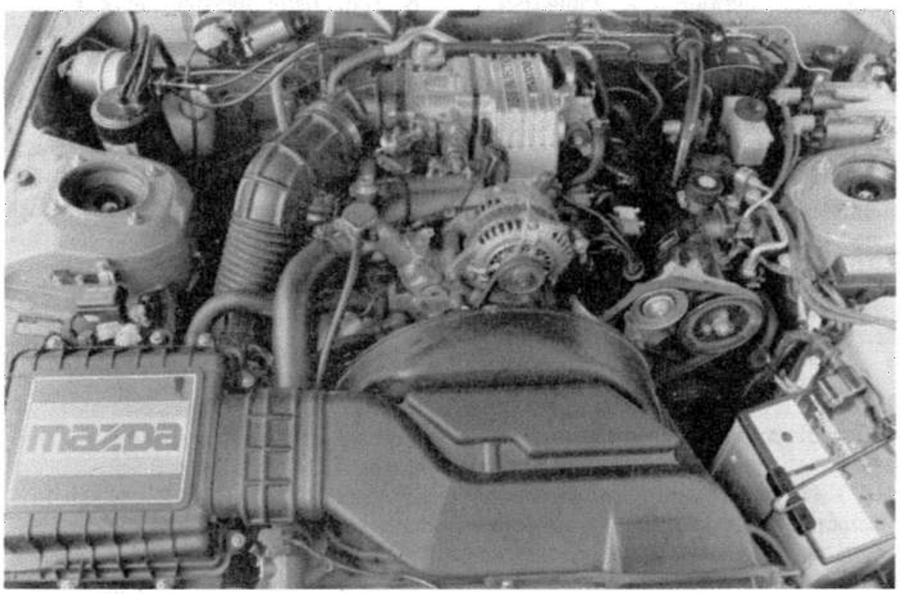
TUNING

Jim Downing's first IMSA racing effort was in 1974 when he raced this RX-2 which was built by Pete Harrison. In terms of ignition systems, that was back in the dark ages, but correct tuning helped car run impressively.

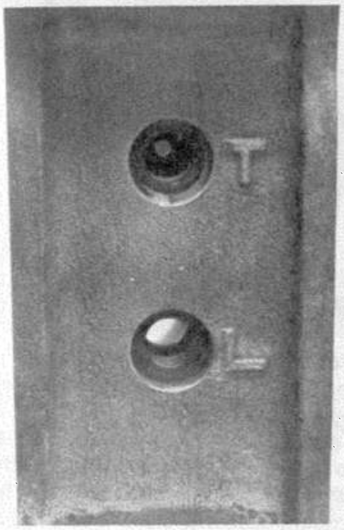


Unless you have a PhD in electronics, tuning a 1986 or later RX-7 amounts to changing sparkplugs and plug wires. Both spark curve and air/fuel ratio are controlled by the onboard computer.

With no pistons bobbing up and down and no valves popping open and slamming closed, Mazda rotaries bring new levels of smoothness to the melody of internal combustion. Of course, the sweetest tunes are played by rotary engines that are tuned for maximum performance.

IGNITION

One of the many ways in which rotary engines are unique is with respect to their ignition systems. Rather than a single sparkplug per rotor, two plugs and, consequently, two ignition systems are used. The *leading* sparkplug is the one placed in the lower position. Above it's the *trailing* plug—unless the engine or car it's mounted in has been turned upside-down. It's not necessary to commit this fact to memory because the letters L and T are cast into the rotor housing. Of



Sparkplug positions are identified on outside of rotor housing by the letters T (for trailing) and L (for leading).

Rotary engines are noted for smoothness, but if they're out of tune, they can run as rough as a—bite your tongue—piston engine. Early-model RX-7s offered more latitude in tuning because engine controls weren't as sophisticated as on later models.

course, if you can't make the connection, tuning the ignition system is the least of your problems.

A rotary engine will run satisfactorily with a single sparkplug firing in each chamber. However, efficiency is considerably better with the dual system. *Efficiency* is the key word. Without the trailing ignition, horsepower decreases by only 10% or so, but fuel economy and exhaust emissions take a dramatic turn for the worse.

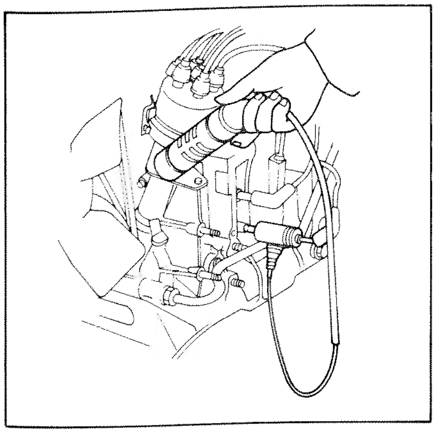
With the rotary engine's relatively long, narrow combustion chamber, it's quite possible that with a single sparkplug, the flame front will be extinguished before it burns the fuel on the trailing side of the chamber. A second sparkplug ensures that this doesn't happen.

In 1981, Jim Downing won IMSA Champion Spark Plug Challenge Series. Although rules were highly restrictive, use of top-quality ignition components made for consistent front-running performance.

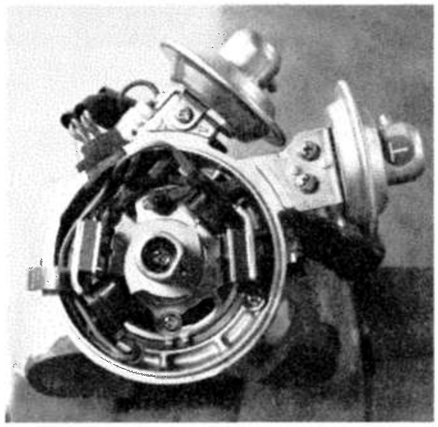
TIMING

On the surface, it appears that timing specifications should be the same for all rotary engines with similar port configurations and speed ranges. However, appearances can be deceiving. Over the years several subtle changes have been made in the 12A and 13B engines and, on occasion, these have had a significant affect on optimum ignition timing. Also, as Racing Beat points out, with some engines timing is critical. With others, varying spark *lead* (advance) by a few degrees has virtually no affect, particularly if the engine is stock.

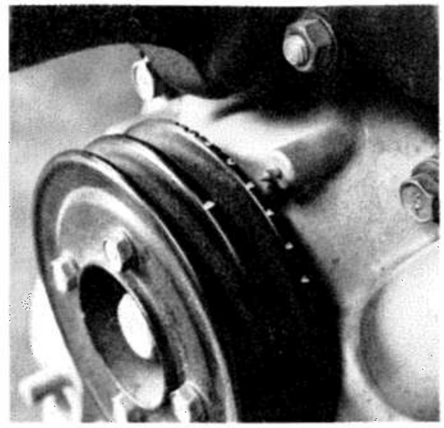
Amongst Mazda rotary engine "experts," there is some disagreement as to the best settings for extracting maximum power without adversely influencing durability. One school subscribes to the theory that increased spark lead in conjunction with high-octane fuel is "the answer." The opposing viewpoint, and the one held by the Downing/Atlanta crew, is that the best results are obtained with conservative spark-lead calibrations provided the engine is fed a diet of low-octane fuel. The fact that both 1985 and



Spark timing is critical on some rotary engines, but a few degrees variation has little effect on others. However, sticking to recommendations given in this chapter will help assure maximum performance. Even though Mazda Workshop Manual shows this rather archaic timing light, current model with three leads should be used. Drawing courtesy Mazda.



On single-distributor engines, leading timing is adjusted by moving distributor as indicated. Trailing timing is changed by loosening screws on trailing vacuum-advance unit and moving canister until desired reading is obtained. Leading timing should always be set first.



Notches in eccentric-shaft pulley correspond to initial-timing settings for engine model originally equipped with that particular pulley. Most factory pulleys have only two notches—one for leading the other for trailing timing. If altering timing from factory recommendations, either a calibrated eyeball or an aftermarket pulley, with additional timing notches, is required.

1986 IMSA Camel Lights championships were won with low-octane fuel is a rather definitive statement of the credibility of the latter philosophy.

With that in mind, Rick Engman recommends a maximum total spark lead of 20° BTC for the leading ignition system of an all-out peripheral-port engine at 6000 rpm. He states, "I depart from the rest of the world because I run very low-octane fuel. Personally, I don't use more than 18° of advance unless we're racing in very cold weather and have a slightly rich air/fuel mixture. I will run 20° of advance on rare occasions, but with the low-octane fuel, I do that very selectively and very carefully. When I got away from the high-octane/high-advance philosophy a number of years ago, everybody used to thumb their noses at me. But now, many of those people are going the low-octane route; some are even taking it further by running *really* low-octane, unleaded gas and adding more lubricant in the premix. Most of the recommendations on premix are about 100:1 (fuel to oil ratio) and I run about 80:1 which lowers octane even further. But I don't recommend going to extremes because it's too easy to get into trouble."

Another point in favor of avoiding the tendency to bump the advance further ahead is the safety margin *conservative* (less advanced) timing provides. Engman states, "You can make about the same horsepower with advanced timing and high-octane fuel, as you can with lower octane and more conservative timing. But when you get into high temperatures or lean conditions, the more advance you run, the sooner you get into trouble."

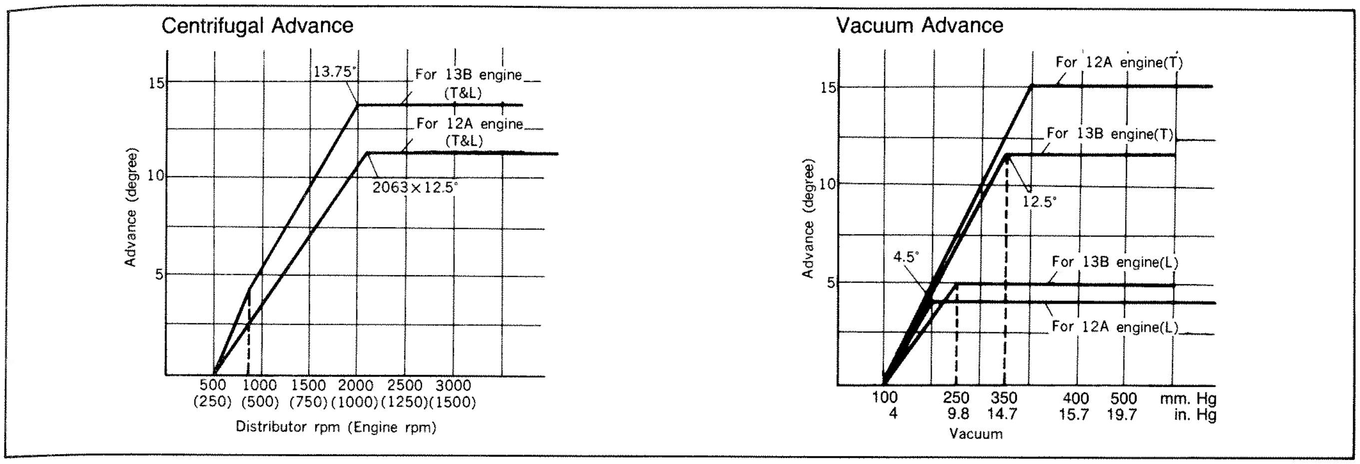
With that philosophy in mind, the objective of establishing a desirable spark-advance curve can be easily achieved by simply removing the centrifugal-advance springs from the distributor and setting initial advance so that spark lead reaches 20° BTC. With the springs removed, maximum advance is reached as soon as the engine starts. Assuming you are using a magnetic-pulse distributor, timing will retard slightly as engine speed increases until it reaches 6000 rpm. The 20° specification will be correct when measured at or above 6000 rpm.

As a rule of thumb, the level of engine modification places limits on maximum-allowable advance. With a bridge-ported or peripheral-port engine, the breathing capability and chamber charging increase with rpm. In turn this increases dynamic compression which limits the degree of spark lead that can be tolerated. By comparison, the restrictive nature of stock porting reduces dynamic compression above certain engine speeds, so more spark advance is permissible.

Unfortunately, the stock pulleys don't have the appropriate marks (18—20° BTC) so a bit of preparatory work is required before timing at higher engine speeds can be checked. It is possible to scribe a pulley with the required marks by using a divider or flexible ruler to measure the distance between the stock marks. A timing decal on the hood will detail the number of degrees to which each mark corresponds; additional marks can be made based on this information. Additionally, degreed pulleys are available from Racing Beat.

An alternate method of reworking the advance calibrations is to follow the recommendations listed herein, which will produce a more desirable spark curve while retaining the stock distributor internals.

The accompanying timing table, which was largely derived from Racing Beat's recommendations, may at first



Centrifugal- and vacuum-advance curves for 1984 12A and 13B engines: Note that trailing and leading vacuum-advance curves differ while centrifugal-advance curves are the same.

seem contradictory because different figures are listed for various year models. Believe it or not, there's a method to this madness. As an example, specifications for the 1974—75 12A engine differ from those of the 1971—73 model. This was because there was a change in sparkplug location (which influences the amount of advance required) and the combustion chamber in the rotor was also modified. Another consideration is that stock advance rates and total amount of centrifugal lead vary from year to year. Many times one engine requires a *bump up* (increase) in initial timing while another requires a *kick back* (reduction) to achieve the same results.

Keep in mind that these are *baseline* recommendations. Some adjustment may have to be made to accommodate fuel quality, altitude and/or ambient temperatures. Also, before toying with the distributor, tie a string around your finger with a card attached to it. On the card, which you should conceal from friends and family, write, "Too little is better than too much."

		1971-1973 12A	1974-1975 12A	1976 12A	1977-1983 12A	1984-1985 12A	1974-1975 13B	1976-1978 13B	1984-1985 13B GSL-SE
stock porting & intake sys.	L	3° BTC	0°	2° BTC	2° BTC	stock	0°	stock	2.5° BTC
	T	5° ATC	5° ATC	15° ATC	19° ATC	stock	10° ATC	stock	12.5° ATC (w/fuel inject.)
stock porting Dellorto, Holley or Weber	L	8° BTC	2° BTC	2° BTC	2° BTC	stock	0°	3° ATC	stock
	T	0°	4° ATC	15° ATC	19° ATC	stock	8° ATC	13° ATC	stock (with Dellorto carb)
street porting & Dellorto, Holley or Weber	L	8° BTC	2° BTC	8° BTC	8° BTC	3° BTC	0°	0°	6° ATC
	T	2° ATC	6° ATC	12° ATC	12° ATC	17° ATC	10° ATC	10° ATC	6° ATC (with Weber carb
All boxed numbers below indicate degrees BTC measured at 6000 rpm.									
bridge porting (open exhaust)	L	35°	20°	24°	24°	24°	20°	20°	not applicable
	T	15°	15°	5°	5°	5°	13°	13°	
peripheral porting (open exhaust)	L	35°	20°	24°	24°	24°	20°	20°	not applicable
	T	15°	15°	5°	5°	5°	10°	10°	
			Note 1						

TIMING RECOMMENDATIONS

Note 1: The Mazda Factory recommends 20° BTC leading and 20° BTC trailing.

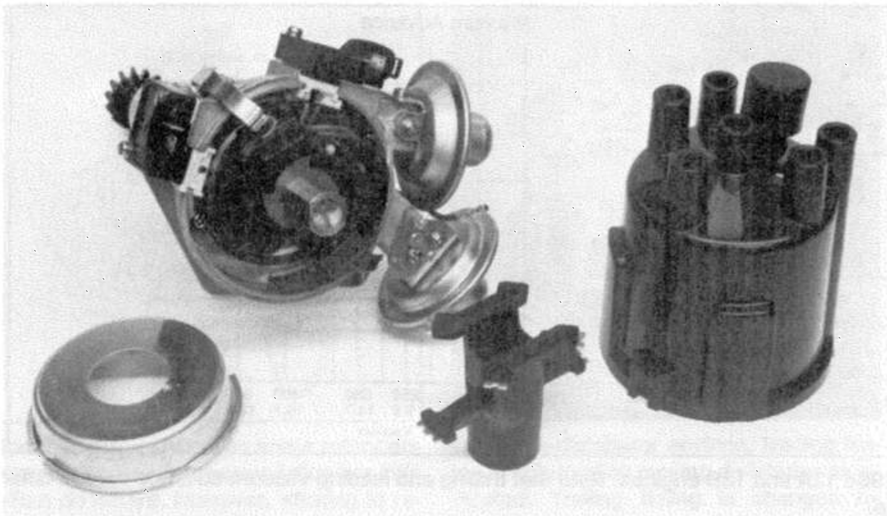
BTC means degrees *before top center* (before 0°)
ATC means degrees *after top center* (after 0°)

boxed numbers mean degrees BTC measured at 6000 rpm.

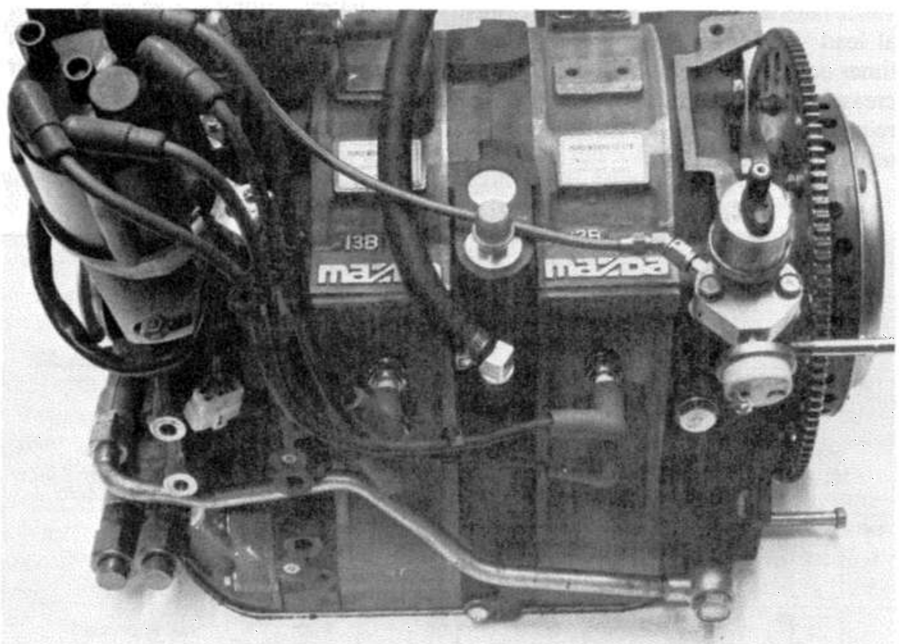
The recommendations in this chart for non-ported and street-ported engines are based on the conventional method of setting the timing—at idle, with the vacuum advance disconnected. The recommendations for bridge-ported and peripheral ported engines—those *boxed* in—are maximum advance settings, usually measured by revving the engine to 6000 rpm. This is *essential* in race engines, since timing is critical to life and performance. No vacuum advance is used in racing, and it is common to eliminate the centrifugal advance to avoid an area for failure.

When attempting to set your ignition timing to a position other than the stock factory setting, you must first identify the marks on the pulley. You can usually do this by reading the ignition timing decal on the underside of the hood. Once you know what each mark means in degrees, you can use a pair of dividers to mark your own settings on the pulley, referenced to the original marks.

Chart Courtesy Racing Beat.



Electronic distributor is preferable to point-equipped model because timing and dwell are more stable—there are no points to get out of adjustment.



Inspection of plug wires should be part of any tuneup. In addition to cracks and effects of age, wires should be checked for correct routing. Use of wire looms keeps wires separated which helps prevent crossfire.

Retarded timing will compromise horsepower and fuel economy, and cause exhaust temperatures to elevate. But it will seldom result in engine damage. On the other hand, over-advanced timing is likely to injure the apex seals, rotor housing and, consequently, your wallet. If, after altering ignition timing, the engine pings, flutters or seems to have a large dent in its horsepower curve, chances are an over-advanced condition exists. Don't push your luck—correct it *immediately*.

With a single-distributor engine, making timing adjustments is about half as difficult as with a dual-distributor engine. The only option is to set leading timing and let trailing timing fall 5—10° behind. Remember: Trailing timing has comparatively little affect on horsepower, so it is not as critical as leading timing when tuning for maximum performance. Dual-distributor engines allow leading and trailing timing to be set independently. However, engine damage can easily result if the trailing timing precedes leading timing very much under high-load conditions. So avoid deviating very much from the recommended figures.

In the real world, the procedure most frequently used when attempting to optimize ignition timing involves repetitive road tests.

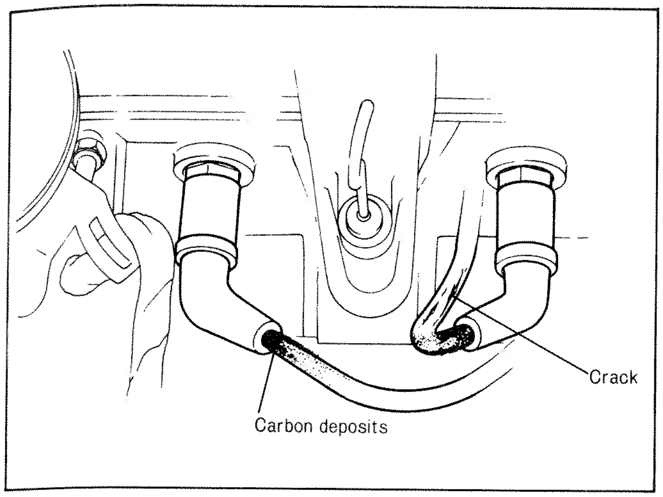
After establishing baseline settings, drive the car and evaluate its performance. If no significant shortcomings come to light, advance the timing an additional 2° from the baseline and repeat the test. Always make an acceleration run in high gear at maximum engine load. A setting that seems satisfactory in low or second gear, may cause detonation once the engine is no longer assisted by the transmission's torque-multiplication capabilities.

Once you've found the optimum spark advance, retard timing 1—2° from that setting to establish a safety margin. This will compensate for a dose of low-quality fuel or abnormally high underhood temperatures.

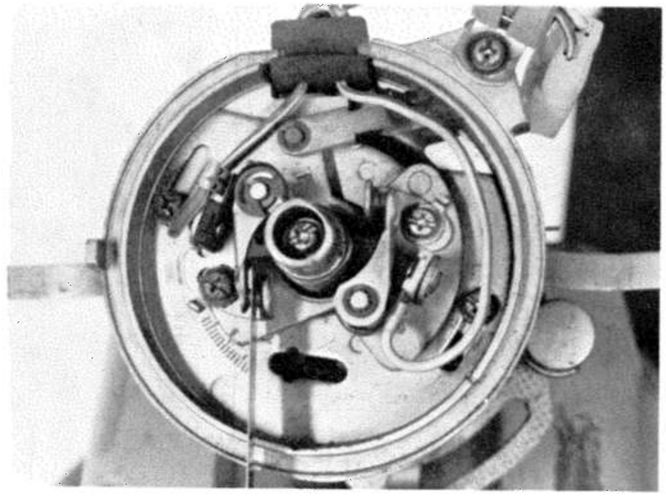
INSPECT IGNITION SYSTEM

When a timing curve is changed, or when an engine is treated to a regular tuneup, it's an ideal time to check the distributor assembly—nobody ever ran into trouble because they were too conscientious about inspecting an ignition system. If the cap or rotor shows any corrosion or damage, replacements are generally in order. In some instances, light corrosion on the terminals can be scraped away, but this practice can also fall into the tripping-over-dollar-bills-to-pick-up-pennies category. If deep in your heart you know a component is too far gone, bite the bullet and pop for a new one.

Although corrosion and carbon tracking rarely prevent an engine from running, many times they can be the cause of



Carbon deposits can accumulate in area of sparkplug boots, providing an alternate current path that can result in misfire. Plug wires should be free of deposits and cracks. Drawing courtesy Mazda.

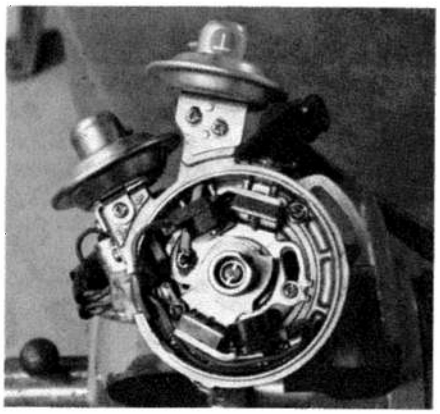


Engines produced prior to 1980 are equipped with breaker-point-type distributors. Point gap should be set at 0.016 in. to provide a dwell of 58°.

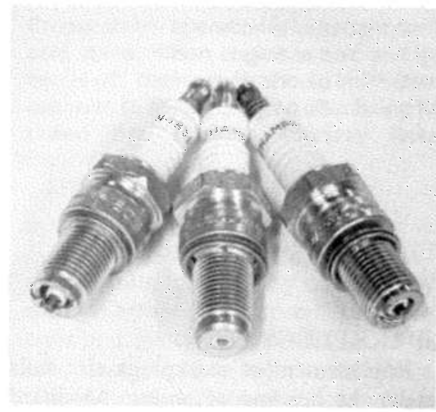
poor performance and misfiring. In some instances, cleaning the offending component will restore performance, but the fix may be short-lived; the carbon tracking and/or corrosion may return relatively quickly. Irrespective of whether the decision is to repair or replace the distributor componentry, while the cap is off, check for signs of corrosion, wear or rust inside the distributor and clean or repair as required.

With older engines, a tuneup also includes replacing the ignition points and condenser and setting point dwell. This should always be done *before* timing is adjusted because a change in dwell affects timing. A point gap of approximately 0.016 in. will yield a dwell of about 58°. Dwell is the important figure—gap is simply a means of achieving it. If a 0.016-in. gap doesn't move the dwell-meter needle over to 58°, alter the gap as required. There's an inverse relationship at work here; *increasing point gap decreases dwell* and *reducing point gap increases dwell.*

If you don't achieve an exact dwell of 58°, try for slightly less dwell of 54—56°. This can be achieved with point gap increased to 0.017—0.018 in. As the rubbing block wears, dwell increases and, in less than 1,000 miles, the desired dwell will be reached. This implies that timing should be rechecked after the points seat in—irrespective of the initial dwell setting. Typically, once the points seat in, rubbing-block wear is minimal. Regardless, you should make a periodic check of dwell and timing.



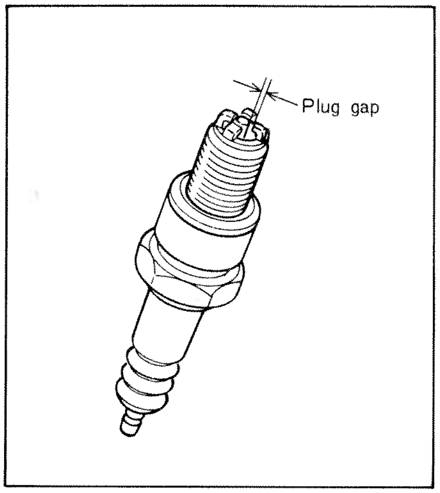
Electronic distributors do not require service during a tuneup. However, reluctor-to-magnetic pickup air gap should be checked periodically. Standard specifications call for a 0.020—0.035-in. gap. If air gap is excessive, either the pickup coil and bearing assembly or distributor shaft may have to be replaced.



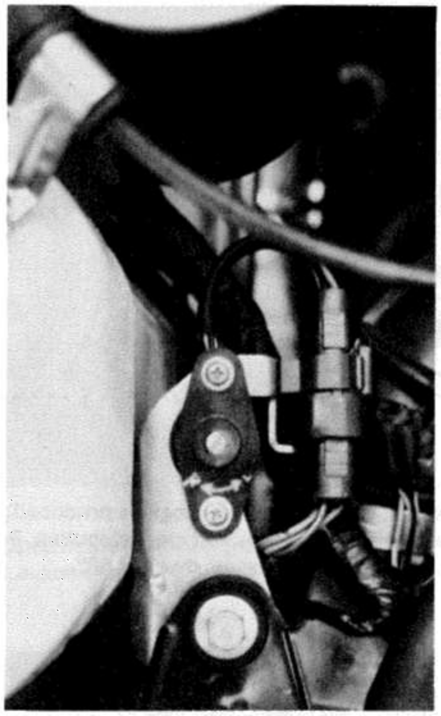
Sparkplug choice depends on application and personal preference. For street use, a multi-electrode plug such as one at left is recommended. Racing plugs are typically of the surface-gap (center) or standard single-electrode variety.

While the dwell meter is connected, check the stability of the needle with the engine idling. If the needle doesn't give a steady reading, it's possible that the distributor shaft is bent or excessively worn. This check can be performed on either a point-type or electronic distributor.

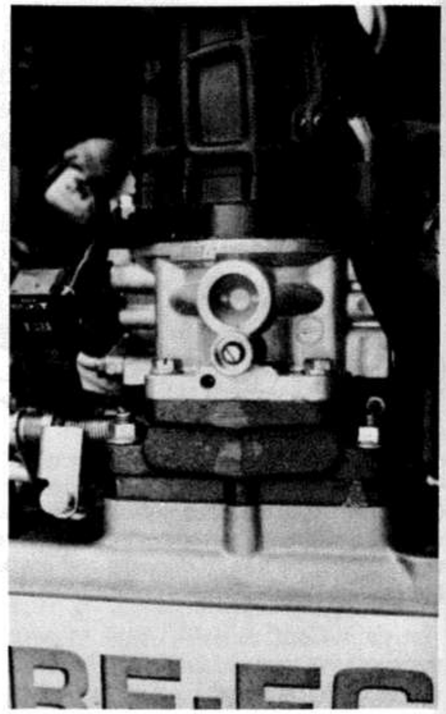
A dab of petroleum jelly (Vaseline) or point lubricant will reduce rubbing-block wear, thus maintaining the desired dwell setting for a longer period of time. A stabilizing effect on initial timing is also affected by a reduction in rubbing-block wear rate. However, wear cannot be totally eliminated, nor can metal transfer and pitting of the contact surfaces themselves—all of which says, "convert to electronic triggering if possible."



Engines equipped with electronic ignition and stock multi-electrode sparkplugs should have 0.055-in. plug gap. Drawing courtesy Mazda.



On 1984—85 engines with Electronic Gas Injection, it is necessary to grind off top of the mixture-adjusting screw, just enough to reveal screwdriver slot. Turning toward R richens idle mixture; turning toward L leans it. Photo courtesy Racing Beat.



Screw on top of throttle body adjusts idle speed on 1984—85 fuel injection. Stock engines should be set to factory recommended idle speed of 750 rpm. Photo courtesy Racing Beat.

SPARKPLUGS

Replacement of sparkplugs also falls under the heading of *tuning*. Modified engines typically call for *colder* sparkplugs than their stock counterparts. A common practice used in tuning a high-performance piston engine is to *read* a sparkplug for color and select sparkplug heat range and carburetion jetting based on its hue. Using this method to tune a rotary engine will get you in trouble because the plugs don't pick up color as quickly as they do in a piston engine (two- or four-stroke).

In a rotary, each plug fires one time per eccentric-shaft (crankshaft) revolution; the sparkplug in a four-stroke piston engine fires once every other crank revolution. Relatively speaking, the plug in a rotary engine has relatively little time to cool between firings. Consequently, color is slow to accumulate unless the air/fuel mixture is exceptionally rich.

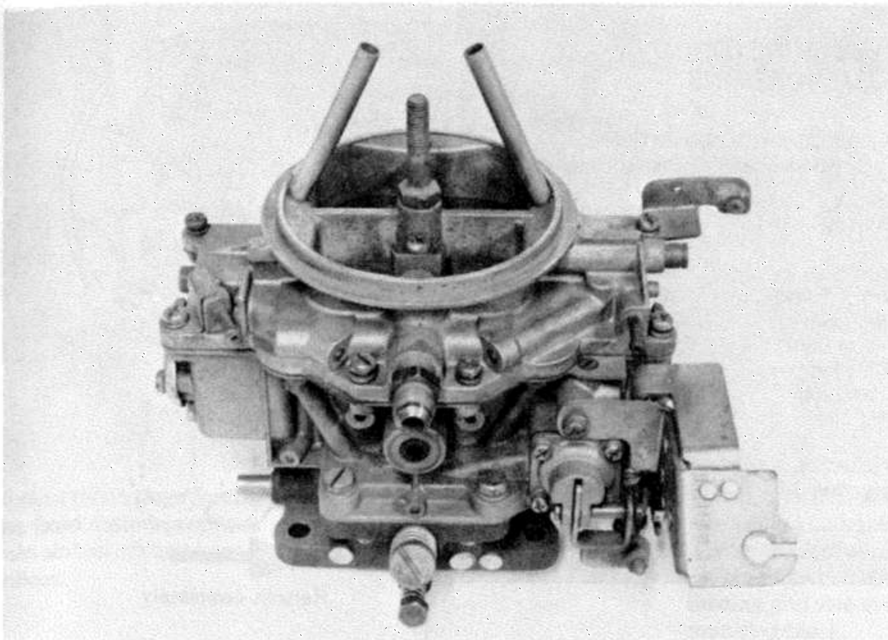
There isn't a wide selection of suitable sparkplugs, so selecting the right ones is not too difficult. Engines sparked by high-energy ignitions are even easier to select plugs for because a colder plug can be tolerated without the danger of fouling problems. Heat-range guidelines noted in the previous chapter can be used to select the appropriate Champion sparkplug or its equivalent.

As previously noted, gap should be held to 0.020—0.025 in. with single-electrode sparkplugs. The factory recommended gap setting with multi-electrode sparkplugs and electronic ignition is 0.055 in. While this is acceptable for a stock engine, it may lead to a high-speed misfire or incomplete combustion after modifications have been made. A wider gap is preferable from an efficiency standpoint, but it comes at the expense of reliability. A narrow gap may not be necessary for street driving, but you will have to determined this for your particular situation.

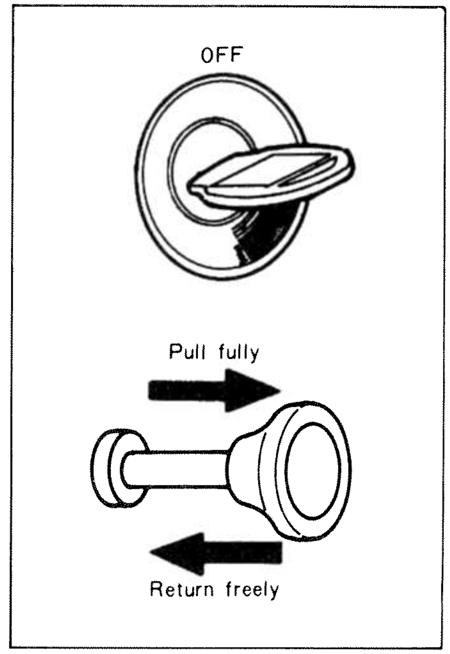
CARBURETOR TUNING

The rule that applies to reading sparkplug-electrode color to determine heat range also applies to carburetor jetting. Again, the common practice with piston engines is to richen the air/fuel mixture if the plugs have little color and lean it if they have too much. Realizing that these are relative terms, they're open to interpretation in the best of circumstances, especially considering that different brands of plugs color differently.

Under racing conditions, sparkplugs in a rotary engine pick up very little color, making them almost impossible to read. Unless heat range or jetting is way off, by the time the plugs color enough to get a good reading, they have either melted (plugs are too hot or mixture is too lean), performed acceptably or fouled (plugs are too cold or mixture is too rich),



Idle quality on engines equipped with stock carburetors can be optimized by carefully adjusting mixture and speed. Upper screw controls air segment of the idle mixture; lower one regulates idle fuel. Air screw is generally used to adjust speed and fuel screw for fine tuning mixture, which also influences idle speed. It's usually necessary to work back and forth between the two screws to achieve desired idle speed and smoothness.



Proper choke operation is important during cold starts. When engine is cold and ignition is off, choke knob should immediately return to its at-rest position after being fully pulled out. Drawing courtesy Rotary Rocket.

color is a moot point. In reading plugs in a rotary engine, the porcelain should be clean and, at the most, slight boiling of the cement between the center electrode and porcelain may be evident. On the ground electrode there should be greenish color at the tip ranging to a sand color at the base.

Overly rich jetting is preferable because it rarely leads to engine damage. Conversely, an excessively lean mixture can cause detonation and, especially under racing conditions, severe engine damage. One advantage of purchasing a high-performance intake system from a Mazda specialist like Racing Beat, Mazmart or Rotary Engineering is that carburetor jetting will be close to optimum as received. But considerable experimenting is required with a home-brewed induction system.

While there's something to be said for moving the air/fuel mixture slightly to the rich side of *stoichiometric*—chemically correct air/fuel mixture, or about 14.7:1—too much of a good thing is still too much. This can be graphically demonstrated on 1971—74 rotary engines as installed in RX-2, RX-3, RX-4 and rotary pickup vehicles. Carburetors on these engines were purposely calibrated to administer an excessively rich mixture in order to clean up the exhaust. Emissions were partially controlled by "excess" fuel burning in the thermal reactor.

Racing Beat has developed jetting recommendations (see accompanying chart) that are claimed to provide up to a 5% increase in both power and fuel economy. Take note that these recommendations apply *only* to the models listed. Later models will experience a decrease in performance—and possible engine damage—with similar jet changes.

Jetting recommendations given in the above chart apply for cars driven at altitudes below 3500 feet. Above 3500 feet use primary jets 0.05mm smaller. At higher altitudes, it may also be desirable to reduce secondary jetting by 0.05mm.

With 1975 and later stock carburetors, stock jetting may or may not be acceptable. Whether it is depends on driving style and the type and extent of engine modifications. Due to the restrictive nature of the stock carburetor, it is not well-suited to high-performance use. Consequently, tuning will not produce appreciable power increases.

To extract maximum power with a stock carburetor, float level should be set so that fuel is centered in the sight glasses. Fuel pressure must also be at the recommended setting as noted in Chapter 3, pages 35 and 36. Although power and economy can both be optimized by experimenting with jetting, significant power increases will come only through carburetor and manifold modifications or the installation of a high-performance intake system.

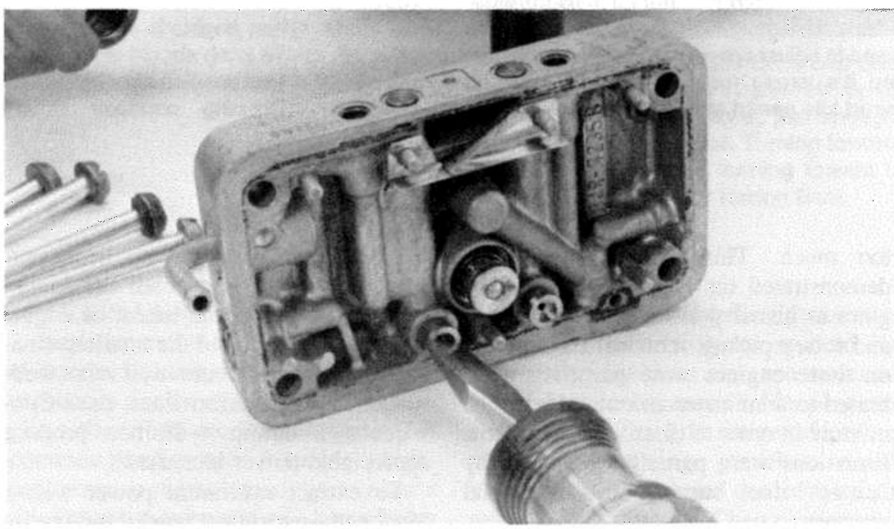
Jim Mederer of Racing Beat notes that, "Increasing air-jet size *reduces* fuel flow. Also, air jets usually make more difference at higher engine speeds.

"In general, almost every aftermarket carb on *any* rotary engine—with one idle

1971—74 STOCK CARBURETOR REJETTING RECOMMENDATIONS

VEHICLE	STOCK JETTING	RECOMMENDED JETTING Primary/Secondary	Primary/Secondary
1971 RX-2	90m/155m	90/150	
1972 RX-2 & -3	92m/155m	90m/150	
1973 RX-2 & -3			
	Manual trans early	92m/155m	90m/150
	Manual trans late	94m or 96m/155m	92m/150
	Automatic early	92m/155m	90m/150
	Automatic late	94m or 96m/150m	92m/150m*
1974 RX-2 & -3	94m/145m	92m/145m*	
1974 RX-4 & pickup	106m/140m	105m/140m*	

*No change on secondary jetting.
All jet sizes in hundredths of a millimeter. For example, a 140 jet has a diameter of 0.140mm. Jets with an "m" suffix are Mazda supplied. All jets are available from Racing Beat.



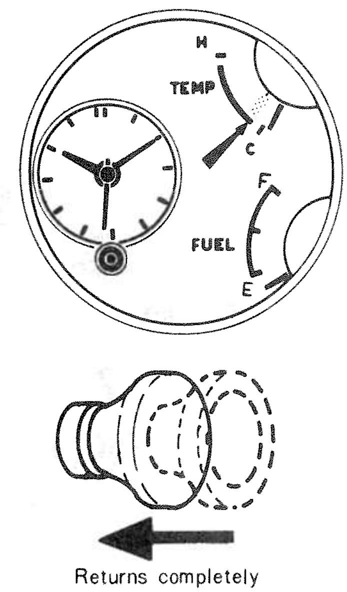
In Holley modular 4-barrel carburetors, main-metering jets are housed in removable metering blocks. Jet changes are easy to perform once fuel bowl has been removed.

jet per chamber—ends up with a 0.70 or 0.75mm idle fuel jet for best results. Rotaries need *large* idle air jets to kill off the idle fuel flow as rpm increases.

"Cruise operation at 50 mph and lower speeds is largely supplied by the idle circuit. Therefore, mileage is mostly determined by the idle mixture. Also, inlet check valves—needle valves—must be large for two reasons: to get adequate fuel flow and to reduce strong spray from the valve, which causes foam that can reach the main jets. We usually find a 3.00mm inlet check valve to be OK. (A Holley with two valves is not so sensitive.)"

TUNING HOLLEY CARBURETORS

In spite of rumors to the contrary, Holley four-barrel carburetors are easy to tune. Because of their modular construction, most major components and subassemblies can be easily removed and replaced. However, unlike Weber carburetors, emulsion tubes and air bleeds are fixed so changing certain calibrations can be rather involved. But the number of variables to be dealt with is less with a Holley.

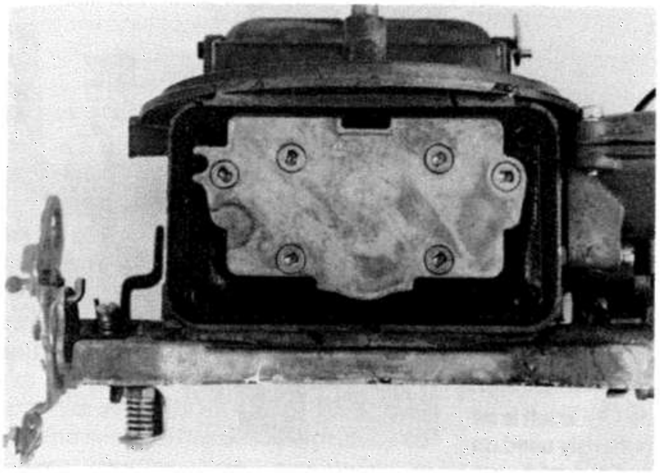


After starting, choke knob should be set so that engine speed is between 1500 and 2000 rpm. By the time temperature-gage needle reaches area indicated by arrow, choke knob should have automatically returned to its at-rest position. Drawing courtesy Rotary Rocket.

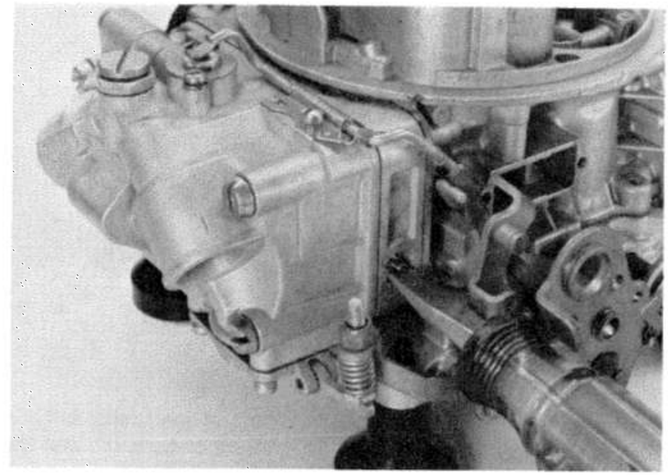
If you plan to fiddle extensively with a Holley four-barrel carb, a Holley catalog is de rigeur. Listed in the "Service Parts" section are jets, power valves, needle-and-seat assemblies, secondary-diaphragm springs, accelerator-pump cams and nozzles, and a host of other custom tuning parts.

Jetting—When jetting a Holley carb, note that all Holley jets are sized according to flow capacity, not diameter. While the number stamped on the jet is usually close to the orifice size, the two get further apart as dimensions increase. A number-40 jet has a 0.040-in. orifice, but a number-95 jet has a 0.118-in. orifice.

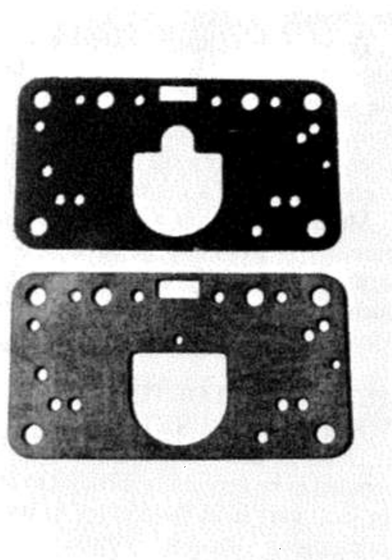
Jet number is the controlling factor, so orifice diameter is of secondary importance. Consequently, Holley jets



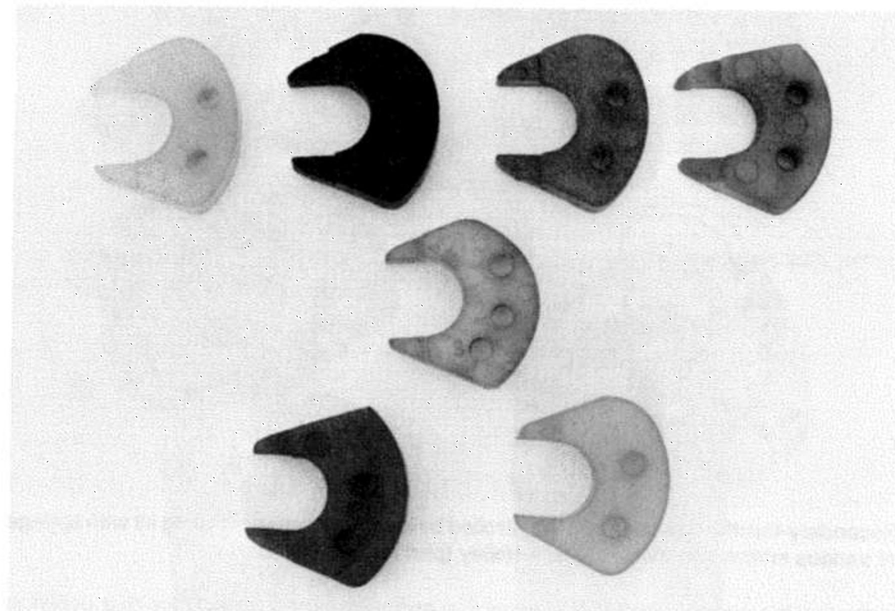
Model 4160 Holleys contain jet plate on secondary side. This plate has fixed metering orifices rather than removable jets. Idle and main air/fuel mixtures can be altered by changing plates or drilling orifices.



Screws in either side of metering block control idle mixture. With most Holley carbs, turning screw clockwise leans mixture; turning it counterclockwise richens it. However, some Holleys have *reverse-idle* circuits where turning the screw clockwise richens mixture and vice versa. These are usually identified with a tag on metering block.



Several types of metering block-to-main body gaskets are available for Holley carbs. Use of wrong gasket can lead to vacuum and/or fuel leaks.

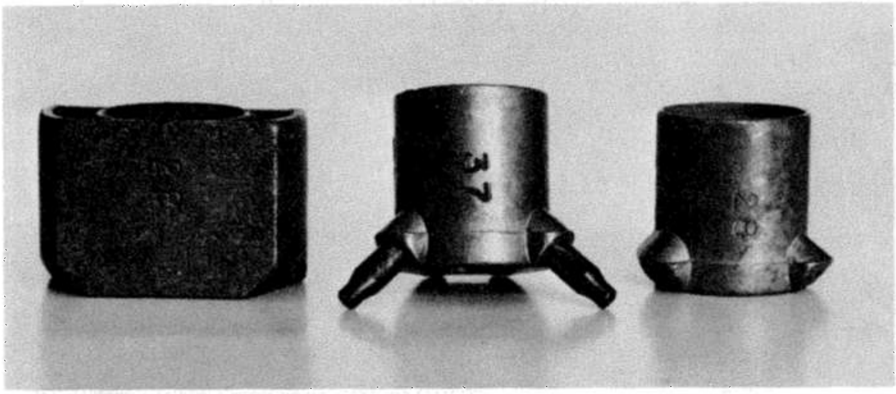


Accelerator-pump discharge can be tuned for timing and volume by changing pump cams. Trial and error testing is the only way to optimize accelerator-pump calibration.

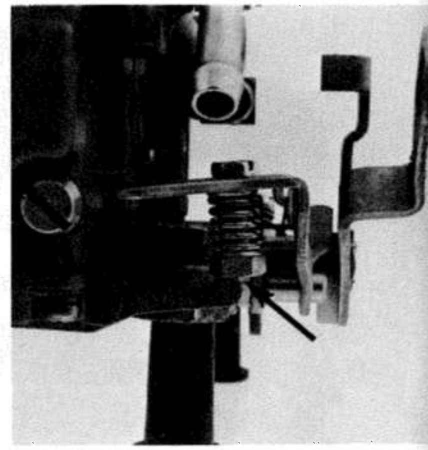
should never be drilled. Flow is controlled not only by diameter, but also the length of the restriction, entry and exit chamfers, and surface finish. When a jet is indiscriminately drilled oversized, the original flow characteristics are altered so there's no guarantee that the desired flow increase or quality will occur.

For extra critical main-metering-system calibrations, Holley offers "Close Limit Main Jets." Their advantage is a significant reduction (approximately 60%) in jet-to-jet flow variations. Close-limit jets, which are available in numbers ranging from 35 to 74, are stamped with a 2 suffix immediately after the jet number.

Accelerator-Pump Tuning—While jetting is rather straightforward, tuning the accelerator-pump circuit can be a bit more confusing. Timing and volume of the pump discharge is controlled by the interaction of pump-cam profile and nozzle diameter. Altering the cam profile (by substituting one of the cams from Holley kit number 20-12) alters accelerator-pump fuel-delivery timing with respect



Accelerator-pump-discharge nozzles differ not only in size, but in style. Nozzle at left is an anti-siphoning type designed for spread-bore carburetors that are not generally used on rotary engines. Either a tube type (center) or plain version is applicable to standard-flange Holleys carbs.



When adjusting accelerator-pump override spring, all clearance should be eliminated between screw head and pump lever.

Secondary-throttle opening rate is controlled by diaphragm spring. Spring kit with springs of various stiffness is available from Holley (part no. 20-13).

to the throttle-opening cycle and causes a minor change in discharge volume.

Depending on the cam selected and its mounting position (there are two), discharge volume can vary from approximately 17 to 37cc's per 10 pump strokes. In common practice, total volume is usually less important than timing. Some cams concentrate fuel discharge early in the throttle-opening cycle, others favor later timing. There's no easy way to determine which is best. Trial-and-error testing is the only positive method of determining which is the optimum pump cam. Once that decision is made, additional fine tuning can be achieved by varying discharge-nozzle size. Irrespective of nozzle diameter, an identical amount of fuel will be discharged for a given amount of cam lift. However, the smaller the nozzle diameter, the longer it takes a given volume of fuel to be discharged. Conversely, increasing nozzle diameter reduces discharge time.

More important than juggling nozzle diameter and pump-cam shape is adjustment of the pump-override screw. Any clearance between the screw and pump lever will delay pump discharge and cause a stumble upon rapid opening of the throttle.

To correctly adjust the override screw, with the throttle closed, tighten it against the spring until a clearance is obtained between the screw head and pump lever. Then back the screw off until all freeplay is eliminated and a *slight* preload exists.

More information about Holley carburetors is available in several books written specifically about that subject such as HPBooks' *Holley Carburetors & Manifolds*.

TUNING DELLORTO & WEBER CARBURETORS

Dellorto and Weber carburetors are reputed to be especially difficult to tune. In fact, they lend themselves to special calibrations because virtually every metering orifice can be easily changed. But this versatility is a double-edged sword. It's easy to make too many changes and wind up with calibrations that are so far off from where they should be that a country mile seems like a precise measurement.

The first tenet of Weber/Dellorto tuning is that if "it isn't broken, don't fix it." The fact that air bleeds and emulsion tubes and the like can be changed shouldn't be construed as an indication that they should be. Unless you're thoroughly familiar with these carburetors, tuning should be confined to conventional practices for setting idle speed and air/fuel mixture. Obviously, if a mixture is too lean, larger fuel jets are called for and vice versa. Minor mixture adjustments, the equivalent of half a jet size, can be made by changing air-bleed jets.

As with all carburetors, idle speed is set by adjusting the screw designed expressly for that purpose. But adjusting the idle-mixture screw will also affect engine speed. Therefore, idle mixture should be set first, then the desired rpm can be achieved by adjusting the speed screw as required.

With some installations, especially on engines sporting altered port timing, it may be necessary to drill a 1/16-in. hole in the lower half of each throttle plate (butterfly) as a means of correcting the butterfly/idle discharge-port alignment. (This practice can also be used with Holley carbs.)

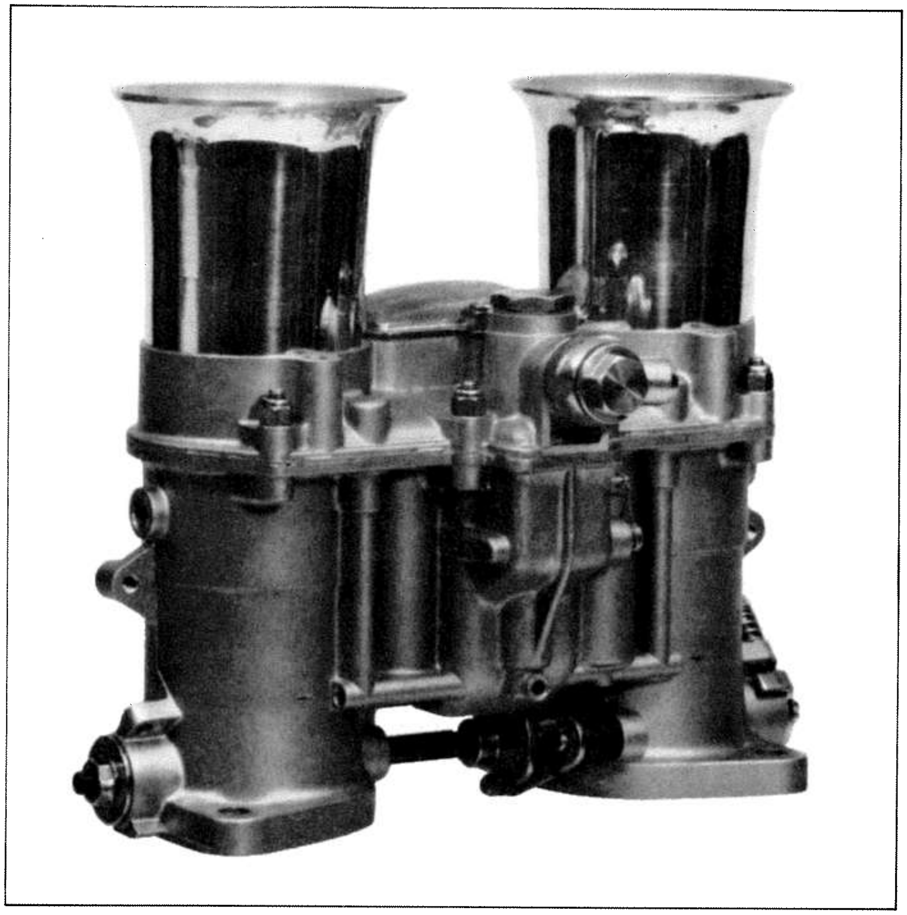
If the throttle has to be opened an abnormal amount in order to supply sufficient airflow at idle, the mixture will be overly rich and the effectiveness of the idle-mixture screws will be diminished. To start with, a 1/16-in. hole drilled in the butterfly simply increases airflow at idle and allows the butterfly to be adjusted so that it is in correct relationship to the discharge and transfer ports.

For exactly what tuning you can do, let's take a look at each in detail.

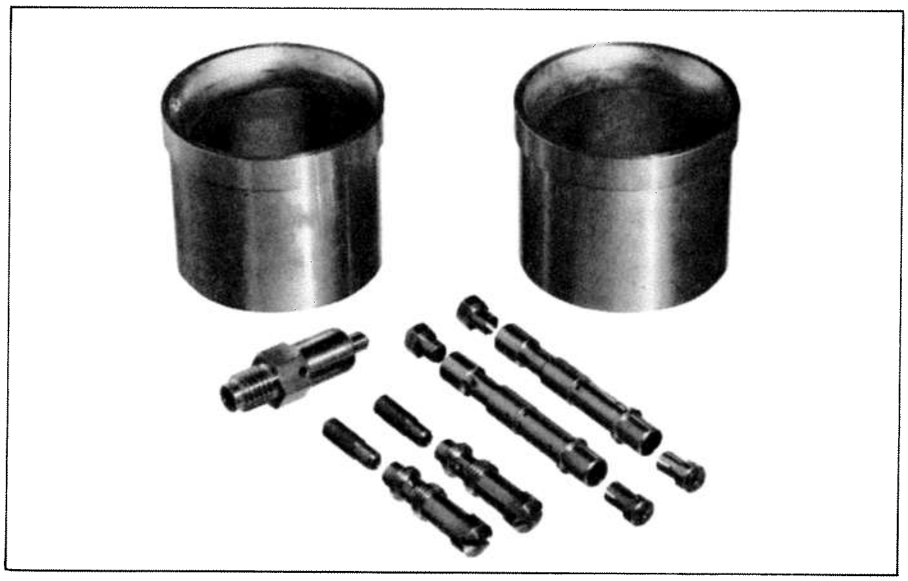
Jetting—When jetting a Weber or Dellorto, it's good practice to change only the fuel jet as opposed to the air jet or emulsion tube. Keep in mind that any change in the air- or fuel-metering systems affects the metering signal—suction pulse that pulls fuel from the carburetor—as well as fuel or airflow.

To avoid causing, as opposed to curing, deficiencies when attempting to alter the air/fuel ratio, work only with the fuel jet until the mixture is very close to optimal. Then alter the air jet one size—if needed—to fine-tune the mixture. On average, moving to the next size air jet (sized in 0.05mm increments) is the equivalent of changing the fuel jet (also sized in 0.05mm increments) 1/2 step. (A number-140 jet has a 1.4mm ID.)

For example, with a number-165 air jet, if a number-235 fuel jet caused the air/fuel ratio to be slightly rich, a 170 air jet might lean the mixture sufficiently.



Due to all the variable calibrations of Weber carburetors, it's best to begin with jetting recommended by rotary experts like those at Racing Beat.



In addition to tuning 48 IDA Weber, it can be enlarged to 51mm. When done, new venturis are required as are new air/fuel calibrations. Air jets, fuel jets, emulsion tubes and venturis are all readily available through Weber specialists. Photo courtesy Racing Beat.

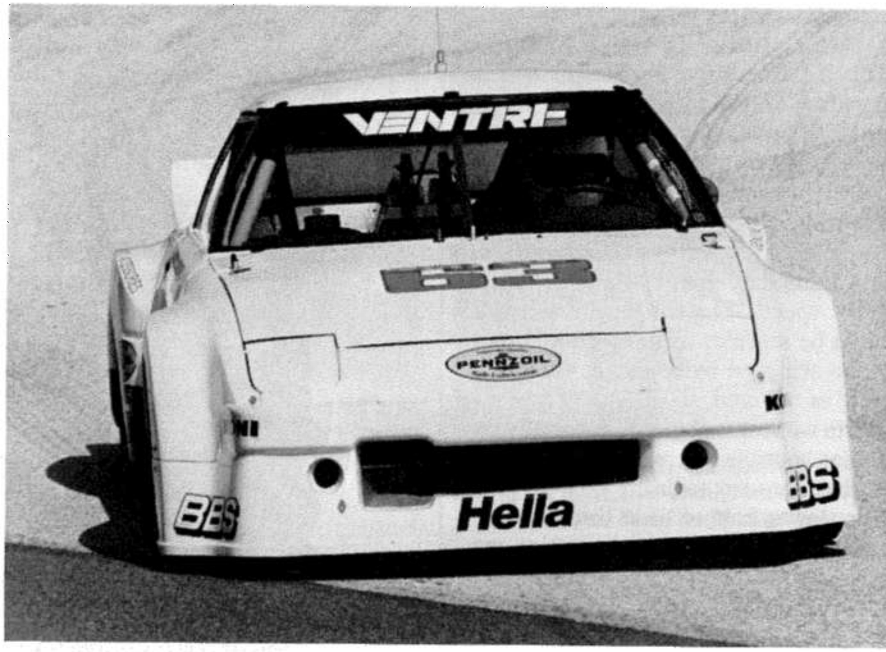
However, if the 165 air jet/235 fuel jet combination resulted in a decidedly rich mixture, fuel-jet size should be reduced one step—to a number 230. Then, if necessary, minor corrections could be made by swapping to the next leaner (larger) or richer (smaller) air jet.

As a general rule, unless you're thoroughly experienced with Weber or Dellorto carbs, messing with air jets is like staying out too late at night—it's bound to get you in trouble. With an increase in air-jet size, not only is the mixture leaner, more of the fuel-metering signal is bled off. (Air jets are also referred to as *air bleeds* because they "bleed" the signal). Excessive variations in air-jet size can throw off the entire fuel-delivery curve, resulting in an excessively rich mixture at low speeds and an overly lean one at high speeds, or vice versa. With an increase in air-jet diameter, the mixture is leaned more at high speed than at low speed.

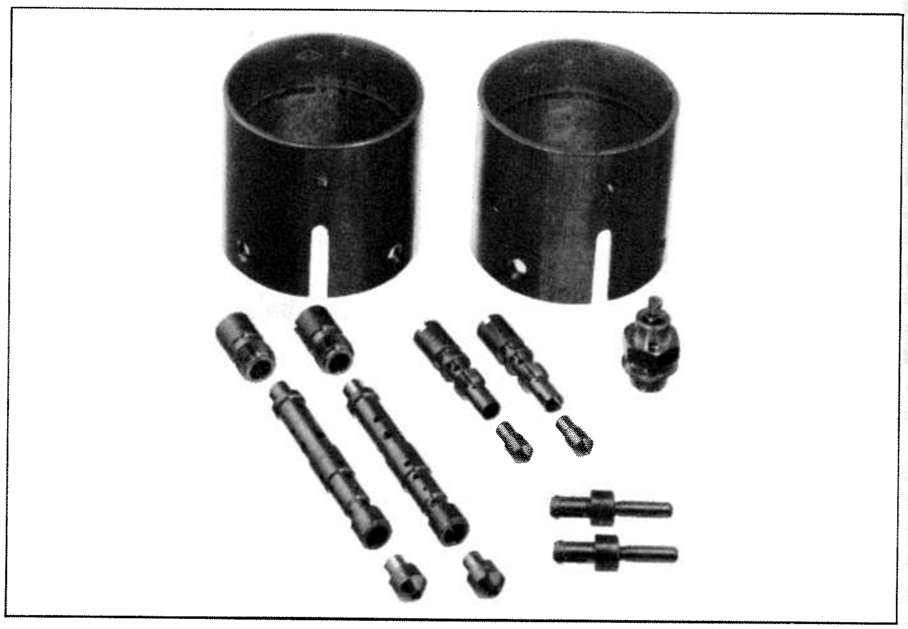
Emulsion Tubes—Emulsion tubes also have more of an affect on the fuel curve than on overall air/fuel ratio. The number of holes and their placement in an emulsion tube determines the shape of the fuel curve. Without changing either air or fuel jets, switching emulsion tubes can either enrichen or lean the mixture at either end of the operating range. F8 and Fll tubes are most commonly used in rotary engine applications.

It's easy enough to see that fuel jets, air jets and emulsion tubes all interact in establishing air/fuel calibrations. But it isn't quite as obvious that venturi size also has an affect on this calibration. An increase in venturi size raises airflow potential and reduces the pressure drop at the main discharge nozzle. Consequently, the metering signal isn't as strong, so an increase in venturi size will, therefore, require the use of a larger fuel jet, smaller air jet or both. As a general guideline, for every lmm increase in venturi diameter, fuel-jet ID must be increased by 0.05mm. Weber jets are precisely calibrated and should always be replaced, not drilled or modified.

The Weber 48 IDA that Racing Beat lists for use on a street-ported 12A engine with headers and a stock muffler includes a 37mm venturi, number-170 fuel jet and number-150 air jet. Calibrations for a

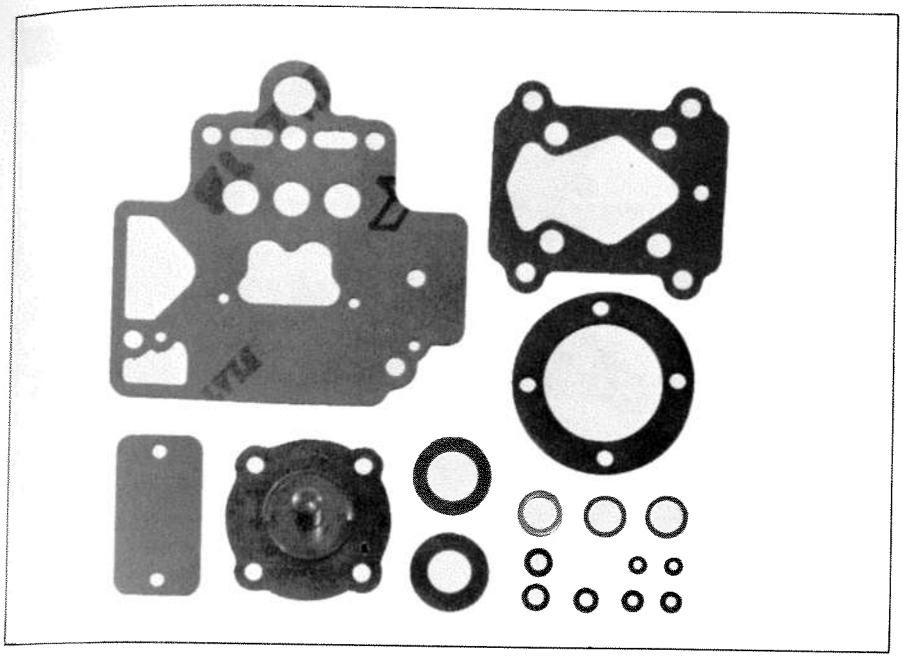


Weber carburetors are better suited to race cars than street cars because the 48 IDA does not have a choke system. However, Webers have been successfully installed on street-driven rotaries that reside in warm climates.



Like Webers, Dellorto carburetors have removable air jets, fuel jets, emulsion tubes and venturis. Dellortos obviously offer considerable tuning latitude. Photo courtesy Racing Beat.

13B powerplant include a larger 38mm venturi, 190 fuel jet and 160 air jet. Note that by changing both fuel and air jets, the entire fuel curve is altered as necessitated by the larger venturi. Changing only the fuel jet would have increased fuel flow to keep pace with the greater airflow of the larger venturi—but with-



In addition to tuning, carburetors occasionally need to be rebuilt. Racing Beat offers a rebuild kit designed for Dellortos installed on Mazda rotaries. It features a specially modified accelerator-pump gasket.

WEBER 48 IDA CALIBRATIONS*

	STREET PORTED **Stock**	STREET PORTED **12A w/header**	**13B w/header**
Venturi Size (mm)	37	37	38
Emulsion Tube	F7	FII	FII
Air Jet	120	150	160
Fuel Jet	135	170	190

*Calibrations are for street-ported engines per Racing Beat recommendations.

out affecting the change in signal.

Fuel Inlet—Although extracting a sufficient volume of fuel from a Weber carb is rarely a problem, the same cannot be said for the inlet side. One of the most frustrating fuel-system problems Rick Engman has encountered centers around the restrictive inlet needle-and-seat assembly in the 48 IDA carburetor. Switching to an assembly with a larger orifice is obviously helpful. The DG Valve Manufacturing Company (8 Mount Vernon, Stoneham, MA 02180) offers oversized Weber needle-and-seat assemblies under the *Grosse Jet* brand name, but there are precise limits that will be tolerated. If the inlet orifice is too large, it presents too large an area against which fuel pressure is exerted. As a result, the force exerted by fuel against the inlet needle increases. Fuel pressure may then overpower the float and completely fill the float bowl with fuel.

One way around the inlet-orifice restriction is to remove it. A "floatless" Weber carburetor can be constructed by installing a return line in the float bowl at the desired fuel level, and connecting it to a small suction pump. When fuel rises to the prescribed level, the excess is drawn out by the pump and returned to the tank. Fortunately, such modifications are necessary only on full-bore race engines. The fuel-supply requirement of a modified street and autocross engine can usually be handled with oversized inlet-valve assemblies.

Float Level—A correct float setting is also instrumental in avoiding fuel-delivery insufficiencies. In addition to text-book methods, it is also possible to set float level by simply inverting the carburetor and adjusting the float so it almost touches the carburetor surface. If the fuel level is inconsistent with float setting, check the float bodies for the presence of fuel. If a float is punctured, it will absorb fuel and sink rather than float. An excessively worn float tongue can also have an adverse affect on fuel control.

Jim Mederer recommends setting float level with the top held at 90° to its normal position, or float hanging down, to avoid preloading the needle and seat. This makes for a more accurate measurement. For float measurements see the following chart.

For Dellorto, measurement from the outer corner of the float to gasket should be:

	76-8512A **76-7813B**	84-8513B **(six port)**
Float level	15mm	17mm
Float drop	28mm	30mm

Mederer says, "Float drop is important. If not enough, it restricts fuel flow; if too much, it can jam down or interfere with fuel flowing to the main jets."

AIR CLEANER

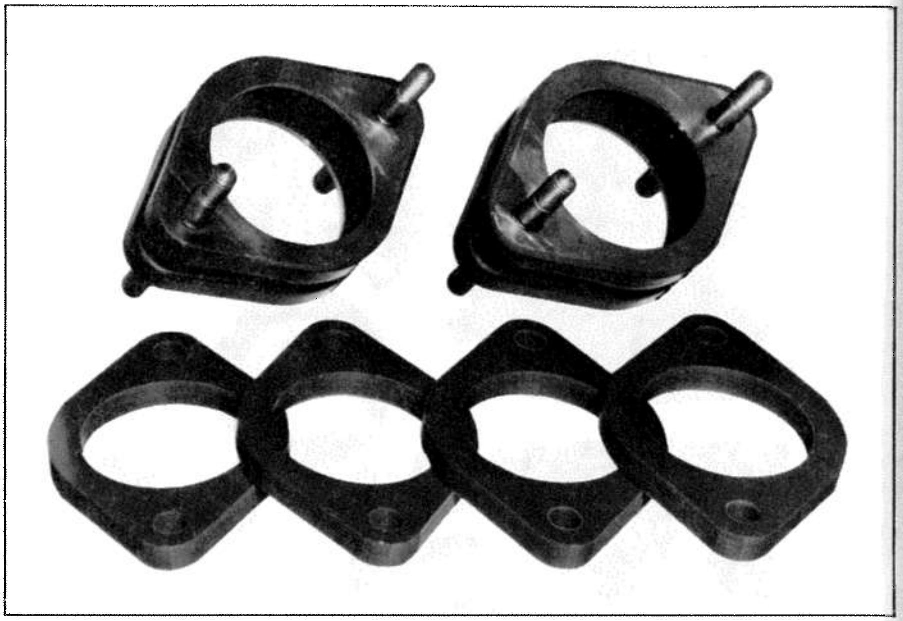
Installation of a non-stock carburetor typically calls for an equally non-stock air cleaner. In the case of a Weber carb, velocity stacks or contoured entry tubes are frequently inserted to smooth air entry. When an air cleaner is improperly installed on top of a "stacked" carburetor, the air/fuel mixing function frequently is disrupted.

What can be so difficult about installing an air cleaner? Placing the air cleaner up where the hood crashes into it, for one. But more to the point, the fuel-bowl vent can't be left out in the breeze. It must be linked to the inside of the air cleaner so that an excess pressure differential doesn't result. Even with a low-restriction air cleaner, a pressure differential can occur, causing pressure inside the air cleaner to be lower than on the outside. If the float-bowl vent doesn't "see" the pressure drop, float-bowl pressure will be too high, causing fuel to be "pushed" as well as pulled through the jets. The resulting air/fuel mixture will then be richer than what the carburetor is calibrated for.

Aside from the carb and its calibration, the length of the intake tract also affects performance. As in any internal-combustion engine, lenghtening the intake system lowers the engine speed at which maximum torque occurs; shortening it raises the torque peak.

Mederer says, "If you are very far off from ideal, which seems to vary depending on the diameter and design of the carburetor (and manifold), changing length gives erratic results. In some cases, at a particular rpm, shortening the intake tract *improves* low-end performance. However, best overall results are obtained across a fairly narrow range of lengths. Outside that range, average power drops."

Within the confines of a stock RX-7 engine compartment, it's impossible to build an intake tract that's too long for a street-driven engine. In fact, most of the time it's impossible to construct a system of sufficient length regardless of the engine-compartment configuration. In addition, stacks on top of the carburetor and rubber spacers placed between the carb and intake manifold are useful in lengthening the intake tract. Additionally, the rubber spacers—available from Mazmart and Racing Beat—reduce the intensity of engine vibrations that reach the carburetor. These spacers should be used wherever practical on engines that can benefit from increased intake-system length.



Rubber spacers (top) not only lengthen tract, they insulate carburetor from heat and vibration. Phenolic spacers (bottom) are thinner (0.320 in. versus 0.920 in.) and can be stacked for precise length tuning. Photo courtesy Racing Beat.