This invention relates to a liquid propelling device and more particularly to a device which may be used as an outboard motor for boats. In attempting to drive the propeller for an outboard motor for boats with a continuous, flexible driving element, the problem arises in that the movement of the driving element, from the motor positioned above the water to the propeller positioned within the water and back again to the motor, is accompanied by relatively large power losses due to the tendency of the driving element to pump water, and due to the drag of the driving element moving in the water both in the direction of the movement of the boat and in the direction of the movement of the driving element.

Furthermore, use of a continuous driving element to frictionally drive a propeller poses additional problems because of the relatively large friction losses because of slipping between the driving element and the propeller, and also because of the tendency of some continuous, flexible driving elements to stretch. One of the objects of this invention is to provide an outboard motor for boats wherein the propeller is driven by a continuous, flexible driving element having positive driving engagement with the propeller so as to substantially eliminate losses due to friction and slipping of the driving element.

Another object of this invention is to provide a liquid propelling device wherein a continuous, flexible driving element is used to drive a propeller wherein streamlinedshrouding is provided for the flexible driving element to substantially reduce the drag of the flexible driving element moving through the liquid.

A further object of this invention is to provide a liquid propelling device including a propeller driven by a continuous, flexible driving element wherein the liquid pumping action by the continuous element, as it becomes disengaged from driving engagement with the propeller, is substantially reduced. Still another object of this invention is to provide a liquid propelling device including a propeller driven by a continuous, flexible driving element wherein the propeller is mounted within a converging-diverging type nozzle and wherein said nozzle serves as a housing for at least partially enclosing the driving element.

Further objects and advantages of this invention will become apparent as the following description proceeds and the features of novelty which characterize this invention will be pointed out with particularity in the claims annexed to and forming part of this specification.

A preferred embodiment of the invention is shown in the accompanying drawings, in which:

Figure 1 is a side elevational view of my liquid propelling device driven by an internal combustion engine and mounted as an outboard motor on the stern of a boat;

Figure 2 is a rear elevational view and is taken looking from the right of Figure 1;

Figure 3 is an enlarged view, with parts broken away, showing the propeller and the flexible driving element of my liquid propelling device;

Figure 4 is a cross-section view taken on line 4—4 of Figure 3.

Figure 5 is a cross-section view taken on line 5—5 of Figure 3.

Figure 6 is a fragmentary view, partly in cross-section, taken substantially on line 6—6 of Figure 2.

Referring now to the figures, there is shown in Figure 1 an outboard motor generally indicated at 10 secured to the stern 12 of a boat, the upper portion of which is above the liquid level indicated at 14. The outboard motor 10 includes an internal combustion engine 16 having a drive shaft 18. The internal combustion engine 16 is mounted on a support generally indicated at 20, which support is provided with appropriate means for securing the outboard motor 10 to the boat.

The liquid propelling means of the outboard motor 10 includes a propeller generally indicated at 22, a housing 24 surrounding propeller 22, which housing 24 also provides means for rotatably supporting propeller 22, a flexible inelastic driving element 26 and tubular shrouds 28, through which shrouds passes the driving element 26, and which tubular shrouds 28 also support housing 24.

Referring particularly to Figures 3, 4, and 5, the propeller includes a wheel rim 30, and a plurality of blades 32 and 34 secured thereto. The blades 32 and 34 are secured at their tips to wheel rim 30 and have a hub 36 formed at the radially inner ends thereof and interconnecting the blades. The wheel rim 30 is provided on its outer periphery with a plurality of axially extending spaced teeth 38.

The driving element 26 is a continuous member—flexible, substantially impervious to liquids, and resilient—and is provided along its inner periphery with spaced teeth 40 adapted to drivingly engage teeth 38 on wheel rim 30. The driving element 26 is raised over a pulley 42 (Figures 1 and 2). The pulley 42 is mounted on drive shaft 18 and is provided on its outer periphery with teeth for meshing with teeth 40 on the inner periphery of driving element 26. The internal combustion engine 16 drives the propeller 22 through means of the driving element 26.

It will be noted that the diameter of pulley 42 is smaller than the diameter of wheel rim 30, and, consequently, the angular rotation of wheel rim 30 is less than that of pulley 42. While previous outboard motors generally use gear reducers, the necessity for a gear reducer may be obviated by this arrangement, and thus the power loss which is inherent in gear reducers is also avoided by my invention.

The supporting structure 44 for the internal combustion engine includes downwardly extending flanges 43 and 45 and an interconnecting web 46 forming a channel shaped structure for supporting the liquid propelling means. Secured to the inner sides of flanges 43 and 45 by appropriate means, such as by welding, are tubular shrouds 28, to the lower ends of which is connected the housing 24. The tubular shrouds 28 are connected to the housing 24 by appropriate means, such as by welding. The points of connection of the tubular shrouds 28 to the housing 24 are liquid tight. The continuous, flexible element 26 passes through shrouds 28 and is trained over the wheel rim 30. The shrouds 28 are streamlined, as clearly seen in Figure 5, to reduce their drag when passing through the liquid.

Referring now to the housing 24, said housing is generally annular and has a plurality of ribs 48 secured thereto and extending radially inward to support a hub 50 thereby. A shaft 52 is supported in said hub 50 and has mounted for rotation on the extending end thereof.
hub 36 of the propeller 22. A thrust washer 53 is provided between hubs 30 and 36. The inner periphery of annular housing 24 has a circumferential channel 54 formed therein to receive the wheel rim 30. The annular housing 24 is streamlined. The inner surface 56 of annular housing 24 is so shaped, and the inner surface 58 of wheel rim 30 is so shaped, that together they form the contour of a converging-diverging, or Venturi nozzle. The tips of blades 32 and 34 are secured to wheel rim 30 substantially at the point corresponding to the throat of the nozzle.

Referring to the wheel rim 30, a pair of circumferential flanges 60 and 62 are secured to the outer periphery of wheel rim 30 and extend radially outwardly of the wheel rim 30 to form with said wheel rim 30 a channel 64 for receiving the driving element 26 and for maintaining said driving element 26 in position.

The spacing between flanges 60, 62 and the surfaces forming the adjacent opposite walls of channel 54 is so small as to be incapable so as to eliminate, as much as possible, pumping of liquid that may enter between the flanges 60, 62 and said surfaces of channel 54.

Now when driving element 26 leaves the surface of wheel rim 30 at region A, Figure 3, there is a tendency for the liquid to rush into the void caused by the separation of the driving element 26 from the periphery of wheel rim 30. Accompanying such tendency of liquid to rush into the void, is great turbulence in the liquid, and pumping of the liquid by the driving element 26, both of which result in power losses. To eliminate or reduce the power losses in this region, means are provided for introducing gases into region A.

The means for introducing gases into region A include apertures 66 in the housing wall. A gas duct 68 is formed on the leading edge of one of the shrouds 28 and extends down into the liquid with the interior of duct 68 in communication with the apertures 66. The upper end of gas duct 68 is provided with tubing 70 or the like for connecting to a source of gas under pressure, such as compressed air (not shown), or the exhaust gases from the internal combustion engine (details of connections to engine not shown).

While only a single duct 68 is required to introduce gases under pressure into region A, a similar duct 68 may be secured to the other shroud 28 to preserve the symmetry of the liquid propelling device.

When the propeller 22 is rotating at an adequate speed, the liquid normally residing with the driving element 26 in the area enclosing the driving element 26, is evacuated and the propelling element 26 operates in substantially dry atmosphere. This is accomplished by utilizing the velocity head of the flowing liquid, created by the rotating propeller, to cause a partial vacuum in the area enveloping the driving element 26, thus evacuating the liquid in that area.

It is desirable that the driving element 26 in this type of outboard motor operate in substantially dry atmosphere otherwise the driving element 26 would operate in part as a pump, pumping the liquid adjacent thereto and reducing the efficiency of the propelling device. The suction created by the propeller and the supplying of gases under pressure into region A as described above, substantially satisfies the requirement that the driving element 26 operate in substantially dry atmosphere. By proper hydraulic design, as much liquid as is possible is eliminated between the flanges 60, 62 and the opposite walls of channel 54 so as to prevent, to as great a degree as possible, the pumping of liquid which may occur in those regions. The velocity of the liquid induced by the rotation of the propeller causes a decrease in pressure in the regions between flanges 60, 62 and the opposite walls of channel 54 and much of the liquid therebetween is removed by such pressure differentials.

At the point just prior to the separation of the driving element 26 from wheel rim 30, which point is just below region A, shown in Figure 3, it is desirable that there be as little clearance as possible between the outer periphery of driving element 26 and the opposite wall of channel 54. Such minimal clearance substantially reduces the possibility of pumping of the liquid by driving element 26 at the point where the driving element leaves the periphery of wheel rim 30. In order to avoid possible friction losses between the outer periphery of driving element 26 and the opposite adjacent surface of circumferential channel 54, as might be obtained by having said minimal clearance referred to extend over the entire region wherein the driving element 26 is driven over the wheel rim 30, it is possible to design the circumferential wheel rim 30 and of circumferential channel 54 in such a way that by merely mounting the axis of wheel rim 30 slightly eccentric with respect to the true axis of the housing 24, the minimal clearance will be provided solely in the region desired and possible frictional contact of the outer periphery of driving element 26 and the opposite adjacent surface of channel 54 will take place only at this point of minimal clearance.

The eccentric mounting of wheel rim 30 with respect to the axis of housing 24 and the clearances between the driving elements 26 and the surrounding surfaces of channel 54 are illustrated in Figure 3 by the dimension lines which are tangent to the various elements and which extend downwardly on both sides of the figure. The relatively wide spacing of the dimension lines on the left of Figure 3 illustrates the spacing between driving element 26 and channel 54, and the relatively narrow spacing of the dimension lines on the right of Figure 3 shows the close spacing between driving element 26 and channel 54 at a point just below region A, for the purposes described hereinabove.

While there has been shown and described a particular embodiment of this invention, it will be obvious to those skilled in the art that various changes and modifications may be made without departing from the invention and, therefore, it is intended to be the appended claims to cover all such changes and modifications as fall within the true spirit and scope of the invention.

What I claim as new, and desire to secure by Letters Patent of the United States is:

1. A liquid propelling device comprising a rotatably mounted member having propeller blades secured thereto and adapted to be immersed in said liquid, a flexible moving belt trained over and driving said rotatable member, a housing substantially surrounding said member with the belt trained over said member, said housing being spaced from said member, a pair of shrouds extending from said housing through which shrouds the belt passes, a plurality of apertures in said housing adjacent the point where the belt disengages from the rotatable member, and means for supplying gases under pressure through said apertures into the space between said rotatable member and said surrounding housing.

2. A liquid propelling device comprising a rotatably mounted member having propeller blades secured thereto, a flexible belt trained over and driving said rotatable member, a housing substantially surrounding said member with the belt trained over said member, a pair of shrouds extending from said housing through which shrouds the belt passes, a plurality of apertures in said housing adjacent the point where the belt disengages from the rotatable member, a flexible light conduit in communication with said apertures, an internal combustion engine driving said belt, and means supplying the exhaust gases of the internal combustion engine through said conduit.

3. A liquid propelling device comprising a rotatably mounted member having propeller blades secured thereto, a flexible belt trained over and driving said rotatable member, a housing substantially surrounding said member with the belt trained over said member, means on said housing supporting a hub on which is rotatably mounted said rotatable member and said propeller
blades, a pair of shrouds extending from said housing through which shrouds the belt passes, a plurality of apertures in said housing adjacent to the point where the belt disengages from the rotatable member, a fluid tight conduit in communication with said apertures, an internal combustion engine in operative association with said belt for driving said belt, means mounting said housing in spaced relation to said engine, and means supplying the exhaust gases of the internal combustion engine through said conduit and through said apertures.

4. A liquid propelling device comprising a rotatably mounted annular member, propeller blades secured to a central hub and extending outwardly and having their tips secured to the inner periphery of said annular member, a flexible member trained over and driving said annular member, a housing substantially surrounding said annular member with flexible member trained thereover, and means for supplying a gas under pressure to the space in said housing bounded by the annular member and the flexible member tangential thereto, where the flexible member leaves the periphery of the annular member, and the spacing between said housing and said annular member just before the point of separation of the belt from said annular member being as small as possible, whereby the pumping of liquid by said flexible member is substantially reduced.

5. A liquid propelling device comprising a rotatably mounted annular member, propeller blades secured to a central hub and extending outwardly and having their tips secured to the inner periphery of said annular member, a flexible member trained over and driving said annular member, a housing substantially surrounding said annular member with flexible member trained thereover, shrouds extending from said housing through which passes said flexible member, and means for supplying a gas under pressure to the space in said housing bounded by the annular member and the flexible member tangential thereto, where the flexible member leaves the periphery of the annular member, including a fluid tight conduit secured to said shrouds, an internal combustion engine for driving said flexible member, and means supplying the exhaust gases of the internal combustion engine through said conduit.

7. In an outboard-type boat propelling device, the combination, with a frame arranged to be secured on a boat hull, of a rotatable drive means mounted on said frame, a support extending downwardly from said frame and having secured thereto a plurality of ribs disposed substantially radially of an axis, which axis is substantially parallel to the axis of rotation of said rotatable drive means, a hub supported by the inner ends of said ribs, a propeller with substantially radially extending blades rotatably mounted on said hub, an annular member surrounding said propeller and secured thereto, a continuous flexible drive member trained over said annular member and in driving association therewith, said continuous flexible drive member being operatively associated with said rotatable drive means and driven thereby, and a portion of said support forming an annular housing substantially surrounding said annular member.

9. In an outboard-type boat propelling device, the combination, with a frame arranged to be secured on a boat hull, of a rotatable drive means mounted on said frame, a support extending downwardly from said frame and having secured thereto a plurality of ribs disposed substantially radially of an axis, which axis is substantially parallel to the axis of rotation of said rotatable drive means, a hub supported by the inner ends of said ribs, a propeller with substantially radially extending blades rotatably mounted on said hub, an annular member surrounding said propeller and secured thereto, a continuous flexible drive member trained over said annular member and in driving association therewith, said continuous flexible drive member being operatively associated with said rotatable drive means and driven thereby, and a portion of said support forming an annular housing substantially surrounding said annular member, and said support including upright extending tubular elements through which passes said continuous flexible drive member.

10. In an outboard-type boat propelling device, the combination, with a frame arranged to be secured on a boat hull, of a rotatable drive means mounted on said frame, a support extending downwardly from said frame and having secured thereto a plurality of ribs disposed substantially radially of an axis, which axis is substantially parallel to the axis of rotation of said rotatable drive means, a hub supported by the inner ends of said ribs, a propeller with substantially radially extending blades rotatably mounted on said hub, an annular member surrounding said propeller and secured thereto, a continuous flexible drive member trained over said annular member and in driving association therewith, said continuous flexible drive member being operatively associated with said rotatable drive means and driven thereby, a portion of said support forming an annular housing substantially surrounding said annular member, and said support including upright extending tubular elements through which passes said continuous flexible drive member.
periphery thereof drivingly meshing with said teeth in the annular member, said continuous flexible belt being operatively associated with said rotatable drive means and driven thereby, and said annular member having spaced circumferential flanges thereon extending radially outwardly thereof to define with said annular member a channel for receiving therein the continuous flexible belt.

References Cited in the file of this patent

UNITED STATES PATENTS

851,389 Waterman .................. Apr. 23, 1907

8

1,023,515 Graves .................. Apr. 16, 1912
1,759,511 Kort ..................... May 20, 1930
1,828,136 Freedlander .............. Oct. 20, 1931
2,058,582 Waterval ................ June 29, 1937
2,306,840 Waterval ................ Dec. 29, 1942

FOREIGN PATENTS

437,583 Germany ................. Nov. 26, 1926
787,656 France ................... July 8, 1935