Sept. 25, 1962 D. E. SINGELMANN 3,055,331

MARINE PROPULSION

Filed Sept. 8, 1961 2 Sheets-Sheet 1

FIG. 1

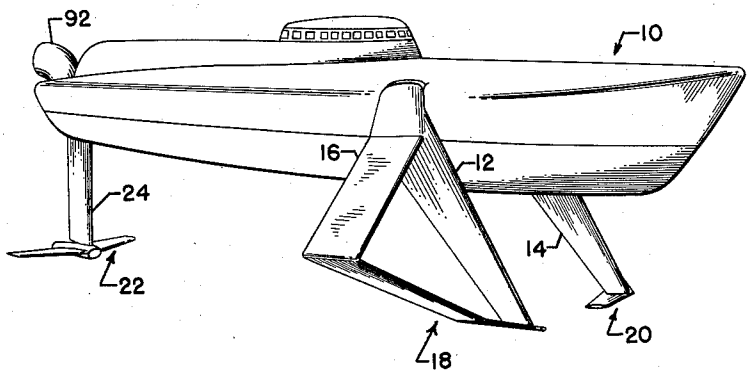

FIG. 2

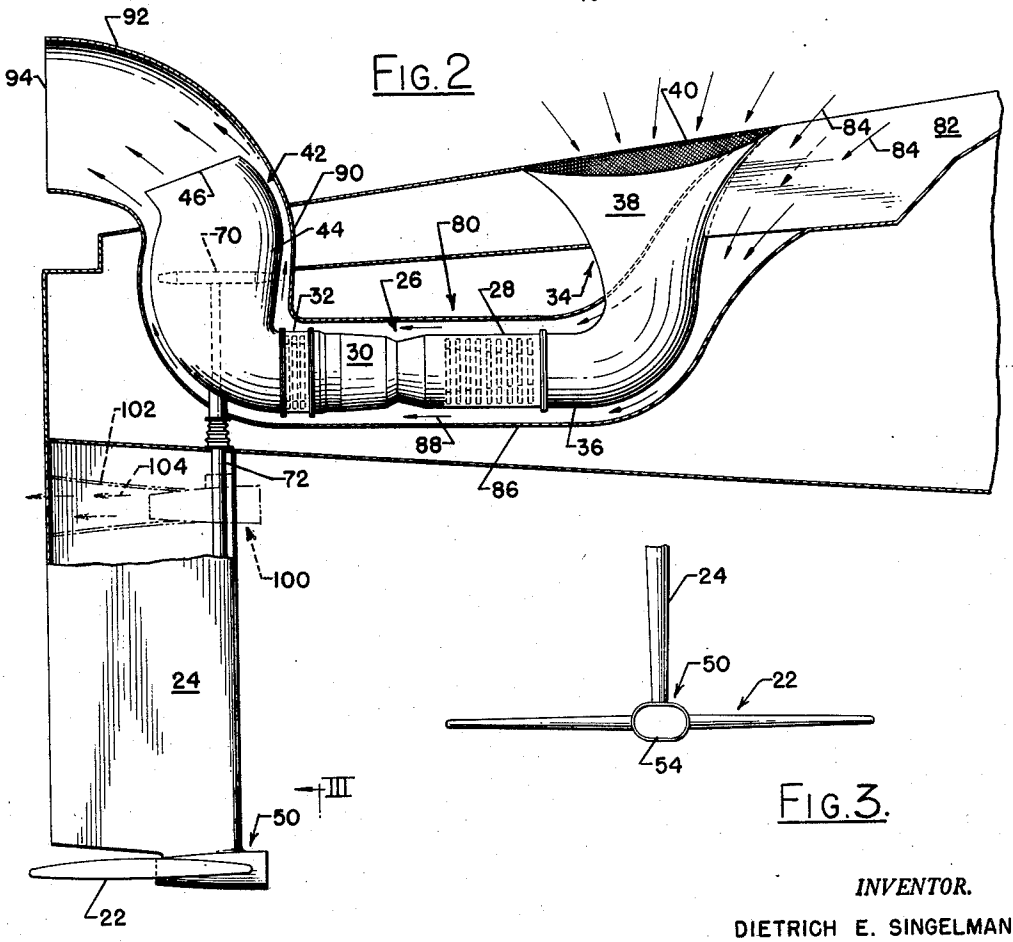

FIG. 3.

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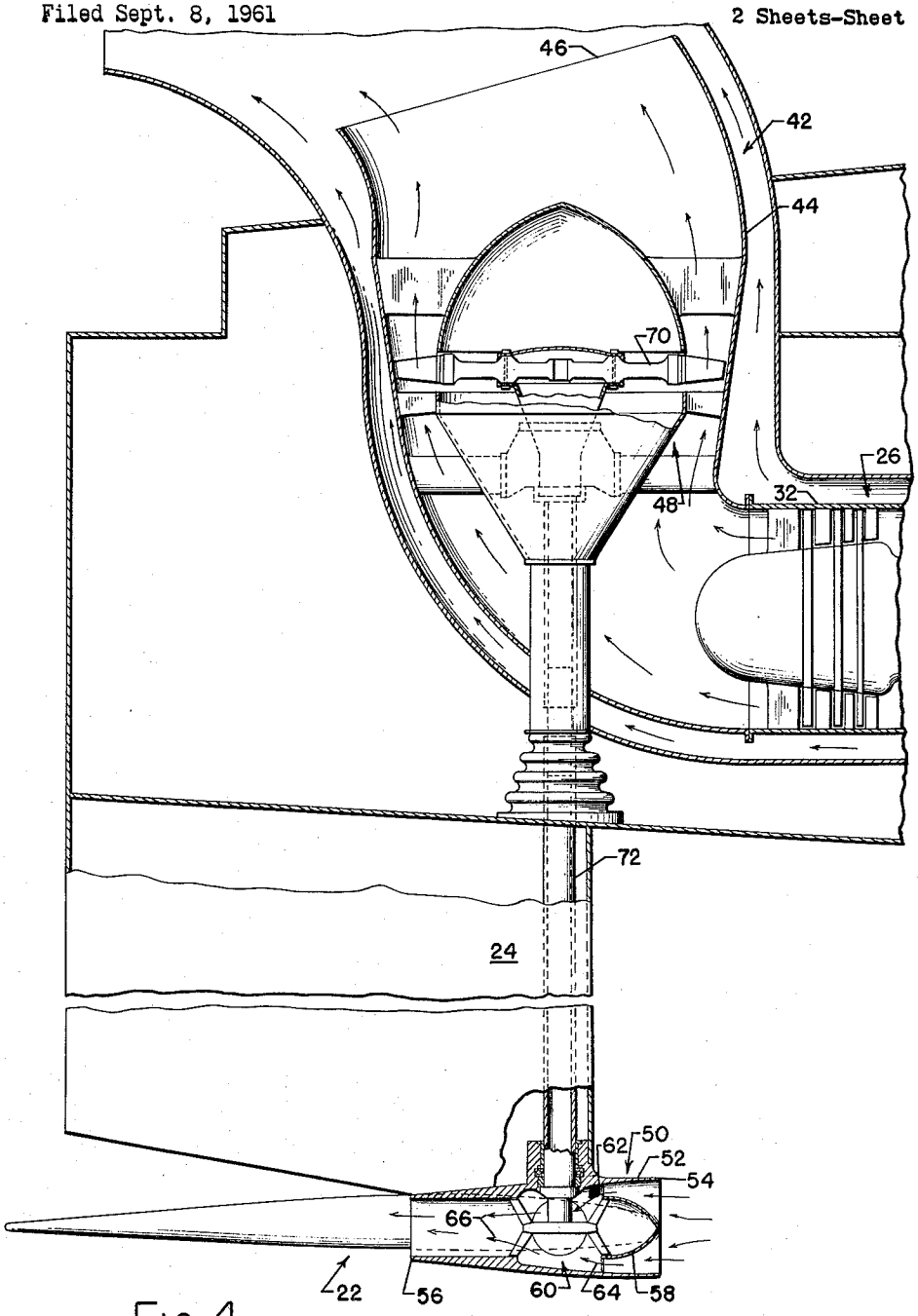

FIG. 4

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MARINE PROPULSION

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8 Claims. (Cl. 114—66.5)

This invention relates to hydrofoil craft and pertains more particularly to means for propelling such craft.

In hydrofoil craft operating in the range of upwards of 100 knots, the use of a jet engine as a means for powering the craft is generally impractical since the small exit area and high exhaust velocity of such engines are very inefficient at speeds much below 400 knots. At the same time, the jet engine is an ideal power plant due to its light weight, simplicity, etc. It is therefore of primary concern in connection with the present invention to retain the primary virtues of a jet engine power plant while achieving, in conjunction therewith, a more efficient driving or propelling system.

More specifically, it is an object of this invention to utilize a jet engine in conjunction with a hydrofoil craft for powering the same but to utilize, in conjunction with such jet engine, means for lowering the exhaust velocity of the propelling system and for increasing its exit area and mass rate of flow so as to render the jet exhaust system more efficient for the speed contemplated, such means at the same time providing additional propulsion or thrust for driving the craft.

Still more specifically, it is an object of this invention to provide a power plant system for hydrofoil craft in conformity with the preceding object wherein such means includes an exhaust turbine driven by the jet engine and a centrifugal propelling pump connected to and driven by the exhaust turbine.

A still more specific object of this invention is to provide a propulsion system of the character described and in conformity with the immediately preceding object wherein such means also includes a ducting system which houses the jet engine but which is provided with an air intake separate from the air intake of the jet engine, the jet engine exhausting within the confines of the ducting system and with the ducting system itself providing the discharge mouth of the propelling system.

Other objects and advantages of the invention will appear from the description hereinbelow and the accompanying drawings wherein:

FIG. 1 is a perspective view of a hydrofoil craft with which the present invention is associated;

FIG. 2 is an enlarged vertical section taken through the aft section of the craft shown in FIG. 1 and illustrating the power plant assembly according to the present invention;

FIG. 3 is an elevational view taken substantially along the plane of section line 3—3 in FIG. 2 showing the intake for the centrifugal propelling pump; and

FIG. 4 is an enlarged vertical section taken through the aft portion of the power plant assembly showing certain constructional details thereof.

Referring at this time more particularly to FIG. 1, the hydrofoil craft as illustrated therein includes a hull designated generally by the reference character **10** provided with depending struts such as those indicated by the reference characters **12** and **14** and additionally by the reference character **16** which support hydrofoil means indicated generally by reference characters **18** and **20**. A tail hydrofoil indicated generally by the reference character **22** is supported by an aft strut **24** substantially as is shown. It is to be understood that the particular configuration and details of the hydrofoil and strut system may be as desired, such not forming per se any part of the present invention.

Referring now to FIG. 2, the power plant in accordance with the present invention will be seen to consist of a jet engine indicated generally by the reference character **26** and itself of conventional form, including a compressor section **28**, a combustion chamber section **30** and a turbine section **32**, it being understood that the turbine **32** is connected to the compressor **28** to impart drive thereto. The compressor **28** is provided with an intake or air inlet horn indicated generally by the reference character **34** which includes a generally horizontally extending stem portion **36** and an upwardly extending and flaring mouth portion **38**. As shown, suitable screen means **40** may be provided to prevent the entrance of foreign material into the jet engine assemblage. The jet engine is also provided with an exhaust horn indicated generally by the reference character **42** which is fixed to the turbine assembly **32** and which is extended generally vertically upwardly therefrom in the main body section **44**, terminating in a rearwardly and upwardly directed discharge mouth portion **46**.

Referring to FIG. 4, it will be seen that an exhaust turbine indicated generally by the reference **48** is housed within the main body portion **44** of the discharge horn **42** for the jet engine. It is to be noted from FIG. 4 also that the main body portion **44** of the discharge horn **42** is aligned vertically above the leading edge of the strut **24** and, more particularly, in vertical alignment with a centrifugal pump assembly indicated generally by the reference character **50** which is fixed to the lower end of the struts **24** substantially as is shown. The centrifugal pump assembly **50** includes a housing **52** having a forwardly directed inlet mouth **54** and a rearwardly directed discharge **56**. The forward part of the housing **52** includes a shroud **58** cooperative with the rotor assembly indicated generally by the reference character **60** so as to provide entrance thereinto as indicated by the arrows **62** and **64** in FIG. 4. The discharge of the pump is indicated by the arrows for example **66** and it is to be understood that the pump is effective to produce a discharge jet of water of relatively high velocity for the purpose of effecting a propulsive force on the craft. To this end, the pump is of the high speed type characterized by the practical absence of cavitation and may be constructed, for example in accordance with the disclosure of application Serial No. 25,254 filed April 28, 1960.

It is to be noted that the rotor **60** is mounted for rotation about an axis coinciding with the axis of rotation of the impeller **70** of the exhaust turbine **48**, there being a drive shaft **72** directly connecting the impeller **70** to the rotor **60**, substantially as is shown. It is to be noted that the effect of the exhaust turbine driving the centrifugal pump is to slow down the velocity of the discharge of the turbine assembly and thus increase its mass rate of flow while at the same time providing an additional propulsive force for the craft.

To further slow down the velocity of the propulsive discharge gases and to effectively increase the exit area, a ducting system indicated generally by the reference character **80**, see particularly FIG. 2, is provided within which the jet engine assembly is housed. This ducting assembly or system is provided withan inlet as at **82** which, it will be noted, is separate from and forwardly displaced relative to the inlet for the jet engine so as to admit of the entrance of air as indicated by the arrows **84** in FIG. 2. It is also to be noted that the main body portion **86** of the ducting system is of considerable greater diameter than the diameter of the jet engine assembly **26** so as to permit of free flow of air therepast as indicated by the arrows **88** for example. The ducting system terminates in an upwardly extending portion **90** which then extends rearwardly as at **92** to present a discharge nozzle or horn. It will be appre-

ciated that the discharge of the jet engine at 46, which is disposed within the confines of the discharge horn for the ducting system, will draw a substantial quantity of air through the ducting system so that the discharge, at 94, from the ducting system will be characterized by a materially lower velocity than would otherwise be the case and which discharge has a greater exit area and a much higher mass rate of flow as compared with the discharge of the jet engine at 46. In this fashion, the discharge velocity, exit area and mass rate of flow emanating at 94 is more compatible with and is more efficient for the speed at which the craft will normally be expected to travel. Thus, by providing the additional propulsion means 50 and the ducting system 80 in conjunction with the jet engine system 26 in the particular environment hereinabove described, the advantages of utilizing a jet engine as a power plant while at the same time realizing efficiency at speeds for which the craft is designed is accomplished.

By the same token, the separate air ducting system also provides excellent cooling for the turbine assembly, increasing the efficiency thereof. The cooling effect is achieved by virtue of the fact that, as described above, the main body portion 86 of the ducting system is considerably larger than the jet engine assembly 26 housed therewithin so that the air as indicated at 88 freely flows therepast.

As an alternative to the system as described above, a further pump unit may be added under certain circumstances. This alternative is illustrated in dotted lines in FIG. 2 and will be seen to consist of an additional pump 100 mounted on the strut 24 closely adjacent the hull 10. Such a pump may be used in addition to the pump 50 in conjunction with large size boats, i.e., those requiring power plants in the order of 120,000 H.P. By using such a pump, additional thrust is produced at the start of a flight to drive the partly submerged hull through the water until the speed of the hull is such that it will rise on the foils, after which the water resistance is far lower and speed is readily maintained by the combination of the exhaust gases and the remaining pump 50.

The pump 100 is coupled directly to the drive shaft 72 and a suitable discharge passage 102 is provided in the strut 24 for allowing water discharge as illustrated by the arrows 104. Once the pump 100 has been elevated out of the water, it continues to operate in the ambient air with insignificant power requirement and may be readily constructed so as to encounter no heating problems. Thus, direct drive thereto is utilized at all times.

Whereas only a few forms of the invention have been illustrated and described in detail hereinabove, it will be understood that various changes may be made therein without departing from the spirit of the invention or the scope of the following claims.

I claim:

1. In a hydrofoil craft having a hull, forward and aft hydrofoils for elevating and supporting the hull above the water surface, strut means connecting said hydrofoils to the hull, a jet engine mounted on said hull for propelling the same, a propelling pump mounted on one of said struts, and an exhaust turbine driven by said jet engine and connected to said pump for imparting a subsurface propelling force to said hull.

2. A hydrofoil craft comprising a hull having depending fore and aft struts, hydrofoils carried at the lower ends of said struts for elevating and supporting the hull above the water surface, a longitudinally extending duct in said hull having a forwardly disposed inlet mouth and having a discharge horn extending upwardly and then rearwardly of the hull, a jet engine located in said duct and having an inlet conduit disposed rearwardly of said duct inlet mouth, said jet engine having a discharge conduit disposed generally concentrically within said duct and terminating in an upwardly directed portion within the confines of said duct, said terminal portion of the discharge conduit being aligned over one of said struts, said one strut having a centrifugal pump assembly fixed to its lower end having a forwardly directed inlet and a rearwardly directed outlet, an exhaust turbine disposed in said terminal portion of the discharge conduit having its axis of rotation vertically disposed, said pump assembly having a rotor for rotation about a vertical axis in line with said exhaust turbine, and a shaft directly connecting said exhaust turbine and said rotor.

3. A hydrofoil craft comprising a hull, a plurality of struts depending, fore and aft, from said hull, hydrofoils connected to said struts for elevating and supporting the hull clear of the water surface, and combined propulsion means for powering said craft, said means including a ducting system having a forward inlet and a rearwardly directed discharge, a jet engine located within said ducting system, said engine having an intake separate from the ducting system and an exhaust within the ducting system, whereby the engine exhausts into and draws air through said ducting system so that the discharge therefrom is characterized by its relatively low discharge velocity and high mass rate of flow, an exhaust turbine driven by said jet engine, and a centrifugal propelling pump mounted on one of said struts and connected to said exhaust turbine, whereby the discharge from said ducting system is further slowed by said exhaust turbine.

4. A hydrofoil craft comprising a hull, a plurality of struts depending, fore and aft, from said hull, hydrofoils connected to said struts for elevating and supporting the hull clear of the water surface, and combined propulsion means for powering said craft, said means including a ducting system having a forward inlet and a rearwardly directed discharge, a jet engine located within said ducting system, said engine having an intake separate from the ducting system and an exhaust within the ducting system, whereby the engine exhausts into and draws air through said ducting system so that the discharge therefrom is characterized by its relatively low discharge velocity and high mass rate of flow, an exhaust turbine driven by said jet engine, and a centrifugal propelling pump mounted on one of said struts and connected to said exhaust turbine, whereby the discharge from said ducting system is further slowed by said exhaust turbine, said pump including a high speed rotor, and said exhaust turbine being axially aligned with said rotor for direct drive connection therewith.

5. In a hydrofoil craft having a hull, depending struts, and hydrofoils connected to said struts for elevating and supporting the hull clear of the water surface; a jet engine having a rearwardly directed exhaust for propelling said craft, and means for slowing the velocity of said jet engine exhaust, increasing its mass rate of flow and providing additional propulsion effect on the craft, said means including an exhaust turbine driven by said jet engine and a centrifugal propelling pump mounted on one of said struts and connected to said turbine.

6. In a hydrofoil craft having a hull, depending struts, and hydrofoils connected to said struts for elevating and supporting the hull clear of the water surface; a jet engine having a rearwardly directed exhaust for propelling said craft, and means for slowing the velocity of said jet engine exhaust, increasing its mass rate of flow and providing additional propulsion effect on the craft, said means including an exhaust turbine driven by said jet engine and a centrifugal propelling pump mounted on one of said struts and connected to said turbine, said means also including a ducting system housing said jet engine but having an air intake separate therefrom, said jet engine exhausting into said ducting system, and said ducting system having a rearwardly directed discharge mouth.

7. In a hydrofoil craft having a hull, forward and aft

hydrofoils for elevating and supporting the hull above the water surface, strut means connecting said hydrofoils to the hull, a jet engine mounted on said hull for propelling the same, a propelling pump mounted on one of said struts, and an exhaust turbine driven by said jet engine and connected to said pump for imparting a sub-surface propelling force to said hull, and a second pump mounted on one of said struts closely adjacent said hull and adapted to be elevated above the water surface when the hull is so disposed, said second pump being driven by said exhaust turbine.

8. A hydrofoil craft comprising a hull having depending fore and aft struts, hydrofoils carried at the lower ends of said struts for elevating and supporting the hull above the water surface, a longitudinally extending duct in said hull having a forwardly disposed inlet mouth and having a discharge horn extending upwardly and then rearwardly of the hull, a jet engine located in said duct and having

an inlet conduit disposed rearwardly of said duct inlet mouth, said jet engine having a discharge conduit disposed generally concentrically within said duct and terminating in an upwardly directed portion within the confines of said duct, said terminal portion of the discharge conduit being aligned over one of said struts, said one strut having a centrifugal pump assembly fixed to its lower end having a forwardly directed inlet and a rearwardly directed outlet, an exhaust turbine disposed in said terminal portion of the discharge conduit having its axis of rotation vertically disposed, said pump assembly having a rotor for rotation about a vertical axis in line with said exhaust turbine, and a shaft directly connecting said exhaust turbine and said rotor, and a second pump directly connected to said shaft and mounted in said one strut closely adjacent said hull in vertical registry above the first pump.

No References Cited.