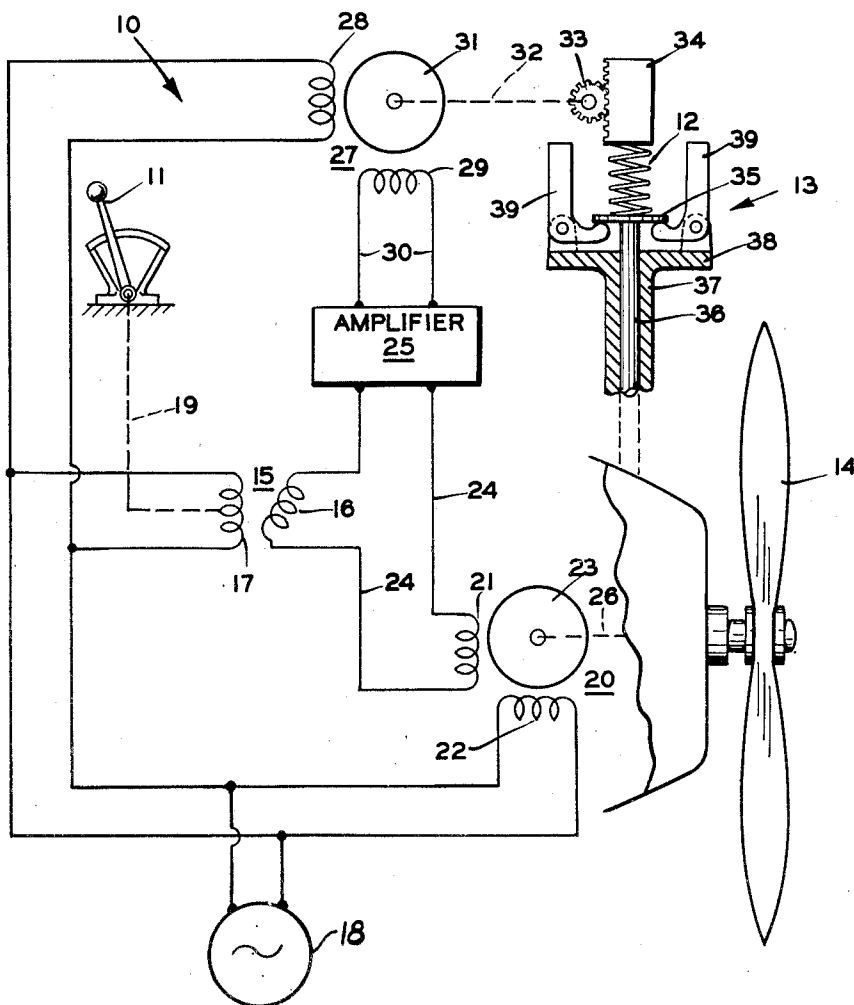


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ENGINE SPEED CONTROL

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This invention relates to an engine speed control, and more particularly to a remote engine speed control in which the speeder spring setting of a propeller governor is altered to vary the speed of the engine.

In previous systems for controlling the speed of an aircraft engine by varying the pitch of the propeller, the free end of the speeder spring of a propeller governor unit is generally positioned to some calibrated position to affect the response of the fly ball type governor to the engine speed. The disadvantage of this type of control is that the calibration of the speeder spring must be known and compensation made for variations therein, as well as for the variations in the governor characteristics. The exact speed required of an engine was not always attainable in prior systems due to these variations in the system.

An object of our present invention is to provide an engine speed control system in which the variations in speeder spring bias and governor characteristics are eliminated.

Another object of our invention is to provide an engine speed control system in which a balanced electrical network controls the bias of the speeder spring for varying the speed of an engine.

A further object of this invention is to provide an engine speed control system in which a signal voltage is applied to an electrical circuit for affecting the speed of the engine, a second signal voltage responsive to the speed of the engine tending to balance the circuit when engine speed is in agreement with the signal voltage.

Still another object of the invention is to provide an engine speed control system of the character indicated which shall be independent of variations in voltage and frequency of the voltage source.

Still a further object of the invention is to provide a highly improved control system of the character indicated which shall consist of few and simple parts, be relatively inexpensive to manufacture, which shall be positive and accurate in its operation, which shall have a large variety of applications, and yet be practical and efficient to a high degree in use.

Other objects of this invention will in part be obvious, and in part hereinafter pointed out.

The invention accordingly consists in the combinations and arrangements of electrical circuit elements which will be exemplified in the circuit hereinafter described, and of which the scope of application will be indicated in the appended claims.

Referring now in detail to the single figure of

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the drawing, in which one of the various possible illustrative embodiments of the invention is shown schematically, the numeral 10 designates an electrical circuit interconnecting a control handle 11 and the speeder spring 12 of a propeller governor 13 for varying the pitch of a propeller 14 to control the speed of the engine (not shown) driving the same; the propeller governor being illustrated schematically, its operation to vary the pitch of the propeller 14 being well-known in the art.

The circuit 10 comprises a synchronous generator, transmitter or rotary transformer 15 having a stator coil 16 and a rotor coil 17. The rotor coil 17 is connected across a suitable power supply or source of alternating current 18 and is adapted to be angularly displaced with respect to the stator through a linkage or gearing, herein indicated by the dash line 19, upon movement of the control handle 11.

As is well-known in the art, a signal voltage will be induced in the stator coil 16, the induced voltage being variable by the displacement of the rotor winding 17. The signal voltage induced in the stator 16 is proportional to the angular position of the rotor 17. The signal voltage thus provided is proportional to the position occupied by the control handle 11.

The stator winding 16 is connected in series with a two phase induction generator 20, having two phases 21 and 22, and a rotor 23. The field winding 22 is connected across the power supply 18, while the other field winding 21 is interconnected by lead 24 in series with stator winding 16 to the input side of a conventional amplifier 25, herein shown in block diagram form. The rotor 23, which is of the squirrel-cage type or could be a drag cup, is adapted to be rotated by the aircraft engine (not shown) through a suitable coupling, indicated by the dash line 26.

The rotation of the rotor 23 by the aircraft engine will induce a voltage in the phase 21 which will be proportional to the speed of the engine. The phase 22 of the generator 20 being connected across the same line 18 as the rotor 17, the voltage induced in the phase 21 of the generator 20 will be of the line frequency, the amplitude of the induced voltage in the phase 21 being responsive to the engine speed. Two voltage sources are thus provided in the input circuit of the amplifier 25, the one due to handle position, the other due to engine speed. When the two voltages are equal, the two voltages will cancel each other, and no voltage will be impressed across the amplifier input leads 25. This

condition will exist when the engine speed is in accordance with the position of the control handle 11. When the two voltages are unequal, a voltage equal to the difference of the two voltages will be impressed on the amplifier input to bring the speed of the engine into accord with the control handle 11.

To this end, circuit 10 is further provided with a two phase induction motor 27 having a fixed phase 28 connected across the voltage source 18, a variable phase 29 connected by leads 30 to the output of the amplifier 25, and a rotor 31. The rotor 31 is provided with suitable gearing 32 for rotating a pinion 33, the teeth of which mesh with the teeth of a rack 34. The lower end of the rack is fixed to the speeder spring 12; the lower end of the spring dependently biasing a plate 35 fixed to a rod 36. The rod 36 is journaled in a sleeve 37 rotatable by the aircraft engine (not shown). Mounted on the upper surface of an enlarged portion 38 of sleeve 37, are pivoted weighted bell-crank members 39 cooperating with the disc 35. Movement of the rod 36 by the weighted members 39 will vary the propeller pitch accordingly, as is well-known in the art.

When a voltage difference exists between that induced in the stator winding 16 and in the phase winding 21, the voltage difference is amplified and applied to the variable phase 29 of the motor 27. The motor 27 will thus be operated to move the rack 34 of the propeller governor 13. Movement of the rack by the rotation of pinion 33 will vary the bias of the speeder spring 12 affecting the response of the weighted members 39 to the speed of the engine. The disc 35 and rod 36 will accordingly be moved by the weighted members 39 to vary the pitch of the propeller 14. The speed of the aircraft engine will thus be varied in accordance with the setting of the control handle 11.

It should be noted that the control circuit herein described is independent of variation in the line voltage (18) and frequency supplying the rotor 17 and the field winding 22 due to the similar characteristics of the two units.

In order to provide stability for the control circuit described, the amplifier 25 may be so designed that the speed of the induction motor 27 controlled thereby will be proportional to the voltage difference between the induced voltages in the windings 16 and 21. Providing a very slow motor speed at small engine speed errors will prevent too rapid a change of engine governor setting. Hunting by the governor will thus be eliminated.

It will thus be seen that there is provided a novel engine speed control in which the several objects of this invention are achieved, and which is well adapted to meet the conditions of practical use.

As various possible embodiments may be made of the above invention, and as various changes may be made in the embodiment hereinbefore described, it is to be understood that all matter herein set forth, or illustrated in the accompanying drawing, is to be interpreted as illustrative and not in a limiting sense.

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

1. For use with a variable speed engine of a type including means for controlling the speed of said engine; the combination comprising motive means for actuating said control means, a balanced electrical network controlling said motive means including two inductive devices,

one of said inductive devices being an induction type generator, said induction type generator including a first winding energized from a main source of alternating current, a rotor member, and a second winding, said first winding inductively coupled to said second winding, means drivingly connecting the engine to the rotor member, said first winding so arranged in relation to said second winding and rotor member as to induce a voltage in said second winding of an amplitude proportional to the speed of the engine and of a frequency determined by the main source of alternating current; the other of said inductive devices being an induction type rotary transformer, said rotary transformer including a first winding energized from said main source of alternating current, a second winding, said first winding inductively coupled to said second winding, and operator-operative engine speed selecting means for angularly displacing said first and second rotary transformer windings relative one to the other to vary the voltage induced in said second winding, the second winding of said generator and the second winding of said transformer being connected in series in said electrical network and in opposing relation so as to unbalance said electrical network upon the engine speed differing from the speed selected by said operator-operative means to effect operation of said motive means to regulate the engine speed to the selected value.

2. For use with a variable speed engine of a type including means for controlling the speed of said engine; the combination comprising a polyphase alternating current motor for positioning said speed control means, a source of alternating current, means for continuously energizing one phase winding of said motor from said source of alternating current, an amplifier for energizing another phase winding of said motor with an alternating current which either leads or lags said alternating current of said source to cause rotation of said motor either in one direction or the other, speed responsive means for controlling said amplifier, said speed responsive means including an alternating current induction type generator, means drivingly connecting the engine to said generator, said generator including an input winding and an output winding, means for continuously energizing said input winding from said source of alternating current, and a normally balanced electrical network connecting said output winding to said amplifier, said generator controlling said amplifier through said network so as to cause said motor to position said speed control means upon an unbalance of the network so as to maintain the speed of the engine at a predetermined value.

3. The combination defined by claim 2 in which said network includes a rotary induction transformer having a pair of inductively coupled windings, means for continuously energizing one of said windings from said source of alternating current, means connecting the other of said windings in said network in series relation to the output winding of said generator, said other winding being arranged to supply a voltage in opposition to the voltage of the generator output winding to normally balance said network, and manually operable means to adjustably position one of said inductively coupled windings relative to the other to vary the predetermined speed of said engine.

4. For use with a variable speed engine of a type including means for controlling the speed

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of said engine; the combination comprising a polyphase alternating current motor for positioning said speed control means, a source of alternating current, means for continuously energizing one phase winding of said motor from said source of alternating current, an amplifier for energizing another phase winding of said motor with an alternating current which either leads or lags said alternating current of said source to cause rotation of said motor either in one direction or the other, speed responsive means for controlling said amplifier, said speed responsive means including an alternating current induction type generator, means drivingly connecting the engine to said generator, said generator including an input winding and an output winding, means for continuously energizing said input winding from said source of alternating current, and an electrical network connecting said output winding to said amplifier, said generator controlling said amplifier through said network and through said amplifier the direction of rotation of said motor to thereby control the speed of said engine.

5. For use with a variable speed power means of the type including means for controlling the speed of said power means; the combination comprising a polyphase alternating current motor for positioning said speed control means, means for continuously energizing one phase winding of said motor from a main source of alternating current, an electrical network for energizing another phase winding of said motor with an alternating current which either leads or lags said alternating current of said main source to cause operation of said motor either in one direction to decrease the speed of the power means or in another direction to increase the speed of the power means, speed responsive means for controlling said electrical network, said speed responsive means including an alternating current induction type generator, drive means connecting said power means to said generator, said generator including an input winding and an output winding, means for continuously energizing said input winding from said main source of alternating current, said input winding inductively coupled to said output winding and arranged in said generator so that said generator effects an output voltage having an amplitude proportional to the speed of said controlled power means and a frequency determined by said main source of alternating current, and said generator controlling through said network the direction of operation of said motor to thereby control the speed of said power means.

6. In a system for controlling a variable speed

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power means of the type including means for controlling the speed of said power means; a polyphase alternating current motor for positioning said speed control means, a source of alternating current, means for continuously energizing one phase winding of said motor from said source of alternating current, an electrical network for energizing another phase winding of said motor with an alternating current which either leads or lags said alternating current of said source to cause operation of said motor either in one direction to decrease the speed of said power means or in another direction to increase the speed of the power means; the improvement comprising an alternating current induction type generator to control said network, means for continuously energizing said generator from said source of alternating current, drive means connecting said power means to said generator, and said generator being arranged so as to control through said network the direction of operation of said motor to thereby control the speed of said power means.

7. The combination defined by claim 6 in which said generator includes an input winding and an output winding, means for continuously energizing said input winding from said source of alternating current, said input winding inductively coupled to said output winding and arranged in said generator so that said generator effects an output voltage having an amplitude proportional to the speed of said controlled power means and a frequency determined by said main source of alternating current so that said generator may control through said network the direction of rotation of said motor and thereby the speed of said power means.

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