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Selected Problems On Noise And Vibrations Of Passenger Cars And Their Resolution By Measurements On The Road And In Anechoic Chambers.

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General

In motor vehicles, the analysis of vibrations and of noise in particular does not only contribute to improving the riding comfort but adds also to the active safety of the vehicle, primarily by safety of the drivers condition. The vibration characteristics, therefore, have to be matched to each other in order to keep the physiological stress of the occupant and of the driver in particular small, thus reducing the likelihood of misjudgement while operating the vehicle. To this end, comprehensive investigations on the road and on the test bed have to be performed. From this work, a few selected problems shall be dealt with subsequently.

(a) Analysis of the vibrations of body shells vs. finished vehicles

During manufacture (of prototypes as well as of production vehicles), the body shell constitutes the first stage permitting vibration measurements on the total performance of the body. In this condition, investigations are particularly suited for comparing different superstructures, for determining critical body areas and for a prognosis on the vibration characteristics of the finished vehicle. This is due to the fact that different installations such as engine, axle or other equipment are excluded as sources of troubles. After being suspended practically free from reactive forces, the body is excited by two electrodynamic shakers. The amplitudes of the vibrations are picked up from the shell by transducers which are sensitive to velocity or to acceleration and then recorded.

For comparative analysis of the finished vehicle, the hydropulse system, simulating driving on public roads, is well suited. With its four wheels, the car is placed onto four hydraulically controlled plungers which can be operated with different amplitudes, frequencies and phasing or after a program.

The reactions of the superstructure are analyzed in all three dimensions by acceleration-sensitive transducers so that critical modes of vibration and critical places of the structure can be located.

One vibration problem which is investigated by these means is

(b) Trembling - a body vibration particularly on smooth lanes

Here, the term "trembling" is understood to represent a low-frequency, mechanical vibration of the superstructure predominantly as a bending vibration of the first order in the range from 15 to 25 cps which can be unpleasantly noticed at the steering wheel and at the seat. With progressive road contruction, it is true, the unevenness of road surfaces acting as an exciter decreases. On the other hand, the influence of irregularities of the wheel proper when driving at elevated speeds and on smooth lanes becomes much more prominent. Unbalance - that is irregularities of the mass distribution - and a poor tire uniformity - that is irregularities of the tire stiffness along its circumference - excite forced vibrations of the body on account of their periodicity which may become highly unpleasant for the occupants in those speed ranges in which the frequencies of the wheel rotations coincide with the natural frequencies of the superstructure (by bending or torsion).

(c) Booming - an acoustic vibration in the vehicle interior

By "booming" an accustical vibration below 70 cps is understood which by its varying form of occurrence and on account of its low frequency range cannot be integrated into normal hearing. For this reason, it seems to be appropriate to separate the measured levels and frequencies from the rest. For evaluation purposes, the unweighted sound level is consequently used.

Booming may as well constitute a standing sound wave oscillating in one of the natural frequencies of the enclosed space as it may be also a forced vibration of any frequency induced, for instance, by resonance of a body component. Acoustical frequencies occurring at natural frequencies of the enclosed space are hard to influence. Depending on the cause, changes of the spatial dimensions, of the vibrational pattern of the space boundaries or of its exciters by displacement of masses or by vibration dampers can be employed. Positive results have also been obtained when attempting to suppress standing sound waves in the body interior via acoustical interference by means of microphones and loudspeakers.

(d) Subjective evaluation of differing noise in the vehicle interior by direct contrast

Subjective evaluation of measures for attenuating noise, meets with difficulties if larger time intervals exist between the noises to be evaluated since the acoustic momory of man is poor.

In addition, objective measurements in dB, using for weighting purposes the "A", "B" and "C" curves, may prove to be unsatisfactory as soon as the noise to be evaluated contains components of greatly varying frequencies.

One possibility for a dircet comparison of noises can be realized by play-back of multi-channel tape recordings, for instance, at the location of their pick-up in the vehicle interior.

(e) Propagation of noise as solid-borne noise and resonance phenomena as well as area radiation in the vehicle interior

Gear noise is frequently heard unpleasantly in vehicle interiors. Using the rear axle drive as an example, the complex propagation via solid-borne noise channels and the amplification of such noise by unfavorable resonators by body components is shown. An analysis of location and of influence of such resonators offers chances for reducing such noise.