HOW TO MAKE AN OLD PORSCHE FLY

356/912 HIGH-PERFORMANCE GUIDE

WRITTEN BY
A TWO-TIME
NATIONAL RECORD HOLDER

HOW TO MAKE AN OLD PORSCHE FLY

written and illustrated by

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PREFACE

When I was growing up in Southern California, the people weren't all here. Sunny Sunday afternoon cruises down Rim-Of-The-World Highway, sinking from the crispness of Lake Arrowhead to the shimmering mirages on the desert floor, presented a seemingly endless panorama of flat and barren valleys spreading out into the coastal haze. Winding down, the tail of my little blue Speedster might even wiggle a bit flirtively around some of the tighter bends. It all seemed so much safer back then. Maybe it was the incense of the pine trees and wild flowers, more probably the vision of those broad and empty valleys and the miles of gently rolling ranch hills; but the future was certainly to be an incredible and endless cornucopia of prosperity for us all.

Uninhibited by such bright prospects, the topless tub would frolick up and down the coast, a 10-foot surf-board roped to the rollbar. When the weather warmed by Easter vacation, I reveled in the sensual cocophany of that bumpity-bump idle echoing off the storefronts along Palm Canyon Drive. Balmy Saturday nights would probably find us at one of a half-dozen local drag strips, showing our teardrop taillights to the various foreign sportscars becoming popular. Cheer leaders, Porsche roads and orange

groves were everywhere. Oh, life was sweet here before MacDonald's had sold their first million!

But the people did come, brought their cars with them, and it got crowded. Some of us natives moved on down to the cleaner air of the Orange County coast, only to watch the housing tracts grow from the strawberry fields, fertilized by more and more people. The open roads became bumper-to-bumper, and fun driving found the same hiding place now used for good gasoline.

When the inventive Bruce Meyers figured out what to do with all the old, dead Volkswagens lying around, a new recreation was born that promised a newness and freedom long lost on the streets and by most organized hot-rodding. Now those of us who felt a bit safer with four wheels under our butts discovered what great fun the motorcycle guys had been having for so long! Years of bouncing over the deserts and dunes in various VW-powered buggies kept alive a smoldering interest in Dr. Porsche's unique designs. The building of a new sand buggy - certainly deserving a unique powerplant - provided the rekindling of interest in the pushrod Porsche and its potential.

The talent behind the Speedster memories was Roger Bursch, doctor of engines and owner of Scientific Automotive in Pasadena. Since I was too young to try road racing, Roger agreed to be my sponsor for the 1/4-mile drag races.

We held the N.H.R.A. class record during the early 60's, defeated the then Bonneville record holder at the Riverside half-mile drags (Harry Umamoto's Super 90 coupe held that record, just recently broken, for twenty years!), and retired as the national record holder when the class rules were changed. The little tub did lose a few times: once to one of the ledgendary 300SL Gullwings at Phoenix Raceway, a real heartbreaker, and a broken clutch cover let one Winternationals victory slip away (lost to a Corvaire - shazbot). But literally hundreds of weekend trophies were collected; mostly gone now, only a few rusting pieces and parts remain to feed today's nostalgia.

From time-to-time, Roger had enough patience to show a curious teenager - one who had absolutely no mechanical skills and hated getting his preppy fingernails greasy - what goes where. Running errands to the machine shops (Ray Litz was just getting started across town), listening to the lunch hour bench racing (Bursch-preped roadracers dominated E-Production. Noteably Allan Johnson, a spectacular young driver then, who is still deeply involved in Porsche racing. George Follmer was another regular, always poking around for any latest tricks), and watching the care and checking during assembly - all helped develop a deep admiration for precision and those funny, finned motors.

Now the sand buggy "Porco" is setting new A.S.R.A. class records (100-yard sand drags), and amassing another collection of cheap hardware. Come with me to discover the many changes that can help your old Porsche fly. The grins - you know, the big ones you just can't hold back - will make it all worthwhile. Class starts right here, right now.

Craig Richter

HOW TO MAKE AN OLD PORSCHE FLY

With the popularity of the VW motor, the venerable old pushrod Porsche has been almost forgotten ....

INTRODUCTION

Dr. Porsche's original four-cylinder design reached its ultimate form in the 912, but what was considered a sporty powerplant in Speedster days ended up wisking tennis-clad young lovelies around Newporsche Beach. The motor was better than ever - but tastes were changing and Porsche was getting into building heavier GT-type cars instead of sporty, lightweight roadsters. By 1970, they decided even the gals needed more performance, and ended over 25 years development of a strong and reliable powerplant.

Over those same years, Volkswagen was developing their own version of the original 1930's Porsche design. The

Beetle's basic engine case was enlargened in 1961, giving enough room to fit longer-stroke crankshafts. When the dual-port heads arrived, the stage was set for some real performance gains. There were millions of Bug and Bus drivers out there really tired of those third-gear hills, so it was good business for the manufactures to start supplying the huge and growing market. And were there ever a lot of parts to sell - everywhere you looked something could use changing! Fifteen years of drag, desert and even Midget racing have now developed the VW into a true racing motor with unique flexibility.

But the 356/912 is still the direct descendent of the older and smaller 25-36HP case. For 1955, Porsche did make some changes to the original design and introduced the "three-piece" case, hardly changed over the following fifteen years. Originally sized for only 1100cc, the case is literally full with a 74mm counterweighted SC/912 crank. Not only was there little room for a longer-stroke crank, but Porsche parts were out of sight compared to VW prices, so nobody wanted to fool with them. Already a thoroughly sophisticated design, it was very difficult to substantially improve performance through any bolt-on parts. E-Production roadracers, constrained by strict rules which said the motors had to "look stock", were about the only ones to really probe Porsche hop-up possibilities.

The VW on the other hand could be improved just about everywhere and show large increases in power and versatility. A unique group of enthusiastic racers and drivers, along with the supporting parts makers and dealers, have grown up around the Bug and its motor. Now that the prices of the really exotic VW engine pieces are up with Porsche replacements, and even beyond, it may be time to dust off that old 356/912 and see what's been hiding in there. If they did it with a VW, there's no reason it can't be done better with a Porsche. By applying some new tricks learned from the VW racers, and lots of well-proven hotrodding skills, you can make your sassy little Speedster, or even a posh Cabreolet fly - with class.

Before getting into all the fun stuff, there are a few practical considerations. First, this is not intended to be a complete technical manual. It is a condensed recapture of one racer's experiences and methods. Several pretty good manuals do exist: the ancient Elfrink, several under Clymer, Ball (good), and of course the factory manuals. Only the stuff not readily available elsewhere will be offered here.

The ultimate addition to this outrageous 356/912 saga is Harry Pellow's "The ABC's of Porsche engines...". This is surely the most detailed and complete work devoted to any engine ever, especially one out of production for well

towards longevity. Modifications that will certainly make any motor last longer, no matter what the power output. Uncracked cranks, cases, heads and their assorted parts are expensive, and anything that can be done to benefit their continued existence will make your whole Porsche experience better. Porsches are loved because of thoughtful design; but, as in all things, what was true yesterday may be completely different today. Some proven engineering facts are staring us in the face, and improving the engineering, if indeed it is an improvement, is not the sin of some Porsche pervert.

Once your high-performance street motor has been dusting off the streets for around 40,000 miles, it should come apart to take a peek inside. Sure, lots of 356's run 150,000 miles before something breaks; but even if the motor still seems to be running well, it's time to check for broken or otherwise defunct top rings (even with forged pistons), valve and valve guide wear (intakes, specifically) and weak valve springs. A total rebuild MAY not be necessary on this first inspection if the motor was properly balanced, maintained, and given a FULL-FLOW oil filter; but a top-end freshening and general major maintenance would definitly be in order.

A true racing engine's longevity is sometimes measured in minutes, and rarely longer than a few weekends. If you expect more, you're not trying hard enough, and you won't win. O.K.? Now to work ....

CHAPTER ONE - THE BOTTOM HALF

DOWN TO CASES

Those little cases are a marvel of engineering - just like the VW. Except on a 356, the timing gear cover, which also houses the distributor, fuel and oil pumps, is a separate unit that bolts onto the front of an assembled case. This change to the "three-piece" case was made for servicing rather than any strengthening reasons. Number four main bearing and the cam gear can now be worked on without completely dismantling the engine, a feature that may come in very handy a little later.

The early 356 series suffers from the same lower-end problems that plague VW's. Non-counterweighted cranks tend to whip around if buzzed much over 4500rpm, pounding out the center main bearings. When the main bearing clearances increase or distort, oil pressure is lost to the rod bearings and presto - instant expensive junk. So to save your rods (and crank and case and ...) check the case for straightness and grooved main bearing saddles carefully. Align-bore if there are any doubts.

A word of caution: align-boring is not always a satisfactory remedy. When a main bearing bore distorts due to crank pounding, the aluminum's density is altered at the pressure points. Boring will make the hole round again, but the hard spots may remain. The bore can fail

again, with a resulting loss of oil pressure, although this is less of a problem with the aluminum Porsche case than with the magnesium VW case. In fact, the Porsche cases rarely ever need "case savers", a normal step in VW case rebuilding. Cases are just too darn expensive to continually replace, so even conscientious motor builders resort to align-boring. Just be advised that Murphy is alive and well, and it can happen.

Early Cases

Very early ('55-'57.5) timing gear covers have a big hole where the oil pump fits. In fact, the only real difference from an early VW pump (6mm mounting studs) is the mechanical tach-drive on the end. This opens some interesting possibilities for reviving early cases, because early pumps haven't been available new for some time. Any VW or VW aftermarket pump will fit (including the late-style for 8mm studs - just use flat washers).

The most unusual and limiting thing about these cases is the single oil by-pass/pressure-relief valve. This was part of the timing cover, and makes these early covers absolutely NOT interchangeable to later cases. The single 12mm piston works adequately if not much is asked from it (VW's used single valves - although 16mm - well into the 60's); but that's just what we want to do, ask it to deliver and control lots of oil. The smaller oil galleries and small

BLOODLINE

Oil Pump

The 356B-on oil pumps have huge 36mm gears, and can handle any size motor as long as the gears and housing are not worn out. The clearance between the gears and the cover plate must be kept to an absolute minimum to keep pressure from slipping away. Because the gears are supported on both ends, they do not wobble around as much as VW gears and wear the housing; but a normal used housing will show some wear and scoring from living the first decade or more of its life without a full-flow filter. They are impossible to repair and just too expensive to replace unless really shot.

The gears are supposed to protrude .0025-.005" ABOVE the housing, and a compressed gasket is .006". Reducing this to as near zero as possible is desirable to compensate for any housing wear, with .003" being the MAX endplay permissable. Any surfacing must be done carefully though, or the cover will leak. If the gear clearance is tight, .003" backlash again being MAX, these pumps can put out over 100psi unregulated, which is adequate for anything.

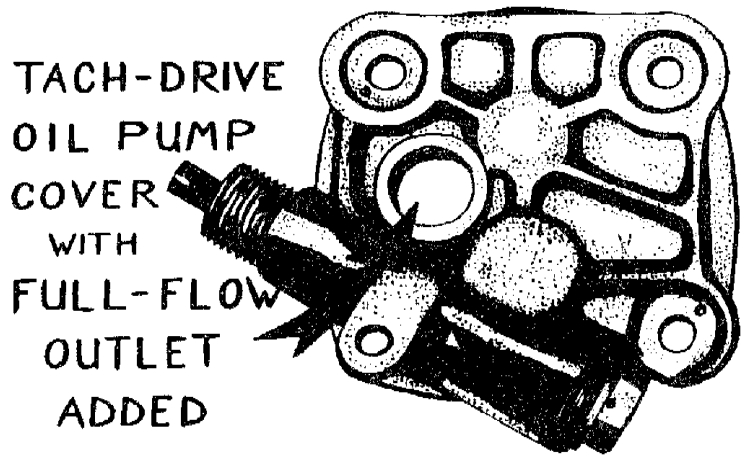
Do not indiscriminately use the Rapid-Cool heavy-duty oil pressure relief spring and piston (horizontal valve on driver's side of case) looking for more oil pressure.

more turns to the inch, it also reaches coil bind quicker; when it does, the oil pump will be pumping with its whole heart, no relief at all.

The driver's side heater box will have to be cut to make room for the adjuster screw. Streeters won't like this idea, but those heater boxes are going to get in the way of other things too, and may be difficult to keep around.

Dry-Sump

One much-discussed method to insure full pressure and cool oil is the dry-sump oil system, as used on 911's and almost all race cars. Much-discussed elsewhere, not here. Several recent periodicals have presented articles on dry-sumping a 912. It is possible, but THERE ARE MUCH CHEAPER AND EASIER METHODS TO ACHIEVE ADEQUATE OIL FLOW. In addition to being substantially cleaner, not having to spin TWO pumps saves A LOT of horsepower.



Oil Filter (Full-Flow)

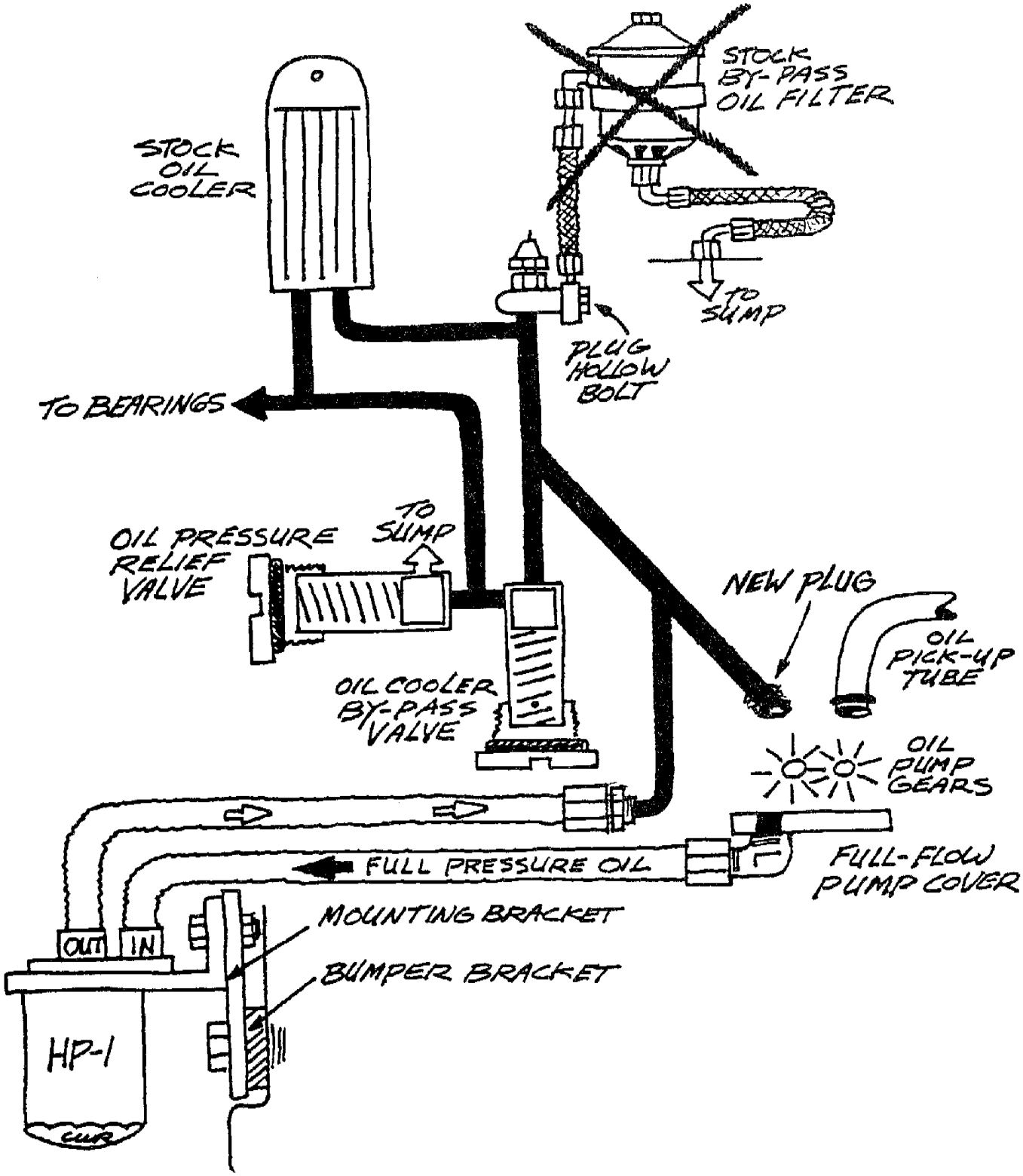
Nothing helps an air-cooled motor stay alive like lots of clean and cool oil. But that messy part-flow filtering contraption provided isn't worth its weight in goo. Undo the whole thing and pack it in a box under the workbench over by all the spiders. Take two 1/8" pipe plugs and fill the delivery and return holes. For the concours look, everything could be left stock, but a tiny plug put in the hollow bolt at the sending unit adapter will keep oil from going THROUGH the filter, which helps keep the engine cleaner.

Either way, the sending unit block can be retained, although there is now some concern that the oil temperature sender will register accuratly. With the oil filter gone, there is no oil flow THROUGH the adapter, just pressure to it. but customers have reported no apparent change in gauge operation.

We MUST have a full-flow system where ALL the oil gets filtered before reaching the bearings. Ford Motor Company tests showed wear reductions of 50% on crankshafts - even less wear on rings and cylinders. And without one, any time one thing fails in the motor, it'll blitz the whole motor!

Competition Engineering makes the full-flow pump cover with an outlet on the face, or they can modify your tach-drive cover for an outlet. The original oil galley from the pressure side of the pump must be plugged, so all the pumped oil is routed through the pump cover, outside the case.

FULL-FLOW OIL FILTER SYSTEM



Oberg Filter

The Oberg filter is amazing. It never needs replacement (lifetime warranty, 5 years on stainless steel screen). A quick solvent (or gas) rinse, and you are back on the road again, running clean. You don't even have to keep track of mileage, because the optional warning light will tell you whenever the screen needs cleaning.

Dirty oil eventually causes major engine damage. The Oberg filter is truly full-flow, cleaning 100% of the oil 100% of the time; and filtering particles as small as 3 microns, 1/25 the diameter of a human hair. As is necessary with any filter, there is a ball valve to let oil through if the screen becomes completely blocked; but it is set at such a high pressure, it would never by-pass the oil with reasonable maintenance. By comparison, the HP-1 filters particles down to 8 microns, will always by-pass the oil when the engine is cold, by-passes some oil at high rpm after only a few hundred miles filtering, and by-passes some oil at any rpm once it's been on the job for 1000 miles.

Changing HP-1 filters and 5 quarts of oil as often as you should gets expensive. With the Oberg filter, the oil will not need to be changed NEARLY as often. Oil doesn't wear out, it just gets dirty and contaminated (although it does "wear out" when overheated). Top-off the oil level

Oil Cooler (Stock)

No oil cooler seems to cool better than the late stock cooler. This is a very broad statement for sure, and wouldn't be brought up to incur the wrath of the cooler makers unless there was some justification for it. But every personal test, and every available test report written by someone who does not make coolers, substantiates this. Mind you, we're not talking about trans coolers or putting a cooler where none existed before; but substituting some aftermarket cooler mounted outside the fan shroud for a good late Porsche cooler.

Unless the head fins are packed with mud and goo, a properly tuned 356 rarely overheats anyway. A 65mph jaunt thru Death Valley in the dead of summer should be no sweat; 95 may get you in some trouble, especially if you left your radar detector at home.

All the B and later coolers have a metal lattice over the fins to offer lots of surface area to the air blast. The mounting holes were changed to 8mm in '63, then back to 6mm with the later 912's, which added a top bolt to the fan shroud and a bunch more rubber mounts. With a late 912, or a factory-rebuilt case, leave this top bolt off (put a plug in the shroud hole) or the cooler works against the case mounting studs, increasing the chance of breakage.

Even if it's new, especially when it's used, clean the

Oil Cooler (Non-Stock)

The only good reason to remove the stock oil cooler is for off-road and race use. Lots of full-throttle operation may require some cooling help. Shock loads on that heavy cooler will, for sure, break the case anyway; a too-common and rather disasterous occurrence on even street motors, due to engine out-of-balance or over-torquing the nuts.

Without the stock cooler in place, the #3-#4 head temperature goes way up! What? Reducing heat by completely eliminating the hot oil from the fan shroud and #3 was the excuse for buying that fancy new oil cooler. But the stock cooler is part of the channel that forces the air UP AND OVER the top, and straight down at the #3-#4 head. Remove it, and the air goes through the vacant space and dumps onto the #3-#4 cylinder bases, even robbing air from #1-#2!

The void must be filled with an air diversion plate fashioned from some thin aluminum angle, with a few holes drilled so SOME air gets to the cylinders. The new plate pop-rivets to the fan shroud, taking place of the stock oil cooler. With the air diverted over the top again, and a cooler properly mounted in the wind stream, the oil temp finally starts to come down.

The adapter seen most often on dune buggies has outlet and inlet ports so an external cooler can be used. Quite

Bearing Saver

More compact than the Accusump, but equally as exotic, the Bearing Saver "external oil pressure relief valve" makes use of all the excess-capacity, by-passed oil, and puts it right back at the oil pick-up. Depending on the oil temperature, as much as 50% of the oil from that huge 36mm pump is released back to the sump through the pressure relief valve. All this extra capacity is unfortunatly released right behind the relief valve, way over in the corner of the case, and takes some time to dribble down to the oil pick-up. If you happen to be in a fast right-hand sweeper, or draggin' some MG, the oil can surge away from the pick-up tube, allowing air to be sucked into the system.

The Bearing Saver keeps the oil pick-up flooded with by-passed oil, cool and clean, eliminating brief oil surges. Since there is no oil reservoir, severe and lengthy cornering forces could conceivably still starve the oil pump. But the results of two years testing on the sand buggy, charging UP steeper than steep sand dunes, then DOWN the other side, and encountering delicious side-forces by taking the high groove around sand bowls, has never shown ANY pressure drop. And not having to mount an oil tank can have certain advantages.

The Bearing Saver is designed for the dual by-pass '60-on cases ('57.5-'60 cases also have the dual by-pass valves, but their 24mm oil pumps don't have enough capacity to make the Bearing Saver operate very efficiently).

THE PARTS THAT GO 'ROUND

Crankshafts

Woe is us! Even though every Porsche crank is a beautiful steel forging, they do break. Much too often. And the factory prices are really unfair. So hope yours rings like a bell, because there is no better crankshaft available.

The SC/912 cranks have 55mm center main bearings, which make the cranks stronger than early 50mm cranks because there is more journal overlap. This makes the crank more resistent to the pounding of each rod, therefore helping to maintain oil pressure to the rods. The VW racers have recently gone to 60mm center mains to achieve even greater strengthening.

Some roadracers are said to use C cranks, which have the 55mm center main bearings - but NO counterweights. The crank is lighter, so will accelerate quicker, but those counterweights really help control crank flex. They are absolutely necessary to really buzz it up - at least for any length of time - no matter how carefully the crank is balanced. They can be a racer's edge, but not a very long-lived one.

Flywheels

Good flywheels are getting real scarce! Too many trips to the resurfacer gets the friction surface too thin, allowing flexing and very grabby clutch engagement. In extreme cases (according to the Maestro, doesn't have to be very extreme), the big springs in the Porsche disk will start hitting the pressure plate and/or flywheel around the gland nut area. No fix possible, although a VW disk, which has smaller springs (or NO springs), can be substituted in a pinch.

Thousands of starts have chipped away at the ring gear until the starter misses more often than it catches. Very annoying, but fixable for a moderate price by machining the bad ring gear off, then shrink-fitting a new gear on. A few spot welds will make sure it doesn't loosen.

Enlarged dowel pin hoses cause many rejections; but usually the matching crank will also have loose dowel pins and require a C.E. "nose job", saving both parts. A "nose job" involves getting the flywheel/crank mating surfaces flat again (actually, the flywheel has a slight angle so it crushes onto the crank for a better seal), match-drilling oversize dowel pin holes, and installing press-fit 8mm dowel pins. The crank/flywheel are now matched for life, but are now a VERY strong combination. It would take real trauma to cause their divorce.

Clutch Covers

Coil spring clutches do not distribute their pressure very evenly because each spring is an individual load source. A series of blue heat spots appear where each spring has distorted the cover; this bluing is hardened by the intense localized heat and causes grabbiness and uneven engagement. A few hard starts and the cover looks more like a burnt waffle. There is something better and Porsche has had the answer for many years - the diaphram clutch.

A diaphram is really a coned spring similar to the wavy spring-lock washers VW and Porsche use everywhere. When pushed upon, a diaphram spring exerts its force around the full circumference, for much better pressure distribution and fewer blue spots. On most units, the pedal pressure actually goes down as the pedal is pushed farther, which is much easier on the equipment and your leg.

Early Porsche 180mm diaphram clutches were really smooth and a pleasure to operate. Roadracers often got through a whole season on just one, but they do go up in smoke quickly when asked to handle more than around 90hp.

200mm became standard for both Porsche ('63) and VW ('67), operate just as smoothly, can contain over 140hp, and are the obvious starting point. All C/SC flywheels take 200mm; the earlier flywheels can be machined.

CHAPTER TWO - THE TOP HALF

SOME PUMPING THEORY

A 100% efficient cylinder could inhale its own volume during one intake stroke. Almost impossible to achieve without the help of some sort of supercharger pushing the air in. A good running racing motor would hope to operate around 75% efficient at the maximum torque point, and much less at peak horsepower. Torque is quite dependant on both volumetric and thermal efficiencies. That is, the most torque happens at the rpm where each cylinder filling is at its best, coupled with getting a strong, technically efficient burn. The tighter a full cylinder is squeezed to hold in the heat to do some work, the more pressure created during ignition. So compression is critical in producing torque, the highest twisting force that cylinder is capable of producing.

Horsepower is a function of torque and engine rpm. It is the rate at which torque is being produced. When the rpm is raised past the peak torque point, each intake stroke takes in a little less volume because there is less and less time per stroke, and it takes time for the air to flow. But more strokes are happening during that time, so more total work (horsepower) gets done. Therefore, horsepower is dependant on the engine's air consumption. Feed it more air and more HP will come until the whole thing

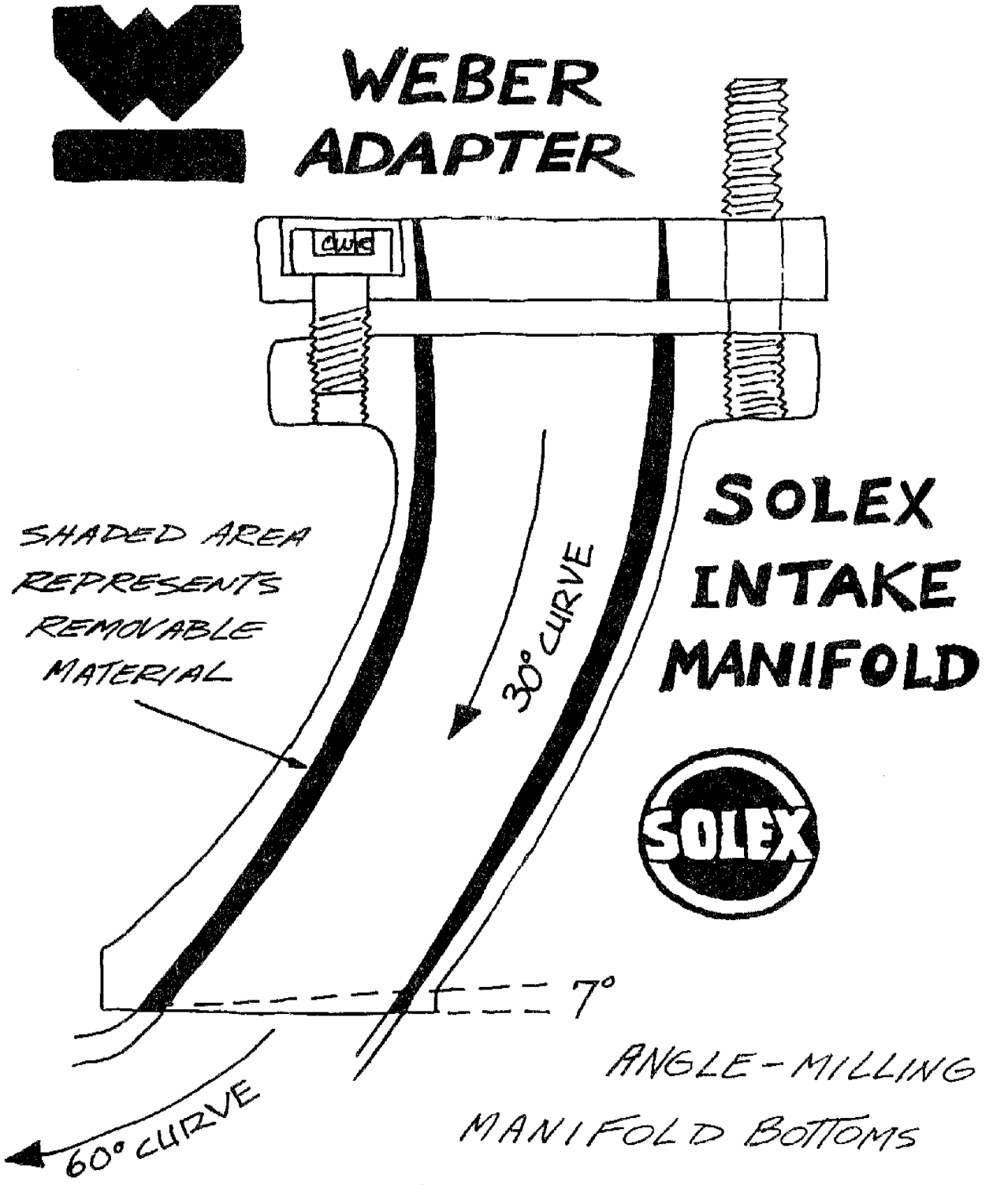
usually be successfully (at C.E.) heliarced cheaper than a new head, especially after adding the cost of race-porting; so Ray, Altadena's favorite Porsche machinist, has developed and refined lots of saving tricks.

Really, the final inspection and major reconditioning of the heads should only be done by such a good professional shop. Too many specialized tools are necessary to do a decent job in your garage, and there is no substitute for knowledge gained through years of experience.

Porting

Hours can be spent, therefore a lot of money saved, by doing your own porting. Some very expensive heads can also be ruined and/or not go very fast. Porting requires lots and lots of patience, in addition to some rather specialized tools.

Air guns are by far the most versatile, but not everyone has a compressor in their garage. A high-speed die grinder is next best. Either tool is fairly dangerous to use - goggles are mandatory and gloves recommended. Good carbide cutters are quite expensive, but really endure. Open flutes are used for aluminum, and the first "murphyism" is that the cutter teeth trap the soft aluminum like crazy, A lot of wax helps, and even then the cutter must be cleaned with an awl every few minutes. For sanding rolls, contact



ANGLE-MILLING
MANIFOLD BOTTOMS
IS QUITE OPTIONAL...
DOES GIVE BETTER FAN
SHROUD CLEARANCE.

the motor 5 to 7 degrees, getting rid of some of the 90-degree bend to the valve. The three mounting holes will have to be oblonged to align the ports and let the manifolds fit absolutely flat for a good seal. BE SURE THEY CAN FIT FLAT.

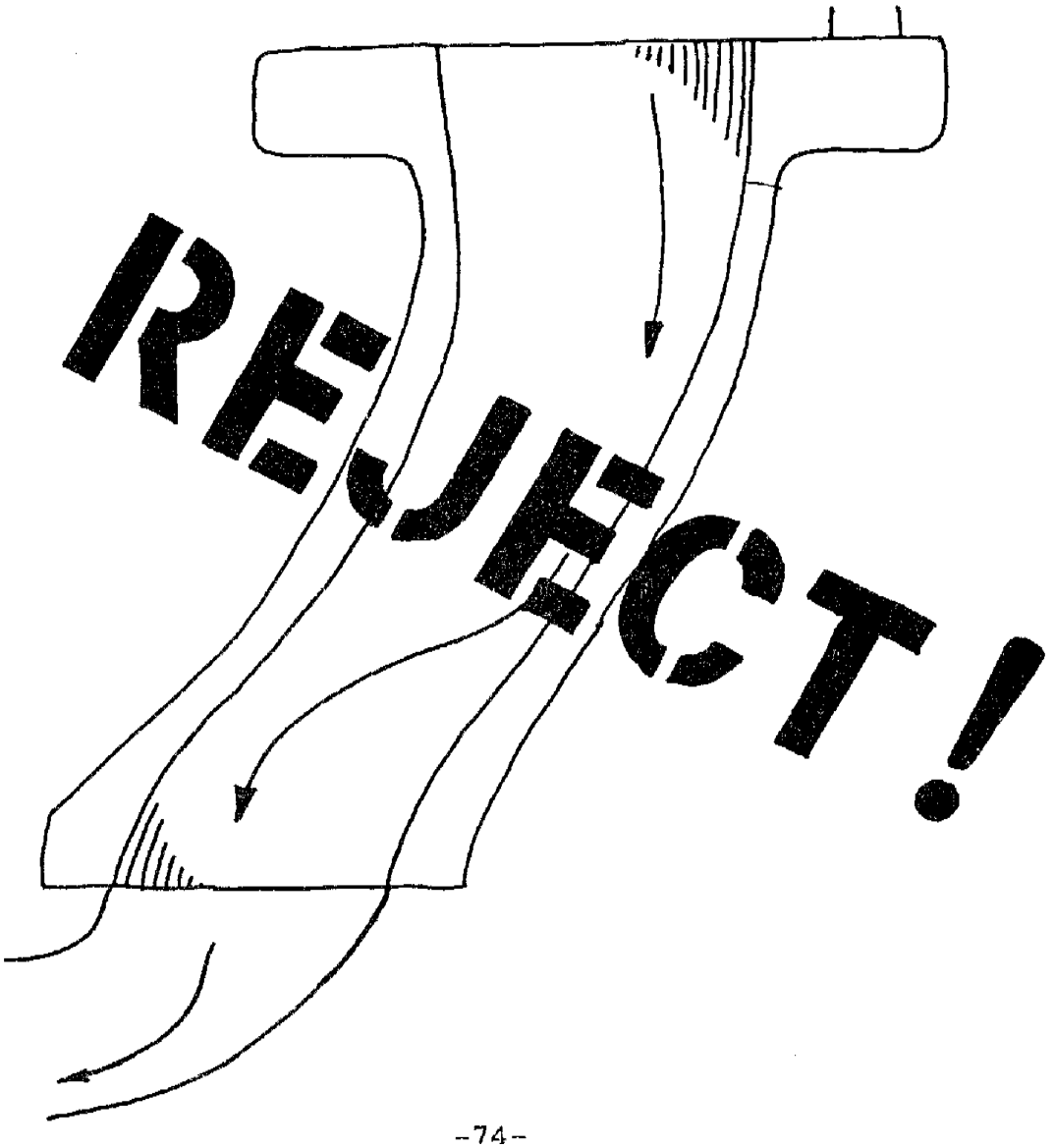
The floats will still operate fine, especially with Grose-Jet ball valves, and the throttle linkage and gas lines are easily adjusted. Every degree of direction change avoided is breathing ability in the bank, and now the manifolds won't hit the fan shroud. The right-hand carburetor should even miss the 6mm bolt holding the spring plate for the throttle crossbar.

The new Weber manifolds, the ones that look almost exactly like the old Solex manifolds, appear to be good goods and should port just the same way. Except that the area right under the throttle butterfly already fits the 44mm Webers, whereas the Solex is only 40mm, and must be opened up to use the bigger carbs.

The old "fat" or "dune buggy store" Weber manifolds not only have severe clearance problems, the manifold runners have an odd bend and just won't produce any horsepower - junk!

"DUNE BUGGY STORE" PORSCHE MANIFOLDS

* USE RESULTS IN ABSENCE OF ANY TOP-END HORSEPOWER !



Compression

The higher the compression ratio, the more torque produced. Free torque - almost - giving the midrange a real punch. But air-cooled motors can't transfer heat away from the heads very quickly, so the compression ratio must be kept substantially lower than a typical water-cooled head to run at the same temperature. 10:1 used to be a workable but maximum limit with yesterday's 96+ octane gas, but today's Premium - whatever the label - can't keep 8.5:1 from pinging and spitting piston pieces out your exhaust pipe.

To safely use a compression ratio of 10:1, which is what the 86mm Arias pistons normally provide with late heads (60cc chambers), 100 octane fuel is necessary. And not just for racers who always have their foot in it. Detonation is most severe at lower revs where volumetric efficiency is better. This is the "almost" about compression. So if you like to punch it from low speeds, you need forged pistons AND 100 octane fuel AND a proper advance curve in the distributor.

The domed Porsche piston with its big exhaust valve relief considerably complicates both measuring and machining possibilities to raise the compression ratio. The piston top (out at the perimeter, not at the top of the dome) must remain at least .035-.040" below the cylinder top to miss

CHAPTER THREE - THE ACCESSORIES

CARBURETORS

Zeniths

The old Zeniths are solidly reliable units, still (used singly) the mainstay of VW desert racing motors; although Webers (also singly) are taking over since the 2700cc Type IV motors hit the dirt. The Zenith's dual float chambers can operate at large angles, real (hills) or induced (turns). The venturis are removeable, and the stock 24-28mm can be cut on a lathe to 30 or 32mm for a little more top end; but leave the big ports to the racers, as air velocity will be great for smooth low-rpm throttle response, whether you like it or not. Those little 32mm butterflys just can't pass enough air to produce much horsepower. Performance is being spoken here, and a LOT of horsepower can be gained by using bigger carburetors and matching headwork.

Distributor Drive Gear

Your distributor labor won't be nearly as effective unless the drive gear is properly shimmed. Install the one stock shim and driveshaft (without the little spring on top), and clamp the distributor into the timing gear cover. The shaft should have no more than .008" up-down movement. Older motors often have .020" or more. Porsche shims are supposedly .048", but may not be dealer available. VW shims are .024", and #202 valve spring shims fit and come in .015, .030 and .060". Mike them all because the thicknesses vary all over the place, but somehow get it right.

Too much clearance causes timing "scatter" as the distributor driveshaft bounces up and down. Since the drive gears are cut on an angle, up-down movement causes advance-retard at the stationary distributor housing anchoring the points. Don't forget to replace that little spring which keeps some downward pressure on the driveshaft against the shim(s), making things snug.

Timing

Depending on which manual you picked up, the total advance should be somewhere from 30 to 37 degrees. If you need one, and pick the other, some catastrophe can result. That wide range should be broken down something like this:

28-30	Regular gas (87-89 Octane)
31 MAX	"Good" pump gas (92 Octane)
32-35	Race gas or additives (100+ Octane)
Up to 37	Alcohol (burns very slowly)

Initial (static) timing is not quite as critical as the final advance, but a satisfactory idle is certainly desirable. Anything less than 0 degrees makes the motor labor, because not much power is produced before the exhaust valve opens. Much over 10 degrees and the idle speed may not want to come down to a reasonable level, and the motor may stumble when the clutch is engaged. A bit more and combustion completes before the piston rolls over TDC, and tries to stop the oncoming piston dead in its tracks. Somewhere inbetween - 5 to 7 degrees - is a good starting place. Hotter cams usually idle better by bumping this to 10 degrees.

For best acceleration under full throttle, the spark should advance as fast as possible just short of detonation. With good gas, full advance by 2200rpm is possible. So the correct amount of built-in distributor advance, plus the proper rate of advance, are both essential for smooth running.

Wave Entrapment

Remember that the high-energy exhaust rushing by the exhaust valve was described as a pressure wave? Well, in addition to making a bunch of hot exhaust gases, the combustion process produces sound waves that are tuned to the opening and closing of the exhaust valve. Just stand beside any running engine and the frequency can be both heard and felt. Low-frequency sound waves produce the deep throaty growl at idle, and the higher frequencies produce the high-pitched scream of a motor "on the pipe". These pressure pulses travel the length of the exhaust system, and then reverberate right back up the whole exhaust system again! In fact, they'll sneak right on up the intake manifolds and are responsible for that odd phenomenon known as "fuel standoff".

These pulses have their own pressure, in this case back-pressure, associated with them. If the waves are timed to arrive back through the open exhaust valve on the next cycle, their pressure interfers with the extractor effect. When their return to the exhaust valve coincides with the end of the valve overlap period, a little extra pressure will actually keep the incoming mixture from being over-scavenged out the closing exhaust valve. The big problem when trying to play with pressure waves is that they spend most of their time messing up the extractor effect, only during a relatively narrow range can they actually help out. So it may be worth

Alcohol

An air-cooled motor can be made to run so cool that the fan and all the shrouding could be removed! The valves won't burn. The pistons won't melt. The engine will sound smoother, run stronger, and last longer. All you have to do is run it on the proper fuel.

Alcohol is really THE fuel for air-cooled motors. Not because its virtues are some great answer to our energy problems - renewable resources and all that - but because it burns so strongly and so cleanly in high-performance motors. Saying there are no emission problems may be getting a little carried away. The fumes may not budge the state meters, but your nose will immediatly know when an alky-burner is around.

Converting to alcohol involves three major changes, the most immediate of which is rejetting the carburetors. Alcohol is an oxyginated fuel - oxygen molecules are part of its chemical composition. A lot more alcohol must be mixed with the air to get a rich enough mixture to burn. The main and idle jets must be increased IN AREA by 2.2-2.3 times with Methanol, the most widely available and used alcohol, to get the proper 6.4 to 1 ratio. That roughly works out to a 50% increase in jet diameter, and means fuel mileage will be some 50-75% worse. That's not too exciting, but the other alcohols, if you can get hold of them, don't need

GEARING

Correct gearing is one of the most potent performance tools available. You gotta get the revs up! Increasing the gear ratio is the only way to get even a stock cam into its power band sooner.

Three ring and pinion gears are/were available. 4.43:1 (7 pinion gear teeth, 31 ring gear teeth) was factory stock for all A and B transmissions. Too high for today's road conditions and speed limits. Most stop light Grand Prix last less than a block, and you'll still be in first gear; but the 40hp V-Dub in front of you just shifted into 3rd!

The 4.86 (also 7 pinion teeth, but 34 on the ring gear) are strong gears (unlike the Webster VW 4.86), and the best compromise for good all-around performance. The 5.18 Carrara R&P (6 pinion teeth, back to 31 ring gear teeth) is the weakest, mechanically speaking; but provides the strongest acceleration. By changing the R&P but leaving the four gears alone, your pocket book won't go completely flat, 4th gear gas mileage will stay pretty good, and initial acceleration will be markedly improved.

Changing 2nd gear to an "A" is expensive, but does tighten the spread from 1st gear. The acceleration increase is subtle compared to changing the R&P. Changing any other gear ratios is the provence of the roadracers, and extravagant for street use.

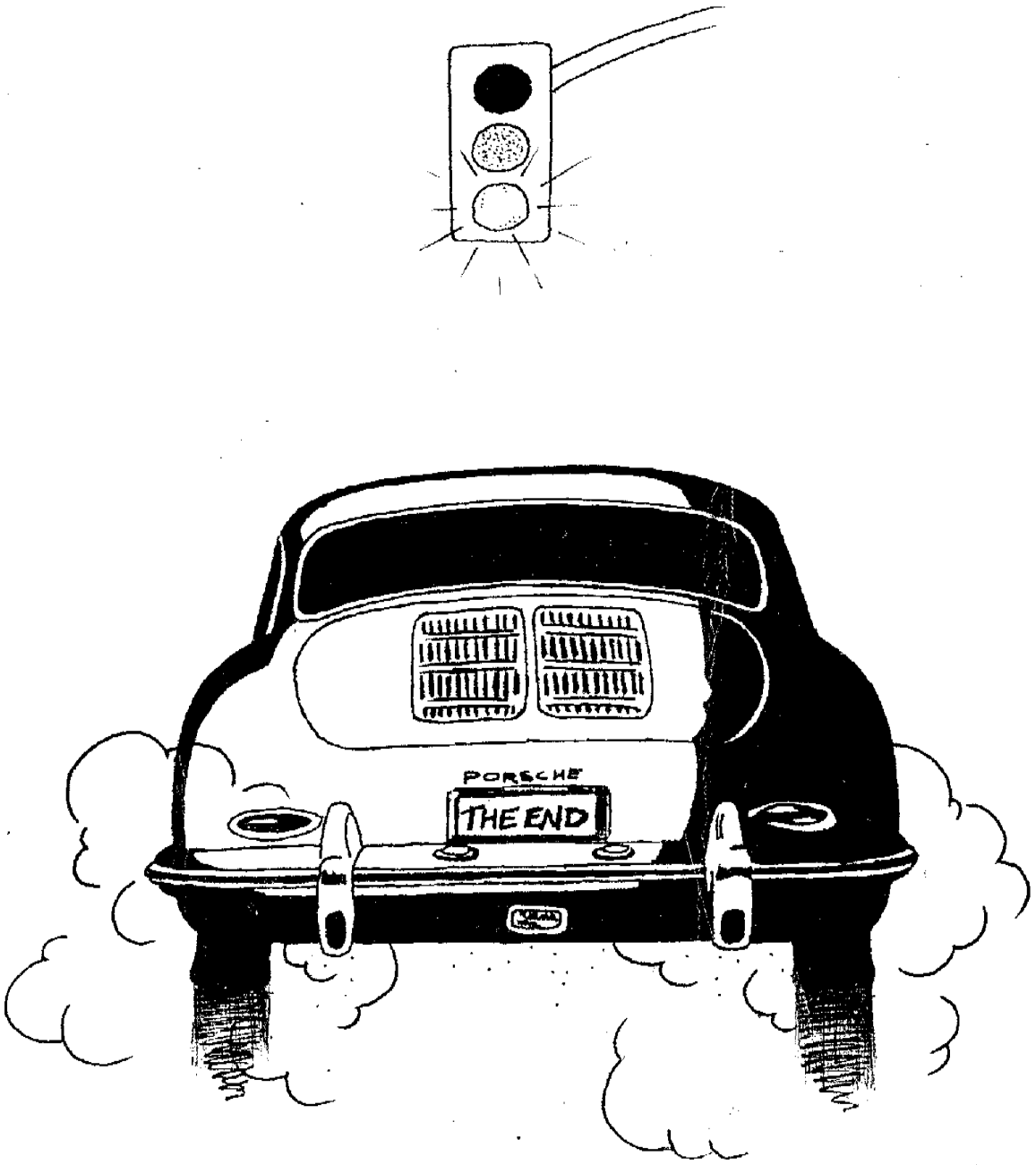
PARTS CHOICE

This is, by definition, a subjective section, fraught with controversy and generalities. But limbs are grown to be climbed out on, so here is some considered opinion on organizing three levels of performance:

1000,000 - Mile Cruiser

Start off with a good C, SC or 912. Super 90's are oddballs, but can end up pretty good motors. A '55-'57.5 case (only) could even be substituted at this level, if you get a good VW oil pump with a full-flow cover (and therefore an electric tach). A balanced C crank should be able to withstand occasional 6000rpm bursts; but to go higher longer, get a counterbalanced crank. .010"-under on either mains or rods is fine, .020" getting sketchy, and .030"-under is spider box time. Late rods (no A-B "spaghetti" rods). A full-flow filter coupled with a good late cooler. A 200mm clutch (I use VW because of availability), and a few pounds off the flywheel will make those throttle "blips" seem quite sporting. Remove too much weight and the motor may stumble on light-throttle take-offs.

Find a wide-lobe 912 cam (or copy) and have it re-ground slightly milder (around 270-degrees), or a good C cam. Use 912 pushrods if the length is still correct, otherwise get a set of the aluminum VW pushrods. Stock valve springs



Source: "How To Make An Old Porsche Fly" by Craig Richter. Available at www.vintagetechinfo.com