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CONTROL DEVICE FOR ADJUSTING A VARIABLE-PITCH MARINE PROPELLER

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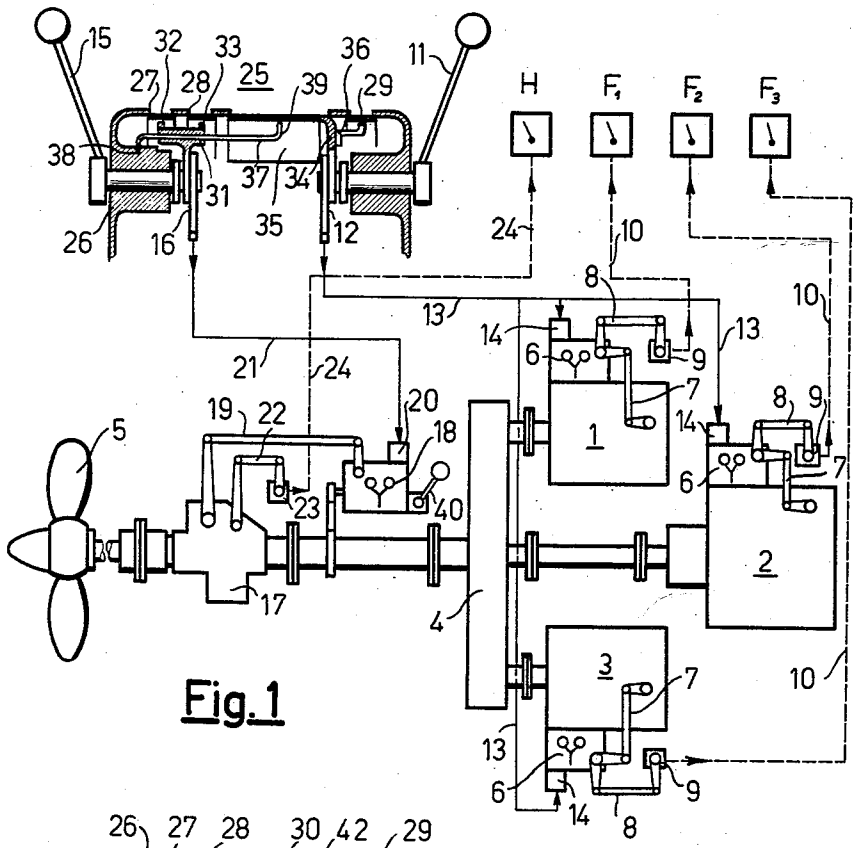


Fig. 1

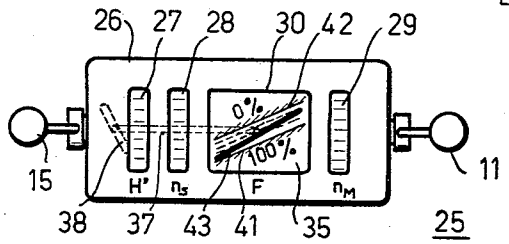
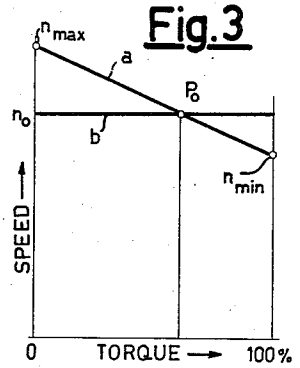


Fig. 2

Fig. 3



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CONTROL DEVICE FOR ADJUSTING A VARIABLE-PITCH MARINE PROPELLER

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This invention relates to control device for adjusting a ship's propeller with adjustable blades and at least one engine driving the propeller and provided with a speed governor controlling the power-medium supply to the said engine. Such devices are known which have two adjusting members, namely a first adjusting member for varying the required value of the engine speed, and a second adjusting member for varying the pitch of the propeller blades.

The speed governor is normally mounted directly on the propulsion engine. It is connected to the navigating bridge by a speed-adjusting member. Its adjusting member affects the supply of power medium, and adjusts the latter so that the speed is maintained within a predetermined range. This regulating system serves principally to protect the propulsion engine from overspeed. On increase in the speed, the supply of power medium is reduced and on decrease in speed, it is increased. Increase in the supply of power medium is, however, impossible when the engine is already fully loaded.

By means of the other adjusting member, the propeller pitch is normally adjusted by hand. A safety device must limit the propeller pitch so that overloading of the propulsion engine is prevented. It should respond to the effective value of the admission as a function of the speed.

For given conditions, a definite propeller pitch, at which maximum economy of working is obtained, can be co-ordinated with each speed. The decisive factor is the product of propeller efficiency and efficiency of the propulsion engine. The co-ordination will be different, however, if the head resistance varies or, for example, if a propulsion engine is inoperative.

In a device of the kind described in the foregoing, all requirements are satisfied, according to the invention, in a simple manner by providing the engine with a speed governor affording comparatively large percentage regulation, and by providing an additional speed governor of the constant speed or isochronous type, for adjusting the propeller pitch. This additional governor includes means for adjusting the control speed of the governor.

A constructional example of the device according to the invention is shown in simplified form in the drawing.

FIG. 1 shows an installation having a variable-pitch propeller driven by three engines, and

FIG. 2 shows a plan of the control device.

FIG. 3 is a graph illustrating the operation of the device.

Three propulsion engines 1, 2, 3 drive by means of a gear 4 a variable-pitch marine propeller 5. Each of these engines 1, 2, 3 is provided with a speed governor 6 which by means of a linkage 7 adjusts the power medium supply to the engine. In the case of diesel engines, the linkage 7 would act on the fuel supply and in the case of steam turbines, it would act on the supply of steam to the machine. Indicating instruments F_1, F_2, F_3 indicate on the navigating bridge the effective value of the admission. This effective value is first transmitted mechanically by linkage 8 to co-ordinated transmitters 9 and thence to the indicating instruments F_1, F_2, F_3 by any remote-transmission means 10 of a mechanical, hydraulic or electrical nature. The governors 6 are proportional controllers

and are designed so that the engines 1, 2, 3 operate with a comparatively large percentage speed change, for example 8 to 10 percent, or even more, between full-load and no-load conditions. This percentage speed change also called speed droop, of the engines 1, 2, 3 is larger than, for example, the percentage speed change permitted by the governors used to regulate the water turbines in power stations.

A first adjusting member 12, to be operated by means of a hand lever 11, serves to adjust the required speed range at the governors 6 of the engines 1, 2, 3. The adjustment of the member 12 is transmitted by transmission means 13 of any kind to speed-adjusting devices 14 of the governors 6.

A second adjusting member 16, operated by a hand lever 15 is intended for adjustment of the propeller pitch. The propeller blades are actuated by an adjusting motor mounted in a housing 17, this motor being controlled by a speed governor 18 driven off the propeller shaft and acting through a linkage 19. The governor 18 is provided with a speed-adjusting device 20, and is so constructed that it operates for constant speed regulation or at the most with a very small permanent percentage regulation, that is to approximately for constant speed regulation. The movement of the adjusting member 16 is transmitted by any transmission means 21 to the speed adjusting device 20 of the governor 18. The effective pitch value is transmitted by linkage 22 to transmitter 23 and thence, by any remote-control means 24 to an indicating instrument H mounted on the navigating bridge.

The parts 11, 12, 15, 16 are components of a control apparatus 25 mounted on the navigating bridge. They are journalled in a housing 26 of this apparatus. The housing is provided with slots 27, 28, 29, with scales above them, and a rather wider rectangular aperture 30. A part 31 rigidly connected to the adjusting member 16 is provided with pointers 32 and 33, permitting the position of the member 16 to be read off on the scales of the slots 27 and 28. Rigidly connected to the adjusting member 12 is furthermore a part 34 carrying a cylindrically convex transparent screen 35 behind the opening 30. In addition, the part 34 carries a pointer 36 permitting the position of the member 12 to be read off on the scale of the slot 29. A rod 37 slidable in the direction of the axis of rotation in the part 31 projects by one end into an inclined slot 38 provided in the bearing body of the housing 26, so that it is displaced in its axial direction on adjustment of the member 16 by means of the hand lever 15. The other end 39 of the rod serves as indicating device behind the screen 35. Each position of the two members 12 and 16 is thus characterised by a point on the curved screen 35 as determined by the relative position of the end 39 of the rod 37 relatively to the screen 35.

Finally, 40 denotes a fixing device, by means of which the influence of the speed governor 18 on the propeller pitch adjustment can be eliminated.

The operation of the device is as follows:

To maintain a predetermined operating condition of the ship, the required speed is adjusted simultaneously by means of the handles 11 and 15 on the speed governors of the engines 1, 2, 3 and on the speed governor 18 of the propeller 5. Due to their comparatively large percentage regulation, the governors 6 permit a certain amount of margin for the speed, which varies according to the load within this margin.

In FIGURE 3, the engine speed is plotted against the engine torque. Governor 6 regulates according to the sloping curve a with comparatively large deviation of the idling speed n_{max} from the full load speed n_{min}.

The constant-speed or almost constant-speed governor 18, however, by suitable adjustment of the propeller pitch,

ensures that the predetermined speed n_0 is maintained by variation in the power consumption of the propeller. Governor 18 causes the blade adjusting motor to increase the propeller pitch on increase in speed and to reduce the propeller pitch on decrease in speed, and regulates according to the horizontal line *b* in FIGURE 3. In this way, regulation to a definite point P_0 on the percentage regulation curve *a* of the engine governor is effected and overloading avoided. Since the governor 18 adjusted by the hand lever 15 in this case ensures that the predetermined speed will be maintained, the hand lever 11 has by itself no influence on the speed. Adjustment of the governor 6 shifts curve *a* in the vertical direction, and, in accordance with its percentage regulation, only produces a variation in the admission and hence in the engine power, whereby point P_0 displaces horizontally on line *b*. This corresponds to the load adjustment in the well known case of power station turbines in an electricity network. If the speed of the ship alters, for example due to influence of the wind, short-time rotary speed variations occur, which however are immediately smoothed out. Thus, the propulsion engines operate with the same power medium supply, even if the head resistance of the ship varies.

Without departing from the invention governor 18 may also operate with a small speed droop, whereby line *b* of FIGURE 3 would slightly deviate from the horizontal direction while still having a definite point of intersection with line *a*.

A definite position of the end 39 of the rod 37 corresponds to each speed. With variation in the supply of power medium to the propulsion engines by the hand lever 11, the screen 35 is displaced relatively to the end 39 of the rod 37. Limit curves 41, 42 for the power medium supply, $F=100\%$ and 0% and intermediate curves are plotted on the screen 35. The hand levers 11 and 15 should always be adjusted so that the pin end 39 lies in the region between the two curves 41 and 42. In regard to a curve 43 which is also plotted it is assumed that it corresponds to a connection between speed and power medium supply at which the best economy of the installation is also obtained.

In the control apparatus 25, it is possible to provide a positive guiding of the rod end 39, so as to impose a suitable co-ordination of the movements of the two adjusting members 12 and 16. When positive guiding is desired, screen 35 is replaced by another screen, similar to screen 35 except that curve 43 is a slot instead of a line. The ship's installation can then be controlled by one of the two hand levers 11 and 16, that is to say, by a single control member. The speed n_s adjusted on the governor 18 of the propeller 5 will then be read off in the slot 28.

This method of operation is more particularly suitable for free-moving ships. The device also operates correctly should one of the propulsion engines be stopped. The propeller pitch will then be adjusted automatically so that the remaining engines are not overloaded.

The governor 18 is preferably so designed as to operate in the region above 75% of normal speed. At lower speeds, its pendulum may rest against the stop. The speed regulation is then taken over solely by the governors 6 of the propulsion engines, with the corresponding percentage regulation. The scale in the slot 28 and the curves of the screen 35 are then no longer valid. The scale in the slot 29 is preferably used for reading the speed range adjusted on the governors 6 of the propulsion engines. The hand lever 15, the position of which can be read off on scale H' in the slot 27, then serves for the optional adjustment of the propellor pitch H, unaffected by the speed. In the lower speed range, therefore, the apparatus can be used directly in the manner heretofore customary for optional adjustment of the propellor pitch in the case of speed-governed propulsion engines. This method of operation is preferably important for manoeuvring.

If, however, in manoeuvring, a higher speed is desired, the fixing device 40 permits the pendulum of the speed governor 18 to be fixed in its lowest position. It is then possible, for any speed range which is adjusted by the hand lever 11 on the governors 6 of the propulsion engines, to vary the propeller pitch arbitrariiy by operation of the hand lever 15, or also to maintain a predetermined functional relationship between speed and propeller pitch.

To facilitate the operation of the device, means may be provided which in the case of free pendulum of the speed governor 18, automatically illuminate the then valid curve diagram F of the screen 35 and the scale n_s in slot 28, but in the case of fixed pendulum, the scales H' and n_M in slots 27 and 29, respectively. A transmission device may be provided for operating the locking device 40 from the navigation bridge.

The propulsion engines 1, 2, 3 may be identical or mutually different engines, for example, diesel engines, steam turbines, gas turbines, the governors 6 being advantageously adjusted to each other in their percentage regulation, particularly in full load region. In the case of the use of different kinds of engines, it may also be found advantageous to distribute the power among the individual engines in a different proportion for partial load from that for full load.

What is claimed is:

1. A control device for adjusting a variable-pitch marine propeller and at least one engine driving the propeller, comprising servo actuated means for adjusting the propeller pitch; means for varying the supply of power medium to the engine driving the propeller; a first speed governor operatively connected with said means for varying the power medium supply so as to increase the medium supply when the engine speed decreases and to reduce the medium supply when the engine speed increases, the first speed governor being designed to operate with a relatively large permanent speed droop; a second speed governor operatively connected with the servo actuated means for adjusting the propeller pitch so as to increase the propeller pitch when the propeller speed increases and to reduce the propeller pitch when the propeller speed decreases, the second speed governor being designed to operate at least approximately with constant speed regulation at a predetermined speed value between the limits of said permanent speed droop of the first speed governor; and two adjusting members operatively connected with said speed governors, one serving to adjust the speed range of the first speed governor and the other serving to shift the predetermined value of the speed to be regulated by the second speed governor within the limits of said permanent speed droop of the first speed governor.

2. The device defined in claim 1 in which the two adjusting member are adjustable by hand independently of each other, and an indicating device is provided by means of which the maintenance of a predetermined co-ordination of the position of the two adjusting members relatively to each other can be controlled.

3. The device defined in claim 1 in which means are provided for the positive co-ordination of the movements of the two adjusting members so as to vary the relative position of the predetermined speed to be regulated by the second speed governor between the limits of the speed droop of the first speed governor in predetermined relationship to the adjustment of the range of said first speed governor.

4. The device defined in claim 1 in which locking means are operatively connected with the said second speed governor so as to allow suppression of the influence of this governor on the propeller pitch adjusting means.

5. A control-device for adjusting a variable-pitch marine propeller and at least two engines driving said propeller, comprising servo-actuated means for adjusting the propeller pitch; individual means for varying the supply of power medium to each of said engines driving the propeller; speed governors, one associated with each of

said engines and operatively connected with respective means for varying the power medium supply so as to increase the medium supply when the engine speed decreases and to reduce the medium supply when the engine speed increases, and designed to operate with a relatively large permanent speed droop; said speed governors having substantially equal speed range settings; a further speed governor operatively connected with the servo-actuated means for adjusting the propeller pitch so as to increase the propeller pitch when the propeller speed increases and to reduce the propeller pitch when the propeller speed decreases and designed to operate at least approximately with constant speed at a predetermined speed value between the upper and lower limits of the permanent speed droops of the first named speed governors; and two adjusting members operatively connected with said speed governors, one serving to adjust the speed ranges of the first named speed governors and the other serving to shift the predetermined value of the speed

to be regulated by said further speed governor within the limits of said permanent speed droops of the first named speed governors.

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