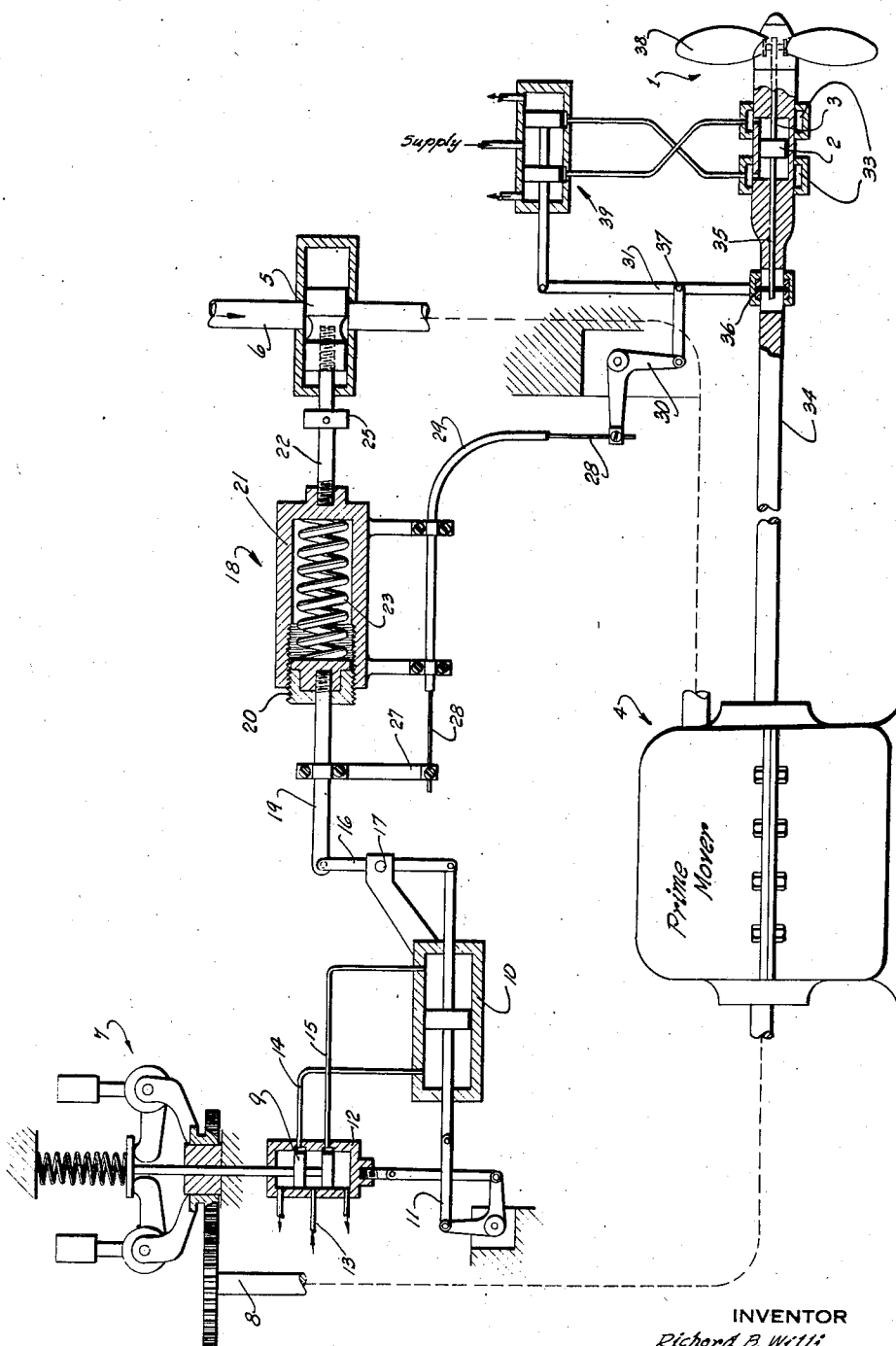


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OVERLOAD CONTROL SYSTEM FOR FLUID
PROPELLING APPARATUS
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OVERLOAD CONTROL SYSTEM FOR FLUID
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This invention relates generally to governing systems for prime mover operated adjustable blade propellers and more particularly to an automatic overload control system for ship propulsion apparatus.

It is desirable to operate a prime mover for a ship propeller so that it is capable, if called upon, to produce its maximum output for a given speed of propeller rotation regardless of the variable resistance of the boat to motion which may be affected by draft loading or other variable forces. Ordinarily, a speed governor is employed on the prime mover for increasing the fuel supply thereto as the load increases. If the load on the prime mover increases beyond a certain point the prime mover might either stall or at least suffer such a material reduction in speed as to seriously reduce its output. The peculiarities of these conditions to ship propulsion are that the load will increase as the slip of the propeller increases and this slip is greatest when a ship is getting under way and reduces as the ship gains speed. In the case of tugboats and trawlers they are greatly overpowered insofar as there is any need for power merely to propel the boat by itself at its normal speed without a tow, trawling for other tug type load. When such load is applied, the boat is slowed down far below its normal no-load speed. During such slowed down loaded condition, it is desired to use effectively the excess power capacity to the fullest. In my present invention I have provided an improved system in which these various conditions are utilized to produce maximum power for any given speed.

It is an object of my invention to provide an improved control system in a ship propulsion apparatus employing a prime mover operated adjustable blade propeller whereby full output of the prime mover is automatically maintained at any predetermined speed regardless of whether the propeller load tends to increase beyond the maximum output of the prime mover.

A further object is to provide an improved control system for ship propulsion apparatus employing a prime mover operated adjustable blade propeller and in which a prime mover speed governor is adapted to maintain a substantially uniform prime mover speed throughout normal load demands on the prime mover and yet automatically effect adjustment of the adjustable propeller blades when the prime mover tends to be overloaded thereby to allow the prime mover to continue operating at its desired speed and maximum output for such speed.

Other objects and advantages will be more ap-

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parent to those skilled in the art from the following description of the accompanying drawing in which the figure is a diagrammatic outline of my improved system.

In the particular embodiment of the invention disclosed herein, I have shown an adjustable blade ship propeller generally indicated at 1 which is well-known in the art and hence a detailed disclosure of the same need not be given except to point out that the propeller blades are adjusted by a servo-motor 2 diagrammatically illustrated as of the piston and cylinder type in which the piston is connected by a rod 3 to the blade adjusting mechanism. The piston and cylinder rotate with the propeller shaft by being disposed internally thereof. The propeller shaft may be driven by any suitable type of prime mover, whether a Diesel engine, steam turbine, etc., diagrammatically illustrated at 4 and whose power medium is supplied through suitable control mechanism in the form of a valve 5 for controlling flow of steam or fuel through pipes 6 to the prime mover. To control the fuel supply valve 5, a speed governor 7, diagrammatically shown as of the flyball type, is driven by gears and shafts 8 from the prime mover and in turn operates a pilot valve 9 which controls a fuel supply servo-motor 10. A follow-up or restoring mechanism 11 connects this servo-motor to an axially movable sleeve 12 of valve 9. For purposes of simplicity the supply pipe 13 and pipes 14 and 15 are shown as directly connected to sleeve 12 and hence such pipes will be considered as movable with the sleeve.

It will be understood that the propeller blades 38 are normally disposed in their position of steepest pitch. Hence, as the load increases on the ship propeller, as when first getting under way, the prime mover will tend to slow down whereupon speed governor 7 actuates its pilot valve 9 to admit operating fluid through pipe 15 to move the piston of servo-motor 10 to the left thereby to move a lever 16 in a clockwise direction about a fixed pivot 17 and accordingly shift a yieldable multiple part link generally indicated at 18. This link shifts the fuel supply valve 5 toward the right so as to increase supply of fuel through pipe 6 to the prime mover 4. The multiple part link 18 specifically consists of a rod 19 having preferably threaded connection with a collar 20 located within a sleeve 21 which, in turn, is connected to a rod 22 of valve 5. A coil spring 23 is interposed between collar 20 and the end of sleeve 21 and offers sufficient resistance so that movement of lever 16 in a clockwise direction will be transmitted from rod 19 and collar 20 through

the spring to move sleeve 21 and valve rod 22 all as a unit.

When the full open position of valve 5 has been finally obtained due to successive increases of load on the ship propeller, a limit nut 25 secured to rod 22 will abut against the end of the housing of valve 5. Thereafter any further increase of load on the ship propeller cannot be taken care of by additional power produced by the prime mover because the supply valve 5 is now assumed to be in its full open position for supplying maximum power medium to the prime mover. Nevertheless, if the propeller load does increase, the prime mover speed will tend to reduce thereby causing the governor 7 to again adjust pilot valve 9 with further movement of the servo-motor piston 10 to the left whereupon link 19 will compress spring 23 by reason of sleeve 22 being held by limit nut 25. During such continued movement, rod 19 will carry with it a link 27 rigidly connected to the rod and will also cause movement of a flexible wire 28 which is connected to link 27 and extends through a guide tube 29 to operate a bell crank 30. The tube 29 is fastened to the sleeve 21 so as to move and stop with it. Hence, the wire will move relative to guide tube 29 to operate the bell crank only when the sleeve is stopped by limit nut 25. Whenever the guide tube is moving the end of the wire connected to the bell crank will simply flex, in the nature of a lost motion connection, without operating the bell crank. However, when the guide tube is stopped, the bell crank will swing lever 31 in a clockwise direction about its lowermost end which is momentarily stationary thereby to operate a pitch control valve 39 so as to admit fluid to the left end of the pitch adjusting servo-motor 2 and exhaust fluid from the right end thereof. It will be understood that the fluid connections to the opposite ends of the servo-motor 2 are through suitable stationary annular chambers 33 surrounding the rotatable propeller shaft 34 which is somewhat enlarged near its propeller end to accommodate the servo-motor 2. Movement of this servo-motor piston causes the blade 38 to be adjusted to a flatter position, i. e., less pitch. During such adjustment the piston 2 axially shifts a restoring rod 35 which is connected by a suitable cross pin and shipper collar 36 to the lower end of lever 31 thereby to swing this lever in a counterclockwise direction about its floating pivot 37 which is connected to the bell crank 30. The valve 39 is thereby restored to its neutral position and the propeller blades 38 held in their adjusted position corresponding to such load and speed conditions as will allow the prime mover 4 to maintain its substantially predetermined speed and maximum output. When the load conditions on the propeller fall off the prime mover will tend to increase its speed and accordingly cause the centrifugal governor 7 to move pilot valve 9 upwardly and thereby reverse operation of the control system so as to first readjust the propeller blades to their steepest position until spring 23 has been expanded to the position shown in the drawing whereupon any further reduced load on the propeller will result in the spring casing 21 moving to the left together with control valve 5 and thereby reduce supply of fuel to the prime mover. The prime mover speed will thereby be maintained substantially constant and will produce such amount of power as is required to drive the propeller at the desired speed.

It will, of course, be understood that when the prime mover is completely shut down, the governor 7 will cause power supply means 5 to be

moved to the right to its full open position and also spring 23 will be collapsed so as to cause blade adjusting servo-motor 2 to adjust the blades to their minimum pitch. However, when the power plant of the boat is initially started up, a full volume of steam would momentarily flow to the prime mover which would cause maximum rotational speed of the propeller because of its minimum pitch, but this excessive speed would instantly cause governor 7 to first move the propeller blades to maximum pitch. Because of the excess power of prime mover 4, the propeller speed would still be above normal with the result that governor 7 would move power supply valve 5 to a partially closed position until a normal speed condition is obtained. The system would now be considered to be in a normal condition from which it is seen that if the tow load should become such as to cause increased propeller slippage and thereby reduce the prime mover speed below normal, the governor 7 would move power supply valve 5 toward the right to increase power supply to the prime mover. Until the power of the prime mover had reached its predetermined or maximum output, the propeller blades would continue to be maintained at maximum pitch. If the tow load should increase still further so as to be beyond the power capacity of the prime mover, then the consequent reduction in speed of the prime mover will cause governor 7 to reduce the propeller pitch in the manner as heretofore described.

From the foregoing disclosure it is seen that I have provided an improved control system for a prime mover operated adjustable blade propeller whereby a wide range of variable propeller load conditions can be effectively taken care of while maintaining the most favorable operation of the prime mover. The speed governor control is so functionally related to the propeller adjusting mechanism that the latter may be effectively controlled from the speed governor in a simple, direct and positive manner and with minimum mechanical complications thereby to allow a smooth and gradual blending of adjustments from that of supplying power medium to the prime mover on through to adjustment of the propeller and then in the reverse order in the event of oppositely changing conditions.

It will of course be understood that various changes in details of construction and arrangement of parts may be made by those skilled in the art without departing from the spirit of the invention as set forth in the appended claims.

I claim:

1. In combination, a prime mover, a propeller driven thereby having blades whose pitch may be varied, a speed governor driven in proportion to the prime mover speed, mechanism for controlling the supply of power medium to the prime mover, a servo-motor controlled by said speed governor, yieldable means interposed between said servo-motor and power control mechanism whereby movement of the servo-motor is transferred to said mechanism up to a predetermined opening thereof and thereafter said servo-motor is adapted to have continued movement by causing a yielding action of said yieldable means, a blade adjusting servo-motor for holding the propeller blades at a maximum pitch throughout increasing supply of power to the prime mover, and means for controlling said blade adjusting servo-motor by said speed governor automatically when said yielding action takes place.

2. In combination, a prime mover, a propeller

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driven thereby having blades whose pitch may be varied, a power control mechanism for a prime mover, means for moving said mechanism to its full open position including a yieldable multi-part element adapted to operate as a rigid one piece device up to the full open position of said power control mechanism and thereafter to allow one part to yieldingly move while said power control mechanism remains in a substantially constant position, a servo-motor for adjusting the propeller blade pitch, and means for controlling said servo-motor by said yieldable means and adapted to render the servo-motor operative to decrease the blade pitch when said yieldable means is subjected to said yielding action after the power control mechanism is in its full open position.

3. In combination, a prime mover, a propeller driven thereby having blades whose pitch may be varied, power supply means adapted to increase flow of power to the prime mover up to a predetermined output thereof, mechanism automatically responsive to increasing loads on the propeller, means connecting said mechanism to the power supply means so as to increase supply of power to the prime mover in response to any and all increases of load up to the limit of said predetermined output, a blade adjusting servo-motor for holding the blades at their maximum pitch throughout said increase of power, and means to effect actuation of said servo-motor to decrease the blade pitch automatically in response to increases of propeller load after the power supply means has reached said limit of predetermined prime mover power output.

4. The combination set forth in claim 3 further characterized in that the load responsive mechanism includes a rotatable device driven by the prime mover in proportion to the speed thereof, and the means connecting said mechanism to the power supply means includes an interposed yieldable connection whereby the power supply means may be moved to its full open position and thereafter said yieldable connection allows said prime mover driven device to be responsive to further increases of propeller load while the power supply means remains in its full open position, and the means for effecting actuation of the blade adjusting servo-motor to decrease the blade pitch in response to increases of propeller load above said predetermined limit includes an element operatively connected to said connecting means of the power supply means.

5. The combination set forth in claim 3 further characterized in that the load responsive mechanism includes a rotatable device driven by the prime mover in proportion to the speed thereof, and the means connecting said mechanism to the power supply means includes an interposed yield-

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able connection whereby the power supply means may be moved to its full open position and thereafter said yieldable connection allows said prime mover driven device to be responsive to further increases of propeller load while the power supply means remains in its full open position, and the means for effecting actuation of the blade adjusting servo-motor to decrease the blade pitch in response to increases of propeller load above said predetermined limit includes a connection between the servo-motor and the connecting means of the power supply means that allows movement of said connecting means during increasing flow of power to the prime mover while the propeller remains at its maximum pitch and that is rendered operative to reduce the blade pitch after the propeller load tends to exceed said limit of predetermined prime mover power output.

6. The combination set forth in claim 3 further characterized in that the means to effect actuation of the servo-motor to decrease the blade pitch includes a lost motion connection between the blade adjusting servo-motor and the load responsive mechanism whereby the lost motion of such connection is taken up when the power supply means has increased the flow of power to the prime mover up to its predetermined output whereupon further increases of propeller load will cause the load responsive mechanism to control the blade adjusting servo-motor through said connection.

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