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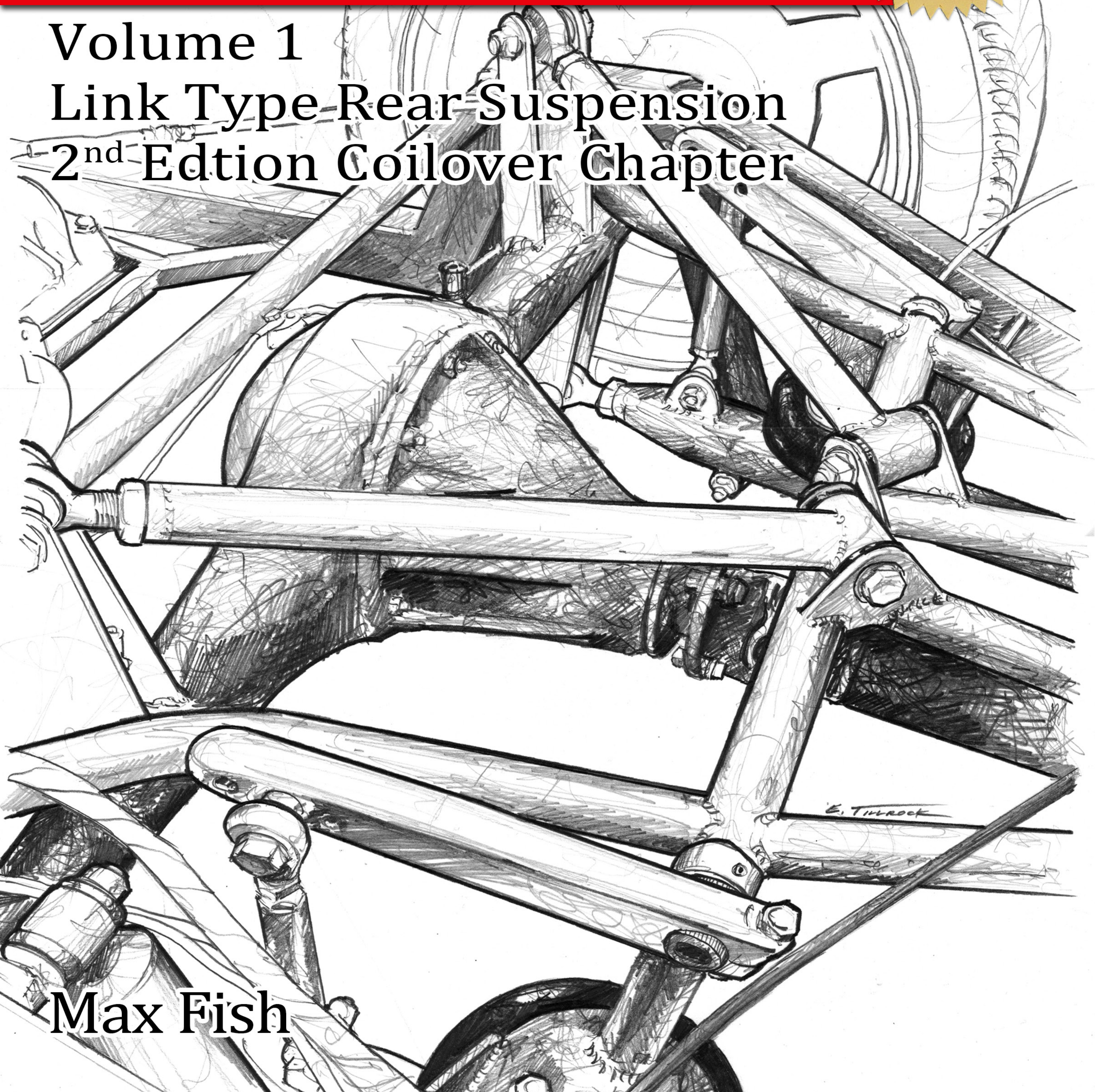
Volume 1

Link Type Rear Suspension

2nd Edtion Coilover Chapter



Max Fish

WHAT ABOUT COILOVERS?

This goes in after page 124

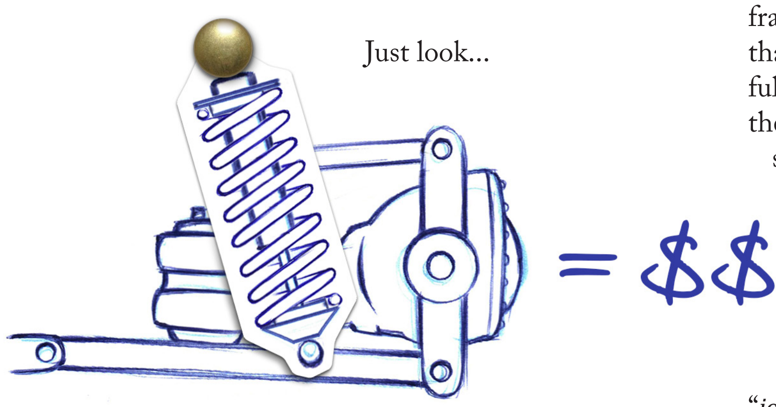
So, you want to build a vehicle without all the fuss and mess that comes with airbags?

I mean - okay, I guess? **I'm secretly judging you**

In all seriousness, there has been enough inquiry about this subject to make adding a dedicated coilover chapter a no-brainer. The beauty is that it won't be a very long chapter because we've already covered pretty much everything necessary for you to determine a total coilover travel length and starting spring-rate for your project. I simply needed to create a few coilover sketches and plug them into some preexisting suspension sketches, and then *BAM* more book sales!

I know... I feel dirty too, but this business-model is infallible.

Just look...



Before diving into coilovers, understand that since a coilover suspension is "static" (meaning non-adjustable), you can be a lot more aggressive with the suspension geometry; you certainly don't have to be, though. If you are building a lowered vehicle and design your suspension around the targets outlined in this book, you will end up with a very nice casual driver. However, since you can't raise or lower the suspension at will, you can push the geometry to have more performance advantage without sacrificing as much drivability. If this is something you are interested in doing, you will need to research the geometry targets associated with whatever performance enhancements you're wanting - acceleration performance will have different geometry than cornering performance. As stated previously, there are too many variables to discuss different IC placement options in the scope of this book.

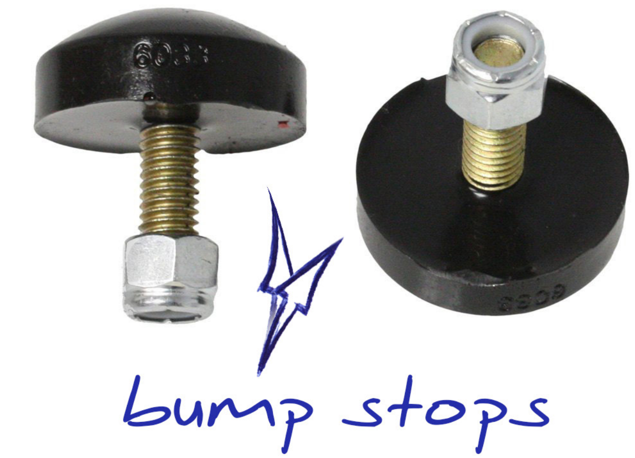
Bump Stops and Jounce Bumpers

Another thing to consider when running coilovers is that the suspension will most likely need bump stops or jounce bumpers to eliminate any axle-to-frame contact. The same goes for any bagged suspension that doesn't "lay frame." In fact, on any vehicle where full-bump results in the axle hitting the frame before the frame touches the ground, you should use a bump stop or jounce bumper. The amount of force generated by a vehicle bottoming out "metal-to-metal" is extremely high and can potentially cause part failure.

"What in the deuce is a jounce bumper?"

Most of us have heard of a bump stop, but "*jounce bumper*" is not commonly used vernacular. To really confuse things for you, a jounce bumper is a type of bump stop, but a bump stop isn't always a jounce bumper. The difference between the two isn't clarified in any of the documentation I have read, and I even called a "classically trained" college instructor friend, and they couldn't shed any light on the distinctions either. So, I am going to define them my way and apologize if I step on any previously established definitions.

A ***bump stop*** is a part that bolts onto a frame or suspension component and eliminates any metal-to-metal contact between two parts. They are usually made from either solid rubber or urethane and install somewhere between the axle and frame or between the A-arm and frame on a front suspension.



A ***jounce bumper***, on the other hand, is commonly made from closed-cell urethane foam and has both spring and damping characteristics. Because of this, they are often used as an integral part of the spring/shock system on many different types of vehicles (every motorcycle I have ever owned uses them). What makes them unique to a standard bump stop is they minimize the sudden *thud* when the suspension bottoms out, which is common with a standard bump stop. The way this works is the closed-cell foam won't let air escape the bubbles in the foam and will act like a mini air spring, raising the spring rate as the bumper is compressed. On top of that, the material used to make a jounce bumper has natural damping characteristics to keep the suspension from being too bouncy when bottoming out. When set-up correctly, jounce bumpers are a far more comfortable option for bottoming resistance than a standard bump stop. This does not mean you can't have a nice ride unless you run jounce bumpers, but this is the reason manufacturers have started using jounce bumpers more often than standard bump stops.

Coilover Theory

Aside from having a coil spring installed "over" the shock body, everything we previously discussed about shock theory crosses directly over here. There still isn't any way to know what your shock valving target should be, so we are unfortunately going to continue ignoring that subject. However, since the spring and shock are essentially a single unit now, the motion-ratio of your coilover install will affect the spring-rate equally as much as the valve rate. It should also be noted that coilovers are not inherently superior to a traditional shock. You can see in the photo of the cheap coilover at the right; the shock looks pretty much like any other "parts house" shock, except it has tabs that the lower spring perch sits on. Also, notice that the spring perch on that coilover is stepped instead of threaded. This means you are limited to those stepped increments instead of the finite adjustment you would get from a threaded spring perch (shown on the next page). This isn't a bad thing for a casual driver, but threaded perches are certainly preferable in a performance application. But the bottom line here is that a coilover is simply a shock with a coil spring mounted to it.

Calculating Spring Rate

As previously discussed, determining the spring-rate for a steel spring suspension is far more direct than it is for an airbag (if you want to revisit this subject, it starts on page 109). However, the problem is that it is more critical to know the weight that the tires are supporting when using a steel spring than it is with an airbag. For example, if you miscalculate the spring rate and the suspension ends up too low, you can potentially add preload to the spring in order to lift the vehicle to your desired ride height, but that may end up putting the spring into "spring bind" (***fig. 89***) if the spring is too soft or you add too much preload. On the other side of that coin, if you ran too stiff of a spring and had to adjust the perches to lower the vehicle, the spring perches may not contain the spring properly during droop, which can cause the spring to fall out of the pockets if you hit a bump hard enough. This is potentially curable using a spring tender, as shown in ***fig. 80*** (page 110), but that doesn't necessarily mean you chose the right spring rate for your application. So, whenever possible, it would behoove you to know the weight that the suspension will be supporting in order to get you as close to your ideal target as possible. Also, before we get into the math part, keep in mind that steel springs can use my SFR theory to net you a soft or firm ride while maintaining the same ride height. So, simply calculating a spring rate based on your desired ride height and install position may not net you the ride quality you are looking for.

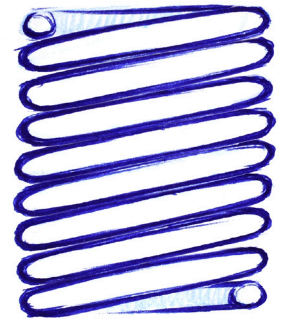


fig. 89 *- Spring bind is when a coil spring is compressed to the point where the coils start touching each other. When this happens, the spring rate will rise rapidly to the point where it goes infinite. Some springs are designed to do this in a way that creates a controlled rising-spring rate, but spring bind typically describes anundesirable situation that may result in part failure.*

The math used to calculate the spring rate of a spring on a coilover is the same math that is used to determine the leverage multiplier of a shock (I should note that if you are calculating the spring rate for a coil that will be installed independently of the shock, you will use the calculators associated with airbag installation instead). Also, keep in mind that depending on how the coilover is installed, the motion ratio may change throughout the travel, which will affect your wheel rate directly.

Using whichever calculator is correct for your application (mounted to the axle or mounted on a link bar - the links are on pages 97 & 100), you can calculate the wheel rate from a known spring rate or calculate a target spring rate based on a known wheel rate.

If you know your spring rate (*SR*) and want to find the wheel rate (*WR*), you will multiply the spring rate by the leverage multiplier (*LM*).

$$SR \times LM = WR$$

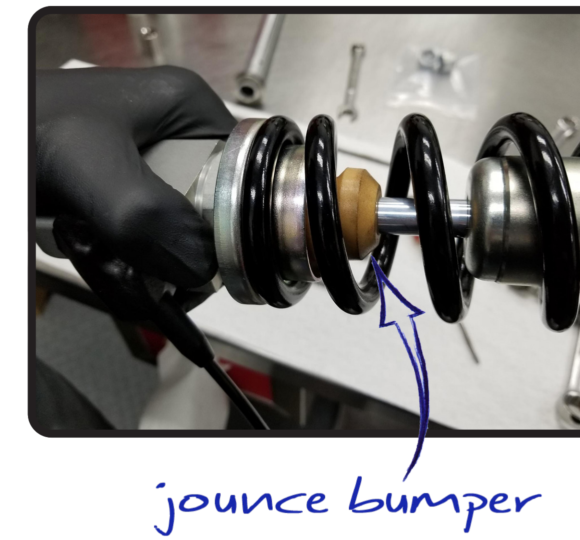
If you know the target wheel rate (*WR*) and want to find the spring rate (*SR*), you will multiply the wheel rate by the motion ratio (*MR*).

$$WR \times MR = SR$$

Coilover Install

The biggest difference between a standard shock install and a coilover install is that coilover mounts will need to support the entire weight of the vehicle where a traditional shock does not (I mean, I hope not - shocks are not good travel-limiters). Having well-engineered mounts are especially important if your coilovers have jounce bumpers in them, as shown in the photo at the right. In this scenario, the mounts will see an enormous spike in the loads when the suspension bottoms out, which can cause the mounts to fail if they aren't up to the job.

Something you should also consider when designing coilover mounts is that it is advisable to avoid installing them in a way where the motion ratio has too aggressive of a falling rate (covered on page 99). On an airbagged suspension, the bags will naturally resist bottoming because they have a rising spring rate, so they can somewhat overcome a compromised shock installation. However, steel springs are typically linear, which means that a coilover installation that has a falling rate motion ratio will cause both the spring and the shock to get softer as the suspension goes into bump. This means that the further the suspension is compressed, the less the coilover will resist bottoming out. Of course, a good jounce bumper can help remedy this, but it's best to shoot for a linear or rising rate installation if possible (covered on pages 96 - 98).



We aren't going to dive any further into the subject of coilovers; things get complicated pretty quickly as we tumble deeper down this rabbit hole. However, you should be able to extrapolate most of the information you need to design a nice coilover system for a casual driver in the shock and bag chapters.