March 21, 1950 | F. ROESCH | 2,501,617

VARIABLE PITCH PROPELLER OPERATING MECHANISM
FOR MARINE PROPULSION PLANTS

Filed May 1, 1944 | 2 Sheets-Sheet 1

Fig. 1.

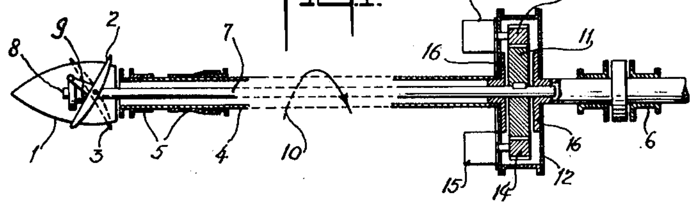

Fig. 2.

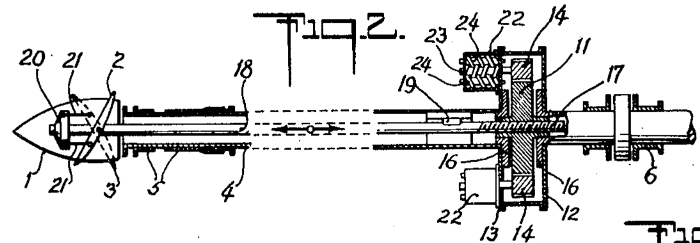

Fig. 3.

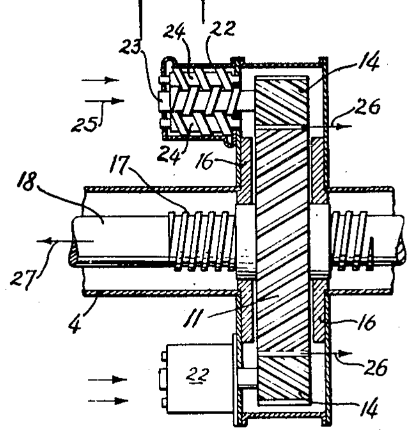

Fig. 4.

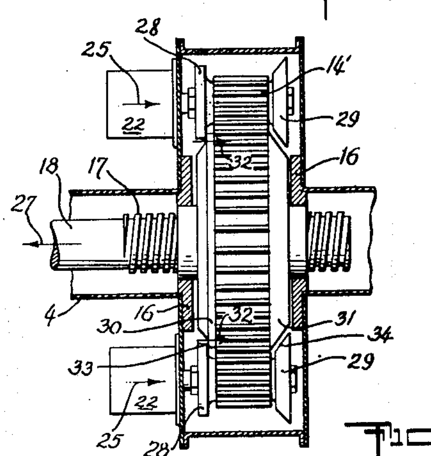

Fig. 11.

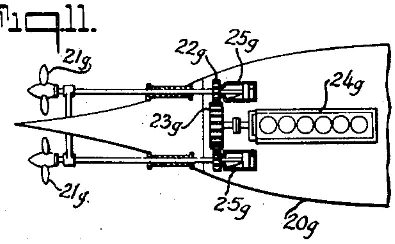

Fig. 12.

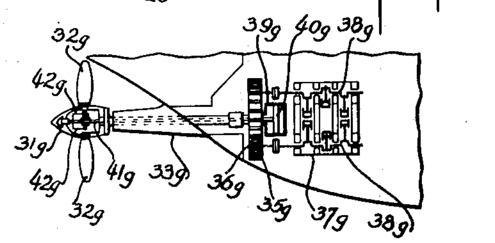

Fig. 10.

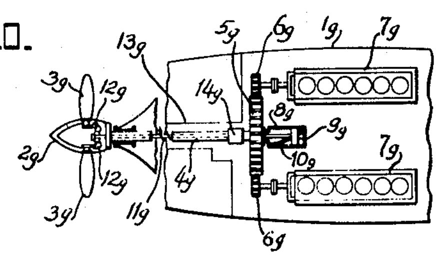

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Fig. 5.

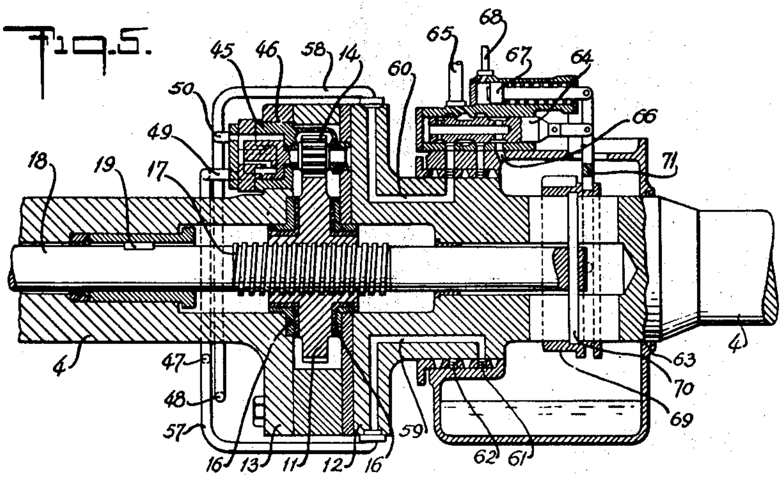


Fig. 6.

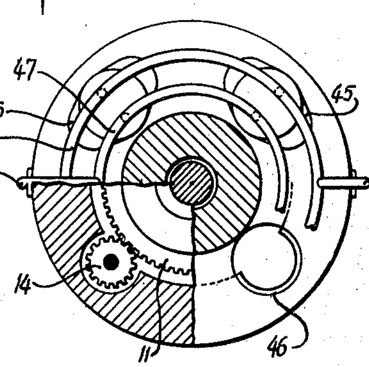


Fig. 7.

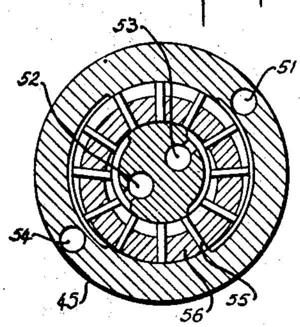


Fig. 8.

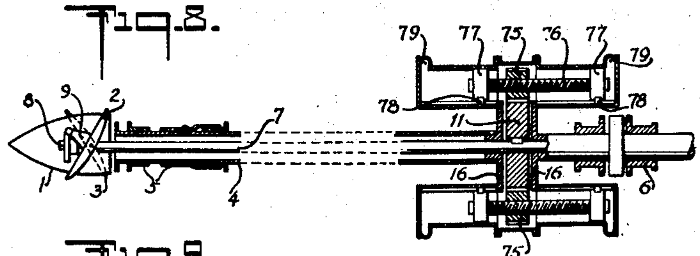
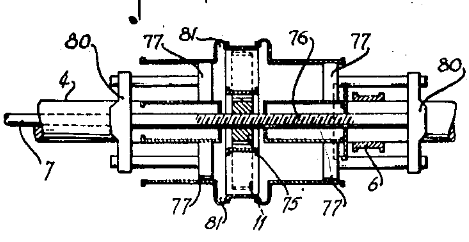


Fig. 9.



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VARIABLE PITCH PROPELLER OPERATING MECHANISM FOR MARINE PROPULSION PLANTS

Fritz Roesch, Lucerne, Switzerland

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12 Claims. (Cl. 170—160.31)

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The invention relates to an auxiliary device with one or more servomotors for adjusting the blades of a ship's propeller.

It is known to house the servomotor in the hub of the propeller or to design the servomotor casing as part of the shafting. This has the disadvantage that the movable parts of the servomotor become difficult of access.

If the servomotor is situated in the hub, the ship has to be docked before the hub can be opened and the servomotor reached. This is not only a complicated procedure, but it also causes great expense. The design in which the servomotor forms part of the shafting is already a considerable simplification. But here again is encountered the great disadvantage that an overhaul of a servomotor requires the dismantling of the shafting.

In a marine plant the space available where the servomotor is installed, which usually lies directly before the propeller shaft, is not only very limited both in large and small ships, but the dismantling of the shafting also requires many steps to be taken, all of which take up time. Finally, erection is by no means simple, as the shaft must not only be well aligned but also well fitted in its bearings, if it is to give no difficulties in service later on.

In marine power plants with variable pitch propellers, the linkage for adjusting the blades is, as is well known, provided in the shaft. In order to eliminate the disadvantages cited above, it is proposed by the invention that the servomotor or servomotors be arranged in the propeller shaft and connected through gears with the blade-adjusting linkage provided inside the shaft in such a way that it is possible to remove a servomotor without dismantling the shafting.

In the drawings several exemplifications of the invention are shown diagrammatically.

Figs. 1 and 2 show arrangements for different types of linkage systems.

Figs. 3 and 4 illustrate the use of a servomotor which partly balances the forces acting through the linkage.

Figs. 5, 6 and 7 show the constructional design of the operating mechanism.

Figs. 8 and 9 show further arrangements.

Figs. 10–12 show the arrangement of the adjusting device in geared plants.

The ship's propeller 1 with its blades 2 and 3 is flanged to the propeller shaft 4, which is supported in the stern tube 5 and has at its forward end the thrust bearing 6, which serves to transmit the thrust of the propeller to the vessel. The auxiliary device for adjusting the propeller blades consists of the following parts.

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Arranged in the propeller shaft 4 is the adjusting shaft 7, bearing at its aft end the spider 8, to which the links 9 of the blades 2 and 3 are movably connected in such a way that, when the shaft 7 turns in the direction of the arrow 10, the blades are moved from the ahead position shown in the drawing into the position for motion astern, that is, the blade 2 comes into the position here shown for the blade 3 and vice versa.

The adjusting angle through which the blades are turned is, for instance, about 40 or 50°. The angle of rotation of the shaft 7 may be equal to this or may differ from it according as the length of the links 9 corresponds to the length of the arm of the spider 8 or differs from it so as to give a certain ratio of transmission. The gear 11 is fitted between the flanges 12 and 13 of the propeller shaft 4 and is attached to the shaft 7 so that relative turning is impossible. It is driven through the pinions 14 of the servomotors 15, which are bolted on to the flange 13. The supporting bearing 16 on both sides of the gear 11 takes the axial adjusting forces acting in the linkage system 7 to 9.

When the blades 2 and 3 are adjusted from one end position to the other, the pinions 14 perform anything from a partial revolution to several revolutions, according to the transmission ratio of the gear 11, 14. The servomotors 15 are designed correspondingly. They may be hydraulic, pneumatic or electric servomotors. Between the gear 11 and the servomotors may be provided a gear with self-locking action, for instance through the interposition of worm gears.

The fact that only the gear and the linkage, that is to say simple mechanical parts, are arranged inside the propeller shaft has the advantage that one or the other of the servomotors 15 can be overhauled at any time after the power plant has been stopped, without any dismantling of the shafting. It is only necessary to loosen the bolts with which the servomotors 15 are attached to the flange 13.

It is easily possible to remove the pinions 14 at the same time as the servomotors, so that not only the pinions but also the teeth of the gear 11 can be inspected. A further advantage is that several servomotors can be employed, and these can consequently be of small dimensions. The small dimensions of the servomotors and in particular their arrangement entirely outside of the shaft 4 make it an easy matter to keep a servomotor in reserve and to replace a damaged one in a very short time.

In Fig. 2, apart from the gearing 11, 14 a screwed gear 17 is provided which transforms the rotary motion of the gear 11 into a reciprocating motion of the rod 18, which is guided in a straight line by means of the longitudinal key 19. Thus the cross-piece 20 is attached to the hub end of the rod 18, and this effects the adjustment of the blades 2 and 3 by means of the links 21.

The servomotors 22 have three pistons 23 and 24 in the form of spindles with threads which engage with one another in such a way that, under the pressure of the pressure medium introduced at one end of the pistons 23, 24, the driving screw pistons 23 and with it the lateral pistons 24 are set in rotary motion. The threads then seal the pistons 23, 24 against one another and against the casing of the servomotor.

The screw spindle servomotors 22 have the advantage that the hydraulic pressure on the driving screw piston 23 can be utilised for balancing the forces acting through the adjusting rod 18. For this purpose the pinions 14 and the gear 11 in Fig. 3 are provided with simple helical teeth of such a type that the hydraulic pressure in the direction of the arrow 25 is transmitted through the axial components 26 of the pressure of the teeth on the main gear and balances or at least partly balances the tensile pull 27 in the rod 18 when the blades 2 and 3 are adjusted from the ahead into the astern position, so that the load on the supporting bearing 16 amounts at most to the difference between the forces 26 and 27, and the bearing friction is to a great extent reduced.

Instead of having helical teeth, the pinions 14 may have straight teeth and be provided at both sides with pressure discs 28, 29, which work together with the pressure rims on each side of the main gear 11 (see Fig. 4). The hydraulic forces 25 of the driving screw spindles during motion ahead are transmitted by the edges of the pressure discs 28, which are rigidly attached to the shafts of the pinions 14, to the pressure rim 30 in the form of axial forces 32, which balance completely or at least in part the tensile pull 27.

When the blades 2 and 3 are adjusted from the astern to the ahead position, the pressure discs 28 are lifted from the pressure rim 30, and the pressures coming into effect in a direction opposite to that of the arrow 25 are transmitted through the pressure discs 29 to the pressure rim 31, since during this adjustment the blades produce in the rod 18 a force acting contrary to the arrow 27.

The discs 28 have a plane contact surface 33, while the discs 29 are provided with tapering pressure surfaces 34, which may for instance be inclined at an angle of 10° to be plane of the discs.

In Figs. 5 to 7 the constructional details concerned in the fitting of the servomotors 45 are illustrated. In the flange 13 of the propeller shaft 4 are provided the openings 46 into which the servomotor casing 45, which is at the same time the casing and support of the pinion 14, is pushed in order to be attached by means of bolts to the flange 13 of the propeller shaft 4. The pressure medium is supplied to the servomotors through the ring mains 47 and 48.

Each servomotor is connected up to these pipes through the branches 49 and 50, which lead to the passages 51 and 52, 53 and 54. These passages are in communication with the pressure

spaces provided between the blades 55 of the rotor 56. If the passages 51 and 52 are used for the supply and the passages 53 and 54 for the discharge, the rotor 56 turns to the left (Fig. 7), and vice versa.

The main pipes 47 and 48 are connected through the pipes 57 and 58 with the passages 59 and 60, which are connected to the grooves 61 and 62 in the casing 63 of the control valve 64, which is fixed and does not turn with the propeller shaft 4. The control valve 64 connects one of the main pipes 47 and 48 in each case with one of the pipes 65 and 66 for the supply and discharge respectively of the pressure medium. The valve 64 is adjusted by the piston 67 by means of pressure air or pressure oil from the pipe 68, which leads to the hand lever at the point of control, for instance the bridge of the vessel.

The return mechanism is operated by the push rod 18, the ring 69 being connected by means of the pin 70 to the left-hand end of the push rod 18. The fork 71 is adjusted by the ring 69, which rotates with the shaft 4, so as to return the control valve 64 into the closed position in a known manner. The control valve 64, each of the servomotors 45 and also the pinion 14 can be inspected and overhauled without the shaft 4 being dismantled.

The shaft 7 and the spider 8 (Fig. 1) can be used for adjusting the blades 2 and 3 in place of the screw gear 17 and the push rod 18 in Figs. 2–5.

In Fig. 8 the same system 7, 8, 9, as used in Fig. 1 is provided for adjusting the blades 2 and 3. On the adjusting shaft 7 is keyed the toothed wheel 11, which is driven by the pinions 75. Each of these is driven through a screw gear 76 by the reciprocating servomotor pistons 77, two pistons being attached to each rod 76, which is guided through the axis of rotation of the pinion 75 and is provided with a steep-pitch thread.

The bore of the pinion 75 has a corresponding counter-thread, so that the reciprocating motion of the pistons 77, which are axially guided by the keys 78, and of the rod 76 is converted by the steep-pitch thread into a rotary motion of the pinion 75, in order to produce the rotary motion of the shaft 7 and of the spider 8 and thus the adjustment of the blades 2 and 3. The pistons 77 may be subjected to the pressure of the operating medium through the pipe 79 on their outside face only, so as to simplify the sealing of the casing.

In order that the rod 76 may have the smallest possible diameter, it is preferable that it should be subjected only to tensile stress, as is shown in Fig. 9, where two servomotor pistons 77 are arranged on each side of the pinion 75, these being connected to the rod 76 by a yoke 80. The pressure medium passes through the pipe 81, which is connected to a control member not shown in the drawing, into each servomotor cylinder and acts upon the pistons 77 on the inner side only.

Instead of the servomotors 15, 22 or 45 being arranged as shown in Figs. 1 to 4 and 5 to 7, their axis of rotation may also be inclined or at right angles to the axis of the propeller shaft 4, while the toothed wheel 11 may be driven by means of a screw or a worm gear. In this way a higher transmission ratio can be obtained by means of a simple gear, with the result that the speed of the servomotor can be higher and its dimensions smaller.

In the single-screw vessel 1g in Fig. 10 the propeller **2g** with its adjustagle blades **3g** is driven through the propeller shaft **4g** from the main wheel **5g** of the toothed wheel gear, the pinions **6g** of which are coupled to the engines **7g**. The adjusting device **8g**, an auxiliary motor operated by pressure medium, is attached to the main wheel **5g** on the side of the gear **5g**, **6g** which is turned away from the propeller, and has a piston **9g** which, when longitudinally displaced, is turned about its axis by the thread **10g** and adjusts the blades **3g** by means of the shaft **11g** and the operating members **12g**.

The pressure medium supply and its control are omitted from the drawing for the sake of simplicity. In the shaft tunnel **13g** behind the main wheel **5g** is the thrust bearing **14g**. In reciprocating internal combustion engines the linear ratio of the pinions **6g** to the main wheel **5g** may be approximately 1:4 or less.

In the twin-screw vessel **20g** in Fig. 11, the two variable pitch propellers **21g** are driven through the pinions **22g** and the main gear **23g** by the engine **24g**. According to the type of the propelling engine and the speed required for the propellers, the gear **22g**, **23g** has a transmission ratio equal to, smaller than or greater than unity. Adjustment of the blades of the propellers **21g** is effected by means of the adjusting device **25g**, which is designed like the adjusting device **8g** in Fig. 10.

Fig. 12 also shows a multiple-screw vessel **30g**, whose side propeller **31g** with its variable pitch blades **32g** is driven through the propeller shaft **33g** and the gear **35g**, **36g** by a single engine **37g**, which is designed as an opposed-piston engine and has two crankshafts **38g**. The gear **35g**, **36g** for the drive of the propeller **31g** serves at the same time as the gear connecting the crankshafts, as required in such opposed-piston engines. The engine **37g** is so far distant from the gear **35g**, **36g** that the adjusting device **39g** can be arranged on the side of the gear **35g**, **36g** turned away from the propeller **31g**, between the gear and the engine **37g**. The piston **40g** adjusts the blades **32g** by means of the push rod **41g** and the links **42g**.

Power may be supplied by any type of prime movers, such as internal combustion engines, steam engines, steam turbines, gas turbines or electric motors, whose output is altered at constant speed by alteration of the energy supplied, or otherwise by alteration of the speed, the propeller blades having essentially only one position for motion ahead of the ship and one position for motion astern. In ships with a plurality of propellers, some of these may be designed as fixed propellers and driven by a reversible engine.

Instead of several propelling engines of any of the types mentioned, one engine only may drive the main wheel **5g** in Fig. 10. Further, an electric gear may also be arranged in such a way that the propelling engines drive high-speed generators whose current is supplied to electric motors driving the propeller shaft direct, these motors being arranged, for instance in the position of the main gear **5g** in Fig. 10. The electrical transmission ratio would result from the difference in the number of poles of generator and electric motor. The adjusting device would be provided at the main gear as in Fig. 10, that is, it would be on the distal side of the electric motor in respect to the propeller, at the free end of the motor shaft, so that the rod connecting the adjusting device to the propeller blades would also be guided through the shaft of the electric motor.

Instead of mechanical means, electric or hydraulic means might be used to connect the adjusting device to the operating members of the propeller blades.

I claim:

1. In a mechanism for changing the pitch of the blades of a variable pitch propeller, an axially movable blade pitch adjusting member having a threaded portion, an axially immovable rotatable member having a threaded portion engaging said first threaded portion and, upon rotation, axially moving said adjusting member, motor means, drive means driven by said motor means and rotating said rotatable member, and a housing encasing said rotatable member and said drive means, said motor means being mounted on said housing, said rotatable member and said drive means comprising thrust absorbing means adapted to counterbalance the axial thrust of said adjusting member.

2. In a mechanism for changing the pitch of the blades of a variable pitch propeller, an axially movable blade pitch adjusting member having a threaded portion, an axially immovable helical gear having an internal threaded portion engaging said first threaded portion and, upon rotation, effecting axial movement of said adjusting member, rotary motor means, a helical spur pinion connected with and driven by said motor means and engaging said helical gear, and a housing encasing said gear and said pinion, said motor means being mounted on said housing, the relative direction of winding of said threaded portion and of the teeth on said spur wheels and of the teeth on said gears effecting counterbalancing of the axial thrust of said adjusting member.

3. In a mechanism for changing the pitch of the blades of a variable pitch propeller, an axially movable blade pitch adjusting member having a threaded portion, an axially immovable spur gear having an internal threaded portion engaging said first threaded portion and, upon rotation, effecting axial movement of said adjusting member, rotary motor means, a spur pinion connected with and driven by said motor means and engaging said spur gear, said gear having a pressure rim and said pinion having annular pressure means adjacent to said rim, and a housing encasing said gear and said pinion, said motor means being mounted on said housing, said rim and said pressure means effecting counterbalancing of the axial thrust of said adjusting member.

4. In a mechanism as set forth in claim 3, the engaging surfaces of said rim and said pressure means being opposedly bevelled.

5. In a mechanism for changing the pitch of the blades of a variable pitch propeller, an axially movable blade pitch adjusting member having a threaded portion, an axially immovable rotatable member having a threaded portion engaging said first threaded portion and, upon rotation, axially moving said adjusting member, motor means, a plurality of drive means driven by said motor means and disposed symmetrically around and rotating said rotatable member, and a housing encasing said rotatable member and said drive means, said motor means being mounted on said housing, said rotatable member and said drive means comprising pressure responsive means adapted to counterbalance the axial thrust of said adjusting member.

6. In a mechanism for changing the pitch of the blades of a variable pitch propeller, an axially movable blade pitch adjusting member having a threaded portion, an axially immovable helical spur gear having an internal threaded portion engaging said first threaded portion and, upon rotation, effecting axial movement of said adjusting member, rotary motor means, a helical spur pinion connected with and driven by said motor means and engaging said helical spur gear, and a housing encasing said gear and said pinion, said motor means being mounted on said housing, the relative direction of winding of said threaded portion and of the teeth on said spur gear effecting counterbalancing of the axial thrust of said adjusting member.

7. In a mechanism for changing the pitch of the blades of a variable pitch propeller, a pitch adjusting member, an axially immovable rotatable actuating member connected with and actuating said adjusting member, motor means, drive means connected with and driven by said motor means and rotating said rotatable member, and a housing encasing said drive means and said rotatable member and supporting said motor means, said rotatable member and said drive means comprising thrust absorbing means for the axial thrust of said adjusting member.

8. In a mechanism according to claim 7, said motor means being of the screw pump type and producing thrust on said drive means in a direction opposite to the thrust exerted on said rotatable member by said adjusting member.

9. In a mechanism for changing the pitch of the blades of a variable pitch propeller, a pitch adjusting member, an axially immovable helical gear connected with and actuating said adjusting member, motor means, a helical pinion connected with and driven by said motor means and rotating said gear, and a housing encasing said gear and said pinion and supporting said motor means, the direction of winding of the helical teeth on said gear and pinion being so as to counteract the axial thrust of said adjusting member.

10. In a mechanism according to claim 9, said motor means being of the screw pump type and exerting thrust on said pinion in a direction opposite to the thrust exerted on said gear by said adjusting member.

11. In a mechanism for changing the pitch of the blades of a variable pitch propeller, a pitch adjusting member, an axially immovable gear connected with and actuating said adjusting member, motor means, a pinion connected with and driven by said motor means and rotating said gear, and a housing encasing said gear and said pinion and supporting said motor means, said gear and said pinion having annular surface portions engaging one another and absorbing the axial thrust of said adjusting member.

12. In a mechanism according to claim 11, said motor means being of the screw pump type and exerting axial thrust on said pinion in a direction opposite to that of the thrust exerted on said gear by said adjusting member.

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