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POWER CONTROL FOR AIRCRAFT ENGINES

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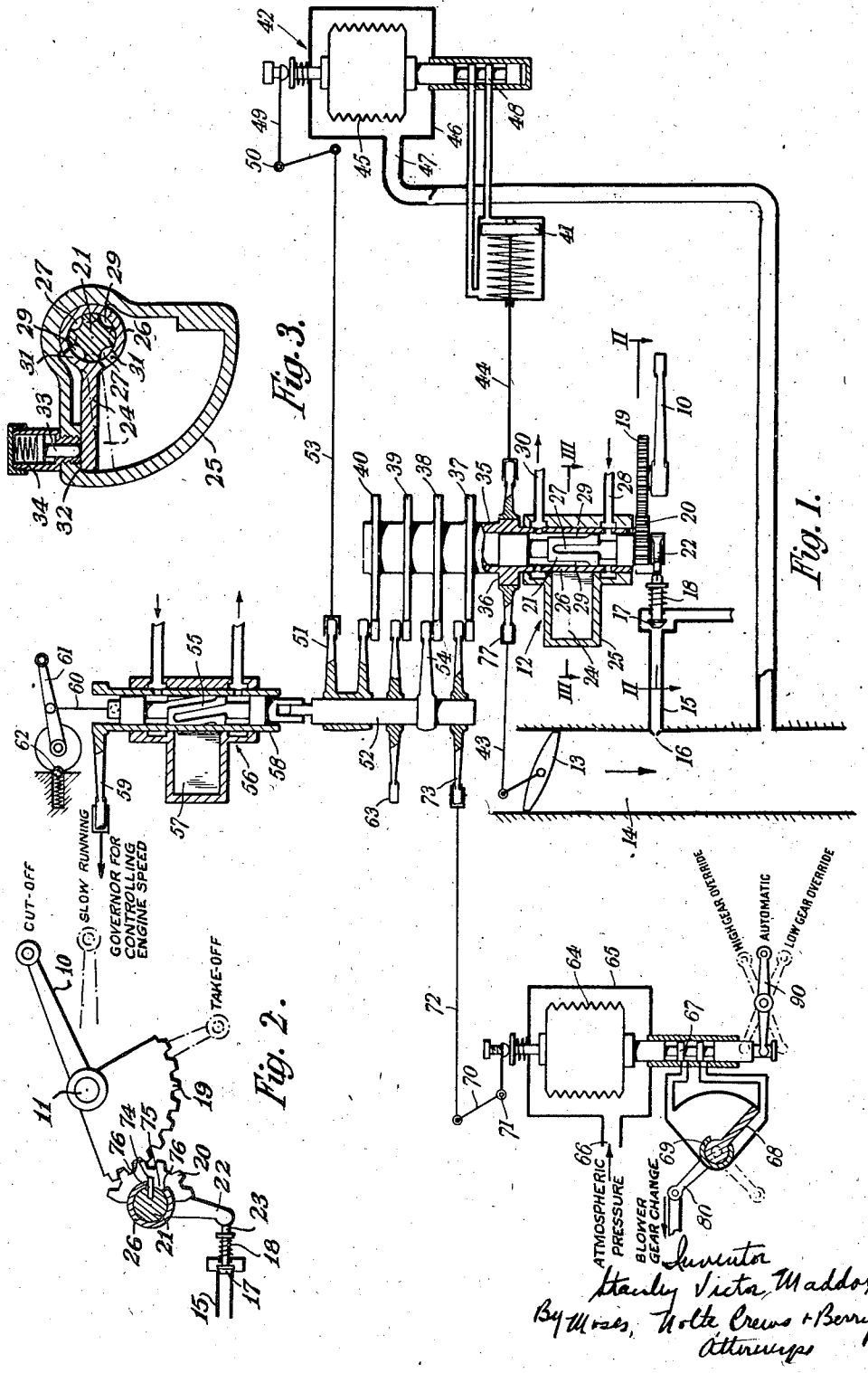


Fig. 1.

Fig. 2.

Fig. 3.

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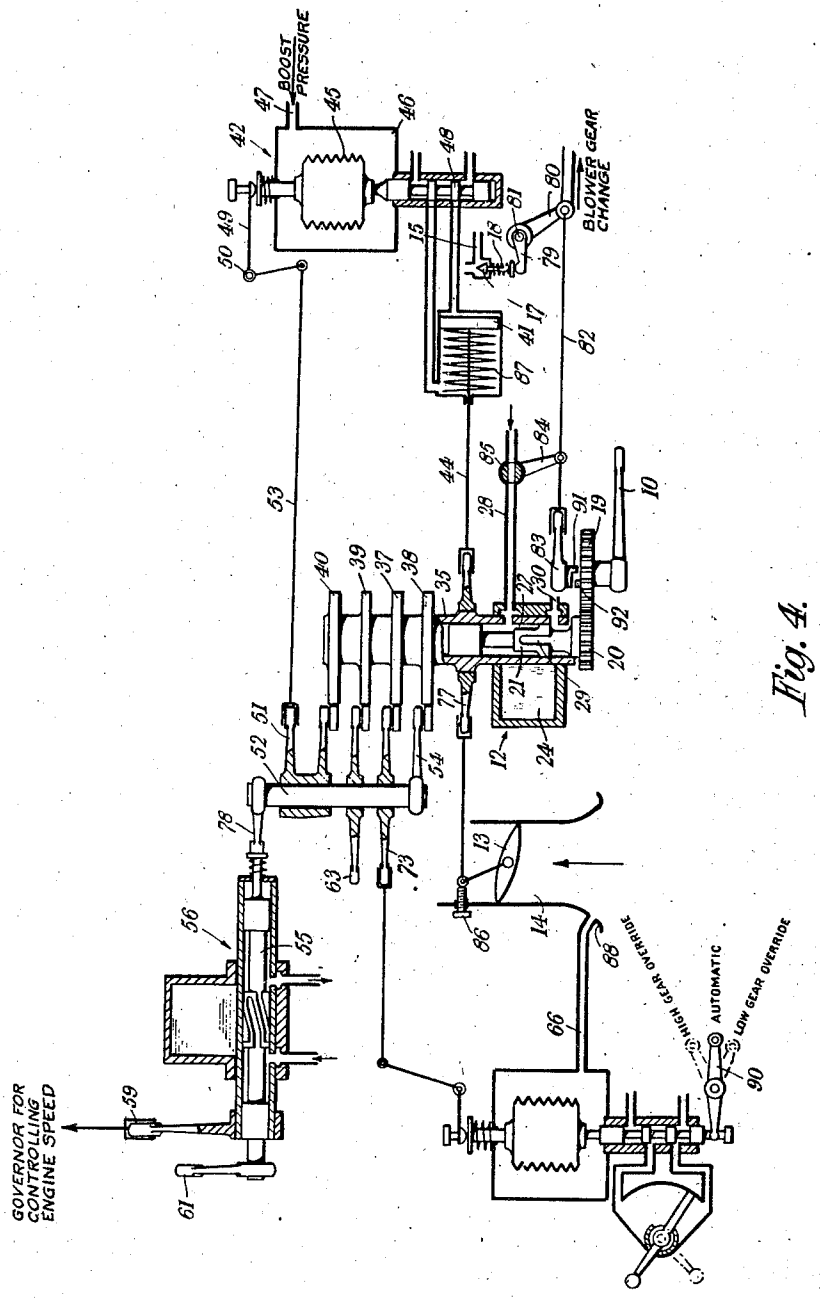


Fig. 4.

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POWER CONTROL FOR AIRCRAFT ENGINES

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Application August 29, 1944, Serial No. 551,707
In Great Britain January 1, 1944

8 Claims. (Cl. 123—103)

This invention provides, in or for an aero engine, the combination with a vane-type servo motor, the operating valve whereof is coupled to a pilot's throttle lever so as to be actuated by movement of said lever and the vane whereof serves to control the position of the throttle valve, of a stop for arresting the vane when the pilot's lever, on movement to close the throttle, has reached the slow running position and a finger operatively connected to the operating valve or to the pilot's lever and arranged to actuate a fuel cut-off valve on further movement of the pilot's lever beyond the slow running position.

It is preferred to provide a spring-loaded plunger which is displaced by the vane on movement thereof into the slow running position, and is effective to move the vane into the "start" position should fluid pressure be cut off from the servo motor while the vane is in the slow running position, the vane being mechanically connected to the throttle so as to open the latter to a position suitable for starting when moved by the plunger into the start position.

It is also preferred to provide the operating valve with a projection, having a restricted range of movement between stops on the surrounding sleeve carrying the vane, said projection cooperating with the stops to permit of manual operation of the vane by the pilot's lever in the event of failure of the fluid pressure.

Two forms of power control for aero engines according to the invention will now be described in detail by way of example, with reference to the accompanying drawings, in which:

Fig. 1 is a diagrammatic layout of the first installation, Figs. 2 and 3 are sections on an enlarged scale taken respectively on the lines II—II and III—III in Fig. 1, and Fig. 4 is a diagrammatic layout of the second installation.

Like reference characters indicate like parts throughout the figures.

In Figs. 1 and 4 the parts are shown in the position they occupy with the pilot's throttle lever in the slow-running position, while in Figs. 2 and 3 they are shown in the alternative positions which they assume when the pilot's throttle lever is in the cut-off position.

The power control illustrated in Figs. 1–3 is actuated by a pilot's throttle lever 10, movable about a pivot 11. This single lever controls, through the agency of a master servo motor 12, mechanisms for controlling the following engine functions:

(a) The boost pressure, and degree of opening of the throttle valve 13 necessary to establish the required boost pressure at the altitude at which the aircraft is flying;

(b) The engine speed;

(c) The ignition timing; and

(d) The change-over in the gear ratio of the blower fitted to the engine.

The pilot's throttle lever 10 is movable between the slow-running and take-off positions shown in Fig. 2, and operates through the agency of the master servo motor 12 to adjust the above-indicated engine functions appropriately to conform with the position of said lever, in the same fashion as the pilot's throttle lever in the case of the installation described in copending application Serial No. 551,703, but through the agency of different mechanism. The lever 10 is also movable beyond the slow-running position into a cut-off position in which it cuts off the flow of fuel to the engine.

Fuel is normally fed to the induction pipe 14 through a pipe 15 terminating in an injection nozzle 16. In the pipe 15 is located a cut-off valve 17 which is normally maintained open by a spring 18 (see Fig. 1). The lever 10 carries a toothed quadrant 19 meshing with a toothed quadrant 20 fixed to the operating valve 21 of the master servo motor. Pivotal movement of the lever 10 therefore effects rotation of the valve 21. To the valve 21 is fixed a finger 22. This finger is maintained clear of the stem 23 of the valve 17 when the pilot's lever 10 occupies a position between the slow-running and take-off positions, so that the valve 17 is open. When however the lever 10 is moved beyond the slow running position and into the cut-off position, the finger 22 presses against the stem 23 of the valve 17 and closes the latter (see Fig. 2), thereby cutting off the fuel supply.

The master servo motor 12 is of the vane type and comprises the usual servo vane 24 rotatably mounted in a correspondingly shaped housing 25 and fixed to a sleeve 26 surrounding the valve 21 (see Fig. 3). The valve 21 has four axially extending grooves, separated by lands. One pair of opposite grooves 27 is closed at the upper end and open at the lower end to an oil pressure inlet 28. The other two grooves 29 which alternate with the grooves 27, are closed at their lower ends and open at their upper ends to an exhaust outlet 30. The sleeve 26 is formed with ports 31 communicating with the housing 25 on opposite sides of the vane 24. Normally these ports are masked by adjoining lands of the valve. On rotation of the valve 21 one of the ports 31 will be open to a pressure groove and the other to an

exhaust groove, and the vane will turn, following the movement of the valve, until the ports 31 are once more masked by the lands.

When, however, the vane 24 reaches the slow-running position, shown in full lines in Fig. 3, it is arrested by a stop 32. In this position the grooves in the valve are located as indicated in chain-dotted lines. On further movement of the pilot's lever 10 into the cut-off position, the vane is unable to follow the valve, which moves on into the position shown in full lines in Fig. 3.

A plunger 33 loaded by a spring 34 normally projects inwardly into the housing 25, but is pushed aside by the vane, as shown in Fig. 3, when the latter moves into the slow-running position. Should the fluid pressure be cut off with the vane in this position, the spring 34 will return the vane to the start position (shown in chain-dotted lines in Fig. 3), thus opening the throttle through the mechanism later described to a position suitable for starting.

To an extension 35 of the vane sleeve 26 are fixed an eccentric 36 and four cams 37–40. Embracing the eccentric 36 is a strap 77 connected to the throttle 13 and to the servo piston 41 of a variable datum boost control 42 by the connections indicated diagrammatically at 43 and 44 respectively.

The eccentric 36 permits the servo vane 24 to effect a limited mechanical opening of the throttle valve, as the pilot's lever is opened up from the slow running position, as described in application Serial No. 530,428. Thereafter the major movement of the throttle valve is exected by the servo piston 41 of the boost control likewise as described in application Serial No. 530,428. The mechanical movement through the agency of the eccentric 36 is effective to open the throttle valve to a starting position, when the spring loaded plunger 33 comes into operation, on failure of the fluid pressure, as described above.

The boost control is of the variable datum type, similar to that described in U. S. Patent No. 1,995,800, and comprises the usual capsule stack 45, located in a chamber 46 open to boost pressure through an inlet 47, and relay valve 48 for actuating the servo piston 41. The datum of the boost control is varied in accordance with the position of the pilot's lever 10 through the agency of a bell crank lever 49 pivoted at 50 and operated by the cam 40, through the agency of a follower mounted on a bifurcated lever 51 pivoted on a shaft 52 and connected to the bell crank by a connection shown diagrammatically at 53.

The shaft 52 is rotated by means of a follower on a lever 54 fixed to the shaft, which follower cooperates with the cam 38. The shaft 52 is coupled to the controlling valve 55 of a vane type servo motor 56 for controlling the engine speed and serves to rotate the valve 55. The servo vane 57 of this servo motor has attached to its sleeve 58 an arm 59 which serves to vary the engine speed by adjustment of the setting of a governor associated with the variable pitch airscrew. The relationship between engine speed and boost pressure is determined by the contour of the speed cam 38 and by that of the boost datum cam 40.

The construction and operation of the servo motor 56 are fully described in application Serial No. 551,703 and it will be sufficient here to state that sleeve 58, like the sleeve 26 of the master servo motor 12, has ports (not shown) communicating with the housing of the vane 57 on opposite sides of said vane. These ports are normally masked by the lands on valve 55, but on rotation of said valve are connected alternatively to pressure and exhaust by the grooves in said valve, so that the vane 57 is caused by the fluid pressure difference so established across it to follow the rotational movement of valve 55, the vane turning until the ports are again masked by the lands on the valve. Servo motor 56 differs from servo motor 12 only in that the grooves in its valve 55 are helical instead of being axial as in the case of valve 21. The arm 59 operates, on rotation of vane 57, to vary the adjustment of the governor controlling the pitch of the airscrew blades, and so to vary the engine speed, likewise as described in application Serial No. 551,703.

The valve 55 is coupled, by a connection shown diagrammatically at 60 to an override lever 61, which is normally latched in the position illustrated by a spring detent 62 and thus prevents the valve 55 from moving axially. The lever 61 is movable to override the automatic setting of the engine speed, by imparting axial movement to the valve 55, so as to feather the airscrew blades or set them at fine pitch as may be desired for emergency purposes, and as described in copending application Serial No. 551,703. The amount of override obtained for a given movement of the lever 61 is determined by the helix angle of the valve 55.

The cam 39 controls the ignition timing. It cooperates with a follower on a lever 63 pivoted on the shaft 52 and connected, by a connection not shown, to the magneto.

The fourth cam 37 serves to vary the datum of a stack of capsules 64 located in a chamber 65 exposed to atmospheric pressure through an inlet 66 and controlling a blower gear change mechanism through the agency of a piston valve 67, vane type servo motor and rotary shuttle valve 69 as described in copending application Serial No. 551,706. The vane 68 of the servo motor is fixed to an arm 80 for effecting the gear change. The datum of the capsule stack 64 is changed by a bell crank lever 70 pivoted at 71 and connected, by a connection shown diagrammatically at 72, to a lever 73 pivoted on the shaft 52 and carrying a follower cooperating with the cam 37. An override lever 90 is provided for manually overriding the automatic gear change as described in application Serial No. 551,706.

The valve 21 carries (Fig. 2) a finger 74 projecting through a slot 75 in the sleeve 26 carrying the vane 24 of the master servo motor. Stops 76 defining the ends of the slot 75 in the sleeve cooperate with the finger 74 to limit the extent to which the valve 21 can rotate in relation to the vane 24. These stops permit of manual operation of the vane 24 from the pilot's lever 10 in case of failure of the fluid pressure in the master servo. Provided pressure fluid is still available in the other servos, the pilot thus still has a considerable measure of control over the engine, and even if pressure has failed throughout the whole hydraulic system the pilot still retains some manual control over the position of the throttle. The stops 76 also permit the pilot to return the vane 24 to the start position should the engine cut out when the throttle is in some more open position.

The alternative installation shown in Fig. 4 is similar in its essentials to that of Figs. 1–3. In this case, however, the operating valve 55 of the servo motor 56 for controlling the engine speed receives an axial movement to operate the servo motor from an arm 78 fixed to the shaft 52. The relationship between engine speed and boost pres-

sure is determined by the helix angle of the valve 55 in conjunction with the contour of the speed cam 38 and that of the boost datum cam 40. The valve 55 is coupled to the override lever 61, as described in application Serial No. 551,704 by a connection allowing of axial but not rotational movement of the valve 55 in relation to the lever 61, which is normally latched in the "Auto" position. The override mechanism operates by imparting rotation to the valve 55 as described in said application Serial No. 551,704.

The fuel cut-off valve 17 is closed, against the action of its spring 18 to cut off the flow of fuel to the induction pipe through the pipe 15, when the pilot's lever is moved to the cut-off position by a finger 79 fixed to a lever 80, which is rocked about its pivot 81 by a link 82 operated by a pivoted arm 83. This carries a dog 91 which is engaged by a dog 92 fixed to the pilot's lever 10, when the latter is moved from the slow running to the cut-off position, so as to rotate the arm 83 and draw the link 82 to the left as seen in Fig. 4. The link 82 also operates, when drawn to the left, a lever 84 to close a valve 85, and so interrupt the supply of fluid to the master servo motor 12 through the pipe 38 when the pilot's lever 10 is moved to the cut-off position.

It is desirable to cut off the master servo in this way when the pilot's lever is moved to the cut-off position. Otherwise when starting the engine on the fuel priming system oil pressure would be immediately transferred to the servo motor and would maintain the vane in the position shown in Fig. 3 in which it overcomes the spring-loaded plunger 33 and closes the throttle so stopping the engine. When this servo cut-out is employed the operation is as follows:

When starting up the engine, the pilot's lever is back in the start position (intermediate between the cut-off and slow running positions) and the fuel and servo fluid are both cut off. The engine is turned over and started on the priming system and, as soon as it is firing, the pilot's lever is moved forward to the slow running position, when both fuel and servo fluid are turned on and the servo motor positions the throttle in the slow running position.

A stop screw 86 is provided for preventing the throttle valve 13 from closing beyond the slow running position when the pilot's lever is moved to the cut-off position, the servo piston 41 remaining at the right hand end of its cylinder, to which position it is biased by a spring 87, as illustrated, when the pilot's lever is moved beyond the slow running position and into the cut-off position.

The inlet 66 for supplying air at atmospheric pressure to the casing 65 communicates, as shown, with the air intake 88 of the induction pipe.

What I claim as my invention and desire to secure by Letters Patent is:

1. A power control installation for an aero engine comprising the combination with a throttle valve and a pilot's throttle lever movable between an open throttle position and a slow running position and beyond the slow running position into a cut-off position, of a vane type servo motor having an operating valve coupled to said pilot's throttle lever so as to be actuated by movement thereof and a servo vane operatively connected to said throttle valve, a stop for arresting the vane when the pilot's throttle lever, on movement to close the throttle valve, has reached the slow running position, a normally open fuel cut-off valve, and a finger operating, on movement of the pilot's throttle lever from the slow running to the cut-off position, to close said cut-off valve.

2. A power control installation for an aero engine comprising the combination with a throttle valve and a pilot's throttle lever movable between an open throttle position and a slow running position and beyond the slow running position into a cut-off position, of a vane type servo motor having an operating valve coupled to said pilot's throttle lever so as to be actuated by movement thereof and a servo vane operatively connected to said throttle valve, a stop for arresting the vane when the pilot's throttle lever, on movement to close the throttle valve, has reached the slow running position, a spring-loaded plunger arranged to be displaced by the vane on movement thereof into the slow running position, but operative to move the vane into a predetermined position on failure of the fluid pressure in the servo motor while the vane is in the slow running position, a mechanical connection between the vane and the throttle valve for moving said valve to a position suitable for starting the engine on movement of the vane into said predetermined position by said plunger, a normally open fuel cut-off valve, and a finger operating, on movement of the pilot's throttle lever from the slow running to the cut-off position, to close said cut-off valve.

3. A power control installation for an aero engine comprising the combination with a throttle valve and a pilot's throttle lever, of a vane type servo motor having an operating valve coupled to said pilot's throttle lever so as to be actuated by movement thereof, a sleeve surrounding said operating valve, a servo vane attached to said sleeve and operatively connected to said throttle valve, and a projection on said operating valve having a restricted range of movement between stops on said sleeve, said projection cooperating with said stops to permit of manual operation of the vane by said pilot's lever in the event of failure of the fluid pressure in said servo motor.

4. A power control installation for an aero engine comprising the combination with a throttle valve and a pilot's throttle lever movable between an open throttle position and a slow running position and beyond the slow running position into a cut-off position, of a vane type servo motor having an operating valve coupled to said pilot's throttle lever so as to be actuated by movement thereof and a servo vane operatively connected to said throttle valve, a stop for arresting the vane when the pilot's throttle lever, on movement to close the throttle valve, has reached the slow running position, a normally open fuel cut-off valve, a normally open valve for supplying pressure fluid to said servo motor, and means for closing said cut-off valve and said normally open valve on movement of said pilot's throttle lever from the slow running to the cut-off position.

5. A power control installation for an aero engine comprising the combination with a throttle valve and a pilot's throttle lever movable between an open throttle position and a slow running position and beyond the slow running position into a cut-off position, of a vane type servo motor having an operating valve coupled to said pilot's throttle lever so as to be actuated by movement thereof and a servo vane operatively connected to said throttle valve, a stop for arresting the vane when the pilot's throttle lever, on movement to close the throttle valve, has reached the slow

running position, a boost control device, means for varying the datum of said boost control device on movement of said servo vane, a normally open fuel cut-off valve, and a finger operating, on movement of the pilot's throttle lever from the slow running to the cut-off position, to close said cut-off valve.

6. A power control installation for an aero engine comprising the combination with a throttle valve and a pilot's throttle lever movable between an open throttle position and a slow running position and beyond the slow running position into a cut-off position, of a master vane type servo motor having an operating valve coupled to said pilot's throttle lever so as to be actuated by movement thereof and a servo vane operatively connected to said throttle valve, a plurality of slave servo motors each for adjusting a separate engine control and all connected to the servo vane of the master servo motor so as to be operated simultaneously under the single control of said pilot's throttle lever, a stop for arresting the vane when the pilot's throttle lever, on movement to close the throttle valve, has reached the slow running position, a normally open fuel cut-off valve, and a finger operating, on movement of the pilot's throttle lever from the slow running to the cut-off position, to close said cut-off valve.

7. Apparatus as claimed in claim 6, which includes a pair of slave servo motors arranged respectively to vary the boost pressure and engine speed as desired functions of the position of the pilot's throttle lever.

8. Apparatus as claimed in claim 6, in which one of the slave servo motors is associated with a boost control device and operates to position the throttle valve and comprising a blower, means for changing the gear ratio thereof, a servo motor for operating said gear changing means, a stack of capsules responsive to atmospheric pressure for actuating said servo motor, to effect the gear change at a predetermined altitude, and means controlled by the servo vane of the master servo motor for changing the datum of said stack of capsules as the boost pressure varies.

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