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Measurement and analysis of angular velocity variations of twelve-cylinder diesel engine crankshaft

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ABSTRACT

This paper presents the procedures for measuring and analyzing the angular velocity variation of twelve-cylinder diesel engine crankshaft on its free end and on the power-output end. In addition, the paper deals with important aspects of the measurement of crankshaft torsional oscillations. The method is based on digital encoders placed at two distances, and one of them is a sensor not inserted directly on the shaft, i.e. a non-contact method with a toothed disc is used. The principle based on toothed disc is also used to measure the actual camshaft angular velocity of in-line compact high-pressure pump the engine is equipped with, and this paper aims to demonstrate the possibility of measuring the actual angular velocity of any rotating shaft in the engine, on which it is physically possible to mount a toothed disc. The method was created completely independently during long-range development and research tests of V46 family engines. This method is specific for its particular adaptability for use on larger engines with extensive vibrations and torsional oscillations. The main purpose of this paper is a practical contribution to all the more interesting research of the use of engine crankshaft angular velocity as a diagnostic tool for identifying the engine irregular running.

1. Introduction

It is a well known fact that the crankshaft angular velocity of piston IC engine during its stationary running is not a constant, but a periodically variable value. The variable characteristic of the engine resultant torque has a predominant influence on the variations of this value.

On the other hand, the construction of piston engines, and first of all, their crank mechanisms must have the variations of crankshaft angular velocity as a result, even if the engine torque caused by active gas power was constant, because the mass moment of inertia of the engine in relation to the crankshaft actual position (angle) is periodically variable, which inevitably implies the appearance of periodically variable inertial forces in this type of mechanisms.

The third factor, which influences the crankshaft angular velocity variations is its torsional oscillations, i.e. elastic, forced, damped angular deformations along the crankshaft caused by the engine variable (exciting) torque. Numerous tests have indicated that, for smaller and less powerful engines, which can be relatively considered as 'torsionally rigid' systems, the influence of this phenomenon on the crankshaft angular velocity variations is not significant. For larger and more powerful engines, this statement is not valid at all, as will be presented in this paper.

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