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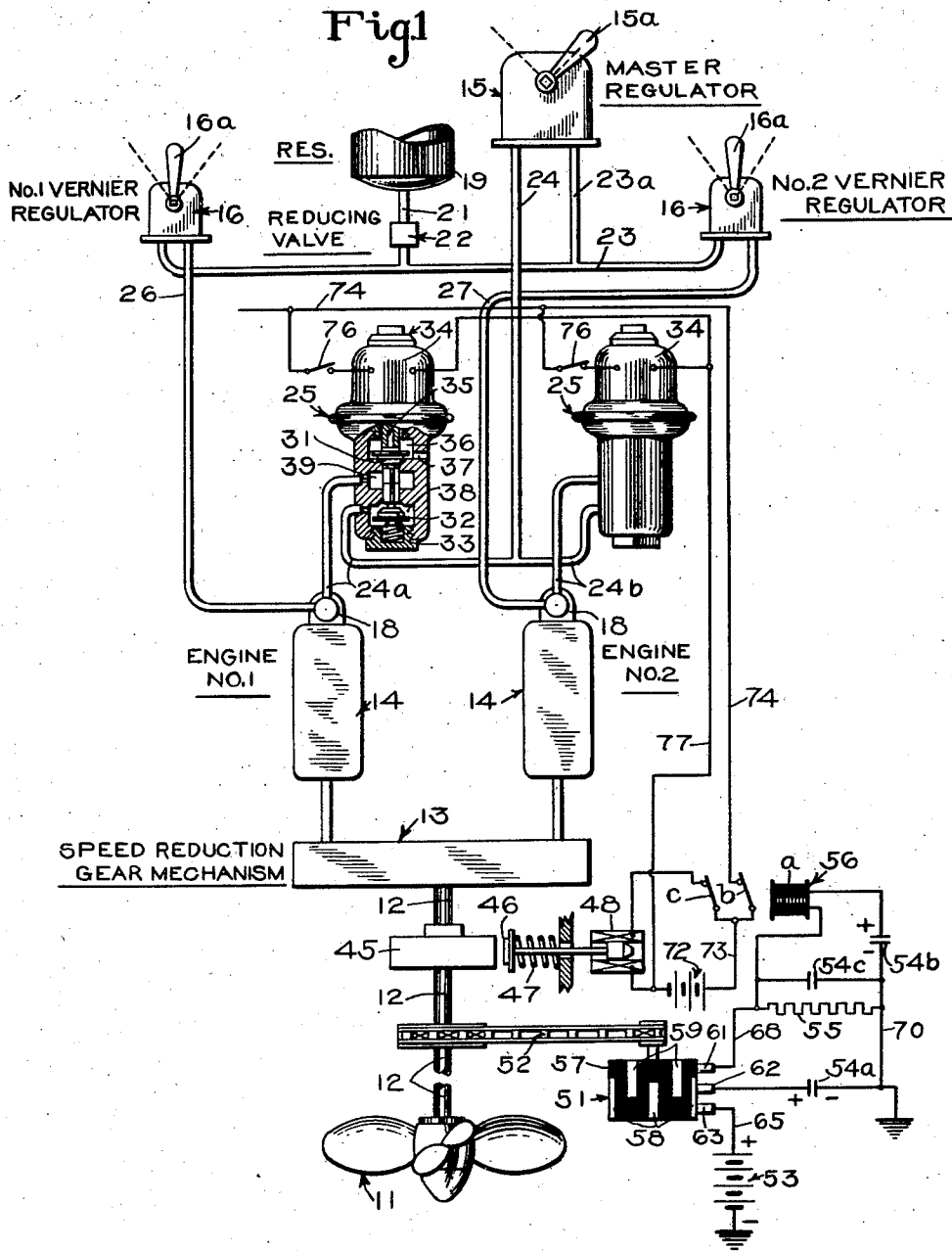
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2,444,254

ENGINE DRIVEN SHAFT GOVERNING APPARATUS

Filed Nov. 28, 1942

2 Sheets-Sheet 1



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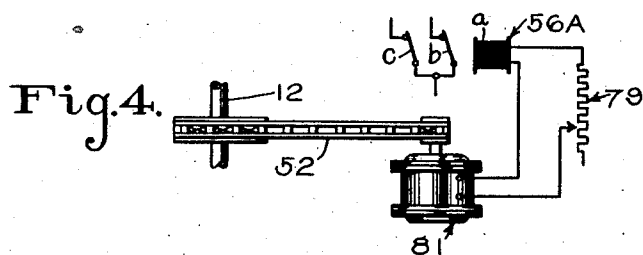
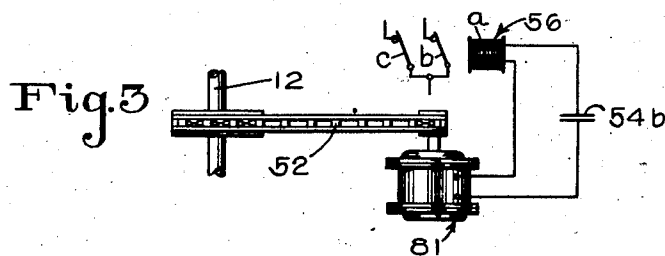
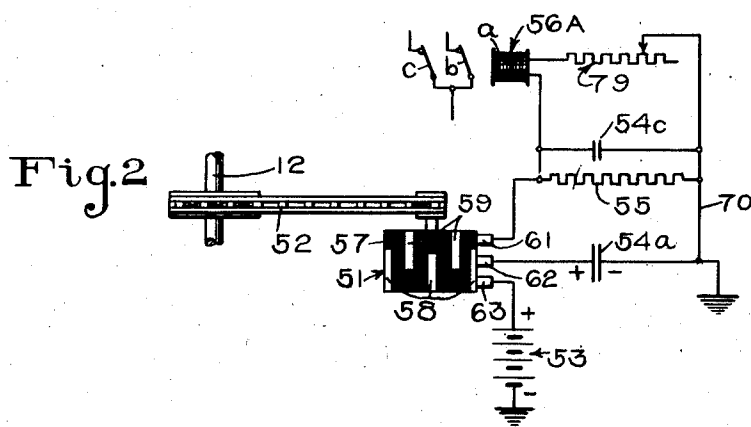
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ENGINE-DRIVEN SHAFT GOVERNING
APPARATUS

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2 Claims. (Cl. 137-159)

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This invention relates to propeller governing apparatus and has particular relation to apparatus for preventing the racing of the propeller of a ship as a result of the propeller partly or wholly rising out of the water due to the pitching or rolling of the ship in a heavy sea.

The racing of a propeller or screw of a ship due to being raised partly or wholly out of the water is a result of pitching or rolling of the ship in a heavy sea and subsequent resubmergence of the propeller in the water produces severe torsional strains on the propeller or screw shaft which may cause breakage thereof. Various control arrangements have been previously devised and proposed for preventing racing of a propeller. Such control arrangements employ a float control device, responsive to variation from the normal depth of submergence of a propeller, for reducing the speed of the driving engine and/or applying a brake to the propeller shaft.

It is an object of our present invention to provide a novel arrangement for preventing the racing of engine driven shafts.

It is an object of our present invention to provide apparatus of the general type indicated in the foregoing object and characterized by control means responsive to the rotative condition of the shaft.

It is another object of our invention to provide apparatus of the type indicated in the foregoing objects and characterized by control means responsive to the rate of change of speed of the shaft for controlling the speed of the driving engine or engines.

It is another object of our invention to provide apparatus of the type indicated in the foregoing objects and characterized by control means responsive to the actual speed of the propeller or its shaft for controlling the speed of the driving engine or engines and/or the application of a brake to the propeller shaft.

The above objects, and other objects of our invention which will be made apparent hereinafter, are attained by means of apparatus subsequently to be described and shown in the accompanying drawings wherein

Fig. 1 is a simplified diagrammatic view, showing a ship propulsion and control apparatus including one embodiment of our invention,

Fig. 2 is a fragmental diagrammatic view, showing a second embodiment of our invention,

Fig. 3 is a fragmental diagrammatic view, showing a modification of the embodiment shown in Fig. 1, and

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Fig. 4 is a fragmental diagrammatic view, showing a modification of the embodiment shown in Fig. 2.

Description

Referring to Fig. 1, ship propulsion and control apparatus is shown which comprises a propeller or screw 11 fixed on a propeller shaft 12 and driven through a speed reduction gear mechanism 13 by two engines 14, designated No. 1 and No. 2, respectively. The engines 14 may be of any suitable type but for purposes of the present invention are taken to be Diesel engines.

Both engines 14 are controlled by a so-called master regulator 15 and each engine is also individually controlled by a corresponding vernier regulator 16, designated No. 1 and No. 2, respectively, to correspond to the individual engine.

Each of the engines 14 has a fuel supply valve (not shown) which is operated by a so-called throttle control device 18. Each throttle control device 18 comprises an operating rod which is biased normally by a spring (not shown), to a position adjusting the fuel supply valve of the corresponding engine to its idling position. Two fluid pressure responsive devices, in the form of flexible diaphragms, are associated with the operating rod of each throttle control device in a manner to control the position of the operating rod in accordance with the pressure of fluid acting on the corresponding diaphragm. One of the operating diaphragms of each of the throttle control devices 18 has a pressure chamber at one side thereof to which fluid at different pressures is supplied from a reservoir 19 under the control of the master regulator 15.

The reservoir 19 is charged with fluid under pressure from a fluid compressor, not shown, and fluid under pressure is supplied from reservoir 19 to a pipe 23 through a pipe 21 in which is interposed pressure-reducing valve 22 for adjusting the pressure of the fluid supplied from the reservoir to a desired value lower than that maintained in the reservoir. The master regulator 15 is connected to the pipe 23 by a branch pipe 23a and is effective to supply fluid under pressure to a delivery pipe 24 which has two branches 24a and 24b. The branch pipe 24a leads to the pressure chamber of the aforesaid diaphragm of the throttle control device of engine No. 1 and the branch pipe 24b leads to the corresponding pressure chamber at one side of the diaphragm of the throttle control device 18 of engine No. 2.

Each of the branch pipes 24a and 24b has

interposed therein a magnet valve device 25, the purpose of which will be hereinafter made apparent. The magnet valve devices 25 are normally conditioned to open communication through the respective branch pipes 24a and 24b.

When fluid under pressure is supplied to the pressure chamber at one side of the aforesaid diaphragm of each throttle control device 18 under the control of the master regulator 15, the operating rod of the control device is operatively shifted to operate the fuel supply device to supply fuel at a rate corresponding to the degree of pressure acting on the diaphragm. The two engines 14 are thus operated at substantially the same speed and should therefore bear substantially equal proportions of the total load of the propeller 11. As a practical matter, however, the two engines do not divide the load on the propeller 11 in exactly equal proportions. The vernier regulators 16 are thus provided for so adjusting the throttle control devices 18 of the engines 14 as to control the speed of the engines in a manner to divide the load on the propeller in proper proportions.

Each of the vernier regulators 16 is operative to supply fluid under pressure from the pipe 23 through a corresponding pipe 26 or 27 to the throttle control device 18 of the corresponding engine. The pressure of fluid so supplied through the pipes 26 and 27 is effective in a pressure chamber at one side of the remaining diaphragm of the throttle control device in a manner to oppose, in varying degree, the force of the fluid under pressure supplied under the control of the master regulator 15.

The speed of the two engines 14 is thus initially set by the master regulator 15 and finally adjusted according to the setting of the corresponding vernier regulator 16.

The master regulator 15 and the vernier regulators 16 are control valves of the self-lapping type described and claimed in Patent 1,939,907 issued to E. K. Lynn. Briefly, each of the regulators 15 and 16 comprises a rotary operating shaft on which an operating handle 15a or 16a, respectively, is fixed and self-lapping valve mechanism operatively responsive to the rotary movement of the operating shaft. The nature of the valve mechanism is such as to automatically limit the pressure of fluid supplied or delivered by the regulator to a value corresponding substantially to the degree of displacement of the operating handle 15a or 16a out of a normal position thereof.

In Fig. 1, the operating handle 15a of the master regulator 15 is shown in its normal position and the regulator 15 is accordingly operative to supply fluid at a progressively increasing pressure as the operating handle 15a is rotated to different degrees of displacement in a counter-clockwise direction from the position shown.

The vernier regulators 16 operate in exactly the same manner as the master regulator 15. In the drawing, however, the operating handles 16a of the vernier regulators 16 are shown in a normal position between the two opposite extremities of the movement thereof. Thus, fluid at a certain intermediate pressure is normally supplied by the vernier regulators 16 to the corresponding throttle control devices 18.

It will be apparent, therefore, that the position of the operating rod of the throttle control device 18 may be adjusted over a small range to either side of the position determined by the position of the master regulator 15, depending

upon which way the operating handle 16a of the vernier regulator is shifted from the normal intermediate position in which it is shown. The fuel supply devices may thus be accurately controlled so that the engines 14 divide the load in proper proportions.

Each of the magnet valves 25 comprises a suitable casing containing oppositely seating valves 31 and 32, which are urged upwardly to unseated and seated positions, respectively, by a coil spring 33 and downwardly to seated and unseated positions, respectively, in response to energization of a magnet winding or solenoid 34, through the medium of a plunger 35.

The valve 31 is contained in a chamber 36 that is constantly open to atmosphere through an exhaust port 37. The valve 32 is contained in a chamber 38 that is connected to pipe 24 by one section of the branch pipe 24a (or 24b). Between the chambers 36 and 38 is a chamber 39 that is constantly connected by the remaining section of the branch pipe 24a (or 24b) to the pressure chamber at one side of the diaphragm in throttle control device 18 of the corresponding engine 14.

It will thus be seen that when the magnet winding 34 of the magnet valve 25 is energized, communication is established through the branch pipe 24a (or 24b) from the pipe 24 to the corresponding throttle control device 18 so that fluid under pressure may be supplied to the throttle control device or released therefrom in accordance with the position of the operating handle 15a of the master regulator 15.

When the magnet winding 34 of each magnet valve 25 is deenergized and the valves 31 and 32 correspondingly restored to unseated and seated positions respectively by the spring 33, communication through the branch pipes 24a and 24b to the throttle control devices 18 is closed and, at the same time, the pressure chamber at one side of the diaphragm in the throttle control devices 18 is connected to atmosphere past the unseated valve 31 through chamber 36 and exhaust port 37. In such case, therefore, notwithstanding the establishment of a pressure in the pipe 24 in accordance with the displaced position of the operating handle 15a of the master regulator 15, fluid under pressure is vented from the pressure chamber of the corresponding diaphragm of the throttle control device 18 to cause restoration of the operating rod to its normal position in which the fuel supply device is restored to its idling position.

It will thus be apparent that when the magnet winding 34 of each magnet valve 25 is deenergized, the corresponding throttle control device 18 is operative to restore the fuel supply device of the corresponding engine 14 to its idling position so that the engine is consequently restored to an idling speed.

Associated with the propeller shaft 12 is braking apparatus comprising a brake drum 45 fixed on the shaft 12, and a brake shoe 46 that is urged into frictional engagement with the brake drum 45 by a spring 47 and retracted out of engagement with the drum in response to energization of a solenoid 48.

According to our invention, we have provided electric apparatus responsive to the rate of change of rotational speed of the propeller shaft 12 for controlling the windings 34 of the magnet valves 25 and the solenoid 48 of the brake device in a manner to restore the engines 14 to idling

speed and apply the brake whenever racing of the propeller 11 occurs.

The electric apparatus disclosed in Fig. 1 is similar to that disclosed and claimed in the copending application, Serial No. 376,599, now Patent No. 2,321,992, of John Canetta and P. N. Bossart, filed January 30, 1941 and assigned to the assignee of this application. This apparatus is thus not specifically claimed herein.

The electric apparatus shown in Fig. 1 comprises a rotary commutator device 51 that is suitably mounted and driven in accordance with the rotational speed of the propeller shaft 12, as by an endless belt or chain 52. Associated with the commutator device 51 is a source of direct current, such as a storage battery 53, three electrical condensers 54a, 54b, and 54c, respectively, a resistor 55, and a relay 56.

The commutator device 51 may comprise a suitable disk having a peripheral portion 57 of insulating material in which two rows of contact fingers 58 and 59 are embedded, the outer surface of the contact fingers being flush with the outer surface of the insulating portion 57. The contact fingers 58 and 59 extend axially inwardly from opposite edges of the commutator device and are spaced at uniform intervals peripherally of the commutator device in such a manner that each contact finger 58 extends into the space between two adjacent contact fingers 59 and each contact finger 59 extends into the space between two adjacent contact fingers 58.

A suitable brush holder is provided for holding three brushes 61, 62, and 63 in an axial row and in contact with the surface of the commutator device whereby, as the commutator device 51 rotates, the central brush 62 is alternately connected to the brush 61 and the brush 63 by contact fingers 59 and 58 respectively.

When the brushes 62 and 63 are connected by a contact finger 58, a circuit is established for charging condenser 54a. This circuit extends from one terminal of the battery 53, such as the positive terminal, by way of a wire 65, brush 63, contact finger 58, brush 62, a wire 66 including the condenser 54a in series relation therein, and thence to the negative terminal of the battery 53, as through a ground connection.

When the brushes 61 and 62 are connected by a contact finger 59, a circuit is established for discharging the condenser 54a through the resistor 55. This circuit may be traced from the positively charged terminal of the condenser 54a by way of the wire 66, brush 62, contact finger 59, brush 61, a wire 68, including the resistor 55 in series relation, and a wire 70 back to the negatively charged terminal of the condenser 54a.

It will thus be seen that as the commutator device 51 rotates, condenser 54a is alternately charged by current supplied from the storage battery 53 and discharged through the resistor 55.

Due to the fact that the charging time constant of condenser 54a is relatively small compared to the interval of time that the charging circuit is established through each succeeding contact finger 58, the condenser 54a receives substantially the same quality of electrical charge each time the charging circuit therefor is established. Each time the discharge circuit for the condenser 54a is established through a contact finger 59 of the commutator device, substantially the entire charge on the condenser 54a is dis-

sipated. It follows, therefore, that a pulsating direct current is established in the discharge circuit including the resistor 55 which current varies substantially in degree according to the rotational speed of the commutator device 51 and thus of the propeller shaft 12.

The resistance of the resistor 55 being constant, the voltage drop across the resistor 55 (which is equal to the product of the electrical current through the resistor and the resistance in ohms of the resistor) will be proportional substantially to the rotational speed of the propeller shaft 12.

Condenser 54c is connected in parallel to the resistor 55 for the purpose of smoothing out the irregularities in pulsating direct current flowing through the resistor 55 and thereby producing a more stable voltage across the resistor 55 for a given rotational speed of the propeller shaft 12.

The relay 56 is of the so-called uni-directional type having a winding a and two back contact members b and c, respectively. The relay 56 is so designed that when current is supplied through the winding a in one direction, the contacts b and c remain in their normal or dropped-out position and when current exceeding a certain value is supplied through the winding a in the opposite direction, the contacts are actuated to their picked-up or open position.

The winding a of the relay 56 is connected in series relation with the condenser 54b across the resistor 55 in such a manner that the flow of current through the winding a of the relay 56 to charge condenser 54b in response to an increase in the voltage drop across resistor 55 with an increasing speed of rotation of propeller 12 will cause a pick-up of the contacts of the relay if the current exceeds a certain value. For well known reasons, the current supplied through the winding a of relay 56 to charge condenser 54b is substantially proportional to the rate of increase of the voltage drop across resistor 55. Thus the winding a of the relay 56 may be so designed that when the current energizing the winding in the proper direction exceeds a certain value corresponding to an abnormal rate of relative acceleration of propeller shaft 12, the contacts of the relay will be actuated to their picked-up or open position. Conversely, when the voltage drop across the resistor 55 reduces, condenser 54b discharges current reversely through the winding a of the relay 56 and the current so discharged is proportional to the rate of reduction of the voltage drop across the resistor 55. Whenever current is discharged from condenser 54b through the winding a of the relay 56, the contacts of the relay are restored to their dropped-out or closed position.

Whenever the propeller 11 begins to race, it accelerates rotatively at an abnormally rapid rate and relay 56 is therefore actuated to its picked-up position. Conversely, when the speed of the propeller 11 reduces, relay 56 is restored to its normal or dropped-out position.

The contact b of relay 56 is effective in its normal dropped-out position to establish a circuit for energizing the magnet winding 34 of each of the magnet valve devices 25. This circuit may be traced from one terminal of a source of energy, such as a storage battery 72, by way of a wire 73, contact member b of relay 56, a wire 74, in parallel through two parallel branch circuits, one of which includes a manual switch 76 and the winding 34 of one of the magnet valve de-

vices 25 in series and the other of which includes a similar manual switch 76 and the magnet winding 34 of the other magnet valve device 25, to a wire 77 which is connected to the negative terminal of the battery 72.

The contact c of the relay 56 controls a simple series circuit including the solenoid 48 of the spring-applied solenoid released brake device and storage battery 72 and needs no description since it is readily apparent in the drawing.

Operation

Let it be assumed that the master regulator 15 has been operated in a manner to so control the throttle control devices 18 of the engines 14 as to cause the propeller 11 to be rotated at a certain normal speed. Now let it be supposed that due to a heavy sea, frequent racing of the propeller 11 occurs due to the propeller leaving the water as a result of the pitching and rolling of the ship.

In such case, relay 56 is immediately picked-up when the propeller begins to race, thereby effecting deenergization of the magnets 34 of the magnet valve devices 25 and of the solenoid 48 of the brake device. The magnet valves 25 are thus instantly operated to cause the throttle control devices 18 of the engines 14 to reduce the speed of the engines to idling speed. At the same time, the spring 47 acts in response to deenergization of solenoid 48 the brake shoe 46 to the brake drum 45 on the propeller shaft 12.

It will be observed that relay 56 will be picked-up substantially at the instant the propeller 11 starts to leave the water since it is responsive to the rate of acceleration of the propeller shaft. The speed of the engine 14 is thus substantially instantaneously reduced to idling speed and the propeller 11 does not attain any substantial degree of speed in excess of the normal speed while it is in the water. Consequently, the danger to breaking the propeller shaft due to excessive torsional stresses set up in the propeller shaft upon sudden resubmergence of the propeller in the water while the propeller rotates at high speed is eliminated.

Whenever the rate of acceleration of the propeller 11 reduces sufficiently due to the reduction in the engine speed and the application of the brakes, whether or not the propeller is resubmerged, relay 56 is restored to its dropped-out position.

The magnet windings 34 of the magnet valve devices 25 and the solenoid 48 of the brake device are thus re-energized in response to the restoration of the contacts of the relay 56 to their dropped-out positions. The throttle control devices 18 are thus restored to the condition corresponding to the setting of the master regulator 15, and the brake on the propeller shaft 12 is released. If the propeller 11 is still out of the water at this time, it may accelerate again at a sufficiently rapid rate to cause pick-up of the relay 56. In such case the above operation is again repeated, that is the speed of the engine 14 is automatically reduced to idling speed and the brake applied. Thus at no time is the propeller 11 permitted to exceed to any substantial degree the normal speed while submerged in the water.

When the propeller 11 is resubmerged in the water to a sufficient degree, the cessation of the acceleration of the propeller 11 causes the relay 56 to remain in its dropped-out position and consequently restore the magnet valves 25 to

their normal conditions and the brake to its released position.

It is desired to cut either one of the engines out of operation for servicing or repair purposes, this may be accomplished by opening the manual switch 76 in series with the magnet winding of the magnet valve 25 controlling the supply of fluid under pressure to the throttle control device 18 of the corresponding engine. This effects deenergization of the winding of the magnet valve 25 and a consequent venting of fluid under pressure from the throttle control device, independently of the seating of the handle of the master regulator, and a consequent reduction of the engine to idling speed. Suitable mechanism, not shown, may then be operated to stop the engine and disconnect the shaft thereof from the speed reduction gear mechanism. The manual control of magnet valves 25 just mentioned is not, however, part of our present invention.

Figure 2

A second embodiment of our invention is shown in Fig. 2 which differs structurally from that of Fig. 1 in providing a relay 56A in place of the relay 56 and substituting an adjustable resistor 79 for the condenser 54b. In this embodiment, the relay 56A is responsive to the actual speed of the propeller shaft 12 instead of the rate of change of speed of the propeller shaft as in Fig. 1, as will be presently explained.

In Fig. 2, the winding a of the relay 56A is connected in series with the adjustable resistor 79, the winding of the relay and the resistor 79 being connected in parallel with the resistor 55 in the discharge circuit of the condenser 54a. By suitably adjusting the resistance of the resistor 79, the proportion of current flowing in the discharge circuit of condenser 54a through the winding a of the relay 56A will be insufficient to cause pick-up of the contacts of relay 56A unless the propeller shaft 12 exceeds a given speed of rotation. Thus the contacts of the relay 56A will be picked-up only while the propeller shaft 12 exceeds a predetermined speed which may be selected to be a certain amount higher than the normal maximum rotational speed of the propeller shaft.

Relay 56A is effective when picked-up to cause operation of the magnet valve 25 and application of the brake to the propeller shaft 12 in the same manner as the relay 56 in Fig. 1.

Figure 3

A modification of the embodiment shown in Fig. 1 is shown in Fig. 3. The apparatus of Fig. 3 differs from that in Fig. 1 in providing a magnet or generator 81 driven, as by an endless chain 52, according to the rotational speed of the propeller shaft 12, and providing a voltage substantially proportional to the rotational speed of the propeller shaft. Generator 81 thus performs the same function as the commutator device 51 and associated apparatus including the resistor 55 of Fig. 1.

Structurally, the embodiment of Fig. 3 and that of Fig. 1 differ, but the principle of operation of the two embodiments is identical. It will be apparent that such is the case because in both Fig. 1 and Fig. 3, operation of the magnet valves 25 and of the brake device associated with the propeller shaft 12 is effected in response to the rate of change of speed of the propeller shaft.

Figure 4

In Fig. 4 there is shown a modification of the embodiment shown in Fig. 2.

The apparatus in Fig. 4 differs structurally from that of Fig. 2 in providing a generator 81 driven, as by an endless chain 52, according to the speed of the propeller shaft 12 and providing a voltage substantially proportional to the rotational speed of the propeller shaft. It will be apparent, therefore, that the voltage of the generator 81 is substituted in Fig. 4 for the voltage across the resistor 55 in Fig. 2. The operation of the apparatus in Fig. 4 is thus the same as in Fig. 2 for the reason that the relay 56A is picked-up only while the propeller shaft 12 exceeds a certain abnormal speed somewhat higher than the maximum normal speed of the shaft.

Having now described our invention, what we claim as new and desire to secure by Letters Patent is:

1. Control apparatus for governing the rotational speed of a shaft driven by an engine, said apparatus comprising the combination of fluid pressure operated throttle control means for the engine operatively responsive according to the degree of a control fluid pressure supplied thereto for correspondingly controlling the speed of the engine, a source of fluid pressure, manually controlled valve means for controlling the pressure of the control fluid pressure supplied from said source to said throttle control means, and auxiliary valve means normally establishing communication through which control fluid pressure may be supplied to the throttle control means under control of the manually controlled valve means and effective, upon operation, to prevent the supply of control fluid pressure to the throttle control means and to cause a reduction of the pressure of the fluid active on the throttle control means, and means operatively responsive only to acceleration of the shaft at a rate exceeding a certain rate for effecting operation of said auxiliary valve means.

2. Control apparatus for governing the rotational speed of a shaft driven by an engine, said apparatus comprising the combination of fluid pressure operated throttle control means for the

engine operatively responsive according to the degree of a control fluid pressure supplied thereto for correspondingly controlling the speed of the engine, a source of fluid pressure, manually controlled valve means for controlling the pressure of the control fluid pressure supplied from said source to said throttle control means, and auxiliary valve means normally establishing communication through which control fluid pressure may be supplied to the throttle control means under control of the manually controlled valve means and effective, upon operation, to prevent the supply of control fluid pressure to the throttle control means and to cause a reduction of the pressure of the fluid active on the throttle control means, means providing an electrical characteristic varying in degree according to the speed of rotation of the shaft, and means operatively responsive only to a predetermined rate of variation of said electrical characteristic for effecting operation of said auxiliary valve means.

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REFERENCES CITED

The following references are of record in the file of this patent:

UNITED STATES PATENTS

Number	Name	Date
474,169	Hellinger	May 3, 1892
660,318	Sperry	Oct. 23, 1900
712,881	Wilson	Nov. 4, 1902
719,325	Gray	Jan. 27, 1903
774,892	Pederson	Nov. 15, 1904
1,120,772	Wallman	Dec. 15, 1914
1,247,611	Apselund	Nov. 27, 1917
1,610,628	Staeger	Dec. 14, 1926
1,625,978	Breland	Apr. 26, 1927
1,643,424	Stafford	Sept. 27, 1927
1,643,574	Breland	Sept. 27, 1927
1,726,599	Wasson	Sept. 3, 1929
1,833,048	Cutler	Nov. 24, 1931
1,836,836	Stubler	Dec. 15, 1931
1,924,377	Pontow	Aug. 29, 1933
1,961,813	Caughy	June 5, 1934
2,092,366	Baughman	Sept. 7, 1937
2,103,274	Sanford	Dec. 28, 1937