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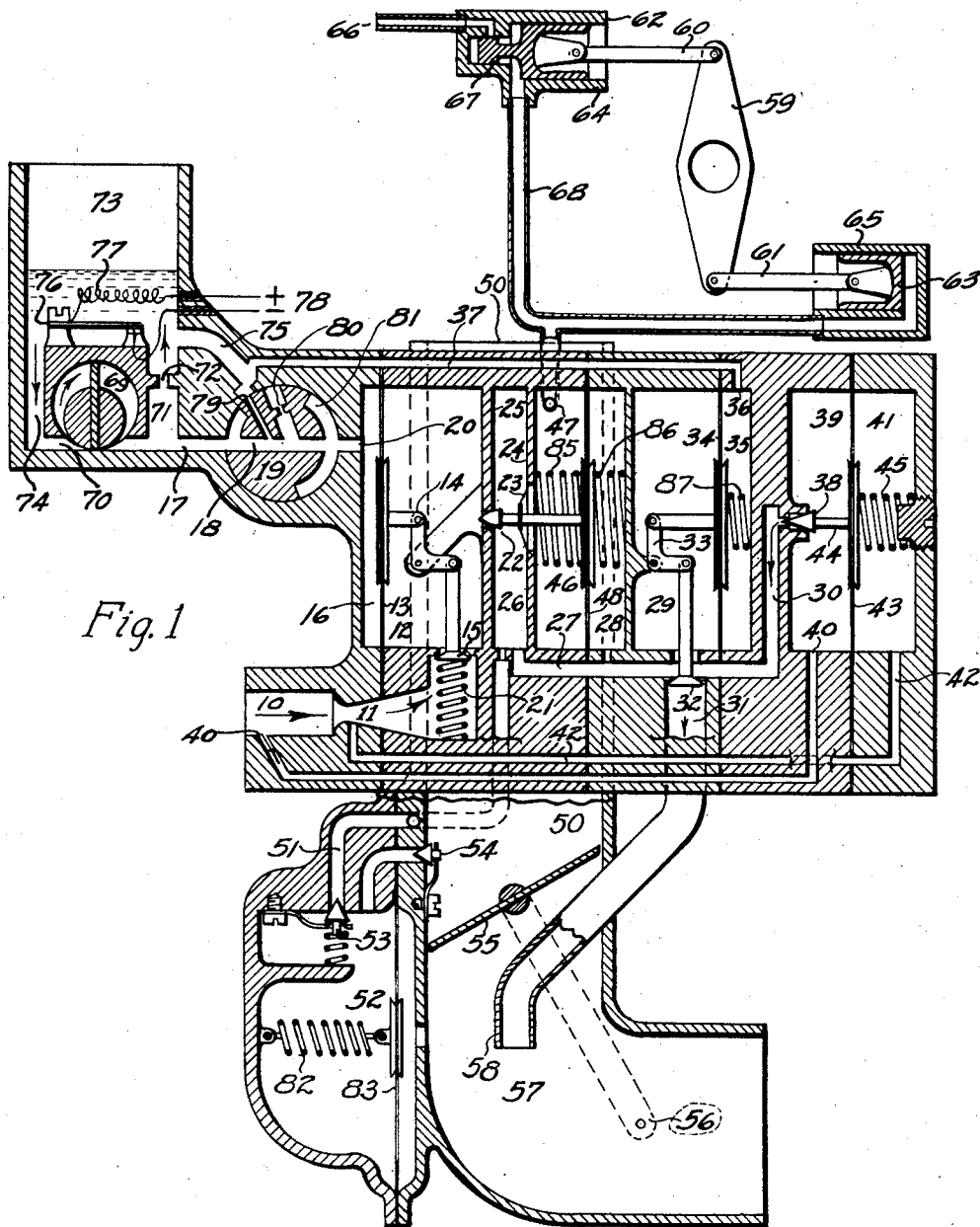
C. F. SCHORN

2,297,918

TORQUE CONTROLLED CARBURETOR

Filed April 26, 1941

3 Sheets-Sheet 1



Carl F. Schorn
INVENTOR

BY *Kearley M. Udels*
ATTORNEY

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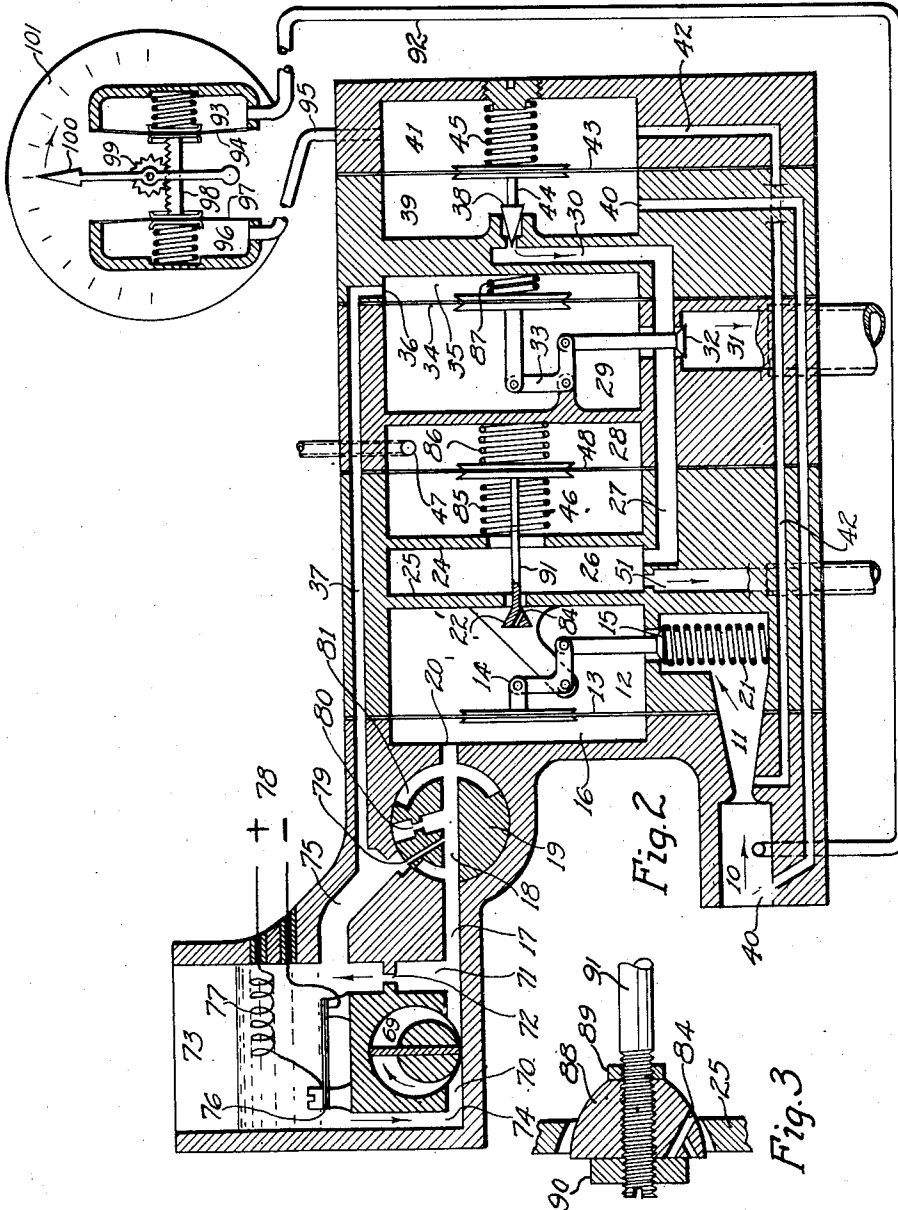
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3 Sheets-Sheet 2



Carl F. Schorn
INVENTOR

BY *Stanley M. Udall*
ATTORNEY

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C. F. SCHORN

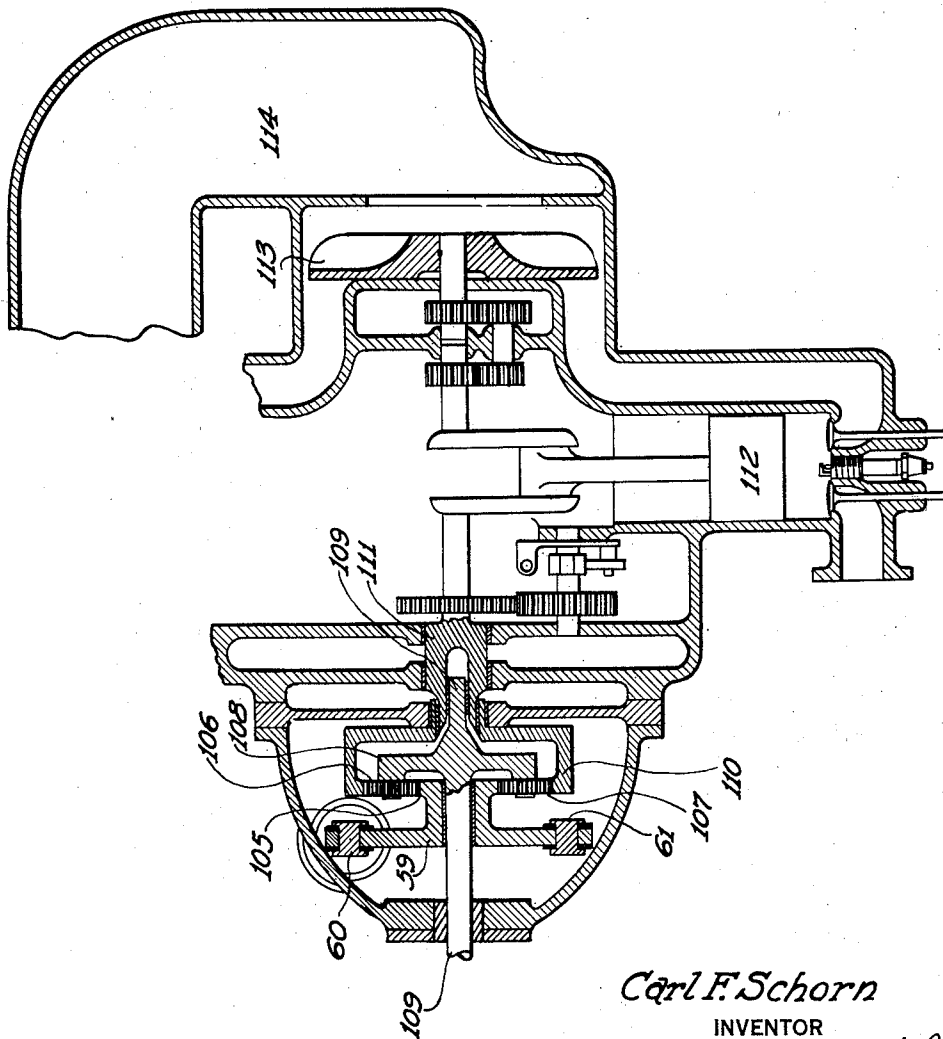
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Fig. 4



Carl F. Schorn
INVENTOR

BY *Stanley M. Udall*
ATTORNEY

UNITED STATES PATENT OFFICE

2,297,918

TORQUE CONTROLLED CARBURETOR

Carl F. Schorn, Detroit, Mich., assignor to George M. Holley and Earl Holley

Application April 26, 1941, Serial No. 390,520

5 Claims. (Cl. 123-119)

The object of this invention is to regulate the fuel supply by means of the torque and R. P. M. developed by an internal combustion engine of the type in which an explosive mixture is controlled by a throttle and in which the charge is ignited by a spark plug.

There is a well known relation between the product of torque and R. P. M. developed by such an engine and the amount of air taken in by the engine. Assume that on opening the throttle an extra charge of fuel is admitted by an accelerating pump, and that this extra charge of fuel is sufficient to accelerate from the idle speed when the throttle is opened. Then assume that the engine is running at any given throttle position with any given air flow. There is a definite torque developed which will vary directly with the amount of air at any given R. P. M., and only to a relatively minor extent with the amount of fuel, assuming that the fuel/air ratio is within certain fairly wide mixture ratio limits.

It follows, therefore, that the product of torque and R. P. M. can be utilized to regulate the supply of fuel so that before the last of the accelerating charge has been dissipated, an R. P. M. torque regulated fuel device can provide fuel to be available to maintain the engine at the R. P. M. and at the torque developed at the termination of the acceleration period.

It follows, therefore, when the throttle is opened and moved slightly, or if a plane ascends from the dense air of sea level to the normal air of normal altitudes, the R. P. M. and torque will vary, and as the product of R. P. M. and torque rises and falls, then the supply of fuel will rise and fall in proportion to this product, and as there is a direct relation between these two, a relatively simple mechanism can be devised in which an increase in the product of R. P. M. and torque provides the necessary increase in fuel.

In the drawings:

Fig. 1 shows diagrammatically the application of this invention to a fuel metering system incorporating the usual fuel accelerating means.

Fig. 2 shows an alternative construction.

Fig. 3 shows a detail of the fuel control.

Fig. 4 shows diagrammatically the detail of the torque responsive device.

The accelerating means is described first. 50 is the air entrance; 51 is the fuel passage leading from a fuel chamber 26, which, as will shortly be described, is maintained at atmospheric pressure. The fuel passage 51 discharges into the 55

accelerating chamber 52, the entrance to which is controlled by the spring loaded non-return valve 53. A diaphragm 83 supported by the tension spring 82 and responsive to the suction on the engine side of the throttle 55 is the operating force for an accelerating pump. The fuel discharges past the non-return valve 54 into the air entrance 50 immediately above the throttle valve 55 controlled by the throttle lever 56. Into the mixture entrance 57 leading to the supercharger of the engine discharges the tube 58 which conveys the fuel controlled by the engine torque and by the engine R. P. M.

The torque arm 59 of the engine conveys torque through the connecting rods 60 and 61 to the pistons 62 and 63, which reciprocate in cylinders 64 and 65 and are supplied with high pressure oil through a tube 66 which supplies high pressure oil to the cylinder 64 past the valve 67. A pipe 68 connects the two cylinders 64 and 65 together, and this pipe 68 communicates through the opening 47 with the torque pressure chamber 46.

The supply of high pressure oil for the speed responsive device is obtained by means of the pump 69 which obtains its supply of oil from the oil entrance 70. This oil is delivered through the outlet 71 and through the entrance 17 to the torque regulated device. A restricted by-pass 72 delivers the oil to a chamber 73 at atmospheric pressure, whence it returns through the by-pass 74 to the oil entrance 70. 75 is an oil passage connecting the chamber 73 with the passage 37. A thermostat 76 controls the heating coil 77 and corrects the error introduced by variations in the viscosity of the oil due to temperature. A source of electricity 78 controlled by the thermostat 76 supplies the heating means to the heating coil 77. The pump 69 generates oil pressure in the pipe 71 corresponding to the square of the R. P. M. of the engine. Hence a variation in viscosity would cause a variation in the operation of the engine. If the heating coil fails, the mixture becomes rich as the pressure generated by a given R. P. M. will show a much greater pressure than will be justified by the R. P. M. if the oil is cold. It is better that the mixture should become rich rather than become too lean.

Fuel enters at 10 and flows through a fuel venturi 11 to a diaphragm chamber 12 where the fuel pressure reacts against the diaphragm 13 which it moves to the left, rotating the bell crank lever 14 counter-clockwise and raising the valve 15 to shut off the fuel. The pressure of the fuel entering at 10 is high enough to exceed

the highest pressure due to the pump 69 transmitted to the diaphragm chamber 16. The highest pressure in this chamber 16 equals the pressure of the oil which varies with the revolutions of the engine squared. The oil flowing from this pump flows through the passage 18 in the valve 19 through the opening 20 to the chamber 16 and balances the pressure of the gasoline admitted past the valve 15.

The valve 19 contains a small by-pass 79 and a larger by-pass 80. The larger by-pass 80 is introduced into the oil circuit when cruising lean. The oil flowing up through the by-pass 80 flows through passage 75 to the reservoir chamber 73. The small opening 79 is open during the rich mixture operation. Hence when the valve is moved, counter-clockwise, an enrichment of the mixture occurs before opening the by-pass 80 which causes the mixture to become leaner. The size of the opening 79 provides a convenient means for adjusting the rich mixture ratio. The cruising lean mixture ratio is adjusted by the size of the opening 80.

In order to seat the valve 15 when the engine is not running, a light spring 21 engages at the bottom of the valve 15. The fuel flows out of the chamber 12 past the valve 22 which has a special contour and is carried by the smaller diaphragm 23 mounted on the wall 24, the seat of the valve 22 being in the wall 25. The chamber 26 between the walls 24 and 25 communicates with the passage 27 which communicates with the chambers 28 and 29 and with the passage 30. The fuel flowing through the passage 27 discharges into the fuel inlet passage 58 of the carburetor through the passage 31 past the valve 32, which valve 32 is connected to the bell crank lever 33 which in its turn, is connected to the diaphragm 34 which forms the left hand wall of the chamber 35 which is connected through the passages 36 and 37 with the oil maintained at atmospheric pressure in the reservoir 73.

The passage 30 admits the extra fuel needed to deliver maximum power and also to prevent the engine burning up. This fuel that flows through the passage 30 is admitted past the valve 38 and allows fuel to flow out of the chamber 39 which derives its fuel from the passage 40 which communicates with the fuel entrance 10. The chamber 41 communicates through the pipe 42 to the throat of the fuel venturi 11. The diaphragm 43 connected through the rod 44 with the valve 38 separates the two chambers 39 and 41. An adjustable spring 45 determines the critical flow through the venturi 11 at which the valve 38 opens and admits the extra fuel to prevent the engine burning up. This is covered by Chandler Patent 2,125,886.

The novel feature of the invention resides more particularly and is associated with the chamber 46 which derives oil pressure through a passage 47 from a torque meter, which torque meter is big enough so that it will deliver oil at a pressure corresponding to the torque of the engine. The diaphragm 48 separates the two chambers 46 and 28 and as the chamber 28 is at atmospheric pressure, the diaphragm responds to torque pressure. Therefore, as the torque goes up, the valve 22 opens and admits more fuel to the passage 27. On the other hand, this fuel which is admitted in proportion as the torque increases acts in the chamber 29 on the left hand side of the diaphragm 34, rotating the bell crank lever 33 clockwise, releasing fuel to the fuel outlet 31, past the valve 32. A light spring 87 is used to keep the

valve 32 on its seat when the engine is not running.

Assuming that the pressure in 17 varies with the revolutions of the engine squared, then the pressure in the chamber 14 varies with the revolutions of the engine squared. The degree of opening of the valve 22 varies directly with the torque and the contour of the valve is such as to give this result. The pressure of the fuel in the chamber 29 is constant at the pressure of the atmosphere acting on the open reservoir 73 disregarding the slight effect of the spring 87. Hence the flow past the seat of the valve 22 responds to revolutions per minute and to the torque as indicated by the pressure of the torque meter. Now, revolutions per minute times torque is directly proportional to brake horse power. Assuming the valve 22 opens to give an arithmetic increase with torque pressure, and as the oil pressure from the rotating pump will vary as the square of the rotation, and as the flow through an orifice varies as the square root of the pressure, it follows that the flow of fuel through the passage 27 is the product of R. P. M. times torque. Therefore, as the horse power varies, the pounds of fuel per brake horse power would stay constant. Changing the initial set of the torque valve will permit the specific consumption curve to be sloped instead of constant.

If the valve seat 22 is unseated when no fuel flows then the specific fuel consumption at low B. H. P. will be high and will rapidly fall as the throttle 55 is opened. As is well known, a high specific fuel consumption at idling speeds and just above idling speeds is desirable.

Changing the torque spring or the slope of the valve will raise or lower the specific fuel consumption curve. The valve 19 permits a selection of a mixture ratio differing from the ideal and also permits a complete shut off of the oil pressure from the pump which responds to the R. P. M.

In Figures 2 and 3, the movement of the controlling valve 22' and the valve 88 is from the right to the left, and not from left to right as in Figure 1. This reversal of movement of the control valve 22' results from the fact that in Figure 2 the torque pressure connection 47 is admitted to the chamber 28, so that the diaphragm 48 moves to the left instead of to the right, and the spring 85 is compressed instead of the spring 86. An opening 84 is shown in this valve which is shown in more detail in Figure 3, and it will be seen that when the engine idles, this opening 84 is the controlling orifice for the fuel, but when the valve 22 moves to the left, the orifice 84 ceases to be operative. In Figure 3, this valve is shown built up of three separate parts, two nuts 89 and 90 and a contoured valve 88 containing the low speed passage 84. Obviously, the location of the contoured valve 88, which corresponds to the valve 22' of Figure 2 and the valve 22 of Figure 1, can be adjusted along the rod 91. With the exception of the fact that the control valve 22' of Figure 2 moves to the left and the control valve 22 of Figure 1 moves to the right, there is no difference in the operation of the device shown in Figure 2 and the device shown in Figure 1. Therefore, it is unnecessary to describe Figure 1 further.

In the upper right hand corner of Figure 2, a dial 101 is shown with a needle 100 rotated by a little gear wheel 99 engaging with a rack 98. The rack 98 is moved by two diaphragms 94 and

97. The pressure in the chambers 93 and 96 reacts on the diaphragms 94 and 97. The chamber 96 is connected through the pipe 95 with the chamber 41. The chamber 41 is connected through the passage 42 with the throat of the venturi 11. The chamber 93 is connected through the pipe 92 with the entrance 10 leading to the venturi.

Now the flow of fuel through the venturi 11 is controlled so as to be proportional to the revolutions of the engine times the torque. Hence the dial 101 will read in horse power directly so that in addition to acting as a fuel control, this device will act as a horse power indicator.

In present practice, it is necessary to read the R. P. M. indicator and the torque indicator, and to use a slide rule to multiply the one by the other. It is not always convenient in a plane to read two instruments and to use the slide rule. Events happen so quickly in the air that it is desirable to be able to read instantly the actual horse power developed by an engine. Over thirty years' flying experience has taught the pilots not to permit the engine to develop more than its rated power and not even that except for a relatively short period of time, as an engine that will average 700 hours between overhauls when operating at about 70% horse power will quickly require attention when operated at 100% of its power for any considerable period of time.

Fig. 4 shows the well known torque device in general use on certain airplanes. The arm 59 of Fig. 1 is shown in a plane at right angles to the plane of Fig. 1. This arm is connected to the upper connecting rod 60 and to the lower connecting rod 61, and these two connecting rods are connected to the pistons shown in Fig. 1. The arm 59 is mounted on a sleeve and carries an external gear wheel 105. Engaging with this are small gears 106 and 107 mounted on a spider 108. This spider 108 is mounted on a small pilot shaft 109. The two small gear wheels 106 and 107 engage with an internal gear 110 which is driven by the crank shaft 111 of the engine. One of the pistons of the engine is shown at 112 and the supercharger is shown at 113 and the mixture entrance is shown at 114.

The shaft 109 is connected to the propeller of the engine. Therefore, as the crankshaft 111 revolves due to the pressure acting on the pistons 112, the internal gear 110 rotates and therefore as the spider 59 is stationary, the small pinions 106 and 107 are rotated and carry with them the spider 109, which delivers power to the propeller. The engine, therefore, travels at a faster rate than the propeller, which is a desirable feature and, of course, the torque developed by the en-

gine and absorbed by the propeller is resisted by the torque on the spider 59. The pressure in pipe 68 therefore varies with the torque developed by the engine and absorbed by the propeller. There is nothing in Fig. 4 which is not in general use, and Fig. 4 forms no part of my invention, but is merely added to illustrate the application of my invention to the engines now in general use.

What I claim is:

1. A pressure carburetor for an internal combustion engine, said carburetor having a source of fuel under pressure, an entrance to the carburetor for said fuel under pressure, a venturi therein, means responsive to the flow through said venturi for adding extra fuel at maximum power, a pump which generates pressure in proportion to the square of the R. P. M., a diaphragm responsive on one side to said variable pressure, means for admitting fuel to the other side of the diaphragm to balance the pressure of the pump, a fuel chamber associated with said diaphragm in which the fuel pressure is maintained at said variable pressure, a valve controlling the outlet from said chamber, and engine torque responsive means for opening said valve in proportion to the increase of torque.

2. A pressure carburetor for an internal combustion engine, said carburetor having a source of fuel under pressure, an entrance to the carburetor for said fuel under pressure, a pump which generates pressure in proportion to the square of the R. P. M., a diaphragm responsive on one side to said variable pressure, means for admitting fuel to the other side of the diaphragm to balance the pressure of the variable pump, a fuel chamber associated with said diaphragm in which the fuel pressure is maintained at said variable pressure, a valve controlling the outlet from said chamber, and engine torque responsive means for opening said valve in proportion to the increase of torque.

3. A device as set forth in claim 2 in which the said valve is contoured so that the area of the opening uncovered by the movement of the valve increases directly in proportion to the movement of said valve.

4. A device as set forth in claim 2 in which there is a slow speed opening in said valve located so as to become ineffective as the valve moves from the position it assumes during the idling of the engine.

5. A device as set forth in claim 2 in which the said valve is contoured so that the flow past said valve is proportional to the product of the R. P. M. and the torque.

CARL F. SCHORN.