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June 6, 1945. J. H. HAMMOND, JR. 2,321,024

PROPELLER CONTROL SYSTEM

Filed Aug. 22, 1941 3 Sheets-Sheet 1

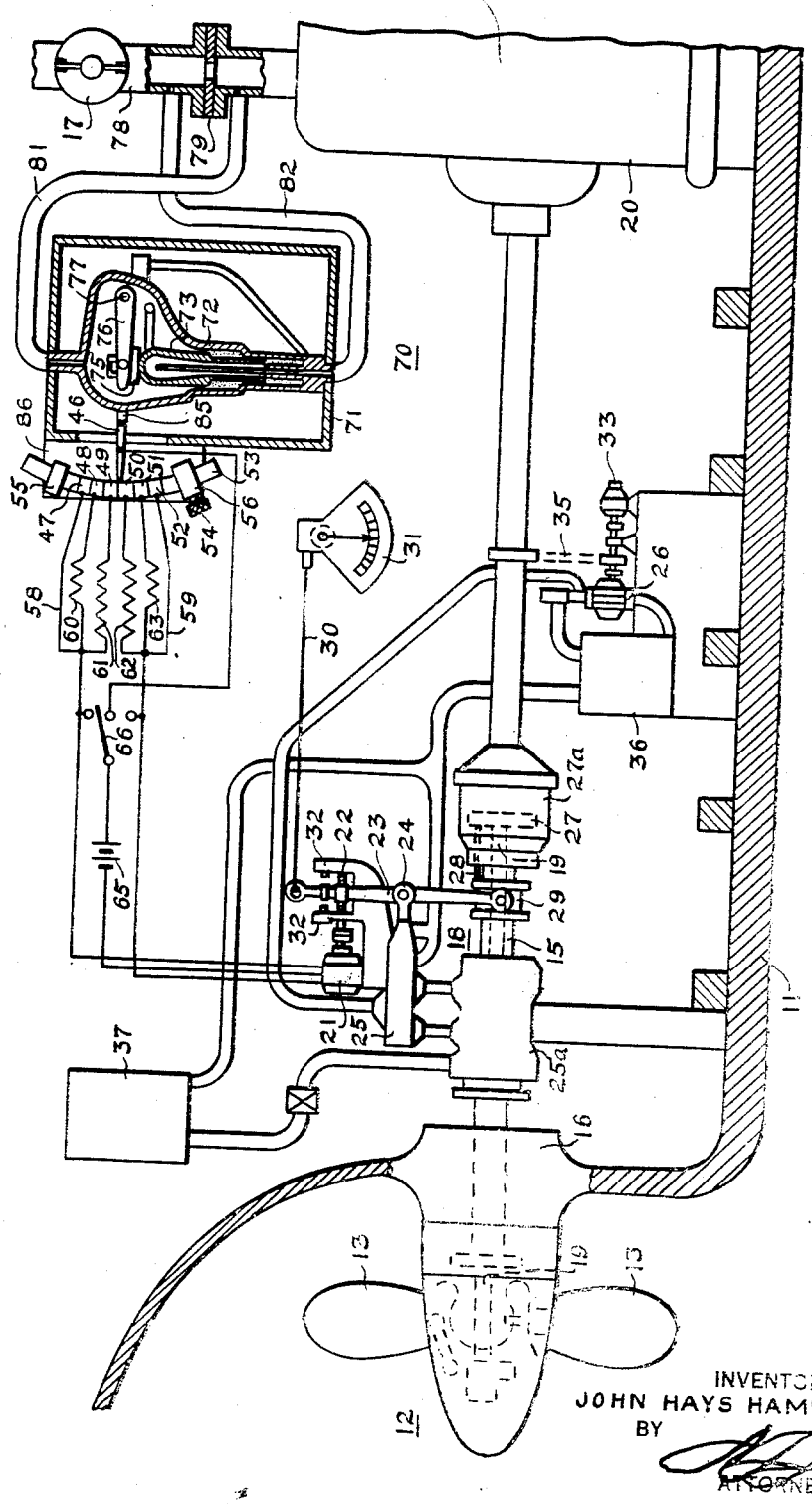


Fig. 1.

INVENTOR
JOHN HAYS HAMMOND, JR.
BY
ATTORNEY

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U.S. MARINE PROPULSION

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PROPELLER CONTROL SYSTEM

Filed Aug. 22, 1941 3 Sheets-Sheet 2

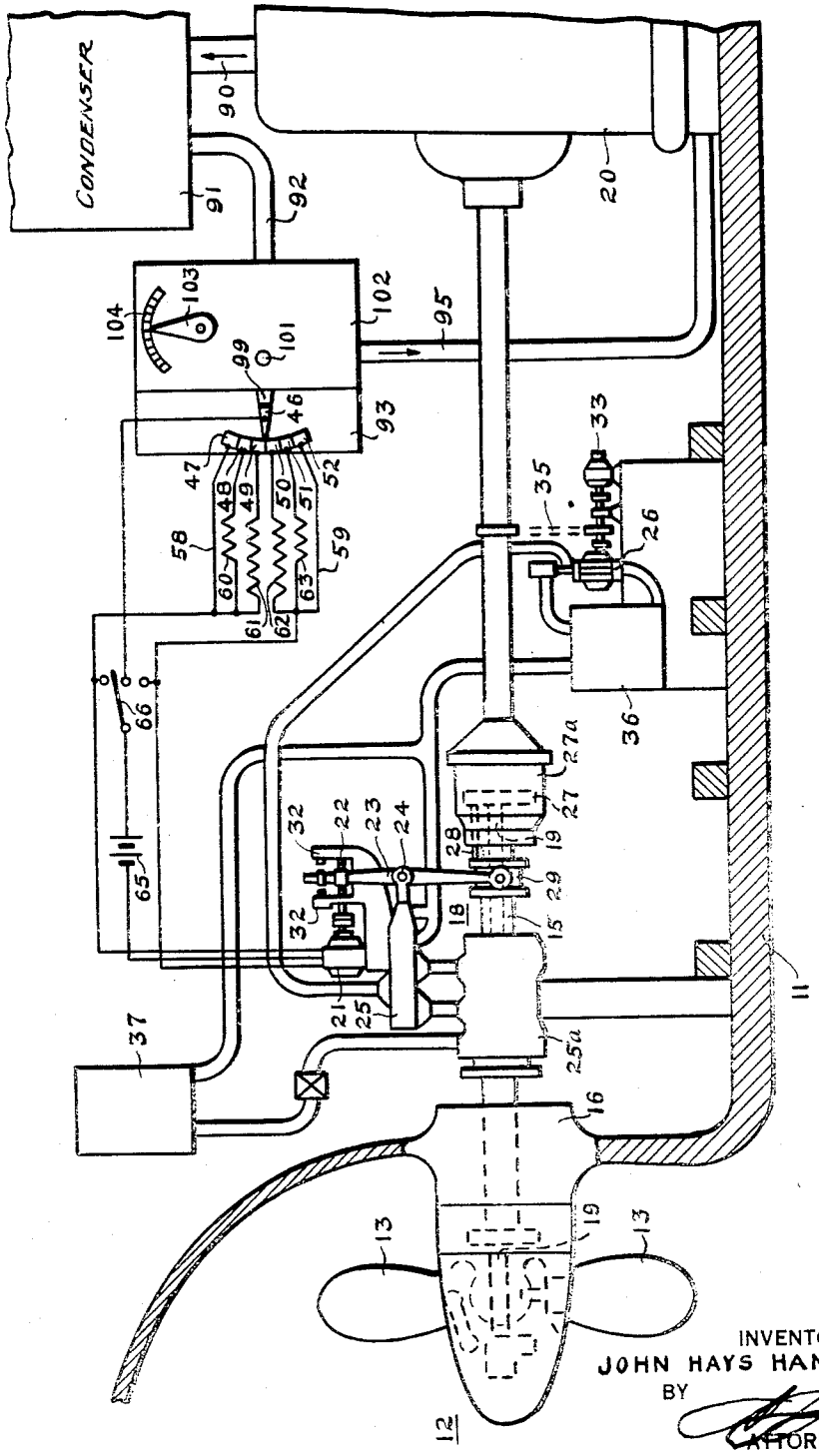


Fig. 2.

INVENTOR
JOHN HAYS HAMMOND, JR.
BY
ATTORNEY

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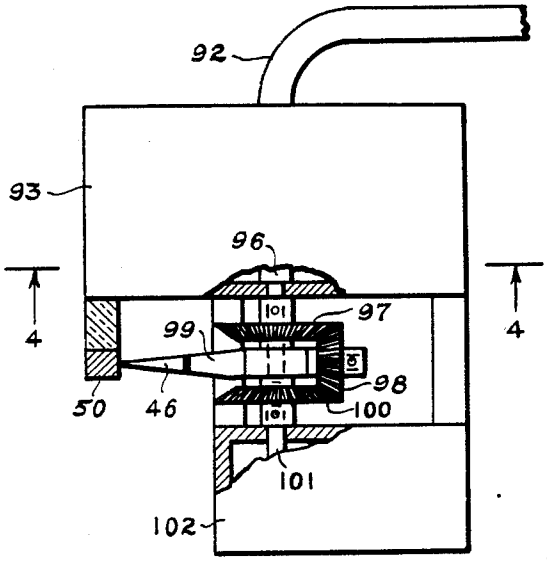


Fig. 3.

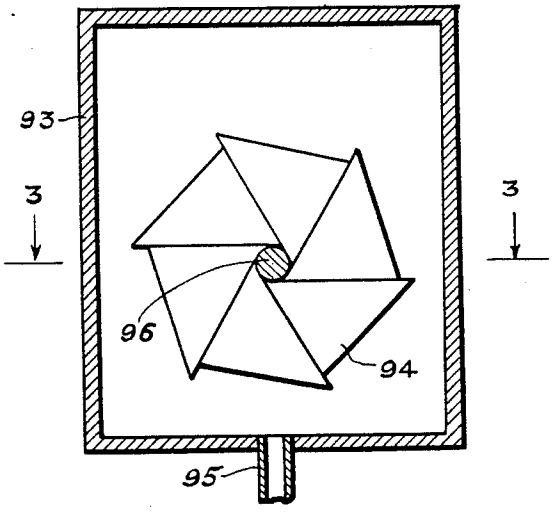


Fig. 4.

INVENTOR
JOHN HAYS HAMMOND, JR.
BY
ATTORNEY

Patented June 8, 1943

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UNITED STATES PATENT OFFICE

2,321,024

PROPELLER CONTROL SYSTEM

John Hays Hammond, Jr., Gloucester, Mass.

Application August 22, 1941, Serial No. 407,892

6 Claims. (Cl. 170—135.6)

This invention relates to variable pitch propeller systems and more specifically to a system for automatically varying the pitch of a propeller in accordance with a characteristic of the prime mover.

The invention further relates to means for controlling or measuring the stem consumption of the prime mover which directly controls means for varying the pitch of the propeller blades in such a way that the steam consumed by the prime mover is maintained at a constant value.

The invention also provides means for varying the rate of change of pitch of the propeller blades in accordance with the rate of change of steam consumption, thus preventing rapid changes of pitch of the propeller blades which might cause unnecessary strain and vibration on the driving machinery.

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 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 drawings forming a part thereof, in which

Figure 1 illustrates diagrammatically the system as applied to the steam consumption meter of the prime mover.

Figure 2 illustrates diagrammatically the system as applied to the condensation meter of the prime mover.

Figure 3 is a top plan view of the control apparatus, partly in section taken on line 3—3 of Figure 4, and

Figure 4 is a vertical section taken on line 4—4 of Figure 3.

Like reference characters denote like parts in the several figures of the drawings.

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, and more particularly to Figure 1, 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. The shaft 15 is driven by a prime mover 20 which may be of any desired type but is preferably of a steam engine type and is provided with a governor 17, 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.

A fluid meter 70, which may be of any well known and standard construction such as that manufactured by the Bailey Meter Co. of Cleveland, Ohio, and described on pages 9–11 of their bulletin 301, is shown for measuring the volume of steam supplied to engine 20. The meter 70 consists essentially of a box 71 in which is mounted a bell casing 72. Positioned inside of this casing is a mercury sealed Ledoux bell 73, which is free to move up and down inside the casing 72. A cap 75 rests on top of the bell 73 and is attached by a forked lever 76 to a spindle 77.

The engine 20 is supplied with steam thru a pipe 78 in which is located an orifice plate 79. The interior of the casing 72 is connected by a tube 81 to a point in the pipe 78 below the orifice plate 79 and the interior of the bell 73 is connected by a tube 82 to a point in the pipe 78 above the orifice plate 79.

The spindle 77, which passes thru the wall of the casing 72, is connected to an arm 85. Mounted on but insulated from the arm 85 is a contact 46, which selectively engages six segments 47—52 mounted on but insulated from an arc shaped member which is slidably mounted in brackets 55 and 56, which are attached to a plate 86 secured to the box 71. The bracket 56 is provided with a clamping screw 54 for holding the member 53 and contacts 47—52 in any desired position.

The segments 47 and 52 are connected by flexible conductors to two conductors 58 and 59 which in turn are connected to the reversing windings of the motor 21. The segments 48 and 49 are connected by flexible conductors to two resistors 60 and 61 which in turn are connected to the conductor 58. The segments 50 and 51 are connected by flexible conductors to two resistors 62 and 63 which in turn are connected to the conductor 59. The common lead of the reversing windings of the motor 21 is connected thru a battery 65 to the blade of a three position switch 66. The center contact of this switch is connected to the contact 46, the upper contact to the conductor 58 and the lower contact to the conductor 59.

Operation of Figure 1

In the operation of the form of the invention shown in Figure 1 the pitch of the blades 13 is first set at the normal operating angle for the speed at which it is desired to operate the vessel. The setting of the propeller blades 13 is accomplished by moving the blade of the switch 65 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 vessel is brought up to the desired speed in the usual manner. The steam necessary to supply the engine 20 under these conditions passes thru the orifice in the plate 79 which causes an increase of pressure in the pipe 82 and a decrease of pressure in the pipe 81. The reduced pressure established in the pipe 81 is applied to the interior of the casing 72 and the increased pressure established in the pipe 82 is applied to the interior of the bell 73. This causes the bell 73 to rise an amount proportional to the difference in pressures in the pipes 81 and 82.

The motion of the bell 73 is transmitted, by means of the cap 75 and lever 76, to the arm 85 and contact 46 which takes up a position depending upon the difference in pressure inside and outside the bell 73 which is proportional to the volume of steam consumed by the engine 20. The member 53 is then moved until the insulation between the segments 49 and 50 is under the contact 46 and is held in this position by tightening the screw 45. The blade of the switch 66 is then moved into engagement with the center contact.

If the forces against which the vessel is moving should increase, the speed of the propeller 12 would decrease and the throttle valve would be opened by the governor to supply more steam to the engine 20. This increased volume of steam would cause a greater difference in pressure between the inside and outside of the bell 73 thus causing it to move up, which in turn would cause the contact 46 to engage the segment 49. This will close a circuit from the battery 65 thru the resistor 61 to the motor 21 causing it to rotate slowly in a direction to move the upper end of the lever 23 to the right which will allow fluid under pressure to pass from the pump 26 to the cylinder 27a by means of the ducts in the shaft 15. This will actuate the piston 27, which, by means of the rod 19 and link mechanism will cause the propeller blades 13 to slowly decrease their pitch. This will allow the engine 20 to increase the speed of rotation of the propeller, which in turn will increase the speed of the governor 17, thus decreasing the supply of steam to the pipe 78. This action will continue until the contact 46 is again on the insulation between the segments 49 and 50 at which time the motor 21 will stop.

If under favorable conditions the speed of the propeller should increase, the opposite action would take place and the contact 46 would engage the segment 50 which would cause the blades 13 to slowly increase their pitch until the steam consumption had been increased to the desired value.

If the changed conditions cause a rapid change of engine speed so that the contact 46 engages either of the segments 48 or 51, then the resistor 60 or the resistor 63 will be thrown in circuit with the motor 21. As resistors 60 and 63 have less resistance than resistors 61 and 62, 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 conditions change so quickly that the contact 46 engages either segment 47 or segment 52, 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 steam consumption, and therefore the power supplied from the engine 20, constant under varied conditions. The rate of change of pitch will vary in accordance with the change of steam consumption so that with a gradual change of steam consumption there will be a slow change of propeller pitch, thus preventing violent changes of pitch which would cause undue strain on the driving mechanism, disagreeable vibrations and inefficiency of the propeller, but a more abrupt change in steam consumption will be promptly and quickly corrected by a more rapid actuation of the pitch control means.

Referring to the modified form of the invention shown in Figures 2, 3 and 4, the mechanism up to and including the tank 37 is identical to that already described and corresponding parts have been given the same numerals. In this form of the invention the governor and throttle valve are not shown but, it is to be understood that such devices may be used to maintain the speed of the shaft 15 constant.

In Figure 2 the engine 20 is shown as exhausting thru an exhaust pipe 90 to a condenser 91, the condensate from which passes thru a pipe 92 to a

metering device 93 which may contain a rotary condensation meter 94 (Figure 4) such as that made by the American District Steam Co. of North Tonawanda, New York, and described in their bulletin No. 35–80. A drain pipe 95 is connected to the device 93. The meter 94 is provided with a shaft 96 to which is attached a bevel gear 97 (Figure 3) which meshes with a bevel pinion 98. The pinion 98 is rotatably mounted on a member 99 which in turn is rotatably mounted on the shaft 96. Meshing with the bevel pinion 98 is a second bevel gear 100 which is secured to the shaft 101 of a variable speed mechanism such as a clockwork mechanism 102. The speed of rotation of the gear 100 is controlled by the position of a pointer 103 (Fig. 2) which registers with a scale 104.

Attached to the member 99 is the contact 46 which selectively engages the segments 47 to 52 which are mounted on but insulated from the device 93. The segments 47—52 are connected to the motor 21 by conductors 58 and 59, resistors 60—63, battery 65 and switch 66 as described in connection with Figure 1.

Operation of Figures 2, 3 and 4

In the operation of the modified form of the invention shown in Figures 2, 3 and 4, the vessel is brought up to the desired speed in the usual manner. The exhaust steam from the engine under these conditions passes thru the pipe 90 to the condenser 91 where it is condensed to water. The condensate from the condenser 91 then passes thru the pipe 92 to the rotary condensation member 94 which is caused to rotate in a clockwise direction at an approximately uniform rate of speed which is determined by the amount of condensate and therefore by the amount of steam supplied to the engine 20.

The clockwise mechanism 102 is then started in motion and its speed is regulated by the pointer 103 until the gear 100 rotates in a counterclockwise direction at the same speed as the gear 97 rotates in a clockwise direction. Under these conditions the member 99 on which the pinion 98 is mounted will not rotate on the shaft 96, but will remain stationary with the contact 46 on the insulation between the segments 49 and 50. The switch 66 is now closed on the center contact.

If the forces against which the vessel is moving should increase, the speed of the propeller 12 would decrease and the throttle valve would be opened by the governor to supply more steam to the engine 20. This increase of steam used by the engine 20 would cause a greater volume of condensate to leave the condenser 91 by the pipe 92 and enter the rotary meter 94. This would cause an increase of speed of rotation of the shaft 96 which would then rotate the gear 97 faster in a counterclockwise direction then the gear 100 is rotated in a clockwise direction. Due to the differential action of the mechanism the member 99 would then start rotating slowly in a clockwise direction.

This action would cause the contact 46 to engage the segment 49 which as already described in connection with Figure 1 would cause a gradual decrease in pitch of the blades 13, thus causing the engine 20 to speed up which, by means of the governor, would decrease the supply of steam and therefore reduce the volume of the condensate. This would cause the gear 97 to reduce its speed of rotation until the contact 46 was again on the insulation between the segments 49 and 50 at which time the motor 21 would stop.

If under favorable conditions the speed of the propeller should increase the opposite action would take place and the contact 46 would engage the segment 50 which would cause the blades 13 to slowly increase their pitch until the steam consumption and therefore the volume of condensation had been increased to the fixed value. If conditions changed more rapidly the change of propeller pitch would be more rapid as described in connection with Figure 1.

It is thus seen that a system has been developed which will maintain the steam consumption of a prime mover constant under various conditions of wind and weather and that the vessel will be propelled in the most economical manner with a fixed steam consumption.

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 limited to any specific construction but might be embodied in various forms without departing from the spirit of the invention or the scope of the appended claims.

What is claimed is:

1. In a system for driving a vessel, a propeller having blades, means controlling the pitch of said blades, a steam actuated motor driving said propeller, a steam consumption meter, means connecting said meter to be actuated in accordance with the rate of steam consumption of said motor, and means actuated by said meter to cause said pitch control means to decrease the pitch of said blades in response to an increased rate of steam consumption and vice versa so as to maintain a substantially constant rate steam consumption.

2. In a system as set forth in claim 1, a governor connected to cause the propeller to operate at constant speed.

3. A system as set forth in claim 1 in which the meter comprises a pressure actuated device, means to produce a pressure differential proportional to the rate of steam flow to said motor and means connecting said device to be responsive to said pressure differential.

4. In a system as set forth in claim 1, a condenser to condense the exhaust steam from said motor, means supplying condensate from said condenser to said meter, said meter being responsive to the rate of condensate flow and being connected to control the pitch of said blades inversely of the rate of condensate flow.

5. In a system as set forth in claim 1, means responsive to the amplitude of change in steam consumption, said last means being connected to increase the speed of operation of said pitch control means when the amplitude of change in steam consumption is greater and vice versa, regardless of the direction of such change.

6. The invention set forth in claim 1 in which the meter is responsive to the rate of steam condensation and means causing condensation of the exhaust steam at a rate proportional to the rate of flow of the steam supplied to said motor.

JOHN HAYS HAMMOND, JR.