United States Patent [19]

Vulliamy

[11] **3,727,486**

[45] **Apr. 17, 1973**

[54] **ENGINE HAVING IMPROVED PERFORMANCE CHARACTERISTICS**

[75] Inventor: **Nicholas Martin Felix Vulliamy,** Peterborough, England

[73] Assignee: **Perkins Engines Limited,** London, England

[22] Filed: **Feb. 11, 1971**

[21] Appl. No.: **114,652**

[30] **Foreign Application Priority Data**

Feb. 13, 1970 Great Britain........................7,011/70

[52] **U.S. Cl.**...**74/860**

[51] **Int. Cl.** **B60k 21/00**

[58] **Field of Search**..74/860

[56] **References Cited**

UNITED STATES PATENTS

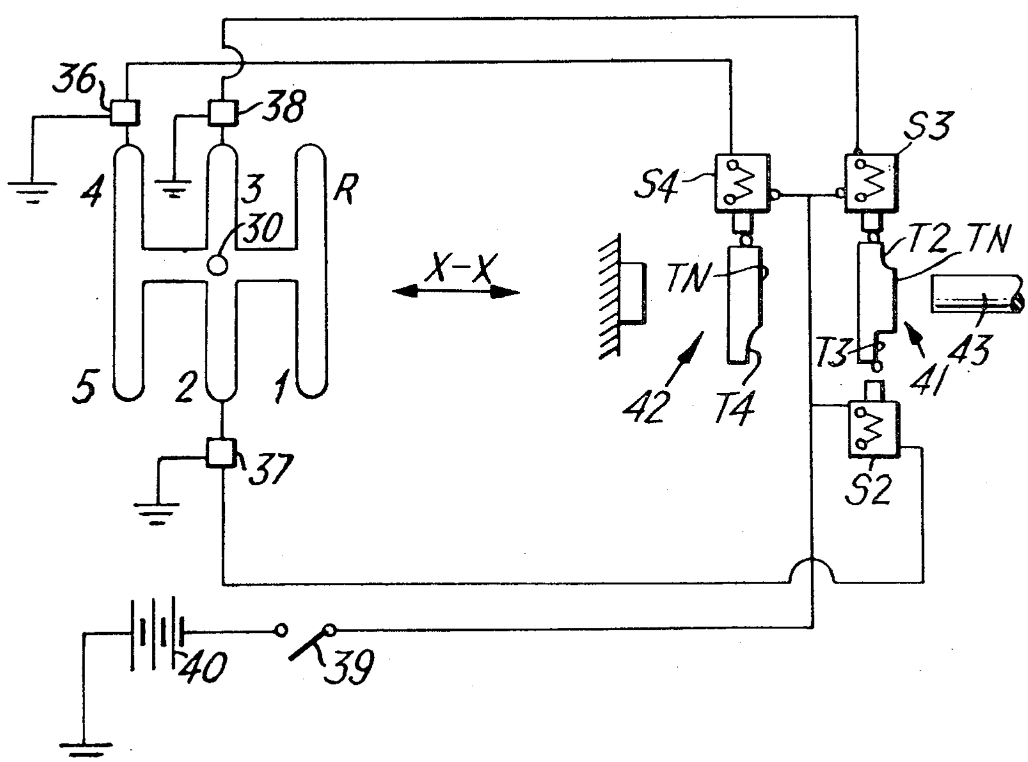
3,487,634	1/1970	Mag et al	60/13
2,909,078	10/1959	Nallinger	74/860
2,355,759	8/1944	Stokes	123/119 CB UX
3,448,640	6/1969	Nelson	74/866
2,719,437	10/1955	Nallinger	74/860

Primary Examiner—Arthur T. McKeon
Attorney—Gerhardt, Greenlee & Farris

[57] **ABSTRACT**

A pressure charged engine and gearbox assembly providing a number of drive ratios and including means which, on selection of certain of the gears below the top gear, conditions the fuelling apparatus of the engine to provide more fuel at the same engine speed than it does in top gear. The presence of pressure charged air enables the fuel to be burnt efficiently and extra power is made available by virtue of the higher brake means effective pressure so produced.

10 Claims, 6 Drawing Figures



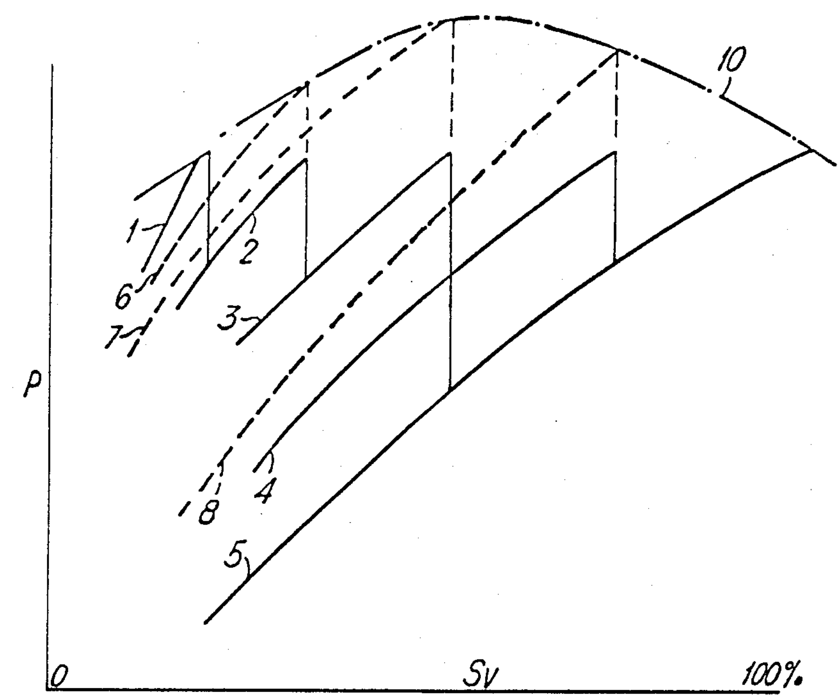


Fig. 1.

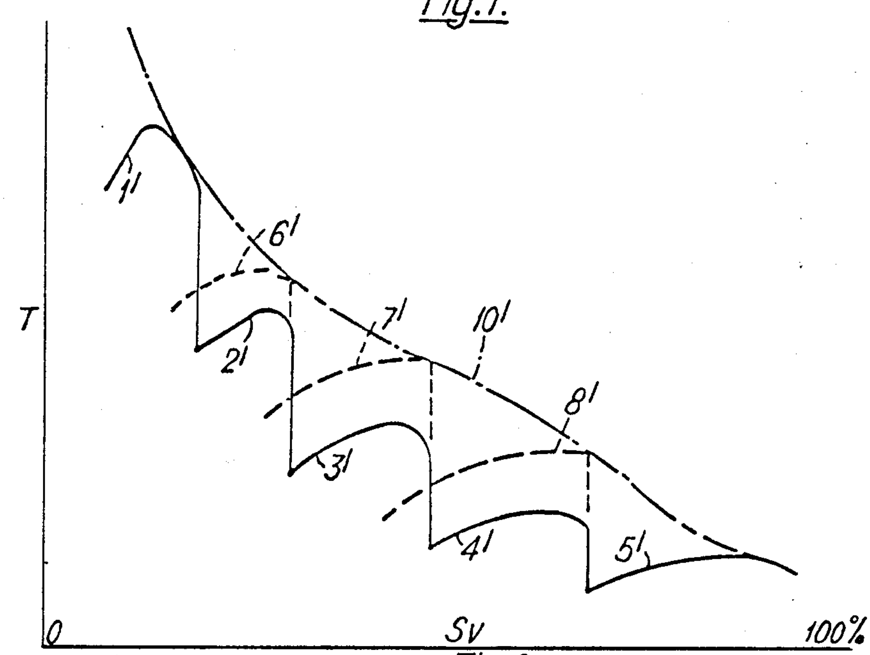


Fig. 2.

INVENTOR.
N. MARTIN F. VULLIAMY
BY
Gerhardt, Greenlee & Farris
ATTORNEYS.

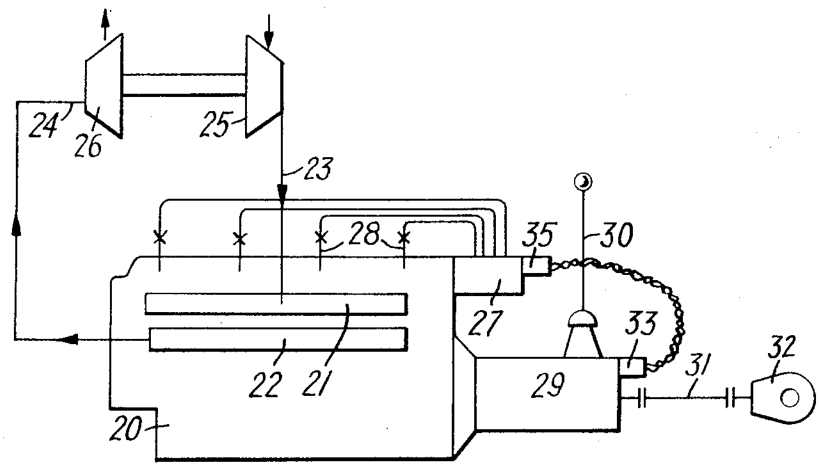


Fig.3.

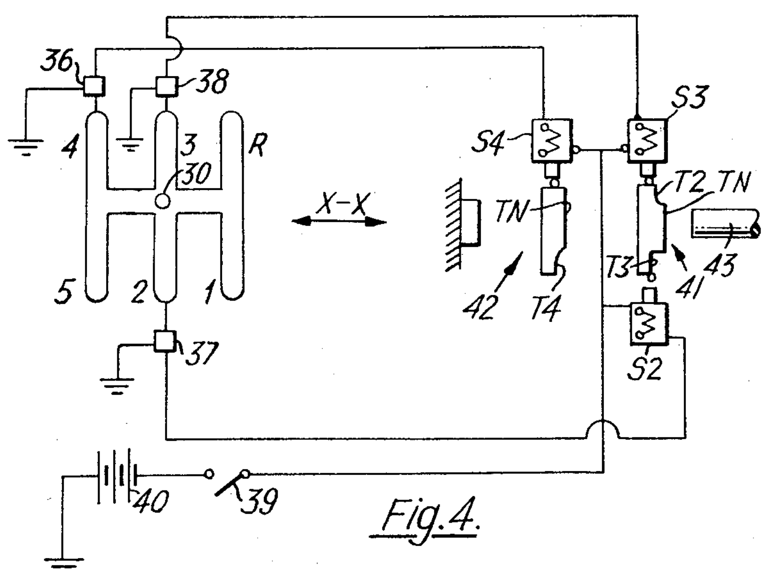


Fig.4.

INVENTOR.
N. MARTIN F. VULLIAMY
BY
Gerhardt, Greenlee & Farris
ATTORNEYS.

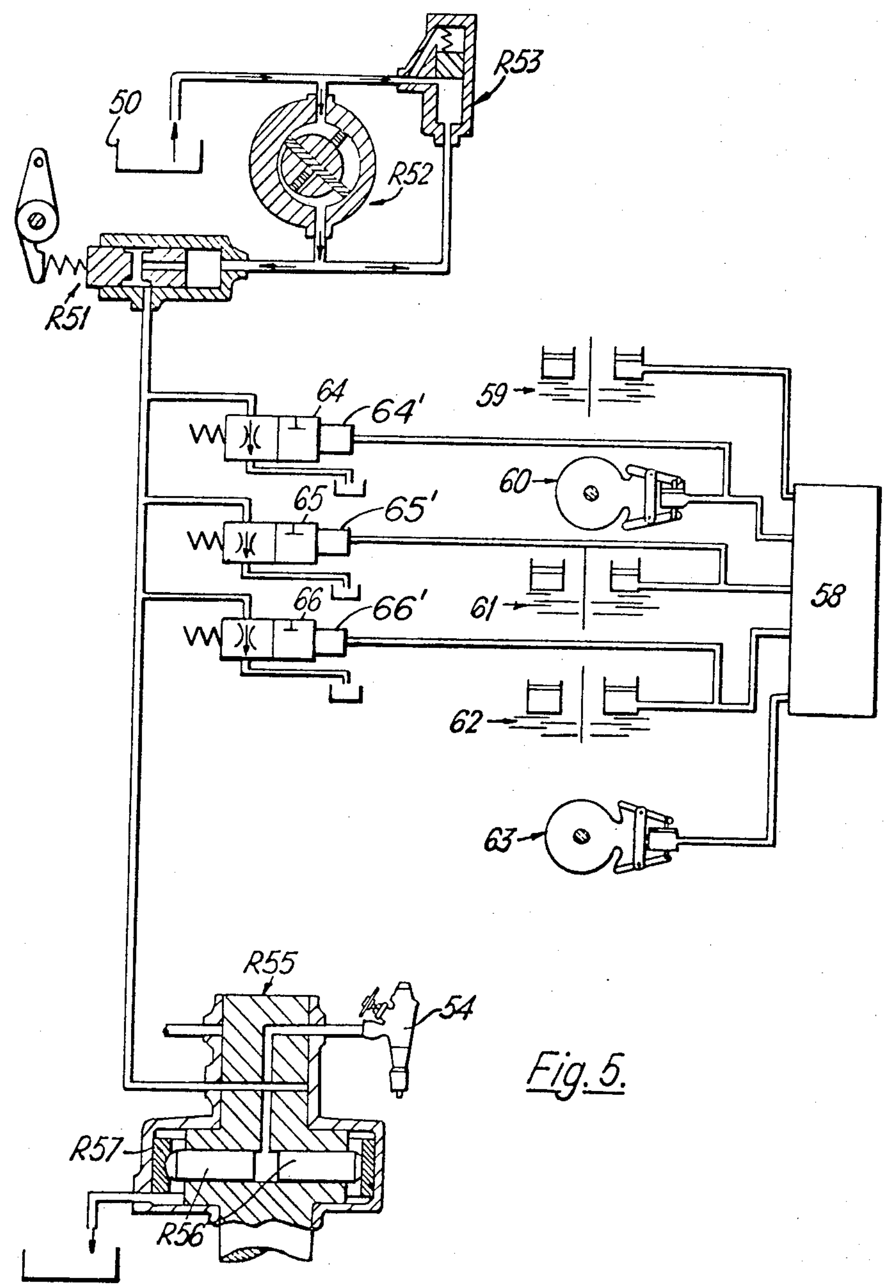


Fig. 5.

INVENTOR.
N. MARTIN F. VULLIAMY
BY
Gerhardt, Greenlee & Farris
ATTORNEYS.

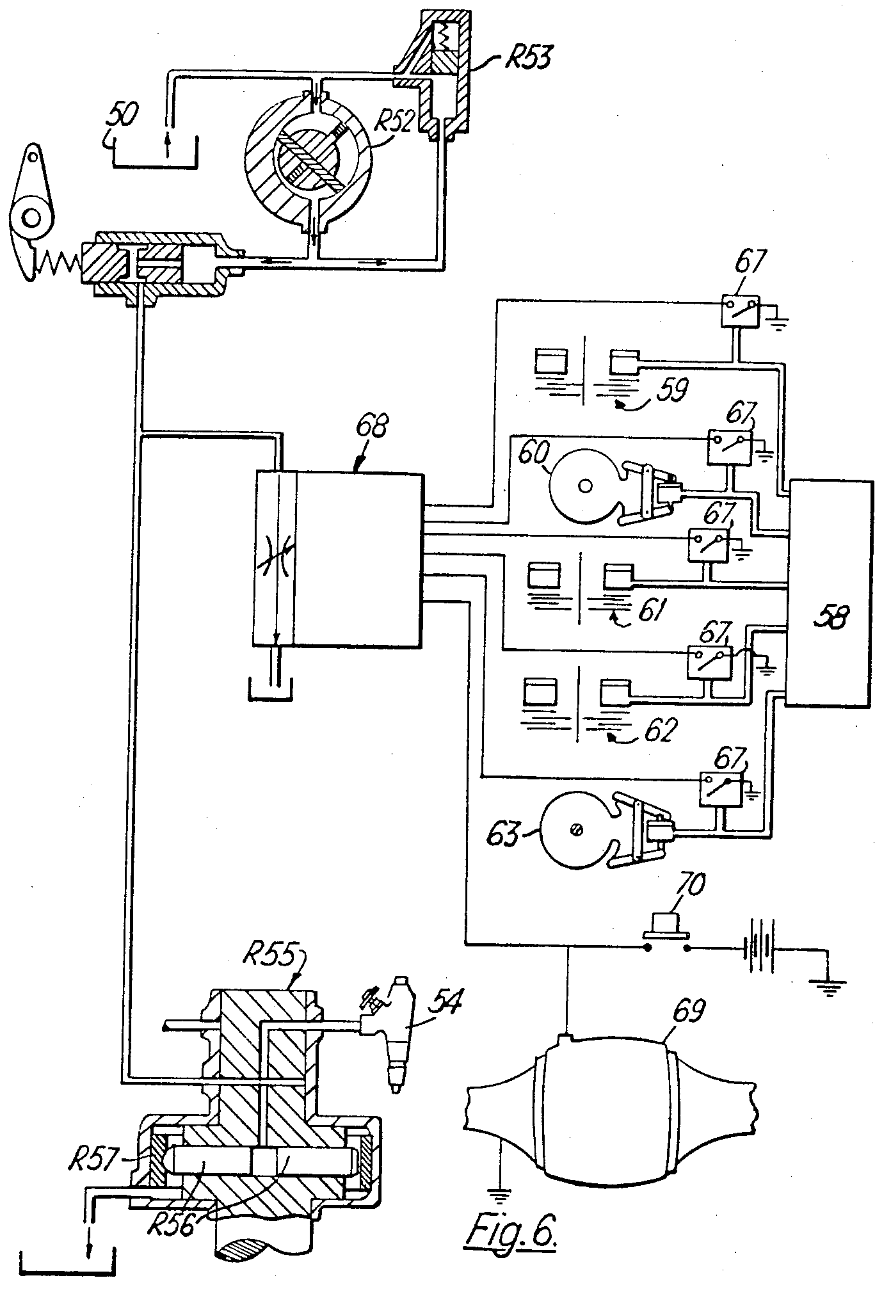


Fig. 6.

INVENTOR.
N. MARTIN F. VULLIAMY
BY
Gerhardt, Greenlee & Farris
ATTORNEYS.

ENGINE HAVING IMPROVED PERFORMANCE CHARACTERISTICS

This invention relates to a motor vehicle, wherein the power unit and transmission includes an internal combustion engine and change-speed gears.

A conventional internal combustion engine installed in a motor vehicle and loaded through change-speed gears develops an approximation to a constant maximum power curve when engine power and vehicle speed are plotted on a graph. In general, the larger the number of gears the closer is the approximation to constant power developed by the engine. It has been proposed in heavy vehicles to use at least ten gear ratios and sometimes as many as fifteen gear ratios.

If the maximum power curve is arranged to be such that good hill-climbing ability is achieved on the average hill found on Intercity routes then use of the vehicle on freeway type routes may result in uneconomic operation.

An object of the present invention is to provide a vehicle with good hill-climbing ability and improved characteristics in respect of economy of operation at higher speeds on level routes.

It will be appreciated that an internal combustion engine disposes of the energy given up by the burning fuel by mechanical means to the load or vehicle, by waste heat in the exhaust and by waste heat in the cooling medium and that a given power demand can be met by burning an excess of fuel which may lead to uneconomic fuel consumption.

According the present invention, there is provided a motor vehicle power unit and transmission, comprising an internal combustion engine having a variable delivery fuelling device, change-speed gears incorporating gear-ratio selecting mechanism, and fuelling control means associated with the fuelling device and the said selecting mechanism and operative in response to selection of an intermediate gear ratio so as to adjust the fuelling device to be capable of delivering a predetermined increased maximum quantity of fuel.

Further, according to the present invention, there is provided a motor vehicle incorporating a power unit and transmission aforesaid.

Embodiments of the present invention will now be described by way of example with reference to the accompanying drawings of which:

FIG. 1 represents engine power (P) curves on the basis of vehicle speed (SV) for different transmission ratios;

FIG. 2 represents engine torque (T) curves on the basis of vehicle speed (SV) for the transmission ratios in FIG. 1;

FIG. 3 shows in diagrammatic form, a motor vehicle power unit and transmission in accordance with the present invention;

FIG. 4 shows one form of fuelling control in accordance with the present invention;

FIG. 5 shows, in diagrammatic form, another form of fuelling control in accordance with the present invention; and

FIG. 6 shows a further form of fuelling control in accordance with the present invention, basically similar to that of FIG. 5, but incorporating modifications.

In FIG. 1, the full lines **1** to **5** represent the power curves of a supercharged compression ignition engine driving a vehicle equipped with a change-speed gear-

box having five forward ratios. The peaks of the curves **1** to **5** are substantially at the same power level, this indicating that the maximum engine power available throughout the vehicle speed range is substantially constant.

The broken lines **6** to **8** show the power curves to be derived from an engine and transmission according to the present invention. It will be seen that the peaks of curves **6, 7** and **8** are substantially above the level of the peaks of curves **2, 3** and **4**. The corresponding engine torque curves are marked **1'** to **5'** and **6'** to **8'** in FIG. 2. This is achieved by modifying engine fuelling according to which gear ratio is selected.

Thus at maximum road speed operation in the highest (fifth) ratio, fuelling is adjusted in a manner consistent with economical operation with the engine being thermally loaded well within its capability leading to low stress levels in the engine and good wear conditions.

When gear ratio four is chosen to negotiate a hill or part of a hill, engine fuelling is adjusted to give increased maximum power and torque at the expense of greater heat rejection and as a result of increased cylinder pressure. Successively, gear ratio three gives a higher maximum power still so that at about half the vehicle top speed the engine is made to deliver very much more power than at top speed. This manifests itself as a "power bulge" **10** and **10'** in graphs of FIG. 1 and FIG. 2. The engine will be very highly thermally loaded at this stage, but vehicle operation in intermediate ratios at full power would be effected for only a limited time so that the engine is capable of accepting this high thermal loading without sustaining damage. The presence of supercharge enables the extra fuel to be burnt efficiently and assists to a considerable extent in reducing the thermal loading below what it would be otherwise.

It will be understood that similar characteristics may be obtained for a naturally aspirated internal combustion engine by modifying engine fuelling control according to which gear ratio is selected though the engine may suffer more from thermal effects.

In FIG. 3, a diesel engine **20** has an inlet manifold **21** connected to the outlet **23** of a compressor **25** and an exhaust manifold **22** connected to the inlet **24** of an exhaust gas turbine **26**. The turbine **26** is coupled to and normally drives the compressor **25**.

A fuel pump **27**, driven by the engine, supplies metered fuel at high pressure to injectors **28** in known manner.

A change-speed gearbox **29** having five forward ratios and having a gear selector lever **30** drives through a drive shaft **31** to a rear axle **32**.

Fuelling control means consists of a sensor **33** on the gearbox **29** connected to an actuator unit **35** operable to vary the maximum output of the fuel pump.

In FIG. 4, the gear lever **30**, when it moves into gate slots **4, 3** and **2**, closes micro-switches **36, 37** and **38** suitably placed therein. A switch **39** connected between battery **40** and the solenoids serves simply as an isolating switch.

Solenoids S2 and S3 each operate when energized to pull a plate **41** a predetermined distance towards itself. Solenoid S4 operates to pull a similar plate **42** the same predetermined distance against a spring. Though shown in FIG. **4** as being upright, the plates **41** and **42** are mutually at right angles and the solenoids are placed accordingly. The plates **41** and **42** are in line with the fuelling control rod **43** of the fuel pump and are allowed a degree of movement in the direction X—X. A fixed abutment is provided behind the plates **41** and **42**. Both plates are spring loaded to the central position.

The plates have different thicknesses at T4, T3, T2 and TN.

When no solenoids are energized and the transmission is in neutral or either of the gears **1** and **5** the combined thickness of the plates **41** and **42** in line with the control **43** is TN + TN.

When ratio **4** is engaged the switch **36** is closed thus energizing solenoid S4 and pulling plate **42** so that T4 is opposite control **43**. Since T4 is thinner than TN the control **43** can move a predetermined amount further to permit more fuel to be delivered to the engine at maximum power.

When ratio **3** is in use switch **38** is closed and solenoid S3 is energized bringing T3 into line with the control rod **43**. T3 is even thinner than T4 and permits the fuel delivery to be such that the peak on power curve **7** in FIG. **2** is achieved. When T2 is brought into line with the control rod **43** by solenoid S2 which is itself activated by selection of ratio **2** and closing of switch **37**, the fueling according to curve **6** in FIG. **1** is achieved.

If, for instance, starting from rest, the first gear ratio is used, no solenoids will be energized so that the power control **43** maximum stop will be limited to its minimum position i.e., to about the same as the fifth ratio position.

In FIG. **5**. parts of a rotary distributor-type fuel injection pump are indicated by the prefix R. Fuel from a tank **50** is pumped through a variable metering valve **R51** by a transfer pump **R52**. Transfer pressure is regulated by means of a regulating valve **R53**. Metered fuel is fed to injectors, one of which is shown at **54**, by a rotary distributor **R55** incorporating opposed high-pressure plungers **R56** whose radial outer ends co-operate with an annular cam **R57** having as many lobes as there are engine cylinders. A five-forward-ratio transmission control unit **58** exercises hydraulic control of transmission clutches or brakes **59** to **63** for first to fifth forward gear ratios respectively. Fuelling control means consists of three two-position, pilot-operated, spring-returned valves **64**, **65** and **66** which are associated with intermediate gear ratios two, three and four respectively. The normally-open inlet port of each of valves **64** to **66** is connected to that conduit of the fuel injection pump containing fuel at metering pressure; the normally-open outlets are commonly drained to a sump or reservoir. Flow restrictors are incorporated or associated one in, or with, each of valves **64** to **66**. In order to obtain the characteristic of curve **10** in FIG. **1**, the restrictors of valves **64** and **66** would each be required to have a smaller orifice than that of the restrictor of valve **65**. According to which intermediate gear ratio is selected by control unit **58**, the maximum quantity of fuel metered to the distributor **R55** is increased over the maximum quantity metered in first and fifth ratios by a factor which is governed by the size of the flow restrictor which is, in effect, closed upon operation of any of the valves **64** to **66** by actuators such as pilots **64'** to **66'**, respectively.

In FIG. **6**, parts corresponding with those in FIG. **5** are given the reference numerals used in FIG. **5**. One aspect of the modifications in FIG. **6** is that sensing of ratio-selection is by means of pressure switches **67**. Each switch **67** is associated hydraulically with a different gear ratio, and electrically connected to an actuator, such as a variable orifice control, in a logic unit **68** adapted to select and bring into operation an escape-flow of fuel from the fuel metering conduit appropriate to the required predetermined performance characteristic. Another aspect of the modifications in FIG. **6** is the inclusion of a two-ratio rear axle or final drive which is indicated at **69**. "Low" or "High" final drive ratio is selected according to whether a manual switch **70** is open or closed. With the two-ratio final drive, ten forward ratios are effectively provided and therefore the logic unit **68**, for this aspect, is provided with electrical gating for giving effect to fuelling control, in accordance with predetermined characteristics, depending, for example, upon whether any of the five ratios selected by unit **58** constitutes an intermediate ratio. Therefore, the logic unit **68** is electrically associated with the switch **70** so that in fifth ratio selection, for example, fuelling control is effected only when the "low" final drive ratio is selected; the combination of "low" final drive with selection of fifth gear ratio constituting an intermediate gear ratio.

I claim:

1. A motor vehicle power unit and transmission, comprising an internal combustion engine, a variable delivery fuelling device, change-speed gears, a gear-ratio selecting mechanism, an intermediate portion of said selecting mechanism for selection of intermediate gear ratios only, and fuelling control means connected to said intermediate portion of said selecting mechanism and to said fuelling device to adjust the maximum deliverable quantity of fuel upward and allow greater quantities of fuel to said internal combustion engine for increased power when operating in an intermediate gear ratio over that when operating in either low or high gear ratios.

2. A power unit and transmission according to claim **1** wherein said engine is a compression ignition engine.

3. A power unit and transmission according to claim **1** wherein said change-speed gears and said selecting mechanism together constitute a multi-ratio automatic gear box.

4. A power unit and transmission according to claim **1** including a supercharger supplying additional air over that otherwise available to enable more complete combustion of the additional fuel supplied by virtue of said fuelling control means adjusting said fuelling device.

5. A power unit and transmission according to claim **4** wherein said supercharger includes an exhaust-driven turbine capable of receiving the exhaust of the additional fuel supplied as a result of the use of said fuelling control means.

6. A power unit and transmission according to claim **1** wherein said fuelling control means includes an actuator capable of adjusting the upper fuel flow limit of said fuelling device upward.

7. A power unit and transmission according to claim **6** wherein said fuelling control means further includes a sensor capable of sensing activation of said portion of said selecting mechanism upon selection of an inter-

mediate gear ratio, said sensor signalling said actuator to cause activation of said fuelling device.

8. A power unit and transmission according to claim **7** wherein said fuelling control means includes a fuel injection pump, at least one valve on said pump for fuel flow control, and said actuator is a pilot on said valve, said pilot capable of shifting said valve causing increased flow of fuel to said engine over that otherwise provided by said pump.

9. A power unit and transmission according to claim **7** wherein said fuelling control means includes a fuel injection pump, a control rod on said pump for metering flow to said engine, and said sensor and actuator are an electrical switch and a solenoid, respectively, said solenoid capable of removing a mechanical constraint on said control rod to permit increased fuel flow to said engine.

10. A power unit and transmission according to claim **7** wherein said fuelling control means includes a fuel injection pump, a logic control unit on said pump with a variable orifice for controlling fuel flow to said engine, and said sensor and actuator are a pressure switch and signal receiving variable orifice control within said logic unit, respectively, said orifice control capable of adjusting the orifice.

* * * * *