Development of Isolated Needle Bearing

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Automotive drivetrains are complex mechanical systems that generate a wide range of noise & vibration. Automakers are continuously working to improve or suppress the noise & vibration in order to meet the needs of the market for a quiet and comfortable car. JTEKT has developed & produced a small isolator which attaches to a roller thrust bearing for controlling the noise produced by the bearing or transmitted through it by the drivetrain. The developed product reduces noise on average by 10 dB and minimized the potential of increased weight. This report presents a revolutionary product which reduces application noise and vibration by the addition of an isolator to a conventional bearing.

Key Words*: noise & vibration, NV, isolator, thrust needle roller bearing, automatic transmission, compact*

1. Introduction

Passenger comfort is an ever increasing priority in the automotive market. The modern automobile is a complex assembly including mechanical systems which generate various levels of noise & vibration (NV).

NV must be regulated to ensure the quietness of the automobile system.

Rolling bearings are a component used in the drivetrain which not only increase efficiency but also contribute & influence NV. JTEKT has taken the initiative concerning NV within thrust needle roller bearings used in automatic transmissions (written in following as "AT", **Fig. 1**).

The following introduces the innovative new technology of the compact bearing isolator (**Fig. 2**), which dampens bearing vibration and enables system level NV reduction.

2. Baseline

An evaluation was carried out to assess the influence of thrust needle roller bearings to passenger comfort of AT equipped automobiles.

2. 1 Test Piece

To understand the current situation, two thrust needle roller bearings were obtained from ATs with and without acceptable NV.

2. 2 Test Equipment/Test Conditions

The test equipment in **Fig. 3**, installed in an anechoic room, is used for the bearing-only NV evaluation. The test conditions are shown in **Table 1**.

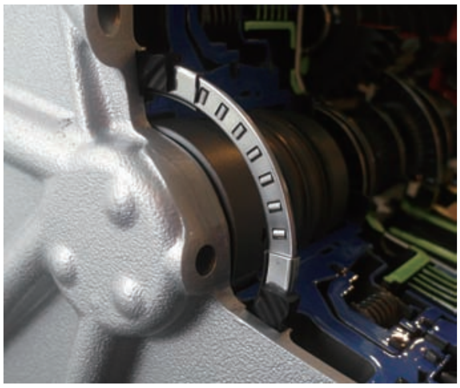

Fig. 1 Thrust needle roller bearing isolator for Automatic transmission

Fig. 2 Developed isolator & bearing assembly

The test equipment was developed specially to measure and analyze the characteristics of NV created by thrust roller bearings at differing speeds and loads.

NV characteristics were analyzed through audible sounds and vibration signals using a microphone and an accelerometer, respectively.

The accelerometer is mounted onto the top plate, where only the vibration of the test bearing is transmitted.

2. 3 Test Results

Results for the bearing-only test and general inspection are compiled in **Table 2**. The results of these two tests confirmed that there were no differences in the bearings.

Since the bearings did not produce a vibration difference, attention was focused on the transfer of vibration within the AT, with the development objective of reducing vibration transfer across the bearing.

Table 1 Test condition

Dynamic Load Rating (C)	13.8 kN
Test Load	1.62 kN
Rotational Speed	1 000 min^{-1}
Lubrication	ATF drop

Table 2 Test result

	Noisy AT	Quiet AT
Bearing only NV test result	84-86 db	84-86 db
Bearing Inspection result	OK	OK

AT：Automatic transmission

3. Product Development

An NV characteristic improvement plan was established and confirmed.

The development results are shown below.

3. 1 Layout Proposal

The placement of a material with superior damping characteristics in between the bearing and housing was proposed as the basic layout to reduce vibration transfer.

A high-polymeric material was placed on the location shown in **Fig. 4**, to act as the component which blocks or isolates the vibration transfer pathway.

The high-polymeric material must have an optimum structure able to preserve the durability of the roller bearing and must provide cost effectiveness, productivity, and compactness, while exhibiting the maximum damping properties.

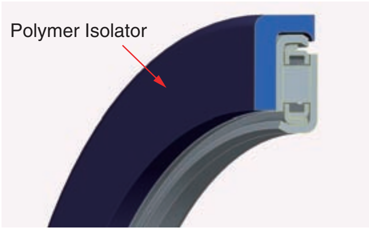

Fig. 4 Original concept layout

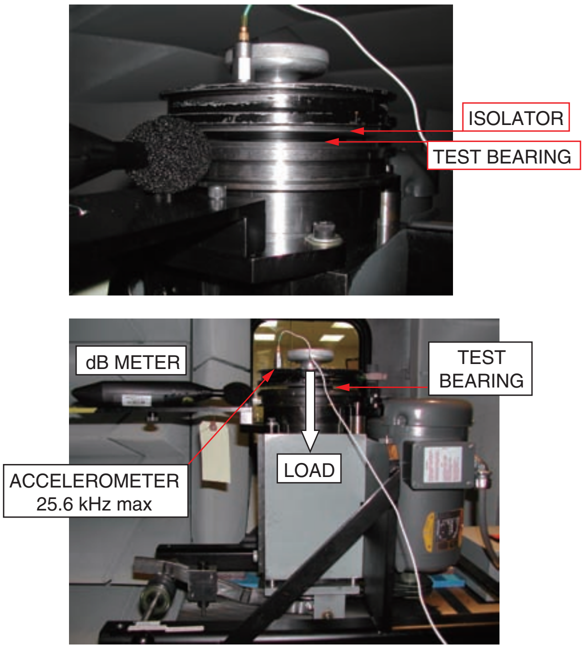

Fig. 3 NV test equipment

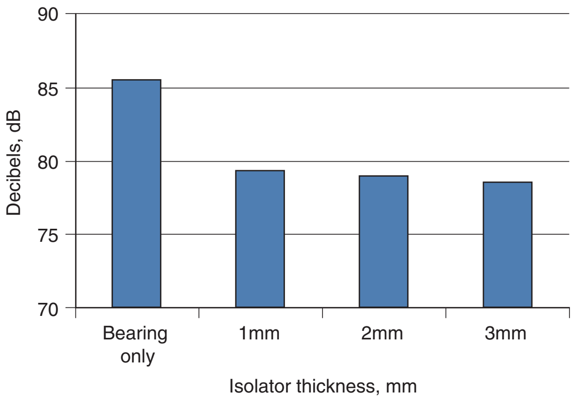

Fig. 5 Isolator thickness effect

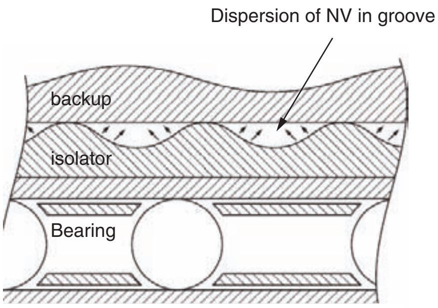

Fig. 6 Groove function

3. 2 Isolator Optimization
3. 2. 1 Isolator Material

A reinforced polyamide (with an excellent AT performance history) was selected as the isolator material.

3. 2. 2 Isolator Thickness

The test results shown in **Fig. 5** demonstrate the influence of isolator thickness on NV. The application of a reinforced polyamide isolator was verified to have a remarkable reduction in NV. It was also confirmed that NV has a tendency to drop with an increase in isolator thickness.

3. 2. 3 Innovation

Next, methods to further reduce NV while maintaining or reducing isolator thickness were examined.

As shown in **Fig. 6**, grooves were cut in the backup side of the isolator, forming a structure to disperse the vibration.

The groove styles are arranged in three types, shown in **Fig. 7**.

The A type features grooves perpendicular to the rolling direction of the roller; the B type features grooves at an angle to the rolling direction; the C type features angled grooves which increase in width from the inside to outside diameters.

Samples of each were used in tests under the conditions of both the test equipment in **Fig. 3** and in **Table 1**. The test results are shown in **Fig. 8**.

The C type produced the best results, verifying that groove angle combined with increasing groove width was the most effective.

3. 3 Final Isolator Specifications

Since the grooves dramatically improved the NV performance, the thickness of the isolator was reduced to minimize the weight and packaging impact on the AT system (**Fig. 10**).

Similarly with the comparison of NV for the conditions in **Table 1** and the test equipment in **Fig. 3**, the results shown in **Fig. 11** confirm the vibration dispersion effects of the grooves were more effective than increasing the thickness of the isolator.

The improvements of NV characteristics are shown over the entire frequency range in **Fig. 12**.

4. Conclusion

The developed compact bearing isolator was successful in meeting the needs of the market concerning comfort, cost & packaging and is now in volume production.

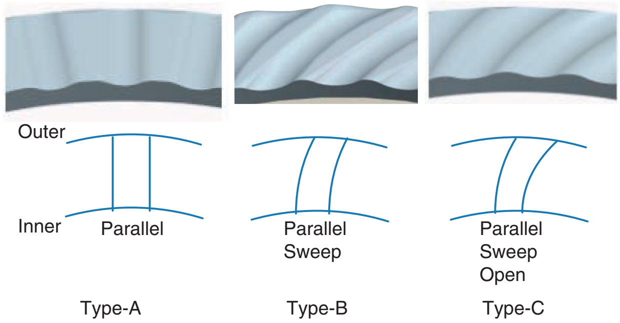

Fig. 7 Groove style

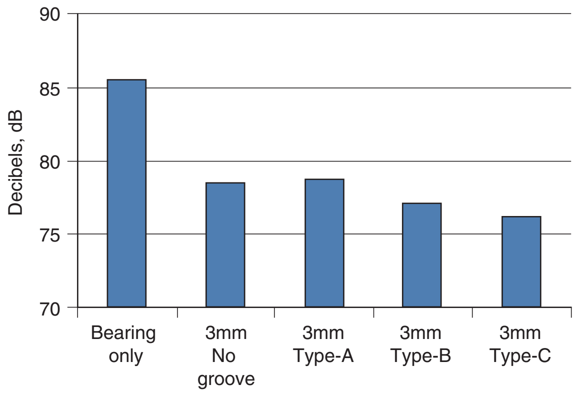

Fig. 8 Groove effect

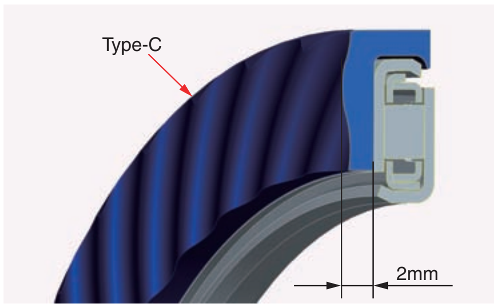

Fig. 9 Final result

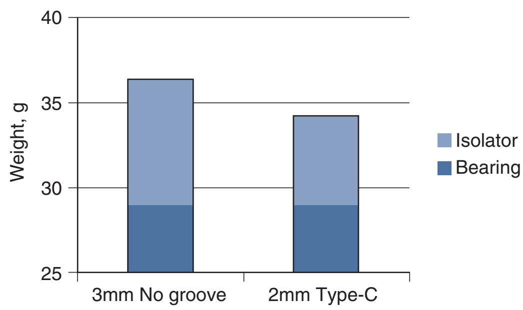

Fig. 10 Weight benefit

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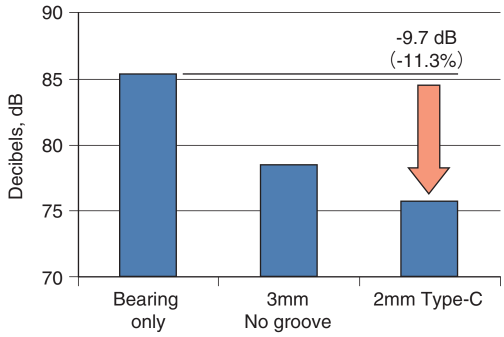

Fig. 11 NV benefit

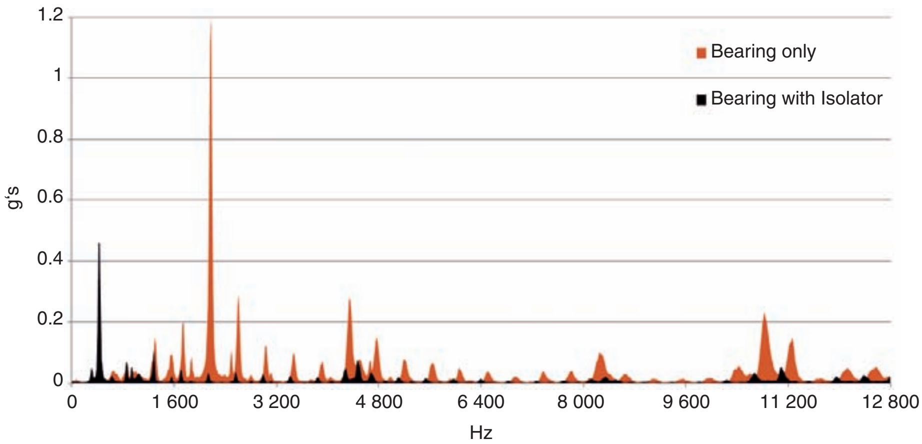

Fig. 12 FFT comparison data

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