PSI SUPERCHARGER
OWNER'S MANUAL

Revised May 30, 2001

This manual is unlike anything else in drag racing. The information that follows is not based on rumor, superstition, or hunches. It's a compendium of thoughts/information that is based on careful observation guided by physical laws and proven by trial and error. If you use it, you will have a performance advantage over your competition, and save yourself a lot of work and money at the same time. If you don't, you'll likely enjoy your PSI supercharger -- and racing in general -- a lot less.

PSI doesn't charge money for this information when you buy a new supercharger from us, because we want you to have the best possible experience with our product. That doesn't mean that this information is worthless. It will keep your maintenance costs down and your performance up. Many people who appear to be having trouble with their PSI supercharger are people who have chosen to ignore part or all of what follows.

PLEASE READ THIS MANUAL BEFORE YOU CALL WITH QUESTIONS.

IF YOU DO NOT INSTALL AND OPERATE YOUR PSI SUPERCHARGER ACCORDING TO THIS INFORMATION, YOU DO SO AT YOUR OWN RISK.

GETTING READY: PREPARING THE CAR

YOUR MANIFOLD

The PSI supercharger uses the standard GM 6-71 bolt pattern that is common to all drag racing manifolds. The PSI design incorporates a 'A" thick aluminum manifold plate that is sandwiched between the bottom of the supercharger and the manifold deck surface. This provides porting and sealing between the supercharger discharge port and the opening in the manifold deck and forms an integral part of the SFI 14-21 restraint bag required by most sanctioning bodies. All 206 models bolt onto the following manifolds with no modification:

Keith Black (WAR)
Brad Anderson Fathead
Ken Veney (Newberry)
Arias/Fontana
Alan Johnson Oldsmobile and Chevrolet
B ac-Man Rat

In addition to providing the mounting interface for the supercharger, the manifold also determines the fore and aft location of the supercharger. Besides airflow considerations, this position determines the snout length, which must be correct if the top and bottom pulleys are to be aligned. If you are in doubt, or if you have a custom manifold, use a straightedge and tape measure to determine the axial distance from the centerline of the left front (#1) blower mounting stud centerline to the bottom pulley mounting surface on the crank hub. You can then calculate the required snout length by subtracting 3.07 inches from this dimension for the 206D supercharger and 1.70 from this dimension for all other PSI models. The snouts available for the 206D supercharger are all 3.7 inches long, so it is important that the mounting distance for that model be within plus or minus 1/4 inch of 6.770 inches. Spacers placed between the pulleys and their mounting flanges (regardless of whether it's the top or bottom pulley) cause serious problems due to the overturning moment they apply to either the snout bearings or the crank snout and are not recommended. If you encounter a difficult problem, call for advice before proceeding.

If your manifold isn't among those listed above, or it has been modified to accept a high helix retrofit supercharger, we recommend the following: either we can send a manifold plate to you, or you can send your manifold to us for a fit check. If you send the manifold to us, be sure it has first been fit checked on the engine. If it doesn't satisfy the following conditions as is, it will require rework:

I . It must provide support beneath the pressurized area of the manifold plate, which is bounded by the 0-ring groove in its top surface that seals to the underside of the supercharger. Some manifolds become narrower behind the stud pattern, and the boost pressure applied above the manifold plate may deflect these unsupported areas downward. This disengages the 0-ring and causes leaks. The manifold plate is stiff enough to allow up to approximately ^{3}/4" of overhang as measured from the outer edge of the manifold to the inside edge of the 0-ring groove in the top side of the manifold plate. If the overhang is greater than this, the remedy is to weld gussets in these unsupported areas to extend the manifold deck surfäce, followed by milling them and the top surface of the manifold to restore its flatness. Some manifolds have multiple cast pockets that interrupt the deck surface intermittently between the plenum opening and the bosses that accept the blower hold-down studs. These pose no problem, as they are not usually located underneath the 0-ring groove in the top surface of the manifold plate. Besides, the manifold plate deflection into these small pockets is minimal because they are surrounded by a supporting surface.

2. The opening in the manifold shouldn't significantly block the openings in the manifold plate. Minor blockages of up to 'A " don't seem to affect performance. If the blockage is much greater than this, then it should be corrected by die grinding or milling the manifold opening to match those in the manifold plate. If the opening requires a major revision that extends into or past the plenum wall, it may require weld repair. Maintain a 3/8" minimum wall thickness to avoid manifold damage or deflection during a backfire. Some manifolds contain a crosswise stiffening rib that blocks the center opening in the manifold plate. Removing this rib completely is the only way to make the plenum conducive to good fuel distribution. Removing this rib doesn't appear to weaken the manifold significantly, and there are no known instances in which its removal has resulted in damage due to a backfire or deflection during use.

3. The 0-ring groove in the manifold must be completely covered by the manifold plate to ensure a good seal and to contain the 0-ring in its groove. There have been instances in which an 0-ring in a partially uncovered groove became dislodged during a run and found its way under an intake valve. If the

0-ring groove is exposed by an opening in the manifold plate, scribe the manifold plate port hole pattern onto the manifold deck and remove the manifold plate to see if there is enough room to move the 0-ring groove farther forward or rearward to correct the problem. 0-rings go around square corners just fine, so there is no requirement that their grooves be cut in a CNC mill. A Bridgeport or other manual milling machine will suffice. To insure that the 0-ring fits the groove correctly, make sure that the entire groove complies with the table showing 0-ring groove width versus depth at the end of this section.

4. Make sure the sides and rear of the manifold clear the slots in the manifold plate that are provided for the restraint hold-down straps. While interference here is rare, it is easily corrected by beveling the offending edges of the manifold with a die grinder.

5. Your manifold needs to have two 1/8" NPT (tapered pipe thread) holes in each port runner to accept a 16-port nozzle fuel system. The holes should be located as far down the port runners as possible to minimize reversion into the plenum. If your manifold has already been tapped for one port nozzle per intake runner and there is insufficient room for another one beside it, it's okay to tap the second hole in line with it, but a little closer to the plenum. The fuel system doesn't seem to be affected by having both nozzles in line. Another approach, if the port runners are wide enough, is to plug the existing centered hole and to drill and tap a hole on either side of it.

6. Verify that the top surface of the manifold is flat when it's in the free state (not bolted to anything). You can check it with a straightedge laid first along each side, next laid crosswise between the stud holes, and finally laid diagonally. Use a flashlight to highlight any gaps between the straightedge and the manifold and a feeler gauge to determine their size. While most newly-manufactured manifolds have acceptably flat top surfaces, beware of used manifolds. It is common practice to bolt a manifold to an engine and then to attempt to lap its top surface flat. A lap generally consists of a rather large, and therefore heavy, piece of steel which has been ground flat and has had a large sheet of abrasive cloth glued to its bottom side. As this type of lap is moved across the manifold top surface, it removes more material from the edges and especially the corners than from the center portion because a portion of the lap always extends beyond the edges of the surface being lapped. The resulting rounded surface is not conducive to blower happiness. If your manifold is more than .005" out of flat in the free state, and especially if it is rounded due to its having been lapped, fix it by milling the top surface flat. It isn't necessary to remove localized dents unless they result in damage to the 0-ring groove. Filling dents that do cross the 0-ring groove with a good high-solids epoxy such as J-B Weld prior to milling is a good alternative to weld repair.

7. A common problem with manifold 0-ring grooves occurs when the manifold has been milled or lapped for flatness and the 0-ring groove hasn't been re-cut. The groove becomes too shallow in relation to its width to accommodate the 0-ring, and the supercharger housing distorts when it's torqued into place. Check all 0-ring groove depths with a depth micrometer or with a dial caliper. The .139 diameter 0-rings work best when the groove **depth** is .110-.125 inch. Check the groove in several places. The following table gives the relationship between the **actual groove *depth*** and the **minimum groove *width*** for .139 cross-section 0-rings:

GROOVE DEPTH	MIN GROOVE WIDTH

110	.151
.115	.145
.120	.139
.125	.133

The above table defines a groove that has 5% more cross sectional area than that of the .139 diameter O-ring at its high tolerance limit. Providing this extra cross sectional area avoids the ever-increasing separating force that the round 0-ring would otherwise apply to avoid being crammed into the last vestiges of the square corners of its groove. If allowed to occur, this large separating force will deflect the bottom of the supercharger housing upward and in turn push the bottoms of the rotor bores upward and into the Nylatron tip strips on the rotors. This is frequently the culprit when the blower first binds and then locks up as the stud nuts are tightened. The bind will disappear when the stud nuts are loosened, as this allows the blower housing to return to its free state.

A comment about sheet-metal manifolds: To avoid deflection and leaks when pressurized, the blower mounting surface needs to be very stiff-- at least 3/4" thick. Also, the rails containing the blower hold-down studs should be tied to the port runners with gussets.

MANIFOLD / BLOWER INTERFACE

<u>THE MANIFOLD PLATE:</u> PSI manifold plates mate with features cast into the bottom of the blower housing to form flow passages that provide even fuel-air distribution along the full length of the manifold. The porting that we put in the manifold plate is the result of years of head scratching, dyno testing, and on-track evaluation and observation. In other words, it didn't just squirt out of a pencil and get manufactured. Using the manifold plate as we send it to you will give you the following advantages:

1. The front and center ports in the plate work with the corresponding passages in the blower housing to create two counter-rotating swirls in the manifold. This stirs up the mixture in the relatively quiet front portion of the manifold plenum. This is very important, as it allows the manifold to deliver a consistent fuel/air mixture to each cylinder.

2. Since the fuel-air mixture in the manifold is homogenized, cylinder-to-cylinder tuning is consistent over a broad range of engine speeds and atmospheric conditions. This is important at a race where the weather changes suddenly, or if consecutive events present drastically different climatic conditions, because your cylinder tune-up from the previous run (or previous event) will be one you can trust.

3. All of our current manifold plates are relieved to provide a small clearance beneath the ribs on the underside of the supercharger housing. This clearance accommodates any reasonable convex bow in the manifold top surface without distorting the supercharger housing.

4. All manifold plates that fit our 206 series superchargers are hard anodized to provide a durable, electrically insulated surface coating that protects the underside of the magnesium supercharger housing

from the corrosion that would otherwise occur when methanol, aluminum, and magnesium all get together.

If you're thinking of modifying your manifold plate, we encourage you to first run it in its stock form. Most people who do this end up leaving it alone because it works as intended. If you wish to experiment with your manifold plate, please feel free to do so, but be sure you actually have a problem before you try to correct it. Cutting out the ports will not increase power. We have learned this on-track and on the dyno: it doesn't work. If it did, we'd be selling it that way. You're not using our competitor's product; so why run it like you were? You can easily tell an installation that is using a cut-out manifold plate, because of its tendency to drop cylinders while staging and because certain cylinders randomly flicker raw fuel out the header during a run. Cutting out the manifold plate reduces or eliminates the turbulence caused by the two counter-rotating swirls described above. The resulting less-turbulent condition in the front part of the plenum appears to allow fuel to puddle on the manifold floor. When the puddle reaches a certain size, it is swept into a cylinder, which then misfires for one or more cycles. You don't make race-winning power with cylinders randomly misfiring.

If you have a Brad Anderson Fathead manifold that has been cut down to run on a funny car, the 0-ring groove on the top will have been machined off, and the top surface is too thin to cut a new one. We now offer a manifold plate with 0-ring grooves on both sides for this situation. To install it, apply a small bead of RTV along the front edge of the manifold to seal between the two front ends of the 0-ring groove. The remaining 90% of the sealing will be accomplished by the .210 0-ring in the underside of the manifold plate.

We discourage the use of custom manifold plates to fit custom manifolds because when they become bent or damaged during a backfire, you won't be able to borrow one from someone at the track. Why not customize your manifold to fit the stock manifold plate? This way the customizing effort becomes a one-time job.

<u>MANIFOLD PLATE/RESTRAINT BAG INTERFACE:</u> The bags we sell, which are made by Taylor Motorsports, have no fit constraints. The Taylor bag uses two rear restraint straps, one on either side of the burst panel in the rear of the supercharger, to tie the top restraint plate to two slots in the manifold plate. This placement avoids scorching them during a backfire.

Bags from TAK and Deist don't fit 206D housings. If you need to contact TAK, his phone number is 904-388-4546.

<u>MOUNTING SURFACE:</u> The PSI supercharger housing is manufactured with a very flat bottom surface. The supercharger rear cover is set .001 to .004 inch above the bottom of the supercharger housing. The 0-ring groove in the manifold plate in this area is cut to accept a fat, squishy .210' diameter 0-ring, which achieves a good seal. **Don't be tempted to lap the housing, as it causes two problems:**

1. Lapping the housing removes the anodized coating, which is the first line of defense against corrosion.

2. Lapping frequently removes more material from the corners and edges than from the center of the supercharger housing. This is bad because the hold-down stud holes are located in these areas. When you bolt **a blower that's been lapped this way onto a flat manifold, the hold-down studs pull the relieved** edges down **until they are in intimate contact with the manifold. This pushes the center of the housing up,** causes the rotor bores to go out of round, and wears the tip strips immediately upon first fire-up.

The manifold deck surface must be **flat when it is torqued to the cylinder heads in order for the supercharger** housing bores to remain round and true. Verify that the manifold deck surface is flat by checking it with a straightedge and feeler gauge. Check it side-to-side in at least four places, lengthwise on each side, and diagonally. If it is more than .004" out of flat, check that the valley sealing rails that run sideways along its front and rear underside aren't so close to the mating surfaces on the block that they are causing the foam rubber seals to distort the manifold. If in doubt, remove the foam rubber seals and see if the distortion disappears. If it does, correct it **by machining the manifold rails to reduce the squeeze.** If it is still bowed, you may remedy it by employing any of the following techniques. We have recently added a pattern of .010" deep recesses to the to the top side of the manifold plate where it would otherwise push **on the ribs that form the airflow distribution passages on the underside of the supercharger housing. This prevents a manifold that is bowed upward in the center as much as** .008 inch from pushing on these ribs and distorting the housing as described above. Another simple cure for a bowed manifold is to fabricate two .010" thick brass shims that are approximately 1" wide, and are punched with four holes each so that they will install over the blower mounting studs on each side of the manifold. Installing them between the manifold and manifold plate accommodates the upward bow in the manifold, but doesn't affect the 0-ring seal between the manifold and manifold plate. Another technique is to mill the top **surface of the manifold approximately .010" deep everywhere except for a 1" wide** land on each side that spans the four hold-down studs. Again, the 0-ring will satisfactorily span the small extra gap caused by the relief.

If you **damage the blower and need to surface its bottom, either mill it flat on a milling machine or send it to us to machine.**

SEALING: **Never use a gasket between the manifold plate and manifold because our studs aren't long enough to accommodate its thickness. The resulting** reduced thread engagement has aborted several runs when the threads stripped beneath the nuts. In addition, gaskets deform most where the clamping pressure is the highest -- under the eight mounting lugs. The remainder of the gasket pushes on the bottom the supercharger housing, which deflects upward in the middle. This damages the tip strips by wiping them on the bottom of the housing bores. In operation, with the PSI delivering up to 60 psig boost, there is a force of up to 8,500 pounds trying to separate the blower from the manifold. Gaskets are not capable of following the deflections between the mating surfaces of the supercharger and manifold and leak severely when pressurized. Always use PSI-supplied .139" dia. 0-ring material to seal the manifold to the manifold plate, and .210" dia. 0-ring material between the manifold plate and the supercharger. 0-rings require only a small clamping force to obtain a good live seal which will follow deflections, provided they are fitted and used correctly. Refer to the table of 0-ring groove minimum widths versus depths located in the first section of this manual.

We now stock a one-piece molded 0-ring for the manifold plate that doesn't require splicing. If you are using 0-ring cord stock, the following technique is useful in preparing its ends for splicing: After

establishing its required length, trim the ends at a 45-degree angle by setting both ends of the 0-ring side-by side and then cutting them both at the same time using a sharp single-edge razor blade. Placing them side-by-side makes it easy to cut exactly the same angle on both ends. Join them together using a drop of Superglue, being careful to avoid gluing yourself to the 0-ring. Contrary to racing folklore, it is not necessary to lubricate face 0-rings to obtain a good seal. The practice of lubricating 0-rings comes from sliding installations such as the magneto drive shaft, where an unlubricated 0-ring might not squirm into place without inadvertently being cut. Silicone grease is frequently used as an 0-ring lubricant. Unfortunately, the practice of lubricating sliding 0-rings with silicone grease to ease installation has gotten confused with applying silicone RTV to face 0-rings. The problem is that the RTV solidifies and therefore immobilizes the 0-ring. The 0-rings between the manifold, manifold plate, and blower are intended to maintain a live seal, which follows the various deflections that occur during a run. Immobilizing the 0-ring with RTV guarantees that it will leak. Besides that, it's virtually impossible to remove cured RTV from the sharp inner corners of the 0-ring groove. This residue will occupy part of the groove's cross section and if there isn't enough room left in the groove to accommodate the 0-ring, it may cause the blower to bind up the next time it's installed.

YOUR ENGINE / CAR COMBINATION

To be determined based on new NIARA rules

LUBRICATION SYSTEM

Highly supercharged engines running at high RPM receive significant blowby into the crankcase. As this blowby escapes into the breathers in the rocker covers, it potentially prevents the drainback of oil from the top end of the engine to the oil pan. Be sure your block has large passages between the valley and the crankcase so the blowby speed through them remains low. Remember that the blowby and the returning oil must go in opposite directions in the same passages. The clearance around the pushrods provides eight large passages between the valley and each cylinder head. If the valley is isolated from the crankcase, the blowby has no choice but to travel up the four relatively small oil drain passages located in the four corners of the block and cylinder heads. This will carry oil from the crankcase up into the rocker covers, which is the wrong place for it to be captured by the oil pickup. Many bottom end failures or near failures have resulted from most of the oil having been squirted up into the rocker covers and valley early in the run, where it remains until the blowby stops at shutdown. Of course, by the time the car has been towed back to the pits, the oil will have drained back into the pan, erasing all evidence of what really happened.

Check the pickup location in your oil pan. Remember that at an acceleration of one G, which is about what a blown alcohol car pulls for the last couple of hundred feet in the run, the oil surface will be inclined 45 degrees to the horizontal. Be absolutely sure the pickup is located at the extreme bottom rear corner of the pan so it remains as deeply submerged as possible for as long as possible. I've seen several commercially available pans in which the pickup is several inches forward of the rear of the pan. By eyeball, at least two quarts of oil would still be lurking in the rear of the pan at the moment the pickup

started sucking air. If you have a pan with this problem, don't hesitate to plug off the existing screened inlet and fabricate an appendage that puts the pickup in the correct location.

A deep oil pan with a good windage tray is very effective at preventing oil from wrapping itself around the crankshaft and being thrown at the four oil drain passages and up into the valley.
A deep oil pan used in a wet sump system is functionally superior to a shallow oil pan used with a dry sump system. Also, dry sump systems carry a weight penalty and add complexity. Therefore, dragsters should use a wet sump system because there is room for the deep pan.

Funny cars require a low engine placement to enable the driver to see, and for proper weight transfer. As a result, they are forced to use shallow oil. Under acceleration, these shallow pans are unable to keep the oil away from the crankshaft, with obvious ill effects. Dry sump systems endeavor to scavenge oil out of the sump, away from the crankshaft, and into a separate tank where the oil pickup has a better chance of remaining submerged. Funny cars should use a dry sump (because they have no option to do otherwise)

Maintaining a minimum of 120 PSI oil pressure throughout the run is vital. If you run out of oil one second before shutdown, you can expect spun bearings along with all the attendant grief and expense. If you are using a computer, you should permanently dedicate one channel to monitor oil pressure and then remember to check it after every run. Oil pressure is far more important than fuel pressure or boost, so be prepared to forsake one of these in order to keep a watchful eye on oil pressure if your computer is equipped with only two pressure transducers.

Don't run low-viscosity synthetics, as they may cause bearing scuffing. Good quality 60 weight oils, either petroleum or synthetic seem to perform best.

Occasionally you will have to start an engine on a really cold day. 60 weight oils are too thick to enter the oil pump properly, especially in the late model Chrysler where the oil pickup is in the rear of the engine and the oil pump is in the front. I once saw Don Garlits put a small metal baking pan containing about a half cup of methanol under his oil pan. With the flick of a match and three minutes, his oil was warm enough that he could safely fire his engine.

<u>COMPRESSION RATIO:</u> Compression ratios between 10:1 and 11.4:1 are best with the present NI-IRA overdrive limits on dragsters (funny cars TBD). Don't assume that running a higher compression ratio equates to running fast. Too high a compression ratio will produce less power because of the need to run the engine richer and with less magneto lead than would be workable with a lower compression ratio. Surprisingly, too low a compression ratio (below 9:1) will result in susceptibility to pre-ignition because the required leaner fuel mixture burns hotter.

To lower your compression ratio on a permanent basis, cut a flat on the piston dome (in hemi-engines). Don't shorten the connecting rods or use thicker head gaskets. These hurt performance by reducing "quench" -- the last-minute movement of air into the area around the spark plugs from the outer reaches of the combustion chamber. This is especially true in engines with cylinder heads having a large combustion chamber volume such as the Veney (Newberry), early Brad Anderson, Dart, and Alan Johnson top fuel hemi. The clearance between the piston dome and the cylinder head may be checked with the piston at top dead center with the valves either closed or with the valves removed from the head.

With the rod bolts backed out 4 to 5 turns and using a dial indicator resting on one of the rod bolt heads, measure the distance the piston and rod move until the piston dome contacts the head. The above engines require .070 inch minimum clearance, while the smaller chamber engines such as the BAE Fathead and the Arias/Fontana may be run as close as .055 inch. This clearance accommodates a combination of connecting rod stretch, crankshaft and wrist pin deflection, and piston rock. It is not uncommon to see evidence of light contact between the piston dome and combustion chamber. I don't believe this is detrimental, as the piston speed is nearly zero as it passes through top dead center. This contact occurs during top dead center overlap where the loads are trying to stretch everything, and not during top dead center firing, where everything is being compressed. With this in mind, there has to be a reduction in the valve to piston clearance, which makes it amazing that the whole thing works at all.

PISTON SKIRT CLEARANCE: Set your piston skirt to cylinder wall clearance at .006 to .008 inch, as measured at the largest point on the piston skirt. This may seem too tight to anyone who is used to running a Roots blower. However, the piston temperature in a PSI supercharged engine is less than that in a Roots-blown engine, and the piston doesn't expand as much. The resulting reduction in piston slap improves piston ring sealing, and reduces blowby.

VALVES: Titanium intake and exhaust valves are mandatory -- their light weight moves the onset of valve float to an RPM that is well above the useable power band. When replacing valves, be aware that the valve face configuration affects the compression ratio. I have experienced the onset of problems that were traceable to the substitution of flat-faced intake valves for ones that had previously been tuliped. The compression ratio had originally been set near the high end of the workable range, only to be pushed into the danger zone by the slightly reduced combustion chamber volume that the new valves provided.

With the camshaft degreed, weak checking springs installed, and the valve lash set, the piston to valve clearances must be checked. Beads of clay may be applied to the valve pockets in the piston, or a dial indicator resting on the valve spring retainer may be used to measure the clearance at the point of closest approach between the piston and each valve face. Be sure the dial indicator stem is parallel to the valve stem or a false reading will result. The goal: 070" minimum intake to piston clearance, .125" minimum exhaust to piston clearance. Keeping the clearances close to these minimums reduces the entrapment of air between the valve faces and the valve pockets in the piston. This air contains products of combustion from the last stroke and will dilute the air in the next stroke. If the clearances are significantly larger than these recommended values, particularly if the cylinder heads are new and have not had the seats severely ground, discuss this with your piston manufacturer. It may be wise to reduce these clearances the next time you buy a set of pistons. Flat-faced valves are beneficial in this regard also. Maintain .230" min. thickness at the thinnest spot of the piston dome.

CAMSHAFT: Most standard blown alcohol cams work well in this application. On hemi engines, this would be a single pattern cam having 296 degrees duration and .500 lift on both the intake and exhaust lobes ground on 116-degree lobe centers. The series of cam lobe profiles having a lift of .500 inch are aggressive in terms of getting the valve open and closed quickly, yet are well-behaved dynamically. Camshafts that have an intake or exhaust duration which is significantly less than 296 degrees have less area under the valve lift curve. This requires that the supercharger develop more boost in order to force the same amount of air through the engine. It's the airflow into the engine, and not the boost that it takes to induce this airflow, that determines the gross power that the engine develops. The net power, which is

what no one ever seems to have enough of, is the difference between the gross power developed by the engine and the power it takes to operate the supercharger The object of the game is to get the most air into the engine at the lowest possible boost, with the most efficient supercharger possible, as this minimizes the power draw of the supercharger.

Avoid any cam that has a lobe with 300 degrees duration at .050 checking height by .5098 lift at the lobe. This particular lobe has terrible dynamics, and causes valve float at lower RPM than other designs. No performance gain -- real or perceived -- could possibly make up for the damage that this lobe has caused.

If you have the choice when buying a block, buy one equipped to accept a camshaft having the largest possible diameter journals. This allows the camshaft manufacturer to increase the strength and stiffness in the relieved portions of the cam, which must be smaller than the base circle between the lobes. Base circles on late model Chrysler cams had gotten pretty small before the introduction of blocks having the larger diameter Ford cam bearings. Camshaft fatigue failures have virtually disappeared as a result of this improvement, and valve spring life appears to improve due to the reduced torsional whip afforded by its increased stiffness.

VALVE SPRINGS: During normal operation, steel valve springs work well with the PSI, since it isn't necessary to run it beyond 10,000 rpm to get it to perform. However, titanium valve springs continue to operate when steel springs float. Everyone has experienced a driveline failure, which results in an almost instantaneous run for the rev limiter. If you have titanium springs installed when this happens, your valvetrain will probably be back for the next round of racing. Look at them as a good insurance policy.

CRANKSHAFT: A vital tip regarding oil delivery to the crankshaft is to verify that a teardrop-shaped chamfer is present on the leading side of each of the oil holes in the main bearing journals. Oil doesn't like to change directions instantaneously, and the leading teardrop allows it more time to turn the corner into the oil passage. The teardrops should be approximately 3/4 inch long and should taper to an approximate depth of 1/8 inch adjacent to the corner radius leading to the oil passage. During the development of the 426 Hemi, Chrysler engineers encountered a problem with rod bearing lubrication. As a diagnostic aid, they put pressure transducers in the crankshaft throws. This revealed that the oil pressure there dropped to near zero at speeds above 8600 engine RPM despite adequate pressure in the oil galley. Increasing the oil supply pressure did nothing to remedy the problem. Adding the leading teardrops to the main bearing journals cured the problem. I have personally witnessed several customers who had serious rod bearing lubrication problems only when one particular crankshaft was installed in their engine. The culprit in each case was either that the teardrops had been totally omitted, that they were too small to be effective, or that they had been mistakenly ground on the trailing side of the oil passages. In each case, the poison crankshaft began working perfectly when teardrops of the correct size, and on the leading side of the oil passage, were added.

It is recommended that the 3/4-16 internal threads in the crankshaft snout be recessed so they begin 2-3/4" into the crankshaft. This recess bypasses the 41,000-pound clamping force generated by the crank hub retaining bolt around the relatively small and weak crank snout. When you order a new crankshaft, it is always wise to order this option regardless of which supercharger you are running. Also, the resulting longer bolt has more stretch when torqued, which helps keep the crank hub tight.

CRANK SUPPORTS: These need to be much stiffer than anything that is available now, so we don't recommend one at this time.

HEAD GASKETS: Limit the use of RTV on head gaskets to areas immediately surrounding oil drainback passages. Since RTV lubricates, keep it away from around the cylinders if you don't want to blow a head gasket. Also, never run an engine without stainless steel 0-rings and receiver grooves around the cylinders.

GETTING THE POWER TO THE GROUND

When selecting driveline components, always start with the tires first and then progress to the rear gear ratio before selecting your transmission ratios. The reason is that the rear gear ratio and tire selection alone determine the relationship between your top end speed and the resulting engine RPM. The PSI supercharger has very small clearances between the rotors and utilizes a combination of raised wear strips and Nylatron to minimize leakage between the rotors and housing. For these reasons, the PSI makes its power "down low." It is not necessary to run a PSI-equipped engine to extremely high RPM in order to make a good run. This point was recently demonstrated by blown alcohol dragsters in the switch from Goodyear to Hoosier tires. At 255 MPH on Goodyear tires with a 4.56:1 rear gear ratio, engines were turning 10,000 RPM at the finish line on a good racing surface. We suspected that this was beyond the optimum power band. While the 4.44:1 gear ratio promised to lower the engine RPM to a more useable range, this particular gearset was impractical due to the small size of its teeth and is therefore prone to fail after one or two runs. The Hoosier tires used with a 4.30: I rear gear ratio reduced the engine RPM to about 9600 at 260 MPH. This ratio change increased the average top end charge by 5 MPH by reducing the engine speed to a range that more closely matches the peak power band.

'TIRES: As of this revision, the Hoosier tires have been well proven in competition. Their rollout is in the range of 110 to 112 inches, and it remains essentially constant throughout the life of the tire. At 250 MPH, they grow approximately 5%, which is minimal when compared to the 12 % growth that was common with the Goodyear 2807 and 3199 tires. It is fairly obvious that the Hoosier tires are constructed to minimize crowning and thereby maximize their footprint. Hoosier tires lay down a 10" wide patch of rubber during a burnout, while 7" is typical of the Goodyear tires. Apparently the Goodyear tires evolved to end-run the NI-1RA Top Fuel 3.2:1 rear gear ratio restriction. The effective ratio change resulting from the substantial tire growth that these tires exhibit are part of what makes a blown fuel car able to charge so hard on the top end. Since blown alcohol cars change gear ratios three times during a run, the ratio change of the tires is less important than the fact that the footprint (and therefore the traction) remains substantial even when the wheel speed becomes marginally high, as it does just before breaking traction.

Beadlock wheels work. The pneumatic spring rate is lower due to the absence of an inner liner, which gives a larger footprint and therefore a better bite early in the run. They are also approximately twenty pounds lighter due to the absence of the tubes and inner liners. Beadlocks got a bad rap back in the late 70s when they were first tried on blown alcohol cars, because they caused tire shake following the 1-2 upshift. However, tire speeds at the top of low gear were much lower then and the tires were therefore less stable. The latest twist is that Goodyear announced in early 2000 that it had depleted its supply of

inner tubes and liners and would not make more, so the die is cast unless you are in possession of a hoard of tubes and liners.

REAR END: Select the gear ratio based on the type of tire you plan to use to set the RPM in the lights.

CLASS	36" GOODYEAR	HOOSIER
FMFC	4.30*	4.30*
FMD	4.56	4.30
1/4 mile Pro Mod	4.56	4.56
1/8 mile Pro Mod	4.71	

*Per NI-IRA rules effective 1-1-2001, rear gear ratios may not exceed 4.30 for screw supercharged Federal Mogul Funny Cars.

TRANSMISSION RATIOS: For racing at corrected altitudes up to approximately 2500 feet, we recommend second gear ratios in the range of 1.25 to 1.31 for both dragsters and funny cars. Select the higher numerical ratios for tracks that are sticky between the 330 and 660-foot markers. Points meet tracks and green national event tracks tend to be marginal in this interval due to the lack of Top Fuel rubber. Select the lower numerical ratios for these conditions to avoid spinning the tires in second gear. With Hoosier tires and the recommended rear gear ratios, the higher numeric ratios definitely improve the 330-to-660 foot incremental times and the half-track MPH. In addition, if you have to short-shift second gear to stop tire shake, the car will accelerate better in second gear than with the taller (smaller numeric) second gear ratios.

Your low gear ratio is determined by multiplying the ratio of your second gear set by the ratio of your low gear set. Low gear ratios in the range of 1.56 to 1.68 are workable for dragsters running at the 2.15 blower overdrive limit, and 1.60 to 1.72 are workable for funny cars running at the 1.92 blower overdrive limit. Dragsters running Hoosier tires with liners should run low gear ratios that are in the 1.64 to 1.76 range. These ratios are for racing at corrected altitudes up to approximately 2500 feet. The higher numeric ratios are only workable on extremely good track surfaces combined with higher corrected altitude conditions where your power is down. This transmission ratio range increases as the corrected altitude increases. The Jetsize program provides a useful index in the form of its relative density calculation, as engine torque follows this index. If you find yourself at an altitude track and need to make an educated guess as to where to start with the transmission, search your records for a good reference run on a track having a comparable racing surface traction-wise. Calculate your new transmission ratio by multiplying the transmission ratio that you used successfully at the reference track by the relative density at the reference conditions, and dividing by the relative density for the unfamiliar conditions at hand. The point is to gear the car so it develops the same axle torque on the unfamiliar track as it did on the successful reference run.

The obvious idea is to run the maximum gear ratio that you can without losing traction, as losing traction almost always precedes tire shake. It's a good idea to go to the track very early and/or stay late so you can walk it when no cars are running. It's very frustrating to observe a team carefully setting a car up for the first run at a track without having examined the surface they are about to run on.

Beware of rapid changes in track conditions due to the weather. A cloudless, hot day at a national event track gives rise to very hot track temperatures that tend to produce a greasy surface. This can be as slippery as a very cold track temperature, as occurs on a cold, cloudy day. A slippery national event track may be that way due to bright sunlight producing high surface temperatures, and this can change rapidly if the sky clouds over or the sun sets. Another factor at national event tracks is the effect that Top Fuel cars have on the racing surface. One or especially two sessions of Top Fuel can completely change the character of the track. Develop an awareness of how the fuel funny cars and pro stock cars perform. If the fuel funny cars are plagued by tire smoke and can't run in the five-second zone in good air, the track is marginal. A really bad track is one on which the pro stockers are plagued by tire shake.

Selecting the low gear ratio is probably one of the most emotionally charged decisions in drag racing. Everyone has a different theory about what ought to work, and most selections are skewed toward the aggressive end of the range out of a desire to run a good 60-foot time. Remember that you have to stick the tires to the track and that tires don't lock you to the track like a rack and pinion. More isn't necessarily better. Tire shake at clutch lockup is an indication that your low gear ratio is one or two steps too aggressive. If, in addition to this, if you occasionally lose traction and actually smoke the tires in low gear, your low gear ratio is several steps too aggressive. Remember that the transmission ratio is your most powerful tool for controlling tire shake and tire smoke.

Much is made of "split" or "drop"(the ratio change between gear shifts), but it's really meaningless because the clutch releases at each gearshift. To prove this to yourself, divide the engine RPM at the shift point by the gear ratio being shifted. You will see that this RPM, which is actually the RPM to which the clutch discs decelerate following a shift, is always less than the lowest engine RPM following the shift.

If you orifice the shift servo to soften the 1-2 upshift, be sure to consult with your transmission manufacturer. There are transmission clutch packs available with various facing materials, each for a different application. Be sure that your facing can withstand the extra heat input that the sliding will generate, and be sure to increase your maintenance intensity until you have learned how this affects the life of the particular facing that you're using.

Dexron and Type F automatic transmission fluids are both made from animal fats and are compounded to rapidly escape from between the engaging clutch discs to provide a crisp shift. The use of engine oil in the transmission is another way to soften the shift, as its better lubricity makes it more difficult to eject from between the discs, thereby allowing them to slide a little longer and thereby soften the shift.

<u>CLUTCH:</u> I have found that this is the sacred subject that causes more suspicion and jealousy than all others combined. Therefore, I won't go there. Talk to your clutch manufacturer for a starting point, keep careful records, use your head, and don't talk to too many people, as every chassis, transmission ratio, racing surface, and manufacturing lot of clutch discs requires a different setting.

When staging the car, **KEEP THE CLUTCH PEDAL ON ITS STOP! DO NOT RIDE THE CLUTCH!** If the clutch pedal is on its stop, the staging RPM is a function of the throttle position only. If you try to ride the clutch, the staging RPM becomes a function of not only the degree to which the clutch is engaged, but also the throttle opening. The resulting increase in driver workload at the most critical part of the run dooms most such runs to a bad start. In addition, you lose all control over the clutch temperature because the entire time you are staged, the clutch is getting hotter. How much hotter therefore depends not only on how long you're staged, but also the degree of clutch engagement on that particular run. What if the guy in the other lane is slow to stage?

IGNITION SYSTEM

KILL SWITCH: For safety reasons, you should have one. Johnny West (714-972-8006) makes a very reliable unit that is up to the task at hand. Don't make the mistake of using hardware store variety switches or wire. It must be high voltage cable, such as ignition coil wire, which can handle 5000 volts reliably without shorting through the insulation.

MAGNETO DRIVE: Following the introduction of the MSD 12, 20, and especially the MSD 44 amp magnetos, our customers started seeing random bearing squeeze on the order of .005" to .015" for no apparent reason. On two successive runs in virtually identical air and with no changes to the fuel system, different bearings would be hit. This disappeared when a crank trigger was used to fire the magneto, but the magnetic pickups that were available in 1999 were unreliable. Between these failures and the fact that a blower belt failure often destroys the magnetic pickup as well as its mounting bracket, the use of crank triggered ignition really didn't become widespread despite the improved timing accuracy that it offered.

Then, we discovered the culprit. The 'A" diameter drive shafts used in all magneto drives were found to be too flexible to keep the more massive armatures of the MSD magnetos in phase with the often-irregular motion of the crankshaft. We designed a much stiffer replacement shaft assembly for the commonly used magneto drives and the problem promptly disappeared.

With the PSI magneto drive shaft in place, not only did the random bearing squeeze disappear, but we also discovered that it was possible to safely run about 4 more degrees of spark advance than had previously been possible. This stepped the performance up considerably over what had previously been possible.

Another unanticipated benefit of the stiffer shaft is that it eliminated the engine damage that used to be caused by hitting the MSD electronic rev limiter. Apparently the magneto had been unable to accurately follow the irregular crankshaft motion caused by the random spark interruptions produced by the electronic rev limiter. Whenever the magneto got ahead of the crankshaft, it wreaked havoc on the engine. This caused most teams to select a rev limiter setting that was high enough, say 10,800 RPM, that it was never inadvertently hit by a driving error. Driveline failures resulting in an excursion to the elevated rev limiter setting still overstressed the connecting rods to a degree that replacement was wise. Additionally, valvetrain damage would frequently occur as a result of these somewhat controlled over-revs. Our stiff magneto drive shaft has eliminated the need for this, and most teams now feel confident in

using a rev limiter setting in the range of 10,400 RPM. This 400-RPM reduction, which may seem too small to matter, is actually very significant, as valvetrain and connecting rod damage are more threshold-related than they are progressive.

REV LIMITER: Most blown alcohol engines use MSD magnetos, and the MSD package includes a very reliable electronic rev limiter. Based on the above information, your installation should include our stiff magneto drive shaft, especially if you are using the MSD rev limiter. There are electronic, battery-operated rev controls, but they are not recommended because they completely shut the engine off when the set point is hit, thereby aborting the run. PSI manufactures a very effective mechanical rev limiter for both the Mallory and Vertex magnetos.

SPARK PLUGS: **FOR METHANOL ONLY!** Use the following spark plugs:

NGK R6061-10
NGK R6061-11
NGK BlOEG
Champion N-57DR*
Autolite Racing 2592**

FOR GASOLINE ONLY! Use the following spark plugs:
NGK R6061-9
Champion N-60DR*
Autolite Racing 2593

*Prior to 1993, these plugs used a ground strap that just reached the near side of the center electrode (1/4 coverage). For a brief period in the mid 1990s, the ground straps reached almost all the way across the center electrode (3/4 coverage). These longer ground straps must be trimmed, so watch out for this.
**This plug is equivalent to the N-57DR, but may be hard to read since it is plated with nickel instead of zinc or cadmium. (See READING YOUR PLUGS)
The nickel is great for durability, so you can use a set of these plugs all season once you learn how to read them.

The recommended spark plugs all have short, fat ground electrodes. Don't overlook the ground strap as a source of trouble, even though it isn't included as a factor in determining the heat range of a spark plug. The tip of the ground strap, particularly one that is long and skinny, approaches the temperature of the surrounding burning charge. The result is a glow plug--just what you don't want, as it could fire the charge at any time, like 40, 50 or 60 degrees before top dead center, depending on how hot it gets.

Do not run NGK B9ES or B1OES, NGK B9EG, NGK R5671-9 or -10, because the ground electrodes are too long and skinny to avoid glow plugging in normal operation. Splitfire plugs have a split in the ground strap. The result is two long, skinny tips on a ground strap that is too long to begin with. Projected tip spark plugs all have extremely long ground straps. If you want to collapse all eight pistons, torch several exhaust valves, push a head gasket, torch a head and block and backfire the blower, then run one of these plugs.

With gasoline, you must worry about detonation, but with methanol the worry is pre-ignition. If you are running methanol, **do not run** Champion N-60DR, NGK R6061-9, or Autolite racing 2593. "Heat range" governs the operating surface temperature of the ceramic insulator. If the heat range is too hot, pre-ignition occurs (the charge ignites before the magneto fires). Unlike a plug with a long ground strap, they will work sometimes, but when you least expect it, will backfire the blower. They never show distress, the engine never shows distress, but replacing them with one of the recommended plugs cures the problem.

The PSI supercharger requires a cooler heat range plug for methanol, with a shorter, fatter ground strap! For the sake of your engine and our reputation, **please don't rediscover this.**

With a Roots blower, if the heat range is too cold, collected fuel will foul the plugs and cause dropped cylinders. When you use the PSI sixteen-nozzle fuel system, dropped cylinders are a rarity (unless the engine is very rich). We haven't found a spark plug that is cold enough to cause a dropped cylinder on an engine that is properly tuned.

<u>INSTALLING YOUR PLUGS:</u> Gap your plugs at .014- .016" gap. Keeping the gap small minimizes the initiating voltage, which is the voltage that is required to initially ionize the gasses that occupy the spark plug gap. Once the spark has been initiated, the voltage to sustain it is greatly reduced. Ignition problems are a common occurrence in blown alcohol racing, and they have gotten worse as cylinder pressures have increased. Forcing the firing voltage to go high enough to initially jump a large spark plug gap opens you up to the possibility of arcing somewhere else -- the points, the rev limiter, the kill switch, the plug and coil wires, or the primary wiring. This causes aborted runs and shortens the magneto and coil life. There doesn't seem to be any downside to running the narrow gap.

It is common practice to lubricate the spark plug threads with Anti-Seize. However, Anti-Seize is conductive. If you get even a tiny bit on the external porcelain insulator, it creates a path to ground, and the plug won't fire. "White" grease (such lithium grease) is just as effective at preventing thread galling, but is not conductive. The salt in body sweat is also conductive, so it's a good idea to wipe the porcelain off with a paper towel or a fresh piece of cheesecloth just before inserting the plug into the engine.

<u>READING YOUR PLUGS:</u> The spark plug is the easiest thing to remove that's been in the cylinder during a run. Its appearance correlates to the appearance and condition of other components, such as the piston crowns, exhaust valves, and rod bearing upper halves after a run. To enhance this correlation, some spark plug manufacturers plate the spark plug shell with cadmium or zinc, which oxidizes at a temperature that corresponds to the correct operating range of engines. Prior to reading the spark plugs, degrease them by spraying the threaded end with brake cleaner to remove any oil that was deposited on them either during shutdown or upon removal from the cylinder heads.

When you lean your fuel system down on successive runs, first the ground strap plating, and then the spark plug shell plating oxidizes. This oxidation is uneven as it progresses around the end of the shell because the side of the spark plug that was adjacent to the exhaust valve seat gets hotter faster than the side that was adjacent to the intake valve seat. The result is a crescent of unburned cadmium that gets smaller as the engine is run leaner When the cadmium is burned across the entire face or countersink on the end of the shell, the burn then progresses down the outside of the shell and into the threads.

The best performance occurs when a plug that is plated with zinc or cadmium (NGK or Champion, respectively) turns white over about 90% of the shell end and leaves a small crescent of unburned plating on this surface. Burning the plating all the way back to the first thread won't result in any engine damage, but It also won't improve your performance either. There is a fairly broad tuning range between the small crescent remaining and burning the plating back to the first thread. Use this as a safety zone to hedge against unforeseen problems by tuning to the rich end of this range. Usually the onset of damage occurs when the plating is burned all the way back to the third thread or so. This stage frequently corresponds to the plating on the end of the shell developing a greenish appearance. Back ofd You're too lean! This is your final warning!

The next step occurs when the ends of the ground strap or center electrode become rounded from having begun to melt. At this point, these parts of the spark plug have become so hot that that they are able to pre-ignite the charge before the magneto fires. Starting the pressure rise in the cylinder too early produces excessive cylinder pressure as the piston is forced toward top dead center by the flywheel. The continuing early combustion with the piston near top dead center confines this excessive pressure whereupon it progresses to huge. This pressure is able to squeeze connecting rod bearing upper halves so hard that they begin to squirt sideways. As the hot spot on the spark plug becomes hotter, the charge ignites earlier and can bend connecting rods and wrist pins, deform ring lands on the piston, and elastically stretch the cylinder head studs. Finally (and thankfully), when pre-ignition occurs so early that the intake valve is still open, the manifold charge is ignited and the burst panels rupture, and perhaps the blower studs sever. This stops the process, hopefully before any of the above destructive events take their toll. The above sequence seems to exactly describe the destructive process at work in a blown alcohol engine that is too lean.

The plug readings develop late in the run. In 1/4 mile pavement drag racing, it is unusual to see much more than a light frosting of the plating on a pass that has been shut off at the 1/8-mile point. A good rule of thumb is that 90% of the elapsed time and plug readings develop by the by the 1000 foot mark, and 90% of the engine damage happens in the last 320 feet. For this reason, a shakedown run to the 1/8 mile is far less meaningful but not much less risky than one that is driven to the 1000 foot point.

The following is a method to learn to read Autolite or Champion nickel-plated plugs. Run a set of eight next to NGKs or zinc plated Champions (in 16-plug engines), or, in an 8-plug engine, in one cylinder that you know to be free from adventure. The extent and color of the rainbow discoloration on the ground strap and the face of the shell indicate the temperature that these surfaces experienced during the run. This is best read in full sunlight because certain colors may not be present in the light emitted from artificial light sources. Be sure to remove the reading after each run by very lightly polishing these surfaces with Scotchbrite. The advantage in running these spark plugs is that one set will last many runs. The disadvantage is that the plug reading covers a broader temperature range and therefore makes it more difficult to determine precisely where you are with your tune-up.

<u>OTHER TUNING HINTS:</u> Head gaskets are a good indicator of too much magneto lead or too high a compression ratio. The tops of the sleeves are set slightly above the deck surface of the block to ensure that they seal intimately with the head gasket. Torquing the heads to the block therefore slightly indents the copper head gaskets in this area, but this slight deformation is insufficient to extrude the head gasket

radially into the cylinder bore. If your head gaskets show signs of radial extrusion into the cylinders, especially if the resulting edge is irregular and sharp burrs are present, it is usually because the peak cylinder pressure is so high that it repeatedly separates the head from the block during the run. If this happens when the spark plugs still have cadmium remaining, it indicates that there is too much magneto lead for the compression ratio, or vice versa. The information that may be gained from an awareness of this is valuable. Making good power depends upon having the proper balance between compression ratio and magneto lead. Knowing that you have too much of both should suggest that you may experiment by reducing first one and then the other to find a more optimum balance between the two. Left unnoticed, the extruded head gasket burs may extend so far into the combustion chamber that they get hot enough to cause pre-ignition. The green tint observed in the header flames of a nitromethane engine are caused by these glowing burrs getting so hot that that the copper is actually vaporizing. The green header flames are usually followed by a spectacular occurrence unless the engine is shut down very soon after the onset of the color show.

TACHOMETER: The inductive type is unreliable and error-prone. MSD magnetos are equipped with a tachometer drive module that delivers a much stronger signal to a dash mounted tachometer than that produced by an inductive pickup. The MSD system is lightweight, easy to install, accurate and reliable. It scores additional points for not having any components that are located near the blower belt. Another very reliable and reasonably accurate system consists of a DC tachometer that is operated by a mechanically driven DC generator mounted to the magneto drive. Finally, the purely mechanical, cable-driven tachometer is still in wide use, and gets the job done reliably and accurately.

DRIVING THE SUPERCHARGER

OVERDRIVE: A comment about overdrive slang: 125% over (2.25:1) is not 10% more overdrive than 115% over (2.15:1) for the same reason that $2.25 is not 10% more money than $2.15. It is really 2.25/2.15 = 1.046, or 4.6% more. Bear this in mind when calculating fuel flows, etc.: to be accurate, divide the number of bottom pulley teeth by the number of top pulley teeth. That's your overdrive. If you change to a different pulley size, your overdrive changes by the ratio of the difference. Please see the discussion of fuel flow calculation below.

CRANK HUB: Galling between the crank hub and crankshaft is a problem that plagues all supercharged engines to some degree. While some people attribute this to the screw supercharger, it is a grim way of life in the blown fuel categories, and they use Roots blowers. After a lot of work, I feel we've developed a satisfactory interface between the crank snout and crank hub. Making the crank hub from titanium, which won't weld to steel, allows it to be removed with a 3/8-inch puller. An additional barrier against galling is provided by applying red Loctite to its bore and to the crank snout prior to installation. The bore in our crank hub is sized to provide clearance with respect to the crank snout to accommodate a thin film of this material. Our crank hubs also trap a high-tensile strength bronze ring between the rear of the crank hub and the cam drive gear to stop the galling between the rear face of the crank hub and the front of the cam drive gear.

CRANK KEYS: Keys made of soft steel yield locally and thereby allow backlash between the crank snout and crank hub. This backlash allows the crank hub to move relative to the crank hub, and this is what causes galling between the two parts.

BELTS: There are three belt configurations in use:

> 8 MM Polychain GT -- offers good belt life (3" wide, or 75mm)
> 13.9 MM HTD -- useful for Roots blowers only, has 111 teeth and is too short
> 14 MM Polychain GT (2.5" wide, or 65 mm)-- works best with Polychain GT pulleys. However, it will work satisfactorily with 14 MM HTD pulleys.

IDLER BRACKET: The bracket must be stiff; use aluminum rather than magnesium. Avoiding flex is important for belt life. When you shift gears, the engine decelerates and has to slow the blower down. This tensions the idler side of the belt, and the outboard end of the idler deflects inward. The same way as a sanding belt climbs toward the tight side of a belt sander's rollers, the belt will track toward the engine, climb the idler flange, and shred itself.

IDLER PULLEY: We engaged in an extensive and successful idler pulley development program in 1997. We discovered that while a toothed idler works well early in its life, it rapidly deteriorates and begins shredding belts. The reason is that the teeth on the idler constrain the belt teeth to engage and disengage along exactly the same path each time. This repeated action very quickly generates a repeating set of grooves in the idler flange. The resulting ridges chafe the Kevlar cord in the edge of the belt, causing it to fray. Soon after the onset of fraying, the Kevlar shreds and the belt fails.

While our solution was unexpected, it did solve the problem. We found that by eliminating the teeth on the idler, the path followed by the belt teeth becomes completely random as they cross the idler flange. The result is an exactly uniform and therefore ridgeless wear pattern on the idler flanges. Adding a crown to the center of the idler causes the belt to seek the center of the idler rather than meandering in one direction until encountering an idler flange and then wearing away at it.

Our idlers are made from aluminum and come in three diameters to extend the useable adjustment range of the idler bracket slot. They are available to fit 2-1/2" (65 MM) wide 14 MM belts, and 3" (75 MM) wide 8 MM belts. We stock bearing flanges for both 5/8" and 3/4" bolts, and the installed lengths of all our idler pulleys are the same as those made by RCD Engineering.

Dual idlers are a poor way to deal with a belt that is too long. Instead, the idler T-nut that engages the bracket may need to be modified so that it can utilize the full length of the idler bracket slot. The idler should deflect the belt at least 2" sideways to prevent the belt from climbing the flanges, and it should be as close to the top pulley as possible. Never put the idler on the outside of the belt so that it deflects the belt inward. That bends the belt cords the wrong way and shortens its life.

SNOUT: The PSI supercharger rotors have large diameter shafts for accurate timing. These shafts can also transmit side loads from the belt into the rotors unless the correct drive arrangement is used. **DO NOT RIGIDLY MOUNT THE SNOUT SHAFT TO THE TIMING GEAR AS IS COMMONLY DONE WITH ROOTS BLOWERS!**

We manufacture a quill shaft snout that offers these advantages:

1) It accepts a 24-tooth pulley without modification.
2) It provides torsional cushioning, which minimizes crank hub galling.
3) It reduces shock loading on the belt.

The quill shaft lengths corresponding to the snout lengths are as follows:

3.85" snout (for 206A or 206B models) takes 4.56" quill shaft.
3.70" snout (for 206C and 206D) takes 5.40" (short shaft) or 4.025" (long shaft)
5.09" (for 206A or 206B) snout takes 5.40" long shaft.

PROVIDING FUEL

FUEL PUMP: The Waterman Racing Components L'il Bertha gear pump is the pump of choice for the PSI system. These pumps exhibit extremely low internal leakage and virtually never fail or wear out, particularly if they are equipped with the optional Meehanite housing. Their one weakness is that they tend to cavitate at high RPM in their stock form. When procuring a pump, be sure to order it with a stock housing and end plates so they may be correctly reworked to move the onset of cavitation to a pump speed that is beyond the operating range. While Waterman does offer a relieved housing and end plates, they do not achieve the desired effect on methanol at high RPM.

At sea level conditions, a PSI-blown alcohol dragster consumes 14.1 gpm, and a funny car 15.5 gpm. So, you will need a pump that delivers 17 to 19 gpm for a dragster, and 19 to 21 gpm for a funny car. If you have an Enderle pump, it is a good idea to have it flowed after every race, and you should disassemble and inspect it after every run. If your fuel pump is too large, you can underdrive it to reduce it to a useful range.

CHECK VALVES: Enderle, Hillborn, Crower, and Waterman check valves are all acceptable. The important points are:

- Never set them with a leak down tester.
- They must have enough travel and flow area when calibrated.
- They must seal when seated.
- Disassemble and inspect them regularly.
- Brass or stainless steel components are mandatory to avoid the corrosion caused by methanol. Never use an aluminum-bodied check valve. Even if its housing is anodized, the poppet will quickly wear through the anodized seat, expose bare aluminum and rapidly corrode the seating surface.

When setting up your fuel system for the first time, disassemble each check valve. Make sure the components are clean and free of hanging burrs, metal chips, or gummy deposits; use Scotchbrite to clean them. Look for sufficient flow area, and a spring having a minimum of 5 coils. Reassemble the valve and use a screwdriver to check that the poppet moves freely at least 3/16" from fully closed. Calibrate each valve.

CHECK VALVE CALIBRATION: Pressure gages are inexpensive. Be sure yours is in a reasonable range for what you are doing. For example, don't try to set a 6 PSI check valve with a 100 PSI gage. Start with the regulator off, then start increasing the pressure. Just as the pressure begins to rise (but when the pressure is still below the crackpoint), listen for a "hiss" from the valve seat. A hiss means contamination, burrs, rough spots or corrosion — clean, repair or replace. Increase the pressure until there is an audible hiss of air accompanied by a leveling off of the gage reading. Use shims or change the spring as required to adjust the setting. **Important:** After calibration, check again with a screwdriver to be sure there is still a 3/16" minimum poppet stroke. **Port check valves that are shimmed to near coil bind can damage engines. Return check valves that are shimmed to near coil bind can damage egos.**

TANKS AND FITTINGS: Galvanic corrosion occurs if there is any unanodized aluminum in electrical contact with other dissimilar metals in the presence of methanol. This chemical reaction yields a material (aluminum hydroxide) that jams valve poppets and plugs nozzles. If you find evidence of corrosion in your fuel system, flush it with white vinegar to dissolve the aluminum hydroxide as a quick fix. For the long term, remove whatever isn't anodized. Unanodized aluminum fuel tanks, fittings, or tubing made of 2011, 2024 or 7075 aluminum are treacherous! 1100 and 6061 aluminum alloys are reasonably corrosion resistant, and are the alloys of choice for custom-fabricated fuel system components. Also, any fittings that are submerged when the fuel tank is full must be aluminum. Never use magnesium fittings in the fuel system, as they will corrode more quickly than an Alka-Seltzer tablet dissolves in hot water. I witnessed a billet magnesium Y fitting that produced several teaspoons of white crud within sixty seconds of its first contact with methanol.

FUEL STORAGE: Always store your fuel in clear plastic jugs upon removing it from the 55-gallon drum. **Never** store it in colored plastic jugs, as there is no guarantee that the dye won't bleed into the fuel, and the NHRA rules state that the fuel must be clear. **Never** leave a 55-gallon drum of fuel outdoors. If it rains, water will collect on its top, and the chill that comes with the rain will contract its contents. If the bung isn't perfectly sealed, in goes the water, and your fuel is ruined. Oh yes, be sure to store gasoline or diesel fuel for your generator in a completely different type of container than a fuel jug, even a colored one. Blown alcohol engines sure sound funny when they're burning gasoline by mistake, and yes, it has happened!

PUMP SAVER: The Enderle barrel valve includes a pump saver that relieves the pressure spike that would otherwise occur at the instant the butterflies are shut at the end of the run. While it has been common practice to return the pump saver flow either to the fuel tank or to the pump inlet, it's better to discharge it into the fuel system downstream of the barrel valve. While this practice works for the lowered 43 square inch funny car injector and for the 53 square inch injector, it is absolutely mandatory for the 64 square inch deep throat injector. This is because the large, square butterflies of the deep throat injector don't have to be very far open to admit enough air to do a burnout. Unfortunately, this also means the barrel valve spool isn't very far open either, which creates a very lean spot (enough to backfire the supercharger) during the burnout. Setting the pump saver to crack at approximately 140 PSI and discharging it as described above solves the backfire problem and affects no other functions. Do not reduce this crack pressure to below 120 PSI, as it could allow fuel to bypass the barrel valve during staging. In addition to solving the above problem, plumbing the system this way eliminates the lean spot

that often occurs if the throttle is feathered for any reason during the run. Additionally, it reduces the number of fuel lines that must be detached when the manifold and blower are removed from the engine.

NOZZLES: While I could preach the many virtues of flowed nozzles, few teams will actually spend the money to buy them. While Enderle nozzles are fairly inexpensive, they are somewhat inconsistent. This becomes a problem when you want to adjust a cylinder a small amount such as .002 inch (two nozzle sizes) because they frequently vary in flow by up to three sizes. Because of this variation, you can't be sure that the actual adjustment is in the intended direction. You may use a leak down tester to solve the problem. A useful technique is to obtain an air blowgun, equip its inlet with a quick disconnect fitting that plugs into your leak down tester, and tap its outlet nozzle 5/16-24 so that it will accept an Enderle nozzle. The shock that engaging the quick disconnect applies to the leak down tester essentially re-zeros its regulator to a degree that it can't distinguish between consecutive nozzle sizes. The blowgun may be plugged in, the leak down tester zeroed once, and as many measurements taken as desired without shocking the leak down tester. After checking a few nozzles, you'll quickly develop a feel for the expected change in leakdown associated with a given change in nozzle size. Using this technique, you may quickly remove a nozzle that you want to adjust, check it, select the one you intend to change to, and verify that it is, in fact, what you intended to change to. This is way better than using your engine as a nozzle tester.

INSTALLING THE PSI SUPERCHARGER

THE PSI'S GEARBOX

PRESSURE RELIEF: The front seals in the PSI do not allow the gearbox to become pressurized, so there is no need for a pressure relief valve to vent it.

LUBRICATION: 10 to 20 weight synthetic, 2-cycle oils, or 5W15 Mobil 1 give the best performance. 5W30 Mobil 1 is acceptable, but consumes slightly more power.

Never **use 50 or 60 weight oil, or rear end 90/120 oils!** These oils are too thick to get out from between the gear teeth at high speeds. In the PSI, the timing gears only transmit ten to twenty horsepower instead of the three-to-five hundred horsepower that Roots blower timing gears transmit, so the gears don't need the extreme pressure qualities that these oils possess.

With the snout removed and with the supercharger sitting level (in the normal operating position), fill the gearbox until oil starts to drip out of the bottom snout mounting hole. **Never over-fill.**

To add oil with the snout installed, remove two of the upper bolts and add oil through one hole with a syringe or a funnel and tubing. The other hole vents the air.

SNOUT INSTALLATION: Bolt the drive flange to the timing gear using the six bolts provided (5/16-24x1/2 hex head grade 8 bolts). Note: These six bolts must be identical to prevent imbalance. Washers are unnecessary as the drive flange is heat treated. Apply a drop of red Loctite to each bolt and torque to 200 In-Lbs (16 Ft-Lbs). To prevent the rotors from rotating, place a clean rag folded twice between the tip of the six-lobed rotor and the side of the housing inlet toward the rear.

with a manifold backfire, you want the studs to break and release the excess pressure before something more expensive (or dangerous) happens. We have found that there are a lot of high strength aluminum blower studs being marketed. We tested one which didn't break during a really big bang, and found it to be three times the maximum allowable strength! The housing of your PSI will be very costly for you to replace, which may happen if you have a manifold backfire while using the wrong studs. If all eight studs break as they are supposed to, you should be able to put your PSI right back on after a backfire and run it competitively.

PSI manufactures studs with a shear neck in the unthreaded portion that is sized to break at about 4200 pounds tensile load. A benefit of this is that when the shear necks break in a backfire, you have something to grab onto with pliers instead of having to dig the broken studs out with a drill and ez-out. Do not Loctite studs into the manifold, as it makes them difficult to remove after a backfire.

In case you are wondering, necked studs do not break during tire shake. The total holding force is 8 X 4,200 + 33,600 pounds. You could lift your car, tow vehicle and trailer with 8 studs!

<u>STUD NUTS:</u> Because of the narrow opening between the housing ribs, use 7/16-20 12-point nuts, the same nuts commonly used for the valley studs on all late-model Chryslers. It isn't necessary to torque the nuts--just snug the nuts down with a short 1/2"-12-point box end wrench. A dot of RTV to connect the unthreaded portion of the end of the studs with the top of the nuts will keep the nut from backing off during the run.

<u>STARTER BRACKET:</u> The starter bracket mounting bolt pattern on all PSIs is identical to that of all 6-71 through 14-71 blowers. Do not use ordinary carbon steel set screws (also called half dogs) for starter bracket studs; as they are brittle and will snap if the engine kicks back during cranking. Because they are hardened, they are very difficult to drill for removal with EZ-Outs. We sell stainless steel socket set screws, which are tough enough to bend before they snap. In a pinch, you may make them from 5/16-18 grade 8 threaded rod, which is available through most industrial fastener supply houses. A second best quickie solution is to make them from ordinary hardware store variety 5/16-18 threaded rod.

<u>BURST PANEL:</u> Premature burst panel failure ends a good run. It results from the turbulent blower discharge air impinging directly onto the burst panel. With our increased boost in 1996, this became critical. We now offer, with SFI's approval, a tandem burst panel kit, which allows you to run two burst panels in series (blower outlet only, not in the manifold). If the inner panel fails, the redundant outer panel allows you to finish the run. The panels are separated by approximately 1 inch. During a backfire, this separation allows the first panel to rupture before the shock wave senses the presence of the second panel. The progression is much like unzipping a zipper, which opens one clasp at a time. A good practice is to put a new burst panel on the manifold, where the tandem setup isn't allowed, every twelve runs or so to keep it fresh. Save these used burst panels for installation as inner burst panels on the rear of the blower .

To verify that the inner panel is intact, install a #70 Enderle nozzle and an 8" piece of port nozzle line in the port provided in the spacer plate that separates the two burst panels. Remove the brass hose fitting from the free end so it doesn't rattle around and damage things during a run. After each run, blow into this line. If it blows back, you know that the inner panel is intact. Do not cap the test line, as the #70

nozzle provides a vent for any leakage that may find its way around the inner burst panel. if the space between the two burst panels becomes pressurized during a run, it may cause the inner burst panel to oilcan inward and rupture when the manifold pressure becomes a vacuum at shutdown. The #70 nozzle is small enough that the leakage it presents in the event of inner burst panel failure is negligible. Just tuck the loose end of the test line under the bag after the test. Neat, huh?

THE FUEL SYSTEM

FUEL PUMP: The best fuel pump available is the Waterman L'il Bertha gear pump. It is very durable, has extremely low internal leakage, and is available in a range of capacities that match the requirements of the PSI system in most blown alcohol applications. Waterman supplies these pumps with rotors that vary in length in increments of .050 inch. As the rotors get longer, the end plates get correspondingly shorter to maintain the same overall length (and therefore fit inside the same housing) while varying the pump capacity. I strongly recommend that you equip your pump with the optional Meehanite (cast iron) housing, as it doesn't corrode internally when in contact with methanol. In addition, the Meehanite housing expands and contracts at the same rate as the steel rotors, which makes the pump immune to the end plate seizure that occasionally used to happen to aluminum-bodied pumps of this type at first startup on very cold days. The one drawback of the Waterman pump is that in stock form, this type of pump is prone to cavitate at high RPM, especially if the methanol is hot, as often happens in the summer when you spend an eternity in the staging lanes.

Cavitation causes the fuel pump output, which is normally very closely proportional to pump RPM, to stop increasing beyond a certain RPM. The result is an unexpected and disastrous lean spot at high RPM

After careful investigation on a flow bench, it appears that the observed cavitation results when liquid methanol has insufficient time to fully fill the rapidly increasing volume that is created each time a gear tooth begins to exit the root space of its mating gear. Since both flanks of the gear tooth are still engaged, methanol can only enter this space from each end of the rotor. This explains why larger capacity Waterman pumps, which have longer rotors, tend to cavitate at lower RPM than the lower capacity pumps, which have shorter rotors. The methanol jetting in from each end simply doesn't have time to meet in the middle, so it flashes to vapor, which fills the remaining space. Therefore, to avoid cavitation, it is wise to choose a pump capacity that will just get you by with a .050 main jet in the best air you ever expect to race in. If you race at a variety of altitudes, you might consider owning two fuel pumps of different capacity to better match these widely differing fuel flow requirements.

We have developed a modification to the end plates, which better feeds methanol to the ends of the rotors, and a modification to the housing, which increases the fill time before the inlet port closes. Together, these modifications, along with a properly sized pump, increase the RPM at which cavitation begins to a point beyond the useful operating range of the engine. Be certain that your pump has been provided with a stock housing and end plates, as the modified parts that are available through Waterman are more difficult to rework than the stock ones. If you are comfortable with a die grinder, we can provide you with sketches that define the rework and you can do it yourself. Otherwise, we can do it for you. Beware of patent medicine salesmen, as there are a lot of people out there who will gladly rework

your pump for a fee. The problem is that if they don't use methanol in their flow bench, they can't diagnose the problem, much less fix it. A reliable second source for this fix is Tom Conway. He may be contacted at (405) 382-0205.

FUEL PUMP UNDERDRIVES: While intuition suggests that an underdriven large capacity pump might be less prone to cavitation than a smaller pump driven straight up (1:1), careful testing on a flow bench using methanol proves that the reverse is true. The longer rotor is more of a villain than the proportionally higher speed to which the shorter rotor must be driven to pump the same amount of fuel.

INJECTOR HATS: PSI manufactures three different injector hat configurations:

Our lowered square-port injector has 43 square inches of flow area, and was designed to provide maximum visibility for installations in which you have to see over the injector. With the NHRA 2001 blower overdrive restrictions in place for Federal Mogul Funny Car, this injector should be given serious consideration as it causes only minimal airflow restriction in that operating range.

Our 53-square inch injector was originally designed as a round-port injector for rear-engine dragsters in which visibility isn't a constraint. As the blower evolved and the rules changed to allow more blower overdrive, its original 43 square inches became restrictive, so its ports were squared to provide an additional 10 square inches of flow area. This injector is widely used on Federal Mogul Funny Cars. The tradeoff between this injector and the lowered square-port injector is in visibility versus flow area.

The deep throat injector has 63 square inches of flow area and incorporates a radiused turn into the blower inlet. This injector was designed for rear engine dragsters where visibility is not an issue. Interestingly, this injector has found use on Pro Mod cars because not only does it look outrageous, but also it has a forward-swept rear that actually allows the driver to see the Christmas tree behind the injector.

We manufacture radiused lips that may be installed just ahead of the butterfly plates. They provide a smooth radius that improves the airflow into the injectors, but don't impede visibility because they are within the envelope of the protective "beanie" cover that is part of the blower bag assembly. The lips for the 43 and 53 square inch injectors are made of black anodized aluminum, and the lip for the 63 square inch deep throat injector is made of Dow 7 coated magnesium. All lips are attached with the six #10-24 socket head cap screws provided. The holes for the 43 and 53 square inch injectors may be located by transfer-punching onto the front face of the injector. The deep throat injector is supplied with these holes already in place. All injectors manufactured after 1996 have had their front faces machined to accept lips. If yours doesn't have this machining done, send it to us, and we will do it at no charge provided you pay the shipping. Apply black RTV to all surfaces of the injector that mate with the lip to exclude moisture from this interface. Secure the bolts with red Loctite.

The butterfly plates, their bolts, lock washers, shaft, needle bearings, and stop pins are shipped assembled into the injector housing. The kit includes the hardware that is required to attach the injector to the supercharger. All injectors are made from polished magnesium, and are coated with Dow 7 for corrosion protection.

BOAT APPLICATIONS: V-drive installations require the drive end of the blower to face aft, so the injector hat must be turned around so it faces into the slipstream. We make a reverser plate which fits between the injector and the supercharger and enables the injector to be turned around

ASSEMBLING YOUR INJECTOR: PSI injectors are compatible with Enderle fuel injection system components. It's wise to first install the injector onto the supercharger with the restraint plate in place, as the injector butterfly bores distort slightly when its six installation bolts are tightened against the 0-rings that seal between it and the mating surface of the supercharger. Install two Enderle throttle stops on the splined ends of the butterfly shaft so the stop screws contact the roll pin stops provided on each side of the injector. With the idle stop screws backed off sufficiently to allow the butterflies to close fully, verify that all four butterfly plates seat simultaneously on both the top and bottom edges. If they don't, loosen all 12 butterfly bolts and tap the butterfly plates lightly with your fingertips until simultaneous seating is achieved. Follow this by moving the butterfly shaft back and forth axially to equalize the side clearance between the butterflies and their bores. Caution! Do not open the butterflies when the bolts in more than one butterfly plate are loose and the injector is mounted to the supercharger, because the butterfly plates will slide downward and are difficult to reposition when they are oriented vertically. If this happens, the easiest way to reposition them is to remove the injector from the supercharger and face the butterfly bores vertically. In some instances, the injector butterfly shaft stress relieves torsionally during machining, which results in the butterfly on one end of the shaft remaining slightly open while its opposite is fully closed. To correct this, grab the offending butterflies and twist them as required to straighten the shaft. While this may seem crude, it does work. Apply red Loctite to the injector butterfly screws and tighten. Caution! We don't Loctite the injector bolts prior to shipping the injector because of the need for the above adjustment procedure. An injector bolt that works loose and falls into the supercharger will do more damage than you can imagine. **Don't forget to Loctite these bolts!** Adjust the idle stops so that a .005" feeler gage fits snugly between the bottoms of the butterflies and the injector housing. Be certain that both idle stops contact simultaneously to achieve a consistent idle. Install a Ti-Wrap around each idle stop screw to prevent the stop screws from migrating inward if one of the lock nuts vibrates loose while the throttle is open. This will prevent the 5000-RPM idle that occasionally happens after a burnout or at shutdown following a run.

Before setting up the injector, you need to be thinking about how to cope with icing. Butterflies ice up when high velocity air is sucked through the narrow openings of almost-closed butterflies. This ice rapidly plugs up the gap between the butterflies and their bores at idle, especially in hot humid conditions when the air holds a lot of water. Many teams that normally race in dry weather conditions are caught unprepared when they venture to the south, the mid-west, or the east. If this gap is the only source of air for the engine at idle, the engine will progress from loading up with fuel to actually dying while backing up after the burnout. Windshield de-icing fluid helps, but it isn't the whole answer. The best solution is to provide most of the idle air through openings that won't ice up in the first place. To accomplish this, set the butterfly stops to close the butterflies are as far as possible without allowing them to bind or jam. This minimizes the change when they do ice up. Supply the majority of the idle air through holes drilled in the top center of each of the two middle butterflies, which don't ice up. You may order your injector with thel 1/32"diameter holes already in place, or you may drill them yourself A good tip is to tap the injector hat in an inconspicuous location to accept several plastic quick disconnect fittings. The addition or removal of quick disconnect plugs will allow you to easily make minor idle speed adjustments.

BARREL VALVE INSTALLATION: Be sure that your barrel valve has a pump saver. If it doesn't, get one that does, as the wear and tear it saves the pump at the moment of butterfly closure following a run is worth it. We recommend the Enderle nitro-style barrel valve assembly for blown alcohol applications. Install the barrel valve on the right-hand boss looking into the front of the injector using two 1/4" studs and low profile jet nuts. Use blue Loctite to secure the coarse-threaded ends of the studs in the tapped holes in the injector. These studs and nuts are rather hard to find and are included in our injector installation kit along with the throttle linkage arms and throttle stops. Close the butterflies to the idle stop position and install the Enderle butterfly shaft linkage arm onto the splined end of the butterfly shaft so that it is clocked roughly 45 degrees to the horizontal.

Install the top rod end bearing in the innermost hole on the butterfly shaft linkage arm. **The barrel valve linkage arm should be set parallel to the butterfly shaft linkage arm.** You may have to shorten the hexagonal barrel valve linkage, as the distance between the butterfly shaft and the barrel valve mounting pad is less on some PSI injectors (particularly the PSI funny car injector) than on Enderle injectors. To do this, loosen the two locknuts, remove the hexagonal link, and shorten it as required to allow approximately 1/4" adjustment on each end before the nuts and threads bottom out. It may be necessary to drill and tap the hole in the hexagonal link deeper to prevent the rod end bearing shank from bottoming out

Be sure to rework the RH threaded end, opposite the grooved end, as looking for a LH tap to deepen the LH threads in the other end is a nuisance. Reinstall the linkage.

BARREL VALVE SPOOL REWORK: Staging (5000-6000 RPM, clutch in) with a PSI-supercharged engine requires a lot less fuel than a Roots blown engine requires. The normal setup for the Enderle barrel valve meters too much fuel to the engine at this condition. To correct this, remove the #10-24 bolt that secures the lower rod end bearing to the barrel valve linkage arm and remove the barrel valve piston from its housing by removing the snap ring with snap ring pliers. Don't remove the barrel valve linkage arm from the piston shaft, as you risk losing its clocking. Using an ignition file or two fine hacksaw blades with the ends taped together, rework the "V" notch in the piston to obtain a rectangle that is the width of the present "V" (.080-.090 inches) and the depth of the present "V". The deeper the notch, the leaner the mixture at stage for a given leakdown setting. Measure the distance between the bottom of the notch and the adjacent edge of the inverted "U" shaped cutout immediately beneath the notch. This distance should not be less than .510 inch in order to maintain a closed-center action when setting the leakdown. This subtle feature is important because in its absence, it becomes treacherously easy to accidentally set the barrel valve leakdown on the back side of the barrel valve spool. If you fall into this pitfall, the engine will go very lean off-idle because the barrel valve opening, which is supposed to increase in concert with the butterfly openings, instead decreases. The resulting surprise backfire isn't nice.

When you reinstall the spool, be sure to lightly grease the 0-ring in the brass seal plate, which will make future disassembly a lot easier.

LEAKDOWN: Do this with the injector butterflies fully closed and on the idle stops. Be sure to disconnect the throttle cable when setting the leakdown, as it often causes a small bind that keeps the

butterflies partially open. The leakdown together with the idle return check valve crackpoint determines the idle mixture. Remove the idle return line from the idle check valve and cap the idle check valve. Disconnect the dribbler nozzle line from the barrel valve. **You must disconnect this line when setting the leakdown on this system because with only two or four hat nozzles instead of the usual eight, the resulting backpressure may affect the setting.** Set the leakdown to 78-80% for a starting point. Set the idle return check valve to crack at 20 **PSI.**

After setting the leakdown, and with the leakdown tester still installed, make certain that the leakdown increases as the butterflies are slowly opened. Any tendency of the leakdown to decrease initially followed by an increase is an indication that the barrel valve is set on the back side.

After shimming the poppet to the correct crackpoint, check that the spring is at least 3/16" from coilbind by pushing on it with the end of a screwdriver. If it approaches coilbind, purchase a new spring for the correct pressure range from Enderle.

FUEL SCHEMATIC: Use the enclosed schematic diagram to set up your fuel system. Use the tables to select your nozzle sizes. Brass nozzle holders are preferred because they don't gall, but if you use aluminum nozzle bodies to save weight, install them using Teflon tape.

THE TUNE UP: Use the following information to select the return jets which will flow fuel back to your pump inlet.

–STEP 1. Find the factor from the charts which corrects for temperature, barometric pressure and relative humidity.

-STEP 2. Multiply the Factor by the fuel flow of your pump at 8,000 rpm in gallons per minute, times the tooth count of your top pulley, divided by the tooth count of your bottom pulley.

Factor X fuel flow **X** T(top)/T(bottom) = Step 2

–STEP 3. Subtract 1.0 from the answer in step 2.

Step 2 minus 1.0 = step 3 answer

-STEP 4. Multiply step 3 by your total nozzle area.

Step 3 X total nozzle area = total area of jets returning fuel (step 4 answer)

SPECIAL NOTE: These calculations are for the PSI 206B model. To get the 206A factor, multiply Step 1 by 1.05. To get the 200H factor, multiply step 1 by 1.18.

IDLE RETURN PORT: At idle and when staging, the idle return port located in the barrel valve spool returns fuel through the idle return check valve. Its position plays a large role in setting the correct mixture at staging. To verify, remove the 1/2" hex fitting located directly below the barrel valve spool. Place a .090 inch thick feeler gauge stack under the idle stop screw on the injector to approximate the butterfly position (and therefore the barrel valve position) at the staged condition. The idle return port should be fully open. **The barrel valve must be set to the correct leakdown for this checkpoint to be valid.**

MAIN JET: The most convenient location for the main (return) jet is in the barrel valve. If your pump capacity is so large that a pump loop is required to handle the flow, then place the pump loop jetholder in

either the fuel pump body (Hilborn, Crower, or Waterman pumps), or place it in a tee fitting between the pump and the fuel shutoff. Set the pump loop check valve to crack at 15 PSI.

DO NOT USE A HIGH SPEED LEANOUT. All attempts at this have caused the engine to lay down at 1000 ft. Or so (with obvious consequences if you stay in it). Unlike Roots blowers, the PSI supercharger delivers air in direct proportion to its RPM, the same way that a healthy fuel pump delivers fuel. High-speed leanouts bend the fuel curve down at high RPM and are a sure way to backfire your PSI. Compensating by enrichening the main jet makes the system too rich and therefore lazy at low RPM. Remember that when poppets are in series their crackpoints add. Don't put a return poppet in the port nozzle block, as its crackpoint plus that of the port check poppet can add up to a very crackpoint which is, in effect a high-speed leanout. The result will be a lazy 60' time and/or a lean condition in the top of each gear.

LOW GEAR LEANOUT: Equip your car with a normally-open, air-activated valve that is open whenever the car is in low gear, and is closed whenever it is not. Installing jets between .040 and .080 diameter in this circuit allow you to tune how aggressively the car behaves in low gear. This technique produces lightning throttle response and will develop up to several hundred extra horsepower in low gear that would otherwise be lost to being too rich at the most critical part of the run. This is one of the reasons that PSI cars must run such a tall low gear ratio to avoid either shaking or outright smoking the tires in low gear. The airflow curve of the D-model PSI supercharger is actually concave upward, which means that while it delivers some really serious airflow at low RPM, the airflow more than doubles when the engine RPM doubles. Since the delivered flow of even an ideal fuel system at best doubles when the engine RPM doubles, the resulting fuel mixture progresses from rich at low RPM to just right in the midrange, to lean at high RPM. If you look at a computer graph of engine RPM on a typical run, you will notice that the engine spends most of its time at low RPM in low gear. Since this is where the fuel/air ratio is rich, it stands to reason that the engine might run better if this problem was corrected. While it's true that the engine enters a lean zone at the top of low gear, it spends so little time there that the spark plugs don't have time to heat up sufficiently to cause pre-ignition. Attempting to avoid this non-problematic lean zone by closing the valve with a timer instead of waiting for the 1-2 shift leaves the door open for trouble if you have to short-shift second gear before the timer activates, as you'll be in second gear with the leanout valve open. The engine remains in the same fairly narrow RPM range in both second and high gear. Therefore the fuel mixture progresses from slightly rich at the bottom of these gears, to just right, to slightly lean in the top of these gears.

STARTING THE PSI: Prior to starting the engine for the first time, thoroughly spray the interior of the supercharger housing with WD-40 or equivalent. The white-colored anodize on the housing components is porous, and absorbs the WD-40. The Nylatron tip strip seals that are installed in the rotors are there to accommodate the normal deflections that the rotor bores undergo as a result of the forces, pressures, and temperatures to which they are subjected during operation. Nylatron will smear itself onto an unlubricated anodized surface and then gall the tip strips. The WD-40 prevents this, but unfortunately, the hat nozzle flow rapidly washes it away. For this reason, you must spray WD-40 into the injector for the first 30 seconds after your first fire-up to maintain this lubrication. The resulting smooth burnish on the tip strips speaks for itself, and needs no further attention.

Using our schematic and the steps below, set up your fuel system to run a half pass, then check your spark plugs (or computer) for signs of lean or rich cylinders.

At idle, the 6-PSI check valve in the dribbler system keeps the manifold vacuum (which is greater with larger engine displacement and shorter camshaft duration) from drawing the fuel away from the hat nozzles. In addition, the fuel flow through a hat nozzle at idle is increased by the vacuum that exists within the small chamber inside an airated hat nozzle. Using hat nozzle bodies that have more than one 1/8" diameter vent hole reduce the vacuum in this small chamber and therefore causes the nozzle to meter less fuel at idle than it would with just one hole. The nozzles are sized to work with nozzle bodies with just one vent hole. **The blower should be cold behind and beneath the hat nozzles at idle. Additionally, the two indentations in the supercharger rear cover on either side if the burst panel should remain comfortable to the touch while the engine is idling.** A useful reference temperature is that the inside of your elbow is usually 94 degrees F. When firing the engine for the first time, installing only one burst panel allows you to accurately monitor the blower discharge temperature. Having both burst panels installed acts a little like a thermos bottle, with the pocket of dead air between them insulating the outer burst panel from the inner one.

At staging RPM, the two airated hat nozzles and dribblers should be flowing, but not the port nozzles. To verify this, remove the -8 port nozzle line and the port check valve from the distribution block. At staging RPM, no fuel should drip from the port check valve. If fuel leaks into the port nozzle system during staging, it drips into the ports on a random basis and makes it impossible to obtain repeatable staging temperatures in each cylinder.

If the port check still cracks at too low an engine RPM, it may be because you are trying to deliver more fuel than the two flowing hat nozzles and the eight flowing dribbler nozzles can accommodate. First, check the exhaust gas temperatures as described in the next paragraph. If they are significantly lower than 500 to 700 degrees F, the engine is too rich. It's not possible to lean the engine at this condition by reducing the dribbler nozzle sizes, because the barrel valve determines the flow at part-throttle conditions. Reducing the dribbler area increases the pressure downstream of the barrel valve, which spills more fuel into the port nozzles, which aggrivates the problem.

If you have a computer on the car, bring the engine to either staging RPM or the RPM at which the port nozzle check starts dripping, whichever is lower. All eight exhaust gas temperatures should be fairly uniform and should be in the 500 to 700 degree F range. Slight variations from cylinder to cylinder may be corrected by adjusting dribbler nozzle sizes. Remember: Unflowed nozzles tend to vary considerably

If the average temperature is too low, the system is too rich at stage. Assuming the idle mixture is correctly set, remove the barrel valve spool, file the rectangular slot (previously the V-notch) deeper (not wider), reset the leakdown and repeat. Caution! Maintain a minimum of .505 inch between the bottom of this slot and the underside of the inverted "U" on the underside of the barrel valve piston. If this doesn't go far enough, again remove the barrel valve spool and drill the idle return hole out to 1/4" diameter. A useful tip is to use the pump saver hole, which is also 1/4" diameter and is in line with the idle return hole, as a drill jig. Deburr the hole prior to reinstalling the barrel valve spool. If this doesn't suffice, verify that the corresponding port in the barrel valve is 1/4" diameter. Some early Enderle barrel valves were manufactured with 3/16" diameter ports. It is not advisable to drill this hole out, as the

resulting unanodized aluminum will rapidly corrode, as this component remains full of methanol until it is blown out or disassembled.

The PSI puts less than half the heat into the air/fuel mixture than you get from a Roots blower. This means that the engine runs much leaner without damage, and this shows up as follows:

a) During the transition from staging top wide-open throttle, the engine doesn't need nearly the amount of fuel that Roots-blown engines require.

b) The reason Roots-blown engines need a lot of fuel injected into the hat is to cool the charge inside the blower. With a PSI, you don't need to put as much fuel into the hat. In fact, doing so will give you a lot less control over where you're putting liquid fuel into your cylinders, and make your fuel system a lot harder to tune.

REGULAR PSI MAINTENANCE

Since you have a PSI, you won't be replacing tip strips every run or two. Your regular maintenance will consist of propping the butterflies open after every run to allow the methanol vapor to evaporate and thereby prevent corrosion. Be sure to use a prop that is too long to fall into the injector, for obvious reasons. It's good practice to leave them propped open overnight as well. Also, while preparing the car to go to a race, glance at the oil sight glass located on the gear case to make sure there's oil in the gearbox.

Every three years, you must return your blower to PSI for re-certification per the SF1 rules.

That's about it.

1.92 OVER FIC

cC

HAT ,0 0 q

2 - .080 IN AIRATED NOZZLES

2 - .080 IN 30 PSI CHECK NO77LES

AREA
.0201 IN

FRONT

r •

	D		P			P		D	
1734	.047	1	.048	1884 P 375 1661		.046	2	.050	1963
1963	.050	3	.047	1734 397 853		.049	4	.050	1963
1963	.050	5	.046	D 1661 3019		.062	6	.050	1963
1963	.050	7	.051	2042 1885		.049	8	.050	1963

DRIBBLER AREA = .0155 IN

PORT AREA = .0157 IN

.0201 IN
.0155 IN
.0157 IN

TOTAL AREA .0513 IN ✓

3/c; f-fa?
3 it"? Z
'3 ((If

DRIBBLER CHECK = 6 PSI
PORT CHECK = 20 PSI
IDLE RETURN = 20 PSI
PUMP LOOP = 20 PSI ,2s

MUST USE STOCK
MANIFOLD PLATE

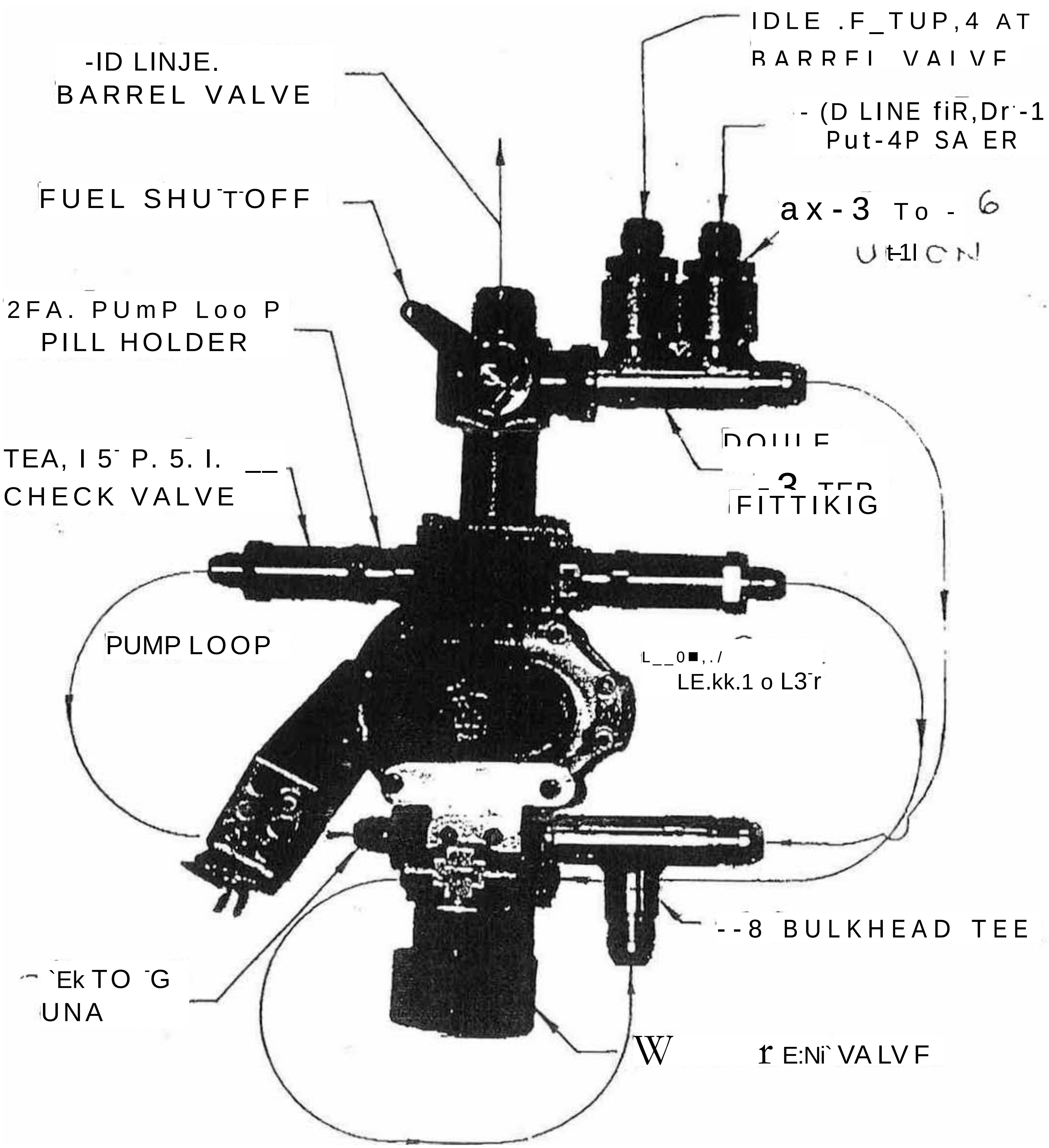
USE A NORMALLY-OPEN AIR-CONTROLLED VALVE CONNECTED TO THE LOW GEAR SHIFT SERVO LINE TO OPEN A .060 JET IN LOW GEAR - NO TIMER

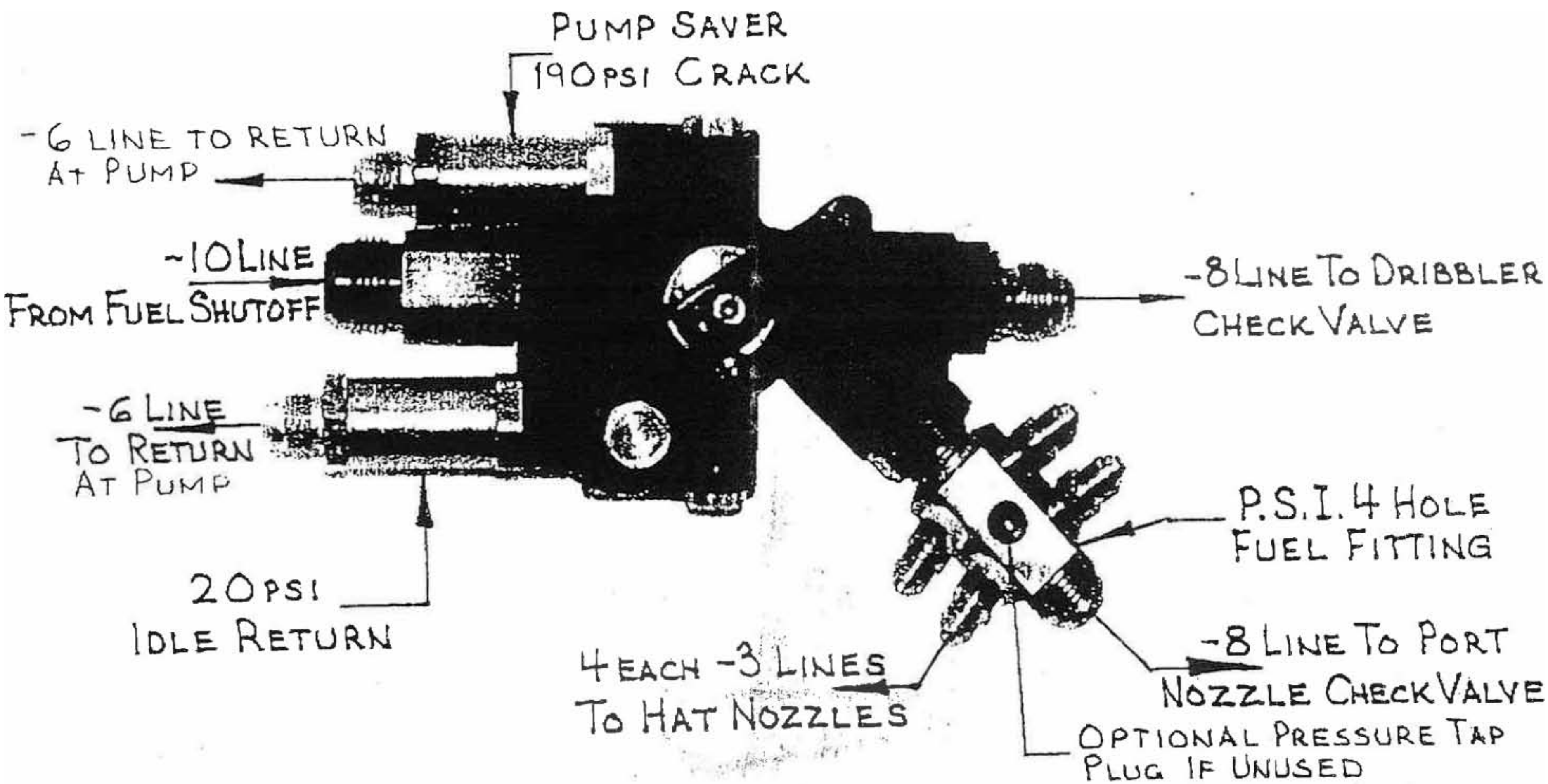
RECONTOUR SPOOL VALVE PER SKETCH, 750 WATERMAN PUMP. SET SYSTEM FOR 14.5 GPM 8000 ON 1500' DAY.

4.30 REAR GEAR, HOOSIER TIRES, 1.60 TO 1.76 LOW GEAR

LEAK BARREL VALVE TO 75 - 80% AS REQ'D TO OBTAIN APPROX 165 DEGREE F.. HEAD TEMP AT WARMUP.

ALCOHOL -/C
VIATERNIAN FUEL SUM p D IA 6RA





ENDERLE BARREL VALVE PLUMBING DIAGRAM

ALCOHOL F/C

Jet	Size & area				
50	=.001963				
51	=.002042=3.87%	more	than	50	jet
52	=.002123=3.82%			51	jet
53	=.002206=3.77%	"		52	jet
54	=.002290=3.67%	"		53	jet
55	=.002375=3.58%	"		54	jet
56	=.002463=3.58%	"		55	jet
57	=.002551=3.45%	11		56	jet
58	=.002642=3.45%	Ti		57	jet
59	=.002733=3.33%	"	11	58	jet
60	=.002827=3.33%	more	than	59	jet
61	=.002922=3.26%	"		60	jet
62	=.003019=3.22%	"	VI	61	jet
63	=.003117=3.15%	"	11	62	jet
64	=.003216=3.08%	"	"	63	jet
65	=.003318=3.08%	"	11	64	jet
66	=.003421=3.02%	"	"	65	Jet
67	=.003525=2.96%	"	"	66	jet
68	=.003631=2.92%	"	11	67	jet
69	=.003739=2.89%	"		68	jet
70	=.003848=2.84%	more	than	69	jet
71	=.003959=2.81%	"	"	70	jet
72	=.004071=2.76%	"	"	71	jet
73	=.004185=2.73%	"	"!	72	jet
74	=.004300=2.68%	"	"	73	jet
75	=.004417=2.65%	"	"	74	jet
76	=.004656=2.58%	VI	11	76	jet

78 " # 77 jet
=.004778=2.56% " " # 78 jet
79 =.004901=2.51% than # 79 jet
80 =.005026=2.49% # 80 jet
more " # 81 let
81 " " # 82 jet
" 11 # 83 jet
=.005152=2.45% „ " " # 84 jet
82 =.005281=2.45% " " # 85 jet
83 =.005410=2.39% " " # 86 jet
84 =.005541=2.37% " " # 87 jet
85 =.005674=2.35% " # 88 jet
86 =.005808=2.31% more than # 89 jet
87 =.005944=2.29% " # 90 jet
88 =.006082=2.27% " # 91 let
89 =.006221=2.24% " 1 # 92 jet
90 =.006361=2.21% " # 93 jet
91 =.006503=2.19% " # 94 jet
92 =.006647=2.17% " # 95 jet
93 =.006792=2.14% " # 96 jet
94 =.006939=2.12% " # 97 jet
95 =.007088=2.11% " # 98 jet
96 =.007238=2.08% more than # 99 jet
97 =.007389=2.05% " # 100 jet
98 =.007542=2.03% " 11 # 101 jet
99 =.007697=2.02% " " # 102 jet
100=.007853=1.99% " " # 103 jet
101=.008011=1,98% " " # 104 jet
102=.008171=1.96% " " # 105 jet
103=.008332=1.94% " # 106 jet
104=.008494=1.91%

105=.008659=1.91%
106=.008824=1.87%
107=.008992=1.87%

	" "	# 107 jet
	" "	# 108 jet
		# 109 jet
108=.009160=1,84% "	"	# 110 jet
109=.009331=1.84%	"	# 111 jet
110=.009503=1.81%	"	# 112 jet
more than	"	# 113 jet
111=.009676=1.79% "	"	# 114 jet
112=.009852=1.79% "		
113=.001002=1.68% "		
114=.001020=1.77% "		
115=.001038=1.74% "		

Exampal 100 jet to 99 jet, divide area 7697 into 7853=98.01 subtract that # from 100.answer, 1.99%

to get right jet find percent **of altatued change, and** find jet **that corosponds with that** change, **using .083 jet as base @ 1507 ft.corected alt.**