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Schaefer et al.

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[54] **POWER TRAIN AND CONTROL SYSTEM**

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[73] Assignee: **General Motors Corporation**, Detroit, Mich.

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[52] **U.S. Cl.** **74/867**, 74/868

[51] **Int. Cl.** **B60k 21/02**

[58] **Field of Search** ..... 74/865, 867–886, 74/843, 645; 192/.048, .073; 60/19, 12; 123/139 T, 139 AT

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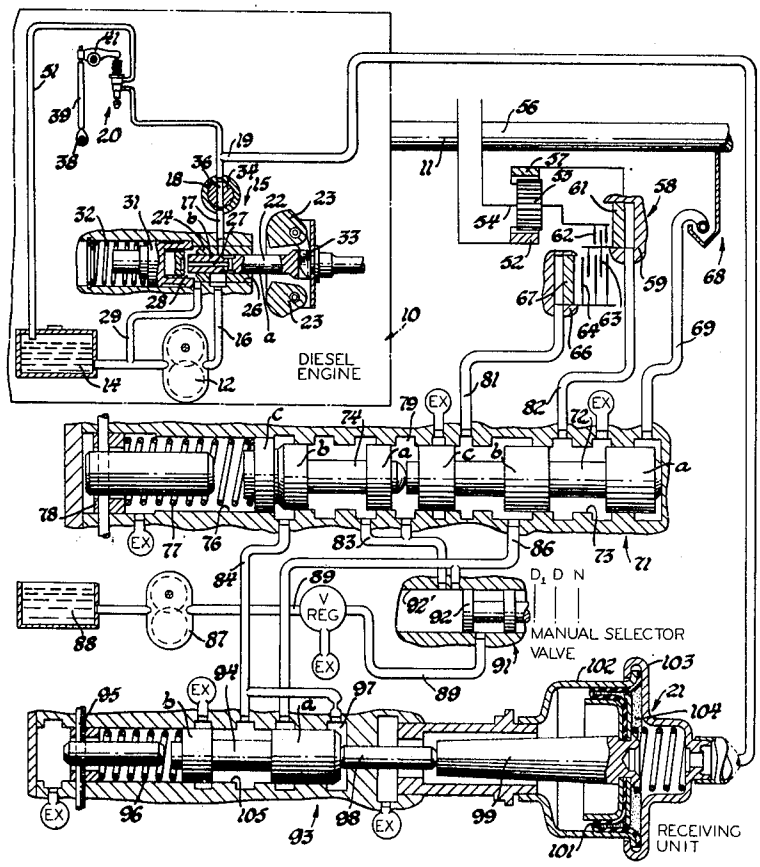
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[57] **ABSTRACT**

A fuel control system for use with a compression ignition engine driven transmission. Fuel pressure modified by a regulating valve responsive to an engine operating parameter is supplied to a diaphragm type motor mounted on the transmission. The output of the motor varies in response to the fuel feed position of the engine fuel control to provide a variable force torque demand signal which is imposed on the throttle valve which throttle valve supplies a control pressure in the transmission. Thus, the control pressure level of the throttle valve is controlled proportional to engine torque demand by the engine fuel control.

3 Claims, 4 Drawing Figures



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2 Sheets-Sheet 1

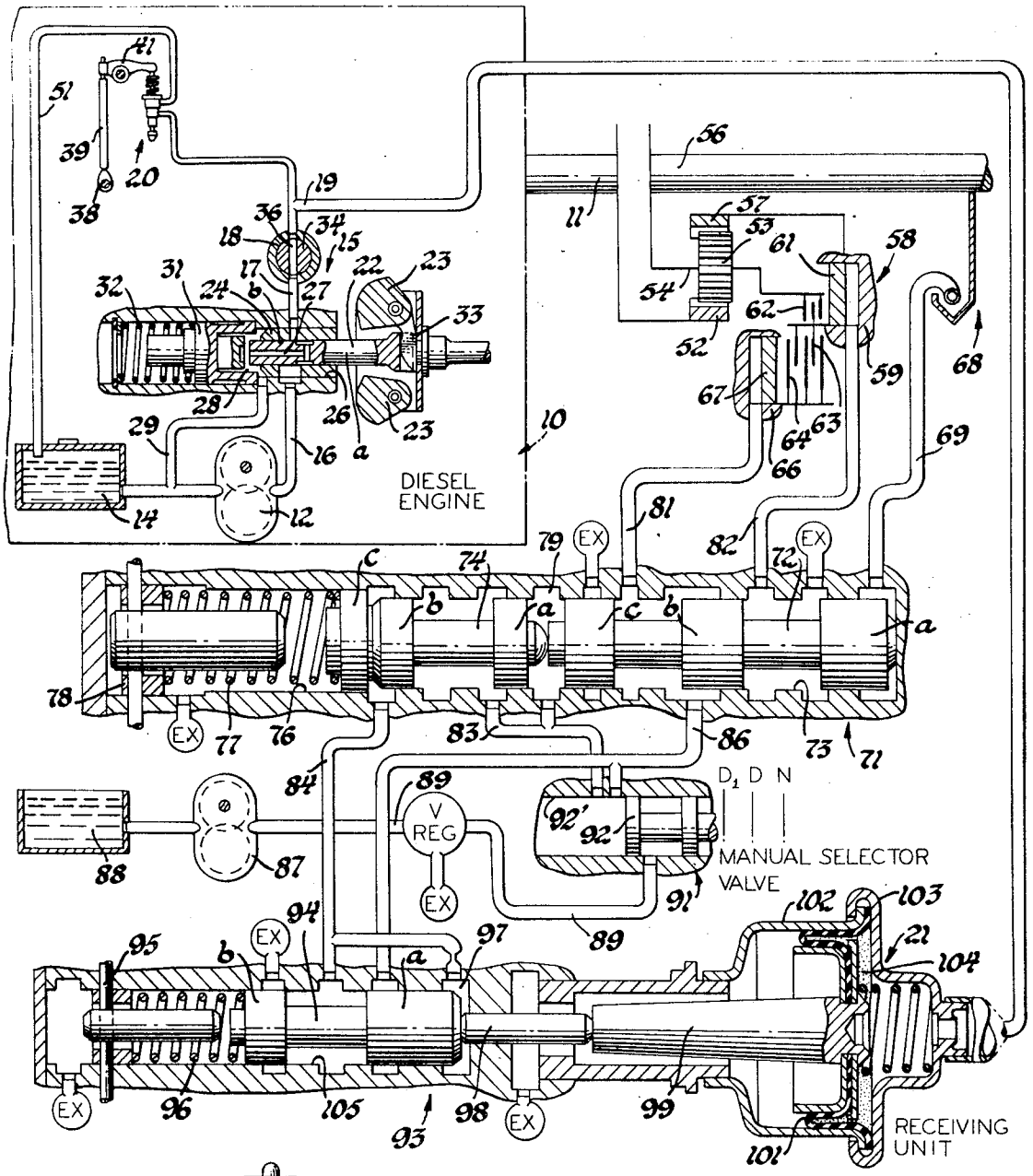


Fig. 1

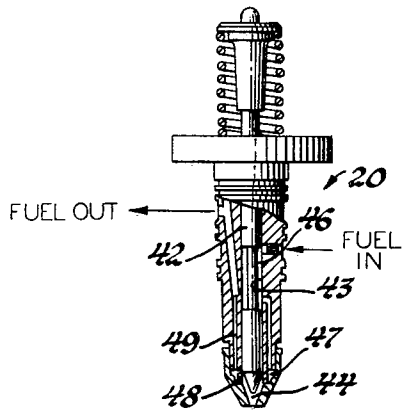


Fig. 2

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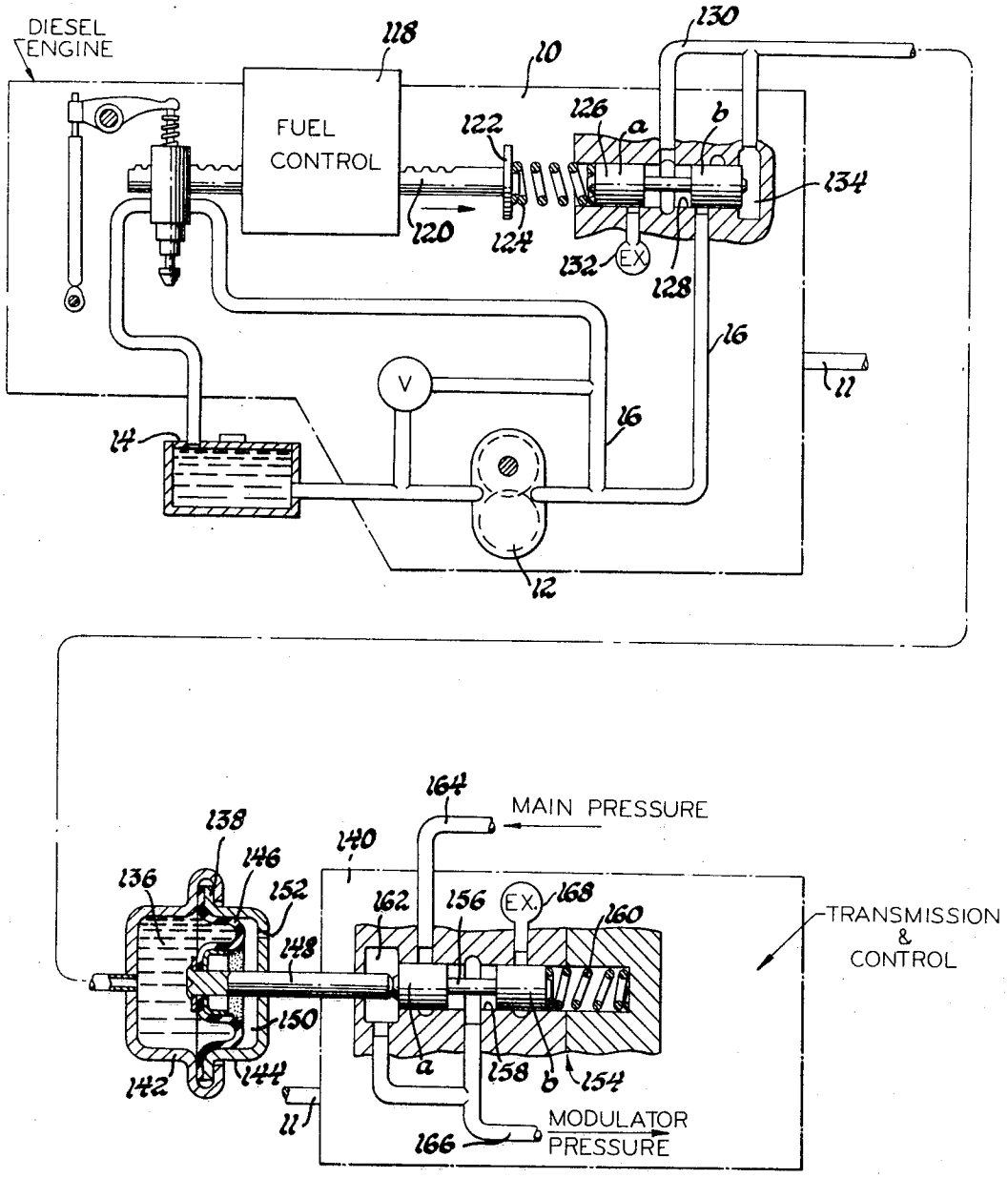


Fig.3

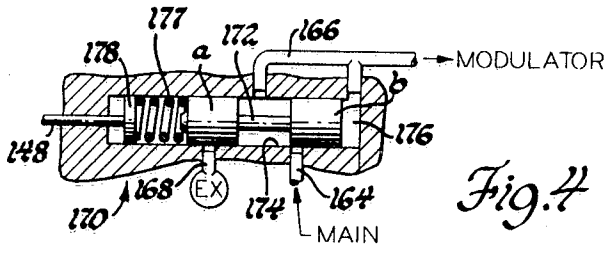


Fig.4

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POWER TRAIN AND CONTROL SYSTEM

This invention is related to engine drive transmission throttle valve controls and more particularly to throttle control pressure responsive valves which develop a hydraulic control signal generated by the engine fuel metering control.

When coupling an automatic transmission with a compression ignition or diesel engine it is necessary to provide a throttle position or torque demand signal to the transmission control. In spark ignition engines, manifold vacuum is used to provide a torque demand signal. However, diesel engines do not generate an inlet vacuum to provide the torque demand signal. The present invention utilizes the fluid pressure of the engine fuel system to provide a torque demand or throttle position signal at the modulator valve in the transmission. The fuel pressure supplied to the modulator valve is controlled by a pressure responsive valve which generates a pressure signal in response to the fuel metering control. This pressure responsive valve provides a control pressure which increases proportionately to throttle position or torque demand thus providing a control pressure proportional to engine throttle position or torque demand. The fluid pressure acts on a diaphragm type motor, the output of which provides a bias force, proportional to torque demand, for the modulator valve in the transmission. The bias force on the transmission modulator valve can be utilized to provide a modulator pressure in the transmission which varies either inversely proportional to the bias force or directly proportional to the bias force to provide the desired control function.

It is therefore an object of this invention to provide in a diesel engine and transmission combination, an improved torque demand control having a fuel pressure responsive valve mounted on the engine to provide a hydraulic bias pressure proportional to torque demand to a modulator valve mounted in the transmission.

It is another object of this invention to provide in a diesel engine and transmission combination an improved hydraulic throttle valve control having a pressure control valve responsive to the engine fuel metering system which valve generates a pres-sure control signal which is communicated with a diaphragm motor on the transmission to impose a bias force on a modulator valve in the transmission whereby the modulator valve generates a control signal or the transmission in response to the bias force.

These and other objects and advantages will be more apparent from the following description and drawings in which:

FIG. 1 is a diagrammatic representation of a throttle valve and control system;

FIG. 2 is an elevational view partly in section of a fuel injection;

FIG. 3 is a diagrammatic representation of another throttle valve and control system; and

FIG. 4 is a modification of the modulator valve shown in FIG. 1.

Referring to the drawings there is shown in FIG. 1 a conventional diesel engine 10 having an output shaft 11 and a fuel pump 12 driven by the output shaft 11 which pump 12 supplies fuel from a reservoir 14 to an engine driven governor generally designated 15 via a fuel feed passage 16. The fuel delivered to the engine governor 15 is directed by an output passage 17 through an engine throttle control valve 18 to another output passage 19 which is in fluid communication with the engine fuel injectors such as 20 and with a diaphragm motor 21 in the transmission. The engine governor 15 includes a spool valve 22 driven by the output shaft 11 and a pair of fly weights 23. The spool valve 22 has equal diameter spaced lands *a* and *b* slidably disposed in a sleeve 24 which is located in a valve body 26 and has a control passage 27 which is open to the fuel feed passage 16 between lands *a* and *b* and an exhaust chamber 28 adjacent the end of land *b*. The exhaust chamber 28 is in fluid communication via passage 29 with the reservoir 14. Also disposed in the valve bore 26 is a pressure control plug 31 which is urged toward the spool valve 22 by a compression spring 32 to close passage 27 from the exhaust chamber 28. When the diesel engine 10 is operating the fly weights 23 tend to rotate outwardly due to the centrifugal force and through a lever arm 33 move the valve spool 22 toward the control member 31 so that fluid pressure is developed in passages 17 and 27. When the pressure in passage 27 is sufficient to counterbalance the force imposed by the fly weights 23, the valve spool 22 will move away from the control plug 31 to permit the exhausting of excess fuel through passage 29. Thus, the pressure developed in output passage 17 is proportional to the square of engine speed.

The throttle valve 18 includes a rotary valve spool 34 having a passage 36 communicating fluid between output passages 17 and 19. As the valve spool 34 is rotated by the operator the passage 36 has more or less restriction depending upon the throttle setting desired by the operator. Thus, the engine throttle valve 18 will operate to provide a pressure decrease from the output passage 17 to the output passage 19 depending upon the throttle setting selected by the operator.

The fuel injector 20 is operated by the engine cam 38, a push rod 39 and a rocker arm 41. As the cam 38 is driven by the engine, the rocker arm operates a plunger 42 which injects fuel into the engine combustion chamber. As seen in FIG. 2, the plunger 42 is slidably disposed in a bore 43, the end of which is cone shaped to compliment the cone shaped end of the plunger 42. A space 44 between the valve bore 43 and the end of plunger 42 forms a fuel chamber. Fuel is supplied to the space 44 through a fuel inlet passage 46 to a feed chamber 47 and a restriction 48. The fuel chamber 47 is also connected to a restricted exhaust passage 49 which permits excess fuel to return to the reservoir 14 via passage 51. Fuel is metered into the space 44 through the restriction 48 at a rate depending upon the fuel feed pressure available in passage 19, as determined by the engine governor 15 and the throttle valve 18. Thus, the amount of fuel injected into the engine combustion chamber is determined by the pressure developed by the engine governor 15 as modified by the throttle valve 18. By varying the fuel feed pressure the engine torque demand may be varied thus providing a variable torque demand signal proportional to the fuel feed in passage 19.

The output shaft 11 is drivingly connected to a ring gear 52 which meshes with the planet pinoin 53 rotatably mounted on a planet carrier 54 which is drivingly connected to a transmission output shaft 56. The planet pinion 53 also meshes with a sun gear 57 which is drivingly connected to a clutch motor 58. The clutch motor 58 includes a clutch housing 59, a clutch piston 61 and a plurality of clutch plates 62 which are alternately drivingly connected with the carrier 54 and the clutch

housing 59 respectively. Also connected with the clutch housing 59 are a plurality of brake plates 63 which are alternately spaced with reaction plates 64 which are drivingly connected to the transmission housing 66. A brake piston 67 is slidably disposed in the transmission housing 66 and is fluid operated to force the brake plates 63 and reaction plates 66 into engagement to prevent rotation of the sun gear 57. When the rotation of the sun gear 57 is retarded, a speed reduction between the engine shaft 11 and the transmission shaft 56 is obtained. The clutch motor 58 is also fluid operated to cause the alternately spaced plates 62 to be engaged to provide a direct connect between the sun gear and the carrier 54. When the clutch motor 58 is pressurized, a direct drive or 1:1 ratio is obtained between the engine shaft 11 and the transmission shaft 56. A Pitot tube type governor generally designated 68 is operatively connected with the transmission shaft 56 so as to supply a transmission speed signal via governor passage 69 to a transmission shift control valve 71.

The transmission shift control valve 71 includes a valve spool 72 having equal diameter spaced lands *a*, *b* and *c* slidably disposed in valve bore 73, a torque demand valve 74 having equal diameter spaced lands *a* and *b* slidably disposed in valve bore 73 and a larger diameter land *c* slidably disposed in a spring chamber bore 76, a stop assembly 78, a compression spring 77 compressed between valve spool 74 and the stop assembly 78, and a hold chamber 79 formed by the ends of valve spools 72 and 74. The valve bore 73 is in fluid communication with a low apply passage 81, a high apply passage 82, a hold passage 83, a torque demand passage 84, the governor passage 69, a plurality of exhaust passages and a drive passage 86.

Fluid pressure for the transmission control is supplied by a conventional fluid mp 87 which draws fluid from a reservoir 88 and delivers the fluid through a main passage 89 to a manual selector valve 91. The manual selector valve has a vlave spool 92 slidably disposed in a valve bore 92' which is in fluid communication with he main passage 89, the drive passage 86 and the hold passage 83. The valve spool 92 is movable to a plurality of positions, D_1 and D, to provide fluid communication selectively between the main passage 89 and the drive passage 86 and between the main passage 89 and both the hold passage 83 and the drive passage 86. The manual selector valve 91 may also be placed in a neutral position N to exhaust the hold passage 83 and the drive passage 86 while blocking the main passage 89.

The torque demand passage 84 and the drive passage 86 are in fluid communication with a valve bore 105 of a torque demand valve generally designated 93. The torque demand valve 93 also has a valve spool 94 having equal diameter spaced lands *a* and *b* slidably disposed in the valve bore 105, a spring stop assembly 95, a compression spring 96 compressed between land *b* and the stop assembly 95 and a control chamber 97. When the manual selector valve supplies fluid pressure to the drive passage 86 the fluid pressure is directed between lands *a* and *b* to the torque demand passage 84. Pressure in the torque demand passage 84 is also communicated to the control chamber 97 adjacent one end of land a to move the valve spool 94 to the left to overcome spring 96 so that excess fluid pressure in the torque demand passage 84 is exhausted. Thus, the compression spring 96 imposes a substantially fixed bias on the valve 93. This bias is varied by the diaphragm motor 21 which generates a force proportional to engine torque demand and supplies the variable torque demand force to the valve spool 94 through a pin 98 and a motor rod 99. The motor rod 99 is secured to a diaphragm 101 which is sealed between a pair of housing shells 102 and 103 which cooperate to form the housing for the diaphgram motor 21. The diaphragm 101 cooperates with the housing portion 103 to form the fuel pressure chamber 104. Fuel pressure in passage 19 is supplied to the chamber 104 so that a force proportional to engine torque demand is generated in the diaphragm motor 21 and imposed upon the valve spool 94 through the rod 99 in the pin 98. The force imposed by the fluid diaphragm motor 21 is subtracted from the force supplied by the compression spring 96 so that as engine torque demand increases fluid pressure in torque demand passage 84 decreases. Transmission control systems utilizing this type of inversely proportional torque demand pressure signals is disclosed in United States Ser. No. 852,760, now abandoned, filed Aug. 25, 1969, Robert H. Schaefer and Joseph R. Fox.

When the manual selector valve 91 is in the D position fluid pressure is supplied between lands *b* and *c* of valve spool 72 to low apply passage 81 to apply the brake piston 67 thus establishing the low ratio in the transmission. As the speed of transmission shaft 56 increases, governor pressure increases to cause the valve spool 72 to shift thereby connecting high apply passage 82 to drive passage 86 while exhausting low apply passage 81. This establishes the high drive ratio in the transmission. The torque demand signal imposed on the differential area between lands *b* and *c* or valve spool 74 and the governor pressure and the end of valve spool 72 cooperate to determine the upshift point as disclosed in U.S. Ser. No. 852,760. When the valve 91 is in the D_1 position, main pressure is delivered to hold chamber 79 between valve spool 72 and 74 to hold the shift valve 71 in the downshift position shown to prevent or retard upshifting.

In FIG. 3 there is shown a conventional diesel engine 10 having an output shaft 11 and an engine driven fuel pump 12 which supplies fuel from a reservoir 14 to the fuel inspectors, not shown, via a fuel feed passage 16. The amount of fuel injected into the engine is controlled by a conventional fuel control 118, such as that disclosed in the U.S. Pat. to Frick et al., No. 3,014,475. The fuel control 118 includes a rack gear 120 movable by a vehicle throttle pedal, not shown. The rack gear 120 has a shoulder portion 122 abutting one end of the spring 124, the opposite end of which abuts a valve spool 126 having equal diameter spaced lands *a* and *b* slidably disposed in a valve bore 128. The valve bore 128 is in fluid communication with the fuel feed passage 16, a bias pressure passage 130 and an exhaust passage 132. The exhaust passage 132 is communicated with the fuel reservoir 14 to permit excess fuel to be returned to the reservoir. The bias pressure passage 130 is connected to the bore 128 between the lands *a* and *b* to a bias chamber 134 at one end of the bore 128.

In operation the bias spring 124 urges the valve spool 126 to the ring in valve bore 128 to permit fluid communication between passage 16 and passage 130 while the exhaust passage 132 is blocked by land *a*. As fluid pressure develops in passage 130, this pressure is communicated to chamber 134 which impose a force on the right end valve of land *b* to oppose the force in spring

124. When the fluid pressure in chamber 134 develops sufficiently to overcome the force in spring 124 the valve spool 126 will move to the left thereby permitting land *b* to block passage 16 so that a further increase in fluid pressure in passage 130 cannot be obtained. If the fluid pressure in chamber 134 is greater than the bias force in spring 124, the valve spool 126 will continue to move to the left permitting valve land a to open exhaust passage 132 to passage 130 to exhaust the excess fluid pressure. As the throttle position is increased the bias force in spring 124 will be increased thereby providing an increase in the fluid pressure in passage 130 and chamber 134. Thus, it is seen the pressure in passage 130 is directly proportional to the metering position of the fuel rack 118 which is proportional to torque demand.

The passage 130 is in fluid communication with a chamber 136 of a diaphragm motor 138 mounted on a transmission and control 140. The diaphragm motor 138 also includes a pair of outer shell portions 142 and 144, a diaphragm 146 secured between the outer shell portions 142 and 144 and a rod member 148 secured to the center of the diaphragm 146. The diaphragm 146 cooperates with shell portion 142 to form the chamber 136 and with the shell portion 144 to form a chamber 150 which is exhausted via a passage 152. The transmission gearing, not shown, may be similar in design to that shown in U. S. Ser. No. 852,760 to Robert H Schaefer and Joseph R. Fox filed Aug. 25, 1969 assigned to the assignee of this application and has an output shaft, not shown, driven by output shaft 11 of the diesel engine 10. The transmission 140 also has a control system, not shown, similar to that shown in U. S. Ser. No. 852,760.

The control system includes a modulator valve 154 having a valve spool 156 with equal diameter spaced lands *a* and *b* slidably disposed in a valve bore 158, a bias spring 160 adjacent land *b* and one end of valve bore 158 and a modulator pressure control chamber 162 adjacent the end of land *a* of valve spool 156. The rod portion 148 of diaphragm motor 138 extends into the chamber 162 and abuts the end of land *a* so that the fuel pressure force or torque demand force in chamber 136 is transmitted to the valve spool 156. The transmission 140 has a conventional fluid pump, not shown, which supplies pressure to the control system and via main pressure passage 164 to the valve bore 158. Also in fluid communication with the valve bore 158 is a modulator pressure passage 166 and an exhaust passage 168. The modulator pressure passage 166 is shown in fluid communication with the modulator pressure chamber 162.

In operation the valve spool 156 is urged to the left by the spring 160 to provide fluid communication between main pressure passage 164 and the modulator pressure passage 166. Fluid pressure will develop in the modulator passage 166 until the fluid pressure in chamber 162 and the force imposed by the fuel pressure in chamber 136 on the rod 148 are sufficient to overcome the force in spring 160 thereby moving the valve spool 156 to the right to permit valve land *a* to block passage 164. If the summation of the fluid pressure in chamber 162 and the force on rod 148 are sufficiently high, the valve spool 156 will continue to move to the right until exhaust passage 168 is opened by land *b* to permit the exhausting of excess fluid pressure in passage 166. It is apparent from the foregoing description that as torque demand or fuel pressure in chamber 136 increases the modulator pressure in passage 166 and chamber 162 will decrease thus providing a modulator pressure for the transmission which is inversely proportional to the torque demand of the engine. The modulator pressure in passage 166 is supplied to the various control valves of the transmission such as shift control valves.

In FIG. 4, there is shown a modulator valve, generally designated 170, having a valve spool 172 with equal diameter spaced lands *a* and *b* slidably disposed in a valve bore 174, a modulator chamber 176 adjacent the end of land *b* and a bias spring 177 compressed between the end of land *a* and a plug 178 which abuts the rod 148. Fluid pressure is supplied to the valve bore 174 by the main pressure passage 164 and is communicated between lands *a* and *b* with the modulator passage 166 when the spring 176 moves the valve spool 172 to the right. Passage 166 is also in fluid communication with the chamber 176 such that when fluid pressure in passage 166 is sufficiently high to overcome the torque demand force in spring 176 imposed by the diaphragm motor 138, the valve spool 172 will be moved to the left so that land *b* will block main passage 164. If the modulator force imposed on the valve spool 172 by the pressure in chamber 176 is higher than the torque demand force imposed on the valve spool 172 by the spring 177, the valve spool 172 will move to the left so that land a will open the exhaust passage 168 thereby exhausting excess fluid pressure in the modulator passage 166.

From the foregoing description it is obvious that the modulator pressure in passage 166 is directly proportional to the torque demand force imposed on the modulator valve 170 by the diaphragm motor 38 through the rod 148.

Many modifications and variations are possible in light of the above teachings. It is, therefore, to be understood that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described.

What is claimed is:

1. In combination a compression ignition engine and a transmission comprising a fuel feed system having a fuel pump for supplying fuel under pressure, and fuel rack means for metering the fuel supply to the engine; pressure control valve means in fluid communication with said fuel pump and being operatively connected with said fuel rack means for generating a pressure control signal proportional to the metering position of said fuel rack means; a source of fluid pressure in said transmission; and modulator valve means including a valve element in fluid communication with said source; and diaphragm motor means in fluid communication with said pressure control valve means to impose a bias force on said valve element, said valve element emitting a control signal to said transmission in response to the bias force.

2. In combination a compression ignition engine and a transmission comprising a fuel feed system having a fuel pump for supplying fuel under pressure, and fuel rack means for metering the fuel supply to the engine; pressure control valve means in fluid communication with said fuel pump and being operatively connected with said fuel rack means for generating a hydraulic pressure torque demand signal proportional to the metering position of said fuel rack means; a source of hydraulic pressure in said transmission; and modulator valve means including a valve element in fluid commu-

nication with said source; a control chamber adjacent one end of said valve element, a bias spring adjacent the other end of said valve element, and a modulator passage in fluid communication with said valve element and said control chamber; and diaphragm motor means having a diaphragm in fluid communication with said pressure control valve means and rod means secured to the diaphragm and abutting the one end, said valve element to impose a torque demand bias force on said valve element, said valve element emitting a torque demand control signal to said transmission in said modulator passage inversely proportional to the torque demand bias force.

3. In combination a compression ignition engine and a transmission comprising a fuel feed system having a fuel pump for supplying fuel under pressure, and fuel rack means for metering the fuel supply to the engine; pressure control valve means in fluid communication with said fuel pump and being operatively connected with said fuel rack means for generating a hydraulic pressure torque demand signal proportional to the metering position of said fuel rack means; a source of hydraulic pressure in said transmission; and modulator valve means including a valve element in fluid communication with said source; a control chamber adjacent one end of said valve element, a bias spring adjacent the other end of said valve element, and a modulator passage in fluid communication with said valve element and said control chamber; and diaphragm motor means having a diaphragm in fluid communication with said pressure control valve means and rod means secured to the diaphragm and abutting one end of said bias spring to impose a torque demand bias force on said valve element, said valve element emitting a torque demend control signal to said transmission in said modulator passage directly proportional to the torque demand bias force.

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