Case History	Automobile Propeller Shaft Vibration Caused by Mounting Angle of Couplings	Transportation machinery
Forced Vibration		
Object Machine	Passenger car, provided with automatic transmission, rear-wheel drive, and two-part propeller shaft with cross joint specification (refer to Fig.1)	
Observed Phenomena	During starting and acceleration, the vehicle body experienced vibration. Its frequency seemed to be proportional to the vehicle speed without depending on the transmission gear stage.	
Cause Presumed	Judging from the above phenomenon, it was estimated that the compelling force was not due to engine rotation, but because of rotation of the rotational axis after the drive system transmission, that is, rotation of the propeller shaft, the drive shaft or the tire wheel.	
Analysis and Data Processing	Measurement of the vibration of the steering wheel upon its occurrence revealed that the vibration had a frequency equal to twice the rotational frequency of the propeller shaft (refer to Fig.2). In other words, it was believed that the compelling force was due to the second-order frequency of the propeller shaft rotation, caused by joint angle between the axes of rotation (refer to Fig.3).	
Countermeasures and Results	In order to verify the above estimation, measurement was made of vibration changes by providing several joint angles of different levels at three joint positions. As a result, it was found that vibration increased according to increasing joint angle (refer to Fig.4). Based on this result, the countermeasure was taken to set the joint angles to be as close as possible to zero, i.e., to attain linearization.	
Lesson Learned	In case of cross joints, problems due to vibration of twice the rotational frequency are well known. However, because of the presence of friction and the like, it is not possible to completely eliminate the compelling force even when uniform velocity joints of several types are used, so that it is a basic design requirement to attain shaft linearization as much as possible.	
References	Orain, M. General Theory and Experiment of Homokinetic Joints: GLAENZER SPICER (France)	
Keyword	Joint, vibration of twice the rotational frequency	

