetor outlet to admit fuel mixture from the carburetor to the induction pipe when the latter valve is open but not when the latter valve is closed, timed firing means for firing the carburetor charge entering said induction pipe, whereby fuel charges are intermittently drawn from the carburetor through the carburetor outlet valve to the induction pipe and fired intermittently, thereby creating intermittent pressurizations in the induction pipe,

combustion chamber and region of the duct at the combustion chamber outlet, which drive pistons of water intermittently downstream through the duct and out the exhaust opening during the periods of pressure during which the two valves are automatically closed, and masses of water are admitted intermittently through the inlet valve during intervals between the pressure intervals in the duct.

2. A jet propulsion motor adapted for operation through water, said motor comprising a duct having an inlet opening and an exhaust opening, an automatic pressure operable valve located within the duct for intermittently blocking and passing water entering the duct from the inlet opening, a combustion chamber symmetrically located within the duct at the downstream side of said valve, so that the water flowing through the duct flows past the chamber and along the walls thereof, said chamber being closed at the end toward the valve, a fuel mixing carburetor having an outlet, an induction pipe leading from the carburetor outlet and into the combustion chamber, an automatic pressure operable outlet valve located at the carburetor outlet to admit fuel mixture from the carburetor to the induction pipe when the latter valve is open but not when the latter valve is closed, whereby fuel charges are intermittently drawn from the carburetor through the carburetor outlet valve to the induction pipe and fired intermittently so that the combustion and creation of gases takes place both in the induction pipe and in the combustion chamber, thereby creating intermittent pressurizations in the duct which drive pistons of water intermittently downstream through the duct and out the exhaust opening during the periods of pressure during which the two valves are automatically closed, and masses of water are admitted intermittently through the inlet valve during intervals between the pressure intervals in the duct.

3. A jet propulsion motor adapted for operation through water, said motor comprising a duct having an inlet opening and an exhaust opening, an automatic pressure operable valve located within the duct for intermittently blocking and passing water entering the duct from the inlet opening, a combustion chamber symmetrically located within the duct at the downstream side of said valve so that the water flowing through the duct flows past the chamber and along the walls thereof, said chamber being closed at the end facing the valve and having an outlet directed toward the exhaust opening, a fuel mixing carburetor having an outlet, an induction pipe leading from the carburetor outlet and into the combustion chamber, an automatic pressure operable outlet valve located at the carburetor outlet to admit fuel mixture from the carburetor to the induction pipe when the latter valve is open but not when the latter valve is closed, timed firing means for firing the carburetor charge entering said induction pipe, whereby fuel charges are intermittently drawn from the carburetor through the carburetor outlet valve to the induction pipe and fired intermittently, thereby creating intermittent pressurizations in the duct which drive pistons of water intermittently downstream through the duct and out the exhaust opening during the periods of pressure during which the two valves are automatically closed, and masses of water are admitted intermittently through the inlet valve during intervals between the pressure intervals in the duct.

4. A jet propulsion motor adapted for operation through water, said motor comprising a duct having an inlet opening and an exhaust opening, an automatic pressure operable valve located within the duct for intermittently blocking and passing water entering the duct from the inlet opening, a combustion chamber located symmetrically within the duct downstream from the valve, said combustion chamber being in the form of a hollow cylinder whose longitudinal axis is colinear with the longitudinal axis of the duct, the cylinder being closed at the forward end by a rounded streamlined closure, and having an opening at the rearward end symmetrically located within the duct, the side walls of the cylinder being substantially parallel to the walls of the duct within which it is placed, the duct narrowing down in diameter just to the rear of the combustion chamber outlet to form a tail pipe of smaller diameter than the duct portion ahead of it, said tail pipe extending to the exhaust opening and having a length at least five times its diameter, a fuel mixing carburetor having an outlet, an induction pipe leading from the carburetor outlet and into the combustion chamber through the side walls of the duct and of the combustion chamber, the diameter of said induction pipe being smaller than the diameter of the combustion chamber and entering the combustion chamber at a distance forward of the combustion chamber outlet, an automatic pressure operable outlet valve located at the carburetor outlet to admit fuel mixture from the carburetor to the induction pipe when the latter valve is open but not when the latter valve is closed, timed firing means for firing the carburetor charge entering said induction pipe whereby fuel charges are intermittently drawn from the carburetor through the carburetor outlet valve to the induction pipe and fired intermittently, thereby creating intermittent pressurizations in the induction pipe, combustion chamber and region of the duct at the combustion chamber outlet, which drive pistons of water intermittently downstream through the tail pipe and out the exhaust opening during the periods of pressure during which the two valves are automatically closed, and masses of water are drawn in intermittently into the duct, and explosive charges are drawn from the carburetor intermittently during intervals of suction in the duct.

5. A jet propulsion motor adapted for operation through water, said motor comprising a duct having an inlet opening and an exhaust opening, an automatic pressure operable valve located within the duct for intermittently blocking and passing water entering the duct from the inlet opening, a combustion chamber located within the duct at the downstream side of said valve so that water flowing through the duct flows past the chamber wall, said chamber being closed at the end toward the valve, a fuel mixing carburetor having an outlet, an induction pipe leading from the carburetor outlet and into the combustion chamber, an automatic pressure operable outlet valve located at the carburetor outlet to admit fuel mixture from the carburetor to the induction pipe when the latter valve is open but preventing the flow of fuel when the valve is closed, whereby fuel charges are intermittently drawn from the carburetor through the carburetor outlet valve into the induction pipe and combustion chamber and fired intermittently so that the combustion and creation of gases takes place both in the induction pipe and in the com-

bustion chamber, thereby creating intermittent pressurizations in the duct, which drive pistons of water intermittently downstream through the duct and out the exhaust opening during the periods at which pressure exists within the duct and during which the two valves remain automatically closed, and masses of water and fuel are admitted intermittently through the automatic pressure operable valve and through the carburetor outlet valve during the periods between said pressure intervals in the duct.

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