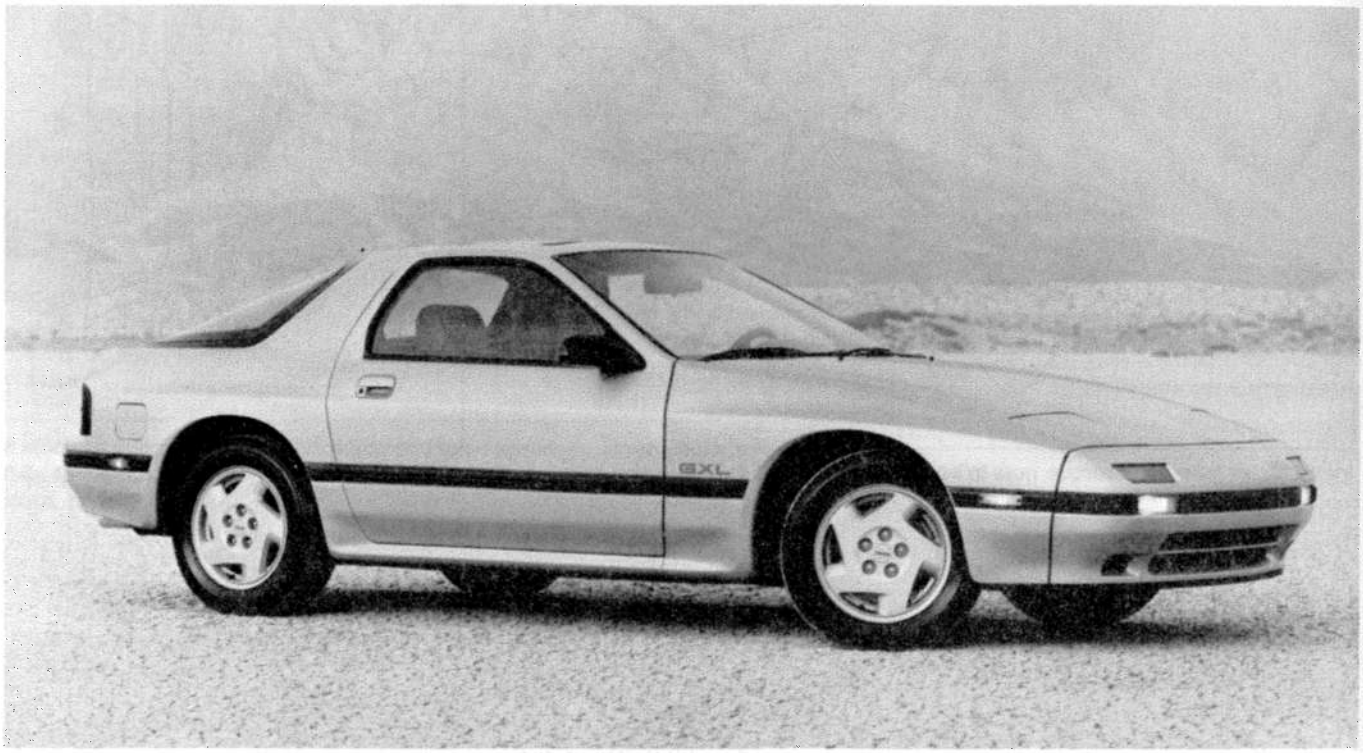
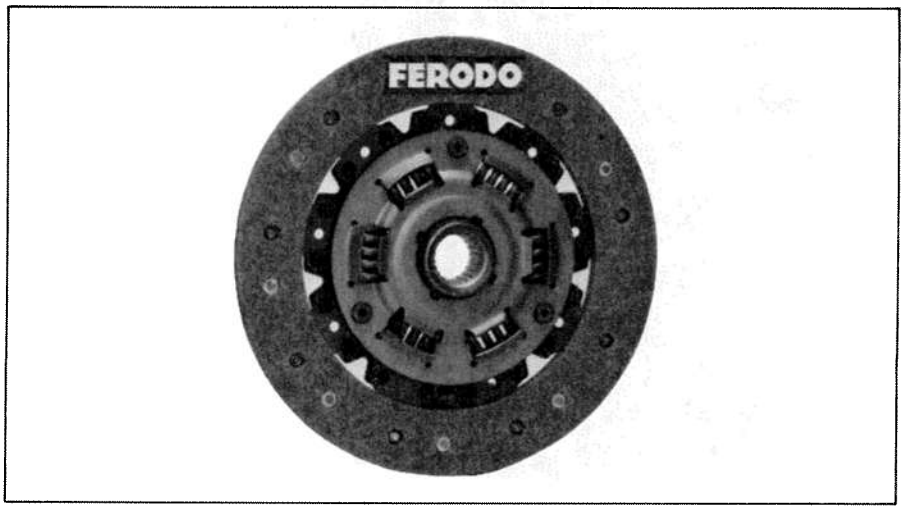
CHASSIS MODS



Original RX-7 was an excellent sports car; second generation is even better. Sophisticated suspension imbues the RX-7 with excellent handling characteristics. Drivetrain is also well designed, but can use some beefing-up for high-performance applications.



Heavy right foot requires that components operated by the left foot can tolerate severe service. Use of a heavy-duty clutch disc will provide long and trouble-free operation. Photo courtesy Racing Beat.

In spite of the considerable improvements made to automatic transmissions over the years, a sports car like the RX-7 should be equipped with a shift lever and *three* pedals. Of course, when the third pedal activates a clutch, as opposed to a "mother-in-law brake" on the passenger's side, the proper pieces must be installed at the receiving end of the linkage.

CLUTCH

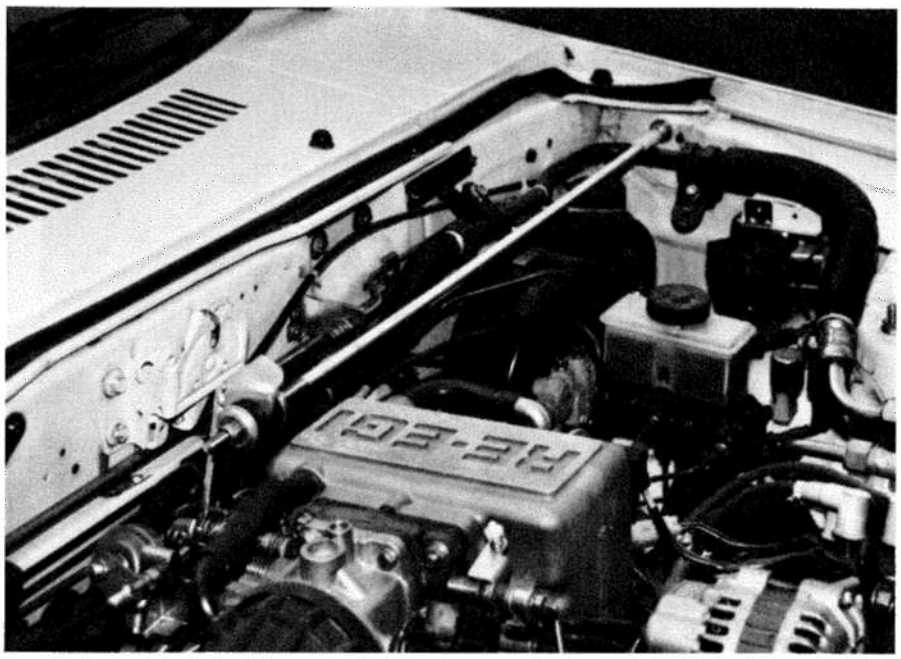
For the everyday RX-7, driven by a meek, mild-mannered accountant, hair dresser, book editor, writer or fashion model, the standard clutch is adequate; with proper driving technique, service life will be excellent. That isn't meant to imply that the car must be driven as though the proverbial "little old lady

from Pasadena" were behind the wheel. Surprisingly, an overly conservative driving style can be most threatening to clutch life. Premature failures are almost always the result of drivers *feathering*—slipping—the clutch for a smooth take off from dead stop. There's a fine line between sufficient and excessive slippage. The latter is what overheats the lining and accelerates wear.

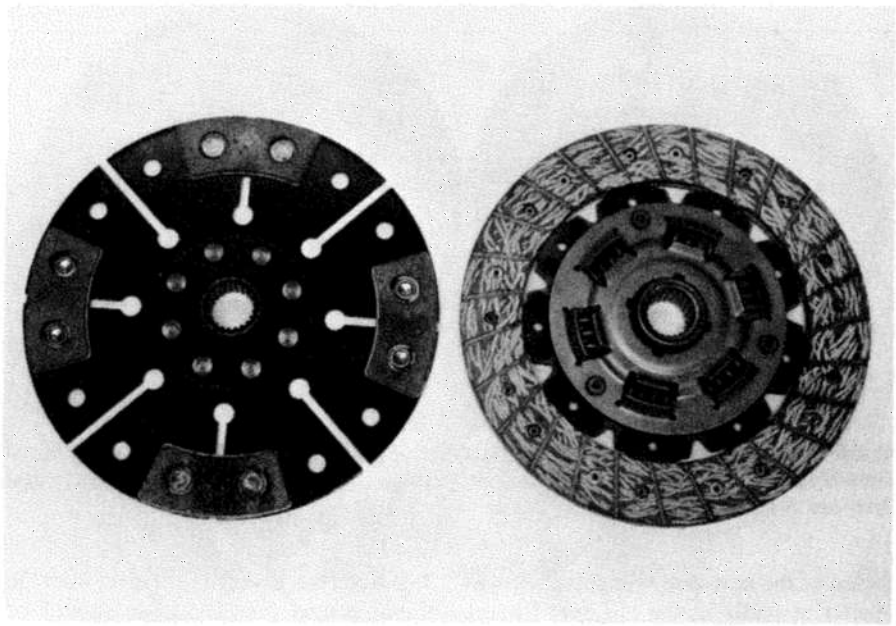
The feathering technique—very gradual engagement with purposeful slippage—is a means of overcoming the jerky start that often accompanies more aggressive clutch operation. With rotary engines not being particularly noted for low-speed torque, many drivers adopt this technique almost unconsciously. But with proper coordination of throttle and clutch pedal, slippage can be kept to a minimum, and clutch life to a maximum. The right technique will result in a clutch lasting 50,000—70,000 miles.

Even with the best of techniques, clutch slippage tends to be more of a problem as mileage accumulates. As the lining undergoes normal wear, its thickness is reduced. Although the load exerted by a diaphragm pressure plate increases to a point with wear, the combination of wear and partial glazing of the lining, slippage not caused by the driver may occur, particularly if the car is driven hard and shifted quickly. As a general rule, slippage is most noticeable when shifting into one of the higher gears because torque multiplication is not as great as in first or second.

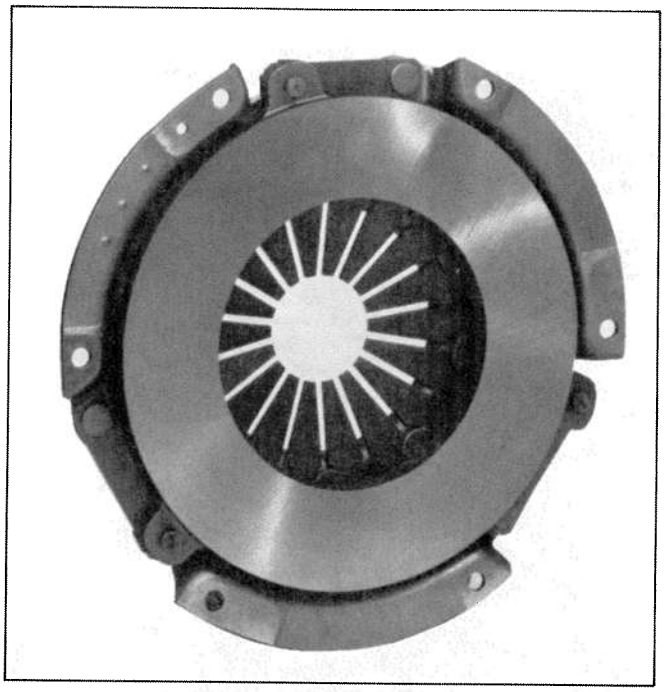
Another common clutch problem is chatter during engagement. Rather than engaging smoothly, a chattering clutch causes the car to shudder as it is engaged. Assuming that the flywheel has not been surfaced or installed incorrectly, the most common cause of chatter is a disc facing that has been given a dose of oil or grease. Possible sources of lubricant include oil leaking from the transmission's front seal, grease from the throwout bearing, a leaking engine oil pan or rear seal, or a greasy-fingered clutch installer. Once a disc becomes oil or grease soaked, it must be replaced. However, before a new disc is installed, the source of lubricant contamination must be cor-



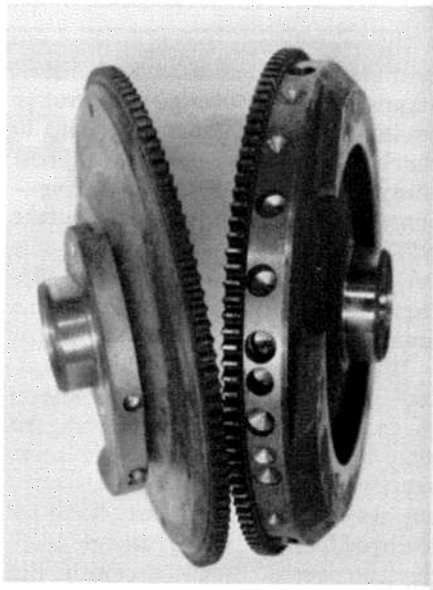
Chattering clutches can lead to chattering teeth because the whole car shakes. Racing Beat offers a special kit that ties engine to left front inner fender to control engine shake. Photo courtesy Racing Beat.



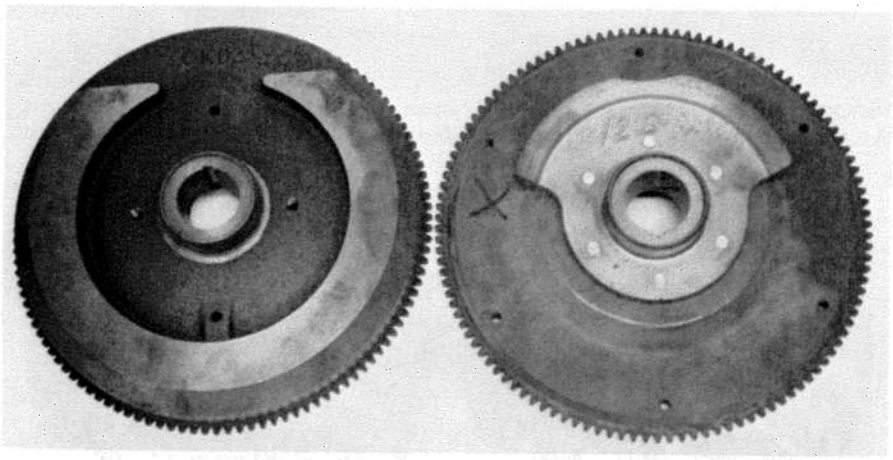
Racing clutch discs frequently use small sinterred-metallic friction facings (left) rather than full-circle organic facings (right). This type of construction makes for minimal slippage and affords superior heat dissipation. Combination of metallic friction material and unsprung hub make this a race-only clutch. Stock disc with organic facings has sprung hub for smoother operation.



Heavy-duty clutch disc without a high-performance pressure plate is like eggs Benedict without hollandaise sauce. The greater spring pressure exerted by a high-performance pressure plate against the disc increases clutch torque capacity and minimizes slippage. Photo courtesy Racing Beat.



Lightweight flywheel is considerably thinner than stock counterpart. Depending upon application, flywheels may be aluminum or steel.



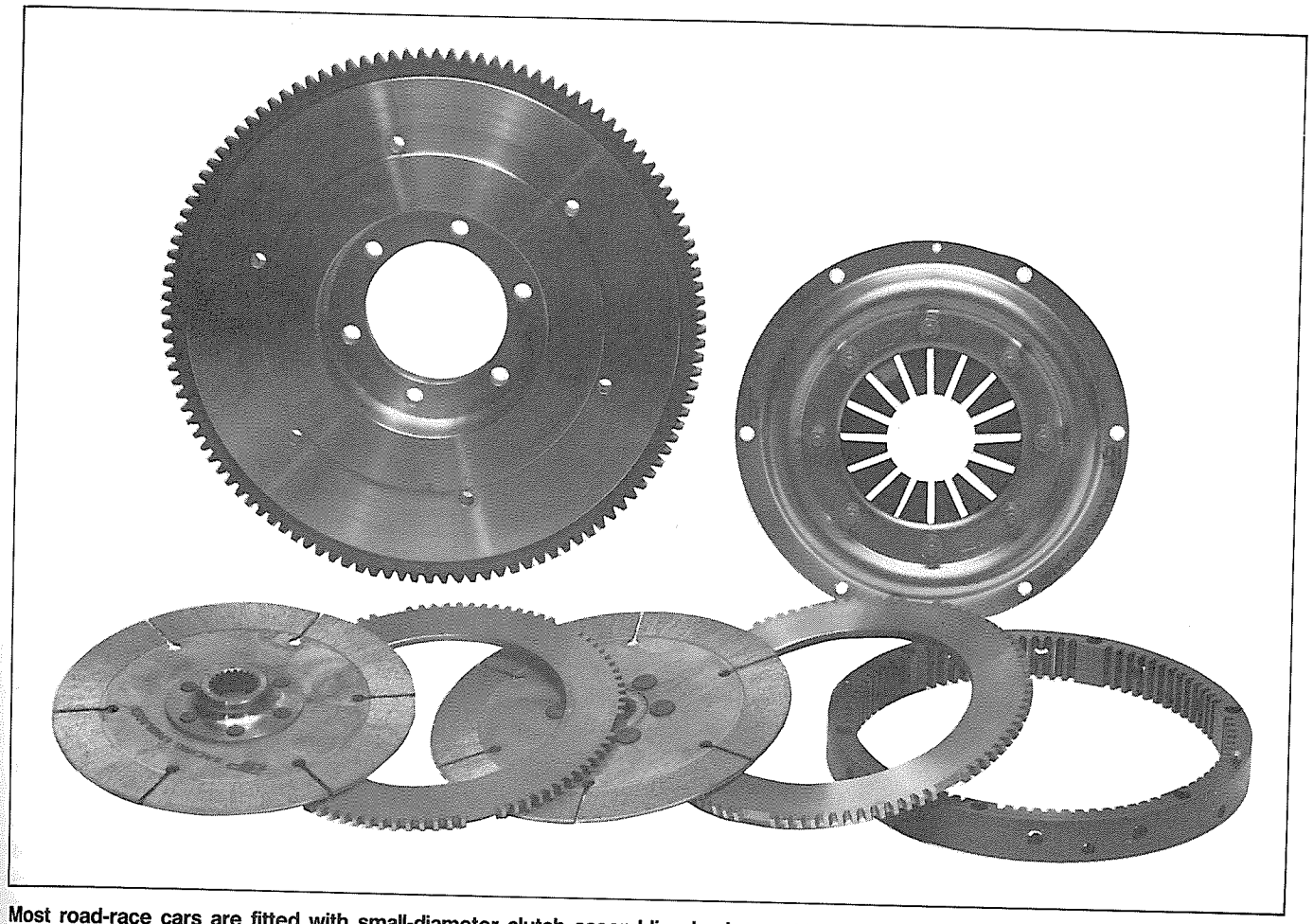
At left is stock flywheel, at right is lightweight version. Counterweight from engine intended to be mated to an automatic transmission must be used to mount lightweight flywheel to eccentric shaft.

rected or the new disc will soon begin to chatter as badly as the old one. Racing Beat suggests that the transmission front seal be replaced whenever the transmission is removed as a leak may be caused by pressure on the input shaft during transmission installation.

Before you install a new disc, both the flywheel and pressure plate should be resurfaced on a grinder designed for that purpose. Material is cut in a non-directional manner. A lathe should not be used because the machining pattern will be in concentric circles and the tool will "jump" over any hard spots, causing high spots.

A disc establishes a wear pattern on the surfaces it contacts, much in the manner that brake pads establish a pattern on a disc-brake rotor. For optimum clutch performance, a new disc should be allowed to work with unworn contact surfaces on both the pressure plate and flywheel. Although it is possible to simply install a new disc and not resurface the flywheel or pressure plate, slippage or chatter may result.

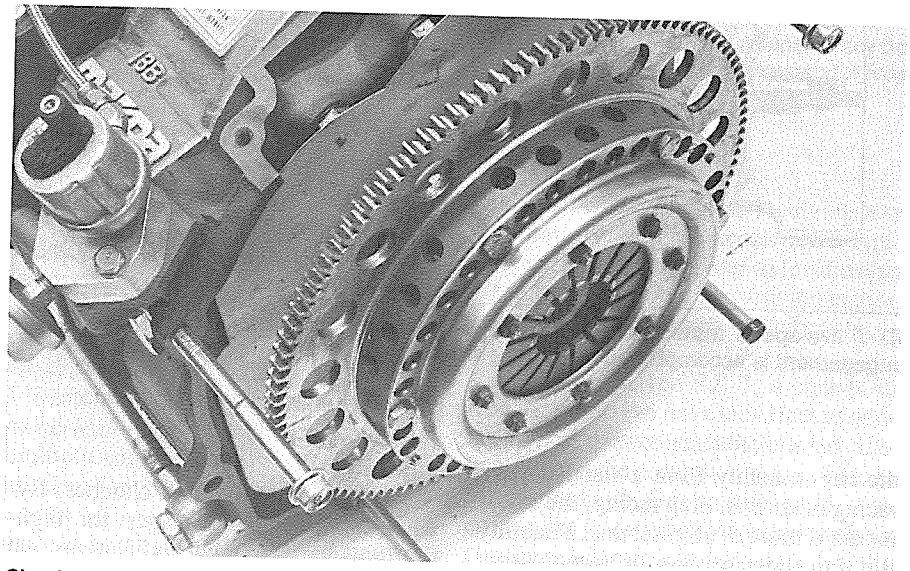
Both Racing Beat and Mazmart offer standard and heavy-duty clutch discs. Although the heavy-duty disc is better suited to high-performance applications, it engages with a minimal amount of slippage and requires more finesse for smooth engagement. For street use, one of these discs should be used in conjunction with a lightweight steel flywheel and a heavy-duty pressure plate. Avoid using a racing clutch and flywheel assembly in a street-driven vehicle. The pressure plate is so "fast" it will have harsh engagement and very high pedal effort.



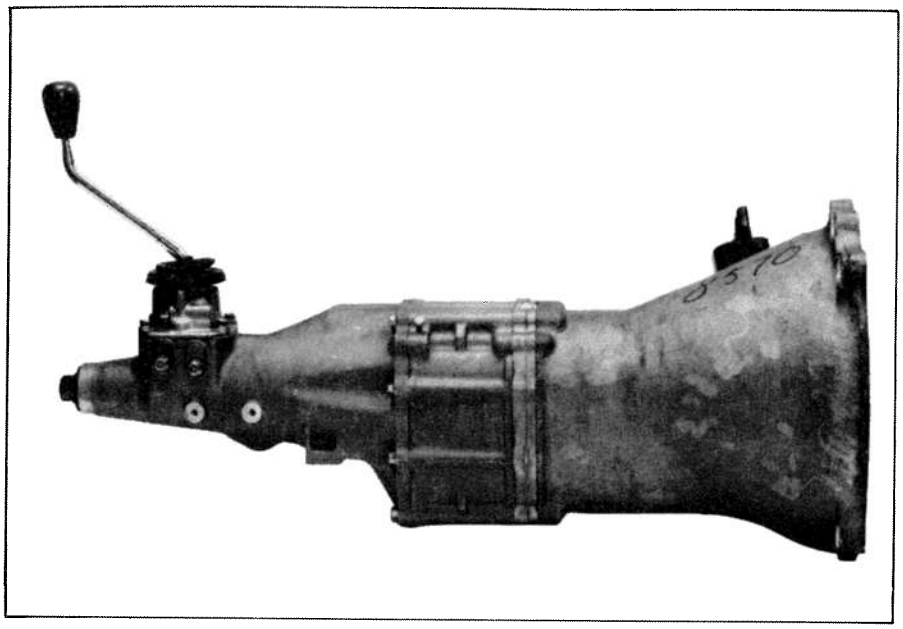
Most road-race cars are fitted with small-diameter clutch assemblies having multiple discs and steel floater plates. This 7-1/4-in., two-plate unit mates to an aluminum flywheel. Photo courtesy Racing Beat.

Although the Mazda competition single-disc clutch/flywheel assembly will handle engines up to 300 horsepower, many race cars are fitted with a Borg and Beck style two-disc clutch. This arrangement allows clutch diameter to be reduced (as opposed to a single disc) because friction surface area is doubled by virtue of the second disc. The resulting assembly is light, durable and offers minimal inertia.

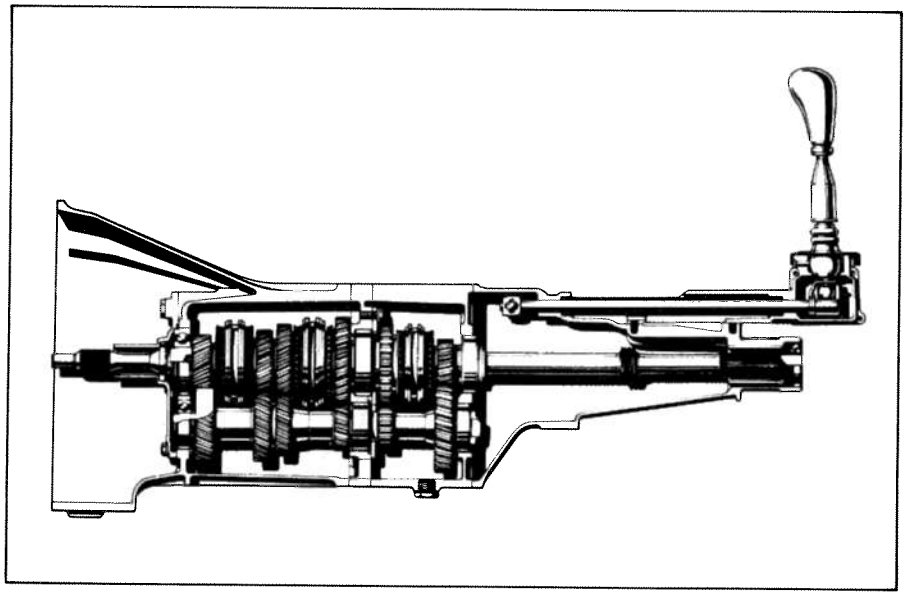
Flywheel—For racing, an aluminum flywheel is typically preferred because it significantly reduces weight and, as a result, inertia. To a degree, a lightweight flywheel is a double-edged sword. The resulting inertia reduction allows the engine to accelerate (or decelerate) more quickly because it has less mass to accelerate (or decelerate), but the lack of inertia makes it more difficult to move



Clutch assembly used on Downing/Atlanta race engine begins as a lightweight unit, then is lightened considerably more. Note lightening holes in both flywheel and clutch assembly.



Standard RX-7 transmission is strong and relatively trouble free, even for high-performance applications. Photo courtesy Racing Beat.



RX-7 five-speed trans features internal shift linkage and cast-aluminum case. Gear engagement is accomplished by moving sliders that lock speed gears to mainshaft.

the car smoothly from a standstill. For racing other than drag racing, the loss of inertia is more of an asset than a liability. But for street driving or autocrossing, where some snap off the starting line is beneficial, a slightly heavier flywheel is preferable .

For an in-depth look at clutches, flywheels and clutch linkages for high-performance and racing applications, get HPBooks' *Clutch & Flywheel Handbook.*

TRANSMISSION

Mazda five-speed transmissions are about as durable as any stock gearbox—except for one particular component; the brass synchronizer ring. Each ring contains three slots into which the shift keys fit. During a gear change, an internally splined slider is moved across a hub. The shift keys that are spring loaded and reside in grooves in the hub are pushed up against the ends of the slots in the synchro rings. This movement forces the ring against a cone-shaped flange on the end of the gear. As the ring "locks" on the cone, the gear is synchronized to the rpm of the slider, which can then be easily pulled into engagement with it.

During a normal gear change, the whole synchronization process takes place in just a few seconds. But if the synchro rings are worn excessively or distorted, they will not lock on the cone; synchronizing action will be poor or nonexistant. A grinding sound during a gear change is a sure sign that a synchro ring needs replacement—assuming the clutch fully disengages. The RX-7 transmission (1978 and later) features synchro rings that are notably stronger than those found in earlier gearboxes.

Synchronizer Rings—When synchro rings are replaced, or transmission is rebuilt, Racing Beat suggests that new rings be lapped on the old gear cone.

To lap a synchro ring, apply a fine lapping compound to the cone, place the synchro ring in its normal position, and with light pressure rotate the ring back and forth for about 30 seconds. This will break the glaze on the cone, making for improved synchronizing action. Before assembling the transmission, wash the gears and synchro rings carefully to remove all traces of the lapping compound.

Tailhousing Bushing—When the stock transmission is subjected to prolonged high-speed operation, the stock tailhousing bushing is likely to be a source of trouble. As the drive-shaft yoke spins inside the bushing, heat is generated. Under normal conditions, transmission lubricant will supply adequate cooling. But at high speeds, lubricant flow in the tailhousing is insufficient to control temperatures and provide adequate lubrication. As things get hot and expand, the bushing may seize on the yoke.

To avoid such problems, Mazda uses roller bearings rather than bushings in the tailhousings of competition transmissions. Racing Beat advises that roller bearings be installed in stock transmissions operated at high speeds. However, the tailhousing must first be modified to accommodate the bearings' larger OD.

Before the hole in the end of the tailhousing can be enlarged to accept the roller bearing, material must be added to the flange. This is accomplished by heliarc welding around the outside of the flange. Once the flange is built up to a sufficient thickness, the inside diameter is bored to the diameter required to accept the roller bearing. Once the bearing is installed, you must also use the competition drive-shaft yoke that features a hardened surface for the bearing to run against.

Competition Transmissions—Mazda competition five-speed gearboxes, will mate to any '74 and later 12A or 13B engine. The "RX-7" race box features gear ratios of 2.350, 1.608, 1.240, 1.000 and 0.881:1; a fifth-gear ratio of 0.839:1 is also available.

Another option, although one that is considerably more expensive, is Mazda's "Quick Change" transmission. This aftermarket transmission is built by a supplier in the United States. A race-only gearbox, it has three optional ratios for each gear position (see chart). At the rear of the transmission is a "Quick Change" gearset. Five different "Quick Change" ratios allow overall gearing to be altered over a relatively wide range. With this arrangement, gearing can be tailored to virtually any race course.

Excessive heat is just as much an enemy of transmission life as it is of engine life. As such, the lubricant temperature of any gearbox subjected to prolonged severe service should be monitored. For optimum transmission durability, coolant temperature should not exceed 200F. If necessary, an auxiliary cooler should be installed to keep transmission temperatures in check.

THIRD MEMBER

Gearing—Over the years, Mazda has produced five distinct rear-axle assemblies for vehicles with rotary engines. All 1979—85 RX-7's have the same style rear, although gear ratio has varied according to year and engine size. In addition to the original production factory-installed gear ratios, Mazda also offers optional ring-and-pinion gearsets with ratios of 4.111, 4.375, 4.444. 4.625, 4.875 and 5.125:1.

Rear-axle ratio, as determined by ring and pinion gears, has a significant affect on both performance and fuel economy. When making extensive engine modifications, it may be necessary to switch to a lower gear ratio (higher numerical ratio) to compensate for less low-speed torque. Photo courtesy Racing Beat.

Switching to a lower ratio—*higher numerical*—gearset will increase torque multiplication and, consequently, acceleration. However, the payback comes as a reduction in top speed; the engine must turn higher rpm to maintain a given speed. Similarly, switching to a higher gear reduces torque multiplication. And with the engine receiving less help through gearing, acceleration typically suffers. Altering rear-axle ratio also affects fuel economy because the engine speed-to-vehicle speed relationship is altered.

In a street-driven RX-7, a change in rear-axle ratio can have the effect of adding 50 horsepower beneath the hood. Unfortunately, the reduction in gas mileage can be dramatic. On the other hand, if an engine has been modified extensively, a change to a lower axle ratio may actually improve fuel economy.

Engine modifications generally in-

crease mid-range and top-end horsepower at the expense of low-speed torque. A lower axle ratio can be installed to compensate for this loss. The change in gearing allows the engine to reach its "happy" operating range—where the engine is more efficient—more quickly.

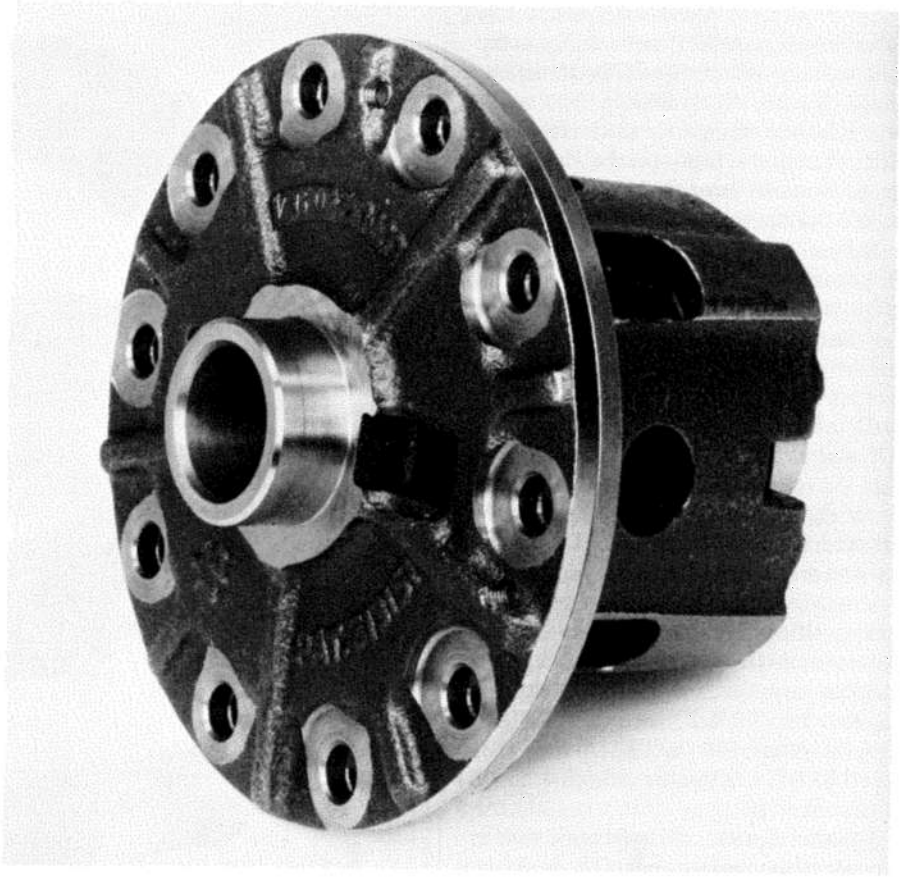
Remember that whenever the axle ratio is changed, the speedometer must be recalibrated.

Each ring-and-pinion set is furnished with specifications to be referenced during installation. Backlash and pinion depth are important when setting up a rear end, but they are not absolutes. Frequently, it is necessary to deviate from factory specifications to achieve a desired tooth-contact pattern; the pattern itself is critical to gear life. Backlash and pinion depth should be adjusted to provide the desired pattern, not vice versa.

As a general rule, a pattern that is centered in the tooth is preferred for street applications. Although a pattern that favors the *toe* side of the tooth reduces loads that tend to cause tooth breakage, it also generates more noise. When checking pattern, gear-marking compound, rather than the traditional Prussian Blue or red lead, should be used as it provides a clearer picture. Marking compound is available from G & G Specialties, 7871 Hickory Street NE, Minneapolis, MN 55432, 612/571-8117.

Once the correct pattern is established—procedures are outlined in Mazda factory manuals—a new crush collar must be installed when the differential is assembled for the final time. But if all specified preloads aren't established, the work put into establishing the pattern will have been needless. When torque is applied to the third member, the pinion gear attempts to push away from the ring gear; the pinion also attempts to move in the fore-and-aft plane.

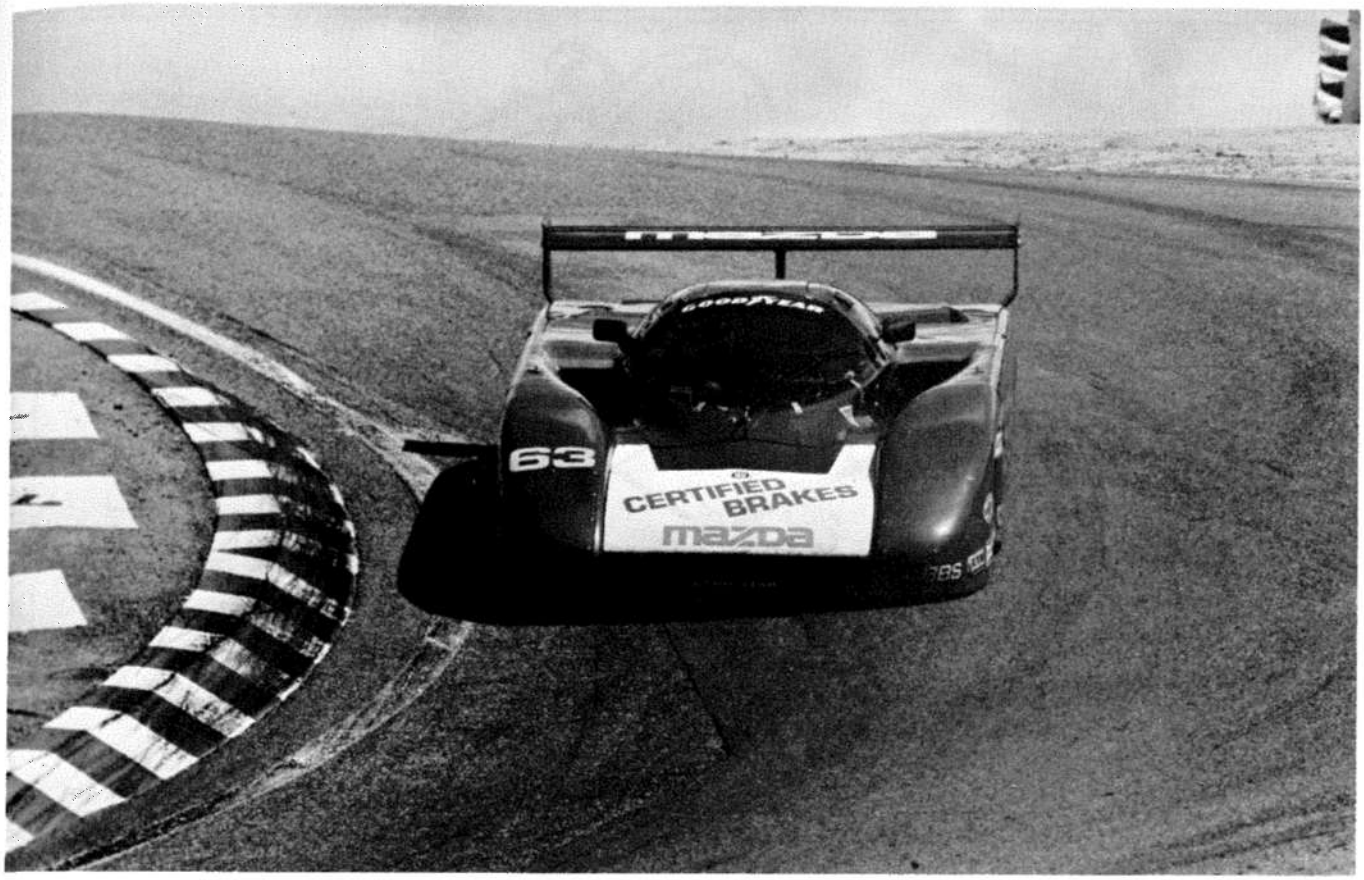
The crush collar establishes pinion-bearing preload when the pinion nut is tightened. If a used collar is reinstalled, it will generally not allow the specified preload to be established as it has already been collapsed somewhat. Therefore, a new crush collar must be installed along with a new set of gears. Mazda specifies that the pinion nut not be torqued beyond 130 ft-lb. If the specified preload cannot be achieved without exceeding this figure, replace the crush collar.



Mazda limited-slip differentials employ a series of clutch discs and plates to transfer power to both rear wheels when car is traveling in a straight line. When turn is made, clutches slip, allowing speed difference between wheels. Photo courtesy Racing Beat.

Limited-Slip Differential—Additional acceleration, whether derived from engine modifications or increased gear multiplication, requires improved traction. While tires and suspension certainly play a role in transmitting power to the pavement, a limited-slip differential is also a valuable asset. Mazda offers street and race limited-slip units; both are direct replacements for the stock differential.

When installing a limited-slip differential in place of the stock unit, new side bearings—Mazda part no. 0221-27-302A—should also be installed. It is possible, but very difficult to remove the bearings from the original carrier without damaging them. After converting to a limited-slip differential, a specific lubricant should be used. Mazda recommends GM 90W gear lubricant (part no. 1052271) and limited-slip additive (part no. 1052358).



Whether it's a race car such as Jim Downing's Mazda/Argo machine or a street-driven RX-7, a top-quality braking system is important for performance, but absolutely essential for safety.

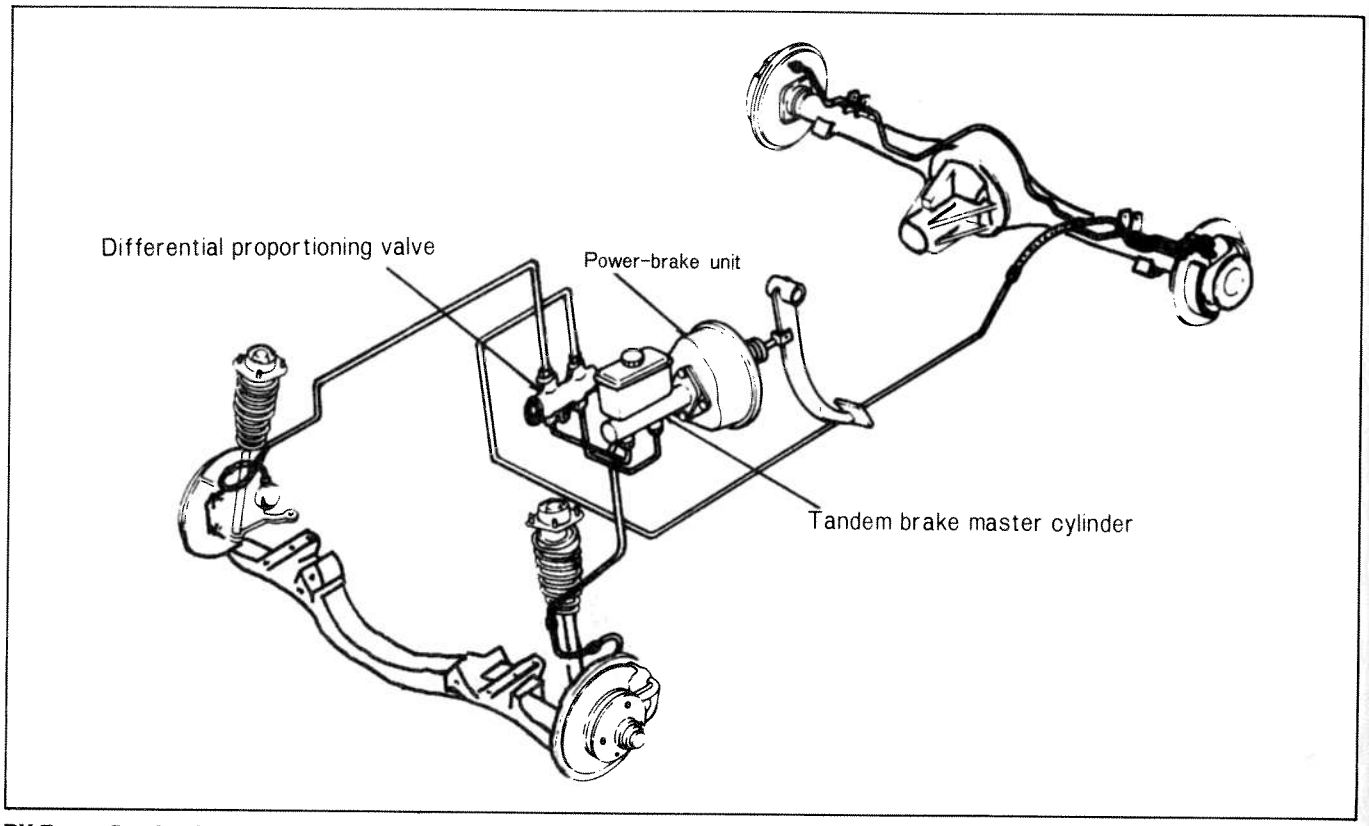
BRAKES

The RX-7 has been blessed with a superior braking system. It is certainly adequate for street driving, and stock systems have been used successfully in race cars for many years. The caveat here is that when the stock system is retained, heavy-duty brake pads should be installed.

Brake Pads & Rotors—Brake fade is the most commonly encountered shortcoming of the stock system. For most street driving, a set of heavy-duty, semi-metallic brake pads, such as the RPG-500 compound from Certified Brakes, should cure most fade problems.

For maximum stopping power, whenever new pads are installed, the rotors should be resurfaced. In addition to establishing a proper surface for seating the pads, machining the rotor will

Certified Brakes, a sponsor of Downing/Atlanta team, offers high-performance brake pads for RX-7s. The RGP 500 pads are noted for fade-free stopping and long life.



RX-7s are fitted with split braking system actuated by a single master cylinder that contains two pistons. One piston operates the front brakes; other handles the rears. With this arrangement, even if a brake line ruptures, it would still be possible to stop car with the unaffected system. Drawing courtesy Mazda.

also correct warpage which may have resulted from overheating the brakes or over-tightening the lug nuts.

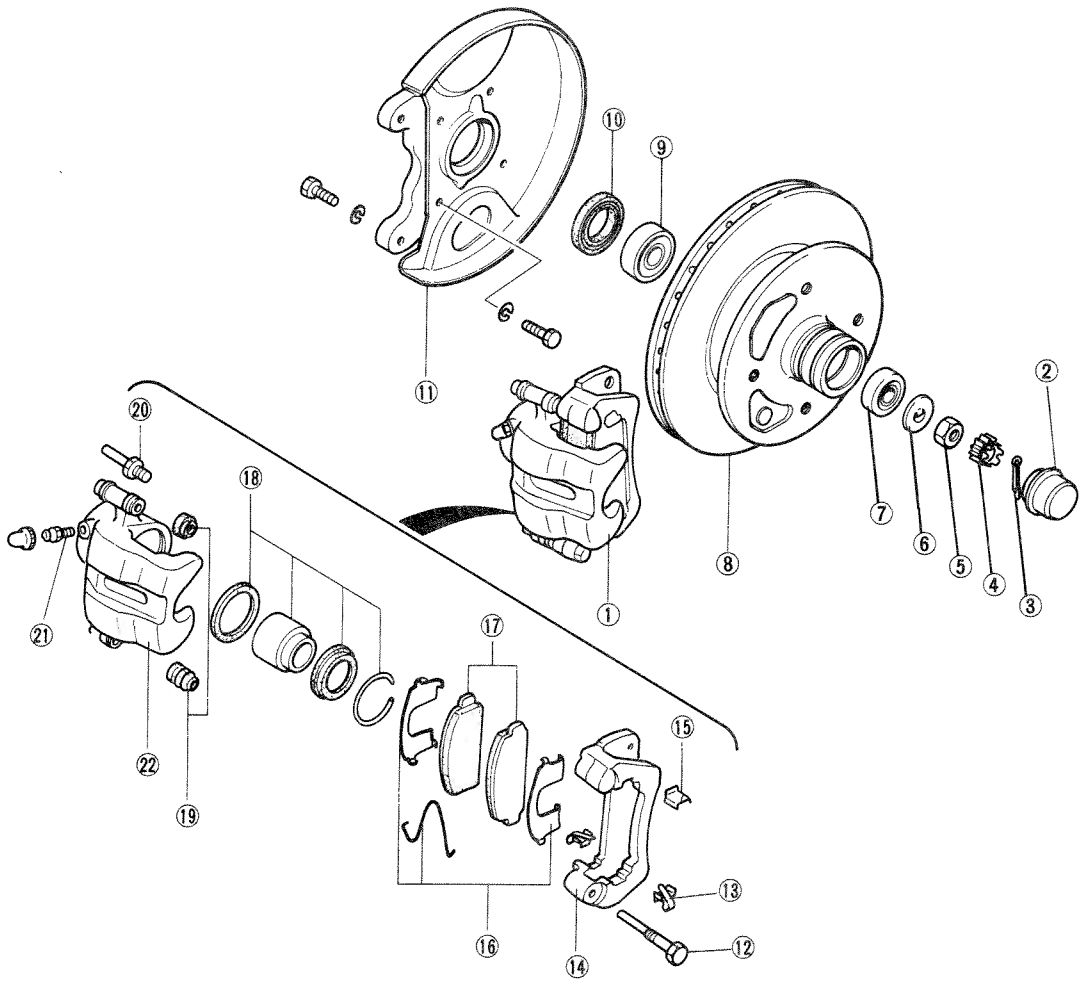
When machining rotors for use with semi-metallic brake pads, brake-lathe spindle speed should be 150—200 rpm. After the rotor has been turned, a non-directional swirl finish should be applied. This may be accomplished by spinning the rotor on the lathe while a rotating sander, with 120-grit paper, is held against the rotor surface. The resulting swirl pattern helps seat the pads and reduces the tendency of the brakes to squeal.

Brake Fluid—In conjunction with top-quality brake pads, top-quality brake fluid must also be used for maximum stopping power. Although silicone fluid has received a lot of good press because of its non-corrosive and non-hydroscopic—doesn't absorb water—characteristics, it shouldn't be used for high-performance and racing applications. Also, silicone fluid can only be used safely in a system that has had every last trace of conventional glycol-based fluid removed. This can be done only by flushing the system and disassembling and cleaning the master cylinder, calipers and rear-wheel cylinders or calipers. Even then, silicone fluid has a tendency to become compressible when heated. This results in the accursed spongy brake pedal that has, on occasion, reduced brave men to whimpering boys.

For street driving, autocrossing and racing, the hydraulic system should be filled with fresh DOT 3 or DOT 4 (Department of Transportation rating numbers) high-temperature brake fluid.

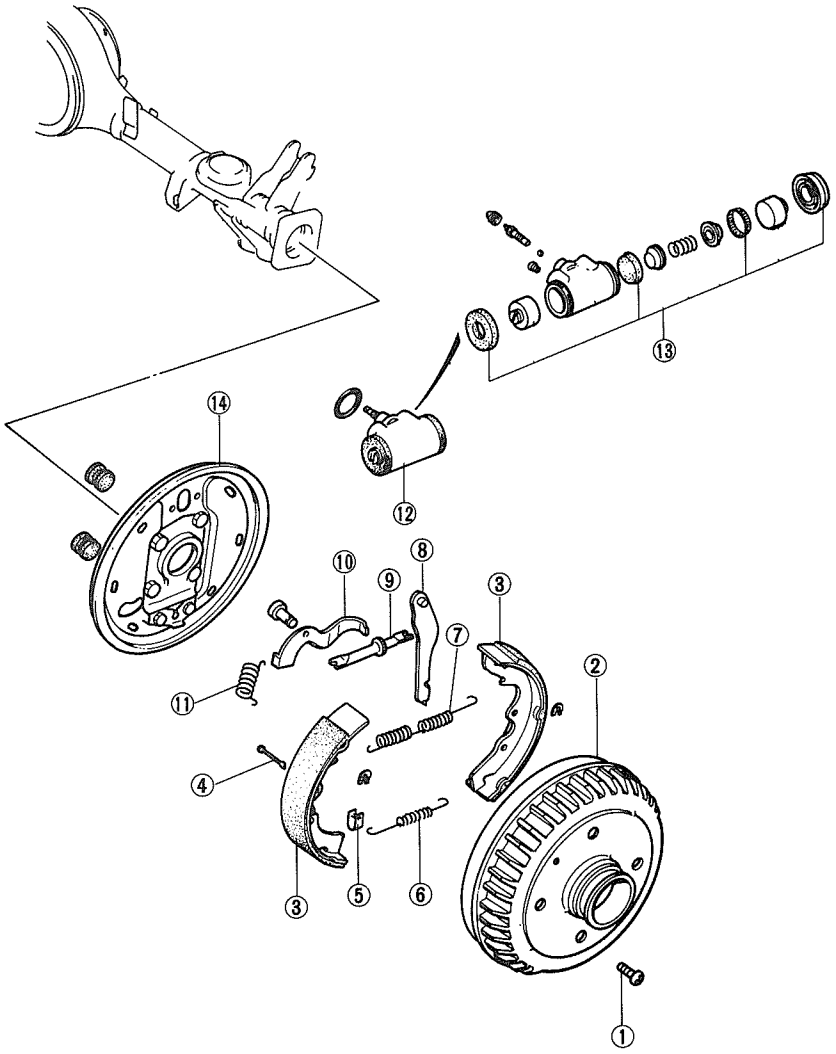
With its tendency to absorb water, conventional brake-fluid boiling temperature drops over a period of time. Most high-performance brake specialists recommend that fluid be changed at least once a year. In a race car, it's not unusual for the fluid to be changed before every race. Whenever fluid is added or changed, only fresh replacement fluid from a new, or recently opened can should be poured in. If brake fluid has been used, or has sat around in a opened can, it should be discarded.

Hydraulic-system maintenance should also include inspection of the flexible brake hoses that connect to the calipers or wheel cylinders. For racing, the stock rubber hoses are routinely replaced with braided stainless lines. While such lines



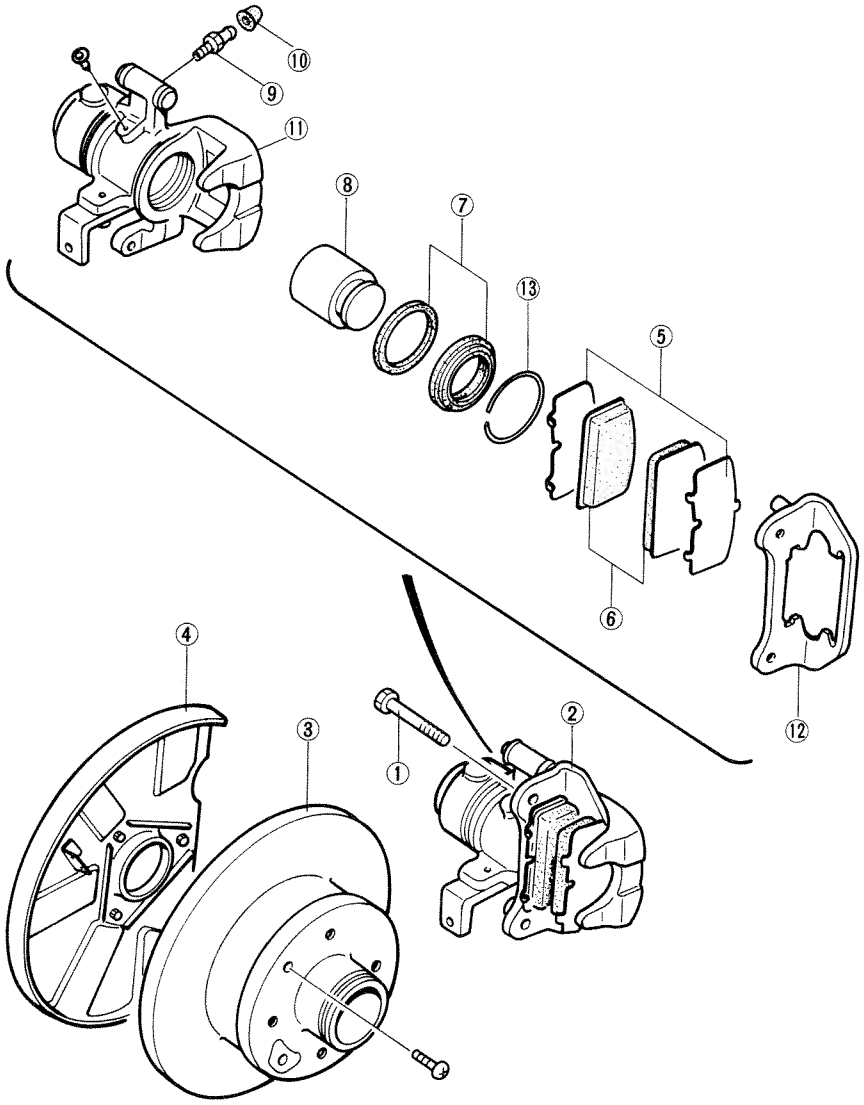
1 Caliper assembly
2 Hub cap
3 Split pin
4 Set cover
5 Nut
6 Washer
7 Front wheel bearing
8 Rotor/Hub assembly
9 Front wheel bearing
10 Oil seal
11 Mounting adapter
12 Lock pin
13 Pad clip
14 Support
15 Clip
16 Pad-attachment
17 Pad
18 Seal kit
19 Boot kit
10 Guide pin
21 Bleed screw
22 Caliper

Front brake-caliper details. Drawing courtesy Mazda.



1 Screw
2 Brake drum
3 Brake shoe
4 Pin
5 Spring
6 Lower return spring
7 Upper return spring
8 Operating lever
9 Adjuster
10 Lever
11 Spring
12 Wheel cylinder
13 Cup & Boot set
14 Back plate

Rear (drum) brake details. Drawing courtesy Mazda.



1 Bolts
2 Caliper assembly
3 Rotor assembly
4 Dust cover
5 Pad attachment
6 Pad attachment
7 Boot kit
8 Piston
9 Bleeder screw
10 Bleeder cap
11 Caliper body
12 Caliper bracket
13 Boot retainer

Rear (disc) brake details. Drawing courtesy Mazda.

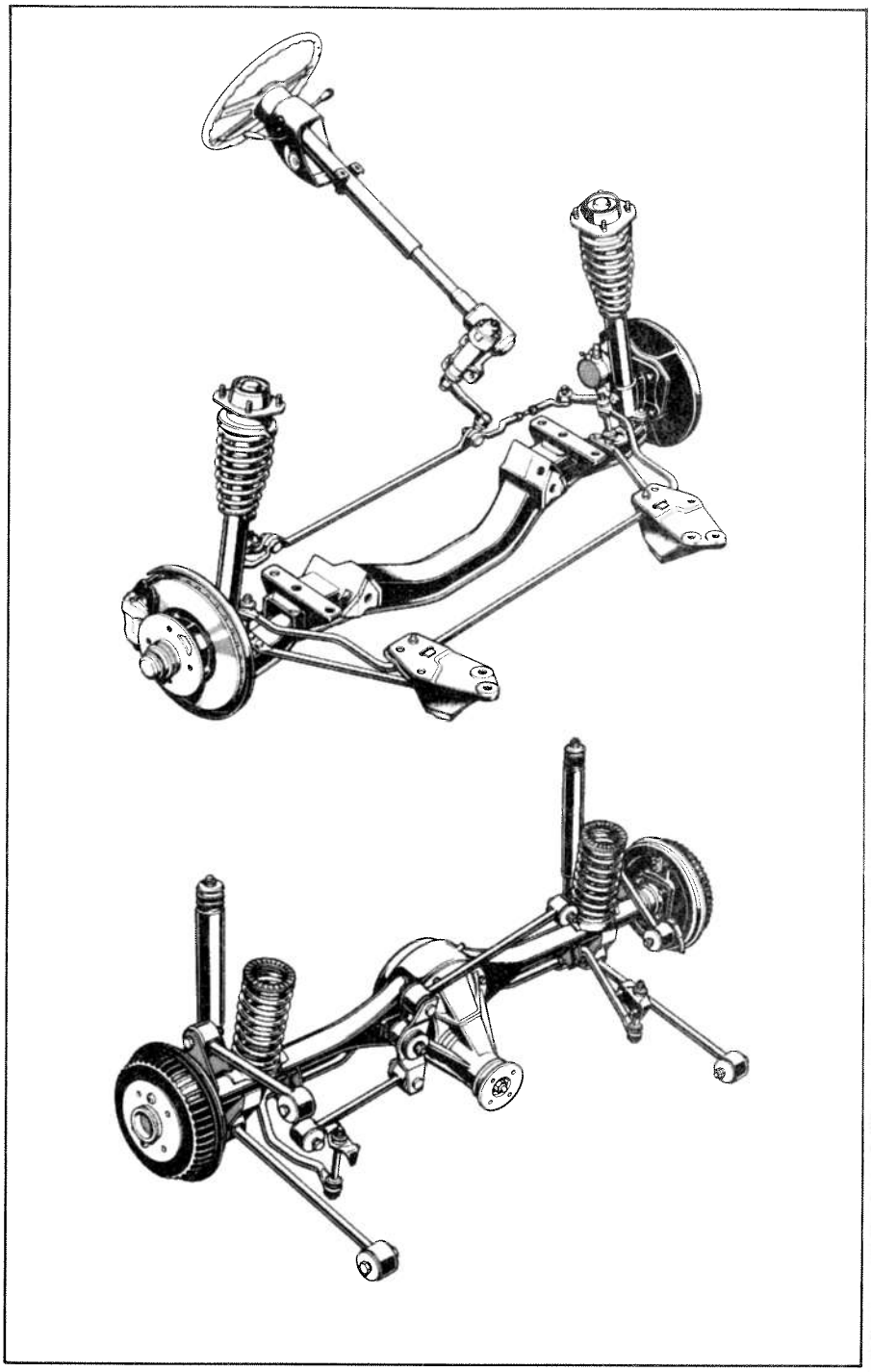
Brake fluid in a can like this is good for only one thing—the trash barrel. Rust on outside of can means that fluid inside has absorbed enough water to fill a small lake. Only fresh fluid from a new container should be used.

result in a firmer pedal—do not expand as much with pressure—they are not DOT approved and hence, due to potential liability problems, should not be used on a street-driven vehicle. Also in the interest of safety, whenever a component in the hydraulic system is changed, disconnected or modified, the brakes must be bled according to the procedures outlined in the Mazda service manual or HPBooks' *Brake Handbook*.

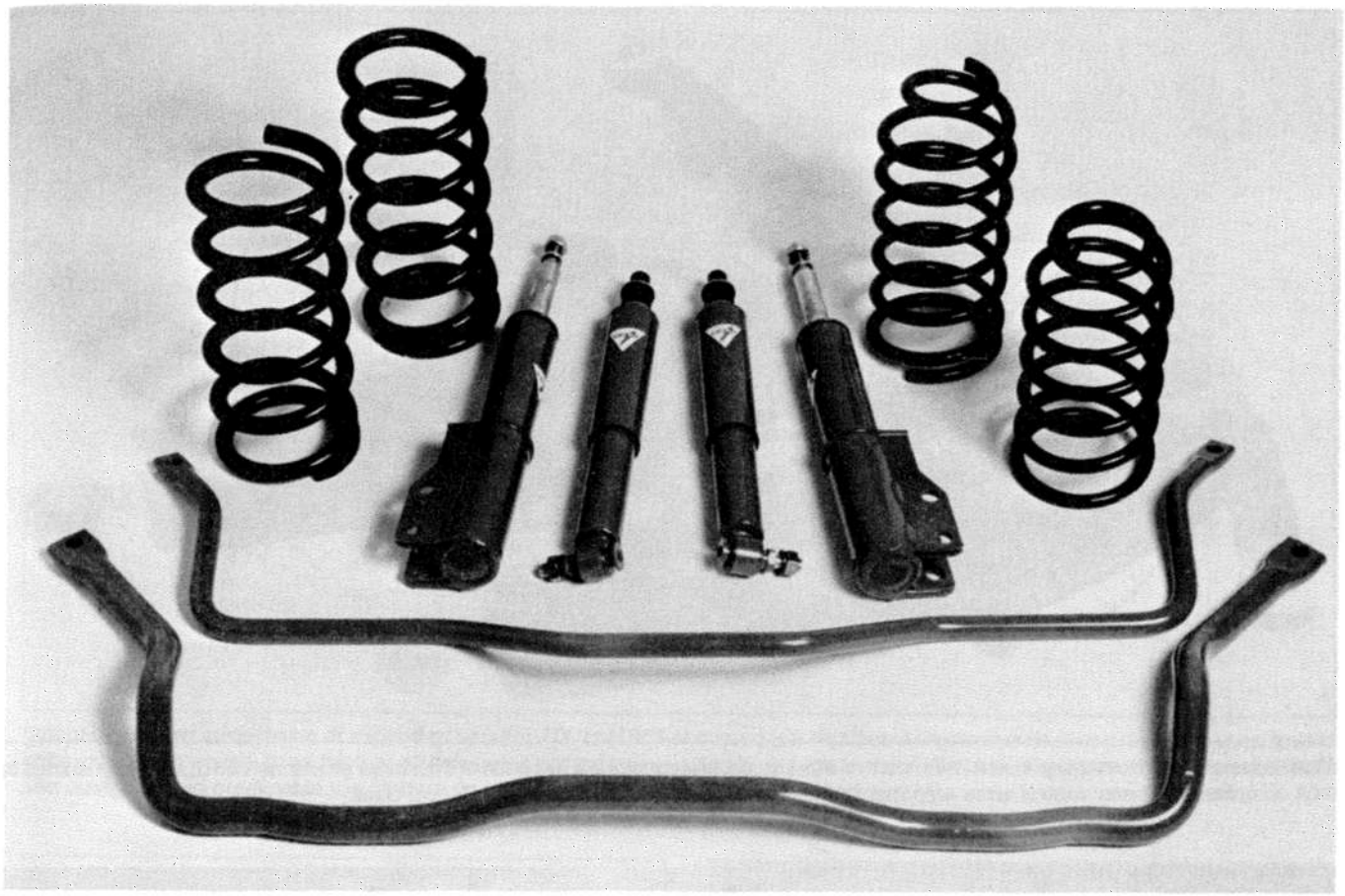
SUSPENSION

The subject of suspensions has filled many a volume. For an in-depth examination of the means and methods of improving handling, pick up HPBooks' *How To Make Your Car Handle*.

Anti-Roll Bars—Although a thorough knowledge of automotive suspensions is vital in optimizing handling, improving the cornering power of an RX-7 is relatively easy. For street driving and autocrossing, a set of large-diameter front and rear anti-roll bars is hard to beat in terms of improvement per dollar. Racing Beat offers a 1-1/8-in. diameter front anti-roll bar and two 3/4-in. rear bars—one is adjustable, the other isn't.



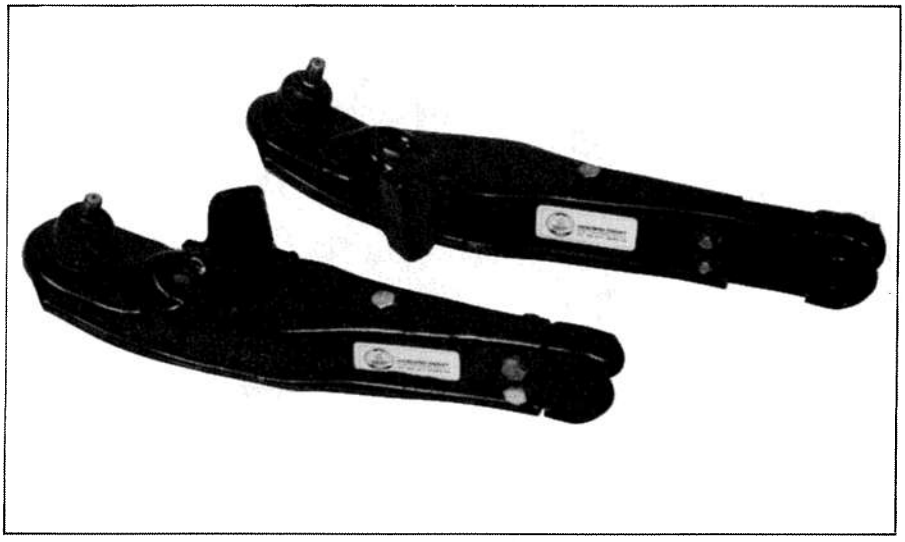
Four-link, Watts located rear suspension used on first-generation RX-7 did a creditable job of keeping the tires glued to the road, but it did have a few quirks. Most notable was severe oversteer under maximum cornering. This was due to bind during high-roll conditions. Front suspension employs MacPherson struts. Drawing courtesy Rotary Rocket.



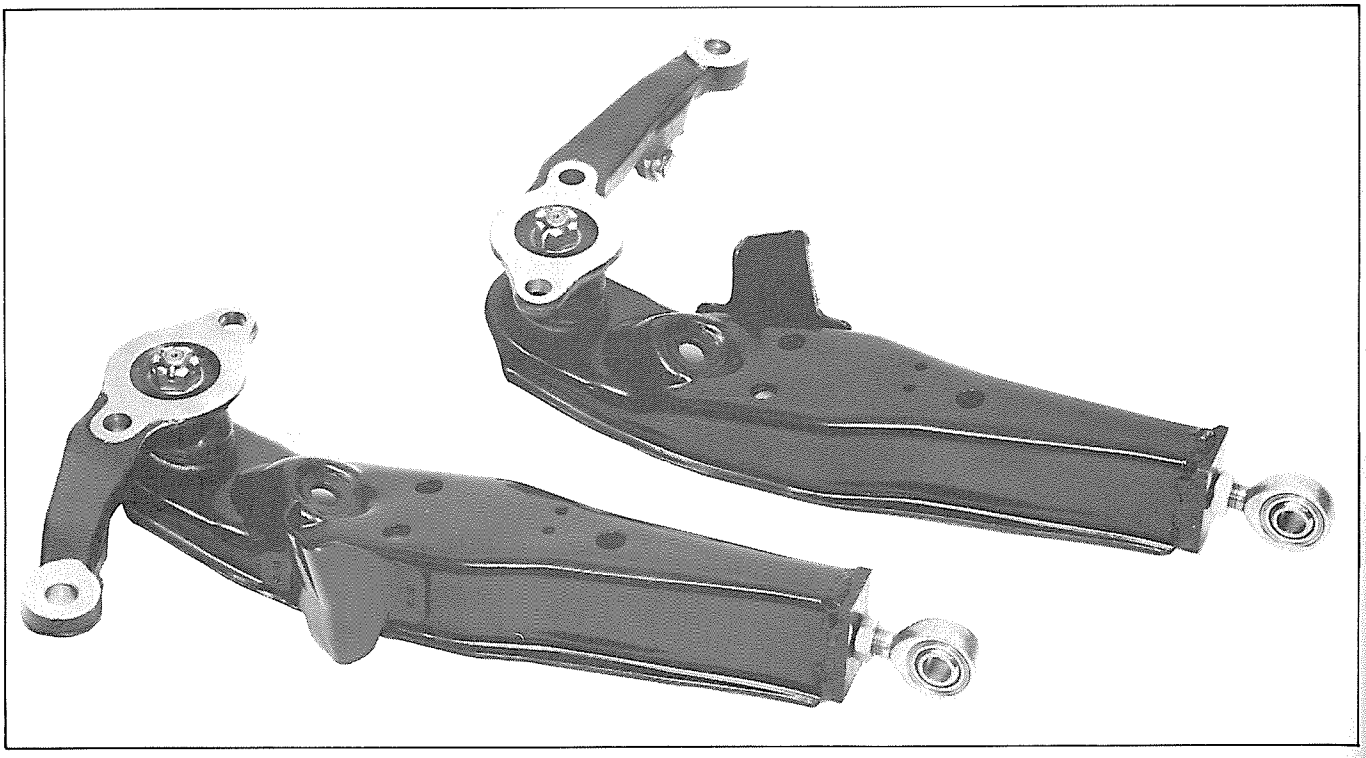
Installation of larger-diameter front and rear anti-roll bars will significantly improve handling without ruining ride quality. But nothing will improve cornering of an RX-7 like the installation of a complete suspension kit such as Koni's "Rallysport Suspension Kit."

Anti-roll bars reduce a vehicle's tendency to lean in a turn, yet they have little adverse affect on ride quality. Although the bars are available individually, for optimum results (and safety) front and rear anti-roll-bar diameters should be properly coordinated to balance front and rear anti-roll rates.

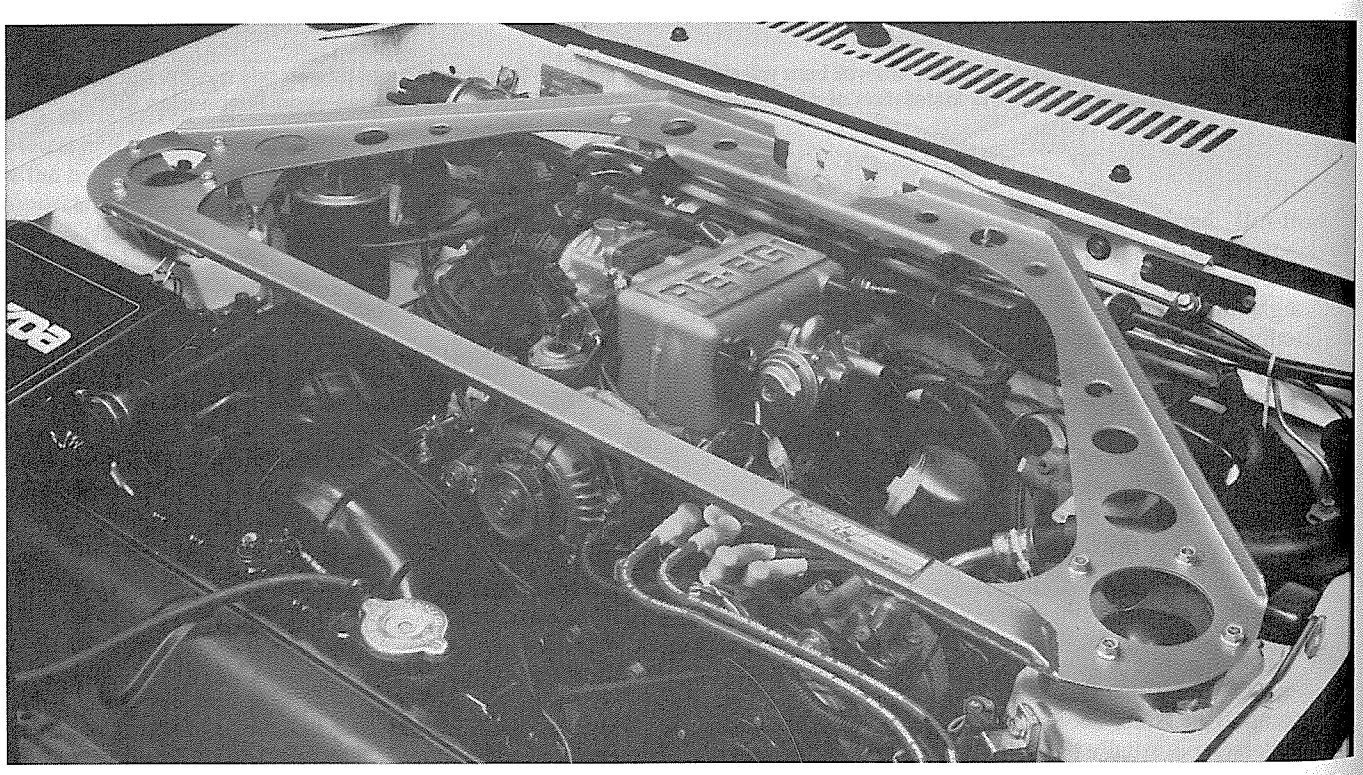
If there's *too much* front bar—bar diameter is too large or distance from the bar pivot to suspension is too small—the car will *push,* or *understeer.* In this situation, too much load is transferred to the outside front wheel during cornering, causing it to lose grip before the outside rear. Consequently, steering-wheel angle must be higher than for a *neutral-steer* setup. This is not necessarily bad. Mild understeer is usually the right setup for street operation and high-speed racing conditions.



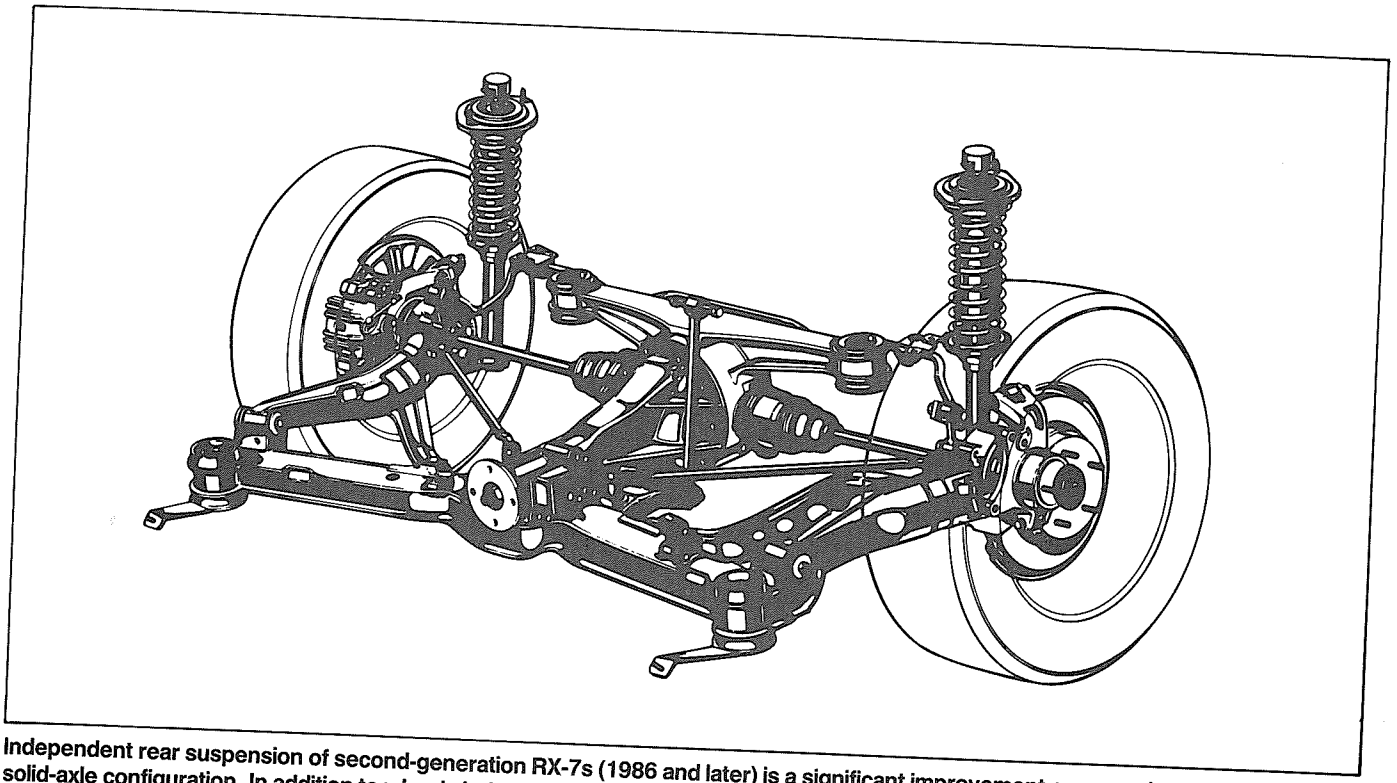
Adjustable front-suspension lower control arms for 1979—85 RX-7s from Racing Beat increases front-suspension camber-adjustment range. Note compressed and extended control-arm lengths. Photo courtesy Racing Beat.



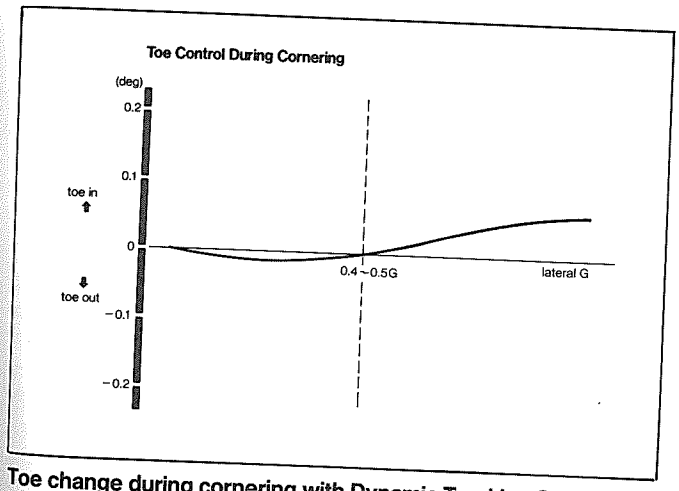
Mazda competition front-suspension lower control arms incorporate spherical rod ends at their inner pivots instead of rubber bushings to limit compliance. These control arms are intended strictly for racing. Photo courtesy Racing Beat.



Racing Beat's strut-tower brace for RX-7s reduces front-structure flex during hard cornering. Brace, which bolts into place, makes for crisper handling and steering response.



Independent rear suspension of second-generation RX-7s (1986 and later) is a significant improvement over previously used four-link, solid-axle configuration. In addition to wheels being sprung independently, unique Dynamic Tracking Suspension System semi-trailing-arm design allows predictable toe change during hard acceleration, braking and cornering.



Toe change during cornering with Dynamic Tracking Suspension System. Between 0.4 and 0.5 Gs, toe-out changes to toe-in, eliminating the dreaded power-off oversteer.

Tests done by the RX-7 Club of America have consistently shown the BFGoodrich Comp T/As (right) to rank at the top of the handling list. At left is the Euro-Radial T/A which offers a bit less cornering power, but at a considerably lower price. Standard Radial T/A is in the center.

Too much rear bar will cause *oversteer*—tendency of the outside rear wheel to lose grip before the front. This is dangerous for most driving conditions, however some oversteer is advantageous for tight cornering such as that encountered in autocrossing.

If you have a 1979—85 RX-7, you may have experienced extreme oversteer while engaged in "spirited" driving. With its unequal-length, unparallel four-bar-link rear suspension, there's insufficient compliance in the small-diameter suspension-link rubber bushings to compensate for the incompatible side-to-side geometry of the rear suspension as the vehicle rolls. This geometry that occurs during hard cornering, parti-

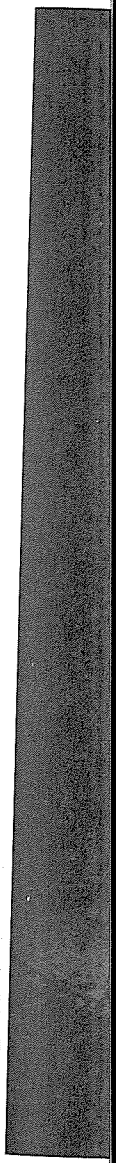
cularly over uneven bumps, causes the rear suspension to *bind*—resist further roll because of dramatically increased roll rate. In effect, the axle housing suddenly becomes a *very big* rear anti-roll bar, causing the outside rear tire to lose traction during hard cornering.

This problem can be remedied by reducing the vehicle's roll angle through increasing its roll stiffness. Do this by installing larger front and rear anti-roll bars, arriving at the right combination as describe above. This will keep the rear suspension from reaching the roll angle where rear-axle bind occurs. Stiffer springs that also reduce ride height can help, but you'll experience some ride-quality deterioration and other ill effects. Finally, so all suspension components work together, upgrade the shocks.

Springs & Shocks—Special springs and shock absorbers are also available for the RX-7. While installation of stiffer springs will generally improve maximum road-holding capability on smooth surfaces, springs that are too stiff will adversely affect ride comfort and can lead to loss of adhesion on rough road surfaces. Racing Beat offers front and rear springs that are specifically calibrated for street and autocross. In conjunction with either stock or high-performance springs, the use of Koni adjustable shock absorbers, or their equivalent is recommended. Koni's are generally recommended because of their excellent valving and proven reliability.

Bracing—Another relatively easy means of improving handling is through installation of Racing Beat's RX-7 strut-tower brace. This device bolts on top of the upper front strut mounts and braces the struts against each other and the firewall. The resulting stiffening of the front end reduces chassis flex and steering vagueness.

Wheels & Tires—Of course, tires play a major role in determining a car's handling. Virtually all major tire companies offer high-performance radials that significantly enhance the cornering power of an RX-7. And while personal preference enters into the process of selecting "the best tire," BFGoodrich's Comp T/A has regularly appeared at the top of the handling comparison tests conducted by the RX-7 Club of America. The club's attractive magazine *Rotary Rocket* regularly reviews the latest in tire developments as they relate to the RX-7.



IMSA GTU
for lift/dow
street perf
courtesy F