SECTION : 501-25G Body Repairs - Noise, Vibration and Harshness

VEHICLE APPLICATION : 2008.0 Falcon

CONTENTS PAGE

DESCRIPTION AND OPERATION

DESCRIPTION AND OPERATION

Noise, Vibration and Harshness

Introduction

This chapter gives an overview of how noise, vibration and harshness (NVH) can be produced in a vehicle, and which corrective measures are possible.

What is understood by NVH in vehicle technology

N = Noise - Sound, can be heard

V = Vibration - Oscillation, can be felt

H = Harshness - Roughness, can be heard and felt

Types of noise in NVH technology

Noises in a vehicle are classified by their notes:

1. Low notes - growling, droning
2. Mid-pitch notes - buzzing, whirring
3. High notes - howling, whistling, squeaking
4. Loud howling and whistling is painful to the ears.

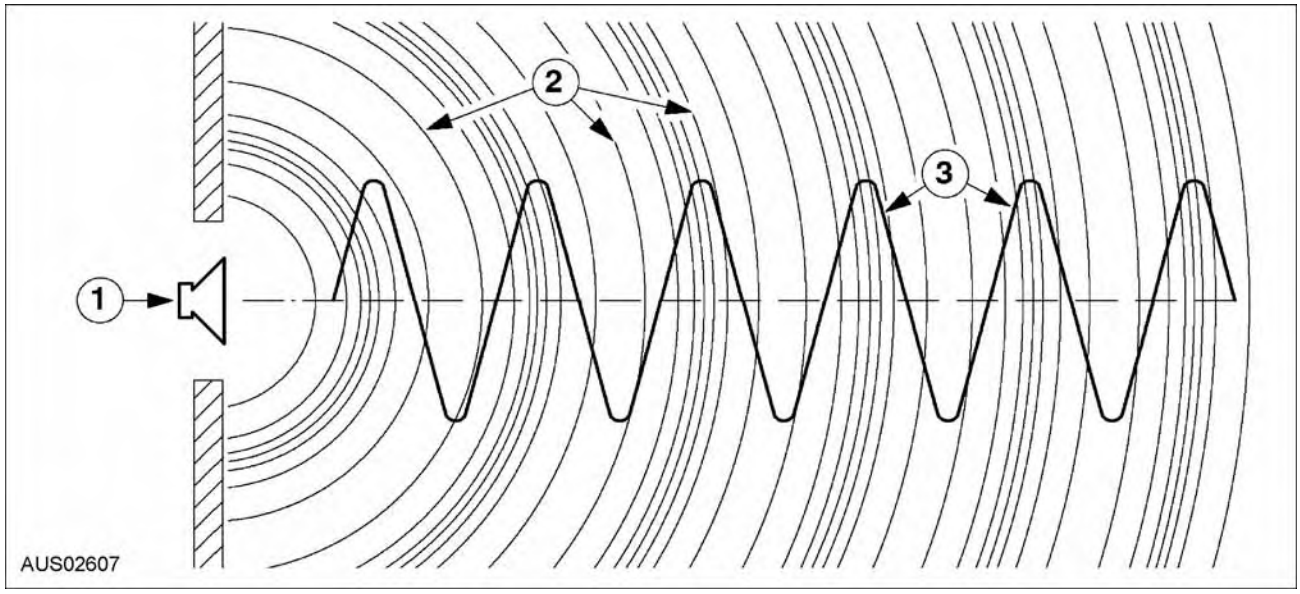
Where the different notes come from in a vehicle:

- Low notes are mostly produced by the engine.
- Low notes are also caused by the road surface, especially if the surface is rough. This is a form of droning which can be felt by the vehicle occupants as vibration or roughness.
- High notes however, which are experienced as howling or whistling noises are often air currents (wind noise) or come from attached components such as the generator, power steering pump or drivebelt.
- There are also clattering noises which can occur when driving over an uneven road. These jerking noises are produced by, for example, the shock absorbers, chassis components or loose articles inside the vehicle.

DESCRIPTION AND OPERATION (Continued)

Noise transmission through air

Spreading of sound waves in the air



Item	Description
1	Sound source e.g. Engine
2	Sound wave
3	Amplitude

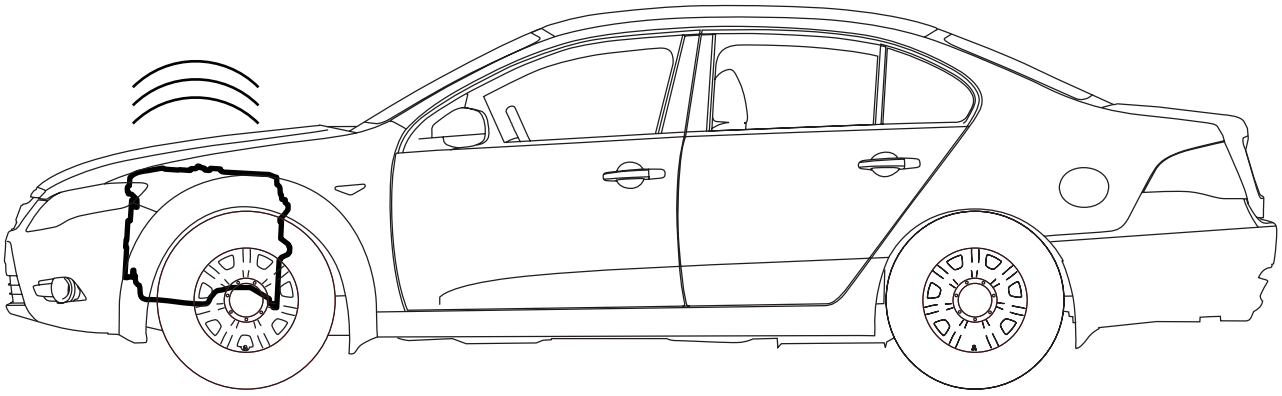
- The sound is spread by longitudinal waves in the form of pressure changes in the air.

DESCRIPTION AND OPERATION (Continued)

Sound transmission through a body

- Sound is passed through liquids or solids e.g. through the car bodywork.

Noise transmission in a vehicle



AUS02614

Item	Description
1	Sound through air
2	Sound vibrations

- Example

1. The source of the noise is the engine

- Engine noises are:

1. Radiated directly through the air
2. Transmitted as vibrations from the engine to the bodywork and radiated into the passenger compartment as air borne sound, for instance by the bulkhead.

- The speed of transmission (speed of sound) in liquids or solids depends on the material, but is generally faster than that in air (about 5 times faster).

Combination of transmission through air and bodies

NOTE: Sound transmission through both air and bodies is of prime importance in vehicle technology.

Vibration Technology

- Frequencies below 20 Hz (low frequencies) and those above 20,000 Hz (20 kHz; high frequencies) are not heard by the human ear.
- The engine is made to oscillate vertically in its flexible mountings by unevenness in the road.
- Engine mountings which are not tuned will transmit oscillations to the bodywork and hence to the occupants.
- The following basic rules apply:

1. In vehicle technology, not only audible frequencies but also inaudible (low) frequencies must be considered.
2. Low frequency oscillations can usually be seen (large amplitudes).
3. High frequency vibrations can be heard, but will also be felt as vibrations in the floor, steering wheel or seat.

Resonance

- Every body has a natural frequency of vibration.
- If a system able to vibrate (a vehicle) is excited at its natural frequency of vibration, it will start to resonate.
- Uneven engine running appears for instance when the resonant frequency is reached (critical engine speed).
- Once the engine speed increases above this speed, the engine will very soon run smoothly again.

Damping

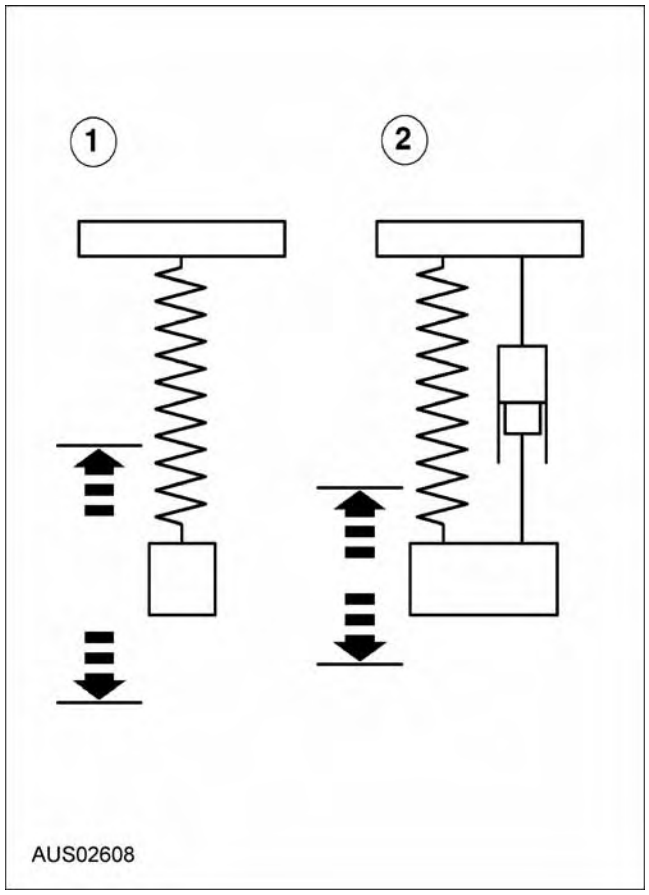
- If a damper is installed parallel to a spring, the damping characteristic acts to reduce the movement of a body.
- This is also the way in which a shock absorber on a vehicle works.
- Damping affects the resonance of an object or system.

DESCRIPTION AND OPERATION (Continued)

- The mass being moved is damped by a correctly operating shock absorber, so that shaking of the bodywork stops immediately.

The shock absorber in a vehicle is an oscillation damper, which allows the bodywork to oscillate in a damped manner.

Oscillation



Item	Description
1	Undamped oscillation
2	Damped oscillation

Isolation

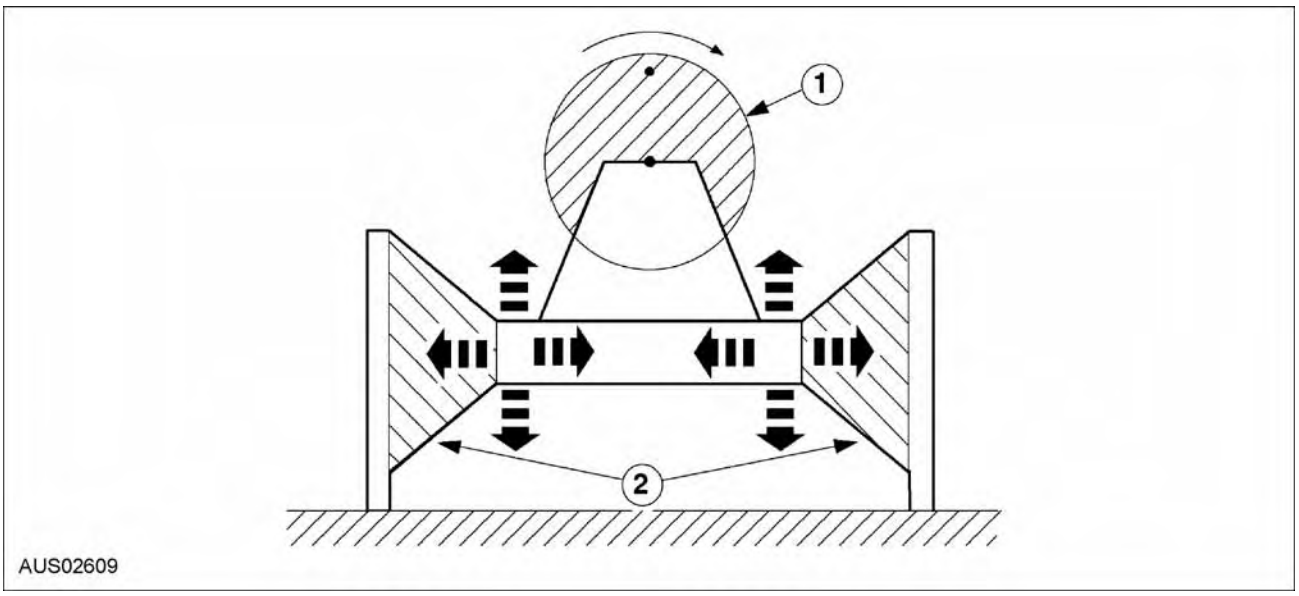
In oscillation technology, the term isolation means decoupling (separation) of components and systems.

- Example:

1. An engine is mounted in sprung elements, so that as little oscillation as possible is passed to the vehicle.
2. In automotive technology, the isolation technique used is nearly always rubber mounting. The elasticity of the rubber acts like a spring.
3. The effectiveness of this type of decoupling depends on the construction of the component.

DESCRIPTION AND OPERATION (Continued)

Directional loading of a rubber mounting in order to achieve optimum isolation

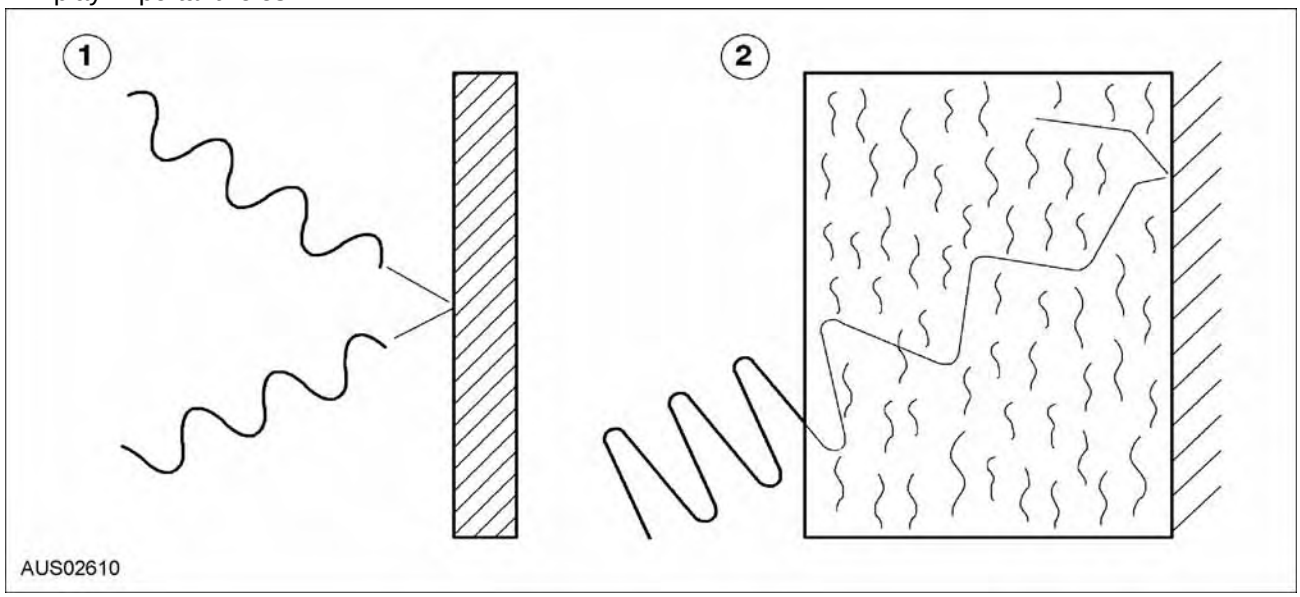


Item	Description
1	Engine
2	Engine mounting

DESCRIPTION AND OPERATION (Continued)

Absorption

- Sound waves are reflected from hard surfaces.
- If they meet soft surfaces, they are absorbed. Here both the material and the material thickness play important roles.



Item	Description
1	Reflection of sound waves
2	Absorption of sound waves

- Example:

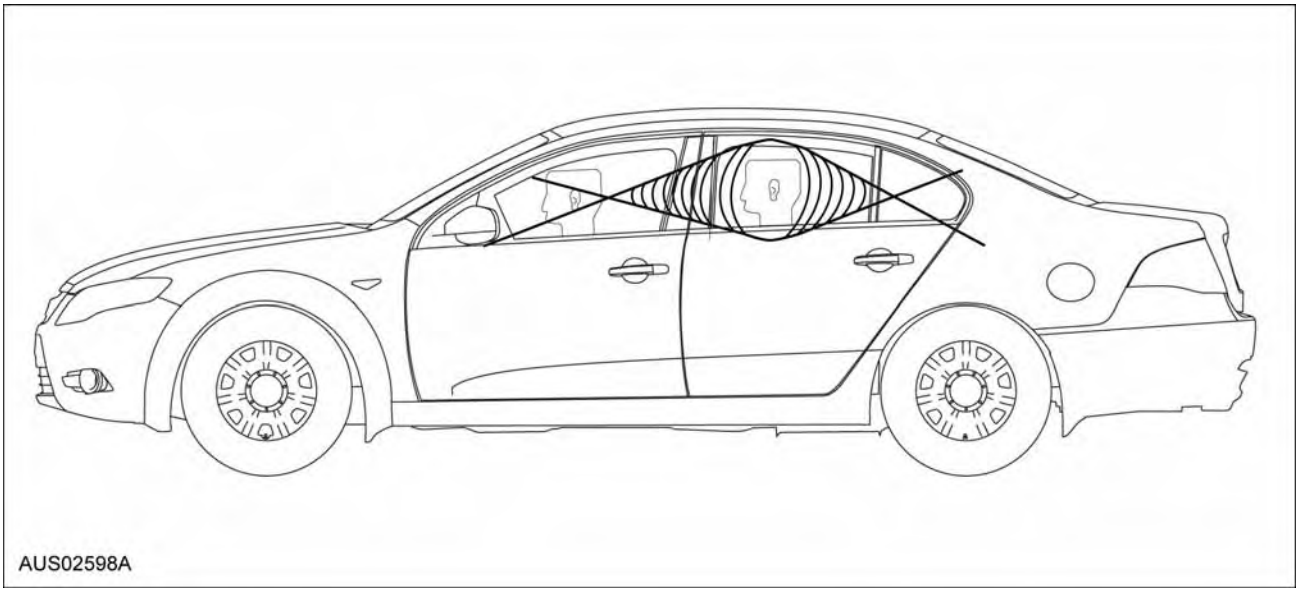
1. All sound deadening components such as door trim, carpets, headlining, parcel shelves and the seats are removed from a vehicle.
2. The result of this is that the sound is directly reflected (the sound level rises), and a concert hall effect is produced.

DESCRIPTION AND OPERATION (Continued)

Noise and oscillation behaviour in a vehicle

The occupants of a vehicle experience different levels of sound or noise depending on where they are sitting.

Sound/noise wave (standing wave) in a vehicle

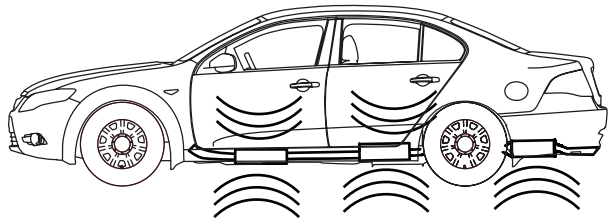


Item	Description
1	Driver sits in a "wave calm"
2	Rear passenger sits in a "wave swell"

DESCRIPTION AND OPERATION (Continued)

Noise and oscillation behaviour of intake and exhaust systems

The vehicle exhaust system has an air borne sound and solid body sound source



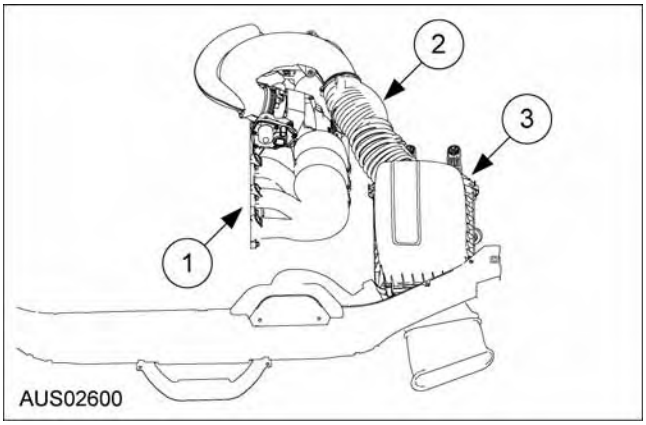
AUS02613A

- Ways in which sound is transmitted

1. The top illustration shows the ways in which sound can be transmitted from intake and exhaust systems.
2. Apart from air borne sound, solid body sound is predominant in both systems. In order to keep this proportion as small as possible, it is necessary for these type of oscillating components to be connected to the body using stiff connection points.
3. The exhaust system especially is an oscillating component and requires optimal isolation through its connection to the floor and also good routing and positioning of the fixing points in order to reduce the solid body sound transmission.

Intake system

Intake system



Item	Description
1	Intake manifold
2	Connection hose
3	Air cleaner

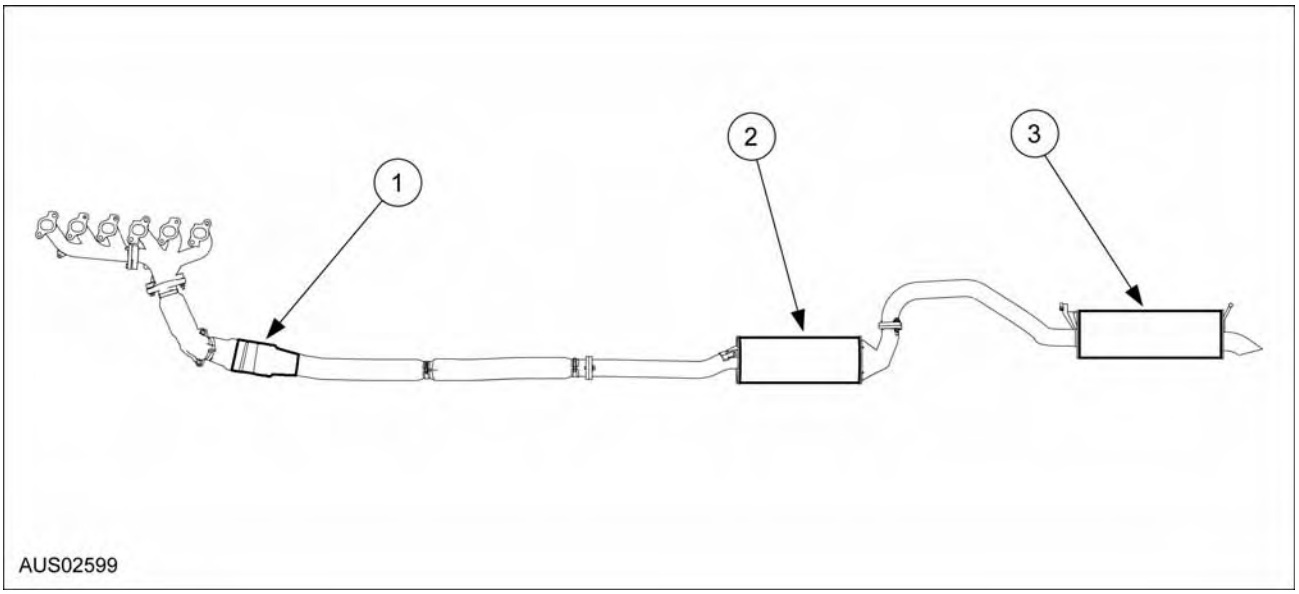
- The volume and length of intake systems are matched exactly. No changes may be carried out during service or repair work. When attaching components (hoses and tubes), pay attention that all connections are air-tight.
- The surfaces of all components affected by the strong pressure variations in the intake system are especially subject to strong oscillations.
- The effects of temperature, such as warming of the air filter housing can cause changes in the rigidity of surfaces.
- In order to prevent solid body sound caused by surface oscillations of the intake system from being transmitted to the vehicle body, the following points must be observed during service:

1. The whole intake system must be isolated from the bodywork and mounted in rubber bushes without tension.
2. The air channels of the intake system must not contact the bodywork components.
3. Insert foam insulation at points of contact with bodywork or other components.

DESCRIPTION AND OPERATION (Continued)

Exhaust system

Exhaust system construction



Item	Description
1	Catalytic converter
2	Front silencer
3	Rear silencer

- Exhaust systems must be installed without strain.

NOTE: The rubber mountings in which an exhaust system is suspended also transmit oscillations and under some circumstances can also cause a noise problem. For this reason it is important that the exhaust system is installed free of strain.

- The rubber mountings must not be over-stretched.
- The exhaust manifold and catalytic converter (if it is mounted directly at the engine) must have a solid connection to the engine (no splits in brackets).
- Simple problem testing:

1. Remove all mountings from which the exhaust system is suspended.
2. Support the exhaust system with rope at two positions at the most.
3. Check the noise level in the passenger compartment during a road test.
4. If this solves the problem, the exhaust mountings are the source of the noise.
5. Put back the exhaust supports one at a time, and road test the vehicle after fitting each one.
6. By proceeding in steps in this way, the mounting that is causing the noise in the passenger compartment can be found.

Bodywork

Function

- Different types of demand are made on the bodywork of a vehicle, particularly when it is being driven. Predominant here are vibrations caused mainly by other vehicle components, such as the engine and mountings. The bodywork is therefore one of the most important vehicle components where NVH is concerned.
- The vehicle components described so far were, according to their function, individual self-contained noise sources. The bodywork however, connects and houses all the vehicle components.
- The bodywork is subject to vibration from both air borne sound and solid body sound.
- The bodywork must absorb all oscillations and impulses from all components and if possible transmit none of these to the vehicle interior.
- The largest proportion of NVH behaviour of a bodyshell is in the steel panels of the roof, sides and floor. They are strongly stimulated by the bodyshell structure and work like a loudspeaker transmitting noise.

Further demands on the bodywork

- Good crash behaviour
- Large interior space
- Corrosion resistance
- Low weight
- Good aerodynamic shape

A compromise must be made on some of these points. One example is between high body rigidity for

DESCRIPTION AND OPERATION (Continued)

good NVH performance and good energy absorption in an accident by the use of crumple zones.

Example:

- Watertight does not mean sound tight, therefore the following points must be taken into account:

1. Correct installation of the windows.
2. Correct installation of the seals.

- Further points

1. Openings into the engine compartment
2. Door and window sealing
3. Heater and ventilation openings
4. Sliding roof drainage hoses

- The side and crossmembers in the body structure are often linking channels allowing sound transmission. Possible corrective measures are:

1. Installation of dividing walls at critical points such as the joint between the sidemember and the A-pillar in order to ensure good air borne sound insulation.
2. Installation of foam plugs in affected areas.
3. Filling hollow sections with foam.
4. Sliding roof drainage hoses.

NOTE: Foam pieces and foam filling are used in production to seal air borne sound transmission routes. If wind, tyre, engine or road noise is a problem, the position of the pieces of foam should be checked.