June 3, 1969 H. V. FRENCH 3,447,324

WATER JET PROPULSION MEANS

Filed Oct. 18, 1967

Fig. 1.

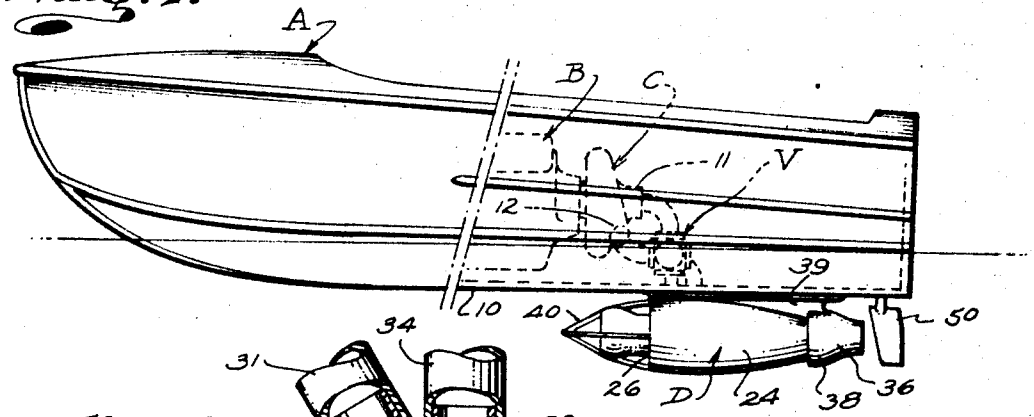


Fig. 2.

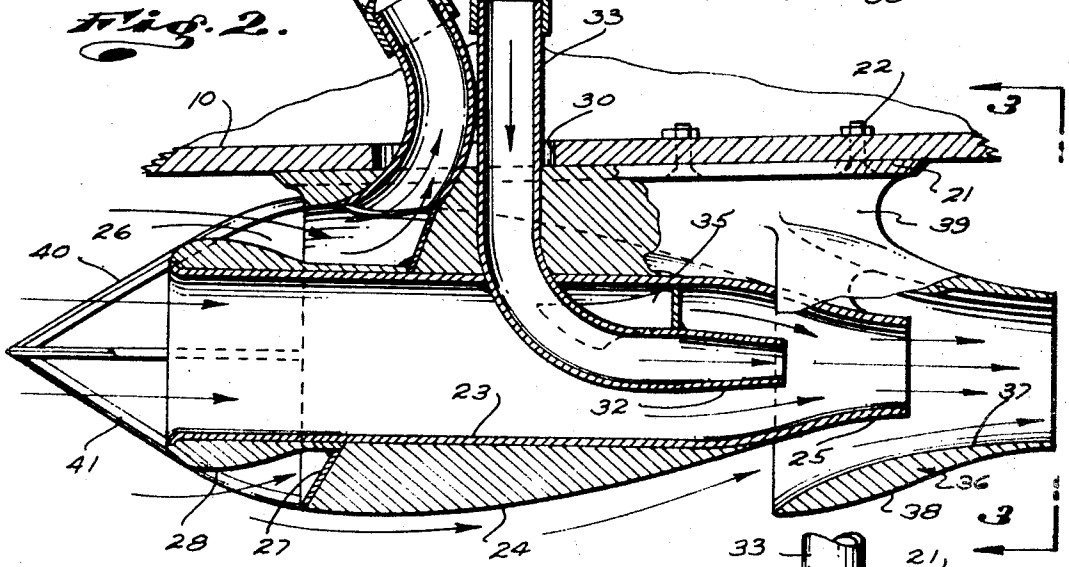


Fig. 4.

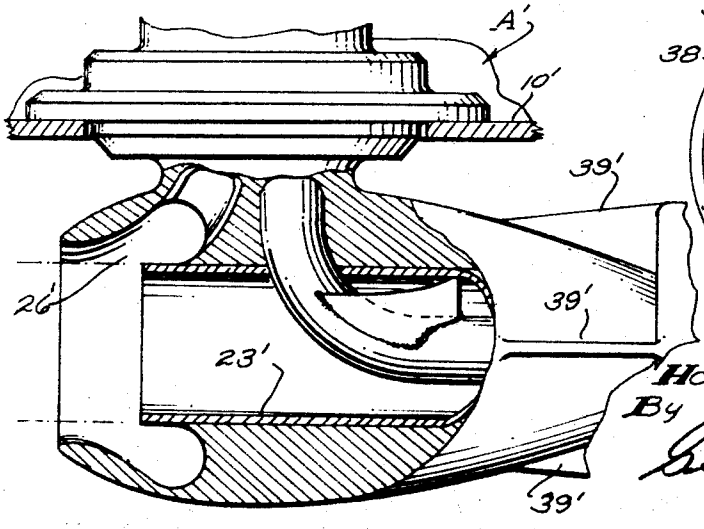
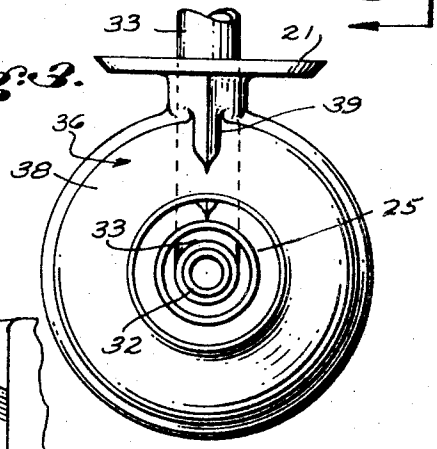


Fig. 3.



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WATER JET PROPULSION MEANS

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ABSTRACT OF THE DISCLOSURE

A water propulsion means for a water craft including a pod having an elongate, cylindrical barrel fixed to the bottom of the craft and having front and rear ends, a hydro-dynamically contoured exterior and a central, longitudinal flow passage, a secondary venturi nozzle at the rear end of the flow passage, an annular forwardly opening scoop in the forward portion of the barrel concentric with and spaced radially outward of the forward end of the flow passage, a suction pipe communicating with the scoop and extending to the inlet side of an engine driven pump in the craft, a delivery pipe extending from the outlet of the pump to the barrel and connected with a primary nozzle arranged centrally in the flow passage and directed rearwardly into the secondary nozzle and an elongate, annular, axially extending flow augmenting sleeve concentric with and engaged freely about and projecting rearwardly from the rear end of the barrel.

For many years, boats or water craft have been propelled across or through the water by means of high pressure water jets. This manner of propelling craft has been achieved by means of motor or engine driven pumps and nozzle means receiving high pressure fluid from the pumps and directing jets rearwardly relative to the longitudinal axis of the craft. The pumps draw water from the underside of the craft and the jets of water issuing from the nozzles create a thrust or reaction to urge the craft forwardly.

Primitive means for jet propulsion of water craft have involved the arrangement of simple nozzles below the bottoms of the craft. In such means the nozzles are submerged and the jets issuing therefrom collide with the ambient water, creating great turbulence and very little propelling reaction. Such means have proven very ineffective and inefficient.

In later water jet propulsion means for water craft, the nozzles are arranged above the surface of the water, in close proximity thereto and so that the water jets issuing from the nozzles, have considerable free lineal flow as they move rearwardly from the craft and thereby generate considerable reactive thrust. Such arrangements have proven to be quite effective and efficient, particularly in small, light, high speed craft, that is, that type of craft having planing or semi-planing hulls. Such arrangements have not proven satisfactory for use in connection with craft having displacement type hulls and which are inherently rather slow.

Another serious disadvantage with the last mentioned form of jet propulsion means resides in the fact that the jets, being exposed and above the water, create considerable undesirable noise and a great amount of splash and surface turbulence which is extremely undesirable in many situations.

In accordance with the above, there exists a great need for an efficient and effective water jet propulsion means which is not only suitable for high speed craft, but which is also suitable for low speed craft.

An object of my invention is to provide an improved highly efficient and effective water jet propulsion means for water craft which is such that it can be advantageously used to effectively and efficiently propel both high speed and low speed craft.

Another object of my invention is to provide a means of the character referred to which includes a submersible propulsion pod which is adapted to be arranged below and fixed to the bottom of a related craft whereby the disadvantages found in propulsion systems where the jets occur above the surface of the water are overcome.

A feature of my invention is to provide a means of the character referred to wherein the pod is provided with water inlet and discharge means and with flow directing and control means which cooperate to effect lineal flow of water into, through, about and from the pod in a manner to create maximum flow of water and reactive thrust for the volume of water pumped into and through the construction.

The foregoing and other objects and features of my invention will be fully understood from the following detailed description of typical preferred forms and applications of my invention, throughout which description reference is made to the accompanying drawings, in which:

FIG. 1 is an elevational view of a typical water craft with my new propulsion means related to it;

FIG. 2 is an enlarged detailed longitudinal sectional view of the propulsion pod that I provide;

FIG. 3 is a rear end view of the pod taken as indicated by line 3—3 on FIG. 2; and,

FIG. 4 is a longitudinal view of a portion of another form of my invention with portions shown in section.

The water propulsion means that I provide is adapted to be related to a water craft A and includes generally, a prime mover B, such as an internal combustion engine, arranged within the craft, a pump C, such as a centrifugal pump, within the craft and driven by the prime mover and a propulsion pod D fixed to the bottom **10** of the craft and connected with the inlet and outlet sides **11** and **12** of the pump. In practice, a suitable valve means V can be provided between the pod D and pump C to control the flow of water through the means.

Since the craft A, prime mover B, pump C and valve means V can vary widely without affecting the novelty of this invention, I have elected to illustrate these parts and/or portions of the propulsion means in a general or diagrammatic manner and will not burden this disclosure with further unnecessary detailed description thereof.

The pod D that I provide is an elongate unitary structure and includes an elongate, horizontally extending barrel **20**, cylindrical in cross-section and fixed to the bottom **10** of the craft A by means of a flat mounting plate **21**. The mounting plate **21** is, in practice, formed integrally with the barrel at the upper side thereof. The mounting plate **21** is fixed to the bottom of the craft by suitable fasteners **22**.

The barrel **20** is arranged below the bottom of the craft with its longitudinal axis extending parallel with the longitudinal axis of the craft and so that it has or defines front and rear ends.

The barrel **20** has a central longitudinal flow passage **23** and a contoured or cambered exterior surface **24**. The interior surface of the flow passage **23** and the contoured exterior surface **24** of the barrel cooperate to define an annular foil, the cross-section of which is similar to a modified Clark "Y" airfoil, the function of which will be later described.

The flow passage **23** opens forwardly, is straight and unobstructed throughout its longitudinal extent and is connected at its rear end with a reduced rearwardly extending, rearwardly opening venturi secondary nozzle **25**.

In practice, the nozzle **25** can be in the nature of an extension formed integrally with and continuing rearwardly from the structure defining the flow passage **23**.

The forward end portion of the barrel is provided with an annular forwardly and radially outwardly opening channel defining an inlet scoop **26**. The scoop **26** has a substantially flat rearwardly and upwardly inclined rear wall of surface **27** upon which water rushing rearwardly into the scoop impinges. The inclined surface **27** directs the water impinging upon it upwardly and rearwardly in the scoop. The scoop **26** is further defined by a radially outwardly disposed annular side surface **28** extending forwardly from the inner periphery of the surface **27**, to the forward end of the barrel and about the forward portion of the flow passage **23**.

The surface **28** can, as illustrated, be cambered longitudinally so that the cross-section of the portion of the pod defining the surface **28** and forward end of the flow passage **23** is a Clark "Y" type foil which serves to induce and control the flow of water into the scoop.

An inlet or suction pipe **29** communicates with the upper rear portion of the scoop, adjacent the rear surface thereof and extends upwardly through the barrel, mounting plate **21**, and opening **30** provided in the bottom **10** of the craft A and, thence, into the interior of the craft where it is suitably connected with the inlet **11** of the pump C or the valve means V as by means of a suction hose **31**.

In addition to the foregoing, the pod D is provided with a primary nozzle **32** concentric with and opening rearwardly at the rear end of the flow passage **23**, forward of the open rear end of the secondary nozzle **25**.

The nozzle **32** is connected with and receives water from a downwardly and rearwardly turned delivery pipe **33**, which pipe extends downwardly from within the craft A, through the opening **30** in the bottom **10** of the craft and, thence, through the pod and into the flow passage therein. The upper end of the pipe **33** occurring within the craft A is suitably connected with the pump C or with the valve means V by means a suitable delivery hose **34**.

In practice, a suitable faring member **35** can be provided at and about that a portion of the pipe **33** extending radially through the flow passage **23** to materially reduce any adverse turbulence and interference with the free flow of water through the passage, caused by the presence of the pipe **33** therein.

Finally, and in addition to the foregoing, the pod D is provided with an elongate, annular flow augmenting venturi sleeve or ring **36** concentric with the central longitudinal axis of the barrel and arranged at the rear end of the barrel with its forwardly opening front end portion occurring in radial spaced relationship about the secondary nozzle **25** and/or rear end portion of the barrel in radial spaced relationship therefrom and with its rearwardly opening rear end portion extending rearwardly from or beyond the rear end of the nozzle **25**.

The flow augmenting venturi sleeve has a radially inwardly and rearwardly convergent, curved, flow accelerating flow passage **37** and a contoured or cambered exterior surface **38**. The exterior surface **38** is contoured so as to streamline the sleeve and so that a minimum resistance to the free flow of water axially rearwardly about the sleeve is generated.

The sleeve **36** is supported and carried by a central, longitudinally extending, vertical vane-like web **39** depending downwardly from the mounting plate **21** and rearwardly from the rear portion of the barrel, as clearly illustrated in the drawings.

If necessary, or desired, additional, circumferentially spaced support webs can be provided between the rear portion of the barrel and the ring, and, if desired, the web **39** can be eliminated altogether and the sleeve can be supported by circumfrentially spaced webs between the rear end portion of the barrel and the sleeve, as illustrated at **39'** in FIG. 4 of the drawings.

If desired, suitable guard means **40** can be provided at the forward end of the pod to prevent foreign matter which might plug or clog the construction from entering the forward ends of the inlet scoop and flow passage. In the case illustrated, the means **40** is shown as involving four circumferentially spaced, radially inwardly and forwardly convergent metal deflecting bars **41**, the rear ends of which are fixed to the forward outer end portion of the barrel at or adjacent to the outer forward edge of the scoop **26**.

In operation, the pump C is driven by the motor B and water is drawn rearwardly into the scoop **26**, through the suction **29** and into the pump. The water discharged from the pump is conducted downwardly through the pipe **33** and rearwardly into the nozzle **32**. The nozzle **32** directs a high pressure, high velocity primary jet of water rearwardly into and through the secondary venturi nozzle **25**. The primary jet flowing through the venturi nozzle **32** induces flow of water into and rearwardly through the flow passage **23**, which rearward flow of water is accelerated by the venturi nozzle and by the primary jet as it enters the nozzle **25** and joins the primary jet. The waters flowing from the nozzle **32** and through the flow passage **23**, when combined, issue from the secondary nozzle **25** as the secondary jet of considerably greater mass and only slightly less velocity than the primary jet.

The rearwardly flowing column of water drawn into and through the flow passage **23** of the barrel by the primary jet flowing through the secondary nozzle **25** establishes a limited reaction and forward thrust. Further, the primary jet, as it issues from the nozzle **32** creates a reaction and forward thrust. Still further, the secondary jet, as it issues from the nozzle **25**, creates yet another reaction and forward thrust in and through the construction.

The above-noted reactions and thrusts are cumulative.

As the barrel moves forwardly through the water, the ambient water forward of the pod is rammed into and through the flow passage **23**. This ramming of water into and through the flow passage supplements the action of the primary jet and, in effect, supercharges the secondary nozzle **25** and greatly accelerates the velocity of the secondary jet.

The water adjacent to and flowing longitudinally about the exterior surface of the barrel and which is parted from the central rearwardly flowing column of water by the leading edge of the barrel, is forced to flow a greater distance before it reaches the rear end of the barrel and/or nozzle **25** to join with the centrally flowing column of water, now the secondary jet. In doing so and as a result of the modified Clark "Y" foil configuration, several forces come into play. First, a positive pressure is created over and about the forward end portion of the barrel as the water is separated by the annular leading end portion of said barrel. Second, the water, thus displaced, and flowing or rushing rearwardly about the exterior of the barrel is greatly accelerated as it moves rearwardly towards and to the trailing edge of the foil configuration, that is, to the rear end of the barrel and/or nozzle **25**. Third, a negative pressure is created in the ambient waters about the rear portion of the barrel by the noted accelerated flow of water and, as a result thereof, additional water is drawn into and joins the noted slip-stream of water about the exterior of the barrel. Fourth, the point or area of greatest impact pressure is over and about the forward end portion and/or leading edge of the barrel, and a positive pressure is created about the inlet of the inlet scoop **26**, which pressure is picked up by the inlet scoop and serves to supplement and, in effect, supercharge the pump C.

The water flowing into the inlet scoop **26** is further accelerated by the modified Clark "Y" configuration established by the surface **28** thereof. The accelerated flow of water in the scoop, upon impinging on the upwardly and rearwardly inclined rear surface **27** of the scoop, is effectively forced upwardly and into the suction pipe **29**.

The secondary jet issuing from the nozzle **25** and the

rear end of the barrel is directed centrally into and rearwardly through the rear portion of the flow augmenting venturi sleeve **36**. At the same time, the accelerated flow stream about the exterior of the barrel and the additional waters picked up by it enter the forward end portion of the sleeve **36** and flow rearwardly therethrough to be accelerated thereby and to join the secondary jet in the rear portion thereof. The waters flowing into and through the sleeve **36** combine to establish one forcefully directed jet of materially greater mass and only slightly less velocity than the secondary jet issuing from the rear end of the sleeve. The force of this third or final jet exerts an equal and opposite force onto and through the pod construction to thrust the pod construction and the craft with which it is related, forwardly.

From the foregoing, it will be apparent that the pod construction is such that a large volume and massive flow of water is effectively and efficiently moved and directed with a relatively small high velocity primary jet of water and in such a manner that the work energy of the primary jet is most efficiently and effectively converted to reactive forces tending to propel the construction forwardly through the water.

In the form of the invention shown in FIGS. 1, 2 and 3 of the drawings, the pod D is mounted in fixed position on the craft A. Accordingly, the craft is provided with a rudder **50**, rearward of the discharge end of the pod to deflect the jet stream issuing from the pod in such a manner as to control the direction of the craft.

Since the pod D is fixed relative to the craft, it can only serve to propel the craft forwardly when functioning in a normal manner.

In order to move or propel the boat rearwardly, I provide the valve means V noted above. The valve means V is such that the direction of flow into and out of the pipes **29** and **33** of the pod construction can be reversed. By reversing the flow through the pipes **29** and **33**, by means of the valve V, the pipe **33** becomes a suction pipe and the pipe **29** becomes a delivery pipe, directing a high pressure stream of water into the scoop **26**, which water flows forwardly out of the scoop to thrust and propel the structure rearwardly.

The above-noted reverse flow is extremely inefficient, but is adequate to provide necessary maneuverability of the craft.

In the form of the invention illustrated in FIG. 4 of the drawings, the pod D' is swivally or rotatably mounted on the bottom **10'** of the craft A' by means of a suitable sealed swivel mounting means **60**. With such a mounting means the direction of the craft can be advantageously controlled by simply turning the pod, and a rudder, such as is required in connection with the first form of the invention, is not required. Further, in the second form of the invention, the pod can be turned 180° to effect rearward propulsion of the craft. Accordingly, a valve means, such as referred to above, need not be provided.

The second form of the invention, illustrated in FIG. 4 of the drawings, further distinguishes from the first form of the invention by terminating the forward end of the central flow passage **23'** in the barrel rearward of the forward end of the barrel and arranging the inlet scoop **26'** within the forward end of the barrel so that it opens forwardly and radially inwardly, rather than radially outwardly, as in the first form of the invention.

With such a relationship of parts, it is necessary that the opening at the forward end of the barrel be substantially greater in diametric extent than the open forward end of the flow passage and so that the scoop **26'** and the pump will not function to starve the supply of water flowing into and through the flow passage and secondary nozzle of the construction.

The arrangement of the inlet scoop **26'** in this second form of the invention, when the pump is operating, induces the rearward flow of an annular column of water through the forward open end of the barrel and into the scoop. This annular flow of water rearwardly into the scoop induces the rearward flow of a central column of water into and through the flow passage **23'**. Such a function is extremely desirable in those cases where the craft is a relatively slow speed craft and a sufficient ram effect to charge the system, as it moves forwardly through the water, is not established.

It is to be noted that there are no moving parts within the pod and that the structure is, therefore, extremely quiet, smooth, safe-in-operation, and can be advantageously used in any and all situations where such characteristics or features are deemed necessary and/or desirable.

While I have restricted this disclosure to a structure applicable to a vessel or boat for the purpose of preferably the boat, it is to be understood and it will be apparent that the structure can be employed to propel, agitate and mix with liquids along a pipeline, conduit or canal, or within a tank or vat by simply mounting the pod in the flow path within such liquid conducting means or within a tank, or the like.

Having described my invention, I claim:

1. In combination, an elongate water craft with front and rear ends, a bottom and an interior, a prime mover in the interior of the craft, a pump with inlets and outlets in the interior of the craft and driven by the prime mover and an elongate, submersible propulsion pod with front and rear ends mounted on the bottom of the craft to occur in water therebelow and connection with the pump, said pod including an elongate cylindrical barrel with a forwardly opening central longitudinal flow passage, an inlet scoop at the forward end of the barrel and occurring radially outward from the flow passage, a suction pipe between the scoop and the inlet of the pump, a rearwardly directed primary nozzle arranged centrally of the flow passage at the rear end thereof, a delivery pipe between the outlet of the pump and the primary nozzle, a secondary venturi nozzle concentric with and continuing rearwardly from the flow passage and primary nozzle and having a rear discharge end smaller than the flow passage and larger than the primary nozzle and an elongate flow augmenting venturi sleeve concentric with and larger in diameter than the rear end of the barrel and having a forwardly opening forward portion in radial spaced relationship about the rear end portion of the barrel and the secondary nozzle and a rearwardly opening rear portion extending rearwardly from the secondary nozzle.

2. A structure as set forth in claim **1** wherein said inlet scoop is an annular forwardly and radially outwardly opening scoop formed in the forward end portion of the barrel.

3. A structure as set forth in claim **1** wherein said scoop is an annular forwardly and radially inwardly opening scoop formed in the inner end portion of the barrel.

4. A structure as set forth in claim **1** wherein said inlet scoop is an annular forwardly and radially outwardly opening scoop formed in the forward end portion of the barrel, said scoop having a substantially flat, rearwardly and upwardly inclined back surface and a substantially radially outwardly disposed inner side surface, said suction pipe communicating with the scoop adjacent the upper rear portion of the rear surface.

5. A structure as set forth in claim **1** including, an opening in the bottom of the craft, mounting means mounting the pod to the bottom of the craft and overlying the opening, said pipes extending from the barrel upwardly through the mounting means and into the interior of the craft to connect with the pump.

6. A structure as set forth in claim **1** including, an opening in the bottom of the craft, mounting means mounting the pod to the bottom of the craft and overlying the opening, said pipes extending from the barrel upwardly through the mounting means and into the interior of the craft to connect with the pump, said mounting

means being a sealed swivel structure pivotally supporting the pod for free rotation in excess of 180° about a vertical axis.

7. A structure as set forth in claim 1 including, an opening in the bottom of the craft, mounting means mounting the pod to the bottom of the craft and overlying the opening, said pipes extending from the barrel upwardly through the mounting means and into the interior of the craft to connect with the pump, said inlet scoop being an annular forwardly and radially outwardly opening scoop formed in the forward end portion of the barrel.

8. A structure as set forth in claim 1 including, an opening in the bottom of the craft, mounting means mounting the pod to the bottom of the craft and overlying the opening, said pipes extending from the barrel upwardly through the mounting means and into the interior of the craft to connect with the pump, said mounting means being a sealed swivel structure pivotally supporting the pod for free rotation in excess of 180° about a vertical axis, said inlet scoop being an annular forwardly and radially outwardly opening scoop formed in the forward end portion of the barrel.

9. A structure as set forth in claim 1 including, an opening in the bottom of the craft, mounting means mounting the pod to the bottom of the craft and overlying the opening, said pipes extending from the barrel upwardly through the mounting means and into the interior of the craft to connect with the pump, said inlet scoop being an annular forwardly and radially outwardly opening scoop formed in the forward end portion of the barrel, said scoop having a substantially flat, rearwardly and upwardly inclined back surface and a substantially radially outwardly disposed inner side surface, said suction pipe communicating with the scoop adjacent the upper rear portion of the rear surface.

10. A structure as set forth in claim 1 including, an opening in the bottom of the craft, mounting means mounting the pod to the bottom of the craft and overlying the opening, said pipes extending from the barrel upwardly through the mounting means and into the interior of the craft to connect with the pump, said mounting means being a sealed swivel structure pivotally supporting the pod for free rotation in excess of 180° about a vertical axis, said inlet scoop being an annular forwardly and radially outwardly opening scoop formed in the forward end portion of the barrel, said scoop having a substantially flat, rearwardly and upwardly inclined back surface and a substantially radially outwardly disposed inner side surface, said suction pipe communicating with the scoop adjacent the upper rear portion of the rear surface.

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103—262; 115—12, 14; 239—265.17, 265.19