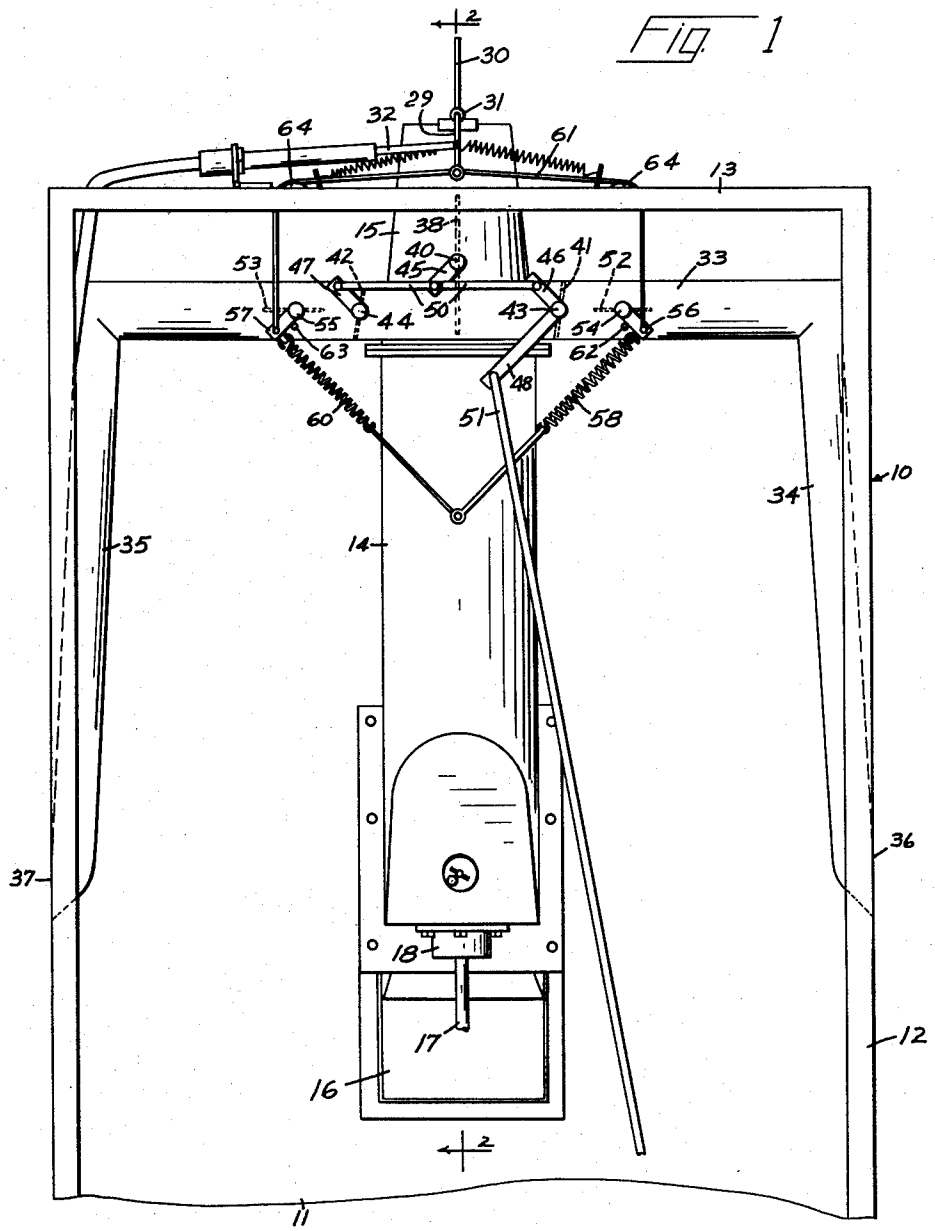
Jan. 7, 1964 C. J. DAHLE 3,116,602

HYDROJET POWER UNIT FOR BOATS WITH POWER REVERSE PROPULSION

Filed May 8, 1961 4 Sheets-Sheet 1

Fig. 1



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HYDROJET POWER UNIT FOR BOATS WITH POWER REVERSE PROPULSION

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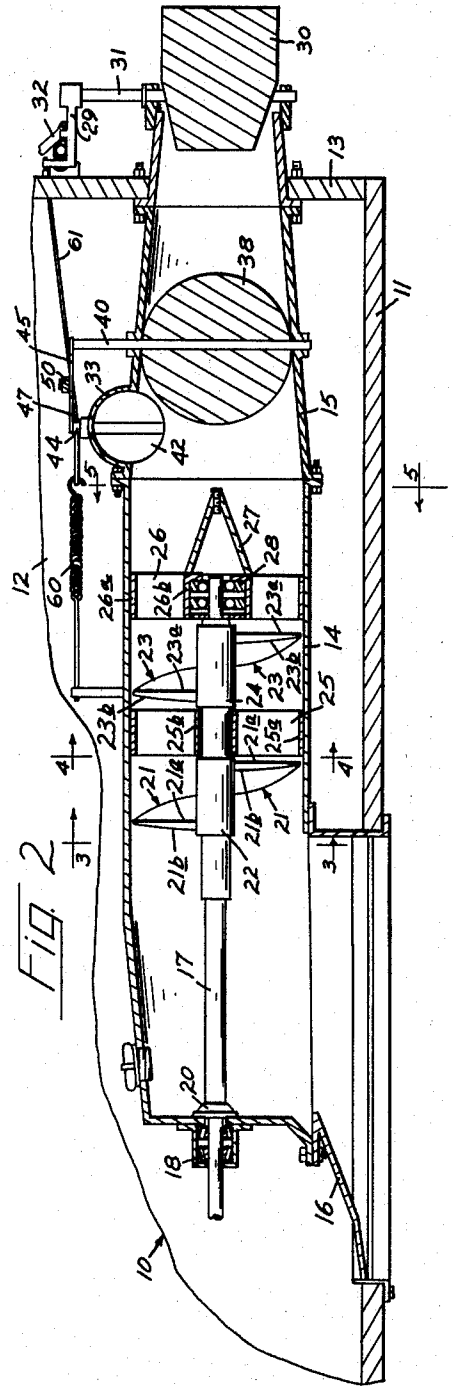


Fig. 2

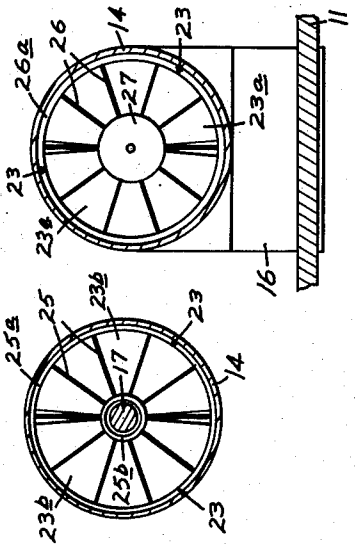


Fig. 5

Fig. 4

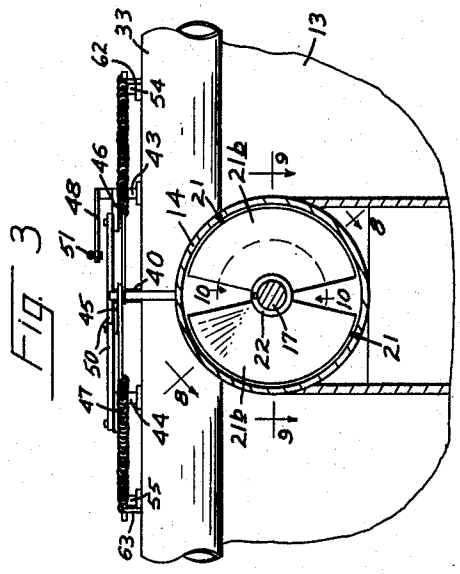


Fig. 3

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HYDROJET POWER UNIT FOR BOATS WITH POWER REVERSE PROPULSION

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Fig. 6

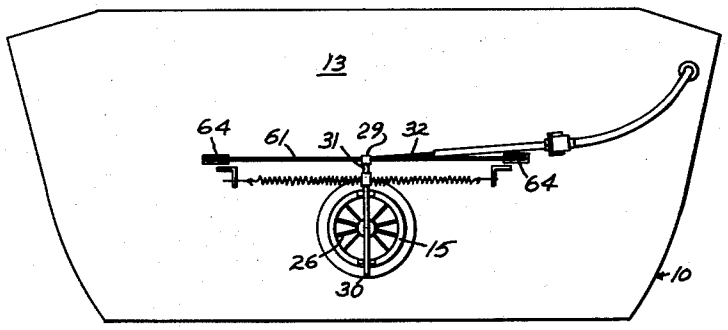


Fig. 7

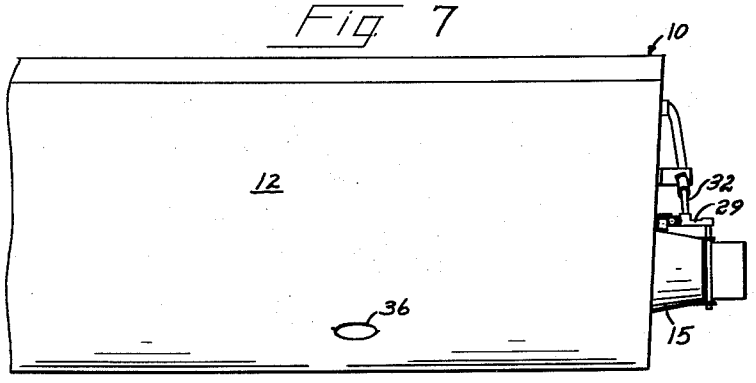


Fig. 8

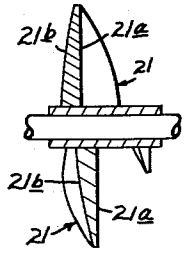


Fig. 9

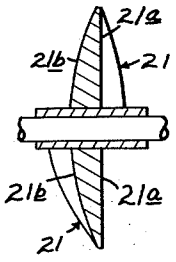
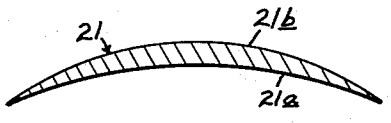


Fig. 10



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HYDROJET POWER UNIT FOR BOATS WITH POWER REVERSE PROPULSION

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Fig. 11

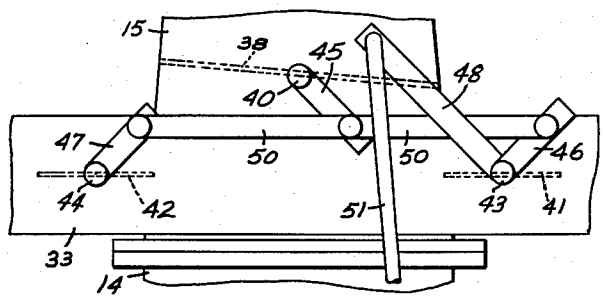


Fig. 12

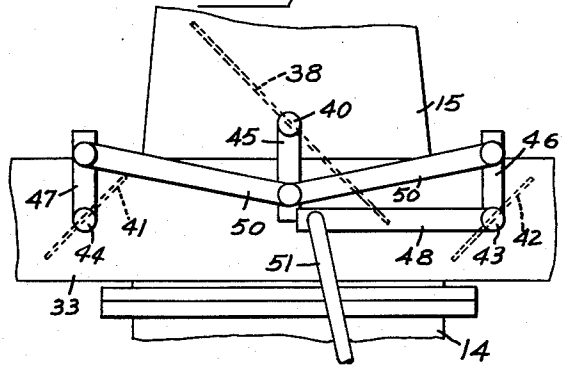
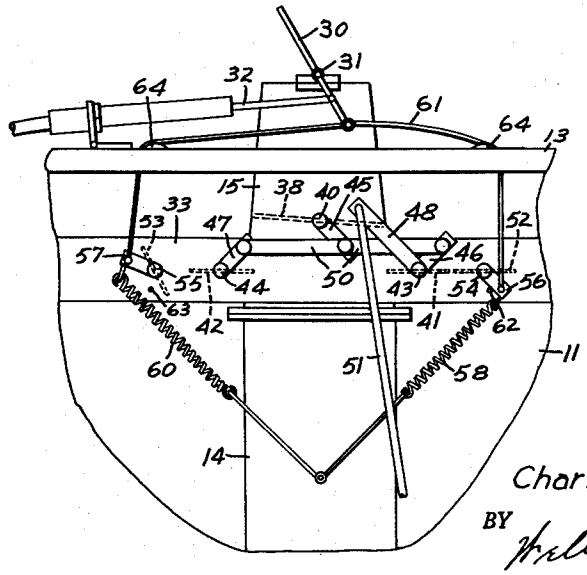


Fig. 13



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United States Patent Office 3,116,602
Patented Jan. 7, 1964

3,116,602

HYDROJET POWER UNIT FOR BOATS WITH POWER REVERSE PROPULSION

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Filed May 8, 1961, Ser. No. 108,558
1 Claim. (Cl. 60—35.54)

This invention relates to a hydrojet power unit for boats and includes a reversing power system.

The present invention is an improvement over the propulsion and steering unit described in my co-pending application, now Patent No. 3,040,696, granted June 26, 1962, for Propulsion and Steering Unit for Boats. In that application was shown a practical version of a hydrojet unit wherein water was taken in along the keel line of the boat and forcibly ejected in a rearward direction through the transom to provide a driving force for the boat. In this prior application is shown a pair of full circle auger impeller units which are used to drive the water through a cylindrical shell. The present invention contemplates an improved form of impeller blades to be used in this earlier combination. It also contemplates revision of the fixed guide vanes which limit movement of the water to an axial direction. It further adds a reverse power unit so as to enable the operator of the boat to operate it in a reverse direction and to steer the boat while utilizing this reverse operation.

It is a first object of this invention to provide a novel impeller blade for use in this combination, which blade will better utilize the two stage impeller system desired in this unit. In order to accomplish this object smaller arcuate blades are used in the impeller unit adjacent the water intake than are used in the second stage impeller unit placed rearwardly of the first unit. In this way water is allowed to be pulled past the first unit by the action of the blades in the second impeller unit.

It is another object of the present invention to provide a blade having an improved profile which increases the efficiency and lessens the turbulence of the water being pulled through the hydrojet unit.

It is another object of this invention to provide a reversible power unit adapted to be mounted on the hydrojet unit so as to enable the operator to reverse the direction of the exhausted water so as to drive the boat in a reverse direction.

Another object of the invention is to provide such a reversing drive which can be operated by a single control lever. The controls for the reverse drive further includes steering controls linked with the normal boat steering mechanism. The steering of the boat in reverse drive is thus identical to the operation involved in normally steering the boat in a forward direction.

These and further objects will be obvious from a study of the following disclosure which illustrates a preferred improved form of the invention. It is to be understood that this form is merely exemplary and illustrates the invention while not limiting or defining it. The invention is to be restricted only by the disclosure of the claim which follows.

In the drawings,

FIGURE 1 is a top view of the rear section of a boat equipped with the instant propulsion unit;

FIGURE 2 is a sectional view taken along line **2—2** in FIGURE 1;

FIGURE 3 is a sectional view taken along line **3—3** in FIGURE 2;

FIGURE 4 is a sectional view through the propulsion unit taken along line **4—4** in FIGURE 2;

FIGURE 5 is a sectional view taken along line **5—5** in FIGURE 2;

FIGURE 6 is a rear elevational view of the boat as seen in FIGURE 1;

FIGURE 7 is a side elevational view of the boat seen in FIGURE 1;

FIGURE 8 is a sectional view through an impeller blade taken along line **8—8** in FIGURE 3;

FIGURE 9 is another sectional view through an impeller blade as seen along line **9—9** in FIGURE 3;

FIGURE 10 is a projected view along an arcuate line shown as **10—10** in FIGURE 3 and designed to show the relative curvatures of the blade surfaces;

FIGURE 11 is a fragmentary top view of the reversing unit as seen in FIGURE 1 with the unit in position for reverse drive of the boat;

FIGURE 12 is a view similar to FIGURE 11 with the drive control in a neutral position; and

FIGURE 13 is a fragmentary top view of the rudder and reversing assembly, showing the steering control utilized in reverse drive.

This invention relates to several improvements formulated with regard to the propulsion unit shown and described in detail in my above cited pending application. The basic operation of the unit remains identical to that described in this earlier description. Many parts of the unit remain unchanged and will not be described in further detail herein. The present invention reflects improvements in the impeller blades, in the guide vanes, in the tail bearing structure and in the directional control for the unit. In the last instance, a totally new reversing mechanism has been added to the unit which was previously only usable in a forward direction.

Referring now to FIGURES 1, 2, 6 and 7, the general scheme of the unit will be described. The propulsion unit is shown mounted upon a boat hull **10**, including the bottom **11**, adjacent sides **12** and the vertical rear transom **13**. The propulsion unit itself is mounted within a cylindrical metal housing **14** which is positioned in a longitudinal direction along the keel of the boat. Mounted at the rear of the cylindrical housing **14** and forming a part thereof is a nozzle section **15**. The nozzle section **15** is suitably fastened to the main body of the housing **14** and protrudes through a sealed aperture cut through the transom **13** so as to extend beyond the normal length of boat hull **10**. At the forward end of the housing **14** is mounted a grill box **16**, identical to that previously shown in my co-pending application. The grill box **16** is adapted to be secured from the exterior of the boat and is sealed within an aperture cut through the bottom **11**. The box **16** is hydraulically opened to the forward section of the housing **14** and is suitably fastened thereto. Thus water drawn through the grill box **16** can be passed through the housing **14**, including the nozzle section **15**, and can be ejected through the open rear end of the nozzle section **15** to thereby propel the boat hull **10** in a forward direction.

Rotatably mounted within the housing **14** is an axial impeller shaft **17**. The shaft **17** extends forwardly beyond the housing **14** and may be suitably driven by a conventional motor equipped with or without a clutch or transmission, as may be desired. The shaft **17** is rotatably journalled by front bearings **18** which are exteriorly mounted on the front end of the housing **14**. The bearings **18** are sealed from the interior of the housing **14** by a suitable packing gland **20**. Mounted at the opening from the grill box **16** and fixed relative to the impeller shaft **17** are two blades **21** which form the first impeller unit. These blades **21** are formed on a hub **22** which is suitably keyed to the shaft **17** so as to rotate as a unit therewith. The blades **21** are spiral auger blades, each of which transcribes an arc having a total arcuate distance of less than 180 degrees. These blades can be seen in FIGURE 3. Thus water can be drawn between the two blades **21**, although the majority of water area encountered by blades **21** will be axially pushed there-

by. Mounted directly rearward of the first blades **21** are a pair of second blades **23** which form the second impeller unit. The blades **23** are formed on a hub **24** which also is suitably keyed to the shaft **17**. The arc circumscribed by each of the blades **23** is greater than that circumscribed by the blades **21**. This may be seen in FIGURE 4. Each of the blades **23** is almost 180 degrees about the center of shaft **17** so that substantially all the water area encountered by blades **23** is axially moved along the longitudinal direction of the cylindrical housing **14**.

Interposed between the blades **21** and the blades **23** is a first stationary guide vane unit. The guide vanes **25** are formed within an outer ring **25***a* and an inner ring **25***b*. The two rings **25***a* and **25***b* are split so as to be positioned about the shaft **17**. The outer ring **25***a* is secured to the housing **14** by any suitable means such as welding or releasable bolts. Mounted directly rearward of the second blades **23** is a second set of guides **26**. The guide vanes **26** extend in a radial manner similar to the guide vanes **25**. The final guide vanes **26** are bounded by an outer ring **26***a* and an inner ring **26***b*, within which the tail bearings **28** are housed. The tail bearings **28** are mounted within a sealed grease housing **27** which tapers rearwardly so as to lessen water turbulence. The tail bearings **28** serve to rotatably position the rear end of the impeller shaft **17** and to accurately position the two sets of blades **21** and **23** within the housing **14**.

The contour of the blades **21** and **23** is extremely important. These blades contours must be formed so as to minimize water turbulence while providing an effective axial push on the volume of water transmitted through the housing **14**. In order to accomplish these results the blade contours are formed as shown in FIGURES 8 through 10. Each blade **21** or **23** has a vertical rear surface **21***a* or **23***a*. This surface is spiralled about the axis of shaft **17** to the desired arcuate extremes. Each blade **21—23** also includes a tapered forward surface **21***b* or **23***b*. These surfaces are tapered outwardly from the hubs **22** or **24** to form a relatively thin outer radial edge adjacent the interior surface of the housing **14**. The thickness of the blades **21—23** also decreases arcuately from their arcuate centers to their outer radial edges. This can be seen in FIGURE 10 which illustrates the fact that the forward surface **21***b* of a blade **21** has a greater convexity relative to the concavity of the rear surface **21***a*. Thus the blades **21—23** are formed with thick central hub areas which taper both radially and arcuately to their extreme edges which are formed in a quite thin fashion. This blade form reduces turbulence in the water by providing a relatively thin meeting edge which extends to a strengthened middle blade area for maximum strength, while also serving further to compress water pushed by the rotating blades **21** and **23**.

The fact that the first blades **21** are less long circumferentially than the second blades **23** provides additional thrust in the unit as a whole. The blades **23** can thus draw the water past the first blades **21** to thereby add to the total thrust exerted on escaping water ejected through the nozzle section **15**. Thus both blades **21** and both blades **23** are fully utilized to move a total volume of water through the interior of the housing **14**. This actually reduces the incidence of vacuum pockets forming within the housing **14** and reduces turbulence throughout the entire unit.

Normal forward steering of this unit is provided by a rudder **30** which extends partially within the nozzle section **15**. The rudder **30** is fixed to a rudder post **31** rotatably journalled on the nozzle section **15**. The post **31** is moved by means of a crank arm **29** and by a control cable **32** which is suitably moved from the interior of the boat hull **10**. In forward operation the rudder **30** is maintained in a straight longitudinal position as shown in FIGURE 1. To turn the boat in either direction the cable **32** is moved to pivot the rudder post **31** and thereby block a portion of the nozzle section **15** and deflect the remaining water volume ejected through the housing **14** and nozzle section **15**. This portion of the steering arrangement is identical to that described in my co-pending application.

Since the instant unit is designed primarily for use in rivers and shallow locations where a low total draft is desirable, the maneuverability of the boat hull **10** is further enhanced by the provision of a reversing mechanism. In order to accomplish this result the instant unit is shown provided with a perpendicular tube **33** fixed to the forward end of the nozzle section **15** and open thereto. The tube **33** is formed integrally with a pair of forward projecting extensions **34** and **35** which open to apertures **36** and **37** sealed through the sides **12** of the boat on either side adjacent the housing **14**. Thus water ejected through the tube **33** will be directed outwardly to the apertures **36** and **37** in a susbtantially forward direction to thereby propel the boat hull **10** in a rearward direction.

The control of water flow through the nozzle section **15** and tube **33** is governed by three vertical butterfly valves. A central large valve **38** is mounted in the nozzle section **15** directly rearward of the opening of tube **33** to the nozzle section **15**. The valve **38** is fixed to a pivot shaft **40** which in turn is suitably journalled for rotation about a vertical axis by the nozzle section **15**. The two sides of tube **33** are selectively sealed by side valves **41**, **42**, which are respectively fixed on pivot shafts **43**, **44** which in turn are rotatably mounted by the tube **33** for rotation about vertical axes. Thus closing of the valves **41**, **42** will prevent entry of water into the tube **33**, while closing of the valve **38** will prevent the issuance of water through the nozzle section **15**.

In order to interrelate the positions of these three valves **38**, **41** and **42**, a combined control system is provided. The pivot shaft **40** is provided with a crank arm **45** at the top end thereof and the two pivot shafts **43** and **44** are respectively provided with crank arms **46** and **47**. These three arms **45**, **46** and **47** are pivotally joined by a common connecting link **50**. The connecting link **50** can thus rotate all three valves **38**, **41** and **42** simultaneously. An operating arm **48** is fixed to the crank arm **46** and provides the necessary leverage for remote movement of the three pivot shafts **40**, **43** and **44**. The arm **48** is moved by a suitable operating rod **51** which is connected to its outer end. The operating rod **51** extends forwardly along the boat hull **10** to any suitable conventional mechanism adapted to reciprocate it in a longitudinal direction. Any common lever system would be suitable. The rod **51** is shown in FIGURE 1 in its forward position with the valve **38** wide open and the two side valves **41** and **42** completely closed. Thus the total volume of water moved through the housing **14** will be ejected through the nozzle section **15**. At the opposite extreme is the condition shown in FIGURE 11 wherein valve **38** has been closed and valves **41** and **42** have been opened by rearward movement of the rod **51**. In this condition no water will be ejected through the nozzle section **15** and the total water volume will be ejected through the side apertures **36** and **37**. Between these two extreme positions the rod **51** may be positioned as desired so as to modulate the boat's speed or to provide a neutral condition by partially opening all three valves **38**, **41** and **42**. Such a neutral position is illustrated in FIGURE 12, with the rod **51** in a position intermediate that shown in FIGURE 1 or 11.

In order to further add to the maneuverability of a boat equipped with this propulsion unit, reverse steering has been provided in the illustrated embodiment. This steering is accomplished by a pair of side steering valves **52** and **53**, positioned adjacent the side valves **41** and **42** respectively within the tube **33**. The valves **52** and **53** are identical in structure to the valves **41** and **42** and are fixed to pivot shafts **54** and **55** respectively. The

shafts **54** and **55** are capped by two crank arms **56** and **57**. The two arms **56** and **57** are biased against stops **62** and **63** by tension springs **58** and **60** respectively. The remaining ends of the springs **58** and **60** are fastened to the top center of the housing **14**. The stops **62** and **63** are fixed to the outer surface of the tube **33**. Thus the springs **58** and **60** maintain the two steering valves **52** and **53** in a normally fully open position. The two crank arms **56** and **57** are connected to the rear end of the rudder arm **29** by means of a cable **61** which is threaded through the transom **13** and guided by pulleys **64**. As can be seen in FIGURE 13 the valves **52** and **53** are operated in conjunction with the rudder **30** by the control cable **32**. In FIGURE 13 the control cable **32** is shown in a position which would normally direct the boat to the right in a forward direction in the absence of the reverse propulsion means described above. With the valve **38** opened and the boat being projected in a forward direction the valves **52** and **53** would operate but would be of no importance since no water would be flowing past the side valves **41** and **42**. If the valves **41** and **42** are opened, as when the boat is being driven in a reverse direction, movement of the rudder **30** will close one of the valves **52** or **53** and thereby restrict the flow of water through one of the extensions **34** or **35**. This will propel the boat to one side or the other. The direction of travel will be opposite to that attained during forward drive. However, the turning moment exerted on the boat hull **10** will be the same so that movement of the boat will not be resisted by the rudder **30**. The valves **52** and **53** will operate in conjunction with the rudder **30** to provide a total steering control during intermediate positioning of the rod **51** between the neutral position shown in FIGURE 12 and the two extreme positions shown in FIGURES 1 and 11.

Thus the improved hydrojet unit described in the above specification provides a more efficient impeller mechanism at a lower cost due to the savings in materials over a full 360 degree arbor blade. It also provides a greater efficiency and load distribution between the two impeller units. It reduces turbulence and increases the volume capacity of the impeller units. The hydrojet unit also embodies a workable reversing drive, utilizing a simple mechanism to great advantage. The reversing mechanism shown is particularly well adapted for the hydrojet unit as described and combines therewith to provide a fully maneuverable power and steering unit. Various modifications may occur to one skilled in this field without deviating from the basic concepts described above. For this reason the invention is to be limited only by the following claim.

Having thus described my invention, I claim:

In a propulsion unit for boats having a cylindrical

housing mounted on the boat hull with a water inlet formed through the hull in connection with the forward end of said housing, said housing including a rear nozzle extending through the boat transom, and impeller means mounted within said housing:

a reversing mechanism, comprising:

a pair of hollow tubes opening to said housing rearward of said impeller means and forward of the nozzle opening, each of said tubes extending transversely from said housing and terminating in a forwardly directed opening formed through the boat hull above the water line adjacent said housing and at each side thereof;

a first butterfly valve located within said housing rearwardly of the openings of said tubes to said housing, said first valve being adapted to selectively prevent flow of water through said nozzle;

second and third butterfly valves located respectively within said pair of tubes adjacent said housing, said second and third valves being adapted to selectively prevent flow of water through said tubes;

a manual control linking said first, second and third valves adapted to simultaneously operate said valves to selectively open said first valve and close said second and third valves or to close said first valve and open said second and third valves, or to attain an intermediate setting of the three valves between these two extreme conditions;

fourth and fifth butterfly valves located respectively within said pair of tubes;

and control means linking said fourth and fifth valves to the boat steering controls whereby operation of the steering controls will selectively restrict flow of water through one of said pair of tubes and increase flow through the remaining tube.

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