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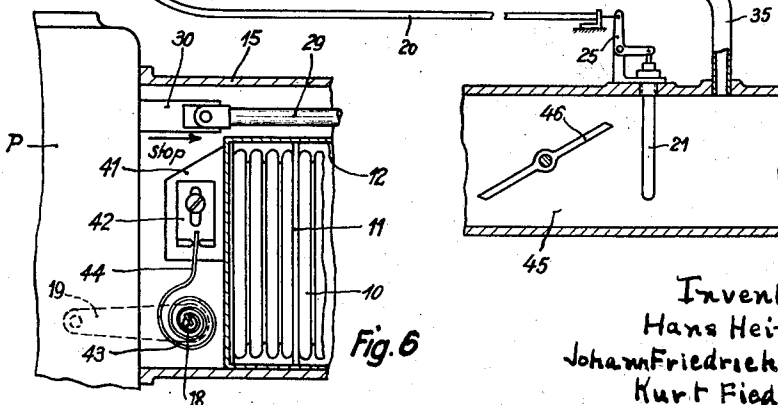
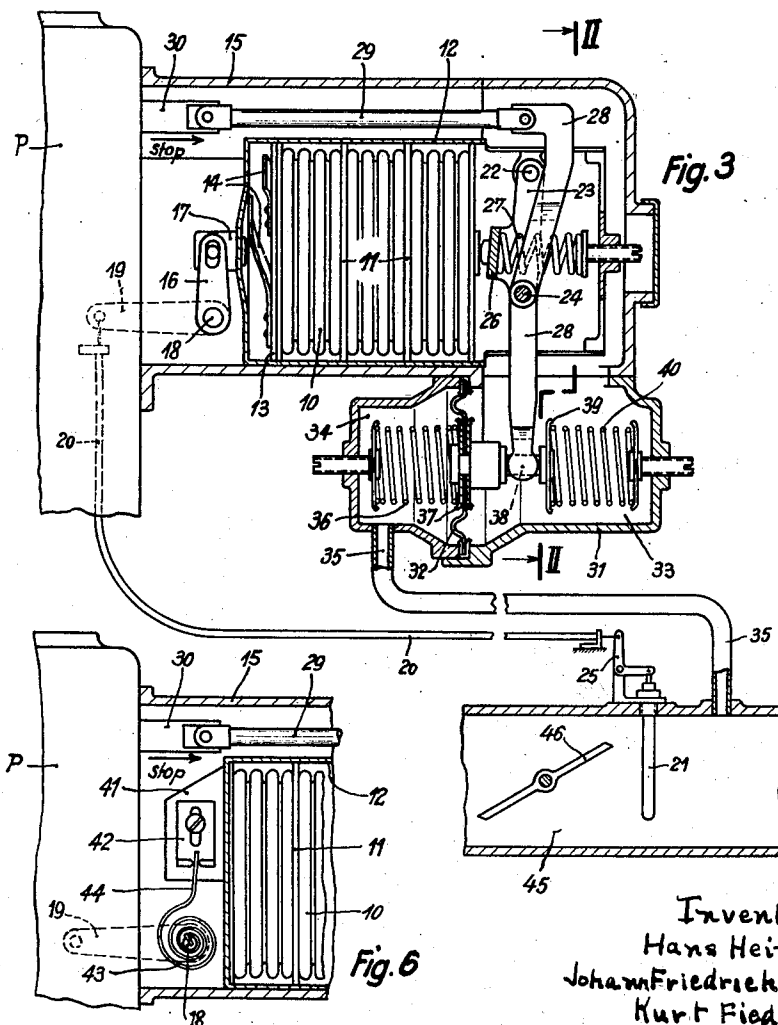
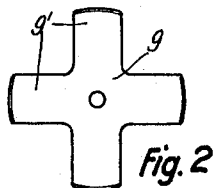
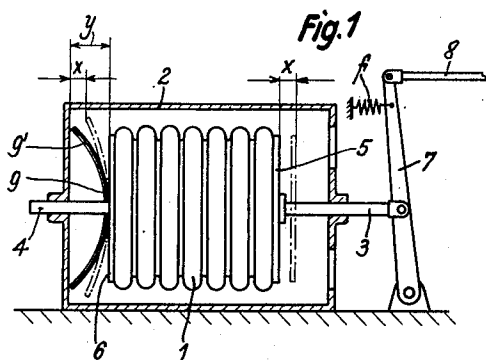
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2,161,743

CONTROL MEANS FOR THE FUEL SUPPLY OF INTERNAL COMBUSTION ENGINES

Filed Feb. 24, 1938

2 Sheets-Sheet 1



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2 Sheets-Sheet 2

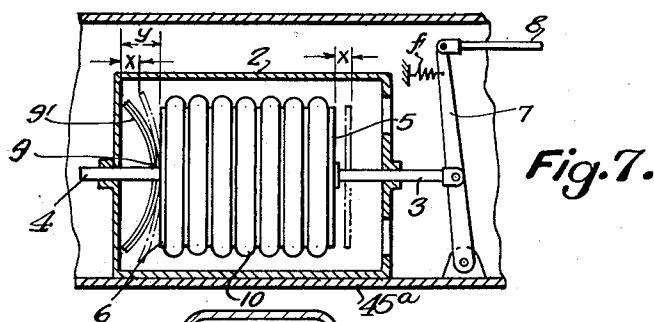


Fig. 7.

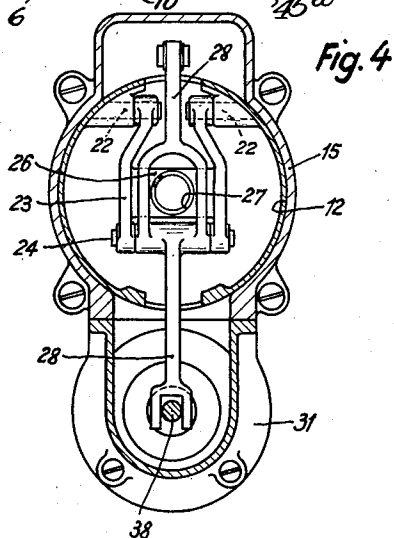


Fig. 4

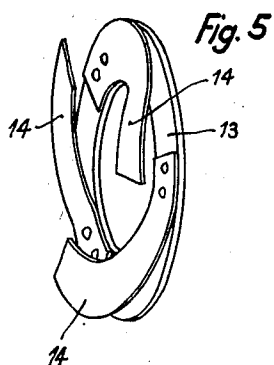


Fig. 5

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UNITED STATES PATENT OFFICE

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CONTROL MEANS FOR THE FUEL SUPPLY OF
INTERNAL COMBUSTION ENGINES

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The present invention relates to control means for the fuel supply of internal combustion engines of the type wherein control rods are under the influence of membrane boxes containing a gaseous medium, the boxes responding to variations in pressure and temperature.

Highly evacuated membrane boxes have the disadvantage that in the event of any leakage or unsoundness, they expand very sharply and completely or almost completely cut off the fuel supply. If membrane boxes of this type are installed in an aeroplane and become leaky, under certain circumstances the pilot may even be compelled to make a forced landing.

As compared with highly evacuated membrane boxes however, gas-filled membrane boxes of the kind mentioned have the drawback that they are fairly sensitive to temperature and accordingly become heated by virtue of their location in the region of the internal combustion engine, and as a result undesirable alterations in length of the membrane boxes adversely affect the control of fuel supply to the engine.

In order to avoid this exceedingly important drawback, the present invention removes the drawback arising from undesired sensitiveness to temperature. This is accomplished by the introduction of one or more temperature sensitive means for rendering ineffective the alterations in length of the membrane boxes caused by the variations of temperature, for at least the greater part, said means being arranged between the membrane boxes and the control rods, and being exposed substantially to the same temperatures as the membrane boxes in such a manner that in the event of variations in temperature they influence movement of the said rods of approximately equal magnitude but in the opposite direction to the alterations in length of the membrane boxes occasioned by the variations in temperature.

It will thus be seen that the membrane boxes can be arranged in a simple manner within the casing of the governor and in the immediate neighbourhood of the engine without a harmful influence being exerted as a result of the application of the high temperature of the engine on the governor.

The invention is more particularly described with reference to the accompanying drawings, in which:

Figure 1 is a longitudinal view in partial section through a governor and a membrane box containing a gaseous medium.

Figure 2 is a view of a temperature sensitive

device for the governor, in the form of a bi-metallic element.

Figure 3 is a partial longitudinal section through a modified form of governor built on to an injection pump.

Figure 4 is a cross section on the line II—II of Figure 3.

Figure 5 is a perspective view of the bi-metal disc provided in the construction according to Fig. 3.

Figure 6 is a further form of construction of governor showing the latter in partial section through its casing.

Figure 7 is a view similar to Figure 1, of another modification.

A membrane box 1 containing air or other gaseous medium is carried on spindles 3, 4, in the interior of a fixed casing 2, said spindles being secured co-axially with each other and to the box itself on the cover members 5 and 6 of the box. The spindle 3 at that end projecting through the casing is pivotally and flexibly connected to a single arm lever 7 of which the fulcrum is stationary. The free end of the lever 7 is pivotally and flexibly connected with rods 8 which engage for instance with an element governing the supply of fuel to the internal combustion engine (not shown). Between the end 6 of the box 1 and the left hand end wall of the casing is arranged a bi-metallic disc 9 which is arched in the shape of a hood or dome and through which the mounting pin or spindle 4 of the left hand end of the membrane projects. As shown in Figure 2, the disc has arms 9' arranged in the form of a cross. The middle portion bears against the end 6 of the membrane box whilst the curved arms 9' touch the inner side of the front wall of the casing. A return force, which is applied for instance by a draw-spring *f* engaging on the lever 7, ensures that the bi-metal disc 9 always bears both on the end 6 of the box 1 and on the adjacent wall of the casing 2.

Should the atmospheric pressure operating on the membrane box decrease, for instance when an aeroplane is gaining height, then the membrane box expands correspondingly. In addition to these alterations in the length of the box caused by the alteration of the atmospheric pressure, which alterations in length are transmitted to the spindle 3, the lever 7 and from the lever to the rods 8 on to the members (not shown in Figure 1) for adapting the amount of fuel fed to the cylinders of the engine, there also occur further alterations in length due to variations in temperature. Since the box is arranged in the

neighbourhood of the engine, however, not only the temperature variations caused by the temporary degree of height, but also temperature fluctuations of the engine itself vary the length of the air cooled box. These temperature influences, which originate from the engine and in themselves vary the length of the box in an undesired manner, are nullified by the bi-metal disc which operates in the opposite direction to the box. For this purpose, the bi-metal disc is so composed that its effective length y , in the event of an increase in temperature in the volume surrounding the box, decreases by the same amount x by which the box has lengthened as a result of the increase in temperature. With a falling temperature, the effective length of the bi-metal disc increases corresponding to the shortening of the box brought about by decrease in temperature. In this form of construction it will be appreciated that alteration of the temperature of the air fed to the cylinders of the engine has not been considered.

In the modified form of construction according to Figures 3 and 4, three membrane boxes containing air are arranged one behind the other longitudinally of the direction of adjustment. Each box is located between two discs 11, which are guided on the inner wall of a housing 12. Against the left hand end disc there bears a ring 13, which is likewise guided in the inner wall of the housing 11 and to which the ends of three curved bi-metal strips 14 are secured. The free end of each of the strips 14 is curved out of the plane of the ring 13 and overlaps the fixed end of the neighbouring strip (Figure 5). The free ends of the strips bear against the inner surface of arched left hand end of the housing.

The housing 12 is guided for linear displacement in a casing 15 which, as shown in Figure 3, is mounted on the casing of an injection pump P, the left hand end of the housing has a hub 17 to which a lever 16 is connected by a pin and slot, the opposite end of said lever being secured to a shaft 18 carried by the casing 15, a second lever 19, also carried by the shaft is connected at its free end to the core of a Bowden wire 20, the opposite end of said core being connected to a bell crank lever 25 mounted on the induction manifold engine whose fuel supply is to be controlled. The other arm of the bell crank lever is connected to a thermostat 21 located within said induction manifold and accordingly exposed to the temperature condition of air induced into the internal combustion engine.

A pair of bosses are provided on the movable housing 12 each boss carrying a pin 22 extending in a direction normal to the longitudinal axis of the housing 12. A pair of arms 23 are suspended from the pins 22 and are interconnected by a cross head 26 which bears against the right hand end disc 11 of the membrane box 10 (Fig. 3) and at the same time forms a support for one end of a spring 27 the other end of which is held against an adjustable end of the housing 12.

The lower ends of the arms 23 are connected to a transverse shaft 24 on which is mounted a lever 28 which is formed above the shaft 24 to pass around the spring 27. The upper arm of the lever 28 projects through an opening in the upper end of the housing 12 into the upper part of the casing 15, and by means of rods 29 is connected with the control rod 30 of the injection pump P which is connected with the internal combustion engine in any desired manner (not shown).

A casing 31 of a pneumatic governor is secured to the base of the casing 15 and is divided into two chambers 33, 34, by a membrane 32, having strengthening plates 37. The chamber 34 is closed on all sides and communicates with the induction manifold 45 of the internal combustion engine in which the thermostat 21 is constituted, by a flexible conduit 35, said flexible conduit merging into the induction manifold in rear of a throttle valve 46 which is adapted to be voluntarily adjusted from a remote control such as one within access of the driver's seat.

A coil spring 36 is provided in the chamber 34 and at one end is supported by an adjustable plate carried in the left hand end wall of the casing 31 and at the other end is supported by one of the strengthening plates 37 of the membrane 32.

The chamber 33 is open at the top where it communicates with the casing 15 and through said opening the lower arm of the lever 28 projects into said casing and into the housing 12. The lower end of said lever 28 is bifurcated to engage about a pin 38 in the chamber 33, said pin being secured at one end to a plate 39 and at its other end to one of the strengthening plates 37 of the diaphragm 32. A spring 40 is interposed between the plate 39 and an adjustable element carried by the right hand end wall of the casing 31.

So long as atmospheric pressure, outer temperature and the temperature prevailing in the neighbourhood of the membrane boxes does not vary the governing rod 30 of the injection pump P is adjusted solely under the control of the lever 28 and the rods 29, i. e., in accordance with the degree of suction prevailing in the induction pipe of the engine which operates to displace the diaphragm 32 and the pin 38.

For example, should the suction in the induction pipe 45, the pipe 35 and the chamber 34 of the pneumatic regulator increase, then the membrane 32 is moved to the left (Fig. 3) against the load created by the spring 36. As a result, the lever 28 is rocked about its axis 24 to force the governing rod 30 to the right (Fig. 3) and thus decrease the amount of fuel supply to the engine.

In this respect, the stop position of the rod 30 is reached by movement to the right in Figure 3 and the position of maximum supply of fuel is reached by movement to the left.

On the other hand should atmospheric pressure decrease as for instance in the case of aircraft driven by the internal combustion engine concerned when such aircraft is climbing, the membrane box 10 expands and thereby pushes the right hand end plate 11 to the right to rock the stirrup member 23, 26, about its pivot 22 against the action of the spring 27 thereby taking with it the shaft 24. As a result the lever 28 is moved to the right about the pin 38 as a fulcrum and the governing rod 30 is similarly displaced in the stop direction to decrease the amount of fuel supply to the engine and to render this proportional to the decreased quantity of air fed to the engine cylinders due to decreased air density.

The thermostat 21 responding to temperature fluctuations of the outer air induced into the induction manifold of the engine displaces the movable housing 12 through the bell crank 25, Bowden wire, core and levers 19, 16, the arrangement being such that with a decrease in the outer temperature the housing 12 is moved to the left in Figure 1.

This movement of the housing to the left in Figure 1 enables the spring 27 to displace the stirrup member 23, 26, about its axis 22 and causes movement of the lever 28 and rods 29 to displace the control rod 30 to the left, i. e., towards the position consistent with maximum fuel supply. In consequence, with a decreasing temperature in the atmosphere the injection pump is caused to deliver a larger amount of fuel.

As in the construction according to Figure 1, however, alterations in the length of the composite membrane box which are produced by temperature variations of the air surrounding the box have no effect on the adjustment of the fuel delivery to the engine as any alterations in the length of the membrane box which would otherwise be caused by temperature variations are compensated by the bi-metallic strips 14 which are effective in the opposite direction to that of expansion of the membrane box i. e., on increase in temperature the bi-metallic strips 14 operate to decrease the space between their free ends and the ring 13 by an amount equal to that by which the membrane boxes expand.

As a result of the use of the bi-metallic strips 14 the membrane boxes 10 themselves set the correct amounts of fuel corresponding to the weight of air induced into the engine even when the boxes are arranged in close proximity to the engine itself. In other words, the membrane boxes may be installed in the casing of the governor and the latter mounted on the engine pump working in close proximity to the engine without any disadvantage.

In the modified construction illustrated in Figure 6 the left hand end of the housing 12 carries a holder 41 to which is secured by a pin and slot mechanism, an angle member 42. The slot in one of the arms of the angle member is to enable it to be adjusted on the holder 41, whilst the arm at right angles thereto is also slotted to receive the straight end 44 of a wound bi-metallic spring 43, the opposite end of which is rigidly connected with the shaft 18 carried by the casing 15.

By the displacement of the angle member 42 the end 44 of the spring 43 can be pushed into the slot in the horizontal arm of the angle member 42 by a variable extent according to requirements in order to vary the lever arm of the spring.

It will be appreciated that the bi-metallic spring 43 transmits the adjusting motions of the shaft 18 to the movable housing 12, that is to say, if the temperature of the spiral spring increases its end 44 is moved to the left by an amount which corresponds to the extension of the membrane boxes and in this way alterations of temperature have no effect on the effective length of said boxes.

Instead of arranging the bi-metallic parts between the membrane boxes and the housing 12 or between the housing and the adjusting shaft thereof, the base of the housing may also be made of bi-metal, or again, a bi-metallic member may be inserted at any desired part of the mechanism utilised in transmitting expansion of the membrane boxes to the displacement of the governor rod 30.

It will be appreciated that if the membrane boxes 10 containing the gaseous medium are so arranged, that the temperature influences arising from the proximity of said boxes with the engine can be practically ignored and the temperature of the combustion air fed to the engine is imparted to the membrane boxes, for instance

by inserting the membrane boxes into the induction pipe 45a, as shown, for example, in Figure 7, then the membrane boxes adjust the governor rod 30 both in dependence on pressure alterations within the induction pipe and on temperature alterations within said pipe. But if one supposes that the membrane boxes are correctly proportioned for displacing the governor rod 30 according to pressure variations in the induction pipe they would vary their lengths at temperature variations so comparatively much that thus would arise too large adjusting paths of the rods 29, 30. To avoid these large paths, bi-metallic parts are inserted which are so composed that their effective variations of length in the event of an increase in temperature decrease the effect of the elongation of the membrane box to such an effective displacement of the governor rod 30, that the displacement of said rod is proportional to the smaller weight of air fed to the engine cylinders due to the decreased air density at increasing temperature, and vice versa. By proportioning the bi-metallic means in such a manner and exposing them together with the membrane boxes to the temperature of the combustion air, fed to the engine, the air filled membrane boxes 10 can operate as a barometer and as a thermostat to adjust automatically the amount of fuel fed to the engine in dependence on the weight of air at any time fed, in which case the necessity for an additional thermostat 21 does not exist.

We declare that what we claim is:

1. Control means for the supply of fuel to internal combustion engines, comprising at least one membrane box containing a gaseous medium and sensitive to temperature and pressure variations, means for feeding fuel to the engine, means for operably connecting said membrane box with said feeding means, and temperature sensitive means operating in opposition to said membrane box for at least partly nullifying that portion of the effect of said membrane box on the feeding means due to temperature changes.

2. Control means for the supply of fuel to internal combustion engines, comprising at least one membrane box containing a gaseous medium and sensitive to temperature and pressure variations, means for regulating the supply of fuel fed to the engine, means for operably connecting said membrane box with said regulating means, and temperature sensitive means exposed to substantially similar temperatures as said membrane box and operating in opposition to said membrane box for substantially nullifying that portion of the effect of said membrane box on the regulating means due to temperature changes, whereby the operation of said regulating means by said membrane box is substantially in accordance with pressure variations alone on said box.

3. Control means for the supply of fuel to internal combustion engines comprising at least one membrane box containing a gaseous medium and sensitive to temperature and pressure variations, a governor rod for controlling the supply of fuel fed to the engine, linkage means for operably connecting said membrane box with said governor rod and bi-metallic members exposed to substantially similar temperatures as said membrane box and operating in opposition to said membrane box for substantially nullifying that portion of the effect of said membrane box on the governor rod due to temperature changes, whereby the operation of said governor rod by said membrane box is substantially in accordance with pressure variations alone on said box.

4. Control means for the supply of fuel to internal combustion engines comprising at least one membrane box containing a gaseous medium and sensitive to temperature and pressure variations, a governor rod for controlling the supply of fuel fed to the engine, linkage means for operably connecting said membrane box with said governor rod, bi-metallic members exposed to substantially similar temperatures as said membrane box and operating in opposition to said membrane box for substantially nullifying that portion of the effect of said membrane box on the governor rod due to temperature changes, and a thermostat sensitive to the temperature of air induced into the induction manifold of the engine for displacing said bi-metallic means, whereby said governor rod is displaced in accordance with pressure variations of said membrane box and temperature variations of the induction air fed to the engine.
5. Apparatus as claimed in claim 3 and wherein the effective length of said bi-metallic means is adjustable.
6. Apparatus as claimed in claim 3 and comprising a spirally wound bi-metallic spring as said bi-metallic means, a housing for said membrane box and an adjustable member carried by said housing for varying the effective length of said spring.
7. Apparatus as claimed in claim 3 and comprising a casing for said membrane box and at least one bi-metallic strip constituting the bi-metallic means inserted with said membrane box in said casing to nullify that portion of the effect of said membrane box on the governor rod due to temperature changes.
8. Apparatus as claimed in claim 3 and including a casing for said membrane box and at least one bi-metallic strip constituting said bi-metallic means between one end of said membrane box and one end of said casing, the other end of said

membrane box being connected through said linkage with said governor rod.

9. Apparatus as claimed in claim 8 and including a casing for said membrane box and said bi-metallic means, said bi-metallic means being supported with their ends abutting against one end wall of the casing and with their centre against one end of the membrane box.

10. Apparatus as claimed in claim 3 and comprising a holding disc secured to one end of said membrane box and a plurality of bi-metallic strips constituting said bi-metallic means, said strips being secured at one end on said holding disc with the opposite ends bent out of the plane to which they are secured to said disc.

11. Control means for the supply of fuel to internal combustion engines, comprising means for feeding fuel to said engine, at least one membrane box containing a gaseous medium and sensitive to temperature and pressure variations, said membrane box being operatively connected to said feeding means and so arranged that the temperature influences arising from the proximity of said box with the engine can be practically ignored and the temperature of the combustion air fed to the engine is imparted to the box, the sensitiveness of the membrane box to pressure variations of the air fed to the engine cylinders being such that with increasing air pressure proportional decreasing of the fuel supply is adjusted by alterations of the length of the membrane box and vice versa, and temperature sensitive means exposed to substantially similar temperatures as said membrane box and operating in opposition to said membrane box, said temperature sensitive means compensating for and substantially nullifying that portion of the effect of said membrane box on the feeding means due to temperature changes.

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