BASIC HANDLING PRINCIPLES, Part 2

John Dowsett
Australia

Last month I covered some basic principles regarding tyre technology and behaviour, which may give a better understanding of how a tyre actually does its job. This month I will cover some of the major characteristics of the suspension system.

As with wheels and tyres, the ideal suspension system must perform a variety of tasks over a widely varying range of road surfaces and vehicle loading and will always be the best compromise in order to perform each task as well as possible under the prevailing conditions and road speed. I suppose the primary purpose of the "suspension" system is just that; to "suspend" the car between a maximum and minimum height above the road surface at all times. In order to do this, a spring of the correct "spring rate" (i.e., stiffness or softness of the spring) is chosen which is on the one hand soft enough to allow the wheel to move when hitting a bump or pothole without transmitting too much shock to the passengers, but on the other hand not so soft as to cause excessive body roll and wheel movement, loss of steering geometry, or a "wallowy" or spongy ride.

On modern vehicles, the trend has been towards softer and softer spring rates, and allowing for generous wheel movements. By choosing a combination of the best spring rates, shock absorbers, and front and rear suspension geometry, even the humble modern Japanese shopping trolley can often out-corner many of the so-called "sports cars" of the '50's and 60's including the Austin Healey.

Excessive body roll is controlled by the use of anti-sway bars. On Austin Healeys I don't advocate going as soft as modern family cars, but I believe that unless regularly carrying four people and a boot full of luggage, our cars can benefit greatly by removing one or perhaps even two leaves from the rear springs. This may have to be compensated for by re-setting the springs to restore ride height and ground clearance, but softening the rear springs in this way significantly improves their compliance to uneven road surfaces, and reduces the tendency of the rear wheels to "hop" when cornering on a bumpy road. If your car tends to be "tail happy", this is one of the first things I would consider, and if you have not already done so, the fitting of a stiffer anti-sway bar (but not too stiff – I will discuss more about this later.)

Race cars the usual practice is to use much stiffer suspensions than on road cars, mainly to resist body roll under the very high cornering forces that are encountered. However it should be remembered that the typical race track is billiard table smooth compared to the average road surface, and does not require as soft a suspension as a road car to maintain contact with the road surface at all times. However even a race car can be too stiff, and the best compromise is usually found only after a lot of testing.

Another important function of the suspension, particularly the front, is to maintain steering geometry at all times. In early sports cars (remember the MG-TC?), the front axle was of the "beam axle" design with the wheels permanently more or less at 90o to the axle. Now this system worked pretty well as long as the car was traveling straight ahead on a dead smooth road, the wheels remained at about 90o to the road surface, the tyre patch remained at optimum shape and size, and road adhesion remained constant. However, as soon as one wheel hit a bump or pothole, particularly whilst cornering, this changed the wheel angle to the road not only of the wheel in question, but because of the movement of the beam axle, of the other wheel also. Thus, there occurred a change in contact patch, shape and loading, with a momentary reduction in adhesion.

Another disadvantage of the beam axle was that the wheel angle, being fixed at all times, could not be varied to suit gentle or hard cornering. Hence the invention of the independent front suspension (or IFS) system, which, as the name suggests, allows either front wheel to move up and down independently of the rest of the suspension system, and to maintain its optimum angle to the road at all times, whether on a bumpy road, or cornering gently with a small amount of body roll, or cornering hard with a large amount of body roll, or a combination of these. By varying the location of the pivot points, and the relative lengths of the upper and lower wishbones, the designer can pre-determine the wheel attitude under all conditions, including increasing the negative camber under heavy cornering to compensate for the high sideway stresses.

Incidentally, the conventional rear axle assembly as used on our Healeys is basically a beam axle design, but works remarkably well in this application. It is only in the last few years that anything but the more expensive vehicles employed independent rear suspension.

There are still many other factors which affect steering and suspension, but as I'm running out of space, I'll talk about these next time.

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Tech Tips - 3.5 Versus 3.9 Rear End Gear Ratios

By Tom Mason
Golden Valley, Minnesota

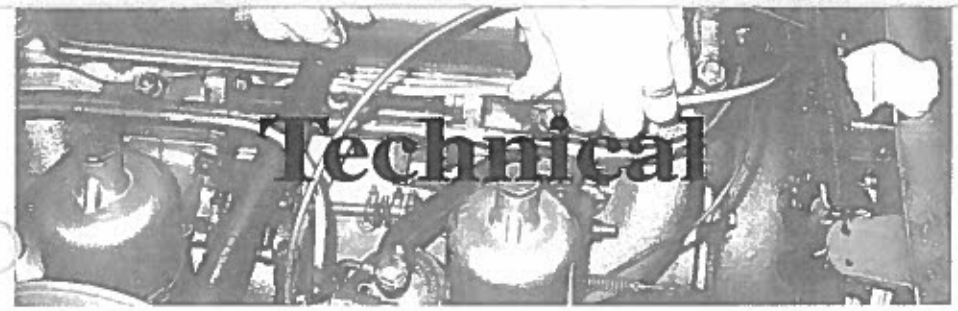
For a long time I had wanted to try the higher rear end ratio that was an original option in a Healey. Healeys are naturally low-geared, and I believe Donald Healey wanted a gear ratio even lower than the standard 3.9, but had to concede to the bean counters. In any case, I ordered a set of 3.5 gears along with about a hundred other people a couple of years ago. Mike Lempert deserves a lot of credit for pursuing this project to its conclusion. What he did was undertake to get gear sets made for big Healey differentials at about the 3.54 ratio of the original optional gear ratios. Those optional gears are pretty rare, but they are excellent for giving your Healey "longer legs" e.g. yielding lower revs at any given speed. This is excellent for cruising as it allows the engine to work less hard and improves gas mileage. The trade-off is that your acceleration is a bit slower. However, Healeys were never dragsters anyway, so in many people's estimate it is a very good trade-off. When I received my new set of 3.5 gears, I was fortunate to have a spare rear end housing (the "pumpkin") on hand, and I sent it to Florida and had "Alan's Gears" install the new gears in it for me. Basically here are the steps to install the unit:

1. Get the rear of the car up on jack-stands. Block the front wheels to keep the car from rolling. Drain the oil out of the differential case.
2. Remove the drive shaft U-bolts and support the drive shaft upwards with a jackstand.
3. Remove the road wheels, axle stubs and brake drums. Pullout the drive shafts and set aside.
4. Remove all 12 differential nuts and lock washers and set them aside.
5. Pull out the differential - Gasket sealant may be "gluing" it to the axel housing.
6. Clean up everything including the nuts and bolts. Clean the face of the housing.
7. Soak the pumpkin gasket in oil; I ordered two as they are brittle and thin.
8. Apply a thin coating of a sealant of your choice to both sides of the paper gasket and apply that over the studs. (Hylomar is an excellent sealant for this application).
9. Install the new differential. It may be a light fit. Tighten the top bolts first. If it hangs up, loosen all the nuts and try again.
10. You may want to consider replacing the oil seals in the, rear axle hubs, but this requires that you remove the floating hubs and take them to a press. Reinstall the axles (with new gaskets), the brake drum and the stub axles. Apply Loc-tite to the five bolts and torque them to 35-40 pounds. Be sure to use Loc-tite on the drive shaft and U-bolts also.
11. Buy three quarts of 90-weight oil. Top up one bottle and squeeze it to fill the differential. Keep topping up the one bottle from the others as you can only get about half the oil out of the bottle into the rear end. When you are done, some oil should run back out the fill hole.
12. Install and lighten the road wheels.
13. I let my car run on stands for a little while to break in the new rear end. The change in low gear is small but noticeable. I have been driving this Healey for about 35 years and I wondered how much I would have to adjust my driving technique. Not much it seems. It goes faster at highway speeds with less RPM, e.g., 3000 RPM now yields about 76-77 MPH versus about 70 MPH with the original gear set. I haven't found the downside yet. I only have a few miles on it, but right now I, am pretty happy!

However, as a result of these new gears your speedometer will need to be recalibrated. So here is a follow-up tech tip regarding that process.

SPEEDOMETER RECALIBRATION FOR 3.5 REAR END GEARS

Almost 150 Austin-Healey owners purchased the 3.5 rear-end gear sets that were reproduced by Michael Lempert a couple of years ago. This story has a happy ending as we all waited almost a year to get the gears. Mike deserves a lot of credit for sticking with the project and delivering a quality product, at no profit, to so many Healey owners. I calculated that the speedometer should read ten percent low, and it did; when I drove over a measured ten miles, it read 9.1 miles. There are several potential solutions to this problem. The one that I chose was to use a gear ratio adaptor purchased from "gearguys.com." Recalibrating the speedometer is also an option, and there are several companies that can do this for you. In general, your speedometer has what is called a "1000 gear head." The ratio adaptor can be installed for about 80 dollars including parts and labor. The fellows at gearguy.com did a nice job. I have not yet been able to give it a full test, but it seems to read accurately so far at lower speeds.



Replacing Rear Wheel Bearings, Axle Oil Seals

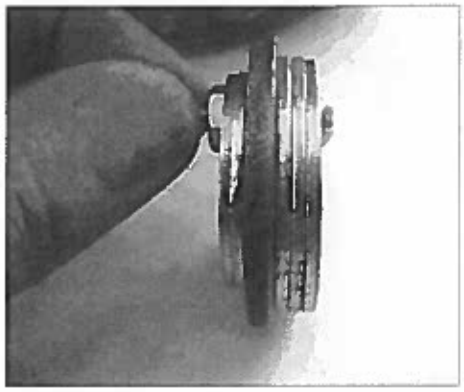
By Mike Jennings, Bel Air, Md.

Have you experienced that sinking feeling when you notice oil seeping down to the bottom rim of your rear wheels on your Healey? Chances are you have a bad rear axle oil seal. It could be the inner or outer seal. But it is sound practice to replace both seals. The inner seal is a typical rubber lip seal. The outer one has an O-ring and a joint-washer gasket. Having performed this task twice recently, I have a few tips that will make the job relatively quick and easy.

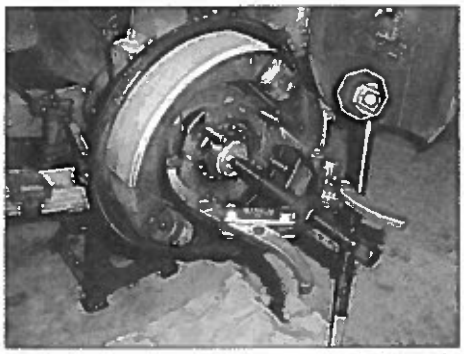
The first step is to jack up the rear of the car, put it safely on axle stands, remove the rear wheels and drain the axle oil. Then remove the self-locking splined hub extension nuts. This is a 9/16 nut. A six-point socket works better than a 12-point socket that can burr the nuts. There is not much of the hex nut to work with, due to the self locking section of the nut. Remove the splined-hub extension and next the Phillips head screw securing the brake drum.

Slacken off the rear brake shoes by screwing the adjuster on the brake back plate out as far as possible. This makes it easier to remove the brake drum. Now you should be looking at the brake shoes and the outer end of the half shaft in the center. Remove the Phillips head securing screw and pry the half shaft out by separating it from the bearing housing. Remove the half shaft. Note how there is a sealing joint washer and an O-ring seal. You should now see the axle hub locknut, which is held in place with a large lock washer. Use a drift or chisel to flatten out the lock washer on the big eight-sided nut, which holds the rear bearing assembly to the rear axle.

This nut can be removed using a special half-inch drive socket tool that I purchased from Hemphill's Healey Haven in Baltimore, Md. Hemphill's is in the supplier list on page 4 of the new membership directory. This socket is shown in picture #2 on the right hand side. Having got this far, you will find it necessary to use a puller to remove the bearing assembly.



***Left:** Picture #1, a close-up view of distance piece.* Note: The configuration may be clearer by looking at picture #2.



***Above:** Picture #2, the puller and distance piece are in place.*

The problem here is that there is a hollow shaft on the end of the axle and no place to put the center point of the puller. To handle this, I made up a distance piece from a selection of fender washers purchased from the local hardware store. This is shown in picture #1. It is held together by drilling through the washers and clamping them with a small machine screw. The largest washers are hefty stainless washers that are the same size as the axle housing and will allow the housing to be pulled out past it. The small washers fit inside the housing bore and the middle size ones provide a place for the puller to bear against.

Picture #2 shows the distance piece in place in the axle bore, with the puller placed on the middle. The puller is a two-jaw Craftsman puller that costs less than $30. Turning the puller screw will withdraw the bearing housing from the axle with ease. Note there is also a bearing spacer under the lock washer.

The bearing and oil seal can be removed by tapping the bearing and seal from the inboard side of the bearing housing. Rinse the bearing carefully. (I used engine oil, not solvent. And do not spin the bearing quickly if dry.) Then hold the outside of the bearing firmly while turning the center. If you feel any roughness or checks as the bearing turns, it is best to replace it.

Now for the reassembly. Let's use the relative expansion and contraction caused by hot and cold! It sure is better than beating the axle housing back on!

The seal inserts easily if you put some oil on the outside of the seal to ease insertion into the axle housing. Make sure the flexible lip points in to the bearing. Put the new or cleaned wheel bearing in a Ziploc baggie and put it in the freezer. Let it cold soak for two to three hours. Then wrap the bearing housing in aluminum foil and put it in your oven at 250 degrees for approximately 20 minutes, or over the barbecue with the top down for a few minutes. You do not want to cook the assembly too long as there

is a rubber seal in the housing already. (If you use your oven, be sure the housing is clean of any oil, as you will stink up the house and not be too popular!)

Take the housing off the heat and place it, with the bore into which the bearing fits, facing up. (The studs will be pointing up.) Take the bearing out of the freezer and drop it into the bearing housing. It will go right in without any hammering or effort at all. Be careful as the housing is hot. Best to use hot mitts!

Now that the seal and bearing are in place, wrap the entire assembly in foil again and reheat the housing. When it is nice and warmed through, remove it from the heat. Keep it wrapped in the foil until you get to the car. After unwrapping it at the car, slide it quickly onto the axle housing. You will get one shot, but I have done this a few times with 100 percent success with no hammering or bashing at all.

Then remember to put the bearing spacer back, the lock washer and replace the eight-sided nut. Tighten it up and bend the lock washer in place. When fitting the half shaft, use a new joint gasket (these are a little tricky to fit over the studs without damage), and make sure the O-ring is in good condition. Better yet, replace it. Replace the securing screw. Refit the brake drum and then the splined hub extension. Remember also to readjust the brakes.

Fit the wheels, refill the rear axle with gear oil (I use a small pump that fits in the top of the quart bottle). Remove the jack stands and retighten the wheel spinners (or lugs if you don't have wires), and the job is done!

Tips on doing rear axle seals.

If you are doing one side, or one side at a time, set the jack stand on the side you are disassembling a little higher to prevent the diff oil from dribbling out as you are working on it.

If you have diff oil on the drums, most like the lip seal in the hubs need replacement, but check the housing surface and make sure it not rusty, pitted or scored. It will make for a poor seal at best, and destroy your news seals in a hurry at worst. If you can't get the housing polished up with some emery cloth, consider a Speedi-sleeve (also known as Redi-sleeve). It will give you a new pristine surface for the seal to mate. They are available a variety of places from bearing houses to Amazon.

You will want a new lip seal, new paper gasket and O-ring for each side too.

The nuts are "handed" meaning one is RH thread, the other LH thread. The easiest way to remember which is which, is they unscrew opposite of forward wheel rotation. If your lock tabs are badly bunged up, replace them with new. The nut is (if I remember correctly) 1-7/8". You will probably need a hub puller to remove the hubs. Sometimes a good yank will get them off, but usually not.

You can clean the brake shoes with brake cleaner, but if they are worn, which they probably are, just replace them with new shoes and save yourself some labor. If you R&R the brakes, do it before you replace the hub. It's a little easier to install the brakes with the hub out of the way. The next step is to re-install the new seals and bearings back in the hub, and reinstall the hubs. The bearings should be a tight fit going back in the hub and on the axle housing. Lubricate the lip seal before putting them back on the axle housing. Cleaning and repacking the bearings is a good idea too. Replace the lock tabs and then tighten the nuts and bend over the lock tabs. If you are not using new lock tabs, try to use a fresh area to bend over.

Before reassembling, I strongly recommend you clean everything really well and especially the mating flanges on the hub and axles. Make sure the groove for the O-ring is clean too. I use a 6" wire wheel in a hand drill or a drill press to get the metal clean of any corrosion or stuck on debris (gasket material, RTV, etc.) Check the surfaces for any high spots or divots from prior rough handling. Take a file to any high spots.

Once you are to the point to put things back together, I like to wipe down the mating flange on the hub and axle with a solvent or degreaser before applying and sealant. Personally, I hate RTV, especially in "mass quantities". Use whatever you want, but my choice of sealant (if you use any at all) is Hylomar, but use it very sparingly... you don't need a lot if everything is clean and smooth. Install the oil ring in the groove, then apply the gasket to the hub, When reinstalling the gasket and axle, pay attention to the orientation of the three small screw holes in the hub. The center one matches the single hole the axle, the opposing 2 are for the brake drum. Align the spine at the end of the axle into the diff and push the axle home and insert the single screw through the axle and snug it up good. Next, replace the brake drum and replace the screws. If you plan to do the other side without reinstalling the wheel, place at least 2 lug nuts on the studs and snug them up. The (Posi-drive) screws alone may not give you enough compression to keep things a tight seal without the wheel in place. Best to use the proper (Posi-drive) screwdriver to keep from buttering up the screws, if they are not already. I put a dab of anti-seize on them too. Torque on the lug nuts is 44-46 lbs.

Gerard

Topping off the rear end fluid

Brian Collins recently asked if there were "Any suggestions on the best way to top up the rear end fluid? I have the Castrol Quart bottles. Looks like I am going to have trouble getting the bottle up high enough to pour or squeeze it in."

A few days later, a Healey Lister responded with a solution that I have used. A pump designed to change the transmission fluid in an outboard engine is ideal for this purpose. It screws into the top of the lubricant bottle. If you have not been cursed by a boat, and don't have one of these pumps lying around, you might find one of them at a marine supply store.

Bits & Spares

Rear Leaf Springs for the BN1 thru BJ8

By Roger Moment,
Rocky Mountain AHC

A kind of "folk lore" has evolved over the years, and primarily during the '80s and early '90s, that the replacement leaf springs for Big Healeys were junk. This was because they would sag within months of being installed. To add insult to injury, their clamping hardware looked rather crude and in no way resembled that of the original springs, especially for the BN1 thru early BJ8s.

I spoke with Michael Grant at Moss about finding new springs for my BN1 and learned that, contrary to the catalog, these are indeed available.

Furthermore, Moss's manufacturer in England told them about two years ago that they actually made two different quality of springs – an "economy" grade which Moss had been buying and selling prior to that time, and an "original equipment" (OE) grade. The OE spring used better steel quality and test loading before shipping. They also have clip hardware that is extremely close to the original, differing only in very slight ways that are easily corrected.

These OE springs are the ones Moss has been selling for about two years now. Also, while they are listed in the catalog for the 6-cylinder cars, but not for the 100s, it turns out they are stocked for the 100s (a catalog omission error).

I have had a pair on my car for two months now, and so far they have shown no sagging at all. Granted this is rather a short test period, but I've heard that others who have installed these "OE" springs on 6-cylinder cars have also not seen any sagging over a period of a year or more.

Finally, if you want to turn these into a truly 100-point set of springs for your car, here is what I did to the set I installed:

1) Strip off the crude paint, disassemble each spring, and repaint the bits separately. Be sure to first remove the bushings if you have them powder coated, as they will not stand up to the heat. It is fairly easy to press them out.

2) Transfer all clips from the original springs to the new ones. The new clips have a hole in the center that should be welded shut and filed smooth, but the original clips are easier to reuse.

3) Since the two rivets attaching the two "U" clips to one leaf are a bit too large on the new springs, I just reused this leaf from my original springs, along with the two clips. It is a short leaf and should be just fine.

4) I reused the smallest leaf from my original spring as well, since this piece has the BMC part number stamped into it.

5) The wraparound supports that slide over the "eyes" of each spring have their ends turned up at about 45 degrees on the new springs, but 90 degrees on the original ones. I just transferred these over to the new spring.

6) I reused my zinc interleaves, but the plastic ones supplied with the new springs should work and hold up just fine.

I ended up with a set of "new" springs having six new leaves each (the longer leaves), new bushings, two original leaves (the smallest ones), and all the original clips and "eye" hardware. They are indistinguishable from the originals, but put the car back to the correct height. So, the good news is that proper quality springs are available, for all the Big Healeys from BN1 thru BJ8.

3.5 Versus 3.9

Tom Mason
National Member

Well, I have wanted to try the high rear end ratio for a long time. Healey's are naturally low geared and I believe Donald Healey wanted a lower gear ratio than 3.9 but had to concede to the bean counters. I ordered a set of 3.5 gears along with about a hundred other people last year. Mike Lempert deserves a lot of credit for pursuing this project to its conclusion. I was fortunate to have a spare rear end, differential or pumpkin on hand, or whatever you want to call it. I sent it to Florida and had *Alan's Gears* install it for me. Basically here are the steps to install the unit:

1. Get the car on jack-stands – 6 ton is preferable. Block the front wheels to keep the car from rolling. Drain the oil out of the differential case.

2. Remove the five shaft U-bolts and support the drive shaft upwards with a jack-stand.

3. Remove the road wheels, axle stubs and brake drums. Pull out the drive shafts and set aside.

4. Remove all 12 differential nuts and lockwashers and set them aside.

5. Work out the differential.

6. Clean up everything and parts wash the nuts and bolts. Clean the face of the housing.

7. Soak the pumpkin gasket in oil; I ordered two and they are brittle and thin.

8. Apply a thin bead of RTV silicon to the face of the new pumpkin. Smear it with your finger to a thin layer.

9. Install the new differential – it may be a tight fit. Tighten the top bolts first; if it hangs up, loosen all the nuts and try again.

10. Reinstall the axles with new gaskets, brake drum and stub axles. Apply loc-tite to the five bolts and torque to 35-40 pounds. Be sure to use the loc-tite on the driveshaft and U-bolts.

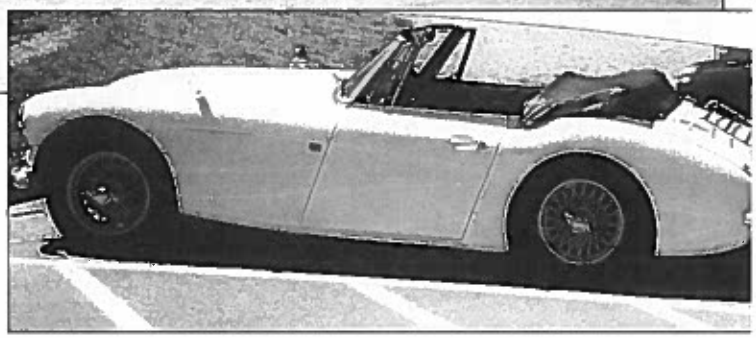
11. Buy three quarts of 90-weight oil; top up on the bottle and squeeze it to fill the differential. Keep topping up the one bottle from the others as you can only get about half the oil out of the bottle into the rear end. When you are done, some oil should run back out the fill hole.

12. Install and tighten the road wheels. You may want to consider replacing the oil seals in the rear axles, but this requires that you remove the floating hubs and take them to a press.

13. I let my car run on stands for a little while to break in the new rear end.

The change in low gear is small but noticeable. I have been driving the Healey for about 35 years and I wondered how much I would have to adjust my driving technique – not much it seems. They go faster at highway speeds with less rpm, i.e. 3000 rpm is now about 76/77 versus the old 70 mph. I haven't found the downside yet if there is any in this swap. I only have a few miles on it, but right now I am pretty happy!

Rear Spring Replacement On a '64 BJ8



***Right:** Before installation of the spring. **Above:** The Healey rides much better with the rear springs replaced.*

by Hoke Smith, Atlanta AHC

I thought that replacing the rear springs of our "Annabelle" would be easy: remove seven bolts, remove spring and replace in reverse order. I should have listened to my Momma!

While trying to find a resource, or at best, instructions on the best way to accomplish this task, I came across the statement, "If you are a religious person leave this task for someone else." After reading that quote, one side of me said, "maybe I can't," but the other side of me said, "I can!"

Some of the best advice ever given to me occurred a long time ago when I was a second grader at Tucker Elementary, it was given to me by a wonderful, non-politically correct teacher named Mrs. Keith. I was trying to do something that was very hard for me to do, and she was trying to encourage me. When in exasperation I said, "I can't do it!" She corrected me by saying, "Hoke, never say I can't, instead say I'll try." Well now, more than 50 years later, her wonderful advice still rewards me on many occasions.

First of all, I will explain what should happen, then, what did happen, and what tools and parts you will need to make your experience easier:

Step one: Raise rear of car and place jack stands firmly under frame. Also, chock front tires in front and behind.

Step two: Remove both rear wheels.

Step three: Soak all attaching bolts and nuts on a daily basis for several days with liquid wrench prior to removal. (I used new product called P.B.)

Step four: Place floor jack under middle of frame where it attaches to the axles and raise spring to relieve pressure. (Oh,

before I forget, it is best to complete removal and replacement on one side at a time where you will have a reference case you forget which bolt went where! his advice seems to come with maturity you know!)

Step five: Remove both nuts from the rear shackles and remove shackle from spring.

Step six: Remove nut and bolt from front of spring.

Step seven: Remove the four nuts from U-bolts attached to axle and lower spring.

Step eight: Prepare new spring and hardware to be reattached by inserting the four bushings at rear of springs and on to the shackles. I used white lithium grease to thoroughly lubricate all contacts on springs before installing. By the way, when you order springs from Moss or Victoria British, (I ordered mine from the latter), the rear bushings part #5-340 were not included. I would also order new nuts for the shackles and a new bolt and nut for the front attachment when you order the springs.

Step nine: Attach spring to the front bracket but do not tighten.

Step ten: Raise the spring with a bottle ack and patiently attach the two U-bolts th the four nuts. Again, do not tighten.

Step eleven: You will now see that the rear of the spring is pushed tightly against the car chassis. You can pull the spring down and attach the shackles and bushings by using a large C-clamp attached to the top of the spring and the frame extension. With shackles bolted in place, tighten all nuts and bolts and repeat on the other side.

Now, this is the way it should go if we lived in a perfect world without rust! Oh, if it were only so easy! This is where the religion from the above quote comes in. This is what really happened:

Step one: I removed the nuts attaching rear shackles to rear of spring (no problem).

Step two: I removed nuts from two U-bolts attached to axle (no problem).

Step three: I removed nut from bolt at front bracket (no problem).

Step four: I tapped bolt with hammer to remove it from bracket (PROBLEM!) No amount of tapping would remove bolt. I soaked and soaked again with liquid wrench to no avail. I brought out my propane torch and heated the thing up, to no avail. I beat the Sam Hill out of the bolt and the blankity blank thing would not budge! See, now it is getting personal. The "I can" from my youth sets in, and I know that this bolt WILL be removed in a proper non-destructive manner. It is now power tool time. After sleeping on this problem for a night or two, I asked a good buddy of mine if I could borrow his air cut off tool.

Step five: Using a metal cutting disk, I removed spring from bracket leaving the bushing still housed within bracket.

Step six: Purchased several metal cutting blades for my sawsall, and I cut the bolt on the inside of bracket (both sides) and removed the source of my problem.

This is what happened after 40 years of rust. The front bolt and the metal sleeve that is attached to the rubber bushing became one. The bracket hole was only large enough for the bolt, and the rust fused sleeve prevented it from being removed. After I had figured out what was wrong, the problem was a snap to fix. However, this is something your Momma will not tell you! Now you know.

This is one project that I am glad that I did. Annabelle now sits higher and handles better and she does not scrape on my driveway. Parts required for this project are: Two springs, four nuts for rear shackles, bolt and nuts for the front bracket, bushing set for rear shackles, and white lithium grease. Tools needed are: assorted wrenches and sockets, cut-off tool with several metal cutting blades, sawsall with metal cutting blade, and large C-clamps. Good luck!