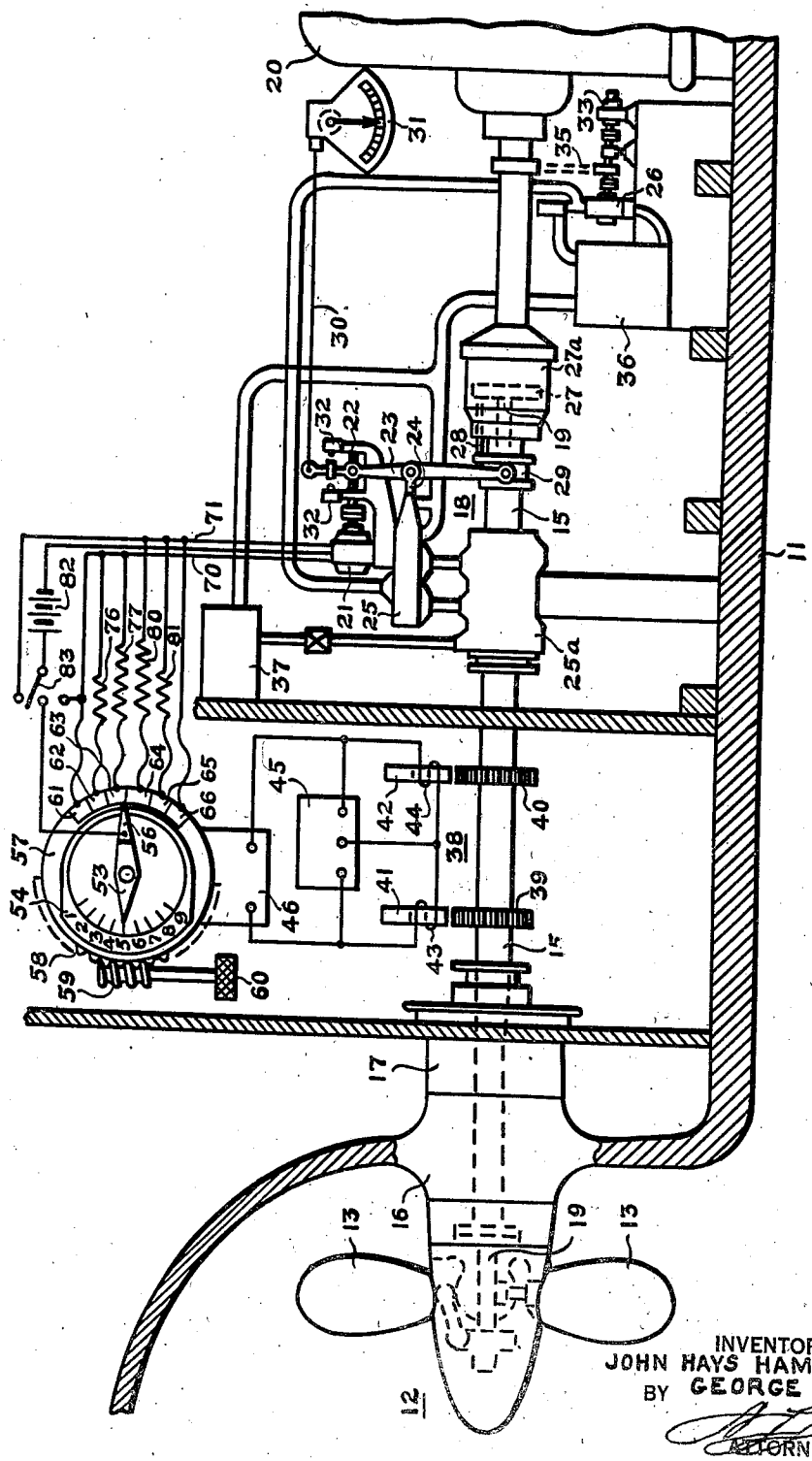
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VARIABLE PITCH PROPELLER CONTROL

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VARIABLE PITCH PROPELLER CONTROL

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This invention relates to variable pitch propellers and more specifically to means for varying the pitch of a propeller so as to maintain the torque of the propeller shaft substantially constant under varying conditions of wind and weather.

The invention provides torque responsive means, operated by the propeller shaft, which directly controls means for varying the pitch of the propeller blades in such a way as to maintain the propeller shaft torque constant.

The invention also provides means for varying the rate of change of pitch of the propeller blades in accordance with the rate of changes of the propeller shaft torque, thus causing the device to operate efficiently and effectively under varying conditions.

An object of the invention is to provide a novel and improved device of the type above indicated, which is suited to commercial use on marine vessels or aircraft.

Other objects and advantages will become apparent as the nature of the invention is more fully disclosed.

The invention also consists in certain new and original features of construction and combinations of parts hereinafter set forth and claimed.

Although the novel features which are believed to be characteristic of this invention will be more particularly pointed out in the claims appended hereto, the invention itself, as to its objects and advantages, the mode of its operation and the manner of its organization, may be better understood by referring to the following description, taken in connection with the accompanying drawing forming a part thereof, in which the single figure illustrates diagrammatically the system as applied to the driving mechanism of a marine vessel.

In the following description and in the claims parts will be identified by specific names for convenience, but they are intended to be as generic in their application to similar parts as the art will permit.

Referring to the accompanying drawing, the hull of a marine vessel is indicated at 11. This vessel is shown as driven by means of a propeller 12 which is provided with adjustable blades 13. The propeller 12 is attached to the end of a hollow shaft 15 which passes through an outboard bearing 16 and a thrust bearing 17. The shaft 15 is driven by a prime mover 20 which may be of any desired type and is preferably provided with a governor, not shown, for maintaining a constant speed of rotation.

The blades 13 are connected to a variable pitch mechanism 18 which may be of any well known and standard construction such as that manufactured by the Escher-Wyss Company of Zurich, Switzerland, the details of which form no part of the present invention and are accordingly not specifically set forth herein. This mechanism, in general, comprises a rod 19 slidable longitudinally within the shaft 15 and connected to control the pitch of the blades 13. The rod 19 is actuated by a piston 27 in a fluid pressure cylinder 27a. Fluid for actuating the piston 27 is supplied by a pump 26 through a control valve 25 and a distribution valve 25a which communicates with the cylinder 27a through ducts, not shown, in the shaft 15. A motor 21 rotates a worm 22 which operates to move the upper end of a floating lever 23, which, in turn, is pivoted to the end of a valve rod 24 which controls the valve 25.

The piston 27 is connected by a rod 28 to a collar 29 which is slidably mounted on the shaft 15 and engages the lower end of the lever 23 so that the position of this end of the lever corresponds to the pitch of the blades 13.

The upper end of the lever 23 is connected by a wire 30 to an indicator 31 which shows the pitch at which the blades 13 are set. Stops 32 are provided for limiting the maximum and minimum pitch of the blades 13. The fluid pump 26 is driven either by a motor 33 or a belt 35 from the shaft 15. A reservoir 36 and a supply tank 37 are provided for the necessary fluid.

It is to be understood that other pitch control devices may be employed in place of that referred to above for varying the pitch of the propeller blades 13 in response to actuation of the motor 21. A particular type is shown for purposes of illustration only.

Attached to the shaft 15 is a shaft-horsepower meter 38 which may be of the type manufactured by the General Electric Company of Schenectady, New York, the details of which form no part of the present invention and are accordingly not specifically set forth herein. This mechanism, in general, comprises two gears 39 and 40 which are attached to the shaft 15 at a suitable spacing. Mounted adjacent to the gears 39 and 40 are two U-shaped permanent magnets 41 and 42 which are provided with teeth on the faces adjacent to the gears 39 and 40. The magnets 41 and 42 are provided with armature coils 43 and 44 which are connected to a horsepower-hour totalizer 45 and a horsepower indicator 46 which is provided with a pointer 53

which registers with a scale 54 which may be graduated in thousands of horsepower, for example.

While the meter shown is the type manufactured by the General Electric Company of Schenectady, New York, it is to be understood that any other suitable type of horsepower or torque meter may be employed for the present purpose.

In accordance with the present invention, means is provided for controlling the motor 21 by the position of the pointer 53. In the embodiment shown this is accomplished by providing a contact 56, attached to, but insulated from, the pointer 53 and a ring 57 surrounding the pointer 53 and rotatably mounted with respect thereto. The ring 57 carries a segment of a worm gear 58. Meshing with the gear 58 is a worm 59 which may be rotated by means of a knurled knob 60. Mounted on but insulated from the ring 57 are a plurality of contact segments 61 to 66 which are selectively engaged by the contact 56.

The segments 61 and 66 are connected by flexible conductors to two conductors 70 and 71 which in turn are connected to the reversing windings of the motor 21. The segments 62 and 63 are connected by flexible conductors to two resistors 76 and 77 which in turn are connected to the conductor 70. The segments 64 and 65 are connected by flexible conductors to two resistors 80 and 81 which are in turn connected to the conductor 71. The return lead from the windings of motor 21 is connected through a battery 82 to the blade of a three position switch 83. The center contact of this switch is connected to the contact 56, the upper contact is connected to the conductor 71 and the lower contact is connected to the conductor 70.

Operation

In the operation of the form of the invention shown, the pitch of the blades 13 is first set at the normal operating angle for the conditions under which it is desired to operate the vessel. The setting of the propeller blades 13 is accomplished by moving the blade of the switch 83 into the upper or lower position, which will cause the motor 21 to move the upper end of the lever 23 to the left or right to increase or decrease the pitch in a well known manner, the angle of pitch being indicated by the pointer of the indicator 31.

The shaft-horsepower meter 38 is so constructed that when there is no power transmitted by the shaft 15 and therefore no torque produced in this shaft the teeth of the two gears 39 and 40 will be exactly opposite the corresponding teeth of the magnets 41 and 42 at the same instant. As the windings 43 and 44 are reversed the respective voltages generated therein will be exactly 180° out of phase so that no voltage will be applied to the indicator 46 and the pointer 53 will be in the zero position. As power is transmitted by the shaft 15 a torque will be produced in this shaft proportional to the horsepower transmitted, thus producing a slight twist between the gears 39 and 40 so that the teeth of these gears will not be exactly opposite the corresponding teeth of the magnets 41 and 42 at the same instant.

The voltages generated in the two windings 43 and 44 will then not be exactly 180° out of phase so that a resultant voltage will be produced which is proportional to both the shaft twist and the propeller speed. This voltage is applied to the indicator 46 the pointer 53 of which will indicate on the scale the horsepower being transmitted by the shaft 15.

After the vessel is brought up to the desired speed the pointer 53 will indicate the horsepower required to maintain this speed under the existing conditions of wind and weather, which in this case is shown on the scale 54 as 5,000 horsepower. The ring 57 is then rotated by means of the knurled knob 60 until the insulation between the segments 63 and 64 engages the contact 56. The blade of the switch 83 is then moved into engagement with the center contact.

If the conditions under which the vessel is travelling should change adversely, such as encountering a strong head wind or running into a heavy sea, the power transmitted by the shaft 15 will increase, thus producing a greater torque and causing an increased twist between the gears 39 and 40, which will shift the teeth of these gears more out of alignment and cause a greater voltage to be applied to the indicator 46. This in turn will cause the pointer 53 to move in a counter clockwise direction to indicate an increase of torque or horsepower. The contact 56 will then engage the segment 63 and a circuit will be closed from the battery 82 through the resistor 77 to the motor 21, causing the motor to rotate slowly in a direction to move the upper end of the lever 23 to the right. This will move the valve 24 to the right which will allow fluid under pressure to pass from the pump 26 to the cylinder 27*a* by means of the ducts in the shaft 15. This will actuate the piston 27 which, by means of the rod 19 and the link mechanism will cause the propeller blades 13 to slowly decrease their pitch, thereby decreasing the torque until the indicated horsepower again reaches 5,000 at which time the contact 56 will again rest on the insulation between segments 63 and 64 and stop the motor 21.

If the torque should decrease due to a following wind or other favorable conditions, the reverse action would take place, thus causing a gradual increase in pitch of the propeller blades which would cause the torque to be increased until the contact 56 again rests on the insulation between the segments 63 and 64, at which time the motor 21 would stop.

If the changed conditions cause a rapid change of torque so that the contact 56 engages either segment 65 or segment 62, then the resistor 81 or 76 will be thrown in circuit with the motor 21 instead of the resistor 80 or 77 as already described. As resistors 81 and 76 have less resistance than resistors 80 and 77 the motor 21 will be caused to rotate faster, thus changing the propeller pitch more rapidly to take care of the more rapidly changing conditions.

If the conditions change so quickly that the contact 56 engages either segment 61 or segment 66, then no resistance will be thrown in the circuit of the motor 21 and it will rotate at its maximum speed, thus changing the propeller pitch at a maximum rate. The stops 32 are provided so that the propeller pitch is prevented from exceeding certain limits beyond which it could not operate efficiently under any conditions.

By the system above described the pitch of the propeller blades 13 is varied to cause the propeller to operate so as to maintain the torque constant under all conditions. The rate of change of pitch will vary in accordance with the change of torque so that with a gradual change of torque there will be a slow change of pitch which would not cause undue strain on the driving mechanism, disagreeable vibrations and inefficiency of

the propeller, but a more abrupt change in torque will be promptly and quickly corrected by a more rapid actuation of the pitch control means. The meter 38 is set forth herein as a horsepower meter. It is to be understood, however, that with the shaft 15 operating at constant speed the meter will measure directly changes in torque or twist of the shaft itself, the horsepower being proportional to the torque or twist of the shaft under these conditions.

The invention has been shown as applied to the propulsion of vessels. It is to be understood, however, that it is capable of various uses where a constant torque is required, and that various changes and modifications may be made therein as will be readily apparent to a person skilled in the art.

Although only a few of the various forms in which this invention may be embodied have been shown herein, it is to be understood that the invention is not to be limited thereto but is only to be restricted in accordance with the scope of the following claims.

What is claimed is:

1. In a system for driving a vessel, an engine provided with a governor maintaining the engine speed substantially constant, a propeller having blades, means controlling the pitch of said blades, a drive shaft driving said propeller, means directly responsive to both the torque and speed of said drive shaft to measure the instantaneous horsepower being transmitted thereby, and means actuated by said last means to actuate said pitch control means so as to vary the pitch of said blades in a manner to maintain constant the horsepower being transmitted by said drive shaft and at a speed which varies in accordance with the amplitude of change of horsepower being transmitted, the speed of operation of the pitch control means being greater when the amplitude of change in horsepower is greater and vice versa, regardless of the direction of said change.

2. In a system for driving a vessel, an engine provided with a governor maintaining the engine speed substantially constant, a propeller having blades, means controlling the pitch of said blades, a drive shaft driving said propeller, means directly responsive to both torque and speed of said drive shaft to measure the instantaneous horsepower being transmitted thereby, said means including a plurality of contacts adapted to be selectively closed in accordance with the direction and amplitude of change in horsepower, and control circuits associated with said contacts to actuate said pitch control means in a direction and at a speed corresponding to the relative position of the respective contacts so as to vary the pitch of said blades in a manner to maintain constant the horsepower being transmitted by said drive shaft and at a speed which varies in accordance with the amplitude of change of horsepower being transmitted.

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