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MULTIPLE ENGINE SPEED CONTROL

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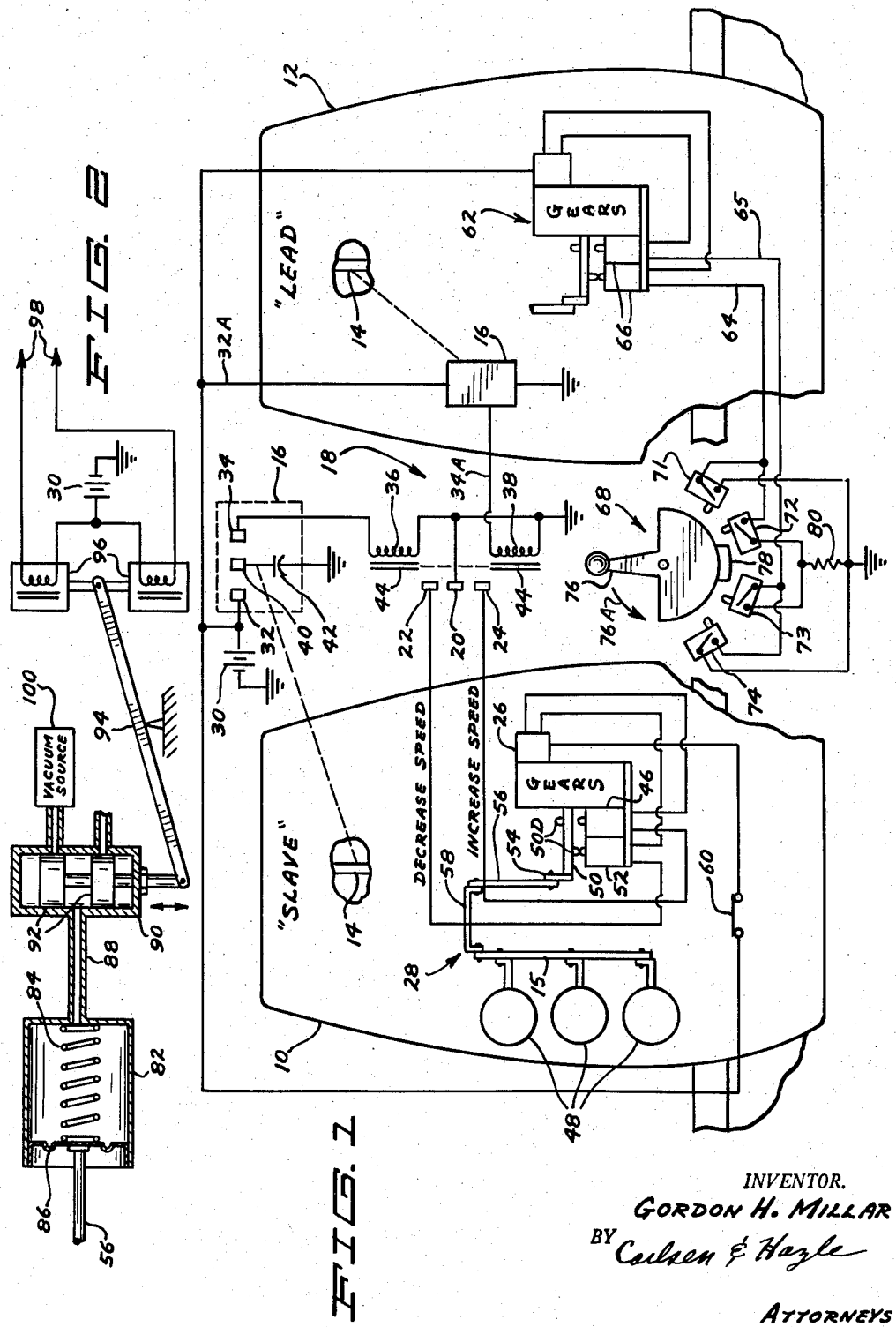


FIG. 2

FIG. 1

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MULTIPLE ENGINE SPEED CONTROL

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This invention relates to engine speed controls and more specifically to an engine speed control wherein one marine engine automatically follows the speed of another marine engine.

It is becoming increasingly popular to have two simultaneously operating outboard motors on pleasure marine craft, such as cabin crusiers and houseboats. These motors are usually placed side by side at the stern of the boat. Each motor should provide the same propelling power so the boat will travel on a straight course without continual steering corrections. Outboard motor engines have had their speeds equalized by mechanical control devices including interconnecting cables between the two engines. Such systems often add considerable weight to the boat.

The present invention provides an electrical speed control wherein two electrical currents respectively indicative of the two engine speeds are compared as to their relative magnitudes in a differential electrical circuit. This circuit is operative to adjust the speed of one engine to that of the other engine. The system is easily installed on most present day outboard motors with only minor modifications. Further only a single electrical lead need be used between the two engines for completely automatically controlling the one engine speed.

Accordingly it is an object of the present invention to provide an electrical magnitude comparison engine speed control.

It is another object of the present invention to provide for marine craft a remotely controlled electrical multiple engine speed control.

These and other more detailed and specific objects will be disclosed in the course of the following specification, reference being had to the accompanying drawings, in which—

FIG. 1 is a diagrammatic illustration of the present invention as embodied on two outboard motors.

FIG. 2 is a sectional view and schematic diagram of a throttle control device usable with the FIG. 1 embodiment.

With more particular reference now to the accompanying drawing, there is diagrammatically shown a "slave" outboard motor 10 which automatically follows the engine speed of the manually controlled "lead" outboard motor 12. The speed of each outboard motor engine is continually sensed as at the respective ignition timing cams 14 which are diagrammatically shown for more simply illustrating the invention. It is believed the constructional details of ignition timing cams in outboard motors are sufficiently well known as to require no further discussion herein. The speed of each outboard motor is indicated by an average electrical current magnitude provided by the tachometers 16. The current magnitudes are compared in a differential relay 18. A current differential urges the center one contact 20 toward one of the two stationary contacts 22 or 24. These contacts break and make two electrical circuits in the slave engine 10 each of which includes one winding of the D.C. reversible motor 26. When the motor speeds and thus the current magnitudes are equal the one contact 20 is spring urged to the illustrated position in non-contact relation to both stationary contacts. Whenever the engine speeds differ by a predetermined amount the resultant larger magnitude current urges the contact 20 to contact one of the

stationary contacts. This completes a circuit to one of the electric motor 26 windings for adjusting the throttle linkage 28 until the outboard motor speeds are equal. The contact 20 then returns to the illustrated position.

With particular reference now to the outboard motor speed responsive devices or tachometers 16, both being identical only one will be described. The lead storage battery 30 used to start and provide ignition current for the outboards is utilized as a voltage reference for both tachometers or speed responsive devices 16. The battery 30 positive terminal is connected to the contact 32 of the slave outboard 10 tachometer and over the line 32A to the lead outboard 12 tachometer. The second stationary contact 34 is connected to the relay 18 coil 36, while the lead outboard tachometer is like connected over single electrical lead 13A to the relay 18 opposingly wound coil 38. The center movable contact 40 is operatively associated with the slave timing cam 14 for movement between the stationary contacts 32—34 in synchronism with the outboard motor engine. The capacitor 42 is electrically between the contact 40 and ground for being charged to the battery 30 voltage as the contacts 32 and 40 are engaged. The cam 14 then moves the contact 40 into engagement with contact 34 for completely discharging it through the coil 36, the average current magnitude flowing therethrough being an accurate indication of the slave outboard speed.

The opposing coils 36 and 38 are disposed on a common magnetic core or circuit 44. During coil current magnitude balance zero magnetomotive force (mmf) is provided in core 44 to provide no urging to the three position switch 20—22—24.

As the coil 38 current and resultant mmf becomes greater as the lead engine speed increases over the slave the contact 20 is urged to engage contact 24. An electrical circuit through the limit switch 46 and the electric motor 26 winding is completed to the battery 30. The motor 26 rotates to move linkage 28 to increase motor 10 speed. The linkage 28 may be connected to the carburetor throttle link 15 as shown in FIG. 1 of the Bandli et al. Patent 2,864,349, issued September 25, 1959, and entitled "Intake Manifold for Internal Combustion Engines."

The linkage 28 includes the motor 26 gearingly driven shaft 50 having the radially outwardly extending dogs 50D. The dogs respectively open the two limit switches 46 and 52 as the shaft 50 is rotated to move the throttle plate in the carburetors 48 respectively to "full" and "idle" throttle positions. As the limit switches are opened the motor 26 forward and reverse windings are respectively disconnected by the switches 46 and 52 preventing further rotation of the motor in the respective directions. The idle and full throttle positions are determined by dogs 50D position on shaft 50.

A lever 54 on one end of the shaft 50 is pivotally connected to the rod 56 which in turn is connected to the throttle link 15 by transverse rod 58. The transverse rod 58 may be readily disconnected from the link 15 for providing manual throttle control. Alternately a manually operated switch 60 may be opened to disconnect the battery 30 from the motor 26. The linkage 28 is then manually moved for controlling the slave motor speed.

As the outboard motor 12 speed decreases with respect to the slave motor 10, the contact 20 is moved to the contact 22 which completes an electrical circuit through the limit switch 52 and the D.C. motor 26 reverse winding for adjusting the throttle linkage 28 toward the idle throttle position.

By constructing the system with the differential relay 18, preferably a meter movement with the illustrated contacts, mounted on the slave outboard motor 10 only the electrical lead 34A is added to automatically control the

slave engine speed. Note that the other indicated electrical leads are already provided between the boat (not shown) which contains the battery 30 and each outboard motor, all other electrical connections being made internally to each outboard motor.

It is preferred that the lead outboard motor speed be electrically remotely controlled, as from the front of the boat. A throttle control apparatus identical to the one described for the slave outboard motor 10 is provided for the lead motor 12, as generally designated by the numeral 62. Two electrical leads 64 and 65 are provided from the throttle control 62 through its limit switches 66 to a five position single pole toggle switch assembly 68.

The toggle switch 68 consists of four snap-acting normally-open switches 71, 72, 73 and 74; one of which may be closed at a time by the pivotally mounted manually actuated speed control lever 76. The lever 76 has a single outwardly extending dog 78 for closing the snap acting switches. The two inner switches 72 and 73 are circumferentially spaced apart to permit the dog 78 to be therebetween in what is termed a constant speed position. One end of each of the inner switches are joined and connected through a voltage dropping resistance 80 to ground reference potential. The outer two switches 71 and 74 are connected respectively to the control lines 64 and 65 in parallel with the respective switches 72 and 73. As the lever 76 is pivoted in the direction of the arrow 76A the dog 78 firstly closes the switch 72 to cause the lead outboard motor throttle control device 62 to increase throttle at a rate reduced by the resistance 80. This provides an intermediate acceleration of the boat. As the lever 76 is further pivoted the dog 78 closes both the switches 71 and 72 which grounds the line 64 through the switch 71 to provide a maximum acceleration. Of course the slave engine speed automatically adjusts to the lead engine speed providing control of both engines with a single speed control lever. Deceleration is provided by pivoting the lever 76 for closing the switches 73 and 74 in the same manner as aforedescribed.

A vacuum operated throttle control may be substituted for the D.C. reversible motor 26 and connected to the rod 56 as shown in FIG. 2 A vacuum chamber 82 has a spring 84 loaded diaphragm or piston member 86 connected to one end of the rod 56. A closed vacuum line 88 connects the chamber 82 to vacuum valve 90. The valve 90 has two spools 92 which are axially slid in the valve housing by a lever 94 as pivoted by the solenoids 96, respectively mounted on opposite sides of the lever. One end of each solenoid is connected to the lead storage battery 30 while the opposing ends 98 are connected respectively to the contacts 22 and 24 for the slave motor or to lines 64 and 65 for the lead motor.

Moving the spools 92 upwardly, as viewed in FIG. 2, connects a vacuum source 100 to the chamber 82 urging the diaphragm 86 to increase the throttle. Moving the spools 92 downwardly vents the chamber 82 to the atmosphere permitting the spring 84 to urge the rod 56 leftwardly changing the throttle toward "idle." This alternate throttle actuator may be substituted for the electric drive while keeping the same electric circuits as herein described. The throttle adjustment is limited by the diaphragm flexing capabilities. The vacuum source 100 may consist of a vacuum pump operated by one of the outboard motors.

It is understood that suitable modifications may be made in the structure as disclosed, provided such modifications come within the spirit and scope of the appended claims. Having now therefore fully illustrated and described my invention, what I claim to be new and desire to protect by Letters Patent is:

1. For equalizing the speeds of two engines each of which has a throttle adjusting linkage for controlling the engine speed, differential relay means having an intermediate and two actuated positions, electrical speed indicating means operatively associated respectively with each engine for providing electrical quantities the magnitudes of which are respectively related to the engine speeds, the relay means being on one engine and respectively electrically associated with each speed means by a single electrical lead, actuator means on the one engine operatively associated with the throttle linkage and relay means for respectively continually adjusting the linkage whenever the relay means is in one of said actuated positions and holding the linkage against adjustment when the relay means is in said intermediate position, and the relay means being responsive to the electrical quantities for being in said intermediate position only when the one engine speed equals the other engine speed.

2. For equalizing the speed of two outboard motors each of which has a carburetor with throttle adjusting linkage for controlling the outboard motor speed, a reversible electric motor connected to each linkage for respectively adjusting the outboard motor speeds, a differential relay on one outboard and having two opposing coils in actuating relation with a three-position switch for actuating the switch respectively toward first and second positions from an intermediate position, a battery electrically connected to one of said reversible motors through the switch when in said first and second positions for respectively causing the reversible motor to rotate in opposite directions, and speed responsive means in each outboard motor and being electrically connected to the battery and respectively to said opposing coils for transferring currents to said coils which are respectively related to the outboard motor speeds whereby the switch is actuated to said first and second positions as each current magnitude respectively exceeds the other current magnitude.

3. Apparatus as in claim 2 further including a manually controlled single lever electrical speed adjusting means electrically connected to the other of said reversible motors whereby the speeds of the two outboard motors are simultaneously adjusted by manually moving said lever.

4. For equalizing the speed of two outboard motors each having a carburetor and speed responsive means for providing an electrical current the magnitude of which is indicative of engine speed, a battery connected to both motors to provide a single reference voltage to both of the speed means, one outboard motor having a three-position differential relay with two opposing winding means respectively electrically connected to the speed means, a single electrical lead extending between the two outboard motors to form the said connection between one relay coil and the other outboard motor speed means, carburetor throttle linkage adjusting means on the one outboard motor and including throttle linkage limit means for preventing the adjusting means from adjusting the linkage beyond predetermined limits, and the adjusting means being operatively connected to the relay for adjusting the linkage such that when the relay is in a position other than a first open circuit position the one engine speed is being continually changed toward causing a current having a magnitude substantially equal to the other outboard motor speed indicating current.

5. Apparatus as in the claim 4 wherein the limit means comprises two limit switches respectively electrically interposed between the adjusting means and the relay for respectively electrically disconnecting said adjusting means for limiting the linkage adjustment between full and idle positions.

6. Apparatus as in the claim 4 wherein the adjusting means comprises a vacuum actuator operatively connected to the linkage, a vacuum valve in fluid communication with the actuator and to the atmosphere, a vacuum source in fluid communication with the valve, two solenoids operatively opposingly associated with the valve for respectively fluidly connecting the actuator to the atmosphere and to the vacuum source, and the solenoids being electrically connected to the battery through the relay

such that the solenoids are respectively actuated when the relay is in second and third positions.

7. For a marine craft, a first engine, an engine speed control for adjusting a carburetor fuel feed to vary the engine speed comprising an engine speed responsive means for providing an electrical quantity having a magnitude related to the engine speed, a carburetor fuel feed bidirectional actuator for adjusting the fuel feed to provide different engine speeds in response to an electrical signal, a second engine having speed determining means providing a second electrical quantity of the same type as the former quantity and having a magnitude related to the second engine speed a common electrical quantity reference associated with each of said responsive means, differential electrical means electrically associated with both of the speed means for determining any difference between the respective quantity magnitudes and providing an electrical signal to the actuator indicative of said difference whereby the actuator adjusts the carburetor fuel feed until the two magnitudes are substantially equal for indicating the two engine speeds are substantially equal, and conductor means connecting the actuator to the differential means.

8. Apparatus as in the claim 7 wherein the differential electrical means is a relay having opposingly wound coils respectively electrically connected to the speed means and having a three-position switch wherein two positions are for respectively completing two electrical circuits for the actuator whereby the actuator respectively increases and decreases the engine speed.

9. Apparatus as in claim 8 wherein the actuator includes two winding means electrically associated with said switch and the battery for adjusting a carburetor fuel feed to increase and decrease engine speed when the switch is respectively in said two positions.

10. In an outboard motor, an engine speed control comprising a differential relay having a three contact electrical switch part with a center one contact being movable between another two contacts and an intermediate open circuit position, a battery, speed responsive means on the outboard motor and being electrically connected to the battery for transferring an electrical current to the relay for urging the center one contact to a first of the another two contacts, the electrical current having a magnitude related to engine speed, carburetor throttle linkage adjusting means including two winding means respectively electrically associated with the another two contacts, the center contact being electrically connected to the battery, and a second outboard motor having speed responsive means for providing an electrical current magnitude indicative of the second motor speed and being electrically associated with the relay for providing an electrical current thereto for opposing the speed means transferred current urging whereby the adjusting means is inactive when the two currents are equal in magnitude.

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