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SPEED GOVERNING SYSTEM FOR DIRIGIBLE CRAFTS

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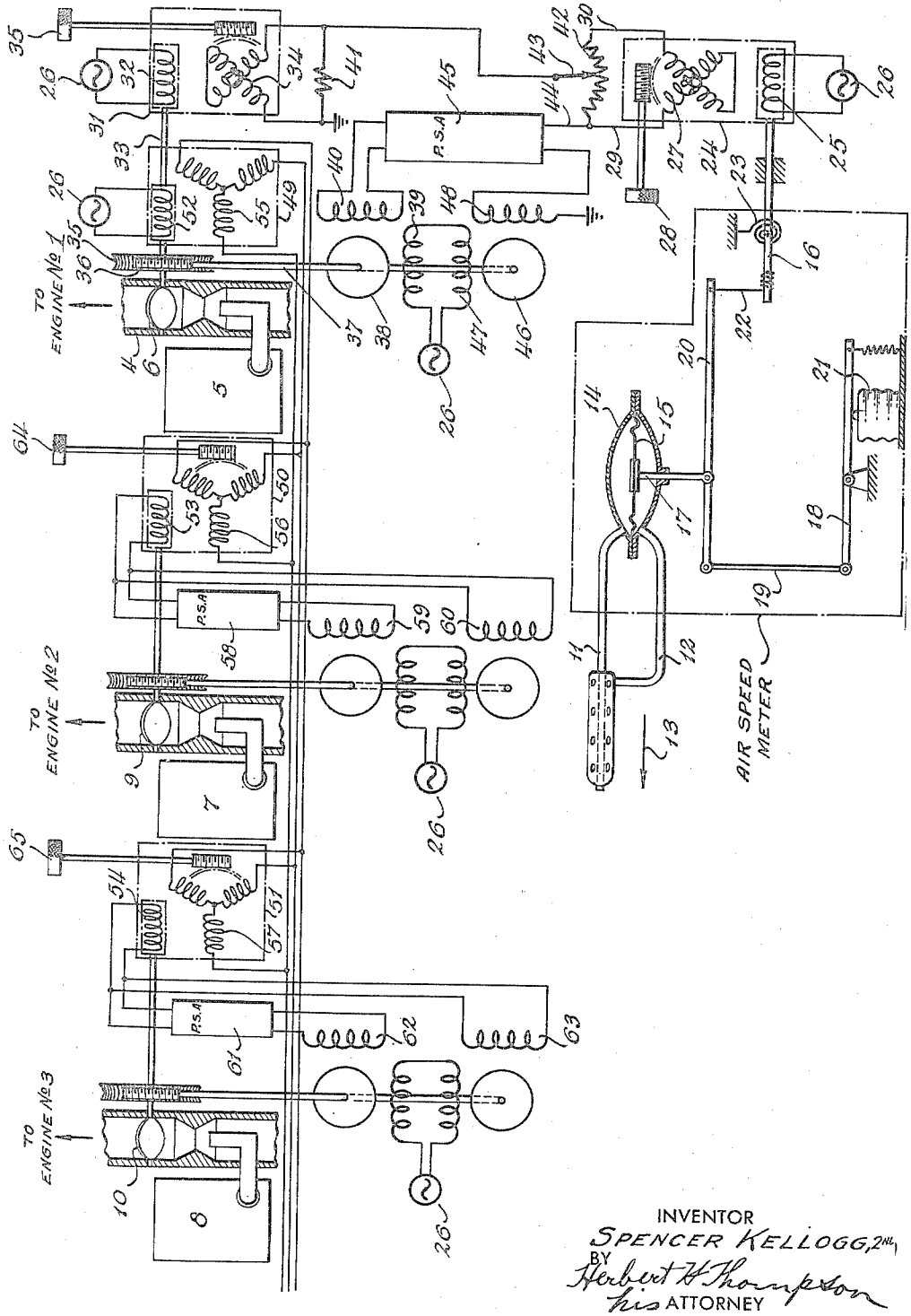

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SPEED GOVERNING SYSTEM FOR DIRIGIBLE CRAFT

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This invention relates to a system for governing the speed of movement of dirigible craft such as aircraft by controlling the prime mover or prime movers thereof. As particularly adapted to aircraft, the system is effective to automatically maintain the craft at a substantially constant desired air speed whether the same is flying straight, yawing about a vertical axis, or tilting about either its pitch and/or roll axes.

According to the present invention, the throttle valve or other means for changing the condition of operation of the prime mover controlled by the system is operated by means controlled by the compared signals of a pick-off positioned by a speed responsive device and a second pick-off controlled by the position of the throttle valve or other means. The signals are compared in a receiver whose output is zero when the signals are of opposite and equal amplitudes. When the signals are unbalanced the receiver is effective to produce an output that controls the movement of the throttle valve in a direction to restore the signals to balance. Where more than one engine or prime mover is controlled by the system, the throttle position of the controlled throttle valve of the primary engine is employed to provide a base for a repeater control device that similarly positions the throttle valves of the other engines.

A further feature of the invention resides in inclusion in the system of means for damping the movements of the automatically operated engine controlling throttle valve. Means for damping the throttle valves of each of the engines are included in a multi-engine controlling system.

Other novel features are hereinafter more particularly set forth in the description of the invention relative to the accompanying drawing in which the system is schematically illustrated in a single view.

With reference to the drawing, the throttle valve including portion of an intake manifold 4 for an engine (not shown) termed engine 1 is represented schematically with a carburetor 5 and a movable throttle valve 6. The system is adapted to control one or more prime movers and as illustrated also governs the operation of further engines (not shown) termed engines 2 and 3. The parts illustrated for changing the condition of operation of engines 2 and 3 respectively include carburetors 7 and 8 and throttle valves 9 and 10. A showing similar to intake

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manifold 4 is made for the corresponding part of each of the engines 2 and 3. The prime movers may be conventional gas engines, as employed to provide the motive power to move dirigible craft such as aircraft. The engines per se are not considered an element of the system and are consequently neither specifically shown in the drawing or positively set forth in the claims of the application.

As shown, the system includes a meter or device adapted to measure the speed of movement of the craft through the air. Such a device is depicted in the drawing as including a Pitot tube 11 whose head-on pressure is dependent on the speed of travel of the craft plus the pressure at the flight level of the craft and a Pitot-static tube 12 whose pressure is dependent only on the flight level of the craft. Arrow 13 in the drawing indicates the direction of travel of a craft with the meter thereon. Tubes 11 and 12 connect with an airtight body 14 having a central diaphragm 15 therein so that the respective pressures supplied are in opposite sides of the diaphragm and determine its position in the body 14. As shown in the present case, diaphragm 15 is operatively connected to a shaft 16 by means of reciprocating piece 17, and a linkage which includes rocker 18 and connected links 19 and 20. The meter illustrated is corrected for change in air density with altitude change by a closed bellows 21 which presses against one end of the rocker 18. Link 19 of the linkage is temperature sensitive so that the meter is corrected for variations in temperature conditions under which a craft having this instrument thereon may operate. A meter having these corrections may be termed a true air speed meter.

Shaft 16 of the meter is positioned by the diaphragm 15 in the present instance through the flexible cable connection 22 which is secured to one end of the link 20. Coil spring 23 for the shaft 16 maintains the cable taut. Shaft 16 moves in one direction when link 20 pulls the cable as reciprocating piece rises as viewed in the drawing due to a decrease in the air speed of the craft or to an increase on the static pressure head. The shaft moves in the opposite direction when permitted by the linkage by means of the spring 23.

In the present instance, the shaft 16 of the device responsive to the speed of the craft controls a pick-off indicated at 24 to produce a signal that

corresponds to the craft's speed. As shown, pick-off 24 is a two phase "Selsyn" instrument whose wound rotor 25 is positioned by the shaft 16. The rotor of this electrical pick-off is supplied with energy from a suitable source of alternating current designated at 26. The other part of the pick-off 24 is a stator 27 whose respective windings are electrically spaced by 180 degrees. The stator part of the two part electrical pick-off is rotatably mounted to move relative to the rotor thereof under control of a setting knob 28 that is manually operable. The pick-off is primarily designed to produce a linear signal output above or below a desired reference speed determined by the setting of knob 28. When the speed of the craft is above that desired by the reference, the voltage output or signal is of one polarity or phase while when below that desired is of the other polarity or phase. When the craft is moving at the desired speed, the output or signal from pick-off 24 is zero. The signal of pick-off 24 is fed to a receiver hereinafter described by way of leads 29 and 30.

The improved system also includes a second pick-off 31 which is shown in the present instance as of the same general character as pick-off 24. The rotor 32 of pick-off 31 however is operated by and positioned in accordance with throttle valve 6 of engine 1 as these elements are fixedly mounted on a common shaft 33. The rotor winding of the pick-off is energized from A. C. source 26. The phase wound stator 34 of this pickoff may also be rotatably mounted and set in position by a manually controllable knob 35. Knob 35 determines the base setting for the throttle valve 6 at which the pick-off 31 has a zero output. When to either side of this desired base, either the throttle is more fully opened or closed, the pick-off is effective to produce an output signal whose phase is dependent on the direction that the throttle has moved in from its desired base setting and whose amplitude is dependent upon the extent of the displacement.

The system further includes means connected to operate the throttle valve 6 or other means for changing the conditions of operation of the prime mover. As herein shown this means includes worm wheel 35 fixedly mounted on shaft 33, worm 36 and shaft 37 which may be driven by a conventional polyphase induction motor of the squirrel-cage type whose short-circuited rotor is indicated at 38. Stator winding 39 of this motor is continuously excited by connection with source 26. The manner in which winding 40 of this motor is energized to control its direction of operation will be hereinafter described.

In accordance with the teaching of the invention, the system includes receiving means for the outputs of the respective pick-offs 24 and 31 which itself provides an output for the throttle operating means that is effective to move the valve in a direction to restore the signals of the pick-offs to equal and opposite amplitudes and a balanced condition. The receiver as shown is a circuit, one end of which is grounded, that includes resistor 41 across which the voltage of pick-off 31 is impressed and potentiometer 42 across which the voltage of pick-off 24 is impressed. The adjustable arm 43 of potentiometer 42 is manually settable to modify the ratio between the signals of the pick-offs to obtain an output from the receiver. With the resistance of each of the branches of the potentiometer equal and equal to resistance 41, the system is normally balanced with zero signals from the

respective pick-offs or with signals from the pick-offs that are 180 degrees out of phase and of equal amplitudes. The receiver in such event has no output. When signals are fed to the receiving circuit by the pick-offs that are not completely balanced across these respective resistors, the circuit provides an output signal that is fed by way of lead 44 to a phase sensitive amplifier 45 of conventional form whose output is directly fed to the control winding 40 of the noted polyphase induction motor. The throttle valve is moved by the motor as is the rotor of pick-off 31 in a direction that restores the receiving circuit for the pick-off to a balanced condition with zero output. The receiver thus compares the signals of the pick-offs in opposing relation and provides an output when the amplitudes of the respective signals are unbalanced. The amplified resultant of the signals of the pick-offs determines the direction of rotation of the throttle moving motor which continues to move in the same direction unitl the phase of the voltage signal fed the winding is reversed.

In operation the system tends to maintain the craft at a substantially constant predetermined air speed as a change in air speed is immediately reflected in the air speed meter to reposition shaft 16 and the rotor 25 of pick-off 24. This either increases or decreases the output signal of the pick-off and unbalances the signal receiving circuit of the system. If the signal of pick-off 24 increases, the motor is driven to reposition the throttle sufficiently to balance the increase in the receiver by the increased signal from pick-off 31 which closes the throttle and reduces the speed of the craft. Reverse relations occur when the signal of the pick-off 24 decreases due to slowing down of the speed of the craft.

The system further includes means for damping the movements of the throttle operating means. As shown, this means may be in the form of an A. C. generator having a movable armature 46 mounted on shaft 37. The generator further includes a stator having a winding 47 continuously excited by energy supplied from source 26. The output winding 48 of the generator or alternator is connected to the phase sensitive amplifier 45, the signal thereof being fed in opposition to the output signal of the receiver circuit so as to damp the operations of the motor at all times and keep the speed thereof in direct proportion to the magnitude of the controlling signal from the receiver circuit. The alternator provides an A. C. signal means for maintaining the speed of throttle operating means in proportion to the output signal of the receiving means.

When the improved system is utilized to control a plurality of prime movers, further means are included to position the respective throttle valves thereof in accordance with the controlled position of throttle 6 of engine 1. In the instant showing three phase "Selsyn" instruments 49, 50 and 51 are employed in this connection. The rotor 52 of instrument 49 is fixedly mounted on shaft 33 and is supplied with energy from source 26. It is understood that shaft 33 determines the position of throttle valve 6 controlling engine 1. Rotor 53 of instrument 50 and rotor 54 of instrument 51 are likewise mounted on the throttle shafts of the respective engines 2 and 3. The stators 55, 56 and 57 of the respective "Selsyn" instruments are interconnected as shown in the drawing. If the angular relation between rotor 53, stator 56 differs from that between rotor 52 and stator 55, a signal is produced in the rotor

53 which is fed to phase sensitive amplifier 58 and to the control winding 59 of a motor connected to move the throttle 9 of engine 2 in the same way as hereinbefore described in connection with engine 1 except that in this event the throttle is moved until the shaft thereof is repositioned so that no output is obtained from winding 53. Damping means is provided for throttle 9 in the form of an alternator as previously described whose output winding is indicated at 60. Corresponding parts for throttle 10 are respectively indicated at 61, 62 and 63. In order to account for engine differences so that the same may be properly synchronized, the stators of instruments 50 and 51 are rotatably mounted so the same may be adjusted by manually settable knobs such as indicated at 64 and 65.

Since many changes could be made in the above construction and many apparently widely different embodiments of this invention could be made without departing from the scope thereof, it is intended that all matter contained in the above description or shown in the accompanying drawing shall be interpreted as illustrative and not in a limiting sense.

What is claimed is:

1. In a speed governing system for dirigible craft having a prime mover with a controllable throttle valve; means connected to operate the valve, a speed measuring meter, a pick-off controlled by said meter to produce a signal when the craft is above or below a predetermined reference speed, a second pick-off operated by the throttle valve to produce a second signal corresponding to the displacement of the throttle valve of the prime mover from a predetermined position, and receiver means for said signals producing an output when the signals are other than of equal and opposite amplitudes for said valve operating means effective to move said valve in a direction that restores said first and second signals to equal and opposite amplitudes.

2. A system as claimed in claim 1, including means for damping the movements of said valve operating means

3. A system as claimed in claim 1, in which said first named pick-off includes two relatively movable parts and manually settable means for positioning one of said parts.

4. A system as claimed in claim 1, in which said second pick-off includes two relatively movable parts and manually settable means for positioning one of said parts.

5. A system as claimed in claim 1, in which said receiver means includes settable means for modifying the ratio of the signals of the first and second pick-offs to obtain an output therefrom.

6. In an aircraft prime mover controlling system, the combination of, means for changing the condition of operation of the prime mover, a device for measuring the air speed of the craft, a pick-off operated by said device to produce a signal when the craft is above or below a predetermined reference speed, a second pick-off controlled by said operation changing means of the prime mover producing a signal corresponding to the displacement thereof from a predetermined position, a receiver for the signals of the respective pick-offs comparing the same in opposing relation and providing an output when the amplitudes of the respective signals are unbalanced, and means responsive to the output of said receiver for operating the prime mover conditioning means to restore the signals of said pick-offs to a balanced

condition and thereby automatically control the air speed of the craft.

7. A system as claimed in claim 6, in which said pick-offs are electrical, the signals are A. C. voltages and the output from the receiver is zero when the voltage signals are compared 180 degrees out of phase and of equal amplitudes.

8. A system as claimed in claim 6, in which said pick-offs are electrical, the signals are voltages and said receiver includes a potentiometer settable to modify the ratio of the first and second pick-offs to obtain an output therefrom.

9. A system as claimed in claim 6, in which said operation changing means for the prime mover is an electric motor, said system further including electrical means for damping the operation of said motor.

10. A system as claimed in claim 6, in which said first pick-off includes two relatively movable electrical parts and manually settable means for positioning one of said parts.

11. A system as claimed in claim 6, in which said second pick-off includes two relatively movable electrical parts and manually settable means for positioning one of said parts.

12. A system as claimed in claim 6, in which said air speed measuring device is compensated for pressure and temperature changes.

13. The combination of a dirigible craft engine throttle, means connected to operate said throttle to control the conditions of operation of the engine, a device responsive to the speed of movement of the craft, means for producing an A. C. signal controlled by said device when the craft is above or below a predetermined reference speed, means for producing a second A. C. signal corresponding to the displacement in position of said throttle from a predetermined base, and receiving means for said respective signal producing means providing an output for controlling said throttle operating means when the signals are other than 180 degrees out of phase and of equal amplitudes.

14. The combination of a dirigible craft engine throttle, means connected to operate said throttle to control the conditions of operation of the engine, a device responsive to the speed of movement of the craft, means for producing an A. C. signal controlled by said device when the craft is above or below a predetermined reference speed, means for producing a second A. C. signal corresponding to the displacement in position of said throttle from a predetermined base, receiving means for said respective signal producing means providing an output for controlling said throttle operating means when the signals are other than 180 degrees out of phase and of equal amplitudes, and means for providing a third A. C. signal for maintaining the speed of operation of said throttle operating means in proportion to the output signal of said receiving means.

15. The combination of, craft speed controlling means having a positionable element, a meter for measuring craft speed, a pick-off controlled by said meter to produce a signal when the craft is above or below a predetermined reference speed, a second pick-off operated by said positionable element to produce a second signal corresponding to the displacement of the element from a predetermined position, means for moving said positionable element, and receiver means for said signals producing an output when the signals are other than of equal and opposite

amplitudes for operating said moving means to move said element in a direction that restores the signals of said pick-offs to a balanced condition.

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