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Clutch Damper for Reducing Clutch Pedal Vibrations

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Abstract - Clutch pedal vibrations in manual transmissions affect driver comfort and control. This study investigates the use of a Clutch Release Line Damper to reduce pedal pulsation without compromising clutch system efficiency. The damper controls hydraulic fluid flow between the master and slave cylinders, absorbing vibrations through volume expansion and contraction in the damper chamber. Four dampers tuned at different frequencies ('A' Hz, 'B' Hz, 'C' Hz, 'D' Hz) were tested at various engine idle speeds (800, 1500, 2500 RPM). Results show the 'B' Hz tuned damper provided optimal vibration reduction across all conditions. These findings shows that proper frequency tuning of the damper improves pedal comfort while maintaining system responsiveness.

Keywords - Clutch Release Line Damper, Anti Vibration Unit, Clutch Pedal Vibration, Hydraulic Clutch System.

I. INTRODUCTION

Clutch Pedal vibration remains a challenge in manual transmission systems, impacting driver comfort and control precision. Clutch Release Line Dampers (CRLDs) provide an innovative solution by utilizing hydraulic fluid volume changes to absorb and reduce vibration energy transmitted through the clutch system. This study investigates the operation, design, and effectiveness of CRLDs combined with Anti Vibration Units to minimize pedal pulsations under various operating conditions.

Torsional vibrations generated during clutch engagement and disengagement are transmitted through hydraulic lines to the pedal assembly, often causing uncomfortable pedal oscillations. Traditional damping methods may reduce these vibrations but often compromise pedal responsiveness. The CRLD system dynamically adjusts damping characteristics based on vibration frequency and amplitude, achieving a balance between vibration reduction and pedal feel.

Working Principle of the Clutch Release Line Damper

The Clutch Release Line Damper is installed within the hydraulic line connecting the clutch master cylinder (CMC) and the clutch slave cylinder (CSC). It contains a chamber with a membrane valve that opens and closes depending on fluid pressure. During clutch disengagement, fluid flows from the master to the slave cylinder as the membrane opens, allowing smooth pressure transfer. Conversely, during engagement, fluid returns when the pressure exceeds the valve's threshold, moving the membrane accordingly.

At the pedal's resting position, hydraulic pressure is minimal, allowing the damper to filter vibrations originating from the slave cylinder effectively. As the pedal moves, fluid pressure changes cause the damper chamber to expand or contract, absorbing vibrations and decreasing their transmission back to the pedal.

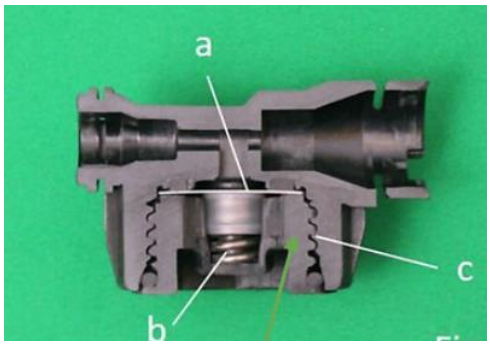

Figure 1: Clutch Release Line Damper
[Source – Google / Valeo]

Experimental Setup and Testing Conditions

Four Clutch Release Line Dampers, each tuned to a specific natural frequency— 'A' Hz, 'B' Hz, 'C' Hz, and 'D' Hz—were evaluated. Measurements were taken at every 10 mm of pedal travel under idle engine speeds of 800, 1500, and 2500 RPM. Testing encompassed different engine types to observe the effect of powertrain characteristics on damper performance.

Accelerometers mounted on the pedal recorded root mean square (RMS) acceleration values (m/s^2) to quantify vibration magnitude. Data analysis focused on identifying which damper frequency offered optimal vibration attenuation across the operating spectrum.

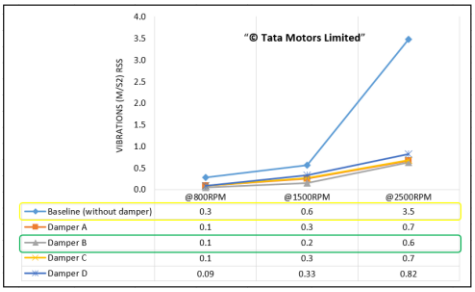

Chart -1: Pedal Vibrations with & Without Damper
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II. CONCLUSION

Clutch Release Line Dampers equipped with Anti Vibration Units demonstrate effective vibration attenuation by dynamically adapting to changing fluid pressures in the clutch system. Among the tested configurations, the damper tuned to 'B' Hz provided the best overall performance. Future work should explore enhanced damper designs for improved durability and interface with active vibration control systems.

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