Sept. 16, 1941. M. F. BATES 2,255,753

AUTOMATIC THROTTLE CONTROL FOR MULTIENGINED AIRCRAFT

Filed Nov. 17, 1939 2 Sheets-Sheet 1

Fig. 1

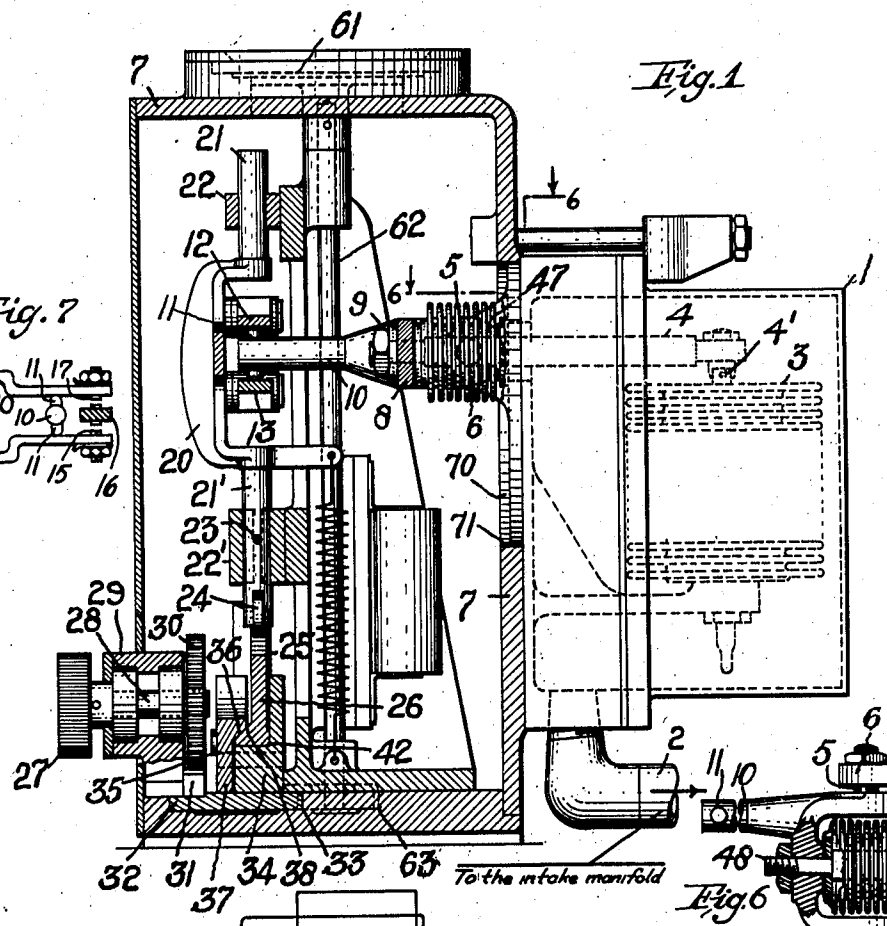


Fig. 7

Fig. 6

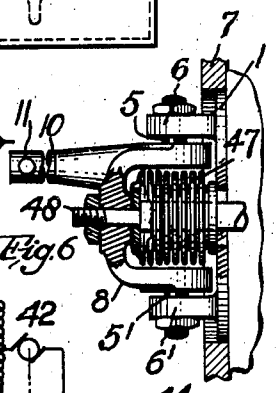
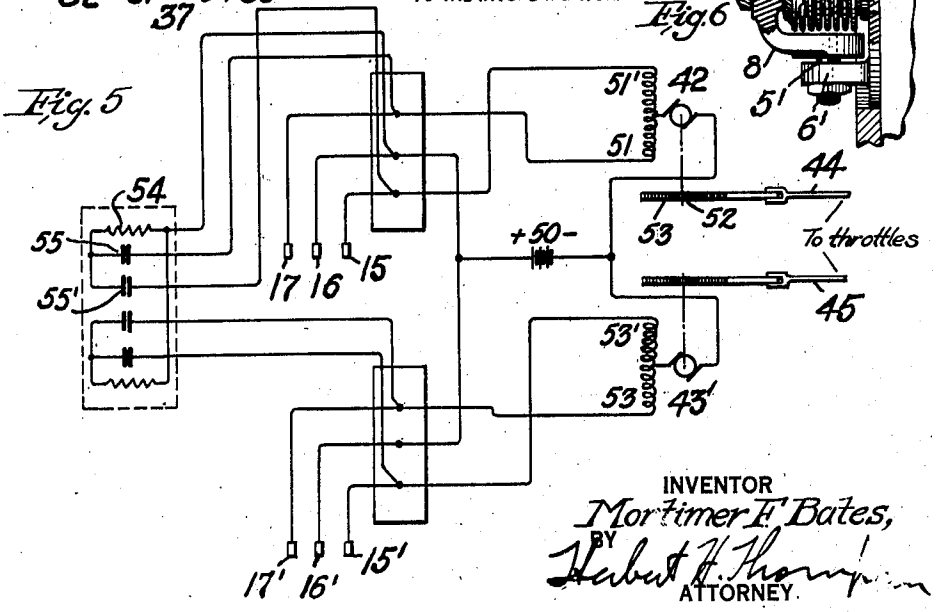


Fig. 5



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Fig. 8

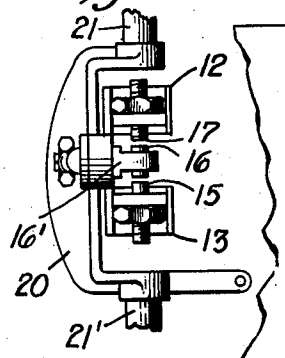


Fig. 2

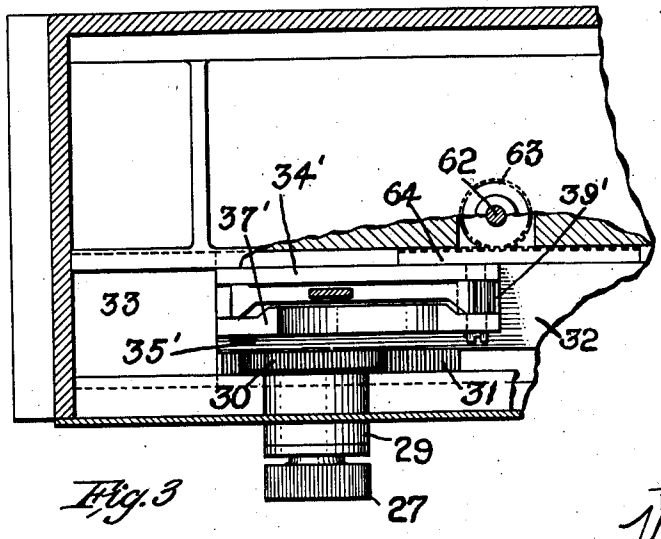


Fig. 3

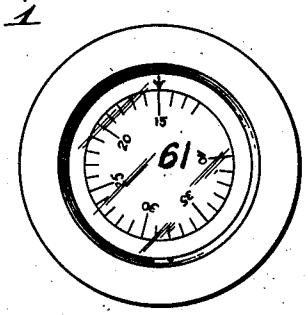


Fig. 4

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AUTOMATIC THROTTLE CONTROL FOR MULTIENGINED AIRCRAFT

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8 Claims. (Cl. 60—97)

This invention relates to means for securing uniform performance of combustion engines in airplanes at different altitudes and has especial application to the supercharged type in which the best performance is secured by maintaining a uniform pressure at the intake manifold.

One purpose of the invention is to provide an automatic means for maintaining the manifold pressure constant by automatically controlling the throttle opening.

Another object is to readily synchronize the speed of the several engines of a multi-engined craft by predetermined settings of the manifold pressure of each.

Other objects of the invention will become apparent from the following description.

Referring to the drawings,

Fig. 1 is a vertical section, partly in elevation, of my engine manifold pressure regulator.

Fig. 2 is a side elevation of the same as constructed for two engines, with the casing broken away to show the interior.

Fig. 3 is a horizontal section taken approximately on broken line 3—3 of Fig. 2.

Fig. 4 is a top view of the setting dial, showing graduations thereon in pounds per square inch (absolute).

Fig. 5 is a simplified wiring diagram showing the motors and control levers leading to the engine throttles.

Fig. 6 is a horizontal detailed section taken approximately on broken line 6—6 of Fig. 1.

Fig. 7 is a simplified elevation, partly in section, of the pressure controlled contact means.

Fig. 8 is an elevational detail looking in the direction of the arrows 8, 8 of Fig. 2.

In order to obtain a regulator responsive to intake manifold pressure, I connect the intake manifold of the engine with the interior of a sealed chamber or box 1 by means of a pipe 2 leading to the intake manifold of one of the supercharged engines on the aircraft. Within said box I mount an evacuated sealed sylphon or metal bellows 3, in which a spring is compressed by atmospheric pressure, and operating somewhat as an aneroid barometer, to rotate lever 4, pinned at 4' to the top of the bellows, about pivotal axis 5, 5'. This pivotal mounting is shown as obtained through the intermediary of a U-shaped bracket 8 to which the threaded inner end of the lever 4 is clamped by nut 9. Said bracket carries the aforesaid pivots or trunnions 5, 5' journaled in the brackets or ears 6, 6' projecting from the outer wall of the chamber 1, which has a circular raised part 70 fitting in circular opening 71 in the housing 7.

To maintain a gas-tight seal for the chamber 1 in spite of the projection of the lever 4 through the wall of the same, I have shown a sylphon or resilient bellows 47 secured around the opening in said wall and through which the reduced threaded end 48 of the rod 4 projects. This bellows offers little or no resistance to side bending within the range of this use.

Extending from one side of said bracket 8 is an arm 10 carrying at its outer end a transverse pin 11 forming nubs extending a short distance above and below the arm. Said pin is normally engaged at top and bottom by the inner surfaces of a pair of contact arms 12, 13 pivoted at 14, 14', respectively, and resiliently held against said pin by a spring 40. The arms 12, 13 are shown as counter-balanced by adjustable masses 19 and 19'. Arms 12 and 13 carry contacts 17 and 15, respectively, which cooperate with opposing contacts 16 carried by a lug 16' mounted on U-shaped member 20. In the unoperated or normal position shown in the drawings, contacts 17 and 15 are both held out of engagement with contacts 16 due to the position assumed by arm 10 (Fig. 7). Upward movement of arm 10 from this normal position is brought about by the collapse of bellows 3 under the influence of an increase in manifold pressure. This movement forces arm 12 upwardly and due to the force exerted by spring 40, arm 13 also rises bringing contact 15 into abutting relation with the lower contact 16, contacts 17 and 16 at the same time being separated to a greater extent by the displacement of arm 12. Downward movement of arm 10 in a similar manner results in bringing contact 17 into abutting relation with the upper contact 16 and effects an increase in spacing between lower contact 16 and contact 15.

The arms 12 and 13 are shown as pivoted on U-shaped member 20, which in turn is slidably mounted for up and down adjustment by means of upper and lower shafts 21 and 21' sliding through bearings 22 and 22'. The lower bearing is shown as provided with a pin and slot connection 23 to the shaft 21' to prevent turning of the member 20. At its lower end, shaft 21' is shown as provided with a roller 24 resting on an inclined or cam surface 25 of a segmental disc 26. It will be readily apparent that if the disc is moved to the right in Fig. 2, for instance, the roller 24 and its shaft 21' will be moved upwardly thereby moving member 20 and contacts 16 mounted thereon upwardly and bringing up-

per contact 16 into engagement with contact 17.

In the wiring diagram (Fig. 5) it is seen that engagement of contacts 16 and 17 completes a circuit from the positive pole of battery 50 through said contacts to one end of field 51 of reversible motor 42 and through this field and the armature to the negative pole of the battery. Motor 42 is thereby caused to move throttle rod 44, by means of pinion 52 and rack 53, in a direction to increase the engine throttle opening and thereby increase the manifold pressure. As the pressure increases, bellows 3 collapses and causes the end of arm 10 carrying pin 11 to move upwardly, and, through the engagement of pin 11 and arm 12, to move contact 17 out of engagement with upper contact 16, thereby breaking the circuit and deenergizing motor 42. Displacement of disc 26 to the right results in increased manifold pressure. Similar displacement of disc 26 to the left results in decreased manifold pressure by causing a downward displacement of shaft 21' and member 20 and the bringing of lower contact 16 into engagement with contact 15. A circuit is thereby completed from the positive pole of battery 50 through contacts 16 and 15 to field 51' of motor 42 and through this field and the armature to the negative pole of the battery. The energizing of field 51' causes motor 42 to run in the opposite direction to that caused by the energizing of field 51 so that throttle rod 44 is moved to decrease the throttle opening and thereby decrease the manifold pressure and cause bellows 3 to expand. Pin 11 on arm 10 is moved downwardly by this expansion and eventually causes contact 15 to break its connection with lower contact 16.

For lateral adjustment of disc 26, I have shown a knob 27, the shaft 28 of which is journaled in bushing 29 and which carries at its inner end a gear 30 meshing with a rack 31 secured to a base plate 32 slidably mounted in a channel 33 in the base of the instrument. Also fixed to said base is the back plate 34 which adjustably carries the disc 26 in an annular depression 42. The angular position of said disc may be adjusted in said plate to vary the sensitivity of the lateral adjustment by first loosening clamp screws 35 which clamp the upper beveled surface 36 of an outer clamp plate 37 against annular beveled surface 38 around the periphery of the segment. After loosening the clamp screws, the operator turns the small pinion 39 meshing with teeth 43 on the periphery of said disc 26 by a screw driver to adjust the disc in its new position, upon which the clamp screws are again tightened. The manifold pressure which is set by the two above described adjustments is maintained constant since variation of pressure causes engagement of one of contacts 16 with either contact 15 or 17 thereby through the described means effecting a compensating change of throttle setting.

The drawings show my invention as applied to a twin engined airplane, so that two discs 26 and 26' are provided with independent cam surfaces 25 and 25', the disc being provided both with joint and independent adjustments. To these ends the supporting back plates 34 and 34' for said discs are mounted on the common base plate 32, so that when the knob 27 is rotated, both plates are adjusted together to vary simultaneously and equally the intake pressure of both engines. The cam roller 24' and shaft 21' control the setting of a double contact 16' having a function similar to that of contact 16 and cooperating with contacts 15' and 17' corresponding to contacts 15 and 17, respectively. Thus, it is seen (Fig. 5) that engagement of contacts 16' and 17' completes a circuit through field 53 of motor 43' causing rotation in one direction while engagement of contacts 16' and 15' completes a circuit through field 53' causing the motor to run in the opposite direction, the throttle opening of the associated engine being varied accordingly. A spark suppression circuit consisting of resistance 54 and condenser 55 is bridged across contacts 16 and 17 and a similar circuit consisting of resistance 54 and condenser 55' is bridged across contacts 15 and 16. Spark suppression circuits are also bridged across contacts 15', 16' and 17'. By this means a uniform performance of both engines is secured and much experimenting with the controls avoided. Independent adjustment is secured for each disc by having an independent clamp plate 37' for disc 26' with separate clamp screws 35' and adjusting pinion 39'.

In use, the aviator operates the throttles of his engines entirely from the knob 27, by which both engines are throttled up and down uniformly. The desired absolute intake manifold pressure for both engines is shown on the dial 61 at the top of the casing 7, which dial is shown as mounted on a vertical shaft 62 which carries at its lower end a pinion 63 meshing with a small rack 64 secured to the back of the base plate 32.

As 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 drawings shall be interpreted as illustrative and not in a limiting sense.

Having described my invention, what I claim and desire to secure by Letters Patent is:

1. In a throttle control for airplane engines, means responsive to the absolute intake manifold pressure, an adjustable controller actuated therefrom, independent throttling positioning means remotely controlled by said controller to maintain a normally constant manifold pressure and manual setting means for altering the adjustment of said controller to vary the manifold pressure.

2. In a throttle control for multi-engined aircraft, means responsive to the absolute intake manifold pressure of each engine, adjustable controllers actuated from each by variations therein, remote throttle positioning means controlled by said controllers for positioning the throttles of the engines to maintain a constant manifold pressure at each engine, manual setting means for simultaneously altering the adjustment of all of said controllers, and setting means individual to each engine for causing said first setting means to equally vary the manifold pressure on all engines.

3. A throttle control for multi-engined aircraft as claimed in claim 2, in which said manual setting means is provided with additional means for varying the individual controller positions for similarly changing the pressure of all the engines.

4. In a throttle control for airplane engines, means responsive to the absolute intake manifold pressure comprising a sealed, partially evacuated, biased, resilient container having a movable end wall, an enclosure for the same connected with the intake engine manifold, a lever resting on said movable end wall and extending beyond said container, and a second metallic bellows secured

around the opening in said container for said lever and having its outer end wall attached to said lever, whereby an airtight seal is furnished for said enclosure.

5. In a throttle control for airplane engines, means responsive to the absolute intake manifold pressure comprising a sealed, partially evacuated, biased, resilient container having a movable end wall, an enclosure for the same connected with the intake engine manifold, a reversible controller operated by the movements of said end wall for automatically varying the engine throttle, and manual means for independently adjusting said controller for varying the speed of the engine.

6. In a throttle control for multi-engined aircraft, means responsive to the intake manifold pressure of each engine comprising a sealed, partially evacuated, biased, resilient container having a movable end wall, an enclosure for each container, each enclosure being connected with one of the intake manifolds for one of the engines, a separate controller for the throttle of each engine operated by movements of the end wall of the respective container, and a common means for equally and simultaneously adjusting all controllers including manual means for independently varying the effect of said common means on each controller, whereby means are provided for adjusting the speeds of all engines simultaneously and uniformly.

7. In a throttle control for airplane engines, means responsive to absolute intake manifold pressure, adjustable contact means including a normally stationary contact and relatively movable contacts cooperative therewith, said movable contacts being positionable by said pressure responsive means, throttle positioning means controlled by said contact means for varying throttle opening to maintain a normally constant manifold pressure, and means for manually adjusting said contact means to vary manifold pressure.

8. In a throttle control for multi-engined aircraft, means responsive to the absolute intake manifold pressure of each engine, a source of electric power, individual throttle positioning means controlled respectively by said pressure means, each including adjustable pressure responsive contact means and a reversible motor operated from said source under the control of said contact means, and manually operated adjusting means for said contact means for simultaneously varying the manifold pressure of all engines in a similar manner.

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