Nov. 29, 1955 J. J. WILDER 2,725,046

ENGINE CONTROLLER

Filed June 2, 1952

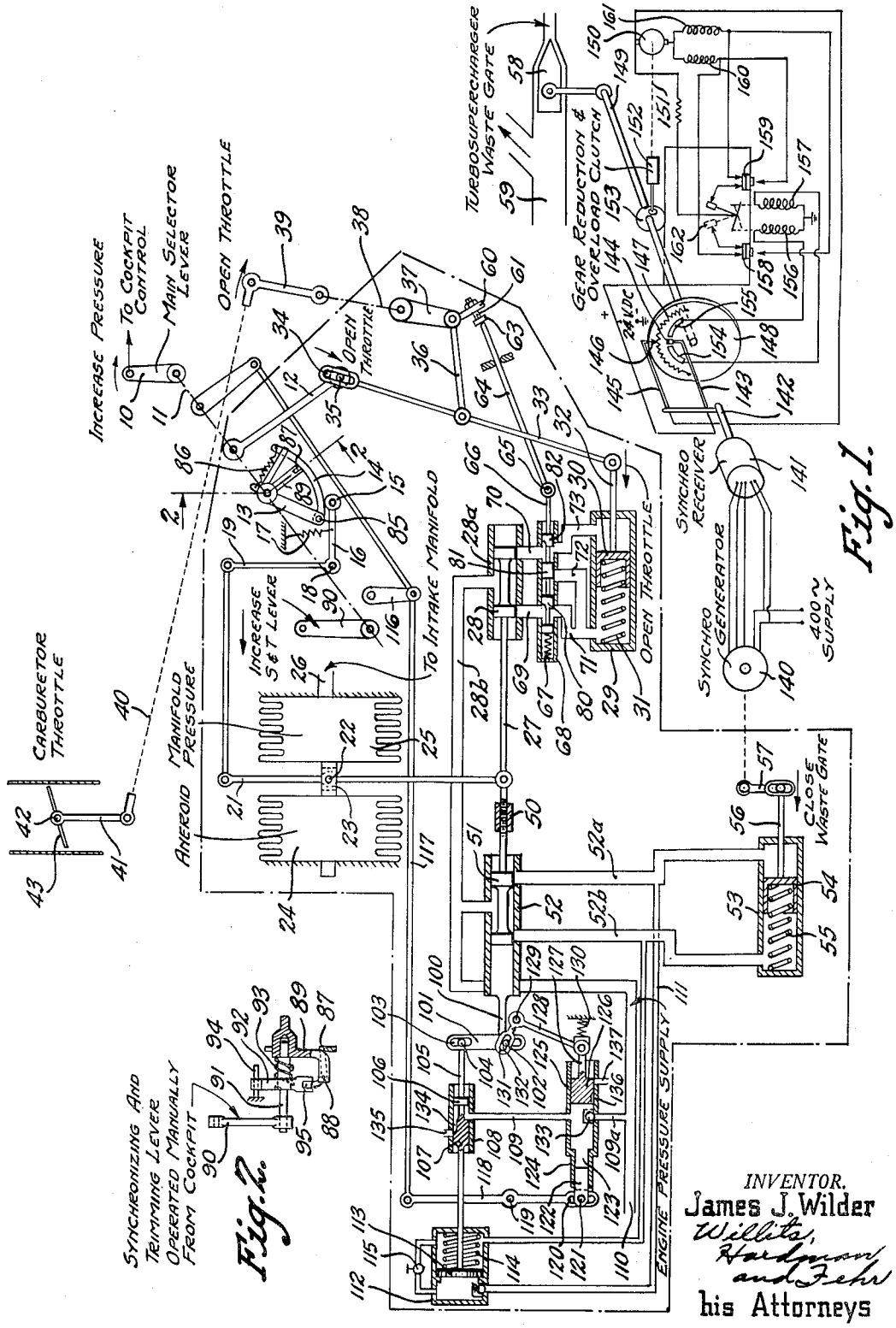


Fig. 1.

Fig. 2.

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United States Patent Office 2,725,046 Patented Nov. 29, 1955

2,725,046

ENGINE CONTROLLER

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Application June 2, 1952, Serial No. 291,163

16 Claims. (Cl. 123—102)

This invention relates to the control of engine intake pressure in an internal combustion engine, particularly of the type generally used in aircraft, having a variable speed supercharger such as one which can be driven by an exhaust gas turbine or by the engine, through the medium of a hydraulic coupling.

It is an object of the present device to provide novel control apparatus for an engine of the type referred to which is effective to variably control and automatically maintain the pressure in the engine intake by variably restricting the engine intake only while the supercharger is running at its minimum or idle speed, up to a certain predetermined maximum pressure, and to variably control the intake pressures maintained, above said predetermined maximum solely by variations in speed of the supercharger.

It is a further object of the invention to provide novel mechanism for controlling the action of the supercharger speed changing mechanism so that such mechanism is effective to change the speed of the supercharger to exactly the proper extent to obtain the selected pressure with substantially no speed fluctuations, and without the permanent introduction of what is known in this art as a pressure "droop."

A further object of the invention is the provision of mechanism to retain the throttle in its fully open position when pressures above the predetermined maximum pressure are obtained and to prevent movement of the throttle from its fully open position when a maintained pressure above said maximum is increased, or when it is decreased, as long as the pressure finally obtained is not below said maximum.

In accordance with the present invention, this object is accomplished by the provision of apparatus for selecting pressures to be maintained and for automatically maintaining such pressures, that includes a pressure selecting member which is movable to different positions to select different pressures to be maintained, and which is effective during a part of its movement to control means for variably positioning the throttle valve for maintaining pressures up to the ambient pressure, which is approximately 30 inches of mercury at sea level, and which is effective during the balance of its movement to select pressures above the ambient pressure and to maintain such selected pressures by variably controlling the supercharger speed.

Another feature of the invention resides in the provision of a single pressure responsive device which operates to automatically control the intake pressure by variably controlling the throttle position and by variably controlling the supercharger speed.

Another feature of the invention resides in the provision of mechanism for stabilizing the action of the speed changing means for the supercharger without effecting any permanent pressure "droop," that is, without permanently stopping the operation of the speed changing mechanism before the speed of the supercharger becomes great enough to produce the pressure called for by the

selecting means. This function is effected by temporarily stopping operation of the speed changing means before the speed is quite sufficient to obtain the desired pressure change and immediately and automatically effecting sufficient additional operation of such speed changing means to increase the speed to the required extent.

An additional feature of the invention resides in the provision of a valve which is movable as the throttle is moved to its fully open position and is effective to prevent the throttle being moved from this fully open position upon any changes of pressure which are effected as long as the pressures finally obtained are above the predetermined pressure.

Another feature of the invention resides in the provision of means to vary the extent of change in the supercharger speed which takes place after the operation of the speed changing means is temporarily stopped in accordance with the amount of pressure selected. In other words, such means effects a greater degree of speed change after operation of the speed changing mechanism is temporarily stopped when a high pressure is selected than when a low pressure is selected.

Further object and advantages of the present invention will be apparent from the following description, reference being had to the accompanying drawings wherein a preferred embodiment of the present invention is clearly shown.

In the drawings:

Fig. 1 is a diagrammatic view of a control apparatus embodying this invention.

Fig. 2 is a detail section on line 2—2 of Fig. 1.

Referring to Fig. 1, a manually operable lever 10, which is connected by means, not shown, to a lever in the pilot's cockpit, operates shaft 11, which is rotatably supported in any suitable way and to which are secured levers 12 and 13, and on the latter is pivoted a pressure selecting cam 14 which will be more specifically described later. The cam engages and moves a cam follower in the form of a roller 15 rotatably supported on the end of a bell crank lever 16 and the roller is held in engagement with the cam by a spring 17. The lever 16 is pivoted on a fixed pin or stud 18 and the arm 19 of such lever is pivotally connected to a lever 21, movement of which actuates mechanism to control the manifold pressures.

The lever 21 is pivoted at 22 on a bridge member 23 which connects an aneroid bellows 24 and a bellows 25 with which a pipe 26 leading to the engine intake connects, for the purpose of maintaining in the bellows 25 whatever pressure is maintained in the engine intake. The left end of the aneroid and the right end of the bellows 25 are fixed so that any pressure variations which occur in the engine intake effect movement of the pivot 22. Since the two bellows are of the same size and are, therefore, balanced with reference to the effect of external pressure, variations in atmospheric pressure do not effect any movement of the pivot 22.

The lower end of lever 21 is connected to a rod 27 which is connected at its right end to a valve 28 slidable in a sleeve or valve guide 21*a*, to which oil under pressure is supplied through conduit 28*b*. The valve 28 controls admission of fluid under pressure to one end or the other of a servo motor cylinder 29 in which a piston 30 is slidable and moved to the right by a spring 31 positioned between the piston and the left end of the cylinder. The piston is pivotally connected by a rod 32 to the lower end of a differential or floating lever 33 which has a slot 34 at the upper end in which is received a pin 35 extending from the lever 12. The floating lever is pivotally connected at a point intermediate its ends with a rod 36 pivotally connected to a lever arm 37 secured to a shaft or rod 38 suitably mounted for rotation and to the other end of which is

secured a lever arm 39, pivotally connected to a link 40. The latter is pivotally connected to an operating arm 41 secured to the shaft 42 on which the throttle valve 43 is also secured.

The mechanism so far described is effective to select various intake pressures and to automatically maintain such pressures by variably positioning the throttle valve until the throttle valve reaches approximately wide open position. Movement of the throttle valve to obtain pressure less than about 20" Hg are effected entirely manually because the contour of the cam 14 is such that it is substantially without effect during a part of the movement of the control or selector lever 10. During this part of the movement of lever 10, such lever moves arm 12 and lever 33 about the pivot at its lower end. This movement of lever 33 moves rod 36 which rocks lever 37, shaft 38 and lever 39 clockwise to move the link 40 to the right and open the throttle valve to the position required to obtain the pressures which are selected or determined by the position of the lever 10. When the lever 10 is moved to select a pressure higher than about 20" Hg, the throttle is moved part way to the required position manually, as above set forth, but the cam 14 also effects a movement of the control valve 28 through the connections previously described and this movement of the valve admits fluid under pressure to the cylinder 29 at the right of piston 30. This will move the piston to the left, moving the lever 33 about the pivot 35 sufficiently to move the throttle, through the previously described operating connections, to the proper position to obtain the pressure selected by the movement of lever 10. When the throttle reaches this position, the valve 28 is restored to its initial position of equilibrium by the action of bellows 25 and the movement of both the piston 30 and the throttle is stopped. If, after a selected pressure is obtained, the pressure changes as the result of a change, for example, the bellows 25 either expands or contracts, operating the control valve 28, to close or open the throttle valve enough to restore the pressure to that which has been selected.

If the throttle valve is wide open and the altitude is increased, the selected pressure cannot be maintained by further operation of the throttle valve, or if the wide open and a higher pressure is selected, such pressure cannot be obtained by further operation of the throttle valve.

In order to maintain a selected pressure upon an increase in altitude, or to obtain a higher pressure after the throttle is wide open, the control valve 28 is connected by a turnbuckle 50 with a control valve 51 slidable in a valve guide 52 to control the flow of fluid through passages 52*a* and 52*b* which connect with a servo motor cylinder 53, to the right or left of a piston 54 slidable therein and normally urged to the right by a spring 55. Movement of valve 51 to the right permits flow of fluid under pressure to the right of the piston and effects movement of the piston and rod 56 to the left. The rod is connected to lever arm 57 which, through electrical apparatus that will be briefly described later, controls the movement of a waste gate 58 of an exhaust gas turbine which drives a supercharger that varies the pressure in the engine intake in accordance with supercharger speed, and when piston 54 is moved to the left the waste gate 58 is moved in a direction to increase the supercharger speed and intake pressure. It will be understood, of course, that when the supercharger speed is increased enough to give the desired pressure, the control valve 51 is restored to initial position, preventing further increase in speed.

The construction of the supercharger and its driving means form no part of the present invention. Any suitable turbine driven supercharger can be employed in this device and an engine driven supercharger operating at variable speeds could also be used, such, for example, as a supercharger, driven through the medium of a hydraulic coupling, in which event, there would be substituted for the element 58, the element which controls the degree of slip of said coupling. Since the construction of the supercharger forms no part of the present invention and superchargers of the type referred to are well known, no supercharger is shown.

The throttle actuating servo motor piston 30 has sufficient travel to move the throttle to wide open position at critical altitude with the selector lever set for the lowest manifold pressure in the automatic range, approximately 20" Hg. When higher pressures are selected, the piston travel which is required for full opening of the throttle is decreased, because the top of the differential lever 33 is moved further to the left when the lever 10 is moved to positions to select higher pressures and the piston is moved part of the way toward open throttle position in order to obtain the pressure selected. Therefore, to select such pressures as are not obtainable by opening of the throttle but are obtainable only by increase in supercharger speed, there must be some means provided to permit movement of the selector lever 10 to select such pressures without affecting either the position of the throttle or the piston 30.

To this end, the throttle operating lever 37 is provided with an extension 60 having an adjustable screw 61 mounted thereon, the head 63 of which is adapted when the throttle is moved to wide open position, to engage a rod 64 suitably mounted for sliding movement. This rod is pivotally connected at 65 with a valve 66 normally urged to the right by a spring 67 and slidable in a valve guide 68 to which passages 69 and 70 leading from the valve guide 28, supply fluid under pressure. The valve guide 68 also connects with passages 71, 72 and 73, the first two of which connect with the cylinder 29 to the left of the piston 30 and the other of which connects with said cylinder to the right of the piston 30. The flow of fluid under pressure through the various passages referred to is controlled by the position of the valve 66 in the following manner.

The valve 66 has three lands 80, 81 and 82 which control the flow of fluid through the several passages being cut away at the top as shown in Fig. 1.

When the throttle is moved to full open position the valve 66 is moved to a position where the lands 80, 81 and 82 entirely block the passages 71, 72 and 73 so that there is no movement of the piston even if the valve 28 is in a position to permit fluid to flow through the passage 70, unless there is also a movement of the valve 66. Such fluid can flow into the space between the lands 81 and 82, but its effect with respect to the valve 66 is balanced so that it exerts no pressure tending to move the valve 66 in either direction.

If, when the throttle is fully open and a pressure higher than the ambient pressure of 30 inches is being maintained, the selector lever is moved to select a still higher pressure, the lever 21 is moved counterclockwise and the valves 28 and 51 are moved to the right, permitting fluid under pressure to flow through the passages 52*a* and 70, the fluid flowing through passage 52*a* being effective to move the piston 54 to the left to bring about such a movement of the waste gate that the supercharger speed and the intake pressure is increased. As the lever 21 is moved to select a higher pressure the throttle is moved beyond full open position and rod 64 is moved to the left enough to open the passages 72 and 73 so that such passages are in communication with the valve guide, but passage 71 is still blocked, the land 80 being of such width that this operation is possible.

With the parts in the position described, the fluid under pressure acting on the left side of the piston 30 moves such piston to the right and the lever 33 in a counterclockwise direction about the point 35 as a pivot. This movement of the lever 33 moves the throttle back to wide open position, permitting the spring 67 to move valve 66 to the right. When the throttle reaches wide open posi-

tion, the valve 66 reaches a position where the said valve blocks the flow through all of passages 71, 72 and 73 and the throttle valve comes to a stop in the wide open position.

If the throttle valve is in wide open position while a pressure above 30 inches, or ambient pressure, is being maintained and a lower pressure is selected, but a pressure still above 30 inches, the lever 21 is moved clockwise. This will move valves 28 and 51 both to the left and at the same time the differential lever is moved to the right at its upper end, permitting the spring 67 to move valve 66 to the right. This will permit fluid under pressure to flow through the passage 69 to the left of the piston 30 and also through passage 52*b* to the left of piston 54, so that as the speed of the supercharger is reduced, the throttle is also moved in the closing direction at least for a time. As the throttle moves toward closed position, the valves 28 and 51 are moved toward the right until they assume a position of equilibrium when the flow through passages 52*a* and 52*b* is completely blocked. In such position the valve 28 is far enough to the right to permit a flow of pressure fluid through the passage 70 and to permit a slight drain from the cylinder 29 through the passage 71. The passage 73 is also slightly open so that fluid under pressure can flow to the right of the piston 30 moving the piston sufficiently to the left to restore the throttle to full open position. When such position is reached, valve 66 again blocks one of the passages 71, 72 and 73.

The cam 14 is pivoted at 85 and is normally urged in a counterclockwise direction about this pivot by a spring 86 into engagement with a stop lever 87 pivoted at 88 on a lever arm 89 which is integral with the arm 13. By adjustment of the stop lever, the position of the cam 14 may be adjusted to some extent so that the cam may be very accurately positioned. This adjustment is provided primarily for the purpose of effecting exact synchronization when a plurality of engines are employed. To effect the adjustment referred to, a lever 90 from which an operating connection extends to the pilot's cockpit is manually moved by the pilot. This lever is secured to a shaft 91 which is suitably supported in any desirable way and as shown has one end journalled in the arm 89. A nut 92 is mounted on the shaft 91, being engaged by threads 93 thereon and held against rotation by a fixed pin 94 which extends through a hole in the nut, so that rotation of shaft 91 by lever 90 effects lateral movement of the nut. A groove 95 in the nut engages one end of the lever 87 and as the nut is moved laterally, the lever is rocked on the pivot 88 to cause movement of the cam 14 as previously described.

The valve guide 52 is pivotally connected by rod 100 to a lever 101 which is pivoted on pin 102 in a manner later described, and has a slot 103 in which a pin 104 extending from rod 105 is received. Rod 105 is connected to a piston 106 integral with a piston 107, both of which are slidable in a cylinder 108 to which fluid under pressure is supplied between the pistons through a pipe 109 which receives fluid from a cylinder later described. Pipe 109*a* is connected to the conduit 110 through which fluid under pressure is supplied from a source of supply to the valve guides 28*a* and 52. A drain or bleed from the cylinder 108, the function of which is more fully described later, is controlled by the piston 107.

When fluid under pressure is supplied to cylinder 53, it is also supplied through pipe 111 to a cylinder 112 to the left of piston 113 normally urged to the left by a spring 114 and forces the piston 113 to the right against the spring pressure to move the lever 101 clockwise on pivot 102. This moves the sleeve or valve guide 52 to the right so that the control valve 51 reaches a position to stop the movement of the piston 54 before the waste gate reaches a position to cause operation of the supercharger at a high enough speed to obtain the pressure selected by the lever 10. For example, the selected pressure might be 60" Hg and the piston 51 might be stopped at a position to cause operation of the supercharger at a speed to produce 55" pressure, these figures being illustrative.

When the valve guide 52 is moved to the position to stop the piston 54 as described, oil under pressure is no longer supplied to cylinder 112 at the left of piston 113 and the latter is moved to the left by action of the spring 114 and oil in the cylinder at the left of said piston can flow out through a valved by-pass 115 into the space to the right of piston 113. As the valve guide 52 is moved to the left, the oil pressure passage to the right of piston 54 is again opened and such piston moves the waste gate to the required position to effect operation of the supercharger at the speed necessary to obtain the pressure called for by the position of the lever 10. In other words, the effect of the so-called permanent "droop" is eliminated and the pressure which is actually selected by movement of the lever 10 is ultimately obtained.

Means are provided to control the amount of droop in accordance with the increase in selected pressure. If the pressure increase is high, it is necessary to have temporarily more droop to effect proper stability of operation than when the pressure change is relatively low. For example, the maximum droop necessary upon the maximum increase in pressure which can be obtained is about 10" Hg, but when lower pressure increases are effected, the necessary droop is proportionately less.

The apparatus for controlling the extent of the droop includes an arm 116 connected to shaft 11 so that it is operated by the lever 10. This arm is moved clockwise when lever 10 is moved to increase the pressure selection and is pivotally connected by a link 117 to the upper end of a lever 118, pivoted at 119 intermediate its ends and having a slot 120 at its lower end, in which a pin 121 extending from a piston 122 is received. The piston is slidable in a passage 123 formed in a reduced extension 124 projecting from a cylinder 125 in which is slidable a piston 126 having a rod 127 extending therefrom which is pivotally connected to the arm 128 of a bell crank lever which is suitably pivoted at 129. A spring 130 positioned between the piston and some fixed member normally urges the piston toward the left. Another arm 131 of the aforesaid bell crank lever has a slot 132 formed therein which receives the pin 102 which projects from the lever 101, so that movement of the bell crank lever raises or lowers the pivot point of said lever and changes the extent of movement imparted to the rod 100 and valve guide 52 by any given movement of the lever 101. Pressure fluid can flow into the cylinder 125 from the pipe 109*a* past a check valve 133 and to the cylinder 108 through pipe 109. A passage 134 is formed in the wall of piston 107 and when the piston is in certain positions the passage 134 connects with a drain port 135. Also there is a passage 136 in the wall of the piston 126 which under some circumstances registers with a drain port 137.

The operation of the mechanism described in controlling the degree of droop is as follows. As the lever 10 is moved to select a high pressure the arm 118 moves the piston 122 to the right. This puts the fluid in the cylinder 125 under pressure, forcing some fluid through the pipe 109 and the restricted passage 134, but the latter is quite small and the action of piston 122 exerts enough pressure on the piston 126 to move it against the pressure of the spring 130, which will rock the bell crank lever on its pivot 129 and the arm 131 will move the pivot pin 102 downwardly, which will bring about a greater movement of the sleeve valve guide 52 than would be effected if the pivot pin remained stationary and would also bring about an increase in the droop. At the same time, the movement of the piston 113 which effects movement of valve guide 52 will move the piston 107 and block the restricted passage 134, increasing the effect of the piston

or plunger 122 in moving the piston 126. Obviously, the movement of the piston 126 and the valve guide 52 is proportional to the movement of the plunger 122 and the arm 116, so that it will be apparent that the greater the pressure selecting movement of lever 10, the greater will be the movement of valve guide 52 and the greater the droop.

As the maximum droop is reached, which is about 10" Hg, the piston 126 uncovers the port 137 and further movement of plunger 122 can be effected without further movement of the piston 126, and the main selector lever 10 can be moved still further to select still higher pressures without increasing the temporary droop. Therefore, such droop is increased proportionately to the movement of the pressure selecting lever up to a predetermined maximum movement thereof, but after such maximum movement has taken place, there is no further increase in the droop above a maximum of approximately 10" Hg, although the pressure selecting lever can have a movement greater than such predetermined maximum, so as to select a higher pressure than that selected when the temporary droop is at its maximum. For example, using figures which are purely arbitrary, and are for purpose of illustration only, the lever 10 might be moved to increase the pressure from 20" to 60" and the maximum droop be effected when lever reached the position to select only 50", in which event the movement of lever 10 from the 50" position to the 60" would effect no further increase in droop.

The piston 107 remains in its displaced position at the right until the supercharger speed has been increased sufficiently to obtain the pressure which is selected by the lever 10, less the amount of droop. When this takes place, the piston moves back to its original position, unblocking the restricted passage 134 and permitting the piston 126 to be returned to its original position by the spring 130 which positions the pivot pin 102 in its normal position. Thus, the parts which control the magnitude of the temporary droop are repositioned after actuation by operation of the lever 10 to increase the pressure selection, so that upon a subsequent operation of said lever 10 to increase the pressure selection, such parts are in position to again control the extent of the droop.

The specific mechanism for effecting the correct movement of the waste gate 58 upon operation of lever 57 by the servo motor which controls supercharger speed comprises no part of the invention and is disclosed purely for illustrative purposes as an example of a device which can be employed for the purpose. As disclosed, a synchro-generator diagrammatically indicated at 140 is connected to the lever 57 to be turned thereby as the lever is moved by servo piston 54. A synchro-receiver is indicated at 141 and is electrically connected with the generator and will follow the movement of the generator. An arm 142 moved by the synchro-receiver supports an arm 143, carrying a contact 144 and a second arm 145 which supports a wiper 146 which cooperates with a rheostat 147 on a rotating disk 148 mounted on a shaft 149 which is moved when the waste gate 58 is positioned.

The shaft 149 is moved to position the waste gate by a 24-volt D. C. motor 150 which operates a shaft 151 that is connected to the shaft 149 through reducing gears at 152 and drive gearing 153. An overload clutch is associated with the reducing gears.

Since the specific mechanism for operating the waste gate and the control circuit therefor constitutes no part of the present invention, it is not necessary to describe such mechanism or the control circuit in great detail. Briefly, however, the contacts 154 and 155, which are engageable by the contact 144, are connected with relays 156 and 157 which operate switches 158 and 159 respectively, in circuit with the field windings 160 and 161 of the motor 150. The relays also operate a contact 162 to control a brake circuit.

If the control mechanism calls for a change in waste gate position, contact 144 is moved into engagement with one or the other of contacts 154 and 155 to energize one or the other of the relays. If relay 156 is energized, the circuit to the winding 160 is closed, the brake circuit is opened and contact 162 moved to the solid line position. While if the other relay is energized, the circuit to winding 161 is closed and contact 162 moves to the dotted line position. Whenever either of the relays are energized, there is a circuit from the source of supply through one or the other of the field windings to the motor and through the rheostat to ground. It will be noted that the greater the movement of the switch 144, the less of the resistance 147 is in series with the motor and it will run faster if a large movement of the waste gate is to be effected.

As the waste gate is moved to the required position to obtain a selected pressure, the neutral point between the contacts is moved toward the position occupied by the contact 144 and when it reaches such position, the relay is de-energized, the motor circuit is broken, the brake circuit is closed and the motor is stopped substantially immediately.

While the embodiment of the present invention as herein disclosed constitutes a preferred form, it is to be understood that other forms might be adopted.

What is claimed is as follows:

1. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure by a variable speed supercharger, a throttle valve in said intake for controlling the flow therethrough and effective when moved to different positions to control the pressure maintained therein, a single pressure selecting cam movable to different positions for selecting different pressures to be maintained in said intake, means controlled thereby for effecting movement of the throttle to obtain the selected pressure up to predetermined maximum, means operated by said selecting cam, when moved to a position to select a higher pressure than said predetermined maximum, to effect an increase in speed of operation of the supercharger in order to obtain the higher pressure selected and means for stabilizing the operation of the speed increasing means when positioned to obtain pressures higher than said predetermined maximum whereby the exact pressure selected may be obtained without fluctuation in the position of the speed increasing means.

2. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure by a variable speed supercharger, a throttle valve in said intake for controlling the flow therethrough and effective when moved to different positions to control the pressure maintained therein, a single pressure selecting cam movable to different positions to select different pressures to be maintained in the engine intake, means for moving the throttle to obtain the selected pressure up to a certain maximum, means for effecting an increase in the operating speed of the supercharger to obtain pressures above said predetermined maximum, a single control member actuated by said pressure selecting cam for controlling the operation of said throttle moving means and the means for increasing supercharger speed, and means for stabilizing the operation of said control member so that the means for increasing the supercharger speed is moved exactly to the position required to obtain the selected pressure.

3. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure by a variable speed supercharger, a throttle valve in said intake for controlling the flow therethrough and effective when moved to different positions to control the pressure main-

tained therein, a selector member movable to different positions to select different pressures to be maintained in the engine intake, means for moving the throttle to obtain the selected pressure up to a certain maximum, means for effecting an increase in the operating speed of the supercharger to obtain pressures above said predetermined maximum, a plurality of control valves for controlling the operation of the throttle moving means and the means for increasing the supercharger speed, a single control member for operating said control valves, and means for stabilizing the operation of said control member when moved to control supercharger speed so as to cause the valve which controls supercharger speed to assume its equilibrium position when the speed of the supercharger is such as to obtain the exact pressure selected.

4. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure by a variable speed supercharger, a throttle valve in said intake for controlling the flow therethrough and effective when moved to different positions to control the pressure maintained therein, a selector member movable to different positions to select different pressures to be maintained in the engine intake, means for moving the throttle to obtain the selected pressure up to a predetermined maximum, means for effecting an increase in the operating speed of the supercharger to obtain pressures above said predetermined maximum, a plurality of control valves for controlling the operation of the throttle moving means and the means for increasing the supercharger speed, a single control member for operating said control valves, a plurality of ported valve guides in which said control valves are slidable, means for moving one of said valve guides with respect to its associated valve when the valve is operated to effect a change in supercharger speed, so as to cause said valve to reach its final position of equilibrium when the speed of the supercharger is such as to obtain the exact selected pressure.

5. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure by a variable speed supercharger, a throttle valve in said intake for controlling the flow therethrough and effective when moved to different positions to control the pressure maintained therein, a selector member movable to different positions to select different pressures to be maintained in the engine intake, means for moving the throttle to obtain the selected pressure up to a certain maximum, means for effecting an increase in the operating speed of the supercharger to obtain pressures above said certain maximum, a plurality of control valves for controlling the operation of the throttle moving means and the means for increasing the supercharger speed, a single control member for operating said control valves, a plurality of ported valve guides in which said control valves are slidable, means for moving one of said valve guides with respect to its associated valve when the valve is operated to effect a change in supercharger speed, so as to cause said valve to temporarily reach a position of equilibrium before the speed of the supercharger is sufficient to obtain the selected pressure and means effective, when the valve reaches its equilibrium position to restore the valve guide to its initial position, to permit a further movement of the control valve so as to cause said valve to reach its final position of equilibrium when the supercharger speed is such as to obtain the exact selected pressure.

6. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is supplied with air by a variable speed supercharger, a throttle movable to different positions to control pressure in the engine intake, means for changing the speed of the supercharger to obtain different intake pressures, a single selector cam movable to different positions to select different intake pressures to be maintained and operable to control movements of the throttle and supercharger speed, a control valve normally occupying a position of equilibrium in which the means for changing the supercharger speed is rendered ineffective, said valve being movable by said selector cam from its equilibrium position when the cam is moved to select a pressure to cause operation of the means for changing the supercharger speed in order to obtain the pressure selected and movable back to equilibrium position to render the means for changing the supercharger speed ineffective when the pressure selected has been obtained, means for causing said valve to reach its final position of equilibrium after it is moved to effect a change in supercharger speed, when the supercharger speed is that necessary to obtain whatever pressure is selected.

7. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is supplied with air by a variable speed supercharger, means for changing the speed of the supercharger to obtain different intake pressures, a selector member movable to different positions to select different intake pressures to be maintained, a control valve normally occupying a position of equilibrium in which the means for changing the supercharger speed is rendered ineffective, said valve being movable by said selector member from its equilibrium position to cause operation of the means for changing the supercharger speed in order to obtain the pressure selected and movable back to equilibrium position to render the means for changing the supercharger speed ineffective, means for causing said valve to temporarily reach a position of equilibrium before the selected pressure is obtained, means operative when the valve reaches its position of equilibrium to upset the equilibrium condition so as to permit an additional movement of the valve and a further change of supercharger speed before the movement of said valve stops, whereby the valve is stopped in a final position of equilibrium position when the exact pressure called for by the selecting means is obtained.

8. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is supplied with air by a variable speed supercharger, means for changing the speed of the supercharger to obtain different intake pressures, a selector member movable to different positions to select different intake pressures to be maintained, a control valve for controlling the operation of the means for changing supercharger speed and normally occupying a position of equilibrium in which the speed changing means is ineffective, said valve being movable from its position of equilibrium and returnable to its equilibrium position as the supercharger speed is changed in order to stop operation of the speed changing means when the desired change in speed is effected, a valve guide in which said control valve is movable, means operable by the pressure selecting means for moving the control valve from its equilibrium position so as to effect the change in supercharger speed necessary to obtain a selected pressure, means for moving the valve guide as the supercharger speed is changed so that a temporary position of equilibrium is reached before the supercharger speed is changed enough to obtain the selected pressure, and means effective when the equilibrium position is reached to restore the valve guide to its original position in order to cause a further movement of the control valve to a final position of equilibrium when the supercharger speed is changed to that required to obtain the selected pressure.

9. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure of a vari-

able speed supercharger, a throttle valve in said intake, means movable to different positions to select different intake pressures to be maintained, means for obtaining the different selected pressures including means for increasing the supercharger speed, a control means operated by the pressure selecting means for controlling the operation of said speed increasing means, means operable, whenever the control means is operated to cause an increase in supercharger speed, to temporarily effect an insufficient increase in speed to obtain the exact pressure selected, and means effective, when such insufficient speed increase is obtained, to cause a further increase in speed to be effected which is sufficient to obtain the exact pressure selected.

10. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure of a variable speed supercharger, a throttle valve in said intake, means movable to different positions to select different intake pressures to be maintained, means for obtaining the different selected pressures including means for increasing the supercharger speed, means operated by the pressure selecting means for causing operation of the speed increasing means so as to effect sufficient increase of supercharger speed to obtain whatever pressure is selected and means for controlling the operation of the speed increasing means which is effective to cause the speed to be increased in two steps, the first of which is insufficient to obtain the selected pressure, but the sum of which is such as to cause operation of the supercharger at the exact speed necessary to obtain said selected pressure.

11. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure by a variable speed supercharger, a throttle valve in said intake for controlling the flow therethrough and effective when moved to different positions to control the pressure maintained therein, a selector cam movable to different positions for selecting different pressures to be maintained in said intake, means controlled thereby for effecting movements of the throttle to obtain any selected pressure up to a predetermined maximum, said throttle being moved to fully open position when said predetermined maximum pressure is obtained, means also operated by said selector cam when moved to a position to select a higher pressure than said predetermined maximum to effect an increase in supercharger speed in order to obtain the higher selected pressure, and means operable to retain the throttle in fully open position when any pressure above said predetermined pressure is maintained in the engine intake.

12. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure by a variable speed supercharger, a throttle valve in said intake for controlling the flow therethrough and effective when moved to different positions to control the pressure maintained therein, a pressure selecting cam movable to different positions for selecting different pressures to be maintained in said intake, means controlled thereby for effecting movements of the throttle to obtain any selected pressure up to a predetermined maximum, said throttle being moved to fully open position when said predetermined maximum pressure is obtained, means for varying the supercharger speed in order to obtain pressures above said predetermined maximum, means operable by said pressure selecting cam for controlling the variations in supercharger speed and operable to effect either an increase or decrease in supercharger speed to effect an increase or decrease in intake pressure, and means operable to prevent movement of the throttle to a partially open position upon a movement of the pressure selecting cam to decrease the selected pressure, as long as said selected pressure is above said predetermined maximum.

13. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure by a variable speed supercharger, a throttle valve in said intake for controlling the flow therethrough and effective when moved to different positions to control the pressure maintained therein, means movable to different positions for selecting different pressures to be maintained in said intake, means controlled thereby for effecting an increase in speed of the supercharger to obtain selected pressures above a predetermined maximum, said means including a servo motor, a control valve therefor movable from a position of equilibrium to a position to cause operation of the servo motor and movable back to equilibrium position to stop operation of the servo motor, a movable valve guide associated with said valve and means for moving said valve guide to cause the valve to reach a position of equilibrium before the supercharger speed is enough to obtain the exact pressure selected.

14. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure by a variable speed supercharger, a throttle valve in said intake for controlling the flow therethrough and effective when moved to different positions to control the pressure maintained therein, means movable to different positions for selecting different pressures to be maintained in said intake, means controlled thereby for effecting an increase in speed of the supercharger to obtain selected pressures above a predetermined maximum, said means including a servo motor, a control valve therefor movable from a position of equilibrium to a position to cause operation of the servo motor and movable back to equilibrium position to stop operation of the servo motor, a movable valve guide associated with said valve and means for moving said valve guide to cause the valve to reach a position of equilibrium before the supercharger speed is enough to obtain the exact pressure selected, said last named means including a fluid operated piston movable to control operation of the valve guide and controlled at least in part by the pressure selecting means.

15. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure by a variable speed supercharger, a throttle valve in said intake for controlling the flow therethrough and effective when moved to different positions to control the pressure maintained therein, means movable to different positions for selecting different pressures to be maintained in said intake, means controlled thereby for effecting an increase in speed of the supercharger to obtain selected pressures above a predetermined maximum, said means including a servo motor, a control valve therefor movable from a position of equilibrium to a position to cause operation of the servo motor and movable back to equilibrium position to stop operation of the servo motor, a movable valve guide associated with said valve and means for moving said valve guide to cause the valve to reach a position of equilibrium before the supercharger speed is enough to obtain the exact pressure selected and means operable when the valve reaches equilibrium position to cause said valve guide to be moved back to its initial position so as to cause a further movement of the valve and additional operation of said servo motor before the valve reaches its final position of equilibrium.

16. Apparatus for variably controlling the intake pressure of a supercharged internal combustion aircraft engine having, in combination, an engine intake which is adapted to be supplied with air under pressure by a variable speed supercharger, a throttle valve in said intake for controlling the flow therethrough and effec-

tive when moved to different positions to control the pressure maintained therein, means movable to different positions for selecting different pressures to be maintained in said intake, means controlled thereby for effecting an increase in speed of the supercharger to obtain selected pressures above a predetermined maximum, said means including a servo motor, a control valve therefor movable from a position of equilibrium to a position to cause operation of the servo motor and movable back to equilibrium position to stop operation of the servo motor, a movable valve guide associated with said valve and means for moving said valve guide to cause the valve to reach a position of equilibrium before the supercharger speed is enough to obtain the exact pressure selected and means operable when the valve reaches equilibrium position to cause said valve guide to be moved back to its initial position so as to cause a further movement of the valve and additional operation of said servo motor before the valve reaches its final position of equilibrium, said means for moving the valve guide being so constructed as to move said guide varying distances in accordance with the pressures selected.

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