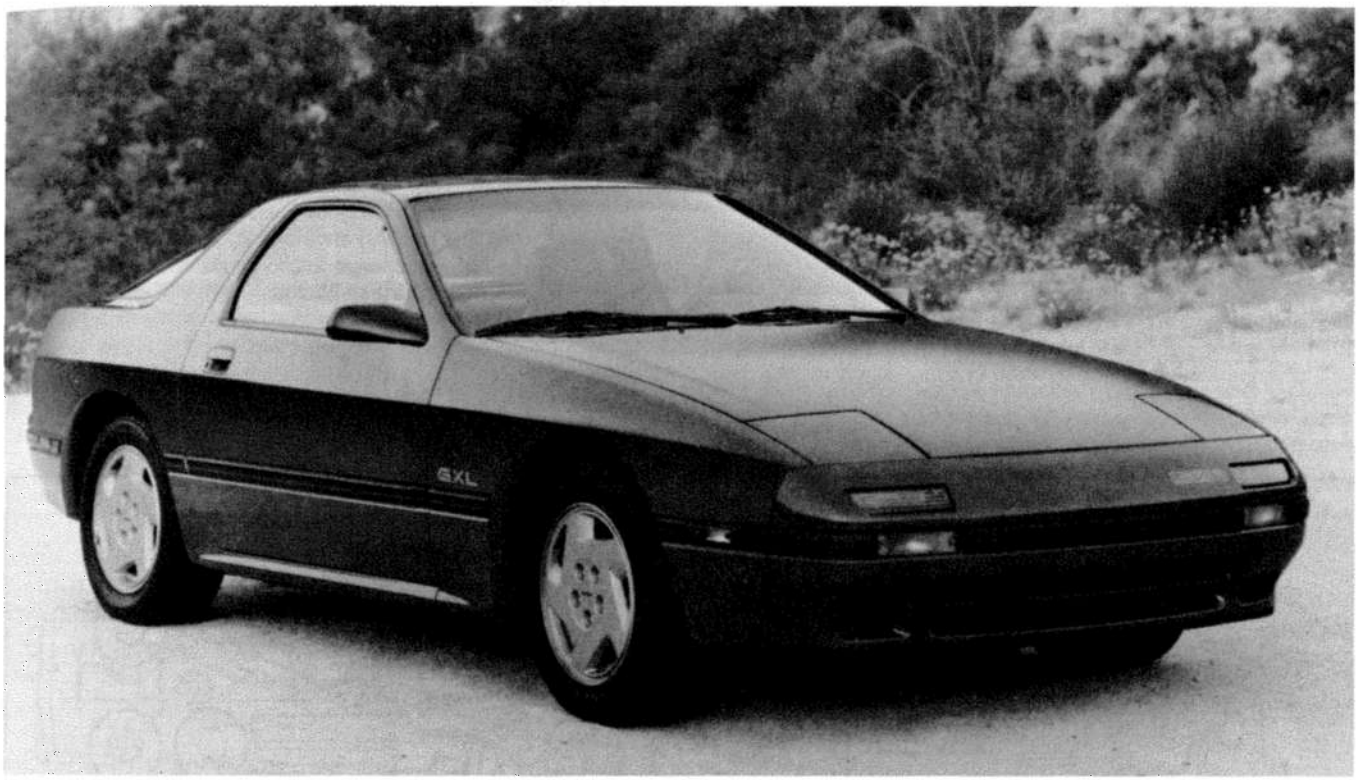
LUBRICATION



Stock oiling system is entirely adequate for stock engines driven "normally," whatever that is. But when engine modifications are made, changes to system are required to keep lubricant supply consistent with loads imposed on engine.

Mazda did an excellent job in designing the stock oiling systems for their 12A and 13B rotary engines. Without modification, the standard lubrication system is capable of supplying more than adequate oil pressure and volume in a stock engine, and will even handle the oiling requirements of some lightly modified powerplants. But that doesn't imply that you should go tripping blissfully off to the races without giving the lubrication system some attention.

The stock system is designed to accommodate *stock* operating conditions. When such conditions are exceeded, the limitations of an unmodified oiling system can be graphically—and expensively—demonstrated.

Under normal circumstances and depending on oil viscosity, oil pressure ranges from approximately 30 psi at idle to about 70-psi maximum at 3500—4000 rpm. (Pressure should never drop below 15 psi at idle.) Much above 4000—4500 rpm, pressure will likely begin to drop because the oil aerates as it is whipped around inside the rotors.

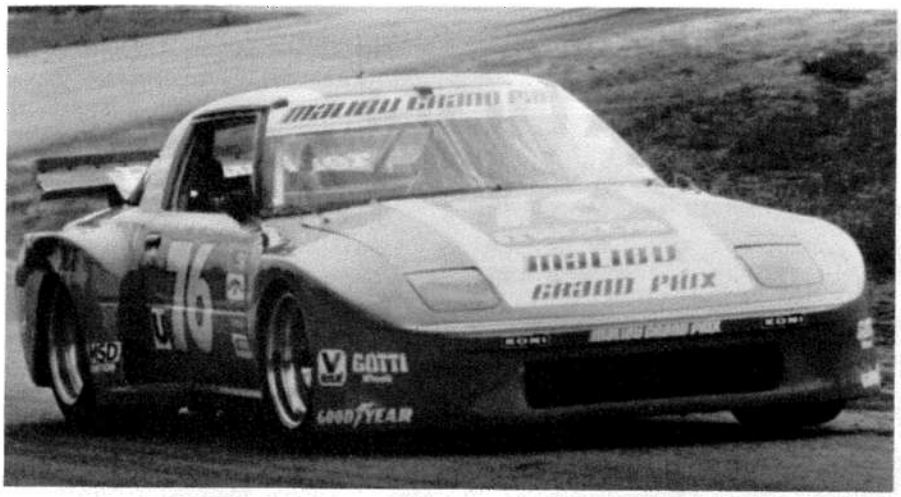
One of the best "oiling-system modifications" that can be made to a Mazda rotary engine is to fill the crankcase with a top-quality SE or SF motor oil and change it regularly. Periodic oil and filter changes are essential with a rotary engine because oil is consumed by design. Similar to some two-stroke piston engines, adequate lubrication can be accomplished only if a small amount of oil is drawn in through the intake system.

OIL METERING

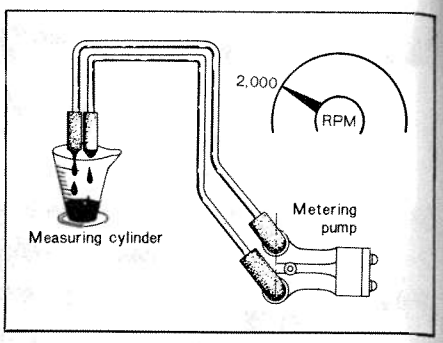
In stock engines, a small metering oil pump receives pressurized oil from the lubricating system and injects it into the intake tract at a ratio of approximately 250:1, or one part of oil for each 250 parts of gasoline. Consequently, the oil level should be checked on a regular basis. Some first-time rotary owners, unaware of normal oil-consumption rates, have allowed the crankcase to run dry.

In terms of oil consumption, a 250:1 ratio can equate to approximately one quart in just over 2000 miles. Or it can equate to one quart every 1000 miles. It depends upon the use of the driver's right foot.

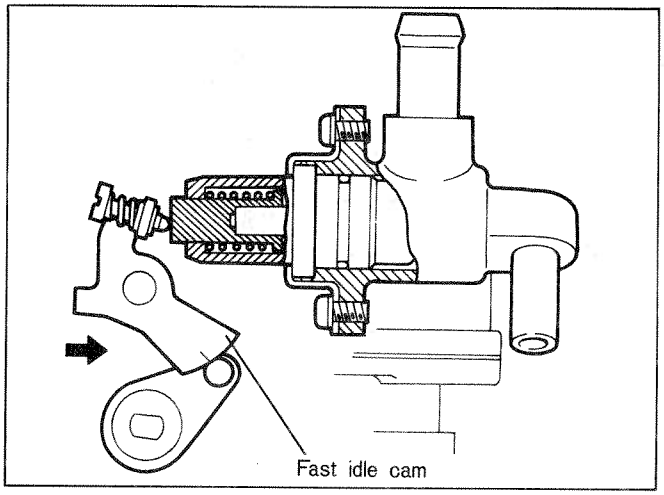
Output of the metering pump is governed by throttle setting—a lever on the



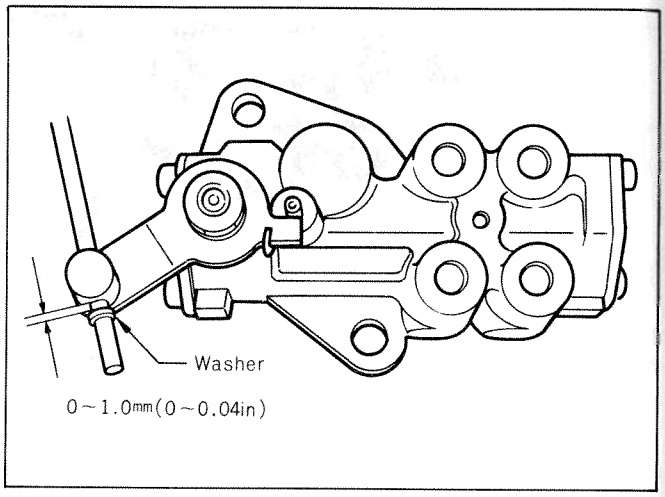
RX-7, originally campaigned by Jim Downing, has seen many changes during its life, however, a well-conceived lubrication system has been one area of consistency. Winning GTU championships has been another.



To check output of oil-metering pump on carbureted engines, Mazda suggests removing oil tubes from carburetor and running engine at 2000 rpm. Tubes should discharge 2.2cc in six minutes. Drawing courtesy Mazda.



On fuel-injected 13B engines, four, rather than two oil-discharge tubes are used, so it isn't practical to measure oil volume. Pump adjustment is accomplished by setting engine at fast idle and measuring pump-rod clearance. Drawing courtesy Mazda.



For proper metering-pump operation, clearance between pump lever and actuating rod should be 0.004 in. with engine at fast idle. Drawing courtesy Mazda.

throttle linkage controls pump metering, administering more oil as the pedal is pushed closer to the floor. Consequently, a "pedal-to-the-metal" driving style will produce a higher rate of oil consumption than would a more conservative the-cops-are-watching approach. With an aggressive driving style, it is not unusual to consume a quart of oil in 1000 miles. But once the consumption rate increases to one quart in 700—800 miles or less under normal driving conditions, the engine is issuing fair warning that rebuild time is approaching.

The factory-recommended oil-flow rate through the metering pump of a 12A engine is 2.2cc in six minutes with the engine spinning at 2000 rpm. In racing applications, the discharge rate should be set at 6cc in six minutes with the pump lever in the wide-open-throttle position. This can be checked by removing the oil tubes from the carburetor and allowing them to discharge into a measuring container.

Late-model 13B engines with fuel injection administer oil from the metering pump at two locations—in the intake manifold and directly through the rotor housing. On these engines, metering-pump discharge volume is adjusted by setting the clearance between the oil-pump lever and actuating rod to 0.004 in.

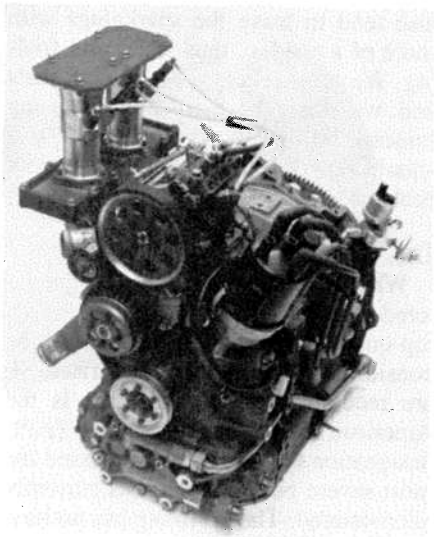
with the fuel-injection system in "fast idle."

In some competition applications, it may be necessary or desirable to remove the metering oil pump. If this is done, oil must be mixed with the gas. The resulting premix should be in a ratio of between 100:1 and 160:1. With the rpm levels and engine loads inherent in Camel Light racing, Downing/Atlanta race engines are usually fed a diet of 100:1 premix, which is approximately 6-1/2 ounces of oil per five gallons of fuel. Such a ratio is not appropriate for race engines that are not as highly stressed.

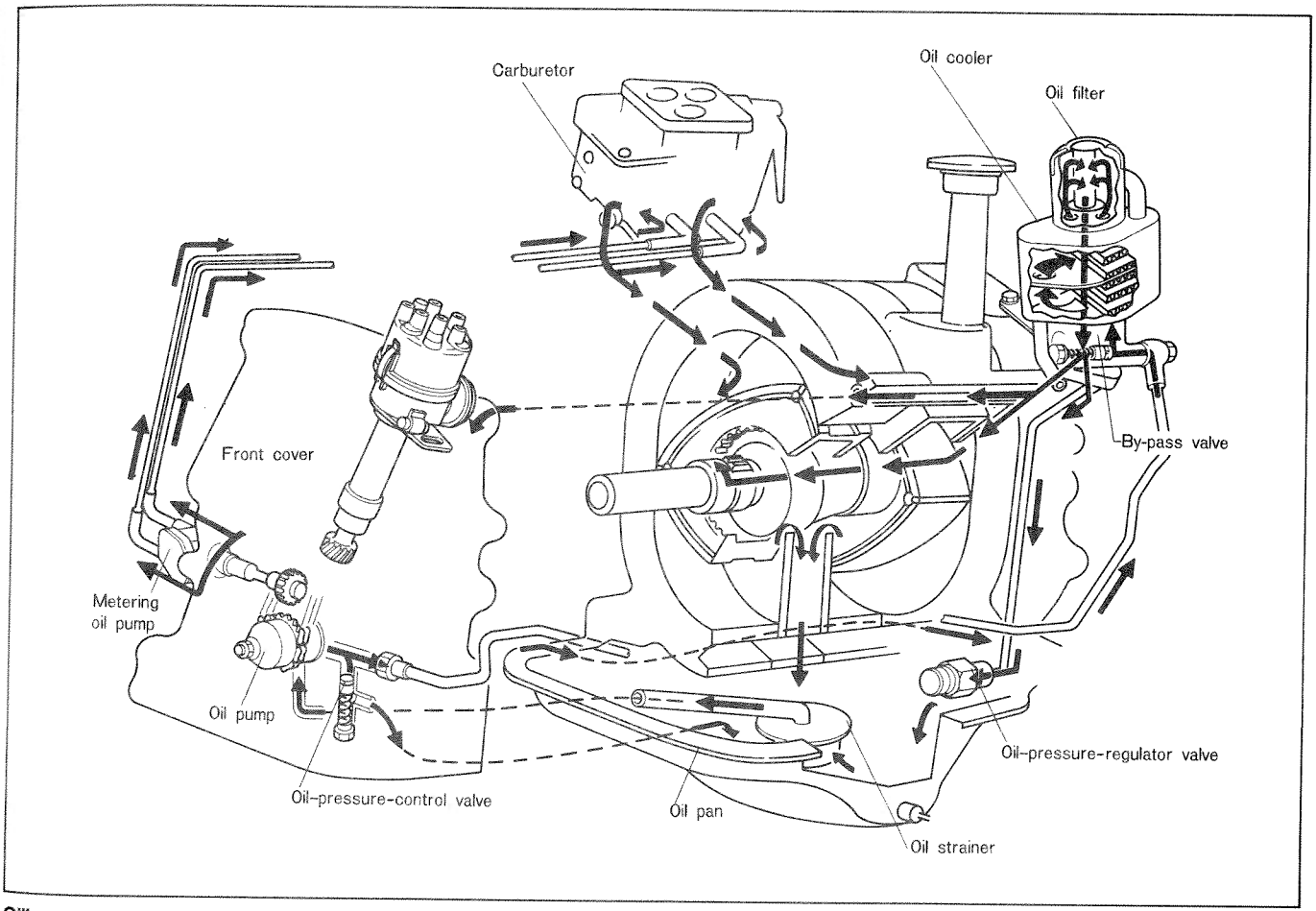
Street engines fed an oil-rich premix will experience an increase in deposits on sparkplug electrodes and possible fouling. For street driving and autocrossing, oil should be administered through the metering pump. (Keep in mind that increasing the percentage of oil in the premix reduces fuel octane.) Premixing is suggested only for endurance-type racing where oil-pump failure could prove catastrophic due to engine operating speed and load.

Note that the oil-metering pump is capable of providing a minimum (oil-rich) fuel-to-oil ratio of about 150:1. Premixing is therefore required if it's necessary to run a richer oil mixture, or up to 100:1.

Jim Mederer says to use a synthetic oil for premix because mineral oils settle out of fuel if it (the mixture) sits for very long. Best choice is a "two-stroke" synthetic which is a good lubricant *and* it stays in suspension. However, Rick Engman uses mineral oil exclusively and is totally pleased with the results. He states, "Synthetic oil doesn't burn, so it will not have the same affect on reducing fuel octane as does mineral oil. Synthetics



Downing/Atlanta race engines utilize Mazda competition front cover that includes dry-sump oil pump. Internal pump eliminates a lot of potentially troublesome appendages on engine's exterior.



Oiling-system schematic, carbureted engines. Drawing courtesy Mazda.

also tend to leave the sparkplugs with more of a residue, thus leading to fouling. We get excellent life out of our seals and we don't have a problem using mineral oil in our premix. Maybe I should rephrase that—if we do have a problem, I don't know about it."

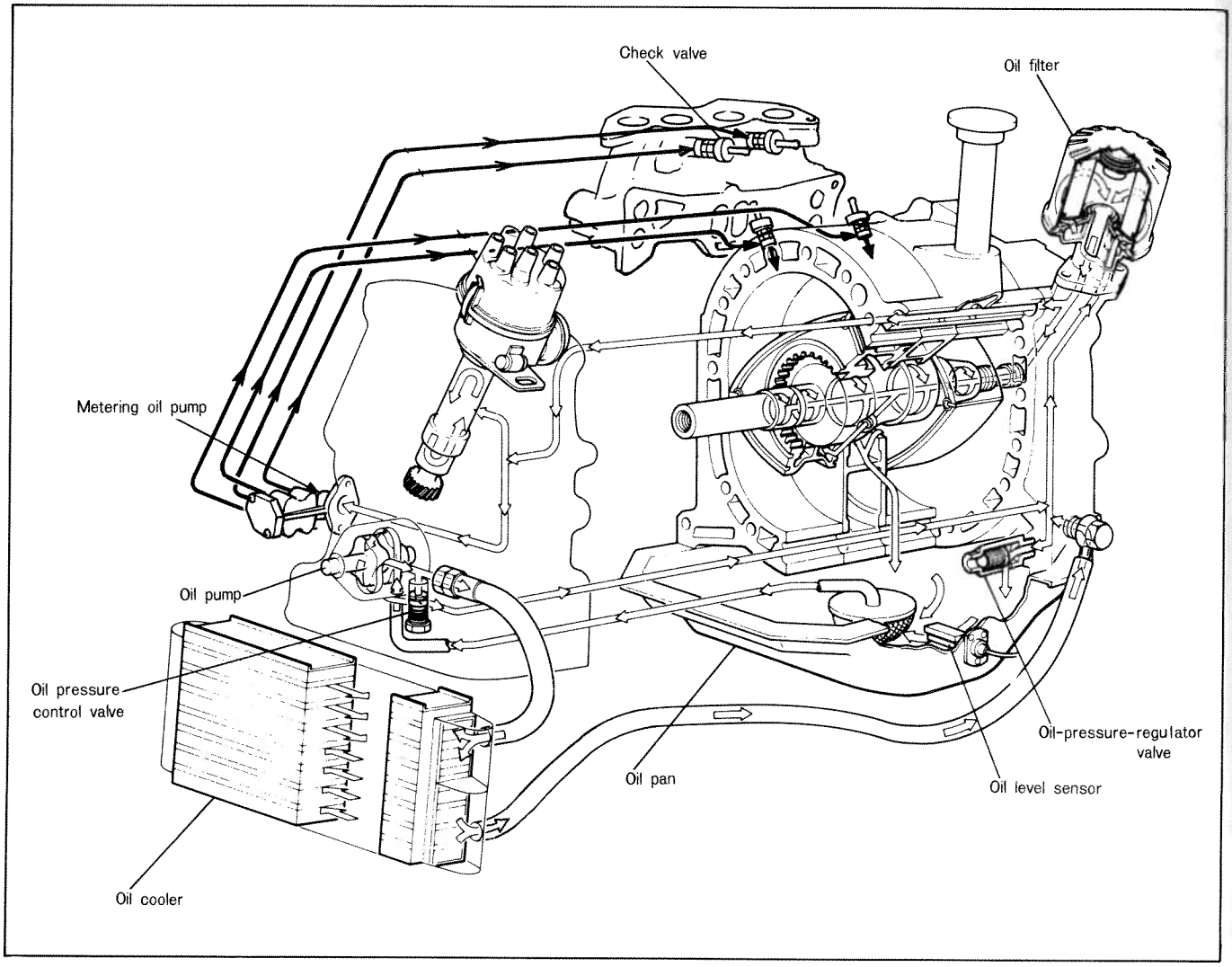
OIL GRADES

Whether oil is premixed or administered through the metering pump, only a top-quality, name-brand oil should be considered. Engine lubricants rated SF are recommended because that is the American Petroleum Institute's (API) designation for oils that have passed the most severe performance tests currently administered. The SF rating has nothing to do with viscosity, but is an appraisal of an oil's anti-wear characteristics and its capability of keeping sludge and varnish from accumulating on internal engine parts. Oils of virtually any viscosity can carry the SF rating.

Downing/Atlanta race engines are fed a steady diet of 20W-50 racing oil. This grade of oil can also be used in street-driven rotaries, although a 10W-40 or 10W-30 is also acceptable, especially in colder climates. As an added benefit, slight improvement in fuel economy may be realized with lighter-viscosity oils. However, considering the comparatively high internal heat levels associated with a rotary engine, as opposed to a reciprocating engine, use of 5W-30 oils in high-output engines is not recommended. In fact, Mazda does not recommend use of 5W-30 oils in stock engines at ambient temperatures above 32F. The factory does recommend 10W-30 and higher viscosity oils for use in ambient temperatures ranging from -10F to +90F. See chart, page 68.

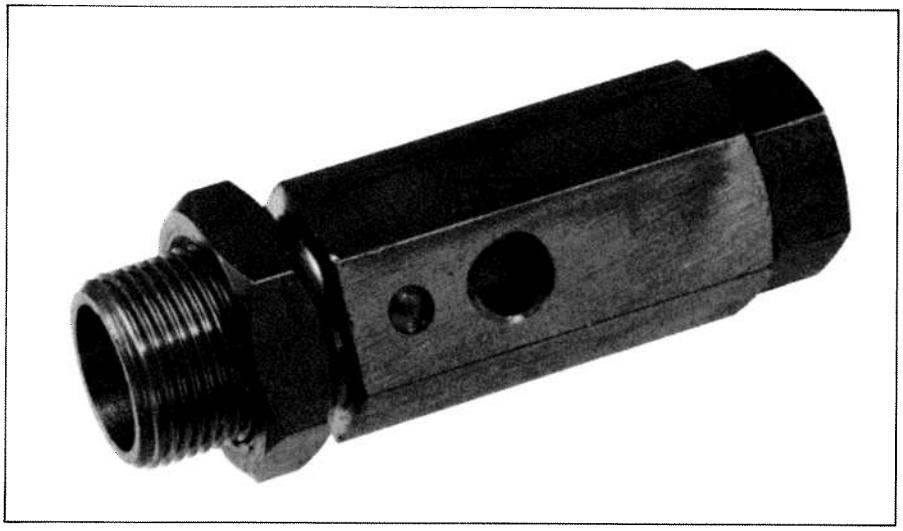
Brand and grade preferences aside, a multigrade oil is preferable to a monograde. The viscosity of any oil changes with temperature, but single-viscosity oils such as SAE 30 or 40 are more highly affected. At zero degrees, you could almost walk on SAE 30 oils, but a 10W-30 or 20W-50 will still pour easily.

The higher viscosity an oil is, the higher its resistance to flow. During cold



Oiling-system schematic, fuel-injected engines. Drawing courtesy Mazda.

Top-quality oil is essential to long engine life. Use only oil rated SF, SE.



Factory competition rear oil-pressure regulator will push oil pressure as high as 115 psi. This amounts to overkill on a street engine and may cause excessive oil consumption during idle and low-speed driving. Photo courtesy Racing Beat.

startup at lower temperatures, it may take as much as a minute or two for a 30-weight oil to reach all critical engine parts. And while lubrication is absent, wear is increased.

Another point in the favor of multigrades is that their viscosity changes less across the entire spectrum of operating temperatures. One of the ingredients found in a multigrade's formulation is a Viscosity Index (VI) improver that reduces the effects of temperature on oil viscosity. Multigrade oils will, therefore, not thin out as much as their single-grade counterparts at high temperatures.

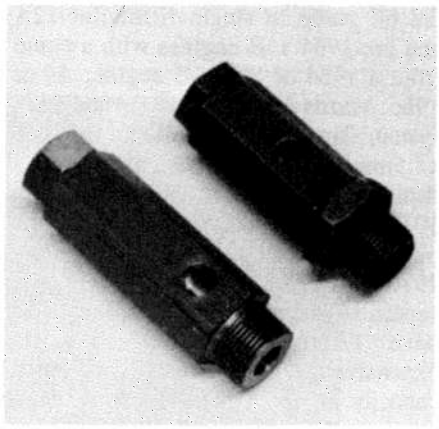
In addition to lubricating, engine oil also performs a cooling function. High-performance engines require increased oil pressures and volume because they generate more heat. Higher than stock oil pressure is recommended not only to ensure an adequate oil-film thickness at all bearing locations, but also to provide adequate cooling of bearings and rotors. Pressure itself doesn't help cooling, but with higher pressure comes increased oil flow which carries away heat faster.

OIL-PRESSURE REGULATOR

On stock and mildly modified rotary engines, the easiest means of increasing oil pressure is to either modify or replace the secondary pressure-relief valve (pressure regulator) found in the rear housing. On 1979 and earlier engines, the valve's end may be removed and a shim placed beneath the spring. Shim thickness should be limited to 1/8 in. as excessive shimming will cause the spring to coil bind and prevent the relief valve from opening fully. The 1/8-in. shim should bring oil pressure up to 80—85 psi which is more than adequate for mild performance applications.

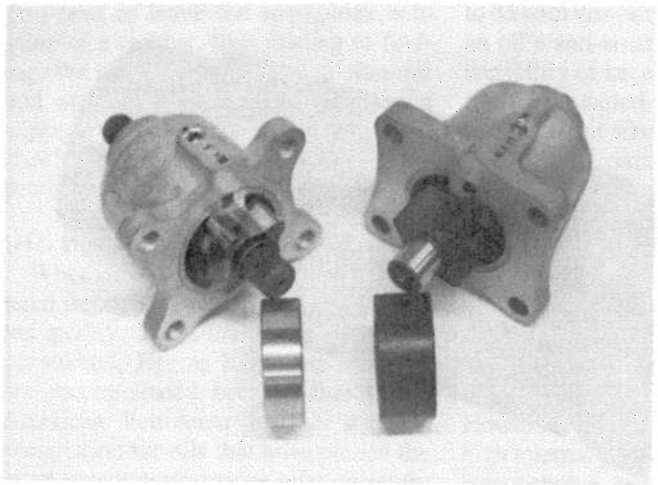
For applications requiring greater oil pressure, on 1980 and later engines which have bypass valves that can't be modified, a Mazda competition regulator can be installed. However, with a high-capacity pump, these regulators can push oil pressure as high as 115 psi, so their use should be limited to race engines. Whenever a Mazda competition rear regulator is installed, the spring in the front regulator should be shimmed 1/16—1/8 in. to ensure that the desired pressure is maintained.

Street-driven rotaries—which 80—85-psi oil pressure is more than adequate—are better off with either a shimmed regulator from a '79 or earlier engine, or a high-performance regulator from Racing Beat or Mazmart. As oil pressure is increased, so too is the load on the oil pump and horsepower draw from the engine. Consequently, raising pressure over required levels is a liability rather than an asset. Too much of a good thing is still too much.

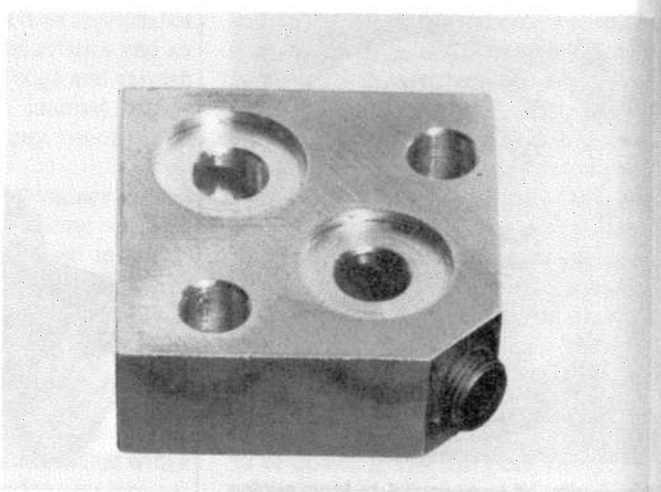


Prior to 1980, rear oil-pressure regulators could be disassembled and spring shimmed to increase oil pressure. Engines produced in 1980 and later have pressure regulators that can't be disassembled.

Note: Although specific tools are required, once the oil pan is dropped, the rear oil-pressure regulator can be changed without removing the engine from the car.



At left is stock oil pump with a 12.5mm rotor set. Mazda competition oil pump with 17.5mm rotors is at right. Competition pump can be installed without any modifications.



When using a remote filter, stock filter mount must be capped off with a block like this. Photo courtesy Racing Beat.

OIL PUMP & FILTER

Oil Pump—Another means of enhancing the lubricating system is to replace the oil pump in single-distributor 12A and pre-1984 13B engines with a pump from a 1984 or '85 13B engine. As of 1986, Mazda revised the pump and drive system. This pump has rotors of the same 17.5mm width and capacity as the Mazda factory competition oil pump. Through 1975, all rotary engines were fitted with oil pump rotors that are 15mm wide. 1976—85 rotor width is 12.5mm, except in 1984 and 1985 13B engines; they have 17.5mm-wide rotors. An inexpensive means of increasing oil-pump capacity is to replace 12.5mm rotor pump with a 15mm or 17.5mm rotor pump and the appropriate spacer plate.

For the overwhelming majority of street engines, a standard 17.5mm pump in combination with a rear pressure regulator set to 80—85 psi will provide more than adequate oil delivery. The race pump has heat-treated gears (rotors) and will, therefore, offer better durability. The oil pump is inside the engine front cover and cannot be changed unless the engine is removed from the vehicle.

Oil Filter—The oil filter, on the other hand, is easily accessible and should be replaced at *every* oil change. You wouldn't drain your dirty bath water down to about the 1/4 level, and then refill the tub with clean water when you were ready for another bath. Please, say you wouldn't! But that's just what you're doing if you don't change filters when you change oil—about a half quart of dirty oil from inside the filter is mixed with the clean oil that was just poured in.

Stock Mazda oil filters are generally of higher quality than replacement brands. However, they do have some drawbacks. One is that the internal bypass pops open at approximately 15-psi differential pressure. This makes it possible for foreign matter to bypass the filter and flow into the engine.

When the engine is cold, the stock filter bypass typically opens when engine speed exceeds 2,000—3,000 rpm. So whenever a stock filter is used, an engine should never be run at high speeds until it has been warmed sufficiently to bring the oil up to operating temperature. This will prevent the buildup of excessive pressure and minimize the possibility of pumping unfiltered oil through the engine. Avoiding excessive pressure will also greatly reduce the possibility of blown oil-filter O-rings and ruptured filter bodies.

Remote Oil Filter—Inadequacies of the stock oil filter can be circumvented by installing a remote filter. With the stock system, oil is picked up from the pan, travels through the pump and is routed out of the engine to the oil cooler. Oil re-enters the engine at the rear housing and flows up a passageway to the oil filter and then to the bearings. When a remote oil filter is installed, it should be plumbed in between the engine and the oil cooler to prevent trash from entering the cooler.

Both single and double remote filter mounts are available. Rotary engines that are more for street driving or casual autocrossing are adequately accommodated by a single remote filter mount and a Fram HP-1 oil filter or equivalent. This filter has an internal bypass, but it will rarely open unless extreme oil pressure is encountered. For racing, a dual filter mount and two Fram HP-2 (no internal bypass) or equivalent oil filters are recommended. A special adapter fitting is required to mate an HP-2 oil filter to a remote filter mount, Racing Beat 11819.

When installing a remote filter mount, position it so that the surface to which the oil filter seals faces down. The oil filter will then be screwed on with its open end up, which means that you can fill the new filter with oil before you screw it in place. If a filter is installed empty, oil will not flow through the engine until the filter has been filled. While this momentary loss of oil flow is rarely catastrophic, it does increase wear and can lead to premature bearing damage. Another benefit of mounting the filter in this way is you can remove it without spilling a drop of oil.

Aside from improved oil filtration, a remote filter also eliminates the need to

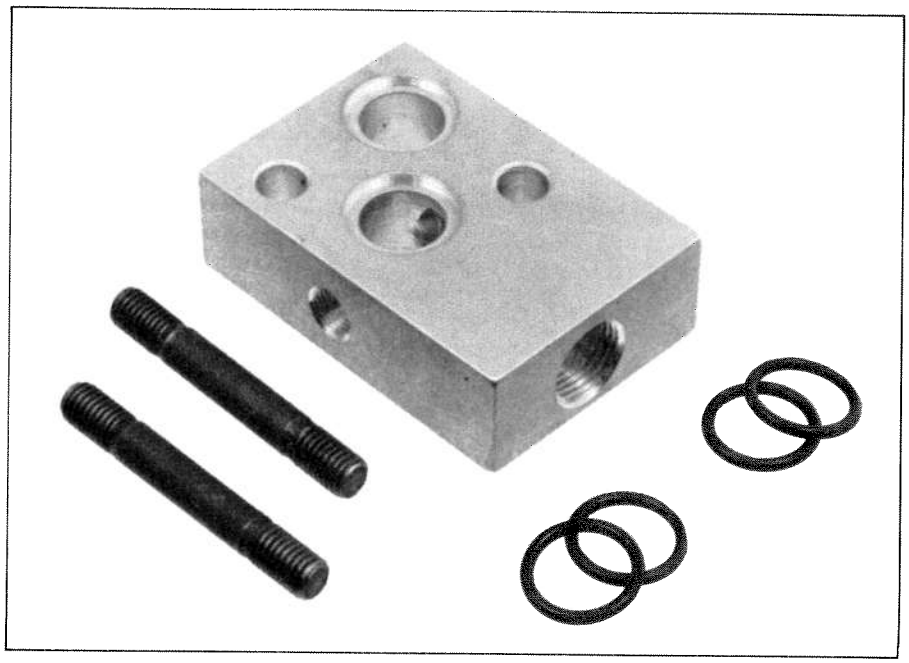
retain the stock filter. Block-off plates are available to cover the stock filter opening, and some variations contain provisions for installing oil-pressure and oil-temperature sending units.

Baffle Plate & Oil Pan—Another accessory that can improve oiling-system performance is a *baffle plate* that fits between the block and oil pan. This flat tray has appropriate cut-outs to clear the oil pickup and other lower appendages. As opposed to a windage tray which would be used in a piston engine to prevent the crankshaft from whipping the oil in the pan, this tray is designed primarily to allow the oil to deaerate before reaching the pickup. A baffle plate also prevents oil from sloshing onto the front counterweight under heavy braking.

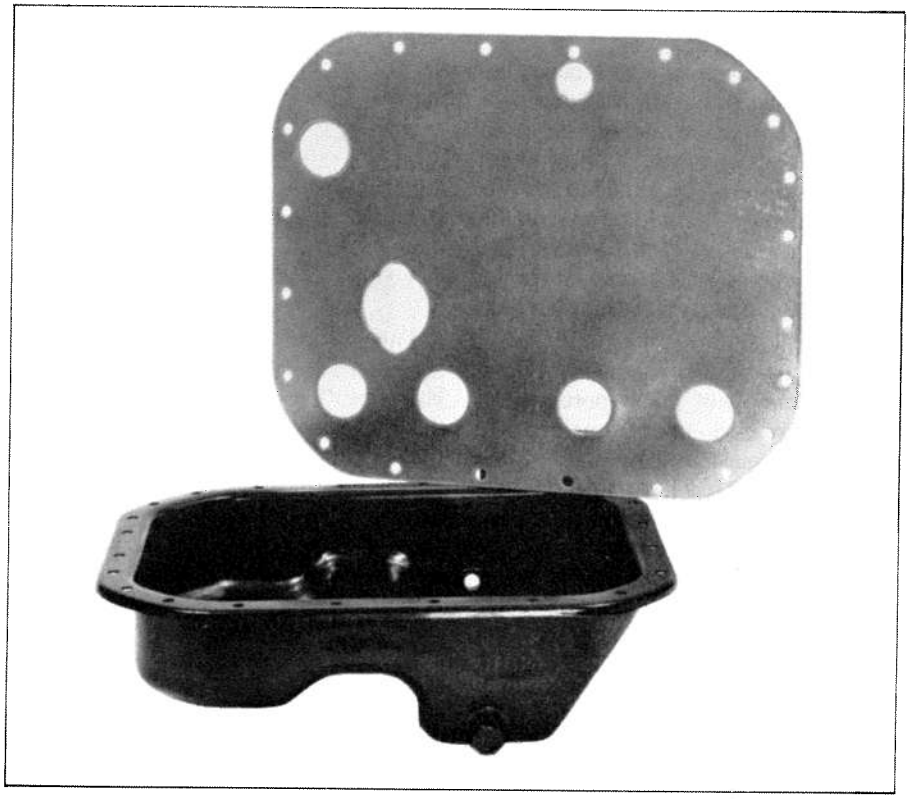
Another means of improving oiling-system performance is the use of a high-volume oil pan. Both Mazmart and Racing Beat offer high-volume pans for 12A engines. Holding approximately one quart more than a standard pan, the high-volume model contains two sumps, a shallow one at the front and a deeper one at the rear. Although not a high-volume model—none are available for 13B engines—an RX-7 oil pan (from a 1984—85 13B) must be used when installing a 13B engine in an RX-7 originally equipped with a 12A powerplant.

In a high-output competition engine of the type used in Camel Lights racing, a dry-sump oiling system is essential. While the conventional approach is to install an externally mounted aftermarket pump, Rick Engman favors the internal three-stage—two scavenge, one pressure—pump that resides in the Mazda factory competition front cover that fits both 12A and 13B engines. Rather than being chain driven—as are stock oil pumps—the internal dry-sump pump is gear driven. Whereas a single filter is adequate with a wet-sump system, dual filters are necessary when a dry-sump system is used; single filters have been known to collapse. Additionally, although the filtering capacity of dual remote filters is more than adequate, as an additional safeguard against contaminated oil reaching the engine, a screen or mesh filter should be inserted in the dry-sump oil reservoir.

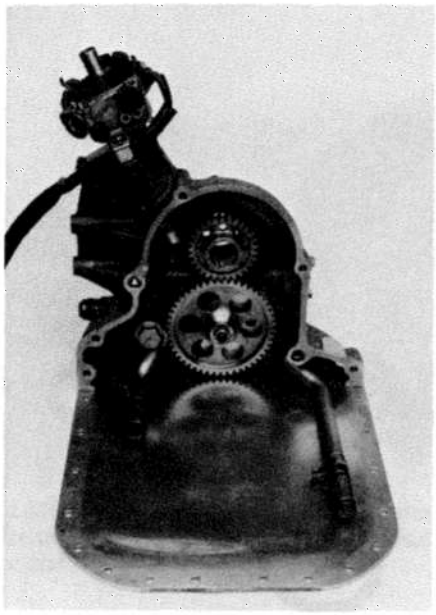
To ensure adequate flow with a dry-



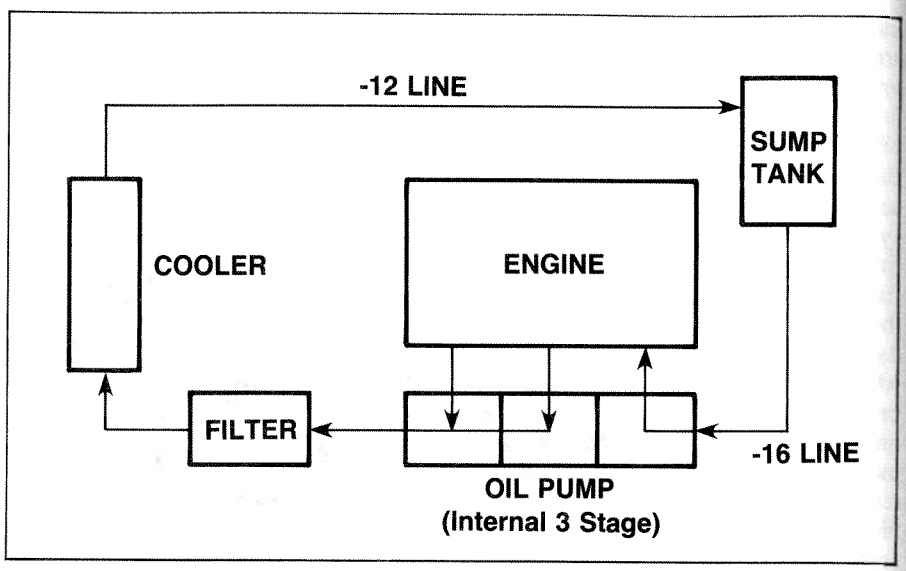
Plumbing in an oil-pressure or oil-temperature gage is considerably easier if adapter plate is used. Plate from Racing Beat mounts directly below oil-filter assembly.



Rather than a windage tray, a high-performance rotary engine should be fitted with a baffle that separates air from the oil. By defoaming the oil, pressure and lubrication are increased at high rpm. Photo courtesy Racing Beat.



When using a dry-sump oil system, flat plate rather than a conventional oil pan is fitted to engine. Oil that would normally reside in pan is picked up by the scavenge lines and pumped to an external tank.



Dry-sump oiling-system schematic

RECOMMENDED SAE VISCOSITY NUMBERS

Temperature	(°C)	−30	−20	−10	0	10	20	30	40	50
	(°F)	−20	0	20	40	60	80		100	120
Engine oil		5W – 30								
		5W – 20								
					10W – 30					
						10W – 40		10W – 50		
						20W – 40		20W – 50		

Temperature Range Anticipated Before Next Oil Change, °C.

Mazda recommended oil viscosities. Chart courtesy Mazda.

sump system, Engman recommends using a minimum of a dash-12 braided-stainless line from the oil reservoir to the engine. Reservoir return (scavenge) lines, which should be routed to the filters and oil cooler before returning to the reservoir, should be dash-12 lines. The tank itself should be mounted above the engine so that gravity assists, rather than inhibits oil flow.

Oil Cooler—Besides adequate oil flow, oil temperature is of vital importance to a high-performance rotary engine. Oil temperature on the inlet side of the engine—after it has passed through the cooler—should never exceed 210F. The best oil cooler available for stock and mildly modified engines is the large-capacity factory-produced model that comes standard with 13B engines.

Engman specifically recommends against the use of aftermarket oil coolers. He states, "I have not found anything on the aftermarket that is worth a . . . The Mazda oil coolers are fairly high tech. All the little tubes that run from header to header have little flat wires woven through them. These help scramble the flow of oil through the tubes to keep hot oil circulating close to the surface. With the aftermarket coolers that I've seen, the oil just flows through a straight tube, so the oil near the tube surface cools, gels and acts as an insulator. Hot oil then flows through the center of the tube surrounded by an insulating barrier. That doesn't do much for cooling efficiency."

On a race car, the factory competition cooler is hard to beat. But there are some competition-proven aftermarket coolers available. Use only those that are big enough to do the job.