United States Patent [19]

Stubblefield

[11] **3,797,447**

[45] **Mar. 19, 1974**

[54] **INBOARD PROPULSION SYSTEM FOR A BOAT**

[76] Inventor: **Robert A. Stubblefield,** 755-5th Ave., Salt Lake City, Utah 84107

[22] Filed: **Aug. 3, 1972**

[21] Appl. No.: **277,817**

[52] **U.S. Cl.** ..... **115/12 R,** 114/151

[51] **Int. Cl.** **B63h 11/00**

[58] **Field of Search** ..... 115/11, 12 R, 12 A, 18 R, 115/18 A; 114/150–151; 60/221–222, 228, 235, 242; 239/265.19, 265.25, 265.27, 265.31

[56] **References Cited**

UNITED STATES PATENTS

2,408,099	9/1946	Sherman	239/265.29
2,969,640	1/1961	Reed	60/242
3,019,600	2/1962	Peek, Jr.	239/265.29
3,137,266	6/1964	Perrier et al.	115/12 R
3,266,242	8/1966	Aschauer	115/12 R
3,302,605	2/1967	Kuether	115/12 R
3,475,912	11/1969	Angier	60/222

Primary Examiner—Duane A. Reger
Assistant Examiner—Jesus D. Sotelo
Attorney, Agent, or Firm—Hill, Sherman, Meroni, Gross & Simpson

[57] **ABSTRACT**

An inboard propulsion system for a boat utilizing a water jet propulsion characterized by a pair of spaced nozzles each provided with individually controlled deflecting hoods to enable providing both a reverse thrust for backing the boat and to selectively reverse the water jet of a single nozzle to provide a turning force for steering the boat. Preferably, each of the nozzles is provided with a servo system which varies the effective opening of the nozzle in response to changes in the pressure differential between the intake pressure to the main impeller unit and the discharge pressure of the impeller unit to attempt to maintain a constant quantity flow from the nozzles independent or regardless of any variations in the intake pressure of the impeller unit.

12 Claims, 5 Drawing Figures

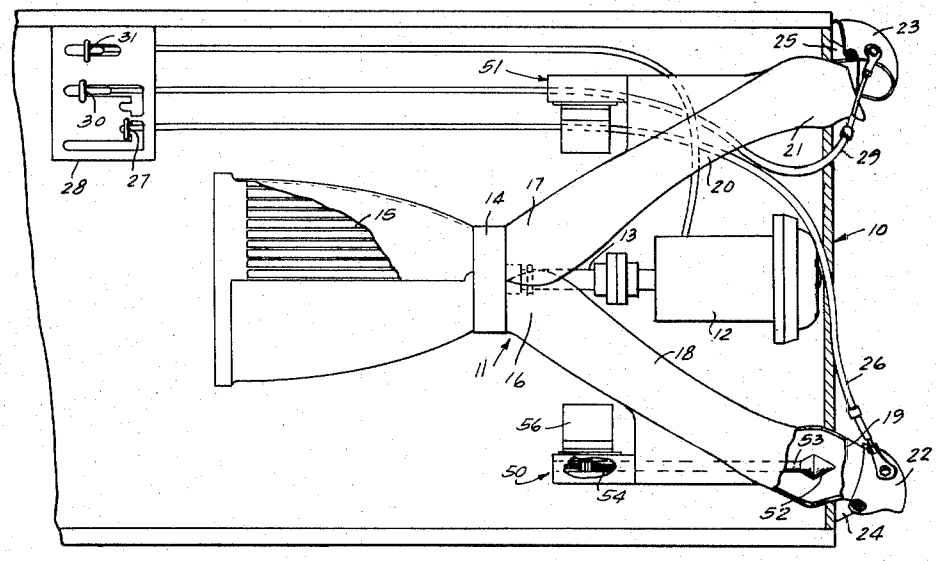


Fig. 1

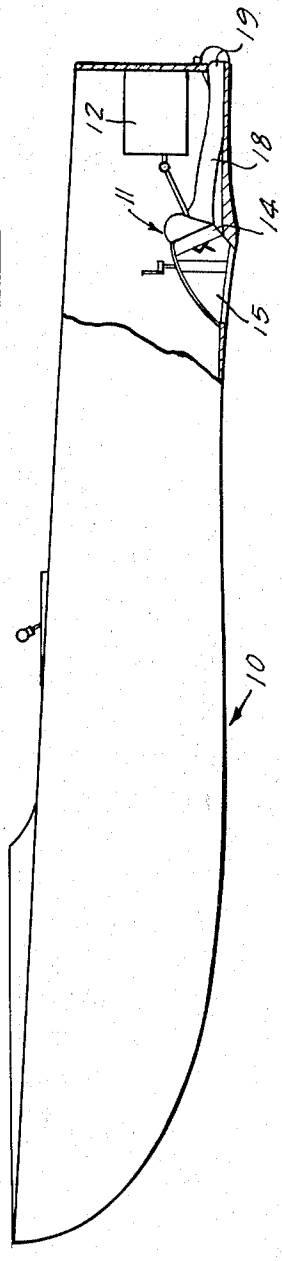


Fig. 5

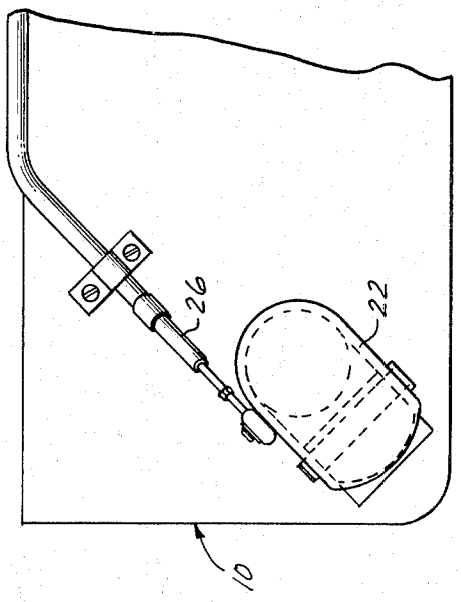
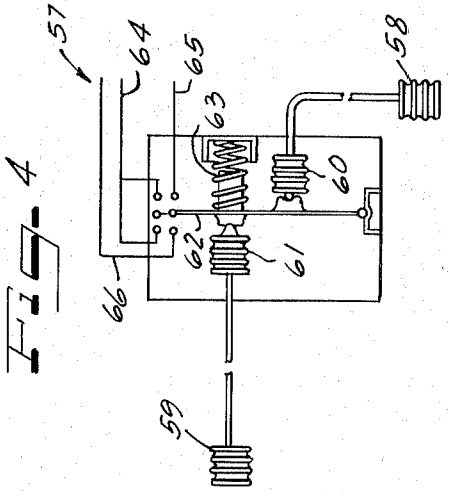


Fig. 4



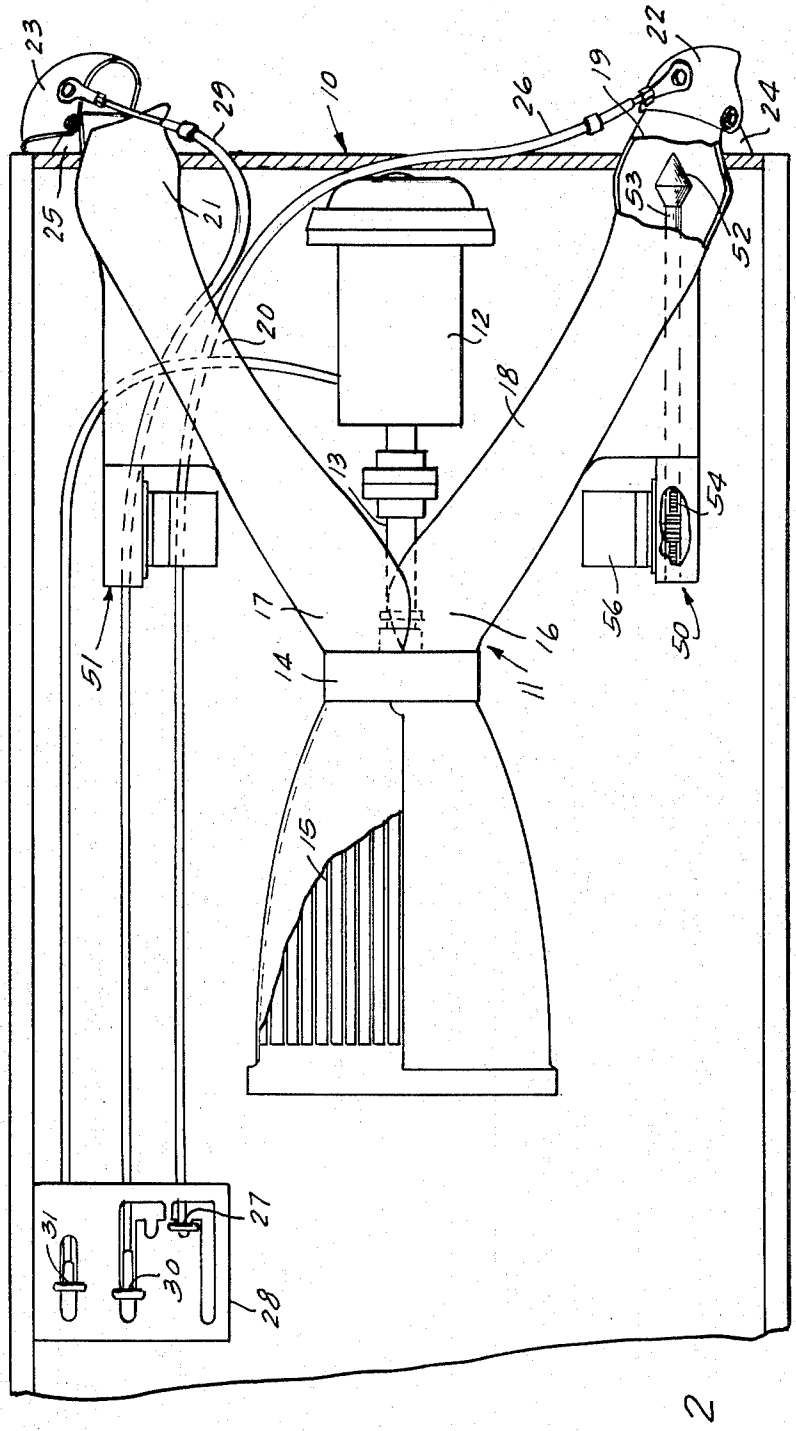

23
29
10
26
19
22
24
25
21
53
52
20
12
18
13
54
56
50
51
17
14
16
11
15
31
27
30
28

Fig. 2

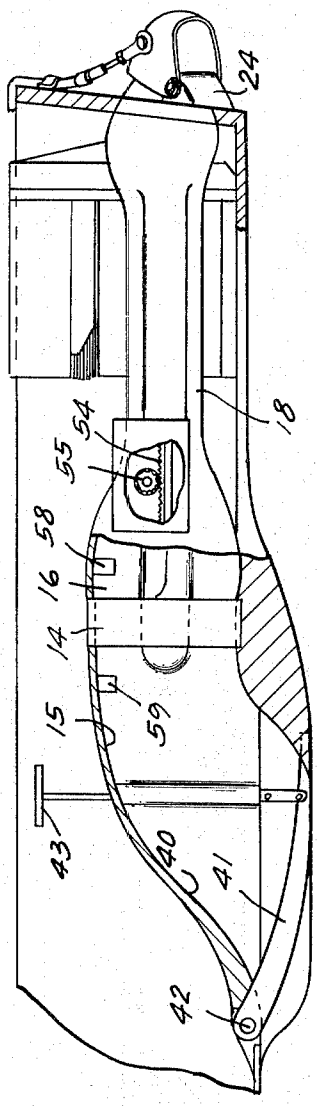

24
18
54
55
58
16
14
15
59
43
40
41
42

Fig. 3

INBOARD PROPULSION SYSTEM FOR A BOAT

BACKGROUND OF THE INVENTION

1. Field of the Invention

The present invention is directed to a fluid propulsion system having a servo for controlling the flow through a nozzle, which system is particularly useful for an inboard boat propulsion system.

2. Prior Art

In recent years, a water jet propulsion system for propelling a boat has become increasingly more popular. One of the advantages of such a system is the reduced maintainance due to no exposed moving parts such as a power propeller being situated in the water below the boat and subject to damage caused by obstructions below the waterline of the boat. An example of a water jet propulsion system is disclosed and claimed in my patent, U.S. Pat. No. 3,494,320 which issued on Feb. 10, 1970.

In the above-mentioned patent, the propulsion unit was an outboard propulsion unit whose direction of thrust could be changed to provide a steering function in a manner similar to a conventional outboard motor. When utilizing a water jet propulsion system as an inboard propulsion system, problems arose when providing a steering function utilizing the propulsion unit. Furthermore, the efficiency of a water jet propulsion unit changes as the speed of the boat through the water changes.

SUMMARY OF THE INVENTION

The present invention is directed to an inboard water jet propulsion system for a boat which provides a steering function by controlling the direction of the water jet and which has means for varying the effective discharge opening of the water jet nozzles to compensate for the changes in the head pressure due to changes in the speed of the boat through the water. In particular, the propulsion system has an impeller means or unit for providing water under pressure which water is discharged into a bowl which is provided with two segments, a conduit extending from each segment to a nozzle which converts the water under pressure as it is discharged from the nozzle into a high velocity flow or jet of water. The pair of nozzles are spaced apart and each nozzle is preferably provided with individually operated thrust reversal means to provide both a reverse direction for the boat and steering functions by the reversing of the thrust from one nozzle while maintaining the thrust in the other nozzle in the forward direction. To compensate for changes in the head pressure in the bowl due to changes in the intake pressure for the impeller means, each of the nozzles is provided with a valve member attached to an actuating means that moves the member into and out of the discharge opening of the nozzle to change the effective size of the opening. The actuating means is controlled by a sensing means that senses the pressure in the intake of the impeller means or unit and maintains a constant pressure differential between the intake pressure to the impeller means and the discharge or head pressure, by causing the actuating means to position the valve member in response to the sensed pressures.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 illustrates a boat with portions broken away to illustrate the propulsion system of the present invention;

FIG. 2 is a plan view with portions broken away for purposes of illustration of a boat of FIG. 1 with the propulsion system of the present invention;

FIG. 3 is a side view, with portions broken away for purposes of illustration, of the propulsion system illustrated in FIG. 2.

FIG. 4 is a schematic illustration of the sensing unit utilized to control the servo valve of the present invention; and

FIG. 5 is a partial end view of the boat of FIG. 1 illustrating the deflecting plate or thrust reversal means of the present invention.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The principles of the present invention are particularly useful in propelling a boat generally indicated by the numeral **10** by a propulsion unit **11**, as shown in FIG. **1**.

As best illustrated in FIGS. **2** and **3**, the propulsion system **11** has an engine **12** connected by a drive shaft **13** to an impeller means or unit **14**. The impeller unit **14** receives water through an intake **15** and discharges it under pressure into a bowl which is subdivided into two equal bowl portions or segments **16** and **17**. Extending from the bowl segment **16** is a conduit or pipe which conveys the water under a head pressure to nozzle **19** where it is converted into a high velocity moving stream discharged from the stern of the boat **10**. In a similar manner, the water in the bowl segment **17** is carried by a conduit **20** and converted into a high velocity moving stream by a nozzle **21** and discharged through the stern of the boat.

As illustrated, the nozzles **19, 21** are spaced apart and located adjacent the sides of the boat **10**. To provide a thrust reversal for the water jet discharged from each of the nozzles **19, 21**, a deflecting or thrust reversing means illustrated as hoods **22, 23** are mounted on the stern of the boat **10** by mounting pads **24,25** which mount the respective hoods **22,23** for pivotal movement from a position reversing the jet thrust from the nozzle **19**, as illustrated by the hood **22**, to the position as illustrated by the hood **23**, withdrawn from the water jet of the nozzle **21**. Each of the deflecting means such as the hoods **22,23** are individually controlled by separate actuating means which pivot them on their respective mounting pads **24,25**. As illustrated, the hood **22** is controlled by a flexible cable **26** extending to an actuating lever **27** on a control console **28**. In a like manner, the hood **23** is controlled by a flexible cable **29** extending to a control lever **30** on the console **28**. The console **28** also includes a throttle **31** for controlling the speed of the engine **12** which can be a conventional gasoline engine.

As best illustrated in FIG. **5**, the deflecting hood **22** pivots on an axis so that the water jet stream issued from the nozzle is deflected in a reversed direction that extends both downwardly and outwardly from the side of the boat. Thus, by selectively actuating the levers **27** or **30**, one nozzle such as **21** can be applying a forward thrust whereas the other nozzle **19** has reverse thrust with the coaction of thrust of the two jets providing a turning movement which will turn the boat to the left, as illustrated in FIG. **2**. To turn the boat to the right, the lever **30** is moved to shift the hood **23** to a reversing po-

sition, and the lever **27** is moved to shift the hood **22** to a withdrawn position. To obtain a reversal in the direction of movement of the boat, both hoods are moved to the reversing position which will reverse the direction of thrust, stopping forward movement of the boat and eventually cause the boat to move backward as the reversed thrust develops a backing-down force for the boat.

The intake **15** for the impeller unit **14** has a scoop **40** with a weed guard or grate **41** disposed thereacross to prevent weeds and other obstructions from being drawn or sucked into the impeller unit **14.** As illustrated, the weed guard **41,** which has a grate configuration, is pivotally mounted in the scoop **40** by pin **42** and held in a closed position by a handle **43.** If the guard or grate **41** becomes entangled with weeds or other obstructions, the guard is cleaned by depressing the handle **43** to pivot the guard on the pin **42** into the flow of water beneath the moving boat to wash the weeds and obstructions away.

The thrust developed by the propulsion system **11** is dependent on the mass of the water being expelled as a water jet and the net velocity of the water jet. The net velocity is equal to the velocity of the water jet being discharged through the nozzle minus the speed of the boat through the water. When the boat is lying still in the water, the pressure at the intake **15** of the impeller means, which acts as a pump, is zero and when the engine is at maximum power output, the discharge of the impeller means into bowl segments **16** and **17** develops a fixed head pressure therein. This head pressure is conveyed by the conduits **18** and **20,** respectively, to the nozzles **19** and **21** which convert the heat pressure into high velocity flows of a given volume and velocity, which flows form the water jets. As the boat gains headway, the pressure in the intake **15** increases resulting in an increase in the head pressure in the bowl segments **16** and **17** with a corresponding increase in the velocity and volume of water being discharged by the nozzles. However, due to the engine characteristic, this increase in head pressure and volume of water is limited. Thus when the speed of the boat approaches the velocity of the water being discharged as a water jet, there is a decrease in the "net velocity" of the water of the water jets with respect to the boat speed and a corresponding drop in thrust. To maintain the thrust, the propulsion system **11** is provided with means to restrict or change the effective area of the discharge opening of each of the nozzles **19** and **21,** which is illustrated as a pair of servo systems **50** and **51,** respectively. This holds the quantity of water constant and permits the pressure in inlet **15,** generated by the speed of the boat, to increase the pressure in bowl segments **16, 17** and augment of the velocity of the water jets.

The servo system **50** utilizes a valve member **52** which is mounted on actuating means illustrated as a rod member **53.** The rod member **53** extends out of the circuit **18** through an appropriate seal and is connected to means for reciprocally moving the rod. An example of such a means is a rack and pinion drive unit comprising a rack **54** and a pinion **55** which pinion is driven by an electrical motor **56.** The actuating means shifts the valve member **52** reciprocally from a withdrawn position to a position with the valve member **52** extending into the discharge opening of the nozzle **19** to reduce the effective area thereof. The electric motor **56** is controlled by control means **57** (FIG. **4**) which utilizes a sensor **58** for sensing the head pressure in the bowl and a second sensor **59** which is disposed in the intake for sensing the intake pressure. As illustrated, the sensors **58** and **59** are bellows which are connected by appropriate conduits to bellows **60** and **61,** respectively, which act on a movable contact **62** which is urged by a spring **63** in a counterclockwise direction, as illustrated in FIG. **4.** The control means **57** has a common line **64** and lines **65** and **66.** When the common line **64** is electrically connected to the line **66** by movable contact **62,** the motor of the activating mean shifts the valve member toward the withdrawn position. When the movable contact **62** is shifted to electrically interconnect line **65** to common line **64,** the motor moves the valve member toward the position to restrict flow through the nozzle.

The servo system of the propulsion unit operates in the following manner. With the engine off, the spring **63** holds the movable contact in a position to interconnect the common line **64** and line **66** to cause the motor to move the servo valve to the maximum withdrawn position. When the boat is at rest in the water with the throttle on the maximum advance position, the engine obtains its full power and the head pressure in bowls **16** and **17** is raised to its designed height. The pressure in the scoop or intake **15** is zero. As the boat gains headway through the water, the boat's velocity is converted into pressure in intake **15.** If the quantity flow which is discharged from the system remains constant, the intake pressure at the scoop or intake **15** will be added to the impeller means pressure to produce a head pressure which is a sum of the intake pressure and pressure provided by the impeller means. Thus by restricting the nozzle opening, the increased pressure is converted to increased velocity of the water being discharged by the nozzle.

To maintain a constant quantity flow, the intake pressure sensed by sensor **59** shifts the movable contact **62** to interconnect line **64** to line **65** and to cause the motor to shift the valve member **52** to restrict the opening of nozzle **19** to compensate for an increase in the flow therethrough due to increase head pressure. As the nozzle is restricted the pressure in the bowl **16** increases. When it has increased to an amount equal to the design output pressure of the impeller unit or pump **11** plus the velocity pressure in the intake **15,** the sensor **58** urges the movable contact **62** in a counterclockwise direction to disconnect or break the electrical connection between lines **64** and **65** to stop the motor which was closing the valve **52.** Any further increase in the boat velocity will increase the pressure at the intake **15** which increase in pressure causes the control means **57** to activate the motor to further restrict the nozzle opening until the head pressure is an amount equal to the sum of the intake pressure and the pump pressure.

When the throttle is retarded, the decreased pump pressure causes sensor **59** to momentarily try to increase the total head pressure in bowl **16.** However, the decreased pump pressure produces a decrease in head pressure to cause a reduction in thrust which decreases the speed of the boat with a corresponding decrease in the intake pressure. The sensors **58** and **59** control the operation of the motor to position the valve member **52** in the desired position so that the head pressure is the sum of the intake pressure and the pressure of pump **11** at the retarded throttle position.

When the throttle is shut off, the pump or impeller means **11** stops and the intake pressure and head pressure decrease rapidly. The spring **63** acting on movable contact **62** causes the lines **64** and **66** to be connected to cause the motor to withdraw the valve member to the withdrawn position.

By changing the size of the nozzle, in response to the measured head pressure and the intake pressure, the velocity of the jet expelled by the nozzles is dependent on the velocity pressure created in the intake **15.** Thus, the change in the area of the discharge opening of the nozzles maintains the efficiency of the propulsion system **11** irrespective of the speed of the boat.

Although various minor modifications might be suggested by those versed in the art, it should be understood that I wish to embody within the scope of the patent granted hereon, all such modifications that reasonably and properly come within the scope of my contribution to the art.

I claim as my invention:

1. In a water jet propulsion system comprising an impeller means for creating a discharge of water under a head pressure from water taken from a water intake, conduit means connecting the discharge to a nozzle for discharge as a jet of water, the improvement comprising means sensing the pressure in the water intake and means for varying the effective size of a discharge opening of the nozzle to control the velocity of the water discharge through the nozzle for a range of different intake pressures sensed by the sensing means so that the effective size is decreased as the intake pressure increases.

2. In a water jet propulsion system according to claim **1,** wherein the means for varying the effective size of the discharge opening comprises the interior of the nozzle converging to the size of the discharge opening, a valve member mounted for reciprocal movement in the nozzle between a position extending into the discharge opening to reduce the effective size of the opening and a position withdrawn therefrom, and means for moving the valve member in response to changes in the intake pressure.

3. In a water jet propulsion system according to claim **2,** wherein the means for moving the valve member comprises an electrical drive means connected to the valve member, and means controlling said drive means, said control means including means sensing the head pressure and said means sensing the pressure at the water intake to obtain a pressure differential with the control means causing the drive means to retract the valve member toward the withdrawn position when the pressure differential is greater than a predetermined amount and causing the drive means to move the valve into the discharge opening when the pressure differential is less than a predetermined amount.

4. In a discharge nozzle according to claim **3,** wherein the electrical drive means includes a rack and pinion drive unit with the rack member connected to the valve member.

5. An inboard water jet propulsion system for a boat comprising a pair of water jet nozzles disposed adjacent the stern of the boat at opposite sides thereof, impeller means discharging water at a head pressure into a bowl, a single water inlet for providing water to the impeller means, means for sensing the water pressure in said water inlet, means for varying the effective opening of each of said pair of nozzles in response to changes in the pressure sensed by said sensing means with the effective opening being decreased in size as the pressure at the inlet increases, conduit means extending from each of the nozzles to said bowl and coacting therewith for dividing the water discharge from the impeller means into equal portions so that each of the nozzles converts the head pressure into a high velocity stream which is discharged as a propulsion jet.

6. An inboard water jet propulsion system according to claim **5,** which further includes deflecting means associated with each of the nozzles to change the direction of the propulsion jet therefrom to provide a reversed thrust for each nozzle, each deflecting means being individually controlled to enable both a selective deflecting of the thrust of one nozzle to provide a steering function and the deflecting of the thrust of both nozzles to provide a backing thrust for the boat.

7. An inboard water jet propulsion system according to claim **6,** wherein each deflecting means comprises a deflecting hood mounted on the stern of the boat adjacent its respective nozzle for pivotal movement into and out of the water jet of its respective nozzle.

8. An inboard water jet propulsion system according to claim **7,** wherein the hood of the deflecting means is mounted to deflect the water jet downwardly and outwardly in a reversed direction.

9. An inboard water jet propulsion system according to claim **5,** wherein the means varying the effective discharge opening of each of the nozzles includes a valve member mounted for relative movement with respect to the discharge opening to change the effective cross-section thereof, control means sensing a pressure differential between the sensed intake pressure and head pressure for the impeller means and means for moving the valve member in response to the sensed pressure differential.

10. An inboard water jet propulsion system for a boat comprising a pair of water jet nozzles disposed adjacent the stern of the boat with a nozzle adjacent each side thereof, an impeller means having a single water inlet and discharging water at a head pressure into a bowl having means forming two bowl segments each receiving an equal volume of the discharge from the impeller means, conduit means interconnecting each of the nozzles to a bowl segment to discharge the head pressure of the impeller means as a water jet from each of the nozzles, means for sensing the pressure in the water inlet, each of the nozzles having means to vary the effective discharge size of the nozzle in response to sensed changes in the inlet pressure of the impeller means with the effective discharge size being reduced as the sensed inlet pressure increases, and deflecting means associated with each of the discharge nozzles, said deflecting means being individually controlled to enable selective deflecting of the water jet of a nozzle to provide a steering function and to enable selective deflecting of the water jet of both nozzles to provide a backing function for the propulsion system.

11. An inboard water jet propulsion system according to claim **10,** wherein the means for varying the effective opening of each of the nozzles comprises a valve member mounted on an actuating rod for reciprocal movement from a position withdrawn from the opening of the nozzle to a position inserted therein, an actuating means for the valve member, a control means for the actuating means including said means sensing the inlet pressure and means for sensing the head pressure in the

bowl segment, said control means causing the actuator means to move the valve member into the nozzle opening to restrict flow therethrough as the pressure differential between the inlet and the head pressure of the bowl segment drops below a predetermined value and causing the actuator to withdraw the valve member when the pressure differential exceeds a predetermined value.

12. An inboard water jet propulsion system for a boat comprising a pair of water jet nozzles disposed adjacent the stern of the boat with a nozzle adjacent each side thereof, an impeller means having a single water inlet and discharging water at a head pressure into a bowl having means forming two bowl segments each receiving an equal volume of the discharge from the impeller means, conduit means interconnecting each of the nozzles to a bowl segment to discharge the head pressure of the impeller means as a water jet from each of the nozzles, deflecting means associated with each of the discharge nozzles, said deflecting means being individually controlled to enable selective deflecting of the water jet of a nozzle to provide a steering function and to enable selective deflecting of the water jet of both nozzles to provide a backing function for the propulsion system, and means for varying the effective opening of each of the nozzles comprising a valve member mounted on an actuating rod for reciprocal movement from a position withdrawn from the opening of the nozzle to a position inserted therein, an actuating means including a rack and pinion drive unit for the valve member, and control means for the actuating means including means sensing both the inlet pressure and the head pressure in the bowl segment, said control means causing the actuator means to move the valve member into the nozzle opening to restrict flow therethrough as the pressure differential between the inlet and the head pressure of the bowl segment drops below a predetermined value and causing the actuator to withdraw the valve member when the pressure differential exceeds a predetermined value.

* * * * *