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(54) Title: DIESEL ENGINE GOVERNOR WITH ANTI-JUDDER DEVICE

(57) Abstract
In an electronic diesel engine governor having an anti-juddering device (20), at least one vehicle operating parameter, such as the gear position (gear ratio engaged or neutral, or engine load) is fed to a speed signal converter (13) which produces a speed-dependent signal (U\textsubscript{s}) in accordance with a characteristic selected by the vehicle operating parameter. The desired value signal (U\textsubscript{Fudd}) produced by an electronic control unit (12) in dependence on accelerator pedal position (\alpha) and engine speed (n) is modified by a transient signal (U\textsubscript{g}) produced from the speed-dependent signal (U\textsubscript{s}) by a transient-responsive signal generator (22). The resulting desired fuel quantity signal (U\textsubscript{desoll}) is fed to a servomotor (14) which adjusts the injected fuel quantity (U\textsubscript{inst}) of the diesel engine (15) accordingly.
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DESCRIPTION

DIESEL ENGINE GOVERNOR WITH ANTI-JUDDER DEVICE.

State of the Art.

The present invention relates to an electronic diesel engine governor of the kind described in the pre-characterising clause of claim 1.

Such a diesel engine governor is known (DE-A-3343854). Due to the resilient suspension of the engine on the vehicle body or chassis and due to the resilience of the vehicle transmission and tyres, the vehicle body or chassis, the engine, the transmission connected thereto and the vehicle wheels in contact with the roadway represent an oscillatory system in which oscillations can be set up in the event of a disturbance, such as a sudden change in the injected fuel quantity (sudden depression or release of the accelerator pedal) or the encounter of a pothole in the road surface. The resulting oscillations, which are manifested as fluctuations in the rotary speed of the engine and relative rotary oscillatory movement between the engine and the vehicle body or chassis, are usually of a frequency between 1Hz and 8Hz and are experienced as a shuddering or jerking of the vehicle. The above-mentioned known governor contains an anti-juddering or jolt-damping device in which the jolt-damping or judder-suppressing signal generator produces a signal in response to a rapid change in engine speed and this signal is used as a negative feedback signal to modify the signal from the control unit and thereby prevent too rapid a change in the injected fuel quantity. However, it has become apparent that various different degrees of suppression of the juddering are desirable for different operating states of the vehicle, e.g., driving in various different gears, engine braking (accelerator pedal released) or idling in neutral.
Advantages of the Invention.

The above object is achieved by a diesel engine governor in accordance with the characterising part of claim 1. The amplification or modulation of the speed signal by means of the speed signal converter can then be adapted or matched to the gear, if any, which is engaged at any given time and a corresponding characteristic curve can be obtained.

At low engine speeds, each pulse in the digital computer (i.e. the electronic governor), insofar as the speed signal converter is not an analog converter) is to be processed immediately by an interrupt. When using the engine as a brake, the juddering should be damped shortly after the accelerator pedal is released. By adopting the measures of claim 3, the amplification or modulation by the speed signal converter can be matched to the load on the engine or to the injected fuel quantity.

The use of a command signal generator in the anti-juddering device can be disadvantageous in certain operating states. This disadvantage is avoided by the adoption of the features of claim 5 or 6.

Drawings.

The invention is further described, by way of example, with reference to the accompanying drawings, in which:-

Fig.1 is a block diagram of an electronic diesel engine governor having an anti-juddering device in accordance with the invention; Fig.2 is a graph of one operating characteristic of a speed signal converter of the electronic governor; Fig.3 is a block diagram, similar to Fig.1, but showing a modification; and Fig.4 is a detailed block circuit diagram of circuit components which can be shunted in some operating states of the vehicle.
Description of the Exemplary Embodiment.

In Fig. 1, an accelerator pedal position sensor 10 and an engine speed transducer 11 are connected to an electronic control unit 12 which operates at least in part digitally and to which other parameters, such as ambient air pressure P and engine temperature T, are also fed. A desired value signal $U_{FSO11}$ appears at the output of the control unit 12 and this is fed to a command variable regulator 21 of an anti-juddering device 20. The output signal $U_{XSOL1}$ of the latter is applied to a servo-motor 14 which regulates the injected fuel quantities of a diesel internal combustion engine 15, the actual injected fuel quantities being represented by the position $U_{XIST}$ of the servo-motor 14.

The anti-juddering device 20 contains a transient-responsive signal generator 22 and an adder 23 to which the output signal $U_F$ of the command variable regulator 21 is fed in a positive sense and the transient signal $U_S$ from the signal generator 22 is fed in a negative sense. The desired injected fuel quantity signal $U_{XSO11}$ is fed by the adder 23 to the servo-motor 14. The input to the transient-responsive signal generator 22 is obtained from an engine speed signal converter 13 which derives a speed-dependant signal $U_N$ from the engine speed n as detected by the engine speed transducer 11.

The command variable regulator 21 comprises a PI controller to whose input an adder is connected, the adder receiving in a positive sense the desired value signal $U_{FSO11}$ and in a negative sense either the desired injected fuel quantity signal $U_{XSO11}$ or the actual injected fuel quantity signal $U_{XIST}$. The command variable regulator 21 modifies the command variable (desired value signal $V_{FSO11}$) so as to
compensate for the fuel quantity subtraction provided by the signal generator 22 when the engine speed is rising only slowly and no judder damping is required.

The judder-suppressing signal generator 22 comprises a serial arrangement of a first high pass filter 61, a signal shaper 62 and a second high pass filter 63. This serial arrangement is supplied with the engine speed-dependent signal $U_N$ from the converter 13. Since the speed-dependent signal $U_N$, after passing through the double high pass filter is applied as the transient signal $U_S$ to the adder 23 where it is combined with the command variable regulator output signal $U_F$ and supplied to the servo-motor 14, there is no need to feed back the signal $U_{x,soll}$ or $U_{x,st}$ to the command variable regulator 21.

The governor thus far corresponds to that of Fig.5 of the aforementioned DE-A-3343854. The control unit 12 has stored therein characteristic curves and controls the injected fuel quantity in dependence upon the accelerator pedal position, the engine speed and other engine parameters and in accordance with the characteristic curves. According to the invention, the speed signal converter 13 receives at least one parameter relating to the state of operation of the vehicle in which the engine is installed. The speed signal converter 13 has stored therein a characteristic feed of curves according to which the speed signal $n$ is processed to produce the speed-dependent signal $U_N$. One such curve is shown in Fig.2. The relevant characteristic curve is chosen by the gear position signal $U_G$ which is fed to the converter 13 by a gear position sensor 71. This arrangement takes into account that the driver may wish to accelerate rapidly by choosing a low gear.
other words, when acceleration of the vehicle with a low gear engaged and at high engine speed $n$, the increase in the injected fuel quantity should be held back to avoid too much energy becoming temporarily stored in the whole oscillatory system.

The converter 13 has a non-linear characteristic as shown in Fig. 2 wherein the speed-dependent signal $U_n$ is plotted against engine speed $n$. The speed-dependent signal $U_n$ is zero or a constant low value at engine speeds up to idling speed $n$ but rises with further increasing engine speed, first steeply and then less steeply. Because the speed dependent signal $U_n$ is passed through a filter ($DT_1$-component), the constant signal level is cut off. This leads to improved speed stability when idling. With the gearbox in neutral, the above-described oscillation system is incomplete and anti-juddering is not required. It also reduces the anti-juddering effect at higher engine speeds where engine torque and acceleration forces are lower.

In the circuit of Fig. 1, should the driver release the accelerator pedal to enable the engine to be used as a brake or retarder, the anti-juddering device 20 rapidly damps any juddering or jerking. In a modification, a signal $U_L$ dependent on the engine load is also fed to the speed signal converter 13, as shown in chain dotted lines. Such a signal could, in fact be the injected fuel quantity signal $U_{\text{fuel}}$, since engine load is directly related to the fuel quantity.

The desired fuel quantity signal $U_{\text{soll}}$ or even the command generator output signal $U_P$ or the desired value signal $U_{\text{soll}}$ could alternatively be used for this purpose.

In the circuit of Fig. 1, the command variable regulator 21 can lead to disadvantages in driving
conditions in which the judder-damping is not operative, e.g., in steady state conditions. These disadvantages can be avoided if the circuit of Fig.1 is modified by omitting the command variable regulator 21 and constructing the engine speed converter 13 as a DT₂-component.

The use of a command variable regulator 21 is also avoided in the embodiment of Fig.3 wherein parts like those of Fig.1 are denoted by like reference numerals. In Fig.3, the desired value signal $U_{F\text{SOll}}$ and the actual fuel quantity signal $U_{\text{Xist}}$ are fed in positive and negative senses, respectively, to an adder 72 whose output is connected to a PT₁-component 73. The transient signal $U_5$ and the output from the PT₁-component are connected in positive and negative senses, respectively, to a further adder 74 whose output is connected in a negative sense to the adder 2.

The PT₁-component 73 is a first order delay element whose output tends to suppress the anti-judder signal $U_5$ to a greater extent, the more the injected fuel quantity signal $U_{\text{Xist}}$ lags behind the desired value signal $U_{F\text{SOll}}$ (the command signal in this embodiment). The PT₁ component 73 thus achieves the same purpose as the command variable regulator 21. The circuit of Fig.4 has the further advantage that other signals, such as idle running control and the desired value set by the driver (pedal position) are not subjected to judder suppression.

Instead of omitting the command variable regulator 21 of Fig.1 altogether, it is possible to arrange for it to be switched out of circuit or switched off responsive to certain states of operation of the vehicle, such as idle running or rough running control.
The states of operation of the vehicle differ widely from one another. In order to match the governor and, in particular, the anti-juddering device 20 to these various operating states to an optimal extent, the various components can be switched over or switched off in dependence on engine speed, the gearbox position or the load. This switching over or switching off can be effected by the use of programmable thresholds, as shown by way of example in Fig.4.

In Fig.4, the circuit components 81,82,83 form the command variable regulator which can be by-passed via a line 84 and an electronic switch 85. The latter can be changed over from its illustrated state in which the command variable regulator 81,82,83 is in circuit to a shunt position by a start signal. Upon starting \(( n < n_o )\) : \( U(K) = X(K) \)
At idle running control : \( U(K) = X(K) \)
While driving : \( U(K) = Y(K) \)
While accelerating : \( U(K) = Y(K) \)
where \( n_o \) is a threshold engine speed, \( U(K) \) is an output signal function, \( X(K) \) is an input signal function and \( Y(K) \) is a modified signal function.
1. An electronic diesel engine governor in which signals from a pedal position sensor (10) and signals from an engine speed sensor (11) are processed in a control unit (12) which controls the injected fuel quantities and in which an anti-juddering device (20) is provided for damping transient-induced fluctuations in the injected fuel quantities, the anti-juddering device (20) comprising a judder-suppressing signal generator (22) connected to a speed signal converter (13), characterised in that the speed signal converter (13) produces a speed-dependent signal \( U_N \) in accordance with a characteristic field in dependence upon the state of operation of the vehicle in which the engine is installed.

2. A diesel engine governor according to claim 1, characterised in that a gear position signal is fed to the speed signal converter (13).

3. A diesel engine governor according to claim 1 or 2, characterised in that an engine load or injected fuel quantity signal is fed to the speed signal converter (13).

4. A diesel engine governor according to claim 1, 2 or 3, characterised in that the speed signal converter (13) is a \( DT_2 \)-component.

5. A diesel engine governor according to any of claims 1 to 4, characterised in that the speed signal converter (13) is an independent component performing corrective functions without other components.

6. A diesel engine governor according to any of claims 1 to 5, characterised in that a command variable regulator (21) of the anti-juddering device (20) is changed over or switched off in accordance with the state of operation of the vehicle, particularly in steady state conditions.

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FIG. 1

FIG. 2

FIG. 3
**INTERNATIONAL SEARCH REPORT**

**INTERNATIONAL APPLICATION No. PCT/EP 88/00127**

**I. CLASSIFICATION OF SUBJECT MATTER**

According to International Patent Classification (IPC) or to both National Classification and IPC

**IPC: F 02 D 41/40**

**II. FIELDS SEARCHED**

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**III. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<td>US, A, 4166437 (BIANCHI et al.) 4 September 1979, see column 1 - column 6, line 58</td>
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<td>FR, A, 2556045 (BOSCH) 7 June 1985, see the whole document</td>
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**IV. CERTIFICATION**

Date of the Actual Completion of the International Search: 7th October 1988

Date of Mailing of this International Search Report: 11 U. 11. 88

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**EUROPEAN PATENT OFFICE**

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ANNEX TO THE INTERNATIONAL SEARCH REPORT
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