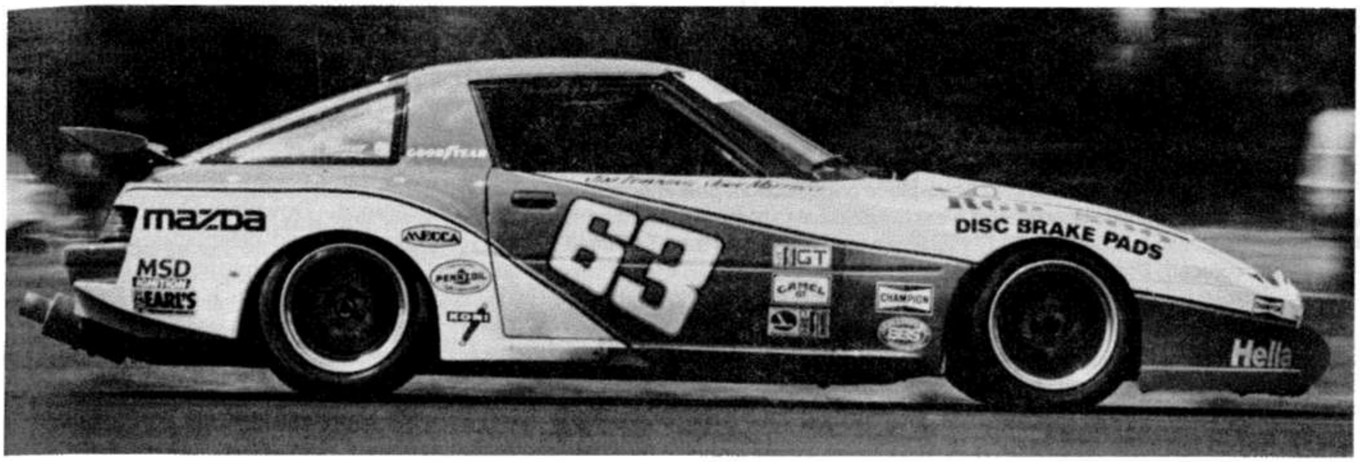
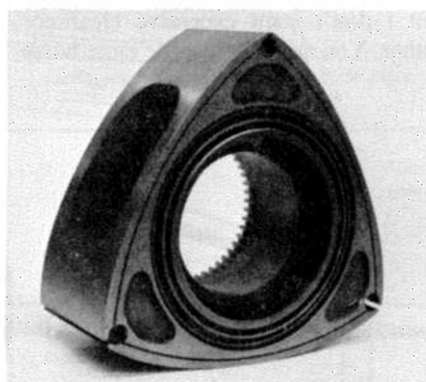
ROTOR MODS & PREP



One reason Jim Downing's race cars have been so successful is engine builder Rick Engman strikes a careful balance between power and durability. Engman's formula for rotor preparation includes precise fitting of seals and extensive rotor lightening.

A rotor is to a rotary engine what a piston is to a reciprocating engine. But there are obvious differences, the most obvious of which are size and shape. There's also a great disparity in weight. Whereas pistons are measured in grams—a typical piston weighs 500—600 grams, or 17-1/2—20 oz—rotors are measured in pounds. A stock 13B rotor—including bearing—weighs approximately 11-1/2 lb.

When a rotary engine is prepared for high-performance or competition applications, paring down rotor weight should be a top priority; reductions of up to 2 lb can be made safely. However, before concentrating on weight-reducing procedures, other aspects of rotor preparation should be understood.



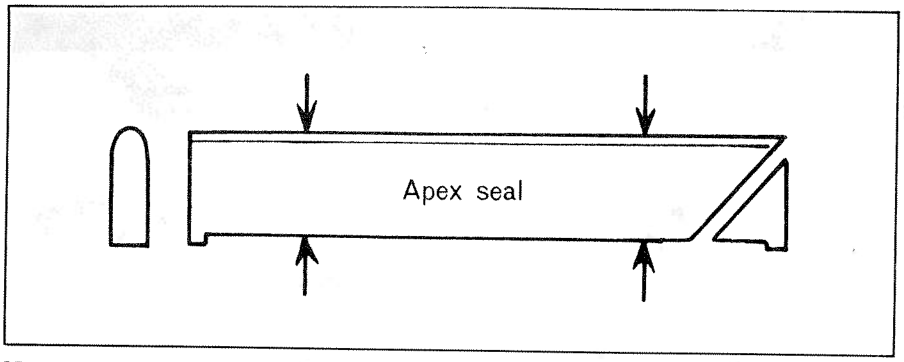
Stock 13B rotor weighs approximately 11.5 pounds, so a considerable amount of weight removal may be required during balancing. Three milled reliefs in side of rotor were cut by factory to facilitate balancing. Number of reliefs and their size depends upon individual rotor.

SEALING

Of primary concern is seal integrity. Just as early efforts aimed at perfecting the rotary engine failed because of inadequate sealing, latter-day endeavors designed to improve performance will be equally unsuccessful if the proper seals are not installed correctly.

Apex Seals—An apex seal fits in a groove similar to how a piston ring inhabits a ring groove. And like the top compression ring in a piston engine, the apex seal is subjected to all the heat and pressure generated by the combustion process. The apex seal-to-rotor housing interface is, therefore, critical to performance and durability.

Over the years, Mazda has used a variety of rotor-housing finishes and apex-



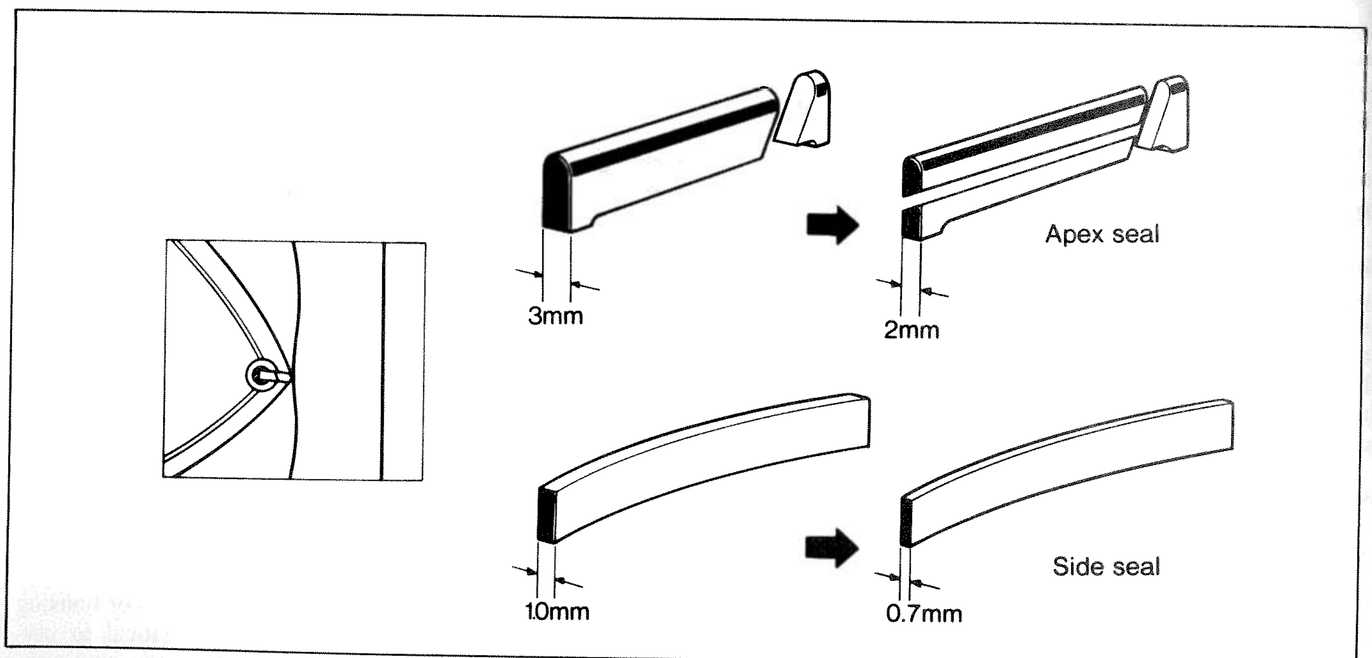
Most stock production apex seals are of two-piece construction. Seal should be measured at two locations (arrows) to determine if wear is sufficient to require replacement. Original-thickness dimension is 8.5mm (0.3347 in.). Seals measuring less than 7.0mm (0.2756 in.) should be replaced. Drawing courtesy Mazda.

seal materials. Some combinations of seals and housing finishes are not compatible. So, as a general rule, mixing and matching from different years should be done carefully. And for any high-rpm application, cast-iron seals should not be used; they tend to warp (sag in the middle). Carbon race seals and a specially designed seal spring should be installed in an engine that will be buzzed to 8500 rpm or higher.

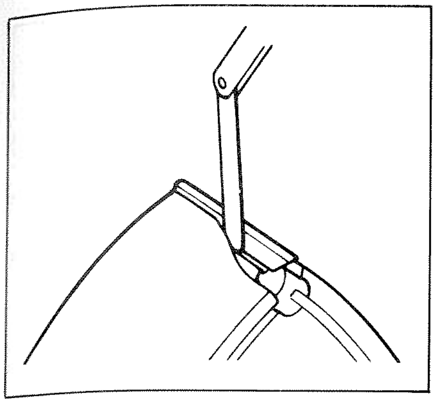
There are some conflicting ideas about seal-to-groove clearance. Some rotary-engine specialists specify a clearance of 0.0035—0.0040 in. for high-performance operation. But Rick Engman takes exception. He states, "I don't go along with wide clearances. I put the apex seals in at stock clearances (0.002 in.). Obviously, I don't want them binding, but I don't want excessive clearance, either. You might get a little more horsepower with wider clearances because a greater volume of combustion gas can get underneath the seal and load it against the housing, but for endurance racing, or street racing for that matter, I have to look at the long term. The minute you fire the engine, the seals start to wear. So there's no sense giving them a head start. With an endurance engine, even at minimum clearance, the seals are worn out before the race is over, so I put things up a little tight."

As far as apex seal-to-side housing clearance, Downing Camel Light engines have end clearances of 0.15mm. This is achieved by finishing the seals to a length of 79.85—69.85mm with a 12A. The best apex-seal length for street-driven rotaries is 69.90mm (2.750 in.) for 12As and 79.90mm (3.1437 in.) for 13Bs. Standard seal length as supplied is typically 69.92mm and 79.92mm for 12A and 13B models, respectively. Remember, always determine seal length using minimum rotor-housing dimensions—housings vary.

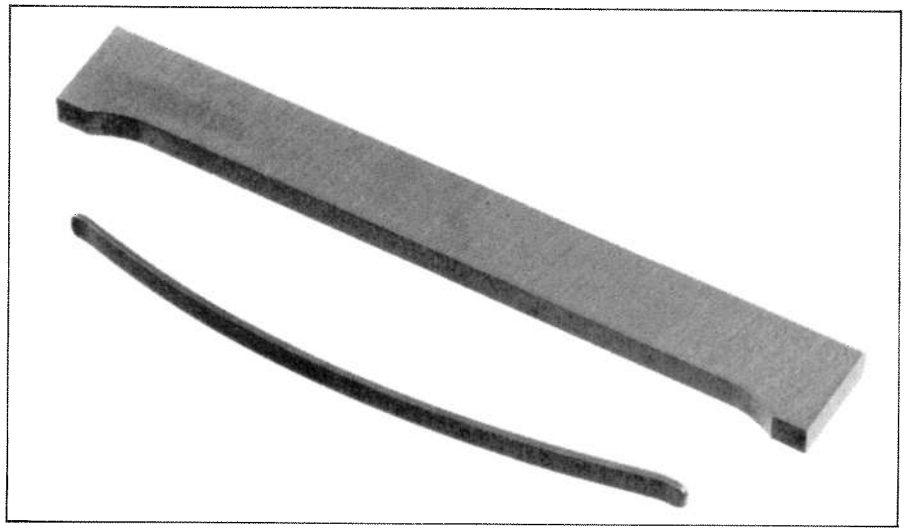
When seals are cut to the desired length, the ends must be square. To ensure that each is cut off square, the seal is installed in a rotor-apex-seal groove and



1987 and later engines have less internal friction made possible by new seal designs. Apex seals have been reduced from 3mm to 2mm in thickness and have been changed to a three rather than two-piece design. Side seals are also thinner as indicated. Drawing courtesy Mazda.



Clearance between apex seal and rotor groove should be set as required by intended engine use. Many engine builders prefer relatively tight clearances or 0.05mm (0.002 in.) for endurance racing as well as street use. Drawing courtesy Mazda.



Apex seals designed for racing are one piece and consist of an aluminum oxide and carbon material. Special springs, designed to provide correct preload, are required with race seals.

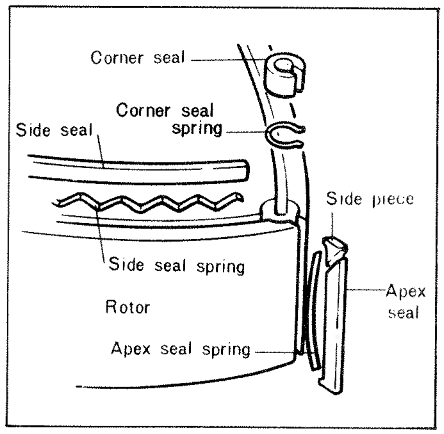
secured with a large rubber band. The rotor is then mounted on the cross-feed table of a surface grinder and the seal ground to the desired dimension.

This is in contrast to the factory-prescribed method which recommends the use of a surface plate and 400-grit emory paper. In sliding the seal by hand across the emory paper, some amount of wobble is inevitable. The result is an end that's not cut square or straight. With flatness being essential, if a proper fixture can't be devised, pre-cut seals should be purchased from Racing Beat, Mazmart or some such source.

In years past, large amounts of apex-seal clearance found in race engines led to hard starting—due to excessive seal leakage—with hot engines or undercharged batteries. The seemingly over-generous clearance specification was necessary with carbureted engines because of fuel-delivery inadequacies when an engine reached the upper end of its rpm band.

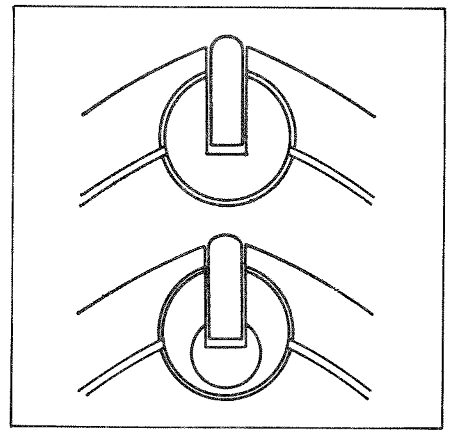
With an overly lean mixture, combustion temperatures soared and seals easily expanded to a length that actually exceeded the distance between side housings. The result: the seal scrubbed the ends, breaking a corner or snapping off.

Cooling capacity has a significant affect on seal life. If, upon disassembling



Seal installation and nomenclature. Drawing courtesy Mazda.

an engine, the flanks of the apex seal and rotor groove show excessive wear or damage, or if the apex-seal spring has lost its resilience, the cause was probably due to excessive rotor temperature. Overheating can be caused by insufficient oil flow from the eccentric shaft to the inside of the rotor, or from excessive combustion-chamber temperatures caused by too much spark advance



Several corner-seal designs have been used over the years. Bottom drawing illustrates later design with a relief below apex-seal slot. Relief allows seal to flex so that it doesn't seize in hole when run at tight clearance. Drawing courtesy Mazda.

or lean air/fuel mixture.

If the surface of the apex seal that contacts the rotor housing shows unusual wear or damage, the indication is excessive rotor-housing temperature. To reduce housing temperature, it's necessary to reduce coolant temperature, increase coolant-flow rate or both. In some instances, it may be necessary to modify the rotor-housing water jacket to improve cooling efficiency.

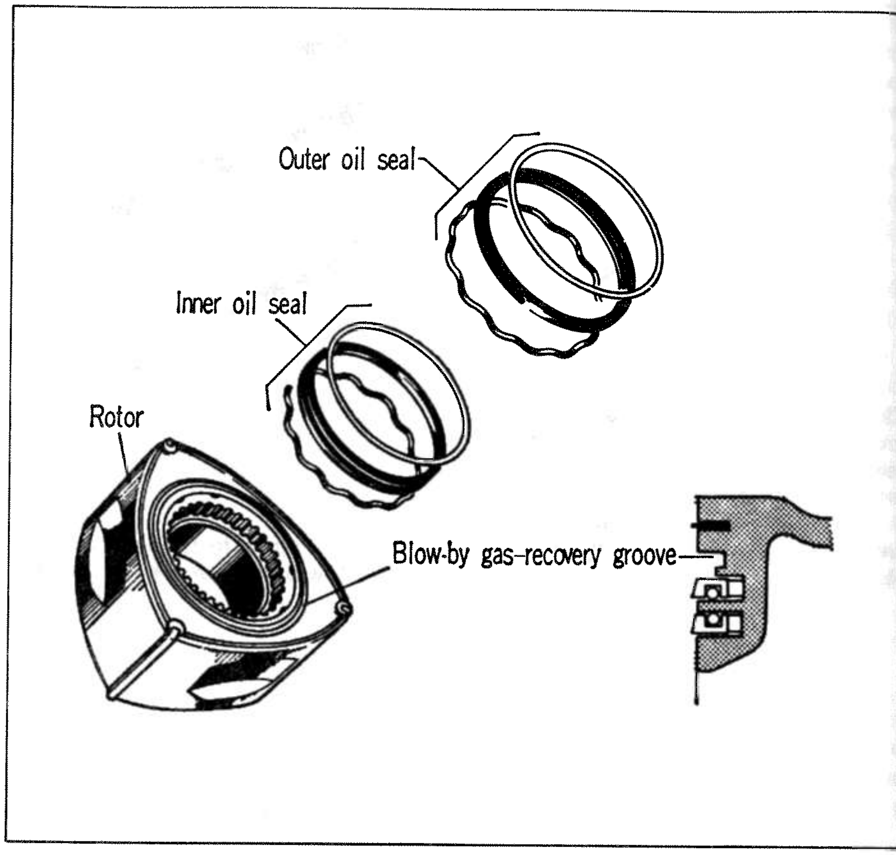
Corner Seals—With the advent of rubber corner-seal plugs (part no. N201-11-322) hard starting problems associated with wide apex-seal clearances were all but eliminated. These plugs must be used with 1976 and later corner seals.

Although oversized corner seals are available, they are usually not applicable to high-performance and race applications. If a rotor is so worn that the corner-seal holes must be reamed for oversized seals, something else has usually occurred that removes the rotor from the serviceable category. Should the corner-seal holes prove to be worn beyond acceptable limits, chances are, so too are the apex- and side-seal grooves. Oversized apex and side seals are not available, so the rotor should be replaced.

Side Seals—Stretching between corner seals, parallel with and just below the rotor face, are the side seals. These are loaded against the side housings by a wavy hair spring. Side-seal end clearance—clearance between side and corner seals—should be set at 0.02—0.04mm (0.001—0.0015 in.). This clearance is in marked contrast to factory specifications of 0.05—0.15mm (0.002—0.006 in.). Chances are you don't have a fixture or machine needed to grind the side seals to this tolerance. If this is the case you'll have to resort to hand grinding. If you do it by hand, shoot for a 0.04—0.10mm (0.0015—0.0040-in.) clearance.

When grinding side seals, grind one end only and match the corner-seal shape as closely as possible. Also, measure the clearance on the unground end for best results.

Some amount of side-seal-length increase is to be expected as an engine reaches operating temperature, hence the need for clearance. However, the rotor is made of a similar material and it too expands as the temperature increases. Consequently, wide clearances are not required. The major disadvantage of increased clearance is accelerated wear. As a rotor spins, the side seals oscillate. As side-seal end clearance is increased, oscillation increases which increases the rate of wear. In addition to seal wear, side-seal grooves in the rotor also wear as the seals oscillate to and fro.



Oil-seal construction. Drawing courtesy Mazda.

Oil Seals—The oil seals fit into circumferential grooves on the flat sides of the rotors. Retaining springs prevent these seals from rotating. In combination with seal 8735-23-180 or a later version, either a standard or competition outer retaining spring may be installed. Competition springs provide higher tension on the oil seal to minimize the possibility of blowby. These should be used in engines that produce more than 200 HP.

To obtain the correct oil-seal-spring retention, there should be a 1/8-in.-diameter hole, 1/16-in. deep to lock the oil-seal spring to the rotor. All 1974 and later rotors are so equipped, as are some 1973 and earlier versions. Mazda tool kit 49-0862-190 may be used to modify early rotors not having the oil-seal-spring retaining holes.

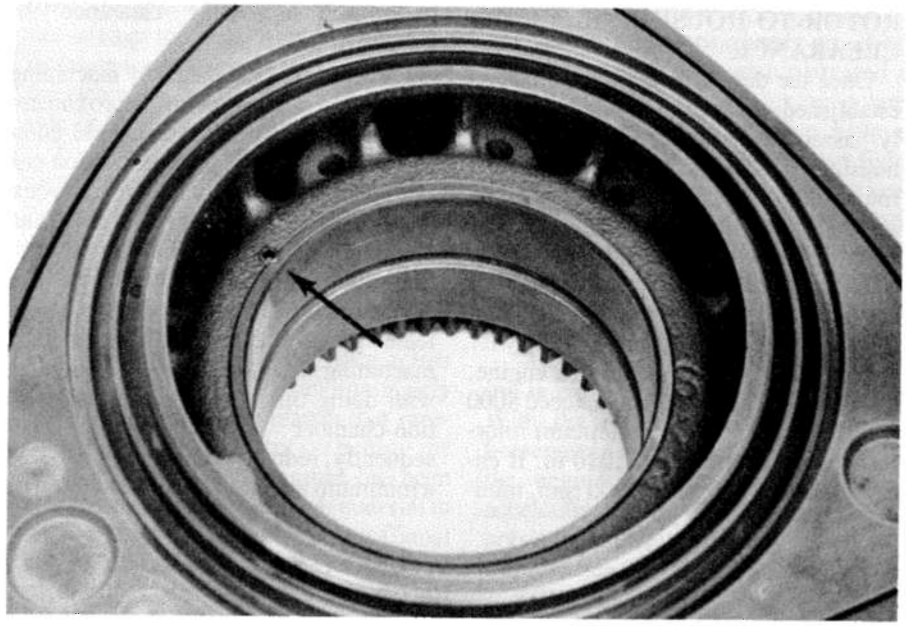
Note: White-marked oil-seal springs *must* be installed on the "front" side of each rotor; blue-marked springs go on the "rear" sides.

BEARINGS

Correct bearing clearance is also vital to the success and longevity of a rotary engine. Engman suggests 0.0030—0.0035 in. for the clearance between the rotor bearing and eccentric shaft. This amount of clearance can usually be achieved by either buffing the bearing or the shaft. A stock bearing usually yields a clearance of approximately 0.002 in.

The most common method of establishing clearance is to polish the inside diameter of the bearing with 600-grit wet-or-dry sandpaper spun with a high-speed grinder.

For best results, Mazda race bearings or modified stock bearings should be used for high-performance applications. The bearings have a 0.040-in. deeper-than-stock center groove that increases the reservoir of oil around the bearing. The Downing/Atlanta crew uses stock bearings and machines the groove to the desired depth, or about 0.060 in.



Rotor bearings press into place and contain a small tab designed to prevent them from spinning. In some race applications, it may be necessary to use a set screw (arrow) for bearing retention.

Although race and stock bearings are made of the same material, race bearings provide about 0.0005 in. more clearance, which makes blueprinting easier. Also, reducing the thickness of *overlay* (gray) material can improve bearing life. Why? The most common type of bearing deterioration is *channeling*—bearing material is washed away, or eroded, by pressurized oil. Thinning the overlay reduces the chance of this happening.

Standard rotor bearings press into the rotor, but include a tab that prevents them from spinning. Some factory competition rotors contain three set screws between the bearing shell and rotor casting as an additional means of preventing bearings from spinning. Mazda suggests that rotors in race-only applications not already equipped with set screws should be modified. Set-screw holes should be equally spaced around the bearing/rotor junction. And no hole should be closer than 1.00 in. to the bearing seam.

When the set-screw holes are drilled—from the open side, not gear side of the rotor—material is removed from both the rotor and back of the bearing. After the holes are tapped, set screws are coated with Loctite and threaded into place. The open end of the holes are then peened over so the screws can't work out.

While this is an effective means of preventing the bearing from spinning, Engman does it differently. He states, "Through experience, I've found that if you have an oil-starvation problem, or something else that causes the bearing to go away, and it tries to seize on the shaft, the screws just add insult to injury. If you get into an oil-starvation situation, the bearing is going to seize on the shaft and it's going to rotate the bearing. I don't care what you do. So what it does is just roll up on the set screws and clamp everything to the shaft. From a parts-reclamation standpoint, you're a lot better off to just allow the bearing to shear the little tab off and spin in the rotor. It might not damage the shaft. Sometimes a temporary oil starvation will only shift the bearing a few degrees. If you're lucky, you can save all your pieces. But if you have the screws in there, you've lost the shaft, the rotor and no telling what else.

"I don't use the set screws. When I install a bearing, I clean everything up really well with solvent, then I'll put triple A weld sealant—which is made from a very low-viscosity Loctite—on the back of the bearing and on the bearing bore in the rotor. Then I warm the rotor slightly—to about 200F—and it's much easier to install the bearing. Now, if you heat the rotor too much, the Loctite sets up too quickly and will deform the bearing as you press it in. Whether it's a street engine or race engine, I'd say to heat the rotor and cool the bearing and use the Loctite before pressing the bearing into place. That'll do a good job of keeping the bearing from spinning. The only time I use the screws is when I'm working with a lightened rotor where so much material has been removed from around the bearing bore that you've lost some of the crush and it flexes more. In that case, you have no choice but to use the set screws—that's just the price you pay—but I still use the Loctite."

It should be noted that due to manufacturing processes, a new bearing will have a strip where the copper backing material is exposed. This is normal in all cases except for some Mazda race rotor bearings. As a general rule, a rotor bearing should be replaced only if it is worn excessively (too much clearance) or the surface has noticeable deteriorated. Used bearings in acceptable condition are preferable to new *unseasoned* bearings.

ROTOR-TO-HOUSING CLEARANCE

Once the desired bearing clearance is established, the engine should be partially assembled—front housing, rotor housing, rotor and eccentric shaft—and rotor-to-rotor housing clearance checked at the narrow section of the housing. The eccentric shaft does flex; increasingly so with rpm. Consequently, as an engine's rev range is raised, so should the amount of rotor-to-housing clearance.

In a stock or mildly modified engine, where engine speed will not exceed 8000 rpm, there should be a minimum rotor-to-housing clearance of 0.010 in. If engine speeds will exceed 8000 rpm, minimum rotor-to-housing clearance increases to 0.015 in.

Clearance is established by machining the rotor face at two points approximately midway between the apex and combustion pocket. The precise location can be determined by spinning a rotor through its normal path of travel and marking with a felt-tip marker on each side of the point on the rotor face where clearance is least—as measured by a feeler gage. Clearance is increased by machining the rotor face. The problem with doing this is it increases combustion-chamber volume and, consequently, reduces compression ratio, so a minimum amount of material should be removed. Otherwise, there are no detrimental effects from increased clearance. Clearance must be checked on all three rotor faces and at two points on the rotor housing.

According to Engman, "It isn't that the rotors are oversize or the housing is undersize, it's the indexing of the gears that makes clearance checking necessary. If either the stationary gear or rotor gear are slightly off, that moves the rotor around so you have to check clearance. We machine clearance with a disc grinder. When you do that, you must make sure that the disc is at 90° to the rotor. You have to adjust the grinder table so that you get a nice even sweep across the rotor

In high-performance rotary engines, rotor-to-housing clearance must be set to compensate for variances in stationary-gear indexing. Components are from a Racing Beat bridge-ported engine. Water-jacket modifications (see Chapter 8) are visible on rotor housing.

face. Then, you remove the material between the two marks. After machining, clearance is rechecked and additional adjustments made as required. Once the final cut has been made, blend the area so there are no sharp corners."

Assuming that the rotor housing is exactly 70mm (12A) or 80mm (13B) wide, rotor thickness, as measured from the gear—which protrudes slightly from the side of the rotor—to land on the opposite side, should be either 69.80mm or 79.80mm (2.748 or 3.142 in.) for 12A and 13B engines, respectively. This dimension should be uniform all the way around and will result in a clearance of 0.200mm (0.0078 in.).

This clearance is necessary because the outside edge of the gear and land on the opposite side serve as bearing surfaces to prevent the rotors from moving fore and aft. Even though most of these surfaces are steel—side housings and rotors are steel—under normal circumstances there is relatively light pressure. So, the steel-on-steel arrangement is trouble free. However, with a stock rotor, the gear is pressed into place and it can attempt to "walk" out. If it does, the movement can eliminate most if not all of the clearance and the rotor can scuff the side housings.

To eliminate gear walking, Mazda race rotors have gears that are held in place with a retaining ring. Racing Beat can do the machining necessary to install a retaining ring in a stock rotor.

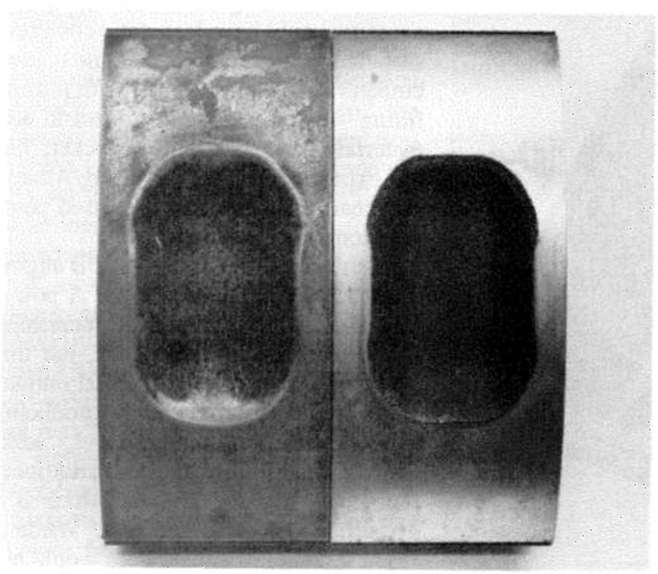
ROTOR LIGHTENING

With both the stock and race rotors tipping the scales at approximately 11-1/2 lb, it stands to reason that race-engine builders are intent on putting the rotor on a crash diet. Engman has been able to machine away enough material to remove 2 lb from rotors used in Camel Lights competition engine. However, he advises that you use caution when lightening a rotor. "We've pushed things to the limit to find out just how much material can be safely removed. I can speak from personal experience—when you cut too much weight, you significantly weaken the rotor.

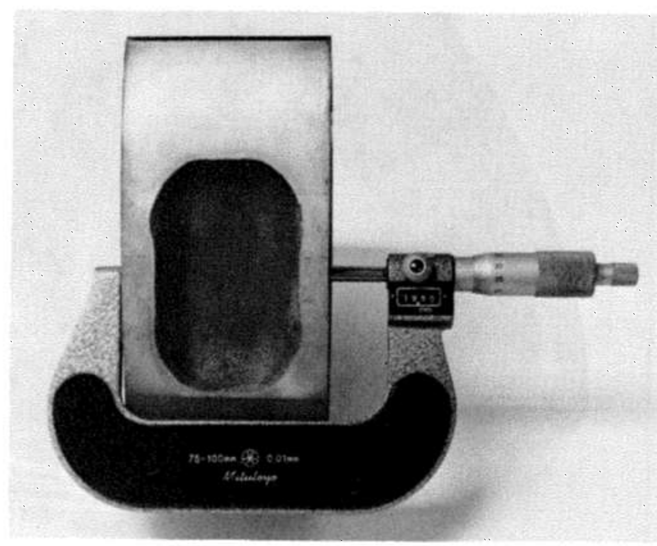
"You actually have a wider safety margin with a high-performance street engine because the parts aren't stressed as highly. But I'd say, with extreme care, about 2 lb is the limit. You have to remember, you're making the part lighter, not stronger. You should always keep that in mind. With the pressures and shock loads encountered in running an engine continuously putting out over 300 horsepower, lightened rotors tend to be not very forgiving.

"The primary benefit of rotor lightening is an increased rate of acceleration. With the rotating mass reduced, less horsepower is consumed in accelerating the engine, so more is available to accelerate the car. There is also a slight horsepower increase to be realized for the same reason."

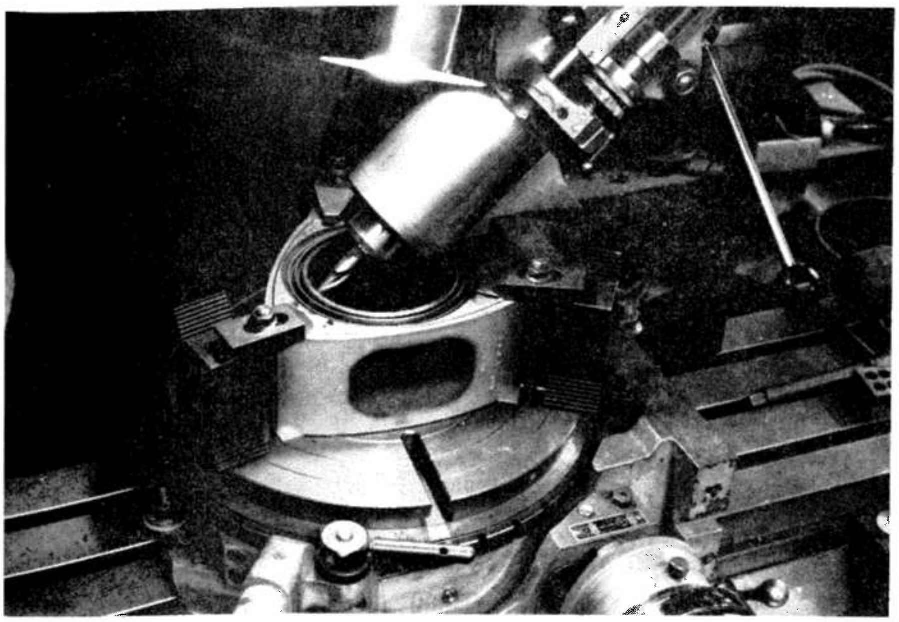
After lightening, both static and dynamic balance must be corrected. The entire rotating assembly must be rebalanced in conjunction with the eccentric weights.



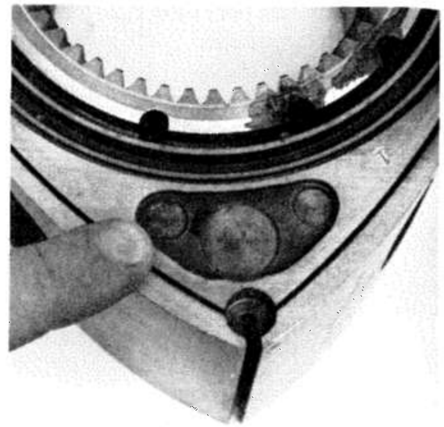
Rotor-to-housing clearance is established by machining rotor face approximately midway between combustion pocket and apex. Area should be blended in to eliminate any sharp corners.



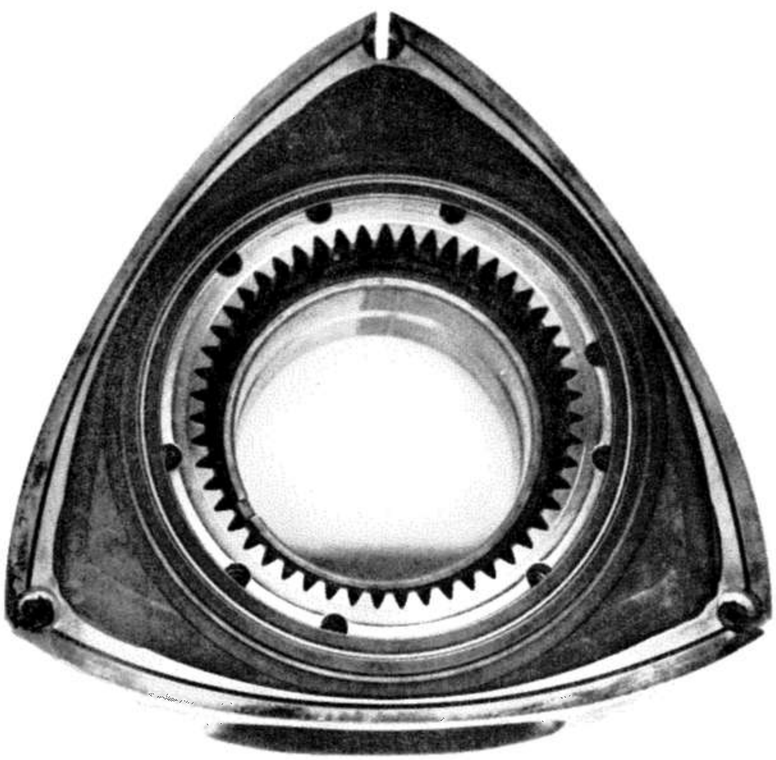
Rotor and housing width must be checked to establish correct clearance. When measured from gear to land on opposite side, dimension should be 69.80mm for 12A and 70.80mm for 13B engine.



In full-tilt IMSA Camel Lights engine, rotor lightening is rather extensive. Material is cut from both inside and outside of rotor.



For optimum smoothness, entire rotating assembly must be balanced. Stock balance machining can't be used if any rotor lightening has been done.



Lightened rotor has been machined all around its sides. Only a thin lip of material is retained to support side seals.

COMPRESSION

While it might seem as though a race engine should have an ultra-high compression ratio, such is not the case with a rotary. Because of the turbulence generated by the moving combustion chamber, a rotary should have less static compression than a piston engine. Some engine builders have experimented with plasma filling—using a plasma process to add material—the combustion pocket, but the experience of the Downing/Atlanta race team indicates that increased compression is unnecessary.

With unmodified rotors, a 13B engine has a 9.4:1 compression ratio. A power increase could be gained by increasing the squeeze up to about 10:1, but this would also increase the thermal output. With rotary engines already producing super-hot exhaust temperatures, additional heat will create additional problems—not the least of which is a greater tendency to detonate. While a slight increase in temperature would not be a problem in a drag-race car, for street driving or endurance racing, increased exhaust temperature should be avoided.

STATIONARY GEARS

Prior to 1976, stationary gears in Mazda rotary engines were much like giving blood—reputed to be far worse than they really were. That reputation was based on a failure rate that wasn't bad, but higher than it should have been. But for the 1976 model year, Mazda changed the stationary gear-tooth design; failures are now extremely rare.

Obviously, if a pre-76 engine is being rebuilt for high-performance driving, the later gears should be installed. For 12A engines, the part numbers of interest are 3743-10-500 for the front gear and 3743-10-550 rear; 13B engines require 3648-10-500 front and 3648-10-550 rear.

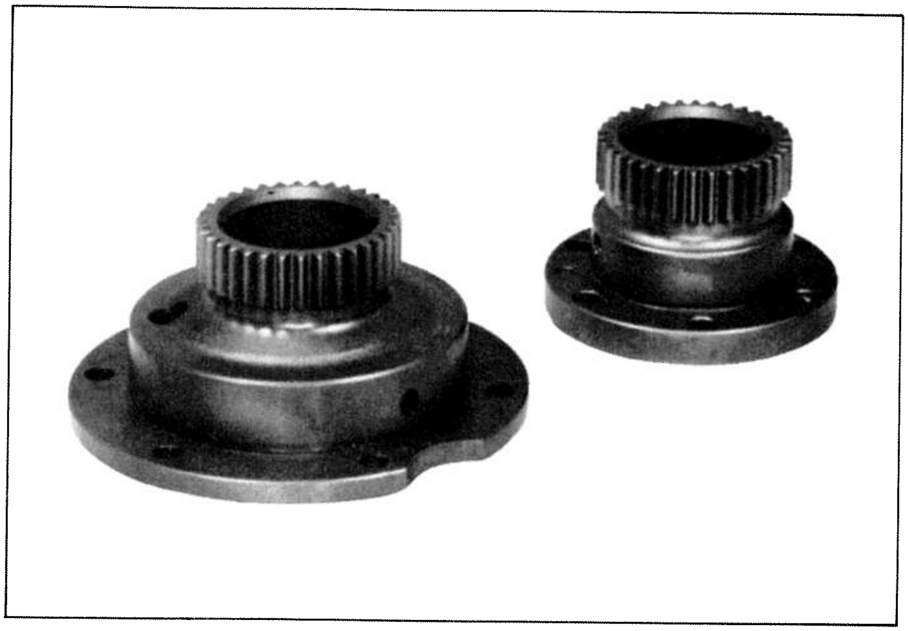
It should be noted that it is possible to order a new gear and receive an old one because some are still in the pipeline. New-design gears can be identified by their longer gear teeth.

For high-rpm operation, modified stationary gears are often recommended. Racing Beat's modified stationary gears and factory race gears include heat-treated teeth and, on the rear gear only, an internal groove on the inside bore that routes oil 360° around the bearing. This groove is designed to work in concert with a special Mazda competition bearing that has three "windows" cut in the relief between bearing surfaces. Standard bearings can be modified by cutting windows in the relief between bearing surfaces.

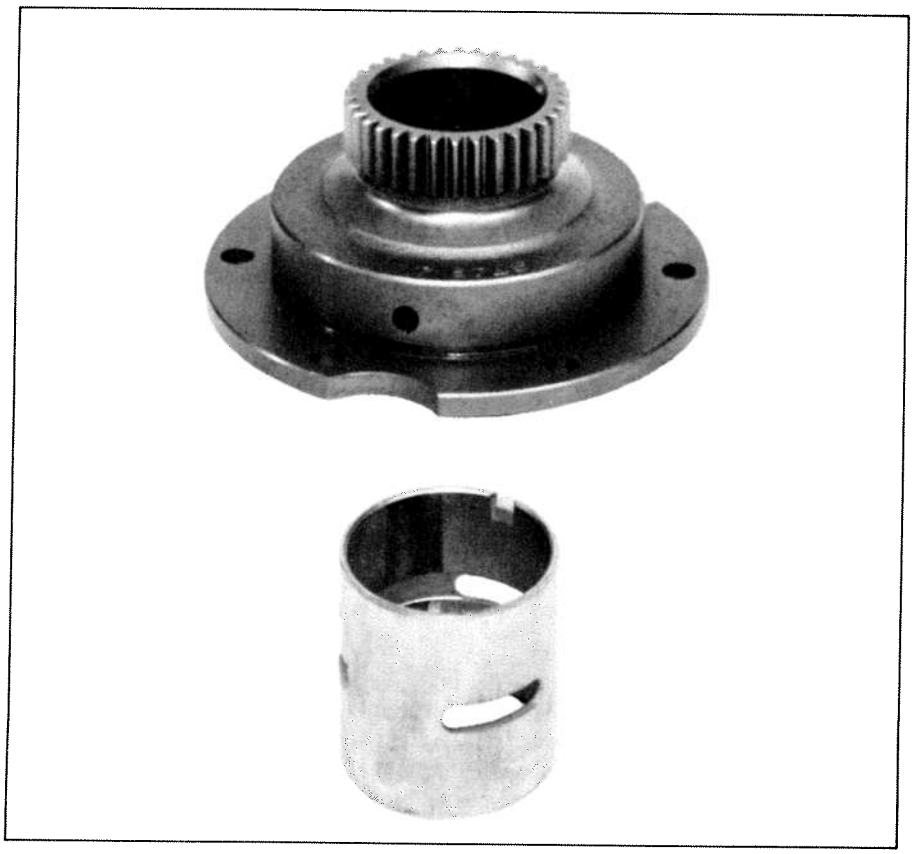
The special bearing/modified rear gear combination brings oil into the groove on the back side of the bearing, and the windows in the bearing then introduce oil at three equidistant ports or windows. This substantially increases oil delivery to the inside of the eccentric shaft and, consequently, to the rotors.

Be aware that the modified rear stationary gear and special bearing are necessary only if planned engine speed is above 8500 rpm. If these parts are used, a high-volume oil pump and race rear pressure regulator must be installed to maintain sufficient oil pressure, especially at lower engine speeds.

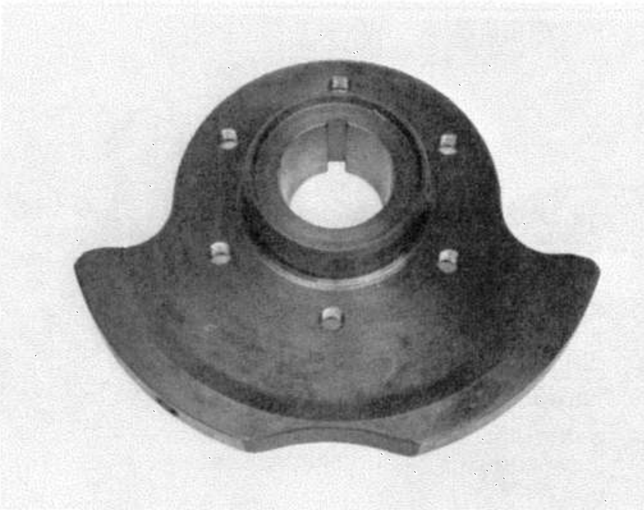
Stationary-gear bearing—also known as *main bearing*—clearance should be 0.0030—0.0035 in. for speeds up to 8500 rpm and 0.0040 in. for operation above that rpm level. This is especially



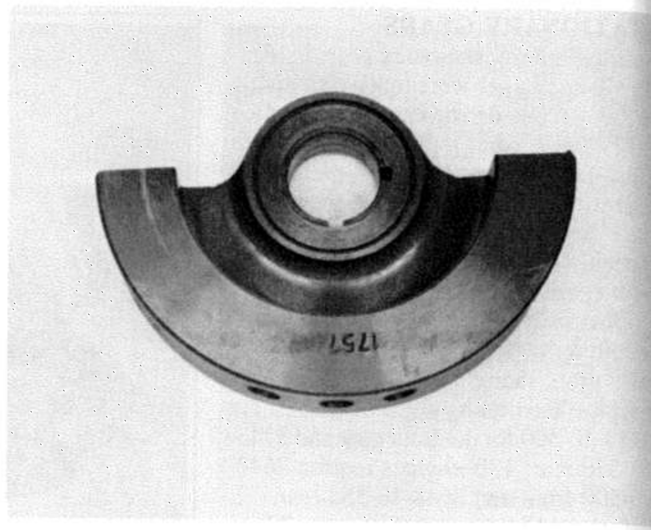
When rebuilding a Mazda rotary engine, latest stationary gears should be used. These have longer teeth than previous models.



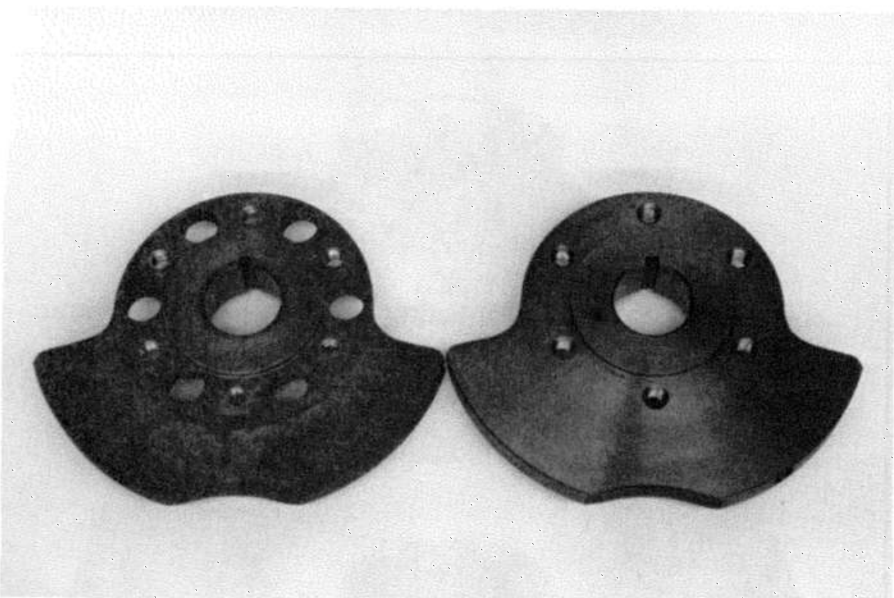
Special three-window bearing is used in race engines to provide improved oil circulation between bearing and eccentric shaft. In order to be effective, three-window bearings must be used with a modified stationary gear.



Engines originally mated to a manual transmission utilize flywheel that incorporates rear counterweight. When changing to an aftermarket flywheel, a weight of this type, which is fitted to engines destined to spend their lives with automatic transmissions, must be installed.



Like waist lines, front counterweights have varied in size over the years. Larger counterweights such as this were used in 1980 and earlier engines. Competition version is machined from billet steel rather than cast iron.



As might be expected, rear eccentric weights are also lightened as part of engine builders' weight-watching program. Modified counterweight is at left.

important at the rear where shaft flex caused by the counterweight uses up a considerable amount of nominal clearance.

COUNTERWEIGHTS

Eccentric-shaft counterweights serve to balance the mass represented by the rotors. Consequently, as rotor weight is altered, so must the counterweights. Engines originally mated to manual transmissions utilize a rear counterweight that is built into the flywheel. Consequently, if an aftermarket flywheel will be used, the engine should be fitted with the rear counterweight to which the automatic-transmission flex plate is bolted. An aftermarket flywheel can then be bolted to this counterweight.

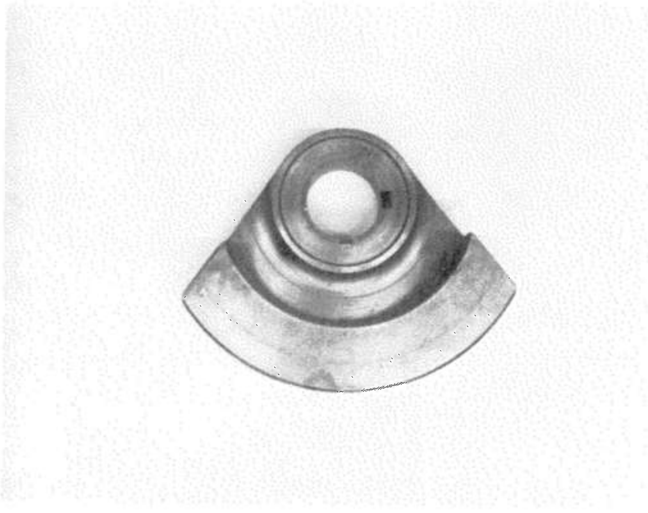
There are three sets of front and rear counterweights; one for pre-74 engines, another for 1974 and later 12A, and the third for 1974 and later 13B rotaries.

Even though rotor weights changed slightly over the years, counterweights have remained the same except for a few unique applications. Some late-model front counterweights are not as large as those for older models, fanning out only 100° or so rather than 180°. Although the narrower counterweights are lighter, they are more concentrated, thus they reduce the weight of the rotating mass.

Competition counterweights are available from Mazda. They are matched to competition rotors which are approximately 1 oz lighter than stock rotors. Irrespective of the counterweight used, it must be matched to the weight of the rotor.

ECCENTRIC SHAFT

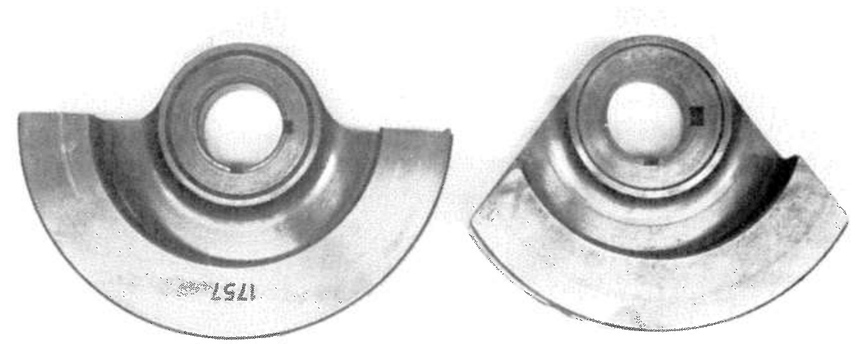
As with other internal engine components, Mazda has changed eccentric-shaft design slightly over the years. With most of these changes coming in the form of improvements, the latest-design eccentric shaft should be selected, especially if an engine has been modified.



Comparatively small front counterweight is used in 1981 and later engines. Some versions have rounded edges. Like larger counterweight, production version is cast iron; competition model is billet steel.

When lightened rotors are used, several "tricks" are often played with counterweights. This 12A counterweight that has had "heavy metal" added was used on a 13B engine.

Counterweight thickness is also reduced as part of a lightening program. Compared to stock version at left, counterweight at right is obviously thinner.

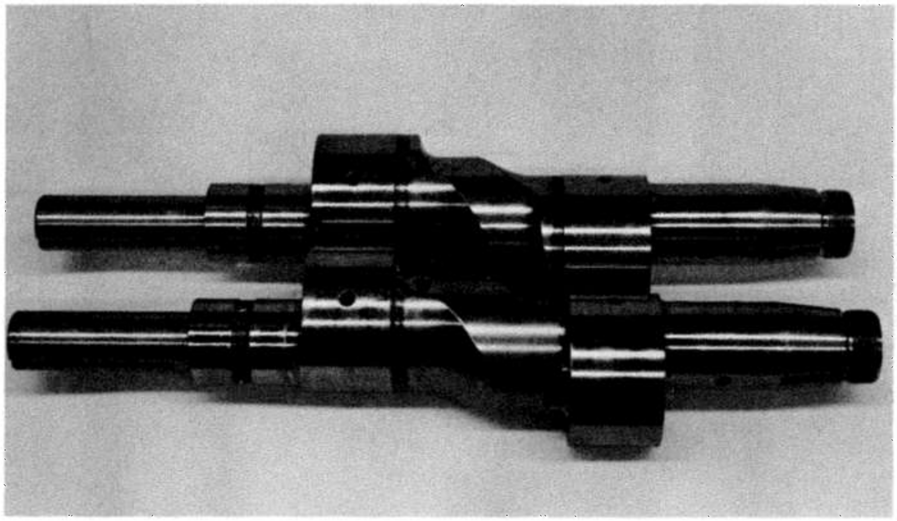


Larger counterweight at left spreads material over a 180° area. Smaller weight at right measures only about 100° and is, therefore, more concentrated. This helps reduce total weight of rotating assembly.

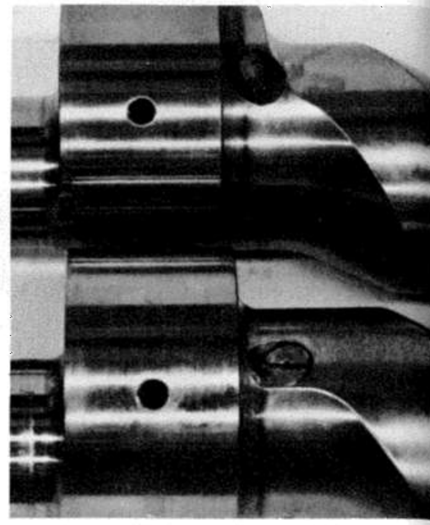
While the stock eccentric shafts are quite strong, they are prone to bending in the area near the front main-bearing journal. According to Racing Beat, "This distortion is usually caused by high rpm or by some excessive force on the front pulley, such as over-tensioning an air-conditioner belt. The best way we know to reduce this problem is to increase the torque on the front pulley bolt to about 80 ft-lb. Beware, however, as this tends to crush some parts slightly and to decrease end play. Do not allow the end play to get below 0.0015 in. The stock needle-roller thrust bearings have proven satisfactory."

Oil Jets—Although competition eccentric shafts are available, they are similar to their stock counterparts. However, in competition shafts, the stock oil-jet arrangement—sprays oil into the open cavity of the rotor—is modified. The check ball and spring are removed. A fixed jet then meters oil flow into the rotor.

At low speeds and low oil pressure, the ball seats so that more oil is diverted to



Eccentric shafts used in race engines also receive their share of lightening. Stock shaft is at top; lower shaft has been modified with removal of material adjacent to journals.

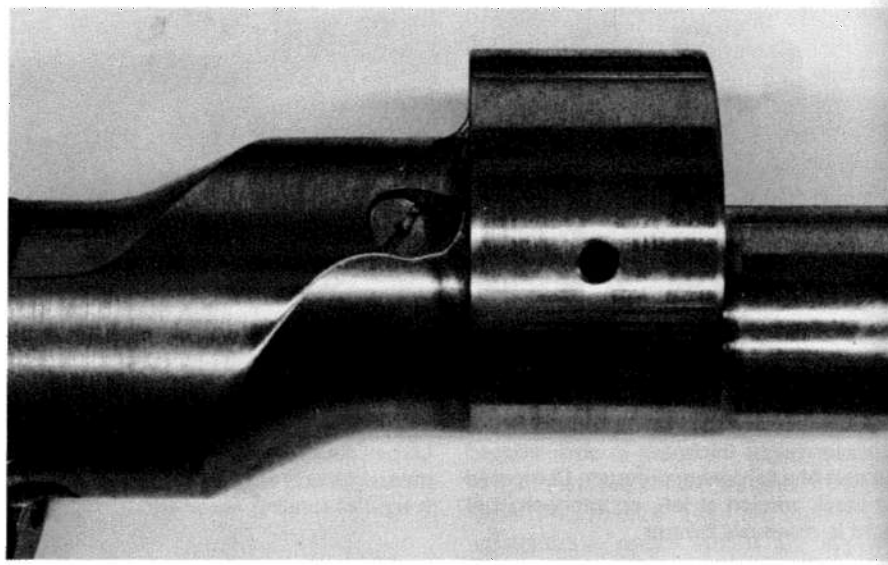


Up close and personal—amount of material removal is more evident. Obviously, thin is in—which is one of the reasons that Jim Downing, like his eccentric shafts, stays on a strict diet.

the bearings. At high speeds and high oil pressure, the ball unseats, allowing oil to be sprayed through the jet, (which has a 2.46mm orifice) into the rotor.

With the rpm swings encountered in road racing, it is conceivable that the stock check ball will close during braking and turning. This momentarily cuts off the supply of cooling oil to the rotor, so the check ball is removed as a means of keeping rotor cooling more consistent. However, with a fixed jet, a considerable volume of oil is directed to the rotor during idling. Without sufficient combustion pressures being exerted against the oil seal, oil containment can be a problem at low speed. Consequently, even a highly modified street engine should be fitted with stock oil jets because the engine will spend a considerable amount of time idling. Another problem with a fixed jet: It will bleed off a considerable amount of oil pressure at low speeds, necessitating a modified oiling system.

When eliminating the spring-and-ball assembly in a shaft destined for a race engine, a Weber carburetor jet is commonly used in its place. For correct metering, the jet should be drilled with a number-47 drill. This will give a diameter of approximately 1.98mm (0.078 in.).



In a stock engine, spring-and-ball assembly is used to control flow through oil jet. Competition engines employ a fixed jet with no check ball.

Eccentric-Shaft Prep—In preparing an eccentric shaft for high-performance use, comparatively little work is required. Many engine builders don't even touch the bearing journals, others polish them slightly to improve the finish and adjust clearances. Chamfering sharp journal edges is useful, as it reduces bearing scraping during assembly.

Of course, in a race engine where the battle against weight is waged as ferociously as at school for fashion models, the eccentric shaft is lightened considerably. Along with material removal must go the prescribed amount of polishing and shot peening so that durability is maintained.

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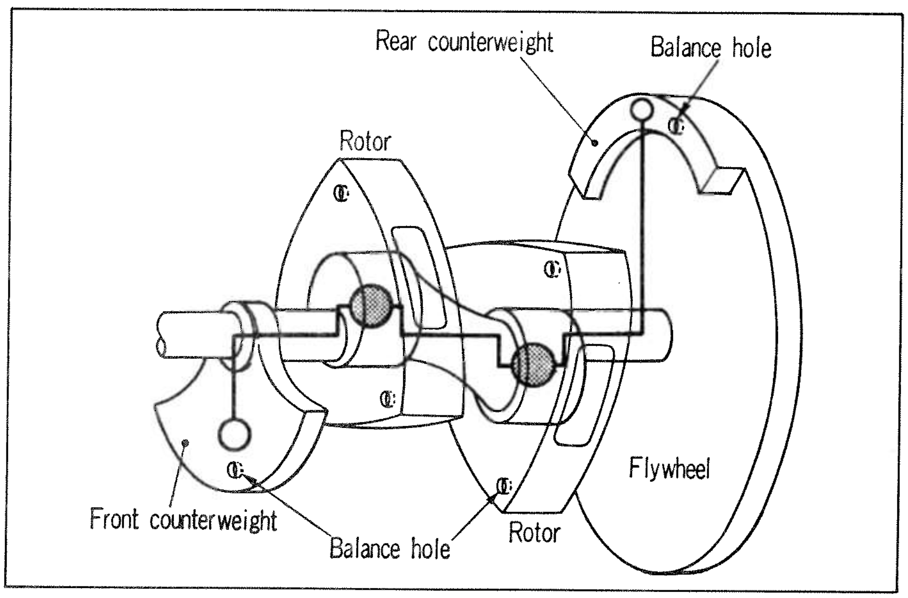
Conditions under which a race car operates differ considerably from those encountered in street driving. This must be considered during preparation of rotating assembly.

should reduce the diameter of the rear portion of the rear main-bearing journal by 0.01mm (0.0004 in.). If a heavy clutch/flywheel assembly is installed, it may cause enough shaft flex to overheat or score the bearing at its rear extremity. The extra clearance minimizes or eliminates this possibility. Older 12A competition shafts featured undercut rear main journals. However, with current lightweight clutches and flywheels, a stepped journal isn't necessary. Some engine builders continue to use a small undercut as insurance.

Jim Mederer says, "The main cause of shaft bending is the rear counterweight, which is the same whether the clutch/flywheel assembly is heavy or light. Therefore, as the rotors—and, hence, balance weight—are lightened, the problem is reduced. Normal practice—if not using a competition shaft—is to provide 0.0005 in. more clearance at the rear half of the rear main bearing than at the front half."



Counterweight/rotor relationship. Drawing courtesy Mazda.

BALANCING

When balancing a rotary engine, the weight of the rotor, with seals, plus a few ounces to allow for oil within the rotor determines the bob weight. Balancing also calls for the bob weights to be off-center. This is because rotor mass is also off-center. This off-set will not show up in a static balance check, but when the assembly is spun, it's essential that the bob weights be correctly located relative to the position of the center of rotor mass.