Sept. 14, 1965 C. M. SPERAZZ, SR 3,205,960

GROUND EFFECT MACHINE

Original Filed Feb. 8, 1961 2 Sheets-Sheet 1

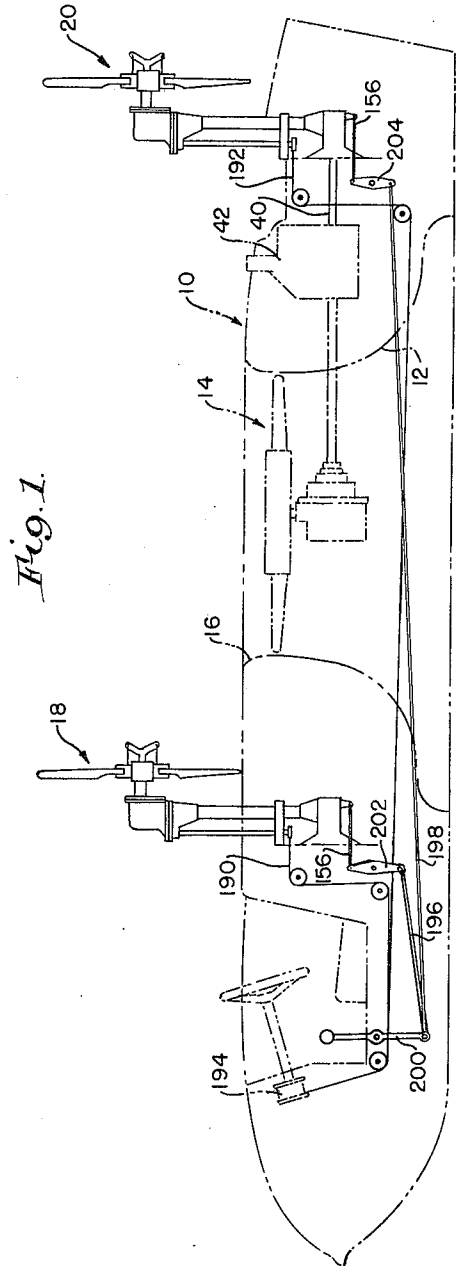


Fig. 1.

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Fig. 2.

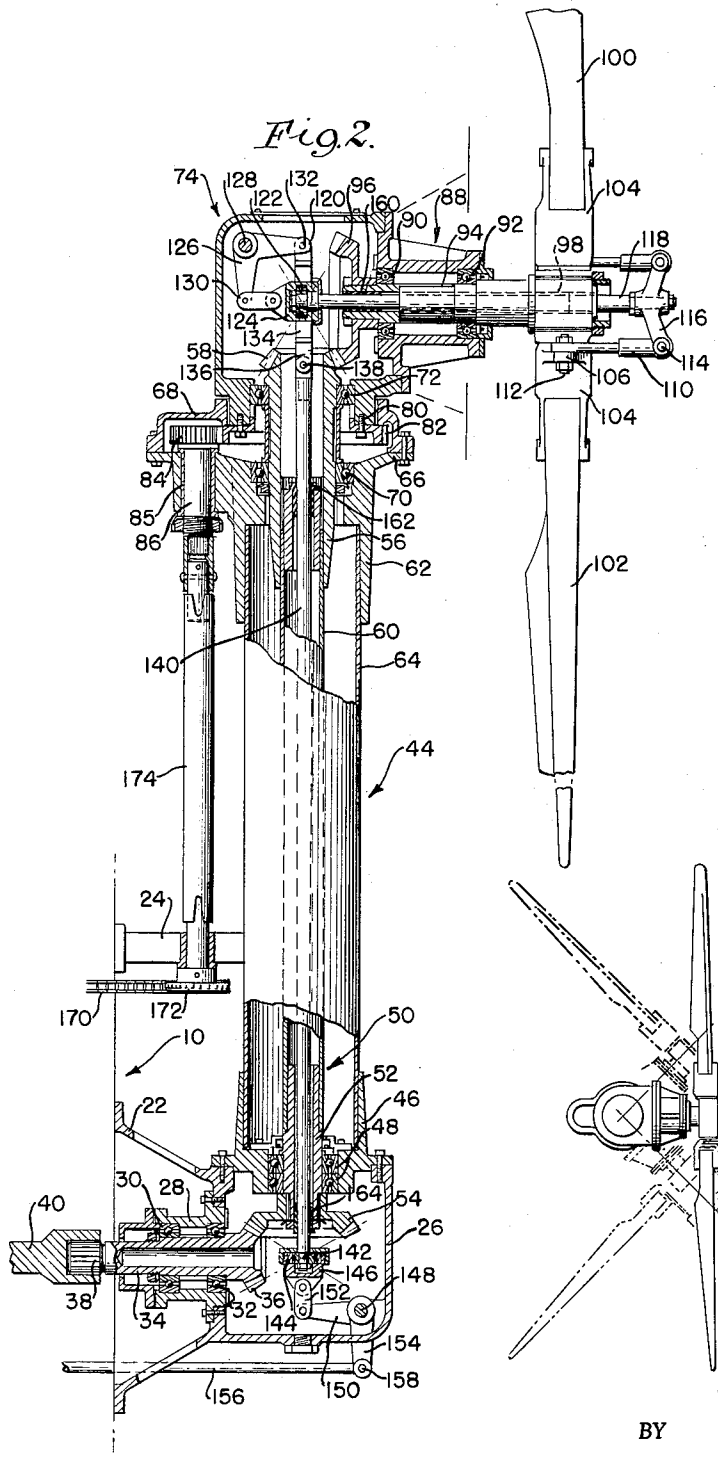
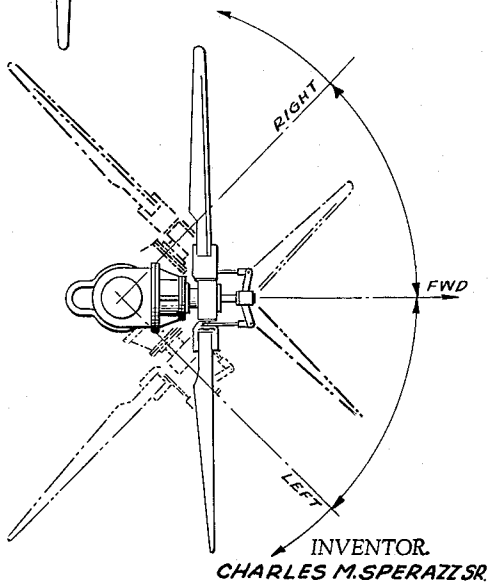


Fig. 3.



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GROUND EFFECT MACHINE

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Original application Feb. 8, 1961, Ser. No. 87,939. Divided and this application July 11, 1963, Ser. No. 294,274

3 Claims. (Cl. 180—7)

This invention relates to ground effect machines and pertains, more particularly, to certain improvements in the propulsion and steering systems for such vehicles; this application being a division of my copending application Serial No. 87,939 filed February 8, 1961, now abandoned.

In order to achieve substantial load carrying capacity as well as capability for elevation to reasonable heights to as to adequately clear the underlying terrain, ground effect machines require substantial plan view areas. As a consequence, such machines are normally rather large. However, at the same time, it is desirable that these machines, despite their size, be capable of rather precise and exacting maneuverability. It is of primary concern in connection with this invention to provide a novel propulsion and steering assembly for machines of the type specified, wherein even extremely large craft may be accurately and precisely controlled under conditions ranging from normal to the most adverse.

Essentially, this invention is directed to a rotating propeller assembly in which the propeller blades are rotatable in pitch to selectively alter their thrust-producing effect, while the assembly is also selectively rotatable in azimuth to control the direction of thrust, the two such motions or controls being independent of one another so as to permit accurate and precise control of the craft with which the assembly is associated. That is to say, independent control of the blade pitch angle may be effected at any time to achieve the exact degree of thrust required whereas, at the same time, it is possible to rotate the propeller in azimuth to control the direction of thrust but without altering the pitch angle of the propeller blades so that, considered together, these two independently operable controls, will permit the craft to be maneuvered very precisely and accurately even in confined quarters and under adverse weather conditions such as in a cross wind or a quartering wind.

More specifically, this invention is directed to a propulsion and steering assembly including a rotatable pylon or housing mounting a variable pitch propeller rotatable in a vertical plane, the housing itself being rotatable about a vertical axis and with the pitch control means for the propeller being operable independently of and unaffected by the position of the housing.

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

FIG. 1 is a side elevational view showing, in phantom lines, a ground effect machine and showing, in full lines, a pair of control assemblies according to the present invention and the associated operator controlled mechanism associated therewith;

FIG. 2 is an enlarged elevational view, partly in section, showing the details of one of the control mechanisms according to the present invention; and

FIG. 3 is a top plan view of the assembly shown in FIG. 2 and illustrating various azimuthal positions of the propeller for effecting steering and control motions.

Referring now more particularly to FIG. 1, the hull or body of a ground effect machine is shown in phantom lines therein, designated generally by the reference charcater 10. Such body is provided with a plenum chamber 12 and associated therewith is a suitable fan assembly indicated generally by the reference character 14 for inducting air downwardly through the opening 16 in the top of the body and directing such air downwardly within the confines of the plenum chamber 12 for establishing a cushion of air beneath the body of the vehicle to support the same in the ground effect fashion as is well known in the art. It is to be understood that the particular construction of the body 10, as shown in FIG. 1, is intended only diagrammatically as is the particular means for sustaining the vehicle in elevated position relative to the underlying ground or water surface. That is to say, the body 10 may take any particular and desired configuration and the particular means for effecting the ground cushioning effect may be as is desired. For example, the machine may operate in conjunction with a plenum chamber or, alternatively, a peripheral jet type of mechanism may be employed, as desired.

Two propulsion and steering assemblies indicated generally by reference characters 18 and 20 are shown associated with the body or hull 10 in FIG. 1, one such means being disposed in the forward section of the body and the other being disposed in the aft section thereof. Each of these assemblies includes a multi-bladed propeller having blades which are rotatable in pitch and, also, the propeller assembly as a whole is rotatable in azimuth so that the combined effect produced by the pitch and azimuth heading of the propeller, in each case, is effective to enable the machine to be closely and precisely controlled and maneuvered, even in close or tight quarters and even under adverse weather conditions as for example in a cross or quartering wind. Furthermore, it is a particular feature of this invention that the propeller may be controlled either in pitch or in azimuth, independently, with no interaction occurring between these two motions or controls except as may be desired and as is imparted thereto by the operator of the vehicle.

In FIG. 2, the details of each of the assemblies 18 and 20 is shown, including the manner in which it is mounted to the body 10. In FIG. 2, it will be seen that a suitable mounting bracket 22 as well as an additional brace means 24 may be employed for rigidly affixing and mounting the assembly to the vehicular body 10. Formed as an integral part of the mounting assembly 22 or otherwise rigid therewith is a lower housing member 26 which, as may be seen, is provided with an open top and, additionally, is provided with an opening in one side wall thereof detachably receiving a bearing sleeve 28 substantially as is shown. The sleeve assembly 28 carries a pair of bearings 30 and 32 journalling a pinion shaft member 34 with the pinion portion 36 thereof disposed within the lower housing 26 and with the opposite extremity of the shaft 34 being suitably splined or otherwise provided with drive transmitting means as indicated by the reference character 38 for drive interconnection with a power take-off shaft 40 or the like driven either directly or indirectly from a suitable source of power such as the power plant 42 as indicated in FIG. 1.

The tube assembly indicated generally by the reference

character 44 is provided with a base portion 46 flanged as shown for detachable securement to the housing 26 to close the normally open top portion thereof substantially as is shown. The member or base 46 carries suitable bearings 48 which journal the lower end portion of a drive shaft member indicated generally by the reference character 50. The shaft 50 may comprise a hollow stub portion 52 splined at its lower end and provided thereon with drive fitting connection with a bevel gear 54 meshing with the aforementioned pinion 36. At the upper end of the shaft 50 is a pinion shaft 56 having a pinion gear 58 integral therewith and the two portions 52 and 56 being connected by a tubular shaft portion 60 for imparting rotary drive therebetween.

The assembly 44 also includes an upper section or portion 62 joined with the base portion 46 thereof by the tubular member 64 and this upper portion 62 is provided with a suitable flange as indicated by reference character 66 for detachably mounting the cover member indicated by the reference character 68. The member 62 mounts a suitable bearing 70 journalling the pinion shaft 56 and a further bearing 72 is carried by the rotatable upper housing portion indicated generally by the reference character 74, substantially as is shown. However, in this case, the bearing 72 is provided to mount the upper housing portion 74 upon the pinion shaft 56 as will be more clearly apparent hereinafter.

The rotatable housing 74 is provided with a shoulder portion 80 which projects into the cover member 68 through a top opening therein and secured to the underside of this portion 80 is a gear wheel member 82 which is in mesh with a suitable pinion 84 rigid with the shaft 86 journalled, as by bushing 88 in the upper member 62 of the assembly 44. Mounted on one side of the upper housing 74 is a boss assembly indicated by the reference character 88 carrying bearing means indicated by reference characters 90 and 92 which rotatably support a propeller shaft 94. At its inner end, the propeller shaft carries a bevel gear 96 meshing with the aforementioned pinion 58, such bevel gear 96 being feathered or otherwise suitably secured or drivingly interconnected with the shaft 94, as will be readily appreciated.

Mounted on the outer end of the shaft 94 is a propeller hub member 98, this hub member 98 carrying a plurality of propeller blades such as those indicated by reference characters 100 and 102. As will be well understood by those skilled in the propeller art, the root end of each propeller blade is provided with a mounting member 104 which rotatably mounts its associated propeller blade for pitch change movements about a longitudinal axis extending along the blade and each such mounting portion 104 is provided with an ear or similar member 106 for imparting the requisite pitch change adjustments to the associated blade.

Associated with each of the ears 106 is a drag link such as that indicated by the reference character 110. One end of each such drag link is pivotally attached as at 112 to its respective ear 106 and its opposite end is pivotally attached as at 114 to a spider assembly 116, it being noted that the spider assembly 116 is carried by the free end of a push rod member 118 so that axial movement of the push rod 118 will effect, through the drag link 110, pitch change adjustments of the various blades 100 and 102. The hub 98 and shaft 94 are hollow so as to receive the push rod 118 and the inner end 120 of this push rod member is received in a bearing 122 held captive by a carrier member 124 substantially as is shown. A bell crank member 126, pivotally mounted in the rotatable housing portion 74 by the means of a suitable pin 128 is provided with a connecting link 130 extending from one arm of the bell crank to the aforementioned carrier 124 and the other arm of the bell crank 126 is pivotally connected as at 132 to a yoke assembly 134 which surrounds and clears the carrier 124 and which is

provided at its lower end with an ear 136 for pivotal connection as at 138 to the upper end of a further push rod 140. The shaft 50 is also hollow and the push rod 140 extends downwardly therethrough with its lower end 142 being received in a bearing 144 mounted in the carrier 146 similar to the carrier 124. The fixed housing portion 26 carries a pivot pin member 148 which pivotally mounts a second bell crank, one arm 150 of which is connected through the connecting link 152 to the carrier 146, as shown, and the other arm 154 of which extends downwardly externally of the housing portion 26 for connection to a control rod member 156, there being a pivotal interconnection therebetween as indicated at 158.

For axially guiding the push rod member 118, a suitable bushing 160 may be provided in the inner end of the shaft 94, as shown, and a similar bushing may be provided in the hub 98. Likewise, axial guiding movement of the push rod 140 is achieved by the upper bushing 162 and the lower bushing 164, as shown. Thus, axial movement of the control rod 156 will cause axial movement of the push rod 140, and through the bell crank 126 and associated mechanism, axial movement of the push rod 118 to control or vary the pitch angle adjustments of the blades 100 and 102.

To control the blade or propeller assembly in azimuth, the shaft 86 carrying the pinion 84 is rotated so as to effect rotation of the housing portion 74, and with it, the propeller assembly, as will be readily apparent. To achieve rotation of the shaft 86, movement of the chain 170 is effected. The chain 170 meshes with a sprocket member 172 rigid with the lower end of the shaft assembly 174 which connects with the shaft 86. Preferably, the lower end of the shaft assembly 174 is journalled in the aforementioned bracket assembly 24 serving to mount the assemblage to the vehicular body 10.

As is shown in FIG. 1, control of the chains 170 may be effected by cables 190 and 192 which, with the respective chains 170, form loops extending from around the sprockets 172 back to a steering drum member 194. Preferably, the cable loops are wound in opposite directions on the drum 194 so that the assemblies 118 and 120 are rotated in relatively opposite directions when viewed in plan. For operating the pitch changes adjustment, rods 196 and 198 extend from a suitable control lever 200 to respective crank members 202 and 204 which actuate the control rods 156. It will also be realized that separate controls for both steering and propulsion or pitch change effect may be utilized if so desired.

I claim:

1. In combination with a ground effect machine having a body and means for producing a supporting cushion of air beneath said body, a housing mounted on said body and including a hollow base portion, an intermediate upstanding tubular portion mounted on the base portion, a closed upper end rotatably mounted on said tubular portion, a hollow propeller shaft rotatably carried by and laterally projecting from the upper end portion and having an outer end portion and propeller hub mounted on said propeller shaft and rotatable therewith, a plurality of propeller blades mounted on said hub and extending radially therefrom for rotation therewith, means mounting said blades for pitch adjustment thereof about their longitudinal axes, a drive shaft rotatably journalled in the base portion, a hollow driven shaft extending axially within said tubular portion, gear means drivingly connecting said drive and driven shafts, gear means drivingly connecting said driven and propeller shafts, a first push rod axially extending through said driven shaft, a second push rod extending axially through said propeller shaft and having means for connection to the blade mounting means for varying the pitch of the blade in response to axial movements thereof, means mounted in the upper end portion connecting said rods and translating the axial movement of said first push rod to said second push rod, operating means connected to said first push rod and operable by

an operator of the machine from his zone of operation remote from the housing, means for rotating said upper end portion to alter the position of said propeller in azimuth, and control means for said last means, said control means being operable by the operator independent of said above-mentioned operating means.

2. The invention of claim 1, wherein said means for rotating said upper end portion includes a gear wheel member on said upper end portion, a pinion enmeshed with said gear wheel member, a rotatable shaft carrying said pinion.

3. The invention of claim 2, wherein said control means includes a sprocket member carried by the shaft, a chain meshing with the sprocket member and cables connected to the chains, a steering wheel having a drum member and said cables being looped around the drum member in opposite directions.

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