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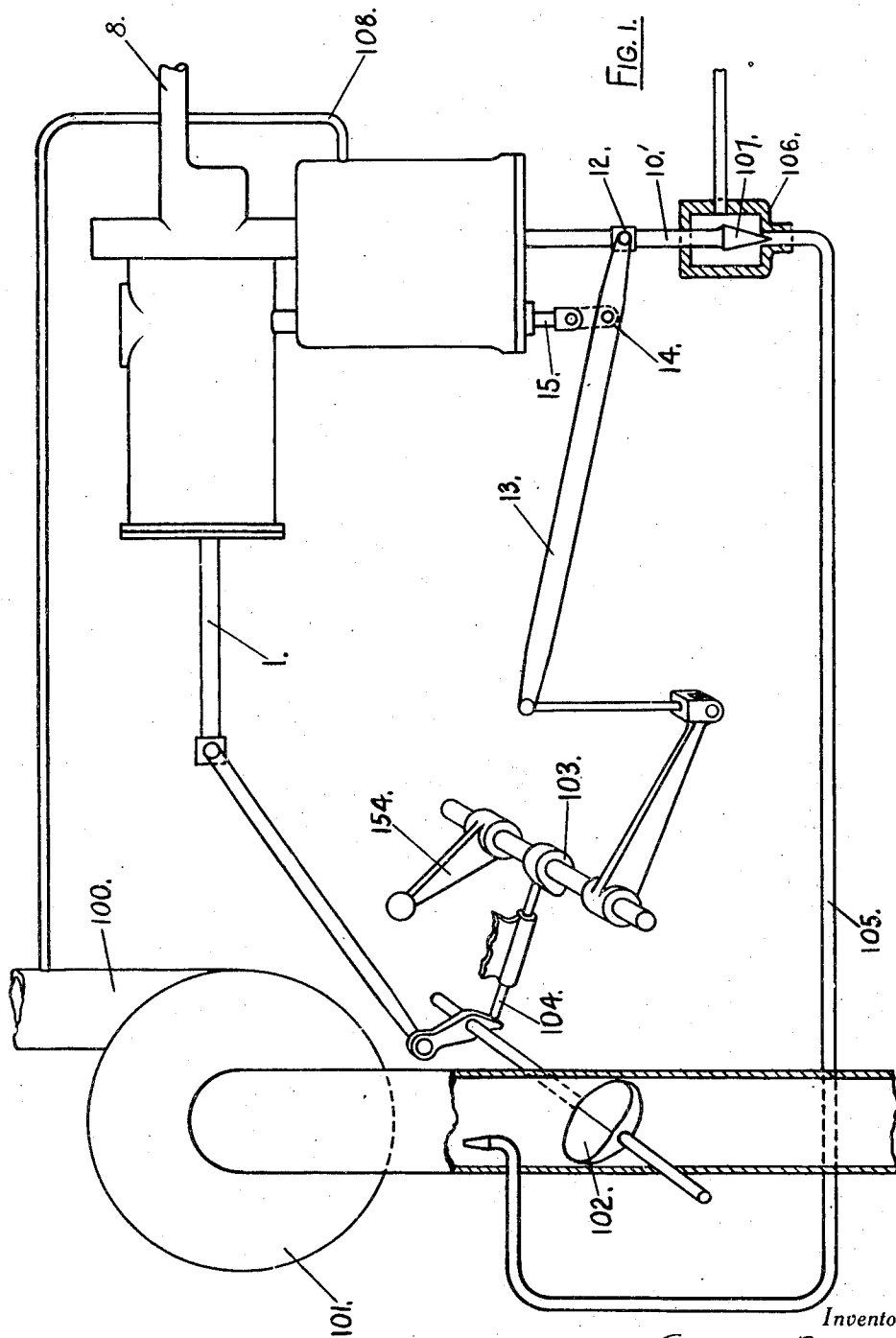
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2,397,835

MECHANISM FOR THE SUPPLY OF FUEL TO INTERNAL-COMBUSTION ENGINES

Filed March 13, 1943

4 Sheets-Sheet 1



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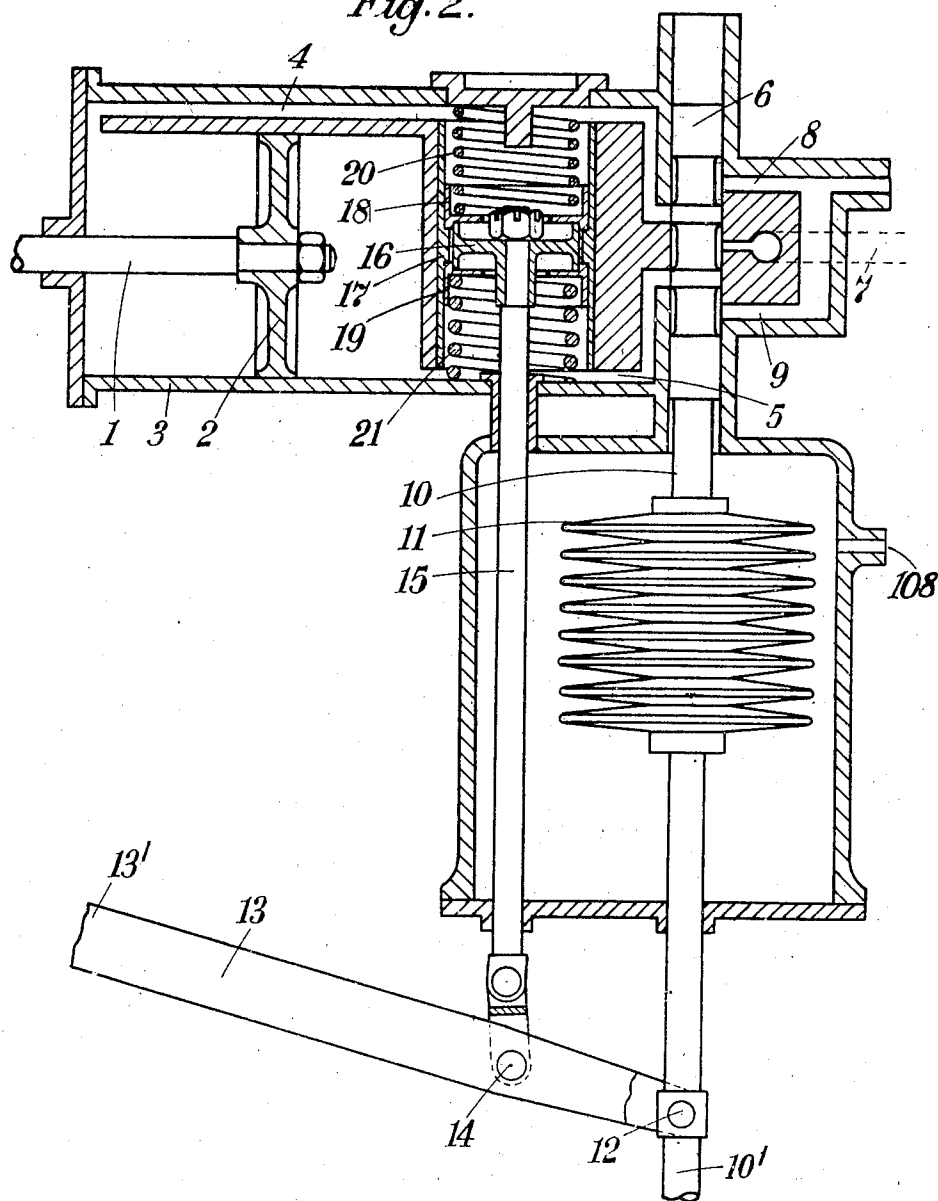
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Fig. 2.



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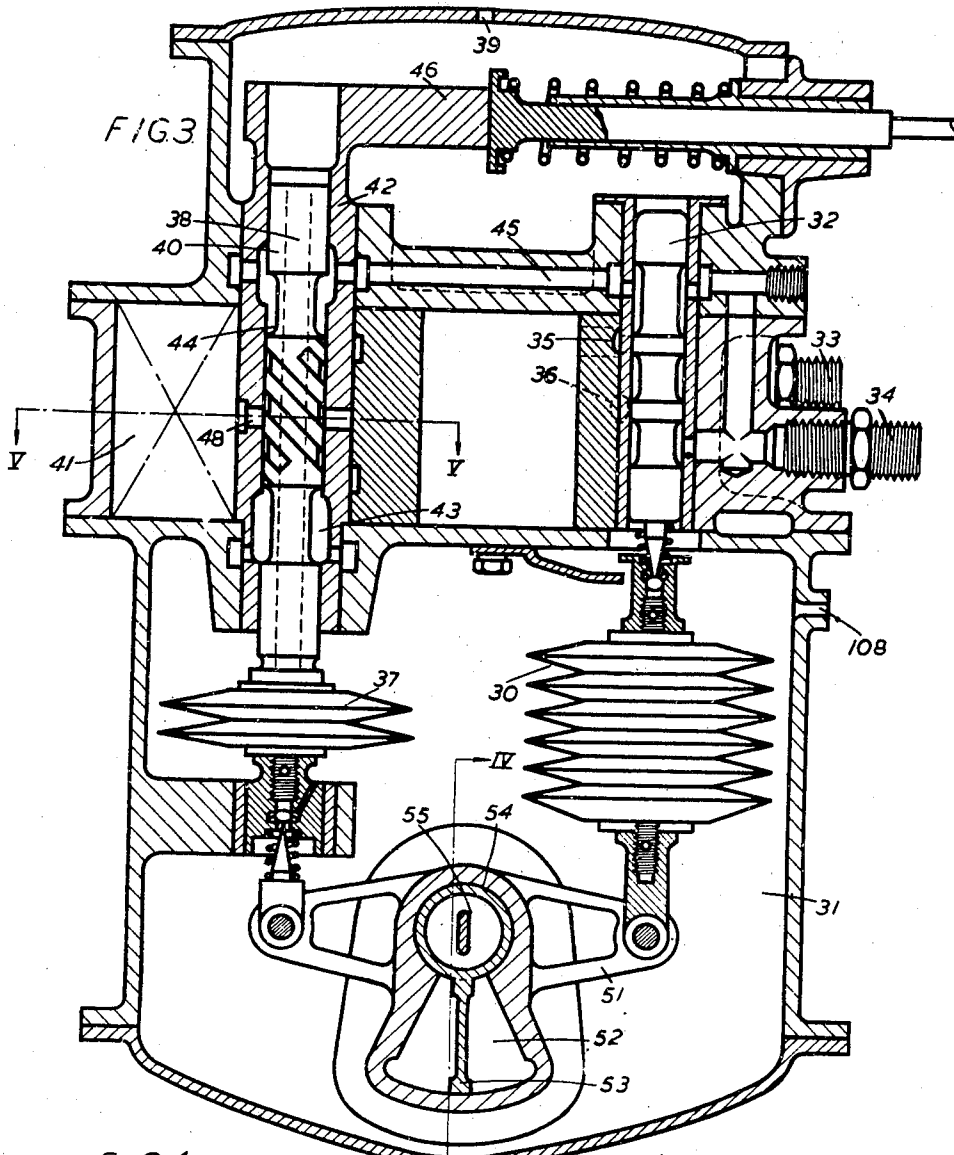
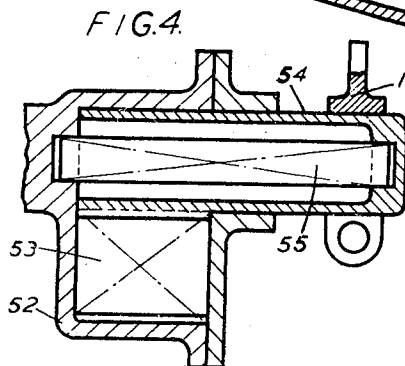
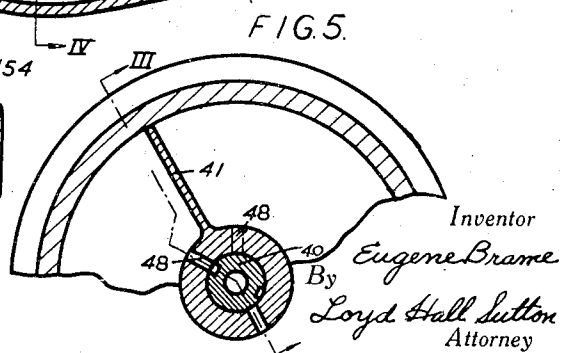
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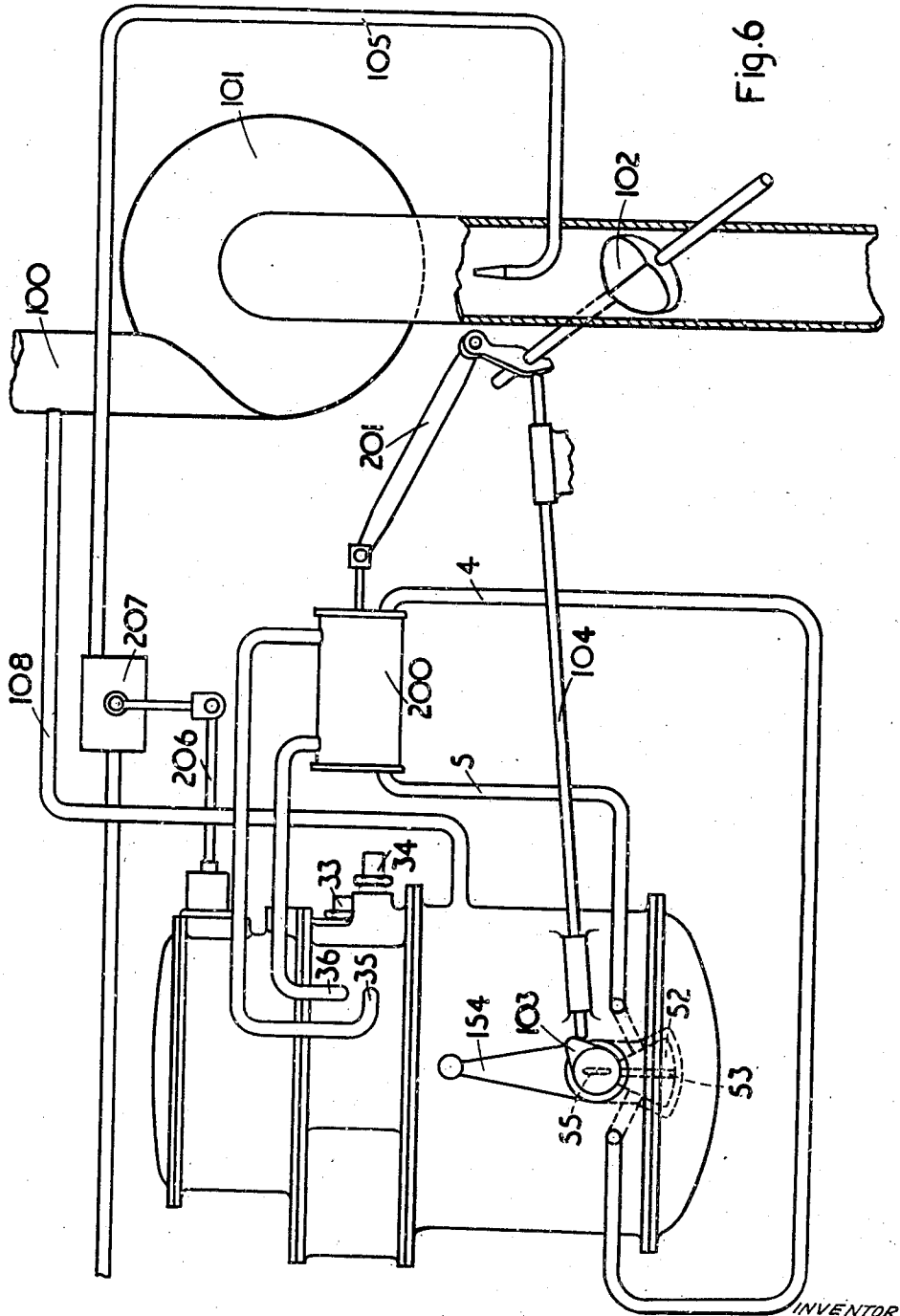


Fig. 6

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MECHANISM FOR THE SUPPLY OF FUEL TO
INTERNAL-COMBUSTION ENGINES

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Application March 13, 1943, Serial No. 479,092
In Great Britain June 14, 1940

10 Claims. (C. 123—103)

The invention relates to mechanism for regulating the supply of fuel to supercharged aero engines in which an automatic boost control is provided to limit in accordance with boost pressure the opening of the throttle, said throttle being actuated by a fluid-operated servo device supplied with pressure fluid through a valve controlled by a member responsive to boost pressure and by a pilot's throttle lever.

In such mechanism when the aircraft reaches its rated altitude, with the pilot's throttle lever in the fully open position, the throttle is fully opened by the servo device, and if the aircraft rises above its rated altitude, the boost pressure will fall, and the automatic boost control will operate to open the valve and thus to cause the fluid pressure in the servo device to increase above the value required to hold the throttle fully open.

In accordance with the invention, fluid operated means are provided for utilising the fluid pressure in the servo device under such conditions to reset the fuel-air mixture strength. Means also may be provided to reset the valve controlling the supply of pressure fluid to the servo device to prevent or limit further rise of pressure in the said device.

In one form the mechanism may comprise a lever connected at one end to the pilot's throttle lever and adapted to be moved in response to movement of a member responsive to fluid pressure in the servo device above a predetermined value. The lever is also connected to the mixture control and through a member responsive to boost pressure, e. g. a stack of capsules, to a valve which controls the supply of fluid under pressure to the servo device. Thus when the engine is run at full throttle above its rated altitude the continued rise in pressure in the servo device actuates the member responsive to excess fluid pressure in the servo device and causes the lever to move and adjust the mixture strength and also adjust the control valve of the boost control servo device. The throttle may be arranged for direct manual operation at small openings in addition to indirect operation through the pilot's throttle lever and servo device at larger openings, and in this case also pressure in excess of the normal operating pressure may be set up in the servo device while the direct manual control overrides the servo control. If the member responsive to such fluid pressure in the servo device is double acting and the opposite sides thereof are connected to the respective sides of the servo device, excessive pressure set up in the servo device during direct manual operation of the throttle may also be

utilised to reset the mixture strength and the control valve for the servo device. Alternatively, two throttles may be provided, the main throttle being located in the induction pipe, and servo-operated throughout its range, and an auxiliary throttle being arranged for direct manual operation and located in a by-pass round the main throttle. In this case the member responsive to fluid pressure above the predetermined value in the servo device will be single acting.

The member responsive to such fluid pressure in the servo device may comprise a piston located so as to move in a cylinder under the action of fluid pressure against a precompressed spring, or it may comprise a vane and chamber mounted for relative movement under fluid pressure.

With the vane and chamber arrangement the lever may have the form of a beam one end of which is connected to the mixture control through a capsule stack responsive to atmospheric pressure and the other end of which connected to the control valve for the servo device through a capsule stack responsive to boost pressure. The beam carries or embodies a chamber in which is located a vane connected to the pilot's throttle lever means being provided for admitting fluid under pressure from either side of the servo device to the respective sides of the vane.

In this way under the influence of pressure from the servo device fluid will be admitted to or withdrawn from the chamber at the respective sides of the vane thereby causing a turning movement of the beam and consequent adjustment of the control valve for the throttle servo device and of the mixture control servo.

The invention is applicable to engines provided with carburettors in which a liquid fuel is mixed with air for its combustion, and the supply of the fuel-air mixture is controlled by the throttle, and to engines equipped for direct fuel injection in which the flow of the air only is controlled by the throttle.

The invention is illustrated in the accompanying drawings, in which Fig. 1 is a schematic layout view of an engine control system embodying the present invention, Fig. 2 is an enlarged sectional view of part of the system of Fig. 1, Fig. 3 is a sectional view of a device illustrating an alternative form of mechanism according to the invention, and particularly intended for direct fuel injection systems, Fig. 4 is a fragmentary sectional view along the line IV—IV of Fig. 3, Fig. 5 is a sectional view along the line V—V of Fig. 3, and Fig. 6 is a schematic layout view to illustrate the operation of the device of Fig. 3.

Referring to Figs. 1 and 2 the control system comprises an intake pipe 100 along which a mixture of air and liquid fuel is passed to an internal combustion engine (not shown) by a supercharger 101, in the intake of which is located an adjustable throttle 102 which controls the mass of air passing to the supercharger 101 and hence the pressure generated thereby. The throttle is adapted to be adjusted by movement of a pilot's throttle lever 154, said adjustment being positive over the first few degrees of angular movement through the cam 103 and push rod 104, and at wider openings being servo operated by means to be described hereinafter. At the side of the throttle remote from the supercharger the intake pipe is open to the atmosphere, and fuel is sprayed under positive pressure into the intake pipe through a pipe 105 including a metering orifice 106 adjustably obstructed by a tapered needle 107 which consequently constitutes a mixture control.

The throttle 102 is also connected for actuation by a rod 1 to which is fixed a servo piston 2 (see Fig. 2) working in a cylinder 3. Fluid under pressure, e. g. oil, is supplied to either side of the servo piston 2 through passages 4 or 5 which communicate with a piston valve 6 actuated by boost pressure and by the pilot's throttle lever 154 and to which fluid is supplied by a passage 7 and from which fluid exhausts through passages 8 or 9. Thus according to the position of the piston valve 6, either side of the servo piston can be subjected to the pressure of the fluid in passages 7, or can be exhausted through passages 8 or 9.

The valve 6 is secured to a rod 10 provided with a capsule stack 11, which is sensitive to variations in boost pressure supplied through pipe 108 and which regulates in conjunction with the pilot's throttle lever the position of the valve 6 accordingly. The rod 10 is pivoted at 12 to a lever 13 secured at its other end to the pilot's throttle lever 154 and is connected to the tapered needle 107 at its lower end 10'. Also pivoted to the lever 13 at 14 is a rod 15 carrying a second piston 16, which may be termed the resetting piston. The resetting piston works in a cylinder having a central constriction 17 past which the piston can move. On each side of the piston are sliding abutments 18 and 19, which are too large to pass the constriction 17 and are urged by springs 20 and 21 towards it. The springs are precompressed to such an extent that they do not move until the fluid pressure on either side of the piston rises above the values required to move the throttle to the limits of its travel in either direction. Since the abutments are too large to pass the constriction 17 movement of the resetting piston away from the central position is resisted by the spring undergoing compression, the other spring exerting no action on the resetting piston. The fluid passage 4 communicates with the upper side of the resetting piston 16, and the passage 5 with the lower side thereof, and thus the resetting piston constitutes a double acting member responsive to increase in pressure in the servo cylinder, above the values required for its normal operation.

In normal operation of the carburettor with the pilot's throttle lever 154 moved to the fully open position so that the throttle opening is limited by the boost control mechanism as the boost pressure falls the capsule stack 11 expands raising the valve 6 and causing the passages 7 and 4 to communicate, admitting pressure fluid to the left hand side of the servo piston 2 thus causing the throttle 102 to open, while the passages 8 and

5 are brought into communication thus permitting fluid to exhaust from the right hand side of the piston 2. After the aircraft has reached its rated altitude, if it continues to rise, excessive pressure at the left hand side of the servo piston 2 will be transmitted to the top of the piston 16 which will descend against the action of the spring 21 lowering the pivot 14 and hence also lowering the rod 10, thus resetting the valve 6 and preventing further supply of fluid to the left hand side of the servo piston, 2 at the same time resetting the tapered needle 107 to reduce the mixture strength.

The throttle 102 is directly manually operated at small throttle openings, through the cam 103 and push rod 104 and when it is opened under such conditions, the servo piston 2 is moved to the right, oil from the right hand side passing through the passage 5 to the bottom of the resetting piston 16, which is thus moved up against the action of the spring 20, raising the pivot 14 and rod 10, resetting the tapered needle 107 to increase the mixture strength, the pivot 12 and with it the valve 6 also being moved to interrupt the supply of pressure fluid from the passage 7 to the passage 5.

If the carburettor is one in which the main throttle is servo-operated through its range, a small auxiliary throttle being provided for direct manual operation, the piston 16 will be a single acting one, the top spring 20 being omitted and the cylinder in which the piston moves, being a plain bored cylinder without a central constriction, the bottom spring being precompressed as before.

Referring now to Figs. 3 to 5, the device comprises a capsule stack 30 in a chamber 31 connected by a pipe 108 to the pressure side of a supercharger, said stack 30 carrying a valve 32 governing the action of a servo device which controls the throttle opening and in which a vane or piston (not shown) but which may be similar to the piston 2 of Fig. 2 constitutes the pressure-responsive member. The valve 32 is fed with pressure oil, through the inlet 33 and exhausts through the outlets 34, the outlets to the servo device being shown at 35 and 36. The mixture strength or rate of flow from the fuel injection pumps (not shown) is controlled by the capsule stack 37 the interior of which is connected to the atmosphere through the drilling 38 and vent 39, and to which is attached a control valve 40, which governs the supply of pressure fluid to a second servo having a vane 41 controlling the fuel pump through the sleeve 42 with which it is integral, and cam 46, which acts on a push rod by which the delivery of the fuel pumps is adjusted.

The construction and operation of the valve 40 is as follows: The valve is slidably mounted in the sleeve 42 and has three lands, the stem of the valve being recessed between the lands. The bore of the sleeve 42 is enlarged at 43 to form a chamber filled with pressure fluid, and at 44 to form a second chamber connected to exhaust through the passage 45. Four spiral channels are cut in the centre land, one pair of which communicate with the chamber 43 but not with the chamber 44, and hence are filled with pressure fluid, and the other pair communicate with the chamber 44 but not with the chamber 43, and hence are filled with fluid at exhaust pressure. A port 48 drilled in the sleeve 42 communicates with the side of the vane 41, and a second port 48' communicates with the other side of the vane. Consequently in operation the sleeve will take up a

rotational position in which the helical ribs between the grooves obstruct the inner ends of the ports. If the valve 40 is moved longitudinally the vane 41 will be subject to pressure fluid on one side and will rotate with the sleeve 42 until the ribs on the valve 40 again obstruct the ports. Thus longitudinal movement of the valve 40 produces rotational movement of the vane 41, sleeve 42 and cam 46. A further passage is provided for balancing and lubrication in the sleeve 42 diametrically opposite the vane 41.

The capsule stacks 30, 37 are connected by a beam 51 housing an oil chamber 52, which contains a vane 53, secured to a hollow spindle 54, one end of which is free to rotate in the chamber 52 while the other end is secured to a pilot's throttle lever 154; the latter end also gripping one end of a flat torsion spring 55 the other end of which is fast with the wall of the chamber 52.

Oil supplying the servo cylinder (see Fig. 6) through passages 35, 36 is also passed to the oil chamber 52 at the two sides of the vane 53 therein, through passages connected analogously to the passages feeding oil to each side of the piston 16 in Figure 1, and which may conveniently pass through the hollow spindle 54.

The operation of the device of Figs. 3 to 5 will be clear from a comparison of Fig. 6, wherein several of the parts of the system are named on the drawings, with Fig. 1. If the oil pressures at the two sides of the vane 53 are equal, adjustment of the lever 154 acts through the torsion spring 55 and causes the beam 51 to move thus positioning the capsules 30, 37 and valves 32, 40. If, however, while the lever 154 is stationary a pressure difference is set up at the two sides of the vane 53 sufficient to overcome the stiffness of the torsion spring 55, the oil chamber 52 and beam 51 will undergo movement relative to the vane 53, twisting the spring 55, and resetting valve 40 to adjust the mixture strength and also resetting valve 32. The pressure difference at which such resetting movement takes place is determined by the stiffness of the spring 55. The vane 53 as shown in Fig. 2 is free to move in either direction so that it is double acting like the piston 16 shown in Fig. 2, resetting of the mixture strength accordingly taking place either when the engine is running with the throttle full open at above its rated altitude, or when the throttle is being positively operated at small throttle openings. When the engine has an auxiliary throttle which is positively operated to correspond with small throttle openings, the main throttle being wholly servo operated, the vane 53 may be prevented from moving from its position of rest in one direction relatively to the chamber 52 either by providing an end stop for the vane in the chamber 52, or by arranging that the vane 53, when in its rest position, lies against one side of the chamber 52, instead of being located centrally thereof as shown in Fig. 3.

I claim:

1. In a mechanism for the supply of fuel to supercharged aero engines, in which the opening of a throttle operated by a pilot's throttle lever through a fluid-operated servo device is limited by a boost control operatively connected to said servo device, a mixture control, a member responsive to pressures in the servo device above those required to bring the throttle to a limit of its movement and means for transmitting response of said member to said mixture control and valve.

2. In a mechanism for the supply of fuel to

supercharged aero engines, having a throttle whose opening is limited by a boost control through a fluid-operated servo device, a mixture control and a member for adjusting the same, said member being responsive to fluid pressures in the servo device above those required to bring the throttle to a limit of its movement.

3. In a mechanism for the supply of fuel to supercharged aero engines, in which the opening of a throttle operated by a pilot's throttle lever through a fluid operated servo device is limited by a boost control operatively connected to said servo device, a mixture control, and a member connected thereto and responsive to fluid pressure in the servo device when the engine is running at above its rated altitude with falling boost pressure.

4. In a mechanism for the supply of fuel to supercharged aero-engines in which a throttle is controlled over part of its range of movement by a pilot's throttle lever through a fluid-operated servo device and adapted for positive control at small throttle openings, and the opening of which is limited by a boost control through said servo device, a mixture control and a member for adjusting the same, said member being responsive to pressure set up in the servo device during positive operation of the throttle at small throttle openings.

5. In a mechanism for the supply of fuel to supercharged aero engines in which a throttle is adapted to be moved over part of its range of movement in response to movement of a pilot's control through a fluid-operated servo device and adapted for positive control at small throttle openings, a boost-actuated valve for controlling the operation of the servo device to provide a boost control to limit opening of the throttle, and additional means for actuating said valve in response to pressure set up in the servo device during positive operation of the throttle at small throttle openings.

6. In a mechanism for the supply of fuel to supercharged aero engines having a throttle operated over part of its range of movement by a pilot's throttle lever through a fluid-operated servo device, and adapted for manual control at small throttle openings and in which a boost control is provided to limit the opening of the throttle, a mixture control and a boost-actuated valve for controlling the operation of the servo device, a double-acting member responsive to fluid pressure set up in the servo device when the engine is running at above its rated altitude with falling boost pressure and during manual operation of the throttle at small throttle openings, and means for transmitting the response of said member to said mixture control and to said boost-actuated valve.

7. In a carburettor for supplying fuel to a supercharged aero-engine having a throttle operated through a fluid-operated servo device, and a boost control to limit the opening of the throttle in accordance with boost pressure, a boost control assembly comprising a valve for governing the operation of the servo device and a boost responsive member to adjust the valve, a mixture control, a member responsive to pressure set up in the servo device when the engine is running at above its rated altitude with falling boost pressure, and a linkage between the pressure responsive member and the boost control valve and mixture control.

8. In a carburettor as claimed in claim 7 having a throttle adapted for positive operation at

small throttle openings, a double acting member which is responsive to fluid pressure set up in the servo device both when the throttle is opened positively and when the engine is running at above its rated altitude with falling boost pressure, said member being adapted to adjust the boost control valve and mixture control.

9. In a carburettor as claimed in claim 7, a double acting member responsive to pressures in the servo device above predetermined values, means for applying fluid pressure from either side of said servo device to the respective sides of said double acting member, a mixture control, a valve for controlling the operation of the servo device, a boost-responsive capsule stack connected to said valve, and a lever linking said double acting member, mixture control and capsule stack.

10. A mechanism for the supply of fuel to a supercharged aero-engine in which a throttle is operated by a fluid pressure actuated servo mech-

anism controlled by a pilot's throttle lever and additionally controlled by a member responsive to boost pressure, and in which the quantity of fuel injected is controlled by a fluid pressure actuated servo mechanism responsive to the difference between boost and atmospheric pressure, and in which valves controlling the operation of the servo mechanisms are connected through pressure responsive members to the ends of a rocking beam, having an oil chamber divided by a vane spring-mounted in said chamber and subject at its two sides to the pressure difference applied to the throttle control servo mechanism, said vane being connected to the pilot's throttle control lever, whereby said vane and beam move together unless the pressure difference at the two sides of the vane exceed a predetermined value when the throttle reaches a limit of its movement.

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