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- (21) Application No. 53223/77 (22) Filed 21 Dec. 1977
 (31) Convention Application No. 2659498 (32) Filed 30 Dec. 1976 in
 (33) Fed. Rep. of Germany (DE)
 (44) Complete Specification Published 23 Jul. 1980
 (51) INT. CL.³ F02D 1/02 23/02
 (52) Index at Acceptance
 F1B B100 B200 B204 B228 B300 BE

(19)



(54) A SUPERCHARGED DIESEL ENGINE HAVING A FUEL-
 INJECTION CONTROL ARRANGEMENT

(71) We, DAIMLER-BENZ
 AKTIENGESellschaft, of Stuttgart-
 Untertürkheim, Germany, a Company
 organised under the laws of the Federal
 Republic of Germany, do hereby declare the
 invention for which we pray that a patent
 may be granted to us and the method by
 which it to be performed, to be particularly
 described in and by the following statement:

The invention relates to a super-charged
 diesel engine comprising an injection pump,
 a fuel-quantity regulator on the pump and a
 control arrangement comprising full-load
 stop means moveable in dependence on
 engine speed for the purpose of limiting the
 fuel quantity permitted to be injected.

A known control arrangement for limiting
 the emission of smoke from supercharged
 diesel engines comprises a diaphragm sub-
 ject to the charging pressure and adapted for
 permitting a predetermined injection quan-
 tity in dependence on the instantaneous
 charging pressure. In the range of operation
 of the engine in an unstable state, however,
 the design of the full-load stop, operating in
 dependence on charging pressure, for full-
 load requirements involves delay in the pro-
 vision of the quantity of fuel to be injected,
 because, for this purpose, the charging pres-
 sure must first build up. The acceleration
 behaviour of the engine with the known con-
 trol arrangement, dependent on charging
 pressure, for the full-load stop is therefore
 poorer than it could be for predetermined
 permissible smoke emission. The present
 invention seeks, inter alia, to improve the
 control of the injection quantity in the unst-
 able range of engine operation.

According to the invention, in a super
 charged diesel engine having a fuel-injection
 pump, a fuel-quantity regulator on the pump
 and a control arrangement comprising full-
 load stop means movable in dependence on
 engine speed for limiting the quantity of fuel
 permitted to be injected, the said stop means

comprises a three-dimensional cam movable
 in one direction in dependence on the said
 speed and in another direction in depen-
 dence upon the engine-charging pressure or
 rate of air flow to the engine.

Thus, the cam may be movable axially in
 dependence on the said speed and rotation-
 ally in dependence on the said charging pres-
 sure or rate of air flow.

With this arrangement it is possible for the
 injection quantity permissible for predeter-
 mined smoke emission to be provided in
 dependence on the instantaneous charging
 condition, for example the mass of air being
 supplied to the engine, and on the engine
 speed. Corresponding values on the three-
 dimensional cam may be picked up by a cam
 follower in the form of a sensing pin con-
 nected to the regulating rod of the injection
 pump, whereby the maximum permissible
 movement of said rod is allowed.

The three-dimensional cam is preferably
 designed so that displacement thereof in its
 axial direction is proportional to engine
 speed, while the extent of its turning is prop-
 ortion to the mass of air flowing through
 the engine.

Alternatively the cam could be turned in
 response to an engine-speed signal and dis-
 placed axially by an air-flow signal. Because
 of the direct relation between the charging
 pressure and the air mass, for a predeter-
 mined engine speed, the charging pressure
 may be used to provide the air-flow signal.
 Consequently means provided heretofore
 for moving a full-load stop in dependence on
 the charging pressure may be utilised for
 effecting one of the two movements of the
 three dimensional cam.

To achieve coordination between the
 charging pressure and the injection quantity
 permissible for predetermined smoke emis-
 sion, the said quantity may, starting for
 example from a point of stable-operation, be
 increased with constant engine speed while

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at the same time permitting air to be blown off upstream of the turbine of a turbo-charger, the charging pressure and temperature thus remaining constant, until the limit permissible for the predetermined smoke emission is reached. The resultant coordination between the instantaneous charging pressure and the injection quantity permissible for the predetermined smoke emission then dictates the geometry of the three-dimensional cam. If the cam is designed in this manner, the advantage is gained that it is possible, at full load, to operate during acceleration with an excess of fuel in those ranges of operation of the engine in which it possesses favourable smoke-emission behaviour. In such cases, however, it must be ensured that other characteristic magnitudes, such for example as maximum peak pressure and maximum permissible torque are not increased beyond values permissible for the engine in question.

With the above described control arrangement, substantially optimum acceleration behaviour of a diesel engine can be achieved for a predetermined limit of maximum smoke emission.

The revolution speed signal may be initiated or introduced by a speed responsive or measuring element of the injection-pump regulator. A revolution-speed regulator may however have a non-mechanical element, for example a pneumatic or electric element, for transmitting a speed signal.

One embodiment of the invention by way of example will now be described with reference to the accompanying diagrammatic drawing of a control arrangement in accordance with the invention.

The illustrated control arrangement for a supercharged diesel engine (not shown), comprises an injection pump 1 having a regulator comprising a regulating rod 2 whose end part 3, of reduced diameter, is guided in a guide 4. The rod 2 is urged, by a spring abutment 5 with its end part 3 towards a stop 6 for zero fuel supply. The rod part 3 carries a holder 7 for a sensing pin 8 which cooperates as a follower with a three-dimensional cam 9. The rod 3 is displaceable against the spring 5, in the direction for increasing the quantity of fuel injected, by operation of the accelerator pedal 10 of the engine. The cam 9 is displaceable in its axial direction, for example in response to a signal dependent on engine-revolution speed, and is rotatable in response to a signal dependent on the mass of air-flowing through the engine. The former signal may be initiated or introduced by way of the measuring element of the injection-pump regulator or by another device affording a measure of engine speed. The latter signal may be obtained from the charging pressure or from an air-mass flowmeter disposed in the air-flow path of the engine.

Depending on the position of the cam 9, the provision of a predetermined quantity of fuel to be injected will be determined as a result of contact between the cam and the pin 8. In order that this position shall not be overridden by operation of the accelerator pedal 10, there is provided in the holder 7 a guide 11 for an override rod 12 which bears on the holder 7 under the action of a spring 14 abutted against a collar 13 on the rod. The rod 12 is connected, with articulation, to the pedal 10 by way of linkage 15. If the pedal 10 is depressed to a greater extent than corresponds to the position determined by the cam 9 and pin 8, the rod 12 can slide in the guide 11, compressing the spring 14, without displacing the regulating rod 2 and thereby causing release of a larger quantity of fuel for injection. The geometry of the three-dimensional cam is determined, for a given smoke-emission limit, in dependence on the instantaneous engine speed and the mass of air actually flowing through the engine.

WHAT WE CLAIM IS:

1. A super-charged diesel engine having a fuel-injection pump, a fuel-quantity regulator on the pump and a control arrangement comprising full-load stop means movable in dependence on engine speed for limiting the quantity of fuel permitted to be injected, wherein the said stop means comprises a three-dimensional cam movable in one direction in dependence on the said speed and in another direction in dependence upon the engine-charging pressure or rate of air flow to the engine.
2. An engine according to claim 1, wherein the cam is movable axially in dependence on the said speed and rotationally in dependence on the said charging pressure or rate of air flow.
3. An engine according to claim 1 or 2, wherein a signal for moving the cam in dependence on the said speed is provided by a speed responsive element of the injection-pump regulator.
4. An engine according to claim 1 or 2, wherein a signal for moving the cam in dependence upon the said speed is transmitted to the cam by a non-mechanical element.
5. A diesel engine having full-load stop means substantially as hereinbefore described with reference to the accompanying drawing.

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