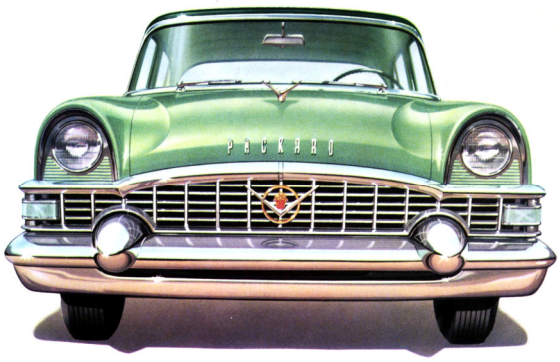
Some thoughts on the

Allison-Packard Torsion-Level Suspension



A Practical Guide To A Perfect Ride

Editorial contributions from Walter McCoskey and Mark Allison

When the 1955 and 1956 Torsion-Level Packards and Clippers were new, they rode and handled unlike any other automobile. I do not believe that it is an overstatement to say that the Allison-Packard Torsion-Level Suspension is the finest automobile suspension ever made, and remains without peer after 62 years. Cars of the time through those of today simply do not compare favorably.

Many Torsion-Level Packard owners today may believe that their car's suspensions are performing reasonably close to the original design parameters and may not be aware of the subtle changes that have occurred over the years. It's difficult or perhaps impossible for an owner to remember exactly how a car performed when it was new compared with how it performs, say, at 10 or more years and at 50,000 or more miles, even if he or she was the original owner. So, I don't believe that there is a Packard owner of today, including those few who bought them new, who remembers exactly how their 1955 or 1956 Torsion-Level car should ride and handle, or what the proper riding height should be. There is no longer a basis for comparison. As good as a TL Packard still rides, the characteristics of that ride are not the same, or as good, as when the car was new.

Since 1969 I've owned seven Torsion-Level Packards including the three now in my collection. My experience with these cars is that the rubber bushings in both the front and rear suspension units deteriorate, as do the shock absorbers, which compromise the ride, handling and riding height. For many years now, I've been on a quest to return my three TL Packards to what they were like when new, or at least as close as I can, and to assist other TL Packard owners achieve the same results with their cars.

In about 1972 I had my first direct experience with this, when I had all of the rubber suspension bushings in my '55 Patrician replaced. The shock absorbers were also replaced with appropriate shocks, which were still available from Monroe. The result was an incredible improvement in the riding and handling experience. It could be that it was very close to that of a new Packard in 1955. After about 60,000 miles it "faded" to something less. Unfortunately, this fine suspension, for the most part, cannot be enjoyed or experienced today, as when the cars were new, for several reasons.

First, Torsion-Level Packards and Clippers are much more dependent on the front rubber suspension bushings than cars with standard suspensions. Front control arm bushings, upper and lower in a torsion bar Packard contribute to its unique, controlled level ride, as well as insulating the body against road shock. The control arm bushings in a TL Packard are critical in maintaining the body in a level attitude while the wheels are moving up and down, during normal driving conditions. The rubber material encased in the metal shells wants to return to the neutral, or level, position every time there is a deviation from that neutral or level position. Changes from neutral occur every time the wheels move up or down as they respond to changes in road conditions (bumps and undulations). The metal shells move, or rotate, with the movement of the control arms. The rubber material inside the metal shells absorbs the rotational forces within itself and then wants to return to neutral, like a rubber band. These same bushings in a standard suspension car serve the same function BUT primarily insulate the body against road shock. Packard front control arm rubber bushings, first used in 1953, are the same for Torsion-Level and standard suspension cars. The rear rubber suspension bushings are unique to Torsion-Level Packards. Deterioration of the rear rubber bushings has a serious negative effect on riding height, on leveling

and in the superior ride and handling qualities of the unique full-length torsion bar suspension. When there are changes in load - number of passengers, luggage, gasoline in the tank - the short torsion bars are automatically wound or unwound by the electric motor and gearbox to adjust the load on the long torsion bars by raising or lowering the rear of the car to maintain level.

A second problem is that available after-market shocks are tuned to be very resistant to jounce and rebound;* in other words, they're too stiff. Control of rebound is the primary job of the shock absorber. The original shocks used on TL Packards had special valving and one-inch internal pistons, which today would be considered a standard duty shock. Fortunately, a similar shock made by Kayaba (KYB) is available. Shocks that are too stiff, even those with perfect bushings, negate the experience of the interconnected suspension, lessening the ride to that of a standard suspension car.

How it Works

In a Packard with standard suspension, with no connection between front and rear suspensions, the springs and shocks keep the car steady and prevent the front and rear ends of the car from most wild up and down movement when driving on rough roads. When hitting a bump, the front of the car goes up and down in a controlled fashion (if all of the springs and shocks are in good condition), and then the rear of the car goes up and down when it encounters the same bump. The interconnected Torsion-Level suspension works differently, and the principles were explained in a paper delivered to the Society of Automotive Engineers (SAE) by Forrest R. McFarland, Packard's Chief Engineer in Advanced Engineering, at Chalfont Haddon Hall in Atlantic City, NJ, in June, 1955:

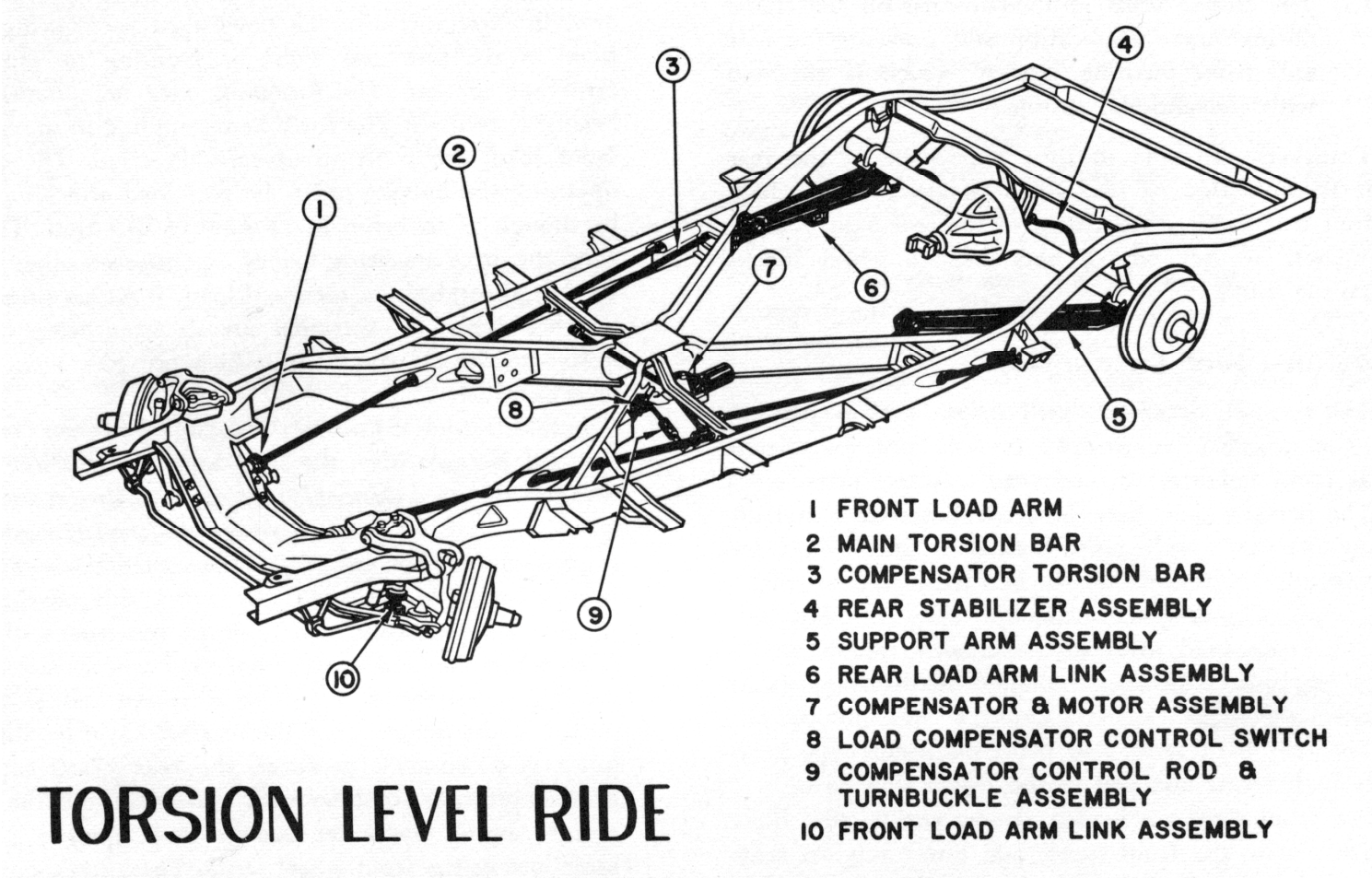
> "When the front wheels encounter a bump, the wheels rise, twisting the [long] torsion bars by the front suspension linkage... The increase in twist [load] in the bars causes the loading of the levers at the rear end of the bars to increase, thereby increasing the loading [downward] of the rear wheels... The net reaction of the rear torsion bar levers and torque arms appears on the rear of the frame upwardly... This increase in upward loading is simultaneous with the increase in upward loading at the front... <u>The result of these two loads appears near the center of gravity of the car fore and aft, tending to lift the car without an appreciable pitch effect</u>. The action of the suspension when the rear wheel goes over a bump is the same as that of the front wheel just described." (Underline added).

Bill Allison summarized it less scientifically, quoting the old proverb: "Problems shared, problems halved."

In a film made in 1955 showing Bill Allison's new 1955 Patrician, his neighbor's new 1954 Cadillac, and another neighbor's new 1954 Lincoln, all driving over an incredibly horrible intersection with railroad tracks on Woodbridge Street in downtown Detroit, the Cadillac and the Lincoln both reacted somewhat violently, with up and down movement in front and rear that was about as bad as any car would encounter. The Packard floated across the same intersection with virtually no up and down movement. I mention this because the Allison-Packard suspension is so good that even the worst possible conditions encountered have little affect on the car's ability to remain level. This is an extraordinary achievement.

In a torsion bar Packard, where the torsion bars interconnect the front and rear suspension, the front control arm bushings serve a critical purpose in addition to isolating the body from road shock. They add a controlled resistance to jounce and rebound motion that is transmitted along the length of the torsion bars, where front upward movement is translated into a downward movement in the rear, and vice versa, which results in a mild, controlled vertical pitch along the entire car, instead of two hard, quick up and down reactions in a standard suspension car with separate front and rear springs. To reiterate this important point, a torsion bar Packard is "relatively pitch free under most normal conditions," to quote the SAE Paper, page 12. Pitch is the see-saw like movement of the car body.

Torsion bars are simply straight springs. Where conventional front and rear springs increase and decrease their compression force with each up and down movement when hitting a bump, the full-length torsion bars respond to road bumps by gently increasing and decreasing the amount of twist in the bars causing the reaction to each bump to be distributed evenly along the torsion bars' length, thus minimizing the reaction felt by the passengers and allowing the car to float and remain relatively level over uneven terrain.



The Fix – Part One

The riding height of all torsion bar Packards was adjusted at the factory by the use of front links of varying lengths. These vertical links are located between the front load arms and the lower control arms, and transmit up and down movement of the front wheels to the torsion bars. Sometimes longer links are installed to increase ride height, but there is a limit to the length that can be used. Replacing the suspension bushings should always be performed before changes are contemplated in the links.

Replacement of the front rubber bushings with new rubber bushings provides a temporary improvement, similar to my experience in 1972 with my ’55 Patrician. The material used remains the natural rubber, released by production at Packard, that deteriorates within a few years and is further reduced in effectiveness by oil and grease contamination, which dissolves the rubber. However, new rubber bushings, made by the OEM, Clevite (division of Tenneco), are recommended, and by coating them with liquid Neoprene (not liquid vinyl) will greatly extend their lifespan by protecting the rubber from ozone and oil and grease contamination. The rubber bushings are inexpensive and will perform very nicely with the protection of the Neoprene coating.

The rear bushings on a 1955 torsion bar Packard last much longer than the 1956 type, which are smaller. The 1955 cars have four upper rear bushings of one design and four lower bushings of a different design, divided between each side. All eight of the 1956 rear bushings are the same. Because the 1956 bushings are smaller and deteriorate more quickly, Walter McCoskey, of Packard Advanced Engineering, recommends using the larger 1955 type bushings when replacing those bushings on all 1955 and 1956 torsion bar Packards. Only one slight modification is needed on a 1956 Packard to allow use of the 1955 type rear bushings. That is the addition of one 1" diameter by 3/16" thick spacer to each of the four metal tubular spacers that are inside the bushings. The 1955 spacers are 3/16" longer than the 1956 type because the 1955 type bushings are larger. The U-bolts on the 1956 cars are long enough to accommodate the changes.

Walter McCoskey was part of team of engineers, including Bill Allison, who designed torsion bar suspension for production. Bill Allison's invention of full length torsion bar suspension, as manifested in his Cycle-Car demonstration vehicle, was designed by the Packard Advanced Engineering team for use in Packard and Clipper cars, with design work beginning in 1951, after approval of the project under president Hugh Ferry.

As for the automatic leveling feature, some owners experience a situation where the car constantly levels. Up and down, up and down. This is caused by worn front control arm bushings that no longer provide constant resistance to jounce and rebound, and deteriorated rear suspension bushings. The car cannot maintain a level posture in normal driving with worn front bushings, even when there are no changes in load due to changes in the number of passengers, cargo in the trunk or the amount of gas in the tank.

While the advantages of any new feature on an automobile are not fully achieved initially, usually within a year or two the engineers and production experts can achieve the desired results. With this in mind, consider the fact that Packard Engineering and Manufacturing had only eighteen months' in-service experience with torsion bar suspension-equipped cars, from roughly January of 1955, when the new 1955 models became available, through June of 1956, when production ended. This is a very short time span in which problems could be discovered and corrected. Pre-production testing at the Proving Grounds over a three-year period disclosed certain areas where improvement or changes were needed. But this experience is no substitute for the problems that may be encountered over many years in regular service.

One such problem area, mentioned above, is the rear axle suspension bushings on the 1956 models. For some unknown reason, the 1956 rear suspension bushings are smaller than the ones used in 1955, which compounded the problems encountered in service. Unfortunately, Packard Engineering was disbanded during the latter half of 1956 and, therefore, corrections to problems that were manifest before and after this time were not implemented. Another area of concern are the front upper control arm bushings. When I first met Bill Allison in the early 1970s, he told me that he wanted to use larger upper bushings, but Packard would not agree due to tooling cost. However, the production bushings provide excellent service if they are in good condition and are properly tightened.

The Fix – Part Two

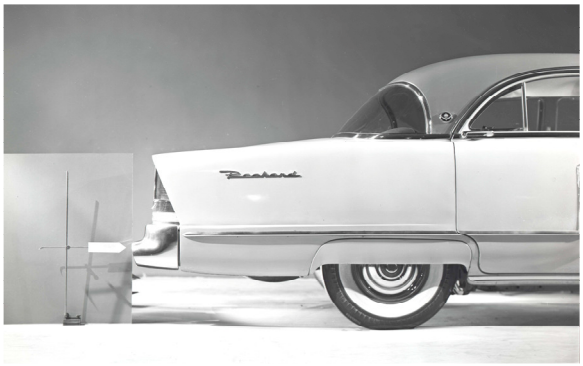
To this point I've explained my efforts to restore the Torsion-Level ride characteristics to what I hope are very close to the original, but have also identified that replacement rubber components degrade and eventually must be replaced again. I discussed this with my friend and fellow Packard owner, Scott Raswyck, an expert in elastomers, inquiring if the rear rubber bushings could be replaced with some material that would have longer life, provide more resistance to jounce and rebound and would be impervious to oil and grease contamination. After many months of consultations with him and Walter McCoskey, Scott decided that a generic compound called "polyurethane" might fit the bill. Further complicating this process was the need to select the correct Durometer value to use. (The Durometer scale was developed by Albert Ferdinand Shore in the 1920s to determine the hardness of a material). The Durometer of the rear bushings is 65, same as the original rubber (and the front rubber A-arm bushings). Polyurethane is not affected by oil and grease, and is a more resilient and longer-lasting material. Further, the "compression set" of the polyurethane is superior than rubber, meaning that it is far less susceptible to being permanently compressed than rubber. In other words, it will hold its shape far longer. Poly also does not rot, is not subject to atmospheric conditions and will not alter its properties due to

age, as does rubber. Front bushings made from polyurethane would cost more than twice as much, are difficult to manufacture so that the poly properly adheres to the metal shells, and they tend to squeak during jounce and rebound. As for riding height, let's defer to what Forrest McFarland says in the SAE paper on the subject: "...parts [torsion bars] are coming through production uniformly enough... Experience to date [June 1955] indicates less loss in riding height in service than present in standard suspensions."

Although Packard's production experience was short - only about six months when the paper was presented - they felt that the torsion bars would not experience a weakness that would affect riding height. Some observations in recent years indicate that some of these cars have a lower profile than normal, and some owners assumed that the torsion bars weakened. I am sure that there was a lack in consistency in the manufacturing of the torsion bars that has adversely affected a small percentage of cars, but a better explanation for most of these vehicles might be that the loss in riding height is due to the deterioration of the rubber suspension bushings. Paul Chuba, of Packard Engineering, told me recently that the "torsion bars are considerably under stressed."

In my case, my '56 Caribbean lost some riding height in just a few years after the restoration was completed in 2010, with all new rubber bushings. The lower rear bushings were flattened. This alone will result in the loss of one to two inches in riding height. The front bushings also were in poor condition, adding to the riding height and constant leveling problems. (This car has the heavy duty, or export bars, which are 1 1/16" in diameter, 1/16" larger than a standard one inch bar. The extra heft does not affect riding height, but stiffens the ride almost imperceptibly.)

A V8 convertible's shipping weight is about 5,150 pounds, compared to about 4,700 pounds for a Patrician or Four Hundred (slightly less for a Clipper), with the same equipment (my car has factory air conditioning, which adds 125 pounds). Therefore, a Patrician, Four Hundred and Clipper with all new rubber and poly bushings will have, perhaps, an even more striking transformation into an "as new" riding quality, due to the lighter weight and standard 1" diameter torsion bars.



The method to determine proper riding height is contained in Packard *Service Technical Bulletin*, No. 55T-1, dated January 17, 1955, "...With the car resting on its wheels on a level floor, measure the distance from the floor to the flat section near the outer edge on the bottom of the body side sill directly below the center pillar post. The correct riding height at this point should be about 10"...a 3/8" variation from one side to the other is considered normal..." The car in question was a 1955 Patrician; other body types might vary somewhat. In the photo is a 1955 Patrician prototype, dated 11/4/1954. The hexagon in the wheel cover is mostly visible. Its position relative to the underside of the fender skirt depends upon the length of the front load arm links, the weight of accessories and other factors.

Also, correct tire size is important. 1955 and 1956 Packards and Clippers used an 8.00x15 and 7.60x15, respectively. They are about 29" in diameter. An equivalent tire size must be used. Diamondback Classics has a fine radial tire, size 7.00R15 that is an ideal replacement. PAC Region Mid Atlantic Packards is an agent for them. A suggested whitewall width for a V8 Packard or Clipper is 3 1/4". Contact Dale Mease in Maryland at measey@atlanticbb.net

If you are interested in transforming your TL Packard or Clipper, I have the new poly bushings available for sale, in sets, for the REAR suspension, and new rubber Clevite bushings for the front, plus new pivot pin seals. They come with instructions for replacement, and include the Watts Linkage*** poly bushings and the 3/16" rear spacers for use on 1956 models, and a copy of bulletin 55T-1. The time and effort required for the transformation may be daunting to many Torsion-Level Packard owners. However, it will be rewarding!

A front torsion bar holding tool will be needed to replace the front upper and lower A-arm bushings. They are available from me, at $275.00, including shipping.

The correct name for the S-shaped rear "sway bar" that journals the rear axle to the frame is the ***Watt's Linkage***. It provides a level of stability to the car and also helps to keep the car from swaying when cornering. The Watt's Linkage bushings are rubber and wear quickly due to the tremendous stresses involved on these small bushings.

Kayaba / KYB shocks are available from NAPA, Rock Auto, Summit Racing, et al. Front shocks are KYB part number 343127; rear is 343149. The front shocks have a crossbar on the bottom and fit all 1956 models. Remove the crossbar and weld a stud in its place for use on 1955 models. The rear shocks fit both years. A set of four KYB shocks can be had for about $125.00. I determined that Monroe and Gabriel do not make shocks that are suitable for Torsion-Level Packards, after consulting with their technicians and finding that the minimum size internal pistons that each company makes today is 1 3/16" diameter. These are simply too stiff. The KYB shocks have internal pistons of 1" diameter, which is what the Packard parts book specifies, and is a standard duty shock; it is nearly identical to the specifications of the original shocks, which were made by Monroe.

If I may be of assistance to anyone in their endeavor to follow the tips here, please contact me. (410) 329-3022 Eastern Time. packardcars@comcast.net

* **Jounce and rebound**. The upward suspension travel that compresses the spring and shock absorber is called the **jounce**, or compression. The downward travel of the tire and wheel that extends the spring and shock absorber is called **rebound**, or extension. Courtesy of Monroe shocks.

****The Packard Advanced Engineering team** included William D. Allison, inventor, who was a paid consultant to Packard and had an office in the Packard Engineering section in Building 22 (former Merlin Engine building, at the extreme north end of the plant), Walter F. McCoskey, who kindly advised me throughout this project, Forrest R. McFarland, George H. Joly, Erwin Weiss, W. E. Macke, G. McNally and Michael J. Kollins, in conjunction with the Manufacturing Dept. There were, of course, other contributions from Packard Engineering, and the development team at one time numbered 15. Packard Production Engineering was a separate group of engineers who assumed responsibility for the new suspension after production began, revisions made on the 1956 models, and a major revision for the planned 1957 Detroit-designed models, upon which the ***Predictor*** was based.

***** **Watt's linkage** (also known as the **parallel linkage**) is a type of mechanical linkage invented by James Watt (1736 –1819) in which the central moving point of the linkage is constrained to travel on an approximation to a straight line. It was described in Watt's patent specification of 1784 for the Watt steam engine. It is also used in automobile suspensions, allowing the axle of a vehicle to travel vertically while preventing sideways motion. Thanks to Wikipedia.

Author's note: The only other make to offer a ride that might be somewhat comparable to Packard's, I am told (but have not experienced), is the Citroen DS, SM and CX built from 1955 to 2005, according to my friend and Citroen & Packard owner, Paul Delaney.

Allison home movies are available from Packard Club Region Motor City Packards. This DVD is the movie made of the Cadillac, Lincoln and Packard driven over that horrible intersection on Woodbridge St. in Detroit, in 1955, plus more. Some of the Packard Engineers can be seen in this film. Bill Allison allowed me to drive his ***Allison Cycle-Car*** demonstration vehicle over that intersection in September, 1971, with the expected wonderful results. The street was pretty awful then, but no longer exists.

I am grateful for assistance with this article and guidance in developing the new polyurethane suspension bushings from elastomers expert Scott Raswyck, Walter McCoskey and Paul Chuba of Packard Engineering, and Bill Allison's son Mark Allison.