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THE DIAGNOSIS OF THE MANUFACTURING FAULTS OF CAR ENGINES BY VIBRATIONS SPECTRAL ANALYSIS

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INTRODUCTION

In order to establish the influence of the manufacturing faults on the vibration spectrum of a car engine , comparison have been carried out between the vibration spectrum of a standard engine and the vibration spectra after that known manufacturing faults have been artificially introduced.

EXPERIMENTAL EQUIPMENT

The analysis was carried out on a car engine put into rotation by a d.c. electric motor. In order to correlate the noise and vibration spectra the engine was mounted into an anechoic room.

The following rotation speeds: 800, 1600, 2400, 3200 r.p.m. has been considered as being significantly to the all types of faults.

Using a standard engine (without manufacturing and assembling faults) standard spectra regarding to the acceleration of vibrations have been registred. Then, successively a certain machine part of the standard engine has been replaced by a similar machine part but with a known fabrication fault. The acceleration spectra have been registred in each case and compared to spectra obtained previously by using the standard engine.

The vibration spectra as well as the comparison between spectra was carried out by using a dynamic signal analyser based on the FFT technique.

EXPERIMENTAL RESULTS

The following machine part and typical faults have been considered:

Crankshafts with Increased Clearance at the central journal bearing since the journal diameter was manufacturid under the minimum value. The spectra obtained with the accelerometer mounted on the lateral side of the crankcase are presented in Fig. 1, when the rotation speed of the crankshaft was 800 r.p.m. and in Fig. 2 when the rotation speed was 3200 r.p.m.

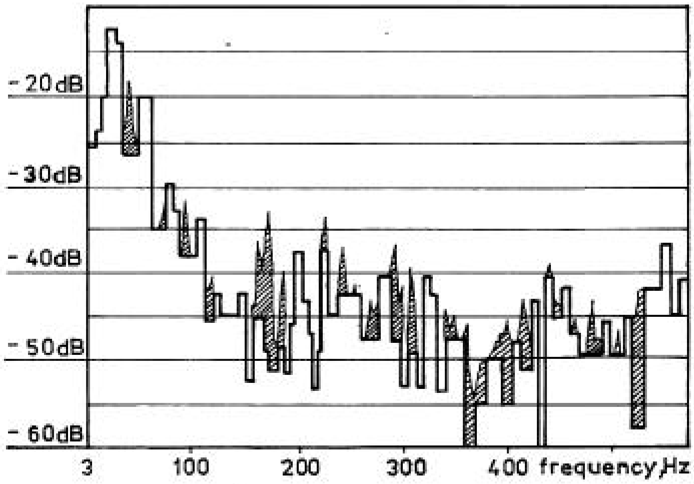

Fig. 1

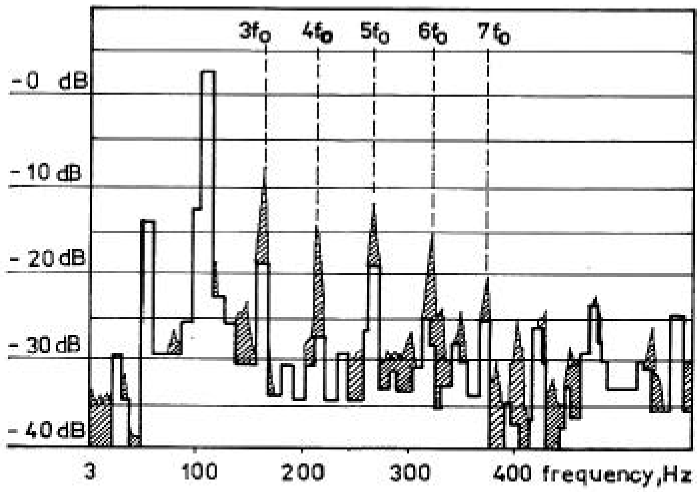

Fig. 2

A stronger appearance of this fault in the vibration spectrum was achieved when the upper value of the rotation speed was used. The comparisons between spectra obtained at 3200 r.p.m. show that this kind of fault determines an increase with about 10 dB the levels of the spectrum components which are multiples of the rotation frequency f_o, ($3f_o$, $4f_o$, $5f_o$, $6f_o$, $7f_o$).

Unbalanced Crankshaft, the value of the unbalance being 60 g.cm. The comparison between the standard spectrum and the vibration spectrum obtained at 3200 r.p.m., presents an increase with 15 dB of the level of the component with the frequency 26,5 Hz that corresponds to the half of the frequency of rotation. There are also increases with about 10 dB at some harmonics of the frequency of rotation ($4f_o$, $\frac{11}{2}f_o$, $6f_o$, $\frac{13}{2}f_o$) Fig. 3.

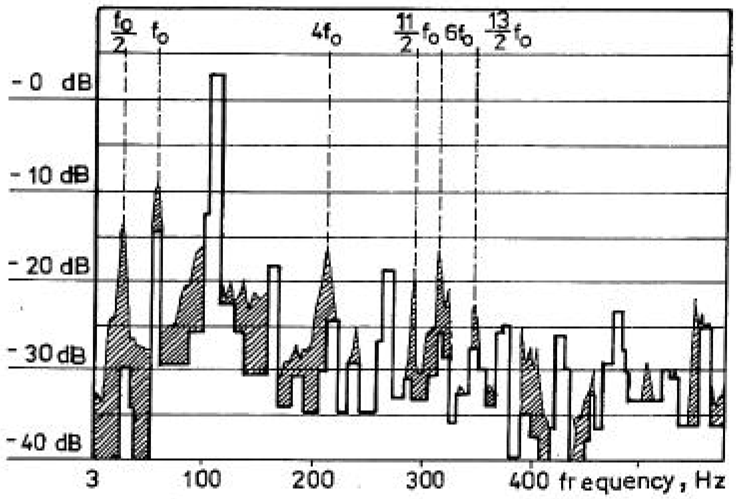

Fig.3

Camshaft with Increased Clearance at an intermediate journal bearing as a result of manufacturing under the minimum value of the journal bearing. In this case the accelerometer was mounted on the engine case in a point close to the camshaft. The comparison of the vibration spectra obtained at 800 r.p.m. for the rotation speed of the crankshaft is presented in Fig. 4. It can be noticed that this kind of fault determines an increase with about 15 dB of the levels of the spectrum components which are multiples of the frequency of rotation.

The measurements carried out at other rotation speeds have shown a continuous descrease of the differences between standard and actual spectra, as long as, the rotation speed of the crankshaft is increased.

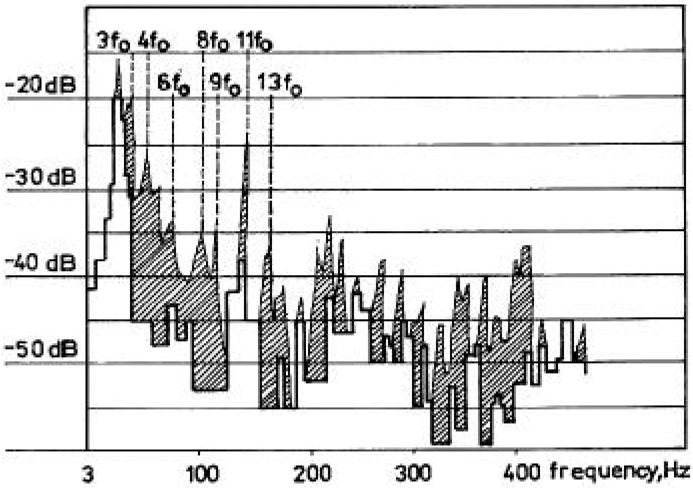

Fig. 4

<u>Camshaft with axial misaligment</u>. The comparison of the standard and actual spectra, Fig. 5, indicates an increase with 10 - 15 dB of the levels of the spectrum components which are even multiples of the frewuency of rotation. In this case, also the 800 r.p.m. was the most favourable rotation speed for diagnose purposes.

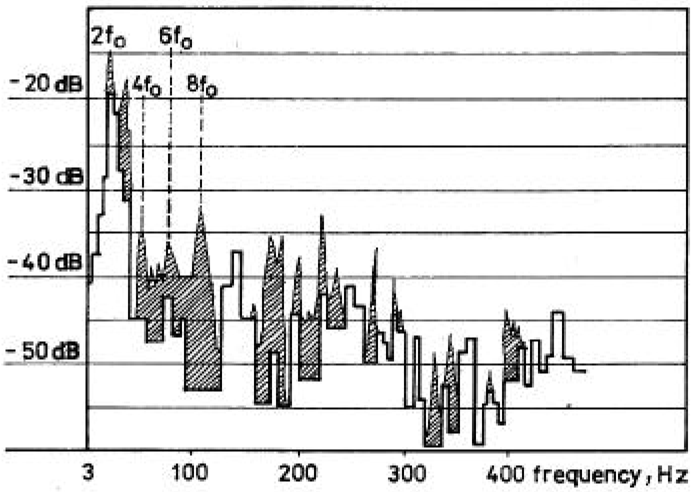

Fig. 5

CONCLUSIONS

Comparisons carried out between the vibration spectra of a standard car engine and the vibration spectra obtained when manufacturing faults have been artificially introduced have pointed out the possibility to diagnose the type of fault by vibration spectral analysis.