CONTROL METHOD AND CONTROL SYSTEM FOR A MARINE PROPELLER

Abstract:
A system and method for controlling a fixed propeller drive for a boat is disclosed which has an engine (18) for driving a propeller hub (16) having propeller blades (12). A control unit (10) controls the engine (18). A temperature sensor (33) is provided for measuring engine temperature and the control unit (10) limits engine speed when the engine is cold, regardless of the position of control lever 28 which selects speed of the engine (18). The system also provides for cruise mode and manoeuvring mode and sets speed of the engine in response to movement of the lever (28) depending on whether cruise or manoeuvring mode has been selected.
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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.
CONTROL METHOD AND CONTROL SYSTEM FOR A MARINE PROPELLER

Cross-Referenced Application
This application relates to an improvement and modification to that disclosed in our International application PCT/AU2004/001204.

Field of the Invention
This invention relates to a method and system for controlling a marine propeller.

Description of the Prior Art
Our above-mentioned International application, the contents of which are incorporated into this specification by this reference, relates to the manner of controlling a variable pitch propeller blade for a marine propulsion system. The system provides significant advantages over fixed propellers and existing variable pitch propellers, both in terms of the ability of the boat having the system to reach the plane very quickly, and also to provide for safe manoeuvring when docking or the like.

Summary of the Invention
The object of the present invention is to make similar improvements in relation to fixed propeller systems.

The invention provides a system for controlling a fixed propeller drive for a boat, comprising:
- an engine for driving the propeller;
- a clutch for allowing power to be supplied from the engine to the propeller;
- a drive element for operating the engine to change the speed of the engine;
- a temperature sensor for providing a measure of engine temperature; and
- a processor for limiting engine speed when the engine is cold below a predetermined temperature.
Thus, according to this aspect of the invention, if the engine is cold, the engine can be prevented from over-revving in a cold condition by limiting the amount of throttle which is available when the engine is cold. Thus, if the drive element is moved beyond a position which would normally provide that amount of throttle and therefore, that amount of engine speed, the additional engine speed and amount is not given and the maximum provided is that set by the processor.

In one embodiment the control element can be set to 'maximum' to override the throttle restriction in an emergency. In this case the throttle is set to its maximum position, even when the engine temperature is still low.

Preferably the engine sensor provides a signal while the engine warms up so that the processor can increase the amount of throttle, which is obtainable, when the drive element is moved, dependent on the engine temperature signal, up to the maximum speed of the engine, when it is at normal operating temperature.

Preferably the system includes selectors for selecting cruise mode or manoeuvring mode and wherein the processor determines the drive element position, the engine speed and the throttle feedback, and wherein engine temperature is again read by the processor and maximum throttle is set depending on whether the engine is warm or cold so that if the engine is cold, the processor limits the amount of speed the engine can produce until such time as the engine becomes warm.

Preferably a number of interrupt commands can be provided to the system including an engine switch off to switch off
the system, a lanyard switch open to switch off the system in the event of a lanyard becoming open because of possible driver emergency, and an emergency stop button signal to shut off the system.

Preferably timers are set when in the cruise or manoeuvring mode so that when a time limit exceeds the set time and the drive element is in neutral, the throttle is reduced to less than the maximum throttle for that particular mode and, if so, a new target throttle is set based on the mode and, if not, the target throttle is set as that maximum throttle for that particular mode.

The invention also provides a control system for a fixed propeller marine propulsion system for a boat, comprising:

- a cruise mode;
- a manoeuvring mode;
- a selector for selecting the cruise mode or the manoeuvring mode;
- a processor for determining which mode has been selected and for setting engine speed in response to position of a drive element dependent upon the mode in which the system is in.

Thus, in cruise mode, any particular position which is set by the drive element generally provides a relatively high speed compared to that which would be provided in manoeuvring mode. However, if the boat is in manoeuvring mode, the same throttle position would provide a much lower speed because the boat is intended to manoeuvre slowly for docking or like purposes, resulting in an increased sensitivity of the control element in manoeuvring mode.

Preferably the processor includes a timer for timing the amount of time the system remains in cruise mode after a drive element has been placed in neutral and if the time
expires before the drive element is moved, the cruise mode is cancelled.

Preferably the timer also times the amount of time the system is in manoeuvre mode if the control lever is in neutral and if a predetermined time is reached, the manoeuvring mode is cancelled.

Preferably the system further comprises a clutch for supplying power from an engine to a propeller.

The predetermined time for the cruise mode is somewhat less than the predetermined time for the manoeuvring mode because it is expected that the drive element is moved in and out of neutral more often and may stay in neutral for much longer periods during manoeuvring than would be the case when the boat is travelling in cruise mode.

After the manoeuvre and cruise modes have been cancelled, the clutch stays disengaged and the processor sets the system to determine whether the target throttle, which is set, is less than the maximum throttle for the particular mode and, if so, a new target throttle is set and the system returns to determining whether engine warm up has occurred and if the target throttle is not less than the maximum throttle, the target throttle is set at the maximum throttle for the particular mode.

Preferably the drive element comprises a manually operated drive lever.

The invention provides a method of controlling a fixed propeller drive for a boat, comprising:

- providing an engine for driving the propeller;
- providing a clutch for allowing power to be supplied from the engine to the propeller;
- providing a drive element for operating the
engine to change the speed of the engine;
measuring engine temperature; and
limiting engine speed when the engine is cold
below a predetermined temperature regardless of the
position of the drive element and its adjustment by an
operator of the vessel.

Preferably the method includes selecting cruise mode or
manoeuvring mode and controlling engine speed to a
predetermined speed until such time as the engine becomes
warm.

Preferably a number of interrupt commands are provided
including an engine switch off to switch off the system, a
lanyard switch open to switch off the system in the event
of a lanyard becoming open because of possible driver
emergency, and a stop button emergency to shut off the
system.

Preferably the clutch allows power to be supplied in
forward and reverse direction.

Preferably the time the drive element is in neutral is
measured when in the cruise or manoeuvring mode so that
when the time exceeds a set time, the throttle is reduced
to less than the maximum throttle for that particular mode
and, if so, a new target throttle is set based on the mode
and, if not, the target throttle is set as that maximum
throttle for that particular mode.

The invention also provides a method of controlling a
fixed propeller marine propulsion system, comprising:
providing a cruise mode;
providing a manoeuvring mode;
selecting the cruise mode or the manoeuvring
mode, determining which mode has been selected and for
setting engine speed in response to position of a drive
element indicative of the mode in which the vessel is in.

Preferably the method times the amount of time the system remains in cruise mode after a drive element has been placed in neutral and if the time expires before the drive element is moved, the cruise mode is cancelled.

Preferably the method times the amount of time the boat is in manoeuvre mode if the control lever is in neutral and if a predetermined time is reached, the manoeuvring mode is cancelled.

The predetermined time for the cruise mode is somewhat less than the predetermined time for the manoeuvring mode because it is expected that the boat may remain in a position in which the drive element is in neutral for much longer periods during manoeuvring than would be the case when the boat is travelling at much higher speeds in cruise mode.

After the manoeuvre and cruise modes have been cancelled, the method sets the system to determine whether the target throttle, which was set, is less than the maximum throttle for the particular mode and, if so, a new target throttle is set and a determination is made whether engine warm up has occurred and if the target throttle is not less than the maximum throttle, the target throttle is set at the maximum throttle for the particular mode.

30 **Brief Description of the Drawings**

Figure 1 is a schematic diagram of a marine propulsion system according to one embodiment of the invention;

Figure IA is a schematic diagram of a control panel of one embodiment;

Figure 2 is a flowchart showing engine start;

Figure 3 is a flowchart showing engine switch
Figure 4 is a flowchart showing operation of a lanyard switch; Figure 5 shows the operation of an emergency button; Figure 6 is a flowchart showing the selection of cruise or manual operation of the system; Figure 7 is a flowchart showing clutch engagement; and Figure 8 is a flowchart showing engine control.

Detailed Description of the Preferred Embodiments

With reference to Figure 1 a schematic view of a control system according to the preferred embodiment, and a marine drive system for a boat is shown. The marine drive system generally comprises an engine 18 which drives a propeller 14 via a clutch 20. The propeller 14 includes a hub 16 and propeller blades 12.

The control unit 10 controls the engine 18 by control signals which are output on line 11. Basically the control is a control over the fuel delivery system of the engine 18 to increase or decrease the power supplied by the engine 18 in response to movement of a control lever 28 to control boat speed. The control unit 10 is also connected to a clutch actuator 25 by line 13 so that signals can be output to the actuator 25 to cause the actuator to open or close the clutch 20. Obviously when the clutch is open, drive to the propeller 14 from the engine 18 is disconnected and when the clutch 20 is closed, the engine 18 is able to drive the propeller 14. The control lever 28 is connected to the control unit 10 and is moveable by a watercraft operator between extreme positions to drive the boat. In one embodiment movement in a transverse direction may indicate cruise or manoeuvring mode, replacing the toggle switch action of switch 29. In general, the signals output upon movement of
the lever 28 are electronic signals which are supplied to
the control unit 10 via line 19 and those signals provide
a control signal to the control unit 10 indicative of the
position of the lever 28 so the engine 18 is controlled in
speed and/or torque dependent on the position of the lever
28.

A propeller blade pitch position sensor 30, a clutch open
or close sensor 32, an engine rpm sensor 34, and a GPS
system 35 for providing a measure of ground speed are also
connected to the control unit 10. The control unit 10
also receives a signal indicative of engine temperature
for temperature sensor 33. Thus, data is provided to the
control unit 10, whether the clutch 20 is open or closed,
the engine speed of the engine 18, and the over the ground
speed of the boat.

Figure IA shows an example of a control panel of the
preferred embodiment. The control panel has light
emitting diodes 41, 42 and 43 which show operation of a
drive request button 40, selection of cruise mode or
selection of manoeuvring mode respectively. As mentioned
above, forward speed, reverse speed or neutral is selected
by moving lever 28. In one embodiment the switch 29 may
be in the form of an H pattern configuration 29’ for
allowing movement of the lever 28 along two spaced apart
lines 45 and 46. The lines 45 and 46 are in the form of
slots enabling movement of the lever around a pivot point
along the lines 45 and 46. A crossover slot 47 joins the
lines 45 and 46 and enables the lever 28 to move from the
line 45 to the line 46. When moving along the line 45,
cruise mode is applicable and when moving along the line
46, manoeuvring mode is applicable. The slot 47 is
located at the neutral position N and Figure IA also shows
the direction of movement towards one end of the lines 45
and 46 for forward movement F and movement in the opposite
direction for reverse movement R. In the alternative
embodiment, cruise or manoeuvring mode can be selected by a switch 29' which may be comprised of two switches 44a and 45a, or a single toggle switch.

Referring now to Figure 2 which shows a block diagram of the engine start up routine, at step 201 an ignition key is turned on and the controller goes through an internal controller check to check whether all LEDs in an optional display unit (not shown) are working and disengages the clutch 20 by an appropriate signal on line 13 to actuator 25. At step 203 the position of the control lever 28 is read. If the control lever is in neutral, as decided at step 204, a decision is then made as to whether the clutch is engaged at step 205. If yes, the clutch is disengaged at step 206 and the program returns to step 203. If the control lever 28 is not in the neutral position at step 204, the program goes to step 207 where a light emitting diode blinks to show that the control lever 28 is not in neutral and must be placed in neutral before the system will advance further.

If the control lever 28 is in neutral and the clutch is not engaged, the system moves to step 208 where the starter circuit is closed and the engine 20 is started. The LED light is switched on indicating the clutch is still engaged. At step 209 the engine speed and engine temperature are read from sensor 34 and 33 and supplied to control unit 10. At step 210 a decision is made as to whether the engine has started, if no, the system goes back to step 204. If yes, the system goes to step 211 where a decision is made as to whether the engine is warm or cold. The maximum possible throttle threshold, which can be set, is then limited to the warm or cold engine throttle limit. Thus, if the engine is cold the throttle position of the engine is set to maximum throttle for cold maximum throttle at 212 and, if warm for maximum throttle at 213. Thus, if the engine is cold, the system can set
the maximum speed of the engine to a relatively low speed, such as, for example, 60% of maximum engine speed, so the engine is not damaged due to running at too high a speed while cold. If the engine is warm, the engine can be set to run at full maximum speed. Thus, if the engine is cold and even if the throttle is in full maximum speed position, the amount of engine speed delivered will still just be 60% of the maximum available. Whereas, if the engine is warm, 100% of available speed would be provided.

The system then goes to Figure 7 at reference A. At step 701 the position of the lever 28 is read, as is the throttle feedback and the engine speed and a check is made as to the status of the drive (clutch button) 40 (Figure IA). At step 702 a decision is made as to whether the drive button 40 is depressed, if yes, the clutch flag is set at 703 and a light emitting diode 41 is caused to blink indicating this status. If no, the throttle is set as a function of lever position in engine check mode at step 704. This step enables the engine to be checked by revving the engine while the clutch is open so the propeller is not driven. Thus, the engine can be revved to determine that the engine is operating correctly if needed. The system then returns to step 701 to determine whether the drive has been requested by depression of the drive request button 40 at step 702 or if the lever has been moved and therefore the throttle position has to be changed. If the button 40 has been pressed, the clutch flag is set at step 703 and the LED 41 starts blinking (as mentioned above) indicating that the clutch will connect power to the propeller as soon as the control lever 28 is moved into either forward or reverse position.

After the clutch flag has been set at step 703 the system moves to step 705 where a determination is made that engine speed is less than maximum engine speed, if no, the system returns to step 701. If yes, a decision is made at
step 706 as to the direction of movement of the lever 28 for either forward or rear travel. If forward is detected, the clutch 20 is engaged to the forward gear at step 707 and the light emitting diode 41 is switched off to show that the clutch has been engaged. If reverse is detected at step 708, reverse gear is selected and the clutch LED 41 is also switched off, showing that the clutch has been engaged.

At step 709 the throttle is set as a function of the particular mode in which the boat is placed, such as cruise mode, and the lever position. At step 710 the position of the throttle is determined from the throttle feedback signal to ensure the engine is controlled as requested by the position of the lever 28 to maintain a speed as is set by the lever position.

At step 711 a decision is made as to whether the throttle set is greater than the maximum throttle for the particular mode and, if no, the system moves to C to continue on as it will be explained hereinafter. If yes, the throttle is set to maximum throttle for the mode at step 712 and the program returns to step 709.

In Figure 8, which shows the continuation of C, engine temperature is read at step 801 and a decision is made as to whether the engine has warmed up at step 802. If yes, the system moves to step 803 where maximum throttle equals the warm maximum throttle position. If no, the throttle limit is set to the limit for the cold engine at step 804. The system then moves to step 805 where the lever position is checked and a check is made for any interrupts and the target throttle is a function of the mode which has been selected by the driver and the lever position of lever 28. At step 806 a decision is made as to whether the control lever is in neutral and whether drive has been requested by pressing button 40. If no, a clutch timer is reset at
806A to zero and drive is possible if the lever is other than in neutral. If yes, and the control lever 28 is not moved before the clutch timer countdown (which may be a period of 5 minutes) is finished and the button 40 has been depressed, the button 40 is de-activated which means the clutch will not transmit drive if the lever 28 is moved until the button 40 is again pressed and the lever 28 moved within a predetermined countdown period of, for example, 5 minutes. A decision is made as to whether cruise or manoeuvring mode flag has been set at step 807. If cruise mode was set, the system goes to step 809 where the timer is started, which after the predetermined time, with the lever 28 still in neutral, the cruise mode is finished and the cruise flag is unset. If manoeuvring mode was selected, a different time is started at step 810, which unsets the manoeuvring flag when the timer reaches its predetermined time limit. At the time limit, the system does not change mode immediately, but an acoustic warning signal is started before the mode is set back to engine check mode or propeller check mode. The system then goes to step 811 to determine whether the time has exceeded the timer limit at steps 809 and 810. The time the position of the lever is monitored in neutral during manoeuvring mode is relatively long because it is likely that the lever will be placed in that position quite often and for reasonable lengths of time during manoeuvring. Thus, the fact that the lever is in neutral for a long period of time is not indicative of the fact that it may be desired to leave manoeuvring mode. If the system is in cruise mode, the time period is less because it is less likely that the lever will be in neutral for any significant period of time whilst in cruise mode. The predetermined time periods for steps 809 and 810 presuppose that after expiry of those times, it was in fact the intention of the driver to place the boat into neutral and if the time does expire, the cruise mode flag and manoeuvring mode flag are unset, depending on
reselection of one of those modes. At step 813, a decision is made as to whether the intended target throttle as set by the lever 28 is less than the maximum throttle for the particular mode the system was in. If yes, the system goes to step 814 to set a new target throttle and then returns to step 801. If no, the system goes to step 815 where target throttle is the maximum throttle for the particular mode and then the system returns to step 814.

Figure 3 shows an interrupt for ignition switch off and at step 301 the ignition switch is switched off. At step 302 the throttle is set to idle and the clutch is disengaged and the system switches itself off. This simply shows the routine of shutting down the system after use. It may be restarted with the ignition switch as shown in Figure 2.

Figure 4 shows an interrupt by a lanyard switch which can be operated by a driver moving away from a particular position or falling out of a boat. At step 401 a decision is made as to whether the lanyard switch is open, indicating that the driver has had a mishap and has pulled the lanyard switch which is usually tied to the driver. The system then goes to step 402 where all power to the engine and system is cut. The system will then go to "End", which means the system is shut off. After the lanyard switch is reconnected, the system can be restarted as shown in Figure 2.

In Figure 5 the emergency button interrupt is detected at 501. As with the lanyard switch the electrical power to the engine and the system is cut at step 502 and the system and the engine are shut down. The system may be restarted after the emergency button has been reset, as shown in Figure 2.

Figure 6 shows how cruise or manual modes are selected.
At step 601 a sensor device is used to sense the position of the lever 28 so the system knows whether the lever is in the cruise or manoeuvring position. At step 600 the operator places the system into either the cruise or manoeuvring mode and the sensor at step 601 is monitored to determine whether it has been set. If the sensor has been set the system moves to step 602 and the flag for cruise mode is set and the cruise LED 42 blinks to show that cruise mode has been pre-selected. If manoeuvring mode was selected, the system at 603 would blink the manoeuvring mode light emitting diode 43 to show that manoeuvring mode was pre-selected. The system then goes to position 604 where the position of the lever 28 is read and the engine speed is read and the throttle feedback is read so the engine speed can be brought to match the lever position having regard to the mode in which the boat is operating.

In cruise mode, the boat is generally moving at high speed out in the open water. In manual mode, the boat is moving at very low speed and typically is docking or otherwise coming to a stop or manoeuvring around objects, etc.

At step 605 the pre-selected cruise or manoeuvring mode, indicated by the set cruise or manoeuvring LED flag, is set by setting the cruise or manoeuvring flag and blinking LED 42 or 43 changes to permanent illumination.

In the claims which follow and in the preceding description of the invention, except where the context requires otherwise due to express language or necessary implication, the word "comprise", or variations such as "comprises" or "comprising", is used in an inclusive sense, i.e. to specify the presence of the stated features but not to preclude the presence or addition of further features in various embodiments of the invention.
Since modifications within the spirit and scope of the invention may readily be effected by persons skilled within the art, it is to be understood that this invention is not limited to the particular embodiment described by way of example hereinabove.
Claims

1. A system for controlling a fixed propeller drive for a boat, comprising:
   an engine for driving the propeller;
   a clutch for allowing power to be supplied from the engine to the propeller/
   a drive element for operating the engine to change the speed of the engine;
   a temperature sensor for providing a measure of engine temperature; and
   a processor for limiting engine speed when the engine is cold below a predetermined temperature regardless of the position of the drive element and its adjustment by an operator of the vessel.

2. The system of claim 1 wherein the engine sensor provides a signal while the engine warms up so that the processor can increase the amount of throttle, which is obtainable, when the drive element is moved, dependent on the engine temperature signal, up to the maximum speed of the engine, when it is at normal operating temperature.

3. The system of claim 1 wherein the system includes selectors for selecting cruise mode or manoeuvring mode and wherein the processor determines the drive element position, the engine speed and the throttle feedback, and wherein engine temperature is again read by the processor and maximum throttle is set depending on whether the engine is warm or cold so that if the engine is cold, the processor limits the amount of speed the engine can produce until such time as the engine becomes warm.

4. The system of claim 1 wherein a number of interrupt commands can be provided to the system including an engine switch off to switch off the system, a lanyard switch open to switch off the system in the event of a
lanyard becoming open because of possible driver emergency, and an emergency stop button signal to shut off the system.

5. The system of claim 1 wherein timers are set when in the cruise or manoeuvring mode so that when a time limit exceeds the set time and the drive element is in neutral, the throttle is reduced to less than the maximum throttle for that particular mode and, if so, a new target throttle is set based on the mode and, if not, the target throttle is set as that maximum throttle for that particular mode.

6. A control system for a fixed propeller marine propulsion system for a boat, comprising:
   a cruise mode;
   a manoeuvring mode;
   a selector for selecting the cruise mode or the manoeuvring mode;
   a processor for determining which mode has been selected and for setting engine speed in response to position of a drive element dependent upon the mode in which the system is in.

7. The system of claim 6 wherein the processor includes a timer for timing the amount of time the system remains in cruise mode after a drive element has been placed in neutral and if the time expires before the drive element is moved, the cruise mode is cancelled.

8. The system of claim 7 wherein the timer also times the amount of time the system is in manoeuvre mode if the control lever is in neutral and if a predetermined time is reached, the manoeuvring mode is cancelled.

9. The system of claim 6 wherein the system further comprises a clutch for supplying power from an engine to a
propeller.

10. The system of claim 8 wherein the predetermined time for the cruise mode is less than the predetermined time for the manoeuvring mode because it is expected that the drive element is moved in and out of neutral more often and may stay in neutral for much longer periods during manoeuvring than would be the case when the boat is travelling in cruise mode.

11. The system of claim 7 wherein after the manoeuvre and cruise modes have been cancelled, the clutch stays disengaged and the processor sets the system to determine whether the target throttle, which is set, is less than the maximum throttle for the particular mode and, if so, a new target throttle is set and the system returns to determining whether engine warm up has occurred and if the target throttle is not less than the maximum throttle, the target throttle is set at the maximum throttle for the particular mode.

12. The system of claim 6 wherein the drive element comprises a manually operated drive lever.

13. A method of controlling a fixed propeller drive for a boat, comprising:
   providing an engine for driving the propeller;
   providing a clutch for allowing power to be supplied from the engine to the propeller;
   providing a drive element for operating the engine to change the speed of the engine;
   measuring engine temperature; and
   limiting engine speed when the engine is cold below a predetermined temperature regardless of the position of the drive element and its adjustment by an operator of the vessel.
14. The method of claim 13 wherein the method includes selecting cruise mode or manoeuvring mode and controlling engine speed to a predetermined speed until such time as the engine becomes warm.

15. The method of claim 13 wherein a number of interrupt commands are provided including an engine switch off to switch off the system, a lanyard switch open to switch off the system in the event of a lanyard becoming open because of possible driver emergency, and a stop button emergency to shut off the system.

16. The method of claim 13 wherein the clutch allows power to be supplied in forward and reverse direction.

17. The method of claim 13 wherein the time the drive element is in neutral is measured when in the cruise or manoeuvring mode so that when the time exceeds a set time, the throttle is reduced to less than the maximum throttle for that particular mode and, if so, a new target throttle is set based on the mode and, if not, the target throttle is set as that maximum throttle for that particular mode.

18. A method of controlling a fixed propeller marine propulsion system, comprising:
   providing a cruise mode;
   providing a manoeuvring mode;
   selecting the cruise mode or the manoeuvring mode, determining which mode has been selected and for setting engine speed in response to position of a drive element indicative of the mode in which the vessel is in.

19. The method of claim 18 wherein the method times the amount of time the system remains in cruise mode after a drive element has been placed in neutral and if the time expires before the drive element is moved, the cruise mode is cancelled.
20. The method of claim 19 wherein the method times the amount of time the boat is in manoeuvre mode if the control lever is in neutral and if a predetermined time is reached, the manoeuvring mode is cancelled.

21. The method of claim 18 wherein the predetermined time for the cruise mode is somewhat less than the predetermined time for the manoeuvring mode because it is expected that the boat may remain in a position in which the drive element is in neutral for much longer periods during manoeuvring than would be the case when the boat is travelling at much higher speeds in cruise mode.

22. The method of claim 21 wherein after the manoeuvre and cruise modes have been cancelled, the method sets the system to determine whether the target throttle, which was set, is less than the maximum throttle for the particular mode and, if so, a new target throttle is set and a determination is made whether engine warm up has occurred and if the target throttle is not less than the maximum throttle, the target throttle is set at the maximum throttle for the particular mode.
Start (Turn Ignition Key on)

Internal Controller Check
LED Check
Disengage Clutch

Open Starter Circuit
Read Control Lever Pos.

Control Lever in neutral

yes

no

Clutch engaged?

yes

no

Close Starter Circuit
Stop Drive LED Blinking

Disengage Clutch

Blink Drive (Clutch) LED

Read Engine Speed
Read Engine Temperature

Has Engine started?

yes

no

Is the Engine warm?

Max. Throttle = Cold maximum Throttle

Max. Throttle = Cold maximum Throttle

FIGURE 2
A

Read Lever Position
Read Throttle Feedback
Read Engine Speed
Check Drive (Clutch) button

701

Drive Button pressed? [no]

702

703 [yes]

Set Clutch Flag
Blink Drive (Clutch) LED

704

Set Throttle if(ENG CHECK &
Lever Position)

705 [no]

Engine Speed <
Max. Engage
Speed

706

Forward
Lever
Direction?

707

Select Forward Gear
Engage Clutch
Switch Clutch LED off

708

Reverse

Select Reverse Gear
Engage Clutch
Switch Clutch LED off

709

Set Throttle = f(Mode, Lever Position)

710

Read Throttle Feedback

711 [yes]

Throttle > max
Throttle(Mode)?

712 [no]

Set Throttle to max Throttle(Mode)

C

FIGURE 7
Read Engine Temperature

Has Engine Warmed up?

Max. Throttle = Cold maximum Throttle

Max. Throttle = Cold maximum Throttle

Read Lever Position
Check for Interrupts
Target Throttle = f(Mode, Lever Position)

Control Lever in neutral

Reset Clutch Timer

Cruise or MAN Flag set?

Start Timer to unset MAN Flag

Start Timer to unset CRUISE Flag

Timer > timer Limit?

Unset MAN/CRUISE Flag

Target Throttle Max. Throttle(Mode)?

Target Throttle = Max. Throttle(Mode)

Set new Target Throttle

FIGURE 8
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.
B63H 21/21 (2006.01)

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DWPI IPC B63H, FO2D 29/ and keywords: engine, temperature, speed and similar terms

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No</th>
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<tr>
<td>X</td>
<td>US 6109235 A (HOSHBA et al) 29 August 2000 Column 2, lines 29-40; column 3, lines 6-14</td>
<td>1, 2, 4, 13, 15, 16</td>
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<td>Y</td>
<td>US 6790107 B2 (TANAKA) 14 September 2004 Abstract; column 4, line 66-column 5, line 3</td>
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<td>Y</td>
<td>Derwent Abstract Accession No. 2001-429884/46, Class Q13 W06, JP 2001 152897 A (SANSHIN KOGYO KK) 5 June 2001</td>
<td>5, 17</td>
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Further documents are listed in the continuation of Box C See patent family annex

Date of the actual completion of the international search
22 December 2006

Date of mailing of the international search report
- 5 JAN 2007

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Form PCT/ISA/210 (second sheet) (April 2005)
### INTERNATIONAL SEARCH REPORT

**International application No.**
PCT/AU2006/001489

C (Continuation).

**DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
<th>Citation of document, with indication, where appropriate, of the relevant passages</th>
<th>Relevant to claim No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
<td>US 65991 58 B2 (SHIDARA et al) 29 July 2003 Column 1, line 5 1-column 2, line 55</td>
<td>5, 17</td>
</tr>
<tr>
<td>A</td>
<td>US 2005/01 99 167 A1 (MIZUTANI) 15 September 2005</td>
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</tbody>
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Form PCT/ISA/210 (continuation of second sheet) (April 2005)
This international search report has not been established in respect of certain claims under Article 17(2)(a) for the following reasons:

1. □ Claims Nos.:
   because they relate to subject matter not required to be searched by this Authority, namely:

2. □ Claims Nos.:
   because they relate to parts of the international application that do not comply with the prescribed requirements to such an extent that no meaningful international search can be carried out, specifically:

3. □ Claims Nos.:
   because they are dependent claims and are not drafted in accordance with the second and third sentences of Rule 6.4(a)

This International Searching Authority found multiple inventions in this international application, as follows:

1. Claims 1-5, 13-17 are directed to a system/method for controlling a fixed propeller drive including a processor for limiting engine speed when the engine is cold.
2. Claims 7-12, 18-22 are directed to a system/method for controlling a fixed propeller drive including a processor for setting the engine speed dependent on a cruise or manoeuvring mode.

1. □ As all required additional search fees were timely paid by the applicant, this international search report covers all searchable claims.
2. □ As all searchable claims could be searched without effort justifying additional fees, this Authority did not invite payment of additional fees.
3. □ As only some of the required additional search fees were timely paid by the applicant, this international search report covers only those claims for which fees were paid, specifically claims Nos.

4. □ No required additional search fees were timely paid by the applicant. Consequently, this international search report is restricted to the invention first mentioned in the claims; it is covered by claims Nos.: 1-5, 13-17

Remark on Protest

□ The additional search fees were accompanied by the applicant's protest and, where applicable, the payment of a protest fee.

□ The additional search fees were accompanied by the applicant's protest but the applicable protest fee was not paid within the time limit specified in the invitation.

□ No protest accompanied the payment of additional search fees.
This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

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<tr>
<td>US 6109235</td>
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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX