PATENT SPECIFICATION

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(19)

(54) AN INTERNAL COMBUSTION ENGINE HAVING A SYSTEM FOR CONTROLLING THE SPEED OF A CRANKSHAFT THEREOF

(71) We, SULZER BROTHERS LIMITED, a Company organised under the laws of Switzerland, of Winterthur, Switzerland, do hereby declare the invention, for which we pray that a patent may be granted to us and the method by which it is to be performed, to be particularly described in and by the following statement:—

The invention relates to an internal combustion engine having a system for controlling the speed of a crankshaft thereof. The invention is applicable to an engine having fuel injection, particularly but not exclusively a diesel engine.

When an internal combustion engine is running, it is normal for the crankshaft to experience torsional vibrations caused by pressure peaks or surges occurring upon ignition of the fuel in the cylinders. The frequency of such vibrations corresponds to the ignition frequency, i.e. the vibrations occurs at low frequencies which do not particularly disturb operation.

As a rule, in a diesel or other fuel injected engine, the crankshaft drives, through suitable transmission means, a fuel injection pump and a speed governor means to control the injection pump. The crankshaft transmits to the injection pump torsional vibrations whose frequency is of the same order of magnitude as the frequency of the crankshaft vibrations. However the governor means is usually driven through a transmission having a high transmission ratio which, when the engine is operating at a governed speed controlled by the governor as opposed to during run up from start or idling, transmits to the governor means torsional vibrations at a frequency much higher than the frequency of the crankshaft vibrations, i.e. the governor means input shaft experiences high-frequency torsional vibrations. The governor endeavours to oppose such vibrations. This leads to corresponding deflections of the governor drive and the same is transmitted to the linkage between the governor and the injection pump and, through the agency thereof, the quantities of fuel injected into the engine cylinders. Often, the vibrating linkage produces excessive deflections which may cause disturbances in fuel injection control and damage of the linkage.

It is an object of the invention to provide an internal combustion engine having a governor drive arrangement which attenuates such high-frequency torsional vibrations and alleviates disturbances caused thereby in the control of the fuel injection pump and obviates damage to the linkage.

Accordingly the present invention provides an internal combustion engine having a crankshaft and speed control governor means driven from the crankshaft and arranged to control the amount of fuel injected into the cylinders of the engine by a fuel injection pump, wherein the governor input drive shaft is rigidly coupled to a flywheel and is driven through the intermediary of a torsionally resilient member, the characteristics of the system comprising the flywheel and the torsionally resilient member being such that the torsional resonant frequency of the governor drive is below the frequency of torsional vibrations transmitted to the governor from the crankshaft at governed operating speed of the engine.

In the context of this specification it should be understood that the expression "flywheel" is intended to include an assembly of masses at the end of rotating arms and other inertia increasing devices as well as simple flywheels of the kind discussed below with respect to the accompanying drawings.

The invention has the advantage that the flywheel helps to reduce the natural torsional vibration frequency of the governor and therefore increases this mistuning between the originating or exciting frequency of the crankshaft and the natural frequency of the governor. The flywheel and the torsionally resilient element can produce mis-tuning, expressed by the relationship between the exciting frequency and the natural frequency of the governor, by a value of between 2 and 3. The damping properties can be determined to suit individual cases by an appropriate choice of the torsional characteristics of the resilient element and of the moment of inertia of the flywheel.

An embodiment of the invention will be described by way of example only with reference to the accompanying drawing which is a diagrammatic view of a system for controlling the speed of a diesel engine crankshaft.

In the system shown a fuel injection pump 1 is driven by a shaft 2 which is driven, via a first transmission gear system 3 comprising a number of gears, from an engine crankshaft 4. A governor 6 is provided, having a control output member 5 connected with the valve system (not shown) of the injection pump 1. The member 5 operates such valve system via a linkage 7 and varies the quantities of fuel to be injected into the cylinders of the engine (not shown) through injection lines 16, in dependence upon the difference between the actual speed and the set desired speed of the crankshaft.

The shaft 2 also drives the governor 6 via a second geared transmission 10 at a speed proportional to crankshaft speed. A control linkage 8 serves to adjust the governor in accordance with the desired crankshaft speed. Gearing 10 comprises a first crossed-helical gear 11 rigidly secured to the shaft 2, a second crossed-helical gear 12 which is in engagement with the first crossed-helical gear 11 and which is carried on an auxiliary shaft 13, a first spur gear 14 secured to shaft 13, and a second spur gear 15 which is driven by gear 14 and which is carried in axial alignment with a governor shaft 9 and is in driving engagement therewith.

Disposed between the spur gear 15 and the governor drive shaft 9 is a tuning system 17 which serves for frequency mismatching, and which comprises a torsionally resilient member 18 and a flywheel 19. The system 17 serves to increase the moment of inertia seen by the drive to the governor and to reduce the natural frequency of torsional vibrations of the shaft 9. The flywheel 19 is rigidly secured to the end of shaft 19 by for instance splines. The resilient member 18 is rigidly connected at one end to the flywheel 19 and at its other end to the gear 15. The resilient member 18 is in the form of a torsion rod which can be circular or rectangular in cross-section, and may be laminated. The mis-matching properties of the damping network can be varied and determined in accordance with the required values by variation of the spring rate of the torsionally resilient member 18 and/or of the moment of inertia of the flywheel, and in the case of a laminated torsion member 18 by the intrinsic frictional damping between the laminations.

WHAT WE CLAIM IS:

1. An internal combustion engine having a crankshaft and speed control governor means driven from the crankshaft and arranged to control the amount of fuel injected into the cylinders of the engine by a fuel injection pump, wherein the governor input drive shaft is rigidly coupled to a flywheel and is driven through the intermediary of a torsionally resilient member, the characteristics of the system comprising the flywheel and the torsionally resilient member being such that the torsional resonant frequency of the governor drive is below the frequency of torsional vibrations transmitted to the governor from the crankshaft at governed operating speed of the engine.

2. An internal combustion engine according to claim 1, wherein the flywheel is disposed between the governor input drive shaft and the torsionally resilient member.

3. An internal combustion engine according to claim 1 or 2, wherein the torsionally resilient member comprises a torsion rod.

4. An internal combustion engine having a system for controlling the speed of the crankshaft thereof substantially as herein described with reference to the accompanying drawing.

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1584167 COMPLETE SPECIFICATION

1 SHEET *This drawing is a reproduction of the Original on a reduced scale*