MERCEDES-BENZ TRANSMISSION

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PROPER VACUUM SYSTEM "TUNING" ACHIEVES OPTIMAL SHIFT CHARACTERISTICS AND AN ACCURATE REPAIR

Pneumatics, or air pressure control, is a common item in all cars. However, nobody uses it as extensively as does Mercedes-Benz. Many have used it only for off-on control of timing and emissions devices.

M-B has extended off-on control to the following items: Door locks (brought out in the ‘60s), seat back locks (two-door models), A/C mode door controls, door closing assist (pulls doors to final lock on ‘92 and up S-Class car doors and trunk), seat lumbar support controls and other devices, such as the position indicators that rise from the trunks of S-Class cars. Variable control also has been used for such things as cruise control, variable EGR control and intake manifold pressure regulation in turbo diesels.

Probably the most interesting of these variable controls are the ones that M-B uses for shift control in M-B diesels. It’s interesting because the engines have no manifold vacuum, actually having positive pressure most of the time in turbo-diesels (they run with small boost at constant highway speed). These vacuum-controlled transmission systems appeared in the first 300SD in 1978. That system was pretty simple. All subsequent systems added more layers of control. Variations of this system are on all M-B diesel automatic transmissions until electronic control took over in 1996.

The basic idea was to create a system that presented vacuum to a transmission modulator. The trick was to simulate the vacuum-to-load relationship in a gas motor. With a gas motor, under heavy load the vacuum would be low as the throttle would be fully open. These diesels have no throttle so there never is any vacuum; the only differences in manifold pressure occur during boost.

What makes this system so special is the variety of ways the system can be adjusted. The basic book adjustment might work for an out-of-the-box, by-the-book transmission. As it happened, M-B made numerous after-production changes to these transmissions. The combinations of pieces and the variety of wear conditions cause these transmissions to exhibit numerous offensive shift conditions. Among these, the number one condition in diesels is a harsh 1-2 shift. The next most common is a 3-4 shift flare. Others include double shifts into either 3rd or 4th, harsh 4-3 downshifts, and various shift overlap and sequence irregularities.

There are many ways of approaching the shift conditions of these transmissions, specifically the 722.3/4 M-B units made from 1981 to 1995. Many of the conditions should be properly handled with internal repairs and modified pieces.

The B1 band was reduced in friction coefficient in the early ‘80s. This allowed a softer 1-2 shift. With the original band, the shifts were very harsh into second gear, unless the modulator (and thusly shift) pressure was lowered. Lowering the modulator pressure would reduce the later shifts to such a degree that slipping or flaring would occur. The new band is MB #126 270 18 62 and should always be replaced on units through 1983.

The variety of 2-3 and 3-4 shifts is increased in older transmissions by leaks in the clutch pack seals. There are seals within the clutch drums K1 and K2 that require rivets to be drilled and rebuilt. This probably doesn’t happen in many rebuilds. The B2 band servo piston has been redesigned, reducing the loss of pressure during release as part of the 3-4 shift (new part M-B #107 270 04 32). The valve bodies were modified numerous times and M-B offers a reasonable valve body exchange program that both addresses repair concerns and the improvements they have found to reduce some shifting sensitivities.

Normal wear and tear changes the state of the various conditions mentioned above. All of these conditions present the technician with a number of decisions to make. The first is whether to repair or replace the unit. In the case of the vacuum-controlled M-B diesels, many a tech has condemned the unit when all that was needed was a vacuum system repair/adjustment. The real problem appears once the unit is changed and the condition still exists or, as often is the case, it changes (every tranny has a separate set of adjustments that are most appropriate).

ADJUSTMENT VS. REPLACEMENT

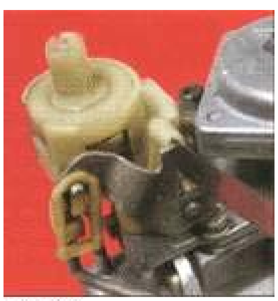
Figure 1

The ability to adjust the vacuum control system can save many a transmission. With proper tuning, this system can significantly alter the performance of these vehicles. Most important is that the conditions change gradually, and with respect to each other, through the life of the transmission. As a result, the ability to "tune" this system can be a real important part of a properly done service.

An understanding of the system is necessary to adjust or repair it. The vacuum starts with a vacuum released from the brake booster supply line.

Note: I will refer to vacuum as a commodity, as thinking of it in quantities helps the understanding.

The vacuum source is a mechanical pump run off the injection timer. The "quantity" of vacuum is most important and is achieved by allowing flow of vacuum through a specifically sized orifice to the modulator. Control is done by leaks. A proportioned vacuum leak is attached in parallel. The leak is achieved by a valve attached to the injection pump (see Fig. 1 and Fig. 2) and regulated by a lever attached to the throttle linkage. The leak increases with throttle rotation.

The system works right when a high vacuum of 10-15 in. diminishes to zero at full throttle. It is most important to note that achieving the ideal vacuum depends most certainly on the proper volume of the vacuum source. Since the leak is of a given variable flow, the size of the source is critical. The most common problem I see is total lack of vacuum. This gives even, harsh shifts, slightly delayed in most variations.

Another common problem occurs after someone breaks the plastic source tee. During most of the ingenious repairs I have worked behind, the orifice was omitted. This leaves either a constant high vacuum or a variable vacuum that is skewed high. Either condition causes slipping or flaring conditions. This occurs when the vacuum supply is so great that the proportioned leak is small by comparison, resulting in vacuum that's too high.

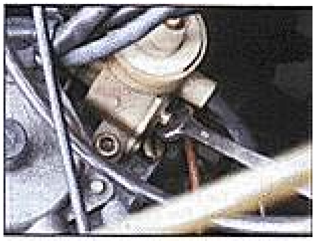
Figure 2


Figure 3

ADJUSTMENT SPECIFICS
Once a proper vacuum curve is created, the real finesse begins. There are a number of possible adjustments. The first is the relationship of the control valve linkage to the throttle lever. The later proportioning valve is mounted to the injection pump and is rotated to achieve this adjustment. The early adjustment is achieved by adjusting the rod length such that the lever reaches within 0.5mm of the full throttle stop (see Fig. 1) with full throttle. The size of the vacuum leak, and thus the range of vacuum, is adjusted on early versions by turning the adjustment under the plastic cap. (See Fig. 2).

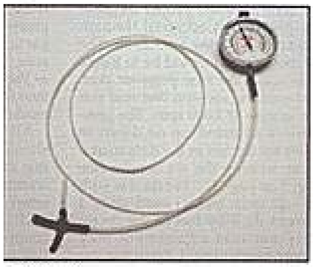
Figure 4

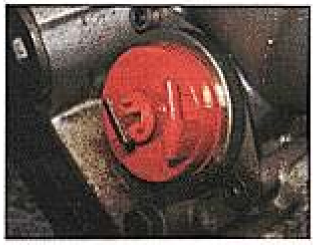
Figure 5

The later version has all of its adjustment in the rotation of the valve mounting (pointed to with a pen in Fig. 3). All adjustments should be monitored with a vacuum gauge and should be done in small increments. A useful tool is created with a standard vacuum gauge, 3 meters of M-B hard vacuum line (M-B #000 158 14 35 - costs a little over a dollar a meter) and one rubber vacuum tee (M-B #117 078 01 45, see Fig. 4). This will allow monitoring while driving (also a necessity to learning the various overlapping adjustment strategies and boost pressure monitoring).

The proportioning valve adjustment allows the range of vacuum to be expanded. For example, a range of 10 in. to 0 in. could be expanded to 12 in. to 0 in. or 15 in. to 0 in. and, in some instances, raised above zero (such as 12 to 2). Generally speaking, a wider range is better, but older trannies with a lot of clutch wear often benefit from a reduced range. Worn clutches are more susceptible to shifts at low pressure. By adjusting to a smaller range and reducing the basic modulator pressure, a slow shift can be modified. Moving the vacuum range also has been of use to cover up valve body problems concerning shift spacing (for example an early shift into 2nd or 3rd).


Figure 6

All vacuum adjustments should be done after the proper modulator pressure is achieved through adjustments at the modulator. The proper method would be to install a gauge at the case pressure port. Remove the vacuum line and run the engine at 2,000 rpm. The pressure is adjusted up or down to meet the figures in the data manual by turning the tee handle (see Fig. 5). We do this with rebuilt units but, in


Figure 6

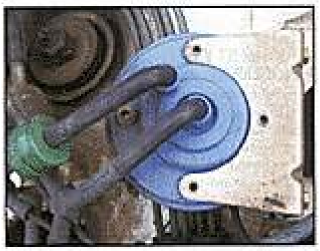
Figure 7


Figure 8


Figure 9

used units, I always do it by feel as the necessary vacuum adjustment may never reach zero. I drive the car full throttle (monitoring the vacuum) and set the modulator such that these shifts are appropriately firm. All the other shifts are modified from this point using the above adjustments. The range of vacuum and its relationship to throttle movement can be varied to achieve relief from the internal problems described above.

As one is varying the above adjustments to achieve shift quality, one more adjustment comes into play on this basic system. That adjustment is the control pressure cable. Control pressure opposes the action of the governor and changes the point of the shift. The basic adjustment on all these transmissions is for the cable to be attached free of play at the point of initial throttle take up (See Fig. 6).

In practice, the shift point can be altered to achieve some measure of control during certain flaring conditions. The most common flare occurs in the 3-4 shift, with some occurrences in the 2-3 shift. The flaring condition exists due to a lack of shift overlap caused by slow filling of a clutch pack either through greater fluid volume needs of loose clutch packs or fluid losses through pack seal leaks (described above). Early cars also had the condition due to low shift pressures, adjusted to keep the 1-2 shift tolerable. Cars with this condition can have their relative shift pressure improved by getting the high shifts sooner so they will be made with greater throttle, giving lower vacuum and greater pressure. If the shifts are made as the throttle is backed off, then the pressure drop in the modulator is very high.

All testing and repairs should be done after viewing the pertinent vacuum schematic, as the system is intertwined with supply of EGR and intake pressure control systems. The system has various other controls depending on installation. On most models, the vacuum is not tied to the proportioning valve until some throttle is taken up, closing a vacuum microswitch on the valve cover. This keeps the vacuum high at idle which keeps some models in second gear until throttle take-up. It also reduces the closed throttle downshift to an almost undetectable level.

The most important modification came with the 1985 model and is continued on all subsequent ones. It involved the addition of a vacuum amplifier to the system (see Fig. 7). The amplifier takes a large vacuum supply, the proportioning vacuum signal and a boost signal and creates the final signal to the transmission. This device did two things. First, it incorporated the input of boost to further tailor the load control of the modulator vacuum signal. The vacuum at the modulator now starts high - 12-17 in. - and is reduced to about five inches through straight throttle movement. As boost builds, the vacuum is further reduced to zero only at full boost.

The second thing this system did was reduce the sensitivity of the final signal to small changes in the proportioned signal. When this signal went straight to the tranny, a

10-20% fluctuation due to linkage or vacuum conditions (the orifices are very susceptible to diesel soot restriction in any of the orifices) caused great changes in shifting. With the amplifier, the proportioned signal is just one input and the output averages out the variations. Shifting in diesels was never better at this point.

Since these systems are designed to fashion the shift characteristic to load through basically mechanical linkages, it is imperative that throttle movements give appropriate power output. In other words, if the engine doesn't run right it will shift wrong. This always has been the case, but is especially true in these systems.

For these fuel systems to deliver the extra fuel required with boost (more air needs more fuel), an aneroid is attached to the governor mechanism. It alters fuel metering due to both altitude changes and intake boost changes. The pressure signal from the manifold is regulated for overboost conditions by a switchover valve (See Fig. 8) in the line. The valve is often sooted closed causing no signal to reach the aneroid. This severely restricts power. The line also clogs at the banjo fitting on the intake. If I doubt the power, I always use my vacuum gauge arrangement (see Fig. 4) to verify boost before adjusting the transmission. I check to see that smooth boost occurs and reaches 9-10 psi. It also must drop immediately with released throttle. I usually check the boost at the aneroid signal line to the vacuum amplifier (see Fig. 9). This is easier and it also monitors the signal where it is used.

I would have liked to give the exact formula to each condition, but I feel that every transmission is different and the moves are unending. I believe that it is much like playing music by ear. Driving the car, visualizing the condition and using the relationships to modify the condition. It is the best part of being a technician.

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