

# Alignment Puzzles



Correcting uneven tire wear and steering pull is like putting together a jigsaw puzzle. Since no two cars, like no two puzzle pieces, will be exactly the same, it takes a keen eye and attention to detail to complete each alignment picture.

Fully independent suspensions and four wheel alignment techniques have added even more complexity to the puzzle solving process. It sure is easy to get nostalgic about the time when men were men, the six gun ruled the West, and all cars came with a rear drive straight axle.

Cars used to be, well—heavy. They were full framed and the driveline/suspension parts were all HEAVY. It seemed that it took an act of Congress or a fall off a steep cliff to get things moved around far enough to cause abnormal tire wear at the rear wheels. You used to set caster, camber, and toe on the front wheels, charge the customer \$12.95, and send him on his way.

## New Pieces In The Puzzle

Our new generation of small cars has added any number of pieces to the alignment puzzle. Let's look at some examples:

- Suspension components are lighter.
- Collision damage results in alignment problems in more cases than it did on full-framed cars.
- The equipment needed to do four wheel alignments is more sophisticated—and as a result, more expensive.
- Improvements in the design and construction of steering components like ball joints and tie rod ends make them last a lot longer on an average. This can

cut into your parts replacement profits.

- Radial tires were a tremendous technological leap forward. But radial tires can be a puzzle in themselves. Overloaded and underinflated, they can rearrange their plies and affect both ride quality and handling. Heel and toe wear on all seasons tires can give us some strange wear patterns, not necessarily caused by misalignment.

- There is a new emphasis on some old alignment terms that were forgotten or ignored for years. Steering axis inclination, included angle, and scrub radius are just as important as caster, camber, and toe. And ride height, as we'll see on one of our test cars, can throw an otherwise perfect alignment into a borderline, or even unacceptable condition.

## The Bright Side

Depending on the weather and your normal disposition, you can view these changes as a curse or as an opportunity. We'd like to look at the bright side:

- Even though it's dying harder than the concept of the nickel cigar, the \$12.95 alignment is gradually fading into history. Many customers are finally realizing that a tape measure and a plumb bob are carpenters' tools.
- The same selling techniques that saved many engine performance shops when points and condensers disappeared from ignition distributors are finding their way to the alignment bays. Selling suspension performance instead of alignments can be a profitable program. Customers want cars to steer well, and their tires

to wear evenly. Periodic inspections, regular tire rotation, and rebalancing of those expensive radials are being added to the suspension performance list.

## Solving The Puzzle

We put ourselves in your shoes. We selected several cars at random and then spent some time getting dirty at the alignment rack. Instructors Lou Romestant of Hunter Engineering and Eric Phiels at the Perfect Circle Chassis School were kind enough to lend their time and energies to our project.

Our sampling included a Chevrolet (Toyota Corolla) Nova, a Nissan Sentra, a Volkswagen Rabbit, and just for the thrill of it, a Honda Prelude with four wheel steering. Every one of these cars needed some kind of alignment correction.

With the exception of the Honda, we won't do a complete blow by blow description of each alignment procedure. Instead, we'll highlight only the problems we found and how we corrected them. And even though we won't mention the basics on each car, don't forget to look at the following areas on any car that comes to you for suspension service:

- **Correct tire pressures to manufacturer's specs before beginning any alignment.** See if the tires are the correct size for the car and that they are all the same size. (Don't laugh, this one can make you crazy.)
- **Drive the car and write down anything out of the ordinary.** That includes everything from suspension noises to vehicle pull or wander. You may want to make a check list and use it for every car.
- **Talk to the customer.** Does he have any complaints? What kind of driving does he do? What kind of roads does he use?
- **Walk around the car.** Look for any visible damage to the unit body. Does the car lean? Does the hood fit

straight, or is it out of square with the front fenders? This could be a clue that there's inner fender damage at the strut mounts. How are the tires wearing? Check for worn ball joints, tie rod ends, strut inserts, and suspension bushings.

A thorough pre-alignment inspection can save a lot of embarrassment and aggravation later on.

- **Regular rotation and rebalancing** of all seasons tires can be just as important to their long and noise-free life as proper wheel alignment.
- **Check those wheel bearings.** Worn or improperly adjusted bearings can cause abnormal tire wear patterns, not to mention some strange readings at the alignment machine.

## Hardware Cures

There are a number of aftermarket manufacturers who make problem solving alignment hardware. Some cars that are out of specs have no factory installed adjustment, while others that do allow some adjustment don't always allow you enough.

This hardware is available as an assortment of shims, wedges, and tapered spacers. In skilled hands, they can correct minor misalignment problems. It's very important that they be used properly, however. Major alignment problems caused by badly bent or broken suspension parts, or damage to the unit body, should only be fixed by the replacement of those parts or proper unit body repair.

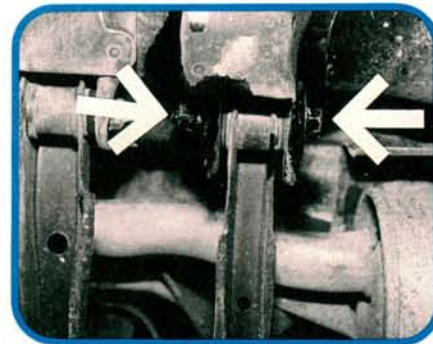
If you're interested in knowing more about these products, we've included a listing of hardware manufacturers, their products, and information about the technical support and training each company offers. See our **Odds'N Trends** department on page 50 of this issue.

—By Ralph Birnbaum



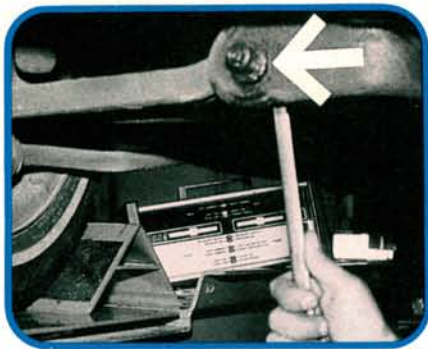
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Our Nova's camber was a little shaky. It was just barely in limits. Ride height was the problem. We lifted up on the sagging side by hand until the car was level, and camber came back to OE specs. Since tire wear was still even, the customer chose to drive the car and recheck camber at a later date.

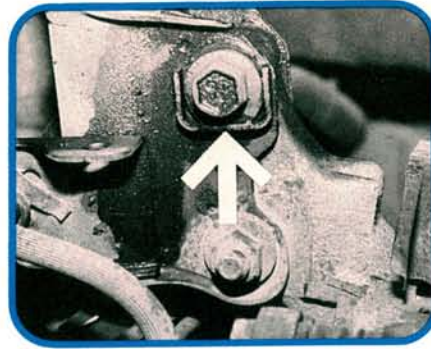


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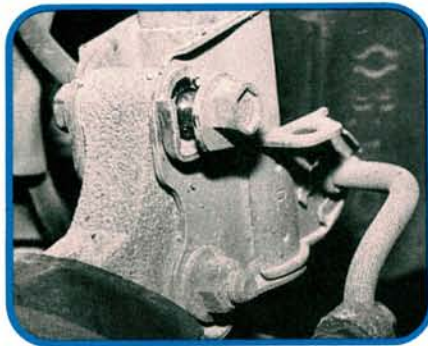
Total toe on the Nova's rear wheels was okay, but our thrust angle was 30 degrees. We snatched some toe from one side and added it to the other. To adjust the Nova's rear toe, loosen the head of the bolt on the rear suspension arm adjustment cam. Then *turn the nut* to make your adjustment.



Our 1987 Nissan Sentra had a similar toe adjustment on the rear. Pre-1987 Sentras had no factory adjustment. (See *Import Service*, August 1988, page 42.) Unlike the Nova, however, on the Nissan, you loosen the nut on the rear arm and *turn the bolt* head to adjust rear toe.



Although the Sentra is equipped with eccentric adjustment cams on the front struts, the first time you use them you'll have to remove and turn the cams before making an adjustment. The cams are factory installed so a flat face on the adjusting cam locks it against the boss on the cam strut.



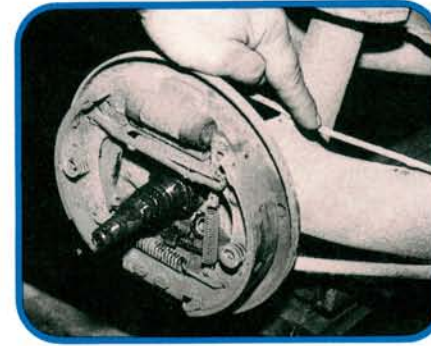
To do this, remove the front wheel or wheels to be adjusted. Unbolt the eccentric cam and drive it out far enough to clear the boss, as shown. Then turn the cam 180 degrees and reinstall it with the flat side facing up. Snug the nut on the cam bolt. Loosen the lower bolt slightly, but leave it snug.



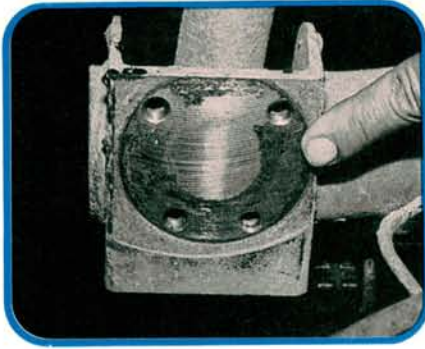
Reinstall the Sentra's wheels and lower the car. Reinstall the alignment heads and recompensate for runout. Bounce the car to settle it. Turn the eccentric cams to correct camber and retighten the bolts on both the cam and lower bolt. Check and correct toe as needed.



The rear suspension on this VW Rabbit presents a different problem. The stub axles bolt tight to the one piece axle beam, and no factory adjustment is provided. Now what? One possibility is to use a tapered full contact shim between the axle and axle beam to make the adjustment.

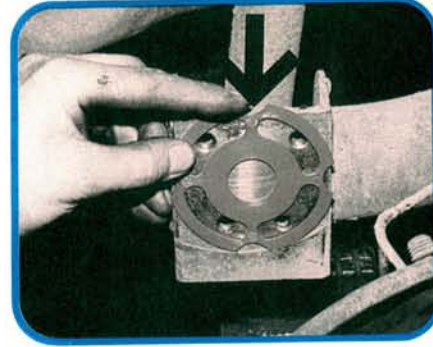


Be careful when you remove the backing plate so you don't damage the brake line. You should be able to move the backing plate slightly without damaging a good line. But keep your eyes open, since even this small movement could weaken or even break a rusted or badly corroded line.



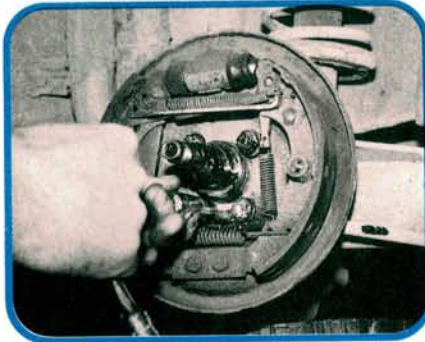
# 9

Clean all the scale and rust from the mating surfaces between the stub axle and the axle beam mounting face. Select a shim that corresponds to the amount of camber change you need to make. Thick side straight up for a positive camber change. Thick side down for more negative camber.



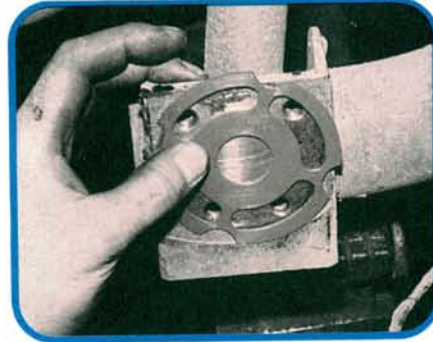
# 10

Let's say we want a 2 degree increase in positive camber. Place the number 2 at the 12 o'clock position between the stub and the axle beam. Snug the two bolts at the thinnest part of the shim first to pull the stub axle tight to the beam. Then snug the other two bolts.



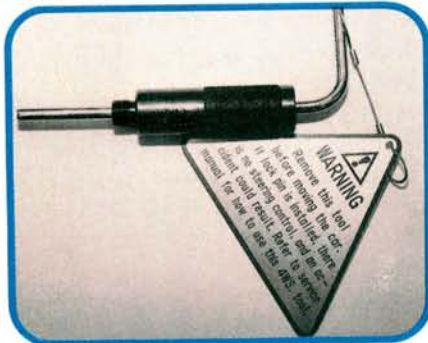
# 11

If you fully tighten the bolts at the thickest part of the shim first, you can put things in a bind and leave an air gap at the bottom. This can overstress the bolts as you try to pull things into place. Torque the bolts to the recommended specs. No impacts please. Overtightening can be just as harmful, and dangerous, as leaving the bolts loose.



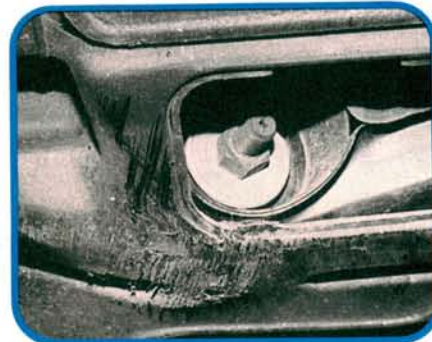
# 12

Slots in the shims let you rotate them to change camber and toe at the same time. You'll need to measure tire diameter and use the chart in the shim package to figure toe change. Camber changes in degrees, but toe is a linear measurement, so tire diameter affects toe change made by the shim.



# 13

What about four wheel steering? Is it really a big mystery? Not really. Honda has thoughtfully provided a fully adjustable suspension on this Prelude. You'll need one special tool to center the rear steering gear, but the alignment procedures on this car are hardly mysterious after that.



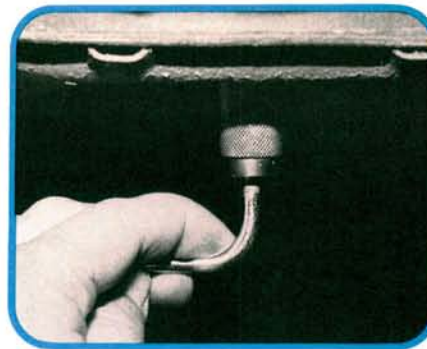
# 14

Adjust front caster at this radius rod. If adjustment is needed, loosen the two bolts holding the rod to the control arm. Then loosen this self-locking nut on the rod. Move the backing nut forward to decrease caster or rearward to increase caster. Retighten bolts and nut and check for  $2^{\circ}20' \pm 30'$ .



# 15

Turn the front wheels to the straight ahead position. Then adjust front camber to  $0^{\circ}00' \pm 1^{\circ}$  by loosening the upper arm lock nuts and then moving the knuckle assembly. Move it in or out to correct camber. Tighten the lock nuts to 55 Nm (40 ft-lb).



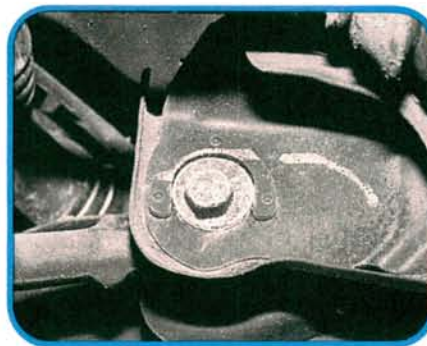
# 16

Forget front toe for now. Turn the steering wheel to center. Then remove the T40 Torx plug at the bottom of the rear steering gear housing. Screw the steering gear centering tool into the plug hole. Have an assistant wiggle the steering wheel very gently until the pin locks the gear.



# 17

The pin on the special tool is spring loaded and has a recessed reference band on it. If you can see the red band, the pin is not engaged in the steering gear. When it does fully engage the gear, the red band will disappear into the outer collar that screws into the gear housing.



# 18

With the locator pin installed in the rear steering gear, adjust rear wheel camber. The first and most tempting thing you'll see are these factory adjustments on the inboard side of the lower suspension arms. Resist the temptation. **DO NOT** adjust camber here.



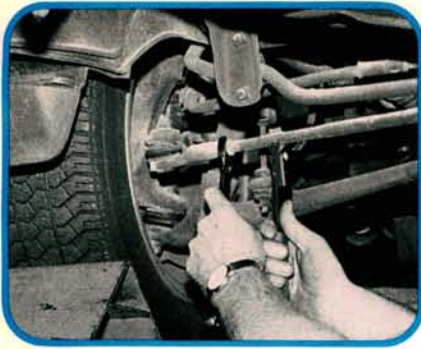
# 19

Rear wheel camber is adjusted at the upper arm just like it was on the front wheels. Loosen the lock nuts attaching the knuckle pivot to the upper arm. Move the knuckle assembly to correct camber to  $-0^{\circ}20' \pm 30'$ . Camber difference between sides should be less than  $20'$ . Lock nut torque is 55 Nm here too.



# 20

With the rear steering gear still locked, make sure the steering wheel is centered. If the steering wheel is off center by more than 5 mm (6 degrees), measured at the steering wheel hub, you'll have to remove and reposition the steering wheel until it's within 5 mm of dead center.



# 21

Remove the centering tool from the rear steering gear and replace the T40 plug. Now finish centering the steering wheel and lock it in place with a steering wheel holder. Adjust each rear wheel to 1-2 mm toe. Total toe is  $3 \text{ mm} \pm 1 \text{ mm}$ , and toe on both rear wheels should be the same.

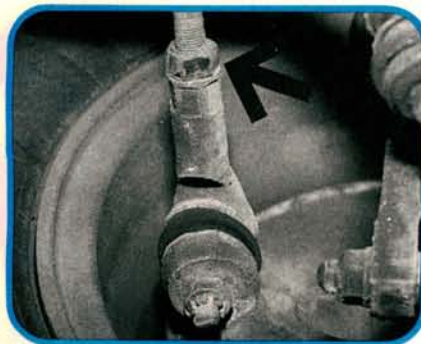
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# 22

Adjust toe on each front wheel to  $0 \pm 1 \text{ mm}$  (total toe  $0 \pm 2 \text{ mm}$ ). Keep the steering wheel locked on center. Adjust each wheel the same amount. If you drive the car and have a minor steering wheel misalignment (2.5 mm or less), you can correct it by turning the front tie rods to bring the steering wheel back to center.

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# 23

If the steering wheel is off center to the left, increase positive toe on the right front wheel, and decrease positive toe on the left front wheel in equal amounts until the steering wheel is straight. The procedure is just the opposite if the steering wheel is off center to the right.