This by Stevan Davis, FV80…May 2017

Jim Schings has now retired and closed his RaceCarSupply business.

He created this FV Manual for the good of the class and has now released it to the public domain and I have made it available on the FormulaVee.us website. There might also be other links to it from other Vee related sites.

I have read it through and corrected a few typos and 'lined out' a few items or made other minor changes due to rules changes since the 'book' was last published. I wish to thank Jim for his original effort as all 'newbies' should find this document invaluable.

You may contact me via email to recommend changes/corrections to this document.

Steve@WedgeRacing.com

I should also mention that Jim has digitized a complete VW Bug parts manual with all of the part numbers with drawings and illustrations. This info can help a LOT in getting the correct parts and getting them installed correctly.

Jim is offering this to anyone that wants it on CD for $25 including shipping (to the U.S.A.). Contact him directly
(info bottom of page below).

Getting Started In Formula Vee

(w/ Formula First and Vintage Vee Updates)

Greg Schings

Jim Schings

RaceCarSupply

Equipment for all levels of Motorsport

SR Racing

~~100 Mercer Ct~~
~~Suite 120~~
Lexington, KY 40511
859-252-2349
sracing@mindspring.com
www.sracing.com
~~www.RaceCarSupply.com~~

Forward

First, let me start out by saying how this got started;

We have sold lots of Vees (new and used) over the years to people who were just getting started in racing and they all asked for the same information on how to maintain their car. So, I ended up writing down all the attached information. I eventually put it all into a word processor so I could re-print it. When I wanted to make it more formal, I just kept adding to it and gave it to anyone who wanted it. Eventually, I received calls from SCCA club schools who wanted to know if they could reprint it for their students. Then, SportsCar Magazine called and wanted to know if they could publish it. Wow! I was really on to something here. So we decided to enhance it even more and offer it for sale.

This is not a document for someone who is an expert in Vees and their maintenance. There is nothing technically wrong with it. It's just basic. However, that is all most people need to get them through a race weekend or even a session. I acquired half the info in this manual from lots of folks, and I thank them for that. The other half we stumbled upon the hard way. So, maybe you can save a few sessions, dollars, or red faces that we didn't.

The great thing about Vee racing is, that if you are willing to try "at the track" maintenance work, there are other Vee guys (or vendors) around that are more than willing to help you out. If you have read this material, you won't come across as too much of a rookie.

All the steps here can be performed with normal tools, some mechanical knowledge, and the assistance of a Type 1 VW Manual. I recommend the Haynes VW 1200-1600 Beetle Manuals. You will probably have to have it special ordered. However, almost any maintenance manuals covering the 64-65 vintage VW Type 1 1200 engine / drivetrain will be adequate.

If you wonder about why you are doing any particular step, I have enclosed some reasoning in *Italics*. I have also included some scientific facts, hidden among subjective statements. You will have to determine which is which. Then write your own book and reverse them.

~~Feel free to write or call with suggestions or corrections to this book.~~ You can even feel free to call me if you just want me to explain or clarify something. Maybe I can sell you a part or two.

Getting Started in Vee Racing

Why Vee ?

Relatively fast. One of the cheapest forms of wheel to wheel road racing. Camaraderie of drivers. Ease of maintenance. Reliability. Parts availability. You can fit 2 of them in a single car garage. A crew of 1 is plenty. And… everything you need to know in the beginning is in this ~50 page manual!

About the Vee Class

The Vee class started in 1963 (SCCA. There were other versions as early as 1962). Much has changed in the rules since then, but far less than most any other class or venue. It is based upon the VW 1200 (1192cc) drive train and front suspension. The car with driver must weigh 1025 lbs. or more after each session. Rear suspension is unlimited, but must be an original VW swing transaxle and wheels/rims. Tires are unlimited. (No radials). Front suspension must be based upon the original Type 1 link pin beam from rim to rim. Torsion rods or springs within the beam are unlimited. Shocks, unlimited, provided they mount on the original VW mounting points. Original or standard VW steering box must be used. The engine is largely stock with GCR (General Competition Rules) with allowed lightening and "blue-printing". Some electronic ignitions allowed. (Drop in points replacements that fit in the distributor). Engines typically develop close to 60hp peak.

No aerodynamic devices for the purposes of down-force are allowed.

The GCR and Formula Vee supplements provide the details on what you are allowed to do. If it doesn't specifically say you can, you can't.

While limiting what you can do to your engine and car, it keeps the price very competitive, reasonably priced and makes drivers the key factors in winning.

(Also, see "Formula First", later in this book.)

Budget

You're here, so I assume you are still interested. The next thing you should do, if you haven't already yet, is to find a Vee racer in your area. (Contact your local SCCA Club and they can provide you names. Or call us.) Call him up, introduce yourself and ask if you can crew at a race for them. The answer will be, "Yes". Attend the race, learn from them, introduce yourself to other Vee racers and ask lots of questions. The Vee guys love to help each other out and want to talk about their cars. Most people are over looking at the GT-1's or Formula Atlantic's, so the Vee guys are lonely.

If it's still what you want to do, continue.

While Formula Vee is about as inexpensive as you can get, no wheel to wheel racing is cheap. So here is some information that will help you see how realistic it is for your wallet.

You will have to determine where the closest tracks are, your method of transportation, accommodations and sustenance arrangements.

Capital Costs

FV Car	~$4000 - $16000	*(See "Buying a Car")*
Trailer	$ Free - $3000	*(A trailer may be a part of the car package)*
Fire Suit	$350 - $800	
Helmet	$250 - $500	
Gloves, Arm Restraints, socks, etc.	$100 - $200	
Spare Parts	$300 - infinity	
Rain Tires	$800	*I include as a capital item since they might last for 4 or 5 years (not absolutely required.. you could sit and watch for that session).*

So, your up-front investment before you sign up for you first race or school will range from $5500 (not very realistic) to $20,000+ (a bit of an overkill). You can prorate this out of course, since most of the above can last 5 plus years. When you decide to move on to sky-diving, much of the above can be recouped when you sell it. Still with me?

Before you can actually get a Novice permit, allowing you to do a Regional race, successful completion of 2 SCCA schools, or the equivalent professional school is required (Check with the school before registering.) There are exceptions to this. If you have prior racing experience, one SCCA school may be waived. Check with the school and your Regional Competition License Director. The entry costs of SCCA schools are approximately the same as a normal race. You, of course, have to provide your own race car .. or rent one. Other SCCA accredited schools usually require use of one of their vehicles (and, of course, are more expensive.)

Expense Costs per Weekend

Entry Fees	~$300 - $700	
Tires	$400*	*(Assumption of 2 weekends per set. This will vary greatly, but generally plan for this.) (In some Vee racing (Vintage and Formula First, etc.) a spec tire may be used that might last up to a full season of racing.)*
Oil / Filter	$40	*(Change every other race weekend)*
Fuel	$75	
Crash Damage	$100	*(Wild estimate. Most weekend $0, But maybe a nose, wheel, tire, etc.)*
Engine Wear	$250**	*Assumes a rebuild every 10 weekends.*
Misc Supplies	$150	*Rags, hardware, T-shirt at the concession stand., etc.*
Accommodations	$50 - $300	*Hotel, camping at the track, pack your own sandwiches, etc.*
Transportation and Food	?	*Fuel to the track alone, might be $300 or more*

* By careful heat cycling and rotations left to right, in cooler temps and smooth tracks you might get 3 weekends out of a set, overall.
** If you do your own rebuilds, this dramatically reduces engine costs.

Buying a Car

Where? Check the classifieds in SportsCar Magazine. (Subscription provided with your SCCA membership.) Ask the guys at the track. Check the Internet. (Even on EBAY). Try our website at:

http://sracing.com/ForSale/forsale.htm

Some more here:

http://formulavee.org
http://www.apexspeed.com/forums/forumdisplay.php?98-FV-amp-F1200-Classifieds-Cars-For-Sale

A turn-key Vee can be purchased for as little as $4000. However, usually this price of car will either need some work and/or not be very competitive. Many times a car includes a trailer and/or some spares. (additional wheels/tires, rain tires, body parts, engine parts, etc.) We have purchased cars where the spare parts alone were almost worth the price.

If you haven't raced before, the main thing you are looking for is mechanical reliability. Even if you can't get to the podium with it, you will have fun and find someone on the track to race with. In a year or two, you can buy a fast "National" car. You can probably sell old reliable for what you paid for it. You need to **finish** to get near the podium. Unless you just cannot afford more up front investment or just love to work on them, I suggest a middle of the price range reliable car.

Note that many times an engine will be referred to as a "National" or "Regional". There is no real defining point. But typically a "Regional" is probably on the low end of competitiveness. It however, may be able to be improved, so don't eliminate it.

Many times a car is offered as a "Roller". This simply means that it has no engine, but should be ready to race other than that. See "Engine Stuff" in this book for more info.

Sometimes you will see "Slider". This is typically a car with no engine and no transaxle or rear suspension.

See if you can get some history on the car. Check the logbook (Make sure it has one) for crash damage, talk to the engine builder, prior owners and other Vee racers in that part of the country. We are a close knit group, and we usually know a little bit about the other guy's car that we race with. Preferably get a car that the manufacturer is still in business or parts are available for it. (Mostly body parts). Most anything else is easily fabricated if needed. Try and find a car that has been raced recently (with SCCA tech inspection stamp in the logbook). You will then know that it has the required safety upgrades. Check the seat harness system dates. You have to replace it periodically. Have your buddy (remember the guy you crewed for) take a look at it. Sit in the car. Does it fit well? Will it fit you when you put on 10 lbs? Is your head (with helmet) 2 inches below the roll bar? Also your helmet should be below a straight line drawn from the top of the front roll hoop to the rear roll hoop. Check your GCR for current rules. Many Vees have some adjustably in the seating, pedals, etc. However there are some Vees that some people will never be able to fit into.

Consider the spares that come with the car. You may want rain tires. Do they come with it? How about some used decent tires to get you through your school or first race weekend. (Don't buy new tires for a school or your first race. You won't be winning either of these events.)

After you think that's the car you want, negotiate. Just like you did for your street car. If you buy it check to see if he has any set-up info with it. Maybe from the original builder or manufacturer.
If you have lots of money, know you will love Vee racing, and are going to be a top notch driver, by all means, go big time. Get a new car or kit with a big motor. That too can be sold later if you made a mistake. However, the depreciation will be greater.

Trailer

You have lots of options, depending upon your budget. Anything from a 10 ft open trailer to a 24 ft dual axle, closed trailer. (Anything more is a bit egotistical for a Vee guy.) Your trailer is a lot like your garage. No matter how big you build it, your junk will expand to fill it. In spite of that, I would buy a trailer like I buy the Vee. Go cheap with reliability. Get an open trailer with a tire rack. Next season you can sell it for what you paid for it. If you do go with a closed trailer, get something that you have a resale market for. A 12 ft trailer won't hold anything but a Vee, Kart or Snowmobile. Go to 18 or 22 ft. You have a much better resale capability. Once you have decided to go closed trailer, the incremental cost per foot is not that much. REMEMBER your towing capability. You can tow a Vee on an open wheel trailer with a decent mid size car. More than that and you need a **real** tow vehicle.

I won't cover trailering safety here, but make sure you have an adequate tow vehicle, hitch, braking equipment and good weight distribution. It's bad enough to wreck on the track. Wrecking on the way there is not nearly as fun.

Renting

Before you mortgage the house... you have another option. Renting. Depending upon the area you live, FV rentals are available. At first glance rental prices may seem very steep, but after recognizing that you won't need any of the above tools, parts, tire, fuel etc. and a crew is even provided, renting may be the way to go. A rental weekend will run you $1000 to $2000, but if you decide racing isn't for you, that is all you are out,. Note: that you will be responsible for some or all of any crash damage. Check your contract. Call us. We might have a rental available or can steer you in the right direction.

Sponsorship

This will be the shortest section of the book. You will be amateur racing on a road course with no or very little real media coverage. All of these things mean that you can do little for a sponsor and he will probably do little for you. Even in major media covered pro racing, as often as not, it is who you know, who your dad is or who your sister married to find a sponsor. There are few things possible though:

1. Is your dad etc. self-employed and has a few bucks? If so he is certainly IRS eligible to be a sponsor of your car and put decals on it for a tax write-off. That also goes, of course, for your sister's husband.

2. If YOU operate a business in the racing industry, you too can get a write-off. (i.e., any of your profits can be offset by your racing expenses for tax reporting purposes.) Check with your accountant. It has to be a serious business intent. If you are not in the racing business, it can get a little sticky. Again check with your accountant. The IRS is watching you. AMWAY sales people

beware.

3. Contingency Awards. There are a few of these available for Vee guys. Tire manufactures and engine builders often offer free products or rebates when you win a race. Typically it consists of a free tire or two or a $50- $100 discount.

4. Many consumable manufactures (oil, spark plugs, etc.) will often give you free products in decent quantity. Send them a request with your racing history, intent, what you want, and a picture of your car.

5. Last but not least, put together a sales package: Info on you, Formula Vee, etc. Send it out. You may get surprised… If you live near a track and there are local businesses nearby (parts stores, hotels, restaurants, etc.). they may in fact like to have an ad on your car and pay you "something" for it. Keep in mind, that it is not their ego. They would like something in return: Business. Make sure you send people their way and have them tell the sponsor you sent them.

In this vein, before we were in business for ourselves, we had a battery manufacturer send us 12 batteries. An oil company sent us 86 quarts of lubricants .We even got free meals at a restaurant for crew and us for the season. We even gave the owner a checkered flag and trophy from our event. He posted them on the wall of his restaurant with a picture of the car. He was happy and we were happy. I had a customer once go to a large thoroughbred horse farm for sponsorship. He actually received a couple entry fees and a check for a new set of tires. I think they just wanted him to leave. But, persistence can pay off.

The point is, in this venue you probably won't get a season sponsorship, but there are a few dollars that can be made or offset. The OTHER point. If you NEED sponsorship money…you can't afford Vee (or any other kind of) racing or, you are spending too much on it.

Engine Stuff

If you don't have a Vee and are just reading this stuff to get started, let me recommend something. **Don't build your first engine by yourself**. Buy a professionally prepared one. You are going to do things to an VW engine on the track that the designers never foresaw. If you build one precisely as per the VW manual, you won't go fast, and you won't go long. **Buy your first one**. Then you can take it apart when it's ready for rebuild and see all the secrets. You can then re-build it and/or buy a new one. Even then, without a dynamometer, flowbench, machine equipment, etc. you will have a difficult time, but you can get closer.

Differences Between a Stock 1200 and a Racing 1200

This won't give you enough information to build one from stock in itself, but will give you some ideas of the differences.

1. Ported flowbenched heads.
2. A dimensionally true high quality engine case. (Note that the case typically used is the 1600 Universal case. It has larger oil galleries, heavier webs, and dual oil reliefs.)
3. Precise rocker arm geometry and lightened rocker arms.
4. Heavy duty valve springs
5. Oil Flow restrictors
6. Lightened/balanced pistons/rods with cut cylinders to match.
7. Intake manifold, acid etched, enlarged, and polished for flow.
8. Carburetor with lots of modifications and re-tuned.
9. Oil Windage System
10. Oil Sump modifications
11. Special designed piston rings
12. Valve Cam timing changes.
13. Lightened flywheel
14. All components machined to optimum balance and legal weight
15. Certain GCR allowed changes in components. (Rocker arms, push rods, distributor, etc.)
16. Dynamometer tuned (timing, mixtures, etc.)
17. And most importantly, a professionally built engine will be SCCA legal. It is very easy to innocently build an illegal engine.

Horsepower, Torque, Dyno's and Flowbenches

Skip this if your Ph.D. is in physics. As a matter of fact, skip this if you stayed awake in high school physics.

Torque is a measurement of force. Horsepower is a measurement of work performed in a given amount of time. A dynamometer is a very simple device that tries to load the engine output shaft with friction, usually via a water impeller. (There are other forms of loading also.) The amount of force on this impeller is measured in foot lbs of force. Here is where the physics come in. Trust me on this. Horsepower is equal to Torque times RPM divided by 5252, So if we run an engine on the dyno at full throttle, and it takes 53 lbs of force to hold the engine at 5500 RPM, the engine is developing 55.5 hp at that point. (53 x 5500 / 5252 = 55.5). Got that? The dyno only measures instantaneous numbers at

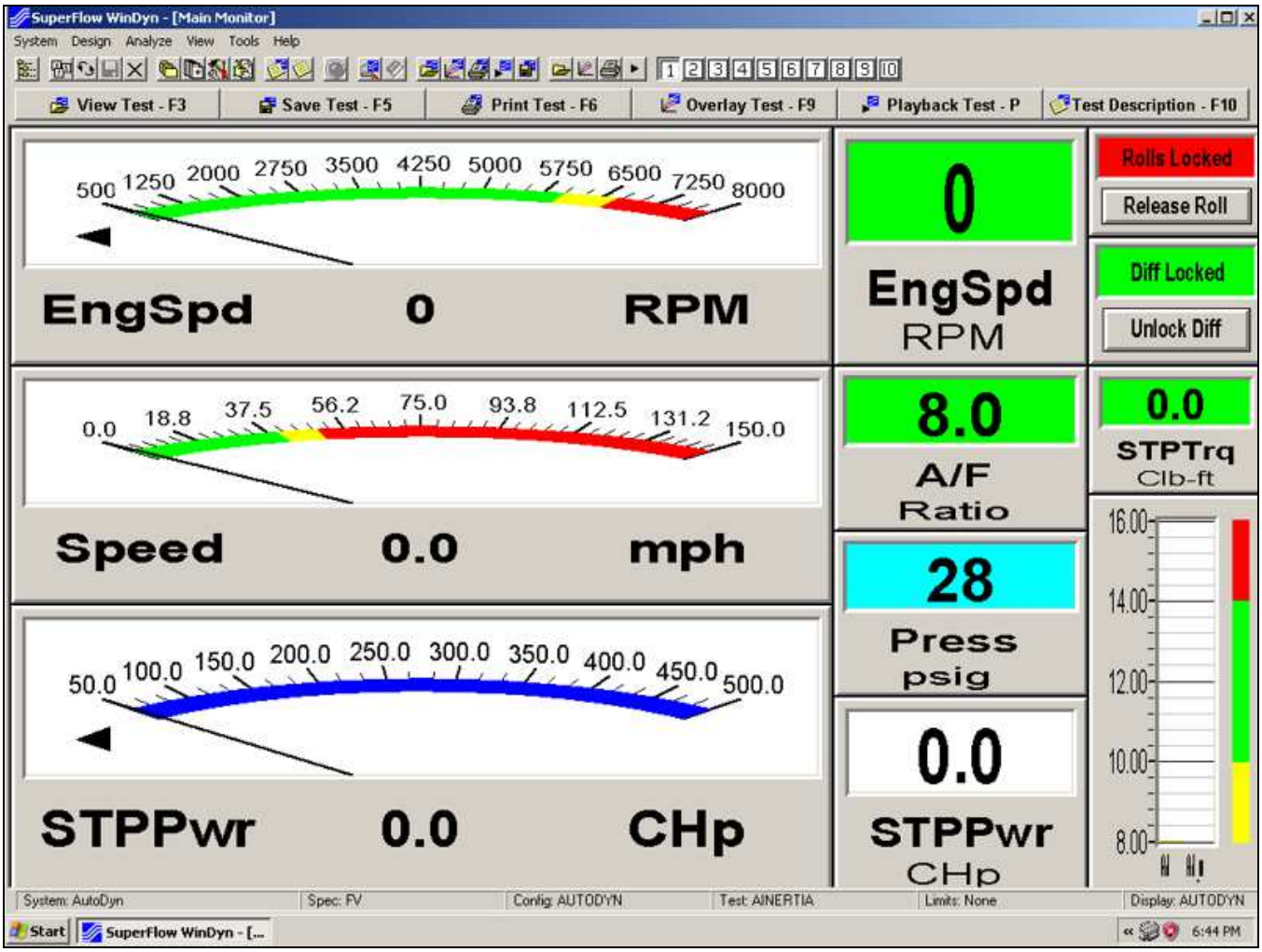
several points throughout the tested RPM range. (Usually every 100 RPM). In theory an engine could be designed to develop 65 HP at 6000 rpm, yet only develop 40 HP at 5000 RPM. So you got a big 65 HP engine. Yet you would probably prefer an engine that could develop 55 HP from 5000 through 6500. So when someone says they got 60HP on the dyno, in itself may not mean much. What you are really interested in is how fast the engine accelerates under load from 4000 to ~6700.

Regarding the numbers that may be provided to you. Because engines develop more or less horsepower depending upon the air density, humidity and ambient temperatures at the time of the test, there are accepted fudge factors to bring these numbers to an "equal playing field". For example, if I dyno an engine here in Lexington (~900 ft above sea level), on a dry winter day, I will get much higher numbers than someone doing the same test on the same engine in Denver on a humid warm day. So we apply factors (or our computer does it for us), called SAE or STP to equalize the numbers. Don't worry, as long as the accepted factors are applied, it will work out pretty close when we bring the engines together to the same track on the same day.

I know everyone wants that last ¼ HP out of your engines and at less than 60 HP, it sounds like a lot. Go back to the math in the first paragraph and listen to this; When your buddy says he gets ¼ more HP when he runs blue plug wires instead of yellow ones.. Using the above torque figures, only 24 more RPM would be that ¼ HP. Maybe he sneezed on his tach.

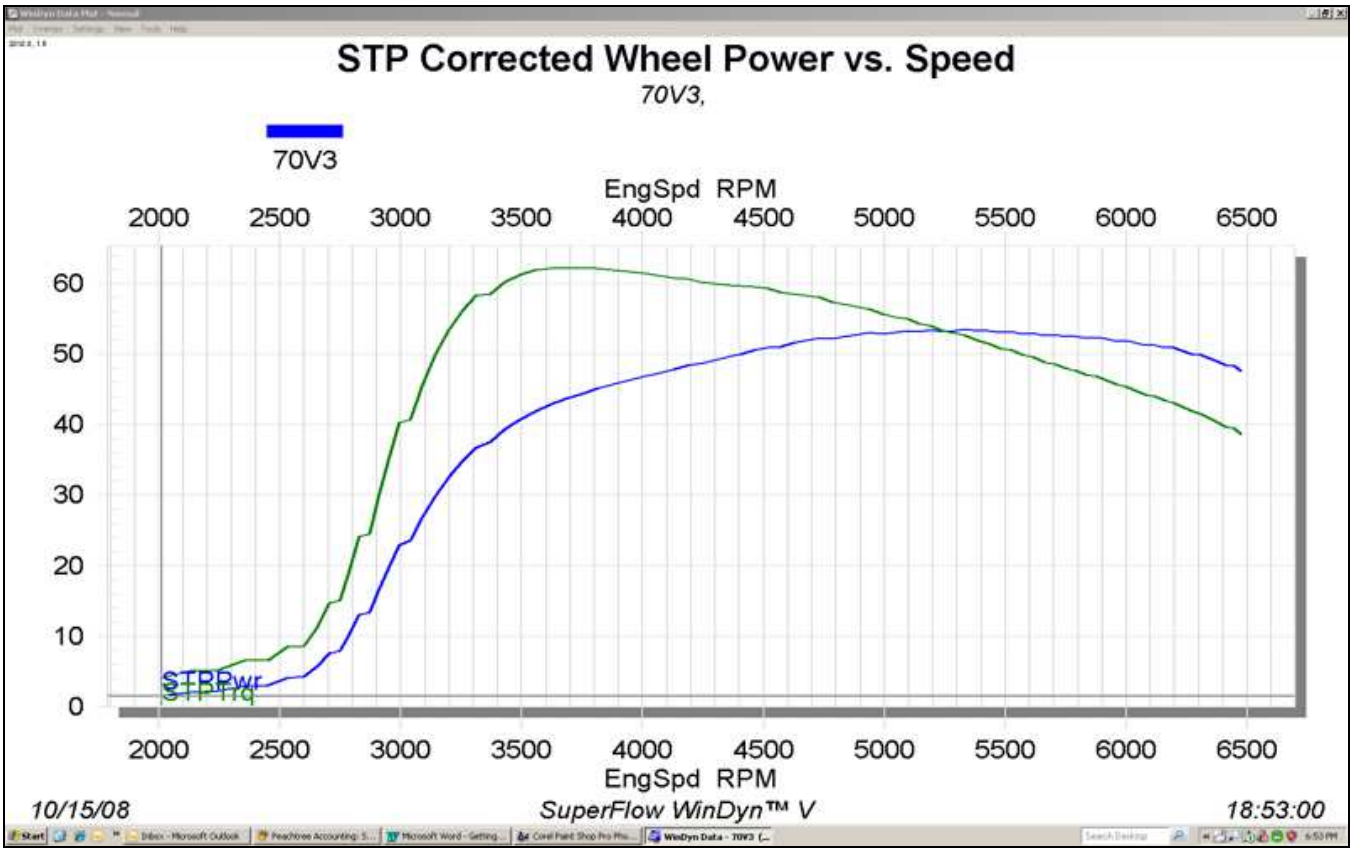
One last item of physics; To accelerate a 1025 lb. mass from 80 to 100 mph in 4.00 seconds takes 56.025 HP. 56.275 HP (1/4 hp more) will allow him to accelerate from 80 to 100 in 3.982 seconds. (So, he probably won't even get by you.)

Another thing you will hear; "This dyno reads higher than that dyno", etc. As I said above, a dynamometer is a very simple device and very easy to calibrate. If two dynos run the same engine in the exact same environmental conditions, they will read exactly the same, **or they are not calibrated correctly**. We are only measuring torque and RPM. Both are easily verified and calibrated. Easier than checking your bathroom scale. If you put a known 100lb weight on it, it should read 100lbs, right? A dyno is calibrated almost the same way. An accurate tachometer is the only other item needed.



Dyno Screen 1

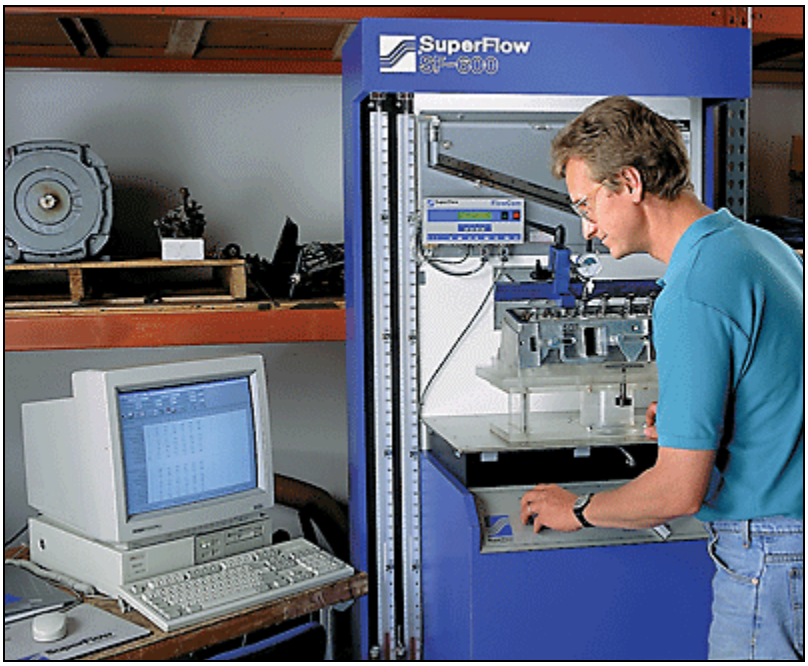
Here is an image of some of the items that can be viewed and logged on a typical **chassis dyno**. This one is set up to view, RPM, Wheel Speed, HP, Air/Fuel Ratio and Oil Pressure. Other screens provide BSFC, Clutch Slip, EGT's, Oil Temps, and more. All these items are used to make sure the engine is tested at proper operating conditions and for tuning of the carb, etc. (An **engine dyno** is similar but usually with much more data collected on multiple screens.



Dyno Screen 2

This is a sample printout of just HP, Torque and RPM. This is from an actual FV on the chassis dyno. The resultant HP peaked at about 53.1 at 5200 RPM. This engine averaged 51.8 HP from 4500 to 6500 RPM. On an engine dyno, the peak HP would be closer to 58 HP. We are seeing about 5 HP loss in the drive train. This is a very good engine and trans.

Please note that the Torque and HP lines cross at 5252. (Remember that physics lesson back a few pages ago?) On all reciprocating engines, HP and TORQUE are equal at 5252. Any dyno chart you see should show this crossing. If not, something is wrong.



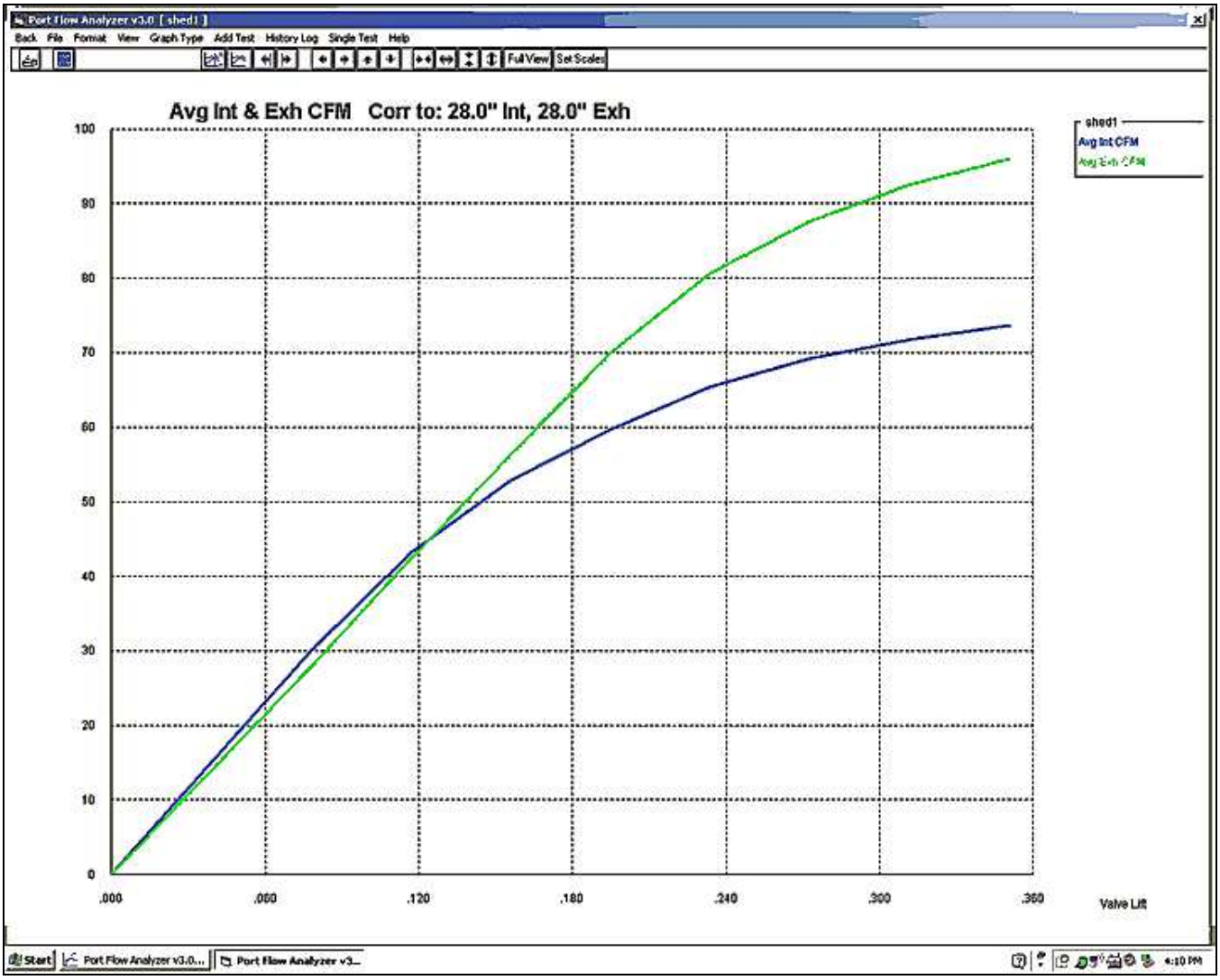
Flow Bench 1

Air Flow and Flowbench

The more air you can get into your engine and the more waste you can get out is the single biggest factor in determining the work (HP) that your engine can do. So, a Flowbench is a tool that is used to measure the capability of the carburetor, intake, heads and exhaust system to do just that. If two engines are developing the same HP at the same RPM point, it really doesn't matter if one has a 65cfm* manifold and the other has a 67cfm manifold. However, you can safely assume that at SOME RPM point the 67cfm manifold will develop more HP. (all other things being equal)

On the next page is a typical graph of a Vee head flow (intake is green, exhaust is blue). The graph shows CFM of flow at 28" of water and several lift points. (Note that the 1200 Vee exhaust valve and ports flow better than the Intakes.) This is due to the shared intake port and its length. On most engines the exhaust flows 30% more than an intake.

* Cubic Feet Per Minute (air)



Head Flow Chart 1

Until you get you own flowbench, it is best to trust your favorite engine builder's assessment of your carb, heads and intake. (i.e., "This is a "National manifold", "this is a regional manifold", or "this is the best manifold I have ever tested." (*There are lots of these.*)) The reason for this non-scientific recommendation is that the numbers that can be provided will bore you and possibly not result in you getting the best bang for your buck. I can give you "cfm", "percent of flow", "at 10" of water", "at 18" of water", etc. By the way, to really understand what all this will do for your HP, you have to evaluate the numbers across all other components of your induction system. Not to mention cam profiles, etc. So take his word for it. If you are really interested in knowing more about this, get a book at the library.

Ok, now let's tune your engine up…

Engine Tune Up

We are going to do a typical tune-up that you would normally do prior to a race weekend, or even at the track when problems are suspected. It's pretty simple stuff, but you do need a couple tools.

1. 13mm Wrench
2. Screwdrivers
3. Set of feeler gauges and/or a dwell meter.
4. Timing Light
5. 12V Test Lamp (not required but helpful in many cases.)
6. A Meter for checking voltages. A simple VOM is fine and usually a Dwell Meter has all the functions you need.

For more advanced engine work, here are a couple other tools that may be helpful for diagnostics of an engine problem. (One or the other is adequate.)

1. Compression Checker
2. Leakdown Tester (A Leakdown tester is optimum but you need a small air compressor to use it.)

Dwell or Point Gap (if your engine uses points/condenser)

You will want to check your dwell before each race weekend. Dwell IS point gap. I.E. The SMALLER your point gap is the HIGHER dwell is. Dwell is simply a number in degrees that the points are closed during an ignition cycle. If your point gap is set at .016 and your dwell is 50 degrees, then if you adjust the points so that they are .015, your dwell will go HIGHER.

The purpose of all this is that when the points are closed, they are running current to the coil. When the points open, the large magnetic field created in the coil collapses into the high voltage windings of your coil, creating the high voltage needed to fire your spark plugs**. (*Your plugs fire when the points OPEN.*)** In theory, a longer dwell will saturate the coil better and give more spark. However, the longer dwell will also use more current and heat the coil more. The good thing is that the Vee engine is a low compression engine and doesn't need a whole lot of spark.

The original VW engine called for about 46 degrees of dwell or about a .017" point gap. Since we are running at 5000 to 7000 rpm we want to adjust to a slightly higher dwell. About 52-56 degrees is fine and not critical. If you start by setting your point gap to about .015, it will be close. If you use the dwell meter, check it after setting the gap. If it's in that 52-56 degree area you are fine.

The easiest way to set the gap is to loosen the screw that holds the points to the bottom of the distributor slightly. Put the car in 4th and roll it until the points are resting on one of the highest points of the distributor shaft (there are 4 high points). Put your .015 feeler gauge into the point gap and move the points on their mount until the feeler gauge just slightly drags on the two point contacts. Tighten the screw. That is it.

If your points are burnt or you plan on replacing them as normal maintenance, it is best to replace the condenser at the same time. (a bad condenser will cause points to burn). Also, lightly lube the distributor shaft with silicone grease where the points rub against the shaft. New points will wear pretty quickly if you don't lube this point. After installation, the distributor gets plenty of engine oil blow-by to keep them lubricated from then on.

It is best NOT to attempt to clean points with a file. If they look burnt or heavily pitted, replace them. The points have a proper curvature to keep contact pressure proper. If you file them you may destroy this design. A slight burn or discoloration can be removed by pulling a strip of 600 grit abrasive through them. Make sure no grit stays in the points.

Points should normally last a full season. But always carry a spare set.

NOTE: Anytime you make a point change or adjustment, you MUST check timing. (Next Section). ANY dwell change will change the timing. You CAN change timing without affecting dwell.

Electronic Ignition

You now have another option. The SCCA now allows any "drop-in" points replacement. Compufire and Pertronix and others make these units. We use them with no problems. This means that dwell no longer needs adjustment. These units go for about 6 or 7 times the price of points, but will certainly outlast 6 sets of points and will never need checking.

Dynamic Timing

Check your timing with a timing light. Rev the engine to 3000 RPM. At this point make sure your timing is at 36 to 37 degrees advanced. At idle it will typically be in the 10-15 degree area, but you DO NOT CARE. You will only be running on the track at 4000 RPM and higher. Once it is set at 36-37 degrees, check it at 6000 RPM also. Make sure that the mark stays relatively stable from 4000 on (one or two degrees of splatter is normal.) If you have much more splatter than that, better go back and check your points. You may also have a defective distributor.

If you don't have a degree wheel with all the marks on it, your engine builder should have marked the 36-37 degree point. He may also have marked the 0 (TDC) point. Ignore the TDC point. If you only have two points marked (TDC and 36/37) and don't know which is which, set it for the point where it idles fastest. This is the 36/37 point.

Static Timing

Don't bother with this unless you have messed something up and the engine won't start at all.

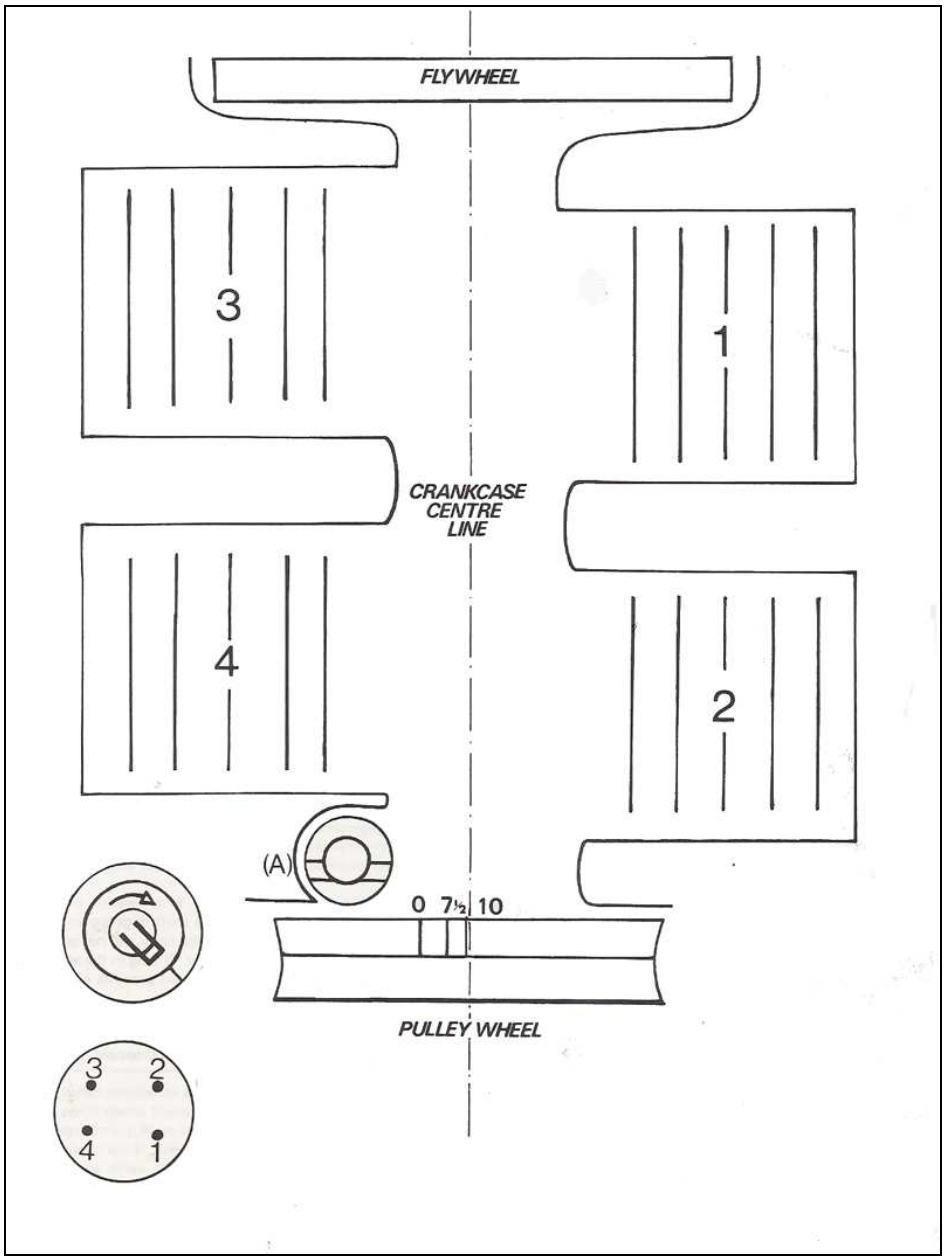
Put the car in 4th gear. Remove the valve cover from the number 1 cylinder side (left rear on a Vee). Remove the sparkplug from that cylinder. Roll the car forward until you see the intake valve (the valve closest to the center of the head) on number 1 open and then close. Put a screwdriver in the spark plug hole until you feel the piston top. Now GENTLY roll the car forward. You will feel the piston moving up the cylinder. When the piston has reached top dead center stop. You may have to rock the car back and forth to determine the top of its stroke.

Remove the distributor cap. The rotor should be pointing to the point where the #1 plug wire is connected. You can either loosen the distributor clamp to achieve this, or shuffle the sparkplug wires around to achieve this. In any case, once you have this set close (The rotor doesn't have to be pointed exactly to the #1 wire but within a few degrees.) Now make sure that you have the number #2 wire connected to the distributor at the next **counter clockwise** position. Number 3 is next. Then number 4. So it's 1, 2, 3, and 4 counting counter clockwise.

Remove the high voltage wire from the coil. Connect your trouble light between the 12V side of the coil and the (-) (the side your points go to) connector on the coil. The trouble light will go on and off as

your points close and open. When the light is ON, slowly turn the distributor counter clockwise. At exactly the point where the light goes OUT, lock the distributor shaft.

You have now set the timing for approximately 0 degrees. This is not the final step, but it will now be close enough for the engine to start. Turn the ignition off and put the coil wire back in. If the car runs now, go back and do the Timing procedure. If it still doesn't run see the **Misc. Maintenance** section of this book.



Engine Layout 1

Idle Speed and Idle Mixture

You may now want to set your idle. Since the race-prepped carbs are pretty modified, the idle circuits work very poorly. So don't worry about this too much. Back off the brass idle air screw 3 turns

from lightly snug. Set your idle speed as low as it will smoothly idle. Then adjust the brass idle air screw in until the idle starts to slow down. Leave it there. If the engine never seems to respond to the brass idle air screw, don't worry about it. Just leave it 2 turns out from the bottom. Now adjust your idle with the idle screw to about 1000 to 1200 RPM. It's not critical. You want to make sure that it's not so fast as to effect your braking via downshift, or so slow as to stall on the track when you spin or are de-clutched.

BTW, the brass idle screw ONLY affects mixture at an idle if at all. It does not affect the air fuel ratios at speed. This is done with jetting. More info on this later.

Sparkplugs

The Bosch Type W5BC or NGK-BP7HS work fine. Gap them for about .028. You have aluminum heads. So DO NOT over tighten them. Normally it is best to remove and install them when the engine is cold.

Plug Wires

Ok, this will be interesting. Use good quality wires. Use any core type you want. (Carbon, solid wire, twisted wire etc.) It won't make any difference. You won't get any more HP out of a Vee engine with wires. At our RPM and compression ratio, spark is not a big issue. Just make sure they are good, with no kinks, cuts, etc.

Valve Lifter Adjustments

You will probably want to do the following after every other race weekend or maybe each weekend. (Actually there is a short cut, but do it this way the first time until you know what you are doing.

First, let's jack up the side of the car that you do first. This will save you from losing too much oil when you remove the valve cover.

Put the transmission in 4th gear. (BTW, Cylinder number one is on the left side of the car closest to the trans-axle. Number 2 is the left side closest to the driver. #3 is the right side closest to the transaxle. #4 is….I bet you already figured it out.)

Do the adjustments on a cool engine.

1. Remove the number 1 / 2 side valve cover.
2. Turn the rear wheels forward until the #2 exhaust valve is **just starting** to open.
3. Adjust the #1 Exhaust valve rocker arm clearance to .004.
4. Adjust the #1 Intake valve rocker arm clearance to .004
5. Adjust the #2 Intake valve rocker arm clearance to .004
6. Turn the rear wheel forward until the #1 Intake is starting to open.
7. Adjust #2 Exhaust valve to .004
8. Clean the valve cover gasket and head mating surface up and install the valve cover.
9. Jack up the other side of the car, and remove the valve cover. Rotate the wheel forward so that the #4 Exhaust valve is fully open.
10. Adjust the #3 Intake and Exhaust valves to .004
11. Adjust the #4 Exhaust valve for .004
12. Move the wheel forward so that #4 Intake is fully open.
13. Adjust the #4 Exhaust for .004

14. Clean the valve cover and head mating surface up and reinstall the valve cover.

You're done!

There are other methods to do the adjustments but this is quick, safe and keeps you from losing too much oil and requires minimal engine movements.

After you have done this a couple times there is a quicker easy way to check the valves. Just remove a valve cover and roll the car forward in 4th gear. At some point during the roll each valve should have ~.004 of free motion. If one or more of them are tight and never go loose, you need to adjust them. When you feel confident with either method, you can use .003 of valve lash instead of .004. This will give you a **little** more HP. You just want to make sure you never have the valves too tight. You can hurt the engine this way. Anything more than .006 and they are going to start making noise and you will be losing some HP. After you do this a few times it becomes very easy.

Now, when you really want to adjust valves quickly, do it without a feeler gauge. When the lock nut is loose tighten the valve adjusting screw in until it touches the valve tip and there is no play. Now back off the screw ~ 1/6 of a turn (or one flat of the locking nut.) This will also put you at .003-.004. Much faster than you can even find the old bent up feeler gauge set.

Leak Down or Compression Checking

Periodically, you should do a leak down or compression check on your engine. Especially if you think you are down on power.

For a compression check, do the following: Remove all spark plugs and install the compression checker in #1. Open the throttle all the way (with your ignition OFF). Crank the engine three or four revolutions. The compression gauge will move up and stabilize at some point. Note that reading. Then do the same thing with the other 3 cylinders. The actual reading will vary upon many things, but you will probably be in the 100 psi area. All 4 should be within about 10 percent of each other. If one is much lower, you probably have a problem with the rings or valves in that cylinder.

It is **important** that your throttle is wide open, all plugs are out and your battery is in good condition. It would help to have the charger on it during this test.

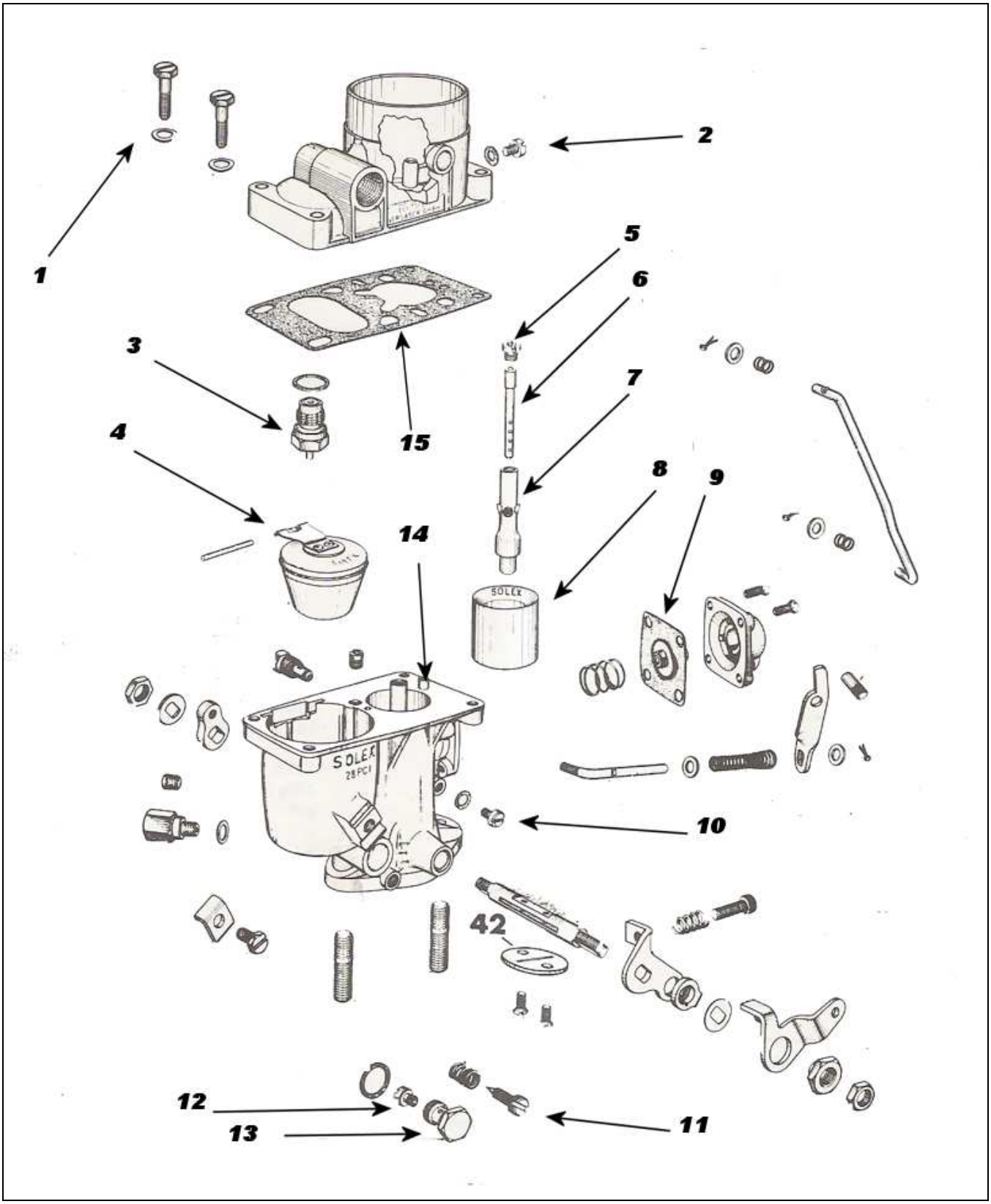
Leak down testing is a bit harder to do and takes more equipment. You need a compressor that is supplying ~100 psi during the test. I won't go into the test itself, since your Leakdown tester comes with instructions. Suffice it to say that you would like all cylinders to be in the less then 10% leak down. Any more than this and the engine might be getting tired. More than 20% and you have a problem. Call your engine builder and discuss it with him. Based upon the numbers and some other checks he can help you make a decision on what to do next.

Carburetor

See figure below. They are relatively trouble free, with a couple exceptions.

Before any long-term storage they must be emptied of fuel. Otherwise the fuel will evaporate and leave residual in the jest, orifices float bowl and float bowl valve. It will kill you next season when you go to run it. After your last race, before storage, totally empty the carb and spray some carb cleaner into it and the orifices.

The float level is very critical. Most all Vee carbs have had the float modified. It is usually disconnected from the operating arm (#4) and counterweighted in some fashion, to keep it from flipping over in high G turns. If the float gets a leak in it, the counterweight comes off, or simply comes out of adjustment you will develop flooding in the corners. We will cover this in another section.



Carburetor View 1

1	Air Horn Screws	
2	Throttle Pump Orifice Screw #1	This is removed to clear out the pump orifices

3	Float Bowl Shut-Off Valve	This shuts the fuel off when the float bowl is full
4	Float Assembly	Controls the level of the fuel
5	Air Corrector Jet	Helps control the a/f ratio at high RPM
6	Emulsion Tube	Properly emulsifies the fuel into the incoming air
7	Emulsion Tube Holder	
8	Venturi	This unit is replaced with a very thin after market unit in a Vee engine.
9	Throttle Pump Diaphragm	Forces raw fuel into the carb throat when the accelerator is pressed.
10	Throttle Pump Orifice Screw #2	This is removed to clear out the pump orifices
11	Idle Air Mixture screw	Maintains a/f ratio at idle. Probably doesn't work well on a Vee racing carb. Due to other mods.
12	Main Jet	Maintains overall a/f ratio.
13	Main Jet Holder	Brass 14mm unit that the main jet is screwed into.
14	Throttle Pump Check Ball Plug	Remove this to clean the pump orifice and remove the larger check ball.
15	Carb Top Gasket	

Every other season or so, you may want to consider a rebuild of the carb. A rebuild kit and a can of carb cleaner is all you normally need. At rebuild time clean all passages and re-assemble with the new parts. Adjust your fuel level as shown later in this book. The only tricky part to a re-build and clean up is the following: The accelerator pump assembly on the carb contains two tiny ball bearings. They act as check valves and reside in a passageway in the carb body. The only way to remove these balls and clean the passageway is to remove the brass plug at the top of the lower half of the carb (#14) and to remove the small brass pin that is under the pump cover housing. Then both balls will come out the top of the lower carb section at #14. The lower ball is very tiny. **Do not lose them**. (might be best to leave them alone.) Clean everything up with carb cleaner and drop the smallest ball in. Replace the pin under the pump cover, then drop in the larger ball and replace the brass plug. ***You may not want to deal with this at all if your throttle pump is working ok. "If it ain't broke don't fix it."***

Fuel Mixture (Air/Fuel)

At the track the only good way to determine if your carburetor jetting is correct is with an EGT gauge or Wide Band 02 Sensor. If your exhaust temp is 1300 to 1350 degrees, at the end of a wide-open throttle run, you are pretty close. You can also "read" your plugs or tailpipe immediately after a WOT run. However by the time you get to the pits, your color conditions will have changed. Officials frown on you stopping on the track to read your plugs.

Air fuel ratio is a significant part of achieving maximum horsepower. Hopefully your engine builder set this up correctly for you on the dyno. Normally as long as your tracks are within a few hundred feet elevation from your builder's dyno, you should be fine. If not, your builder can compensate for this at dyno time. Let him know your track'(s) elevation. He may have to supply you multiple jets if you race on tracks wildly apart in elevation. If he says it doesn't make any difference, find another builder.

As far as you changing jets at the track, don't do it, unless you KNOW what you are doing. You will hurt horsepower and can hurt the engine. Call us if you have questions.

Carburetor Jetting

I will probably be sorry I put this in here, but we get so many questions I had to.

For all practical air/fuel ratio purposes, there are two jets that control a/f ratios. One is the Main Jet (#12) and the other is the Air Correction Jet. (#5). Here is how they work: The main jet handles the primary function of fuel delivery anytime the throttle is open. However at high RPM (lots of airflow) excessive amounts of fuel would be sucked into the main jet causing a rich condition. That is where the Air Corrector jet comes into play. It works inversely to the main (at high RPM). So the larger the **main jet**, the richer the a/f at all RPM ranges. The larger the **a/c jet**, the leaner the a/f at WOT.

The main jet (#12) is located under the main jet holder (#13). It is removed by removing the holder and then unscrewing the jet from the holder. (The main jet is typically in the 1.85 to 2.20 mm range.) Often just referred to as a "200 or 210" etc. main.

The air corrector jet (#5) is screwed into the emulsion tube holder (#7). The emulsion tube holder is a thin cast piece that breaks very easy and is expensive. Thus, the a/c jet should not be screwed in too tight, or you will crack the emulsion tube. Since the a/c jet is "free" (not dictated by the rules), it has probably been reshaped to maximize airflow. (The a/c jet is typically in the 2.00 to 2.40 mm size. Your safest bet is to **LEAVE THIS ONE ALONE**. **Emulsion tubes have become VERY hard to find and they are VERY easy to break. Leave this to your engine builder!**

The jets are marked at the factory with sizes. However they seldom are correct since they are often resized by the builder with jet files or drills to optimize the a/f ratio. So ignore the markings. You have to use a jet gauge or small mm drill bits to check them.

Your jets may vary wildly from the above typical sizes. Due to carb modifications, worn throttle shafts, etc. Or someone may have compensated with a strange set of jets to cover up another problem.

Barometric pressure, other atmospheric conditions and to some degree, fuel type, will effect the final a/f ratio of your carb. But by far the most influencing factor is barometric pressure due to elevation changes. If you are running at tracks in the 500 to 900 foot ranges and your engine is jetted at 700 ft, you won't have to worry much about changing jets at the track. If you are concerned about your a/f ratio, contact us. There are tools to help you with this. The best thing to do is send us your carb and we will jet it on a dyno for your environment. (A carb does not have to be jetted on the particular engine it will run on.) The carb has no idea what is underneath it. It simply meters fuel based upon the jet sizes. This is not always true if you have a radical cam or a turbo, but if you are in a Vee you don't.

Oils and Lubes

Check your oil about 1 to 2 minutes after running the engine. If you check it too much later than that depending upon your plumbing it may read high due to oil flowing back into the engine from the cooler, filter, hoses, etc. The oil level should be at the upper mark on your dipstick. **Check with your builder!** There may be 2 or 3 marks on your dipstick. Your builder should know the proper set up.

If you have an unknown engine, you will have to do it this way: Start the engine and let it run at an idle. Check the oil level. Now remove the dipstick and hold it up against the engine near where the tube is at the same level it would be when installed. You will want the oil level to be about ½" below the bottom of the push rod tubes when RUNNING. Mark a point on your dipstick at that level.

Oil levels are the main cause of engine failure in a Vee. Excessive temps and low levels will destroy your engine. You will be making 1.5G turns in a Vee and braking heavy at high RPM during a downshift. The oil will be on one side of the engine or way up front and the oil sump will come uncovered. You will get quick oil pressure dropouts in these situations and you won't see them on your gauge and probably won't even be looking at the gauges in these situations. MAKE SURE YOUR OIL LEVELS ARE CORRECT. Check before every session**. [Steve Note: I always check mine AFTER every session – when the engine is hot. Cold readings seem very unreliable to me. If you have your oil level too high, the excess goes into the puke tank. If your level is too low, you might spin a bearing and/or ruin a crankshaft or rod. Play it safe until you KNOW how your oil level works!]**

A Vee is a Flat tappet cam engine. They stopped making good over the counter street oils for these engines years ago. Many of the additives have been removed to prevent destruction of 02 sensors, catalytic converters and the environment. You HAVE to use an oil that is marked for "Off Road Use Only". Mobile, Red Line, Royal Purple and others make these types. You will PROBABLY get by with a good over the counter synthetic for a while, but it's not worth the risk.

You will want to use a 30 weight (10W-30) oil. There is some slight HP advantages to a 20 weight oil (or even less), but it gets a bit risky with lower oil pressures, especially in high temp conditions. With current synthetics the advantages aren't significant. You might consider a 40 weight oil if your oil pressure is a bit low and/or you are running on a track where there are high G turns or esses. This will protect a little better. **[Steve Note: I ALWAYS run 20W-50 full synthetic. The extremely minimal gain from running lighter weight oils is negligible. Again .. play it safe till you know and understand your engine!]**

Oil Temperature

You want your oil temps to be in the 190 to 240 degree range in the sump. Lower than this and your oil will retain water condensation (white milky color at the top of the filler tube or cap) and it won't distill out fuels that get into the system, as well. Higher than this and your oil doesn't lubricate as well and it is indicative that your heads and everything else are getting warm. If you get to 260 at the end of a race on a warm day, don't worry about it. It happens. With good synthetic oil you will be fine.

Transaxle Lube

The most robust thing in a Vee drive train is the transaxle. It will handle twice the torque and HP you can give it. It is also quite efficient, eating up only 5 or 6 HP at full load. People use everything from ATF to 140 weight over the counter gear oil with few ill effects. Leaks are probably the biggest problem. I would suggest a 75 weight synthetic. It will protect well and give low friction from cold to hot.

When filling your trans, do not fill to the bottom of the plug as described in the VW manuals. They were assuming in traffic driving in a 2000 lb. car. You are ~1000 lbs. and are turning 1.5 g corners constantly. You will get plenty of lube and less leaks if you fill it about 1" from the bottom of the plug. If you fill it higher, you will leak and lose HP.

Fuel

You don't have many options here with the current rules. You have to use a fuel that will pass the SCCA fuel tests. This means you use the Leaded fuel at the track, 100LL Aviation fuel, or something

available in the after market that specifically states it will pass SCCA testing. If you are near a general aviation airport and they will sell you 100LL Av Gas, that is the best, cheapest, easy option. If not, use the track fuels. Anything above 92 octane is fine. YOU WILL NOT get any more HP with higher octane. To the contrary, you may lose it with our compression ratios.

Battery

By now you may have noticed that you have no charging system. (Unless you are running Vintage) So, charge the battery before each session. 15 minutes or so at a 6 amp rate is fine. Also charge it at the end of the weekend before storage. When a battery sits for a long time after some depletion, it will "sulfate". This means that you will never get back to a full charge. Also when storing for the winter, use one of the small "float" chargers. (Battery Tender, etc.) on it all the time. They will keep it fresh all year. If you take care of your battery it will last 3 to 5 seasons easily.

You will want to use a battery that is rated above 12 amp hours. They are available in several shapes and sizes. A Gel cell or AGM battery is the best option since it can be mounted in any location on in direction and requires no maintenance. A 17 Ahr battery will usually allow you to restart on the track should you spin and kill the engine. Anything less and you are likely DONE for the session.

Torque Specs

Following are the torque specs for the 1200 engine with comments as applicable. Due to multiple sealing points and expansion factors of the metals involved, torque specs are extremely important.

All 8mm Head studs / Nuts	18 ft lbs.	Very important. Do NOT over tighten
All 10mm Head studs / Nuts	21 ft lbs.	Same thing
All 8 mm case half nuts/bolts	14 ft lbs.	Includes oil pump, fuel pump, etc
12 mm Case Nuts	24 ft lbs.	
All 8mm nuts on case studs	12 ft lbs.	The VW shop manual will call for 14. However, error on the low side. These cases get opened up a lot and go through heavy heat cycles. They can strip out easily.
Rocker arm Studs	18 ft lbs.	
Rocker arm adj. Nuts	14 ft lbs.	
Clutch plate	24 ft lbs.	
All 6mm studs	5 ft lbs.	Intake manifold and sump
Gland Nut (36mm)	325 ft lbs. With thread locker.	See text re: gland nut.
Crank Pulley bolt	35 ft. lbs.	

Many of the above bolts are threaded directly into the alloy case. (A case that might be 25 years old and get split a dozen times or more.) It is far better to not go too tight than it is to be too loose. Use a Beam type torque wrench. They are cheaper, more accurate, and don't require calibration, if not misused.

Suspension Setup

Push and Oversteer (or Loose)

I know that you know this but.. "Push" is the tendency of the car to not want to turn into a corner. (the front of the car won't turn it.) The car "plows". Oversteer or loose is the tendency for the car to turn too much. (*The rear of the car is loose and wants to pass you.*) Both of these conditions are used to describe the car under neutral throttle conditions. That is to say, just enough throttle to keep it at the same speed. *Obviously if you hit the throttle hard enough in the middle of the corner you will go loose. This is not what we are referring to here.*

We won't go into much of the causes of the above, since it would take another book and there are plenty of books available and I am not smart enough. Suffice it to say, most drivers would prefer to have a "neutral" car. I.E. If you were to run in a circle at a constant throttle, both rear and front tires would slide the same amount. The problem with this balance is that it can be achieved two ways. You can fix the end that is sliding too much, or screw up the end that is ok. Either way the car is neutral. You will end up doing a bit of both.

While this book was not meant to coach you on driving, here are just a couple points. You may have a push or oversteer condition that you will discuss with other drivers to get suggestions. Remember that push and oversteer are used to describe a car in a static condition. If you hit the brakes in the middle of the corner, you have just transferred weight forward.

One thing about a Vee is that they almost always stick better when on the throttle, than when on the brakes. We have lots of sticking power on the rear tires and low HP, So when you are on the throttle the small amount of weight that transfers to the rear can help you stick. However, our brakes are much better than our acceleration. So when we brake we can transfer lots of weight forward. The rear end gets loose and we spin out. More often than not when a driver thinks his car is loose, it is actually because he touched the brakes in the middle of the corner. A Vee will normally plant itself much better under power than under braking. (This may not work in a Formula Atlantic or GT-1).

Scale Use

On a Vee with "zero-roll" suspension, a set of scales is only useful for seeing what the car weighs. Corner weighting a Vee isn't of much value since the Zero Roll will make it look balanced in almost any condition. (This, of course is for ROAD CIRCUITS .. not Ovals where all turns are in the same direction.)

On the scales what you are interested in is the diagonal weight. That is, you want the combined left front and rear right to weigh the same as the combined right front and left rear. If yours is off by more than 10lbs, you have one of the following:

1. A bind in the Zero Roll system
2. A radically maladjusted torsion spring on one front wheel
3. A bind in one of the front suspension components.

Alignment

Front Toe

Toe is simply the difference in the angles of two wheels. For example if the left one points 1/8" to the left from center and the and the right one points 1/8" to the right from center, your TOE is normally referred to as ¼" Toe Out. (Too much!)

Typically on a Vee with a fresh driver, you want about 1/8" to 1/16" Toe In on the front wheels…i.e., both wheels are pointing in towards the center line by about 1/32" to 1/16" inch. The easy way to measure this is with Toe Plates and a couple tape measures. However you can also do it with just the tape measure.

Jack the car up and spin the wheel. Using a sharp pointer or yellow crayon, just lightly scribe a line in the center of the tire as it spins. Make sure you have a straight line around the tire. Now put the car back down on the ground with a driver in it. Move the car back and forth a bit. Now measure the distance from the line at the front of one wheel to the front of the other wheel. Note the measurement. Now do the same at the back of the wheels. If the front measurement was 64 and the rear was 64 1/8, you have 1/8" toe in. If your measurement is off, you will have to adjust one or both of the steering tire rods to achieve the desired amount of toe. Ideally, these measurements should all be taken at the vertical center of the tire using a trammel bar with vertical posts to raise the measurement point from the floor to the correct height on the tire.

Another problem now occurs. Depending upon the geometry of your car's steering system, you may have "bump steer". Bump steer is when the tow changes as the ride height changes. Have some one stand on the front beam of the car and take the same measurements. You may find they have changed. If they changed more than 1/8", you will want to compromise your adjustments.

Keep this in mind when deciding how to compromise. The more toe-in that your car has, the more stable it will be, especially under braking. However, with 0 or even 1/8" toe out, the car will turn in quicker and probably have less push in slow corners. But under braking the car may dart around a bit and even wander on the straight. A 0 or 1/16" toe in is probably the fastest way around the track for an experienced driver.

Now for the compromise: If you can set it up so you have 0 toe-in at normal ride height and 1/16 to 1/8" toe in under braking. Your bump steer will actually work well for you. You can put spacers under the tie rods at the pickup points to raise or lower one end of the tie rod. This will alter your bump-steer. The first time you go through this, you will take a while. However, it's good to take your time and understand it. Then it will be easy.

Rear Toe

You also have Toe on your rear wheels. You can measure it the same way as you did your fronts. Don't worry about bump steer though. There isn't much you can do about it. You do however, want the car at normal ride height when checking. Most people want 0 toe-in on the rear or possibly 1/8" at most. In this range toe makes very little difference, but 1/8" Toe-in will probably make it a bit friendlier in the rain.

Front Camber

Camber is the measurement of the angle that the tire sits off of vertical. For example, if your front tire is tilting in at the top by 1 degree, this is considered 1 degree of negative camber. If tilted out at the top 1 degree it is considered positive camber.

Typical Vees run about 1.5 to 1.9 degrees negative camber on each front wheel. Use your VW manual to adjust. It is accomplished with what are called link pin shims. You will have to add or remove them from the upper and lower link pins. [Steve Note: There are offset link pin bushing available that can be used to reduce front end binding that may occur from moving the shims.]

If you have too much front negative camber, you will be wearing out the inside of the front tires prematurely. If you have too little, the car will tend to push.

Rear Droop Limit

The following adjustments are extremely car dependent. Models vary significantly. Hopefully you have some set-up information from the manufacturer, or previous owner. If not, start with this. Jack the rear of the car up and measure the angle of the axle droop. You can use a protractor etc. The objective is to make sure the axles never droop more than about 2 degrees negative. (They will never be parallel to the ground.) If this is a zero roll car you are interested in total droop. I.E. If one axle is at 0 degrees and the other is at –2, then your total is fine. Or, both could be at –1 degree.

You set this by adjusting the rear "Droop Rod". It is typically a threaded bar that runs between the 2 zero roll bell cranks. Tighten it to increase rear droop, or visa-versa. Let the car sit a few minutes to make sure this is the final set by measuring it again.

Rear Camber

Lower the car. With driver and ½ tank of fuel in it, roll the car back and forth a few times to get it to settle to its normal ride height. Measure the same axle angle that you did above. It should now be about 5 to 7 degrees total negative camber. Again, with a zero roll car, the total is all we are interested in -the total. Negative 2 on one axle and negative 4 on the other is fine. You will adjust the push rods or spring perch to achieve this. Remember that after each adjustment you must roll the car back and forth to get it to settle to the normal ride height.

Brakes

Use your VW manual for brake adjustments. Before adjusting, make sure that your drums are not bent and that wheel bearing adjustments are correct. You SHOULD adjust your brakes before each weekend. You will get maximum wear this way. When the brakes wear, they tend to have less surface area in contact with the drum. Frequent adjustment prevents this and excessive pedal travel.

Turn the star adjusters so that the drums drag quite heavily. Press on the brake pedal. Now back the adjusters off until the wheel turn freely. (This shouldn't be more than 2 or 3 clicks on the adjuster). Remember that the more you have to back them off, the more pedal travel you will have. If you have to take them off more than 2 or 3 clicks to stop the drag, you may have a bent drum or bad spring etc. in the system. [Steve Note: I always try to spin every tire at the end of every session and adjust HOT if necessary to eliminate drag.]

Brake Bias

The standard Vee has some brake bias built into the system (60 Front / 40 Rear). You will probably want slightly more on the front on a dry track and slightly less on a wet track. Most Vees have an adjustable bias system on board. If you don't, invest in one – it will come in handy if RAIN should start falling during a session.

Clutch

If you have a hydraulic clutch system, make sure you have the system bled well. Sometimes depending upon how the slave cylinder is mounted, bleeding can be difficult. You might have to move the cylinder around a bit to make sure that the bleed hole is as high as possible so that the air rises to this point.

After you have it bled and all the linkage is connected, use a crow bar to operate the clutch arm on the transaxle, taking out almost all the slack. You should have about ~1/4 in slack before the clutch arm starts to operate. You may want to adjust this a bit after you try it out in the car, in actual shifting conditions.

Wheels and Wheel Bearings

On most cars, the wheels play an important role (No pun intended). They do on the Vee also. So before each session jack up each corner of the car and check the wheels. Check the fronts by firmly wiggling top and bottom and then side to side. If there is excessive play in all directions, you probably have a wheel bearing out of adjustment. If you only have it side to side, you probably have a loose steering component. If you only have it top and bottom, it's probably a loose link pin or worn kingpin. Visually check the kingpin area while pushing/pulling the top of the tire, you may need some assistance

Check your rears also. You will probably have 1/8 to 1/16" in and out movement. This is normal. However if you have any side to side movement you probably have a loose rear axle nut...Fix it now! It will destroy the rear brake drum and/or axle on your next session.

VW Specs call for tightening to be 215-ft. lbs. For our purposes this is not enough. You will have to go to 250-300. If you have a 2 foot breaker bar, you will have to exert 150+ lbs. on the bar near the end. If you have a 3-foot breaker bar, 100 lbs. is enough. DO NOT USE an impact gun except for loosening this nut. When trying to tighten to this amount the wheel is certainly going to turn. So you will need someone in the car pressing on the brakes. Also, see in the TOOLS section of this book for an easy way to do it with one person.

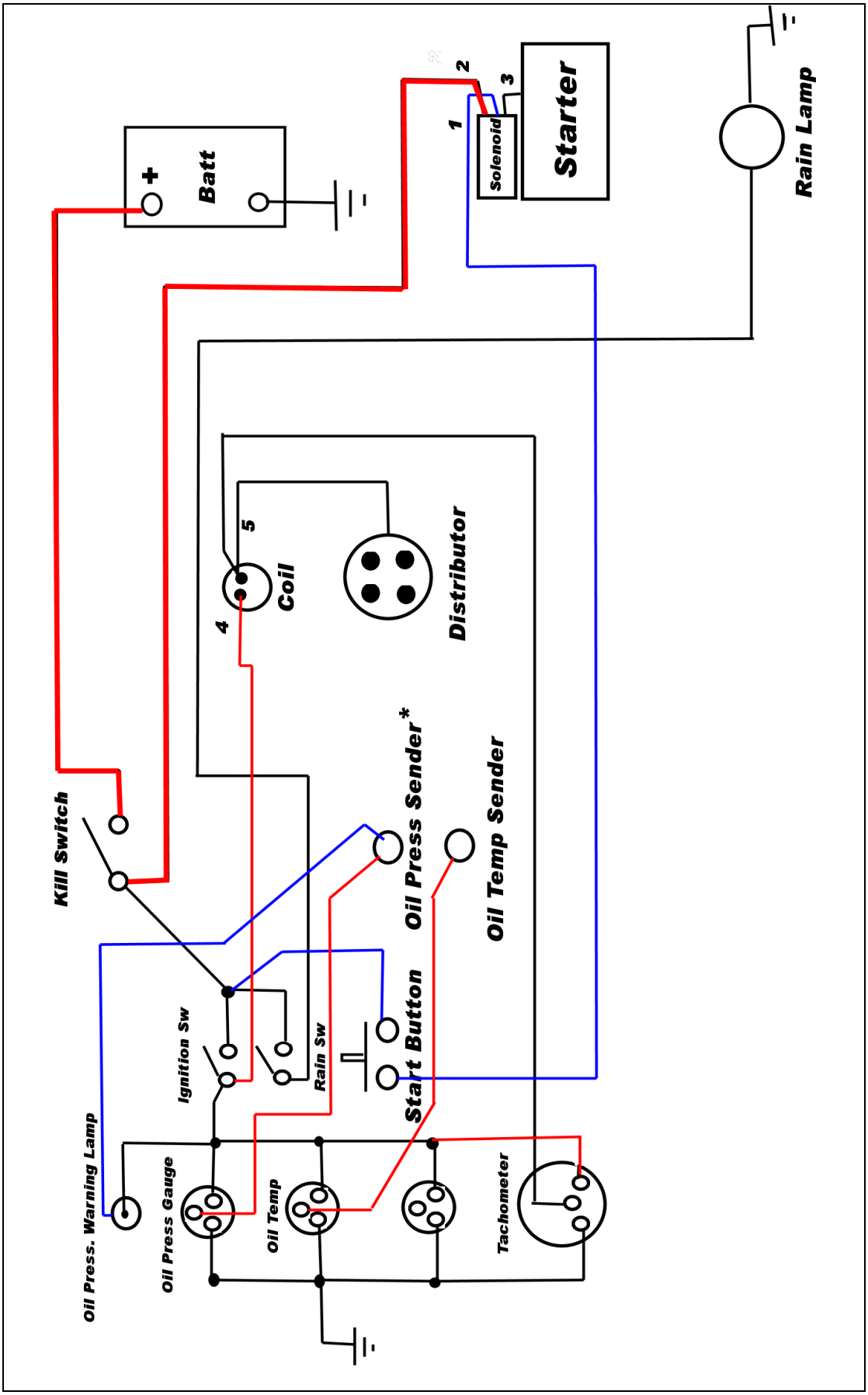
Initially tighten it to the LOW range of ft. lbs. then look to see where the cotter pin will fit through the holes on the axle and nut. Now tighten it until you can fit the cotter pin in. Check this every race weekend.

Electrical Wiring

As far as cars go, there isn't much wiring to a Vee. However, it seems that they have more than their share of electrical problems. Since electrical problems are, as often as not, intermittent, they can be difficult to diagnose. The surest way to prevent these problems is with a clean, reliable wiring layout in the beginning. Invariably, electrical problems will be either a poor connection or a short to the frame from abrasion of the insulation.

While the 3 wire splice and butt connectors are handy, they are prone to problems. We use an electrical barrier strip (available from Radio Shack and other suppliers)) to do our dash wiring. This makes for a neat layout that is easy to test and troubleshoot. After all connections are made and screws tightened, a bead of clear silicone is laid across the screws on the barrier strip. This keeps the screws from loosening up.

On the track, you car is going to experience lots of vibration, heat and other forms of stress. ALL wiring should be checked periodically. It should be covered with additional looms, etc., anywhere it runs near metal. It should always run through a grommet when entering firewalls, etc.



Wiring Diagram 1

The above is a typical Vee wiring diagram. Yours should be similar. A few things of note:

- The coloring of wires shown here is simply to differentiate between wires that crossed in the drawing.
- This diagram shows the kill switch in the Positive Battery line. Some put it in the negative side. Then the negative side of the battery goes through the switch and then to ground.
- This diagram assumes a "Dual" Oil pressure sender unit. One connector operates a warning lamp. The other operates the Oil Pressure Gauge. I always recommend an oil pressure warning lamp. When you experience an oil pressure failure, it will most always be in a corner or under braking. You will not be looking at your gauge during these times. A lamp will attract your attention (if it's bright enough). When using a dual sender, the Gauge connector is usually marked with a "G" and the lamp is marked with a "WK".
- This diagram is wired so that your Rain Lamp can be switched on whether the ignition switch is on or not. This is a good idea. If you spin on track in the rain/fog, and have to park the car there, it's a good idea to leave the rain lamp on. You don't want to have to leave the ignition on also.
- The numbers on the drawing are only for assistance when using the maintenance map charts in this book.

Here is some info re: the wire sizes that you should use.

#16	Gauges and lamps.
#14	Coil and Ignition Switch Circuits
#12	Starter Motor push button switch
#2 - #6	For Battery Cable and Starter motor Primary circuits.

Note: You can go heavier if you wish, but do not go smaller.

Most all Vees have been converted to 12V systems, with the exception of the starter motor/solenoid. Most run the 6V starter motor setup. The main reason for this is that the 12V flywheel and 6-volt flywheel have a different number of teeth in the ring gear. Since you probably have the 6V flywheel, you MUST use the 6V starter motor. If you don't, the starter will likely jam in the flywheel intermittently. There are no drawbacks to using a 12V battery. The starter cranks a little faster and makes the chokeless FV motor start a bit faster. Using a 12V battery makes it easier to supply power to all the standard 12V gauges and lamps.

You should also use a 12-Volt ignition coil. The normal Bosch "Blue" works fine.

Instrumentation, Switches, etc.

Just a comment about gauges. Some people prefer the mechanical oil pressure gauge and possibly oil temp gauge. Normally these gauges are a 270 degree sweep, so they have better resolution. However, you don't need them. The electrical gauges are cheaper, easier to install, and don't have oil lines or thermal lines running in the cockpit prone to kinks and breakage.

Since you don't have a lot of room on the typical Vee dashboard for a lot of gauges, you have to make some choices. Here is the list I recommend in priority ranking. Install all you can fit.

Tachometer	Probably your number one choice and need. However, there are people that don't use them and instead use a shift lamp set at ~6500 RPM.

Oil Pressure	Pretty much mandatory
Oil Temperature	Also mandatory. (In my opinion.)
Exhaust Gas Temp	They have them in double gauges. So you can measure 2 cylinders at once. These are nice for determining proper A/F ratio
Cylinder Head Temp	Ok, but not my favorite for importance. Oil temperatures can tell you *almost* the same thing.
Wide Band 02	This is by far the best for determining A/F ratios, but it's pricier. If you use this, you don't really need Exhaust Gas Temps
Oil Pressure Warning Lamp	A VERY good idea and very inexpensive.

Once in a while check/calibrate your tach. They can go sour. It won't help you a bit to be shifting at 200 RPM too low, or worse 200 RPM too high.

The same goes for your temp and pressure gauges. The temp gauge can be tested by putting the sender in water just as it starts to boil. (212 degrees). You can test the pressure gauge with air from a known good source. (Don't exceed the rating of the sender. Usually 80 to 100 lbs.)

If a switch ever starts to feel "funny" or ever seems to operate intermittently, replace it now. They're cheap compared to losing a session on track.

Periodically check all your connectors and screws for tightness. When they come loose, it will be on the track as you are leading in the last lap .. or maybe as you leave the false grid with PLANS to lead.

Tach Inoperable

1. Make sure the tachometer ground lead is grounded.
2. Connect your trouble lamp to ground and probe the 12V connection on the tach. Make sure your ignition and kill switches are on. The lamp should be on full brilliance. If not, you have an open 12V line to the tachometer.
3. Disconnect the coil spark plug lead from the coil to the distributor cap. Crank the engine with the test lamp on the Ignition line **on your tach**. (This line should go to your coil where the points are connected.) While cranking, the lamp should flash on and off. If it doesn't, you have an open wire from the tach to your coil.
4. If all the above are correct and the tach does not work, you have a defective tach.

Electric Oil Pressure or Oil Temp Gauge(s) In-operable

1. Make sure the gauge ground lead is grounded.
2. Make sure the 12 V is connected to the gauge as in step #2 above.
3. Disconnect the wire from the pertinent sender unit. Ground the wire. The gauge should swing from one extreme to the other. If not, the wire from the sender to the gauge is open or the gauge is defective.
4. If the gauge DOES swing to the extreme, your sender is defective.

Data Acquisition Dash

In the first couple iterations of this book, I didn't even cover these. In 1998, you would have to spend $2000 or more for one of these systems. However, now they can be purchased for under $1000 and can include most all the above sensors along with track mapping, G-Forces, lap times, logging to your computer and more. Most are plug and play, and come with all the cables and sensors you need.

They take up less dash room, have back lit displays, etc. A great investment and not much more than complete dash gauge setup with the wires, etc. Take a look at AIM/Mychron systems.

Pre-Race

Wheel Bolt Torque

Torque your wheel bolts to about 55 to 65 lbs. More is NOT better. The drums are pretty soft and the bolt threads stretch easily. Torque them as often as you wish, but not more than 65 lbs. By the way, you should torque in sequence. Do one bolt, skip one, do the next etc. until all 5 are torqued.

Battery Charge

I have covered battery charging in a prior section, so I won't here. However, remember you are going to have to start this thing at least twice before the race. Once now and once at the 3 minute signal on the grid. Make sure you can. Charge it just before your session. These 14-17 AH batteries are great for weight but you don't get too many starts out of them. God forbid you might even stall on the track in a spin. It's embarrassing enough to spin, let alone getting hauled in on the tow truck.

Tire Pressure

With ambient temps in the 72-85 area and tires in the sun, start the session with about 21 lbs. on the rear and 19 lbs. on the front. Manufacturers and compounds vary over the years. Check with your tire manufacturer or retailer. Make sure to have all tires either in or out of the sun. They can vary 2 or 3 lbs. when one is heated from the sun. Rain tires are typically set at 20 lbs. [Steve Note: Nitrogen can be used in the tires to reduce the pressure changes due to temperature due to water vapor.]

Tire Temps

I won't cover much here since there is lots of information elsewhere (including in the pamphlet you get with your tire temperature probe). A probe is nice to have, and I would suggest you take temps to get a baseline once in a while. This may help you diagnose a problem that comes up later. It won't be the most important investment you make. [Steve Note: I find little to no information from tire temps that I can't get from LOOKING at the tires at the end of a session. YMMV]

Quick Check

Do a look and feel again.

1. Wheel Bolts Tight
2. Check for cracked drums *
3. No bent or loose tie rod ends
4. Excessive play in the steering linkage, steering box itself, or the steering wheel attachment
5. Bodywork fasteners all locked
6. Fire Safety pin(s) out.

(* Recent drum castings have been developing cracks and often breaking on the track. Check closely around the drum inspection holes for the development of hairline cracks. Many FV parts suppliers now have an after-market drum that seems to be better.)

Throttle Linkage

Periodically you should check your throttle linkage. (Especially when you think you are down on horsepower and are about to send it back for a rebuild.). While someone holds the throttle pedal at WOT, check and make sure that your carb butterfly is actually going full throttle. There should also be a stop on the throttle pedal to limit movement to that point. Otherwise you may break the cable, or bend the manifold or carb operating arm.

Hot Weather

This is your mother speaking…. You are going to be on the grid for 5 to 10 SCCA minutes. (10 to 15 REAL minutes). It will be real hot down there on the black top in your fire suit. You will also dehydrate some more on the track. So drink plenty of fluids up to this point.

Here is a tip I learned from a fellow racer that works surprisingly well: Fill a Zip-Loc sandwich bag with ice. Wrap it in a small towel and place inside your suit on your chest. It really helps to keep you cooler. After the race, when you are sitting in impound, you can drink the water. Neat huh?

On the Grid

Start the car at about the 2 or 3 minute warning. This will help get the oil up to temperature before the race. (It will also give you a minute or two to arrange for a push start if the battery goes sour.) Don't run it much longer than that standing still. You have no fan and you can overheat and damage the engine.

Run it at or above 2000 RPM with the clutch out and the trans in neutral. This will help heat up the gear oil quicker.

End of the Race Weekend / Season

Crank the engine over a few times with no spark while spraying WD-40 into the carb. This will protect the intake manifold from rust for awhile. They will get a fine layer of rust on them after sitting for only a few days.

At the end of racing for several weeks, do the same thing but also spray into the spark plug holes and tail pipe. Plug the carb and tail pipe with a stopper of some kind. Also remove the main jet holder (See Carb Drawing) and let the fuel drain out. Pump your accelerator several times to clear the pump. Replace the jet holder. This is **mandatory** for long term storage. The race fuel will evaporate and leave lots of residue in the carb orifices. [Steve Note: This last part is not necessary if you use Av Gas – it will evaporate and leave no residue.]

Charge the battery every 30 days or so or use a good auto-shut off trickle charger on it for the off-season.

Miscellaneous Maintenance and Trouble Shooting

If you aren't inclined mechanically, or familiar with the VW engine, you may want to get help from a fellow driver the first time you do some maintenance. Or… If you have this book, I trust you bought it from us. ~~So feel free to call us from the track to walk you though a procedure or diagnostic. We will be happy to help. (859-252-2496). If we are closed, that's ok, the phone message will give you our cell phone number. You can call us anytime for assistance. We WANT you to have fun out there~~.

Cranks Slow

The obvious is a dead battery. But if you are reading this you have probably already checked that? Possibly a bad starter motor. But before you replace it, check the starter motor pilot bearing located in the transaxle housing. When this wears, it allows the starter motor armature to rub on the motor field windings. It will act and sound EXACTLY like a dead battery. And if you jumper it with a charger or another battery it might start fine. This one will get you at least once. So, carry a spare $3 bushing. It's cheaper than a $100 starter. (*Wish I had a buck for every time someone replaced a starter motor for this problem. Hell, I wish I had a buck for every time I did it.)*

After you do check the bushing, make sure all your battery and starter motor connections are tight. This includes the connections on the Kill Switch and all grounds. The Kill Switch can also produce these symptoms. They are meant to be self-cleaning contacts. Flip the switch on an off a few times [Steve Note: It's a good idea to flip this switch multiple times OFTEN to keep it clean inside] to see if that helps. If not… change the starter.

No Crank At All

Check all the above, but you probably have an electrical problem. See the sample wiring diagram in this manual and follow along. Better connect a charger to the battery. We need to do some checking here and we don't want to kill the battery.

Cranks, But Won't Start

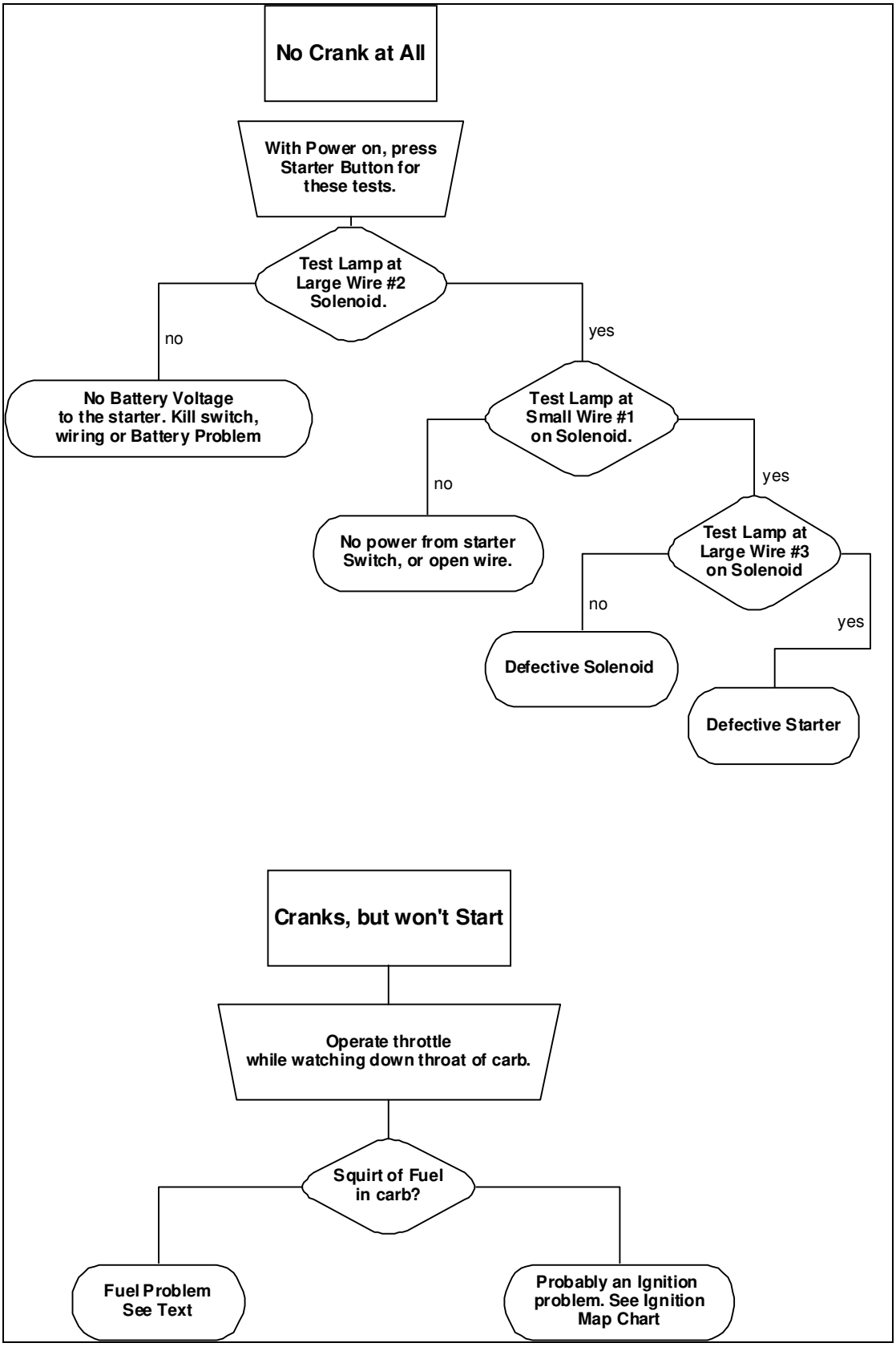
Let's assume that this engine did run once and you saw it. So, now you either have a air / fuel or electrical problem.

Cranks but won't even attempt to fire.

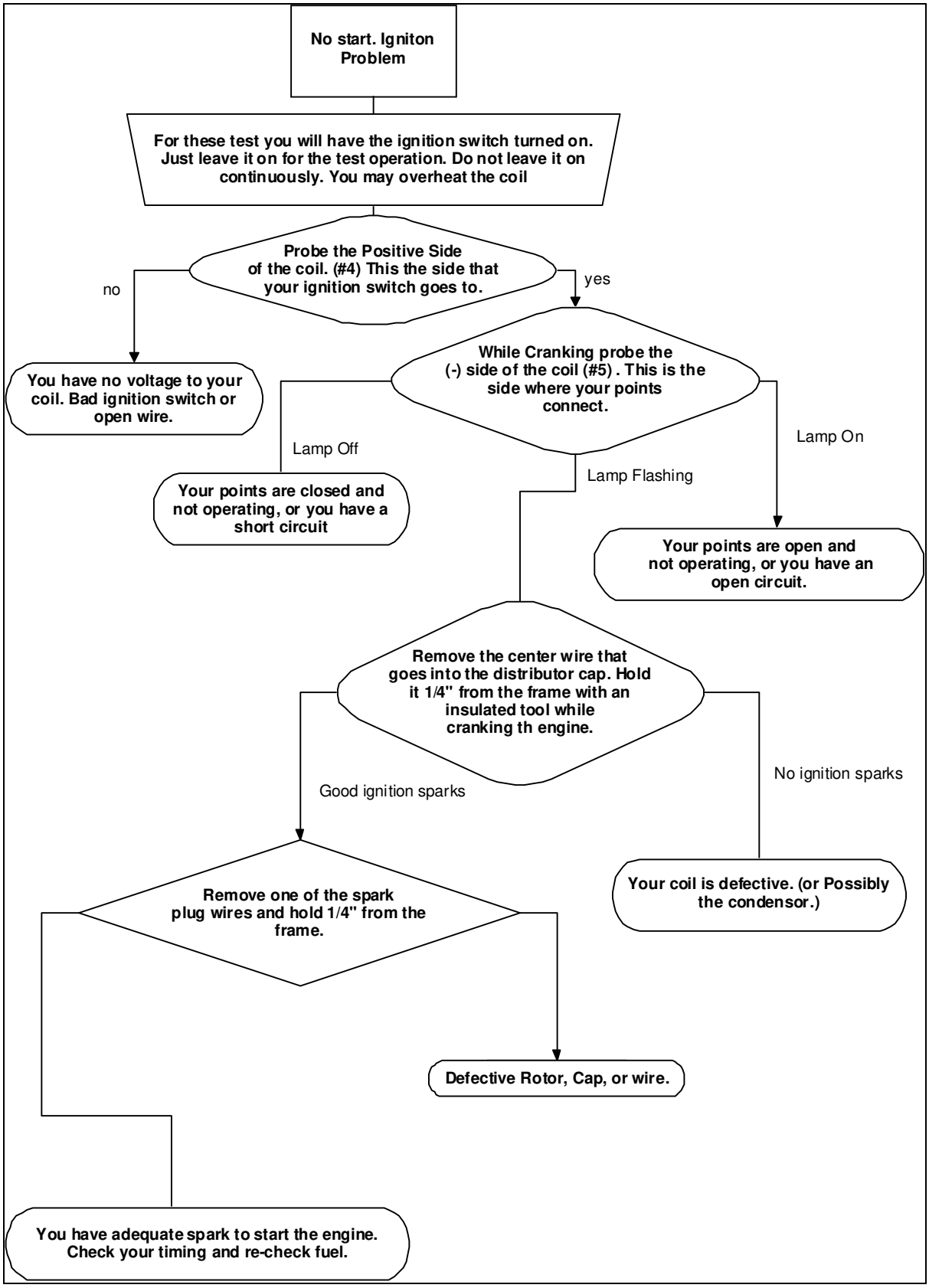
First, let's assume it's a fuel issue.

See the "**Cranks but no Start**" Map Chart

If you do have fuel, check the "**No Start, Ignition Problem**" Map Chart



Maintenance Flow Chart 1



Maintenance Flow Chart 2

Won't Idle Reliably

This symptom is most often a vacuum leak. The VW manifold seals were not great when they were stock and we messed them up even more by cutting the cylinders and modifying the manifolds and sometimes using different gaskets.

The easy way to find the leak is to get it idling as slow as you can (it may take some help with someone else modulating the throttle to keep it running.) Now spray some Windex, WD-40, or Starting Ether, etc., near the intake ports where the manifold mates to the heads. As soon as you hit the leak, the engine will quickly speed up or die. It can also be at the carb base or even the carb throttle shaft, if it gets very worn. When you do find the leak, replace the gasket, etc. If it is at the mating of the head and manifold, try the following first: While idling, loosen one of the nuts a turn or so, and tighten the other one a turn. Then do the reverse if that didn't help. When you get to the right combination, the engine will smooth out. [Steve Note: If you are in a rush, you can often seal the leak using RTV on the outside of the manifold/head junction. Fix the leak properly after the session.]

Cuts Out in the Corners

A bear to fix sometimes… It is almost always a carb float problem. But, it could be something else. So, make sure you don't have an electrical problem; wire chaffing on the frame, a loose connector, etc. If you are pretty sure that's not the problem, and the following describes your condition, it's a float problem. Usually it starts at the highest G point of a corner. When you hit the accelerator at exit, it stumbles for a while and then clears itself out. What has USUALLY happened is that the float has turned enough in that high G corner to not be able to regulate the float shut off valve. Thus, the carb gets excessive fuel and floods. To fix the problem, you are going to have to remove the top of the carb (4 screws) (#1 in the carb picture). Check the float to make sure the counter weight hasn't come off (if you have a plastic float). If everything looks right, you are going to have to either bend the brass operating arm that the float operates and/or remove the float valve in the top of the carb and install another washer or two. This will shut the fuel off a little earlier.

To check your float level, place the top on the carb and hold it on with your hand. Now start the engine and let it idle for a couple seconds. Shut it off and quickly remove the carb top. Normally you want the fuel to be a good 5/16" to 7/16" below the flange of the bowl. But they can be temperamental and you might have to play a bit to get it right. Get some help from a veteran Vee guy if you can. It's expensive to waste sessions on the track.

[Steve Note: Another reason for STUMBING when applying throttle after being OFF throttle is a lack of fuel from the accelerator pump. If you move the throttle from closed to WOT, there SHOULD be a pretty good sized splash of fuel dumped into the throat from that pump. If not, FIX IT!]

Misses on the track at high RPM

Another pain in the butt. Let's not waste a lot of race sessions on this. Do the following:

1. Replace your points and condenser (unless you are running a Pertronix ignition or equivalent)
2. Replace your plugs
3. Check your dwell and timing (dwell is not relevant with Pertronix)
4. Replace your fuel filter. (using a CLEAR filter [but not GLASS!] helps to diagnose fuel problems)
5. Remove your main jet (#13 and #14 in carb picture) from the carb and blow it out.
6. Check all your fuel lines (especially the suction lines on the cell and fuel pump) *An air leak will cause you to starve for fuel and cause a 'miss' at high RPM.*

Ok, you have only spent 20 minutes and 20 dollars. So let's hope that fixed it. If it didn't...

1. Replace the Coil
2. Replace the distributor cap. (check or replace the rotor button as well)
3. Replace the plug wires
4. Go back and check the 5 things above again.

You have now spent another $50. Let's hope that gets it. But here are some outside chances that it could be:

1. It is possible that you have a jetting problem. Highly unlikely unless this is a new carb that has never been tested before, or someone has changed the jetting. Environmental conditions can certainly hurt your HP a bit, but will not cause you to miss. But a plugged jet will.
2. At high RPM, you are using the maximum amount of fuel, so any fuel delivery problem will show up there. (Fuel pump, filter, lines etc. – air leak on input line to fuel pump from cell)
3. At high RPM your peak cylinder pressures are also the highest and it take the most spark to fire the plugs. So, ANY spark issue from the points to the plugs can cause problems.
4. Go back and check all the above again.

By the way, you might be able to help diagnose the problem on the track. Does the tachometer jump around wildly when it starts missing? If so, you probably have a primary ignition circuit problem. (Points, Condenser, Distributor, Coil, Battery or switches (Kill and Ignition).

If the tach stays relatively constant, you PROBABLY have a fuel issue.

Leaking or Smoking

I won't worry about small leaks here, they probably won't black flag you and you can use your eye and VW manual to fix the problem. [Steve Note: To isolate small leaks in the engine area, I wrap various areas with paper towels and secure in place with zip ties. Whichever one is WET with oil at the end of the next session hides the culprit.]

But, if it's leaking or smoking bad try these:

Please note that even a teaspoon of oil on the headers will smoke profusely. So even though you are smoking badly, it MIGHT be a very small leak.

Head Stud

If you break one of the lower head studs that are under the valve cover, it will usually blow lots of oil. Especially in turns to the opposite side.

If this is a new engine that you just put the heads on, it is possible that one of the washers under the above studs is not sitting in its place correctly. They can leak almost as bad. In either case, you will have to pull the valve cover and check it out. You may be able to see/feel the loose stud if broken. See Torque Specs for replacement.

Push Rod Tube

A common problem. You might have bent one installing the engine or in an off track incident. Take a look if one looks severely bent or broken, you will have to replace it with a new one. The head has to be partially removed to do this. One of the tube end rubber washers may be damaged or misplaced. There are spring loaded replacement tubes that can be installed without removing the head. We carry one in the trailer.

Valve Cover Gasket

Another common problem that shouldn't be. Remove the valve cover and inspect the old gasket. The problem may be obvious. Cleaning the mating surfaces on the cover and head very well. Use RTV (Silicone sealer and a CORK composition gasket.) Run a bean of sealer around the valve cover surface ONLY. Not on the head. Make sure you get it in the corners well. Now, place the gasket on the valve cover lightly pushing it into place. Now press the cover onto the head with hand pressure only! Remove the valve cover and let it set for a hour if you can. Now put it back on the head and install the Bale spring. If you do it this way, the cover will not leak and you will be able to take the valve cover on and off for many seasons - without it leaking.

Oil Cooler

If you are lucky, it's just a seal. You can replace it simply. However the cooler itself can develop a crack at some point that won't be visible but at high temps and high pressures on the track it will mist the oil out. Replacement is the only fix.

Drain Plug or sump

Check both of these after any off track excursion. You can bend, crack or loosen the drain plug in the tall grass or on a curb. If the sump is cracked it can be brazed.

Gland Nut

Ouch! Hopefully it's not the Gland Nut. This is the nut that holds the flywheel on. The leak will be in the bell housing and you will only see the leak seeping out at the trans/engine mating point. The engine has to come out. If this is the cause, you will also probably get a large vibration and noise immediately or certainly within a few laps.

Transaxle Shaft Seal

Check to sure if any leak at the transaxle/engine mating surface is gear oil or engine oil. (Gear Oil smells worse). If it is gear oil, the leak might be the transmission input shaft seal. Easy to fix (if you have a new seal), but you need to remove the engine.

Case Pressure

Your case should have a line that runs from it to a "puke tank". If this line is kinked, or the puke tank is full, you will build up high case pressures. This will cause excessive blow-by of oil, usually from the front pulley area. This line should be at least a 5/8 inch hose. The bigger the better. Excessive blow-by can also be caused by bad piston rings.

Over Filling Oil

Contrary to popular opinion, you won't hurt your engine or blow any gaskets, etc. with too much oil. However you will leak it out or spray it out into the puke tank (or beyond).

There is no front seal on a Vee engine (at the pulley). It simply has a worm gear to pump the oil from this hole back into the case. However, when you hit the brake and downshift, the G forces throw all the oil into the front of the case. The worm gear won't keep it in. So, oil will come out at the pulley shaft

and the pulley will sling it all over the engine compartment. [Steve Note: It is now legal to add a 'sand seal' at the front of the pulley .. but that won't stop an overfull engine from leaking through it.]

There is a critical balance between too much and not enough oil in the engine. See the earlier section on oil filling.

Smoke Only

If its only smoke coming from the tail pipe, you probably have a broken ring, worn valve guides or you have filled it with too much oil. It's time for a rebuild… or you just have a 'loose engine' and it may very well be normal. Depends on HOW MUCH Smoke…

Transaxle Leak

Rear wheel seals, axle boots, side covers and gaskets are typically the culprit. Over filling of the trans is also a possibility. Fill the level so that you can just touch the oil with your pinky finger. (about 1" below the inspection hole.

I Want More Horsepower

Yeah, Me too. Well assuming your engine was built to be competitive and it seems to not be that way anymore, here are a few things to check:

1. The obvious tune-up items covered in this book.
2. Throttle Opening. Make sure your throttle is fully opening with your pedal. (You can get close by eye, but a flow bench is the only real way to make sure that the throttle is opening full and not past that point.) ~~Call us for questions~~.
3. Intake leaks at car or manifold that we discussed earlier
4. Air/Fuel Mixtures way off.
5. Exhaust leaks. Check gasket, flange seating to head match, and flange nuts. Surprisingly, large leaks here can cost significant HP.
6. Excessive Blow-by of valve leaks. (Time for a rebuild? Check compression and/or leakdown)

6A.. be sure to check to make sure your valves are fully CLOSING at the appropriate time. You will loose a LOT more HP with a valve that is not closing properly than one that is 0.020" below max allowed lift.

7. Clutch slipping? Not always obvious. Often only appears in 4th gear at the 5000 and above RPM point.
8. Transaxle tight or brakes dragging? Jack up the car - a good spin on the wheels will tell you. Fronts should spin for several seconds. Rears should spin for a few revolutions.
9. Tachometer ok? You might be shifting at 6000 RPM or worse 7000.
10. Driver? Nah. It MUST be something else.

Parts and Tools

Spare Parts and Supplies

You are going to have to carry some spare items with you to the track. (Or hope someone else there has them for you). I have listed those items that you might need in order of most needed, and weighted by cost. So, depending on your budget, you can go as deep as you want into the list and add your own items (beams, engines, transmissions, etc.).

Engine Oil
Gear Oil
Brake Fluid
Racers Tape
Gasket Set
Some assorted nuts and bolts (based upon your car's need)
Wheel
Set of Plugs and Points
Electrical connectors and wire (Including a spark plug wire set.)
Lug Nuts
Fuel Pump
Front wheel drum
Rear wheel drum
Spare switches
Oil Filter
Assorted pop rivets and washers
Wheel Hub Cap
Large cotter pin (Rear wheel axle, nut)
Distributor cap and Rotor
Coil
Carburetor rebuild kit
4 push rod tubes
A few push rods
Rocker Arm
Set of front wheel bearings
Set of brakes
Clutch disc
Front and Rear Brake Rebuild Kit (Slave and Master)
Starter Motor Nose Bushing. 6V (See Starter Motor section)
Clutch Release bearing
Clutch Cross shaft and spacers, cir-clips

Other Supplies

First Aid Kit
Hand Cleaner
Vinyl shelf lining paper (See **"Other Stuff I Didn't Know Where to Put"**)*
Roll(s) of paper towels
Rags
Brake Cleaner

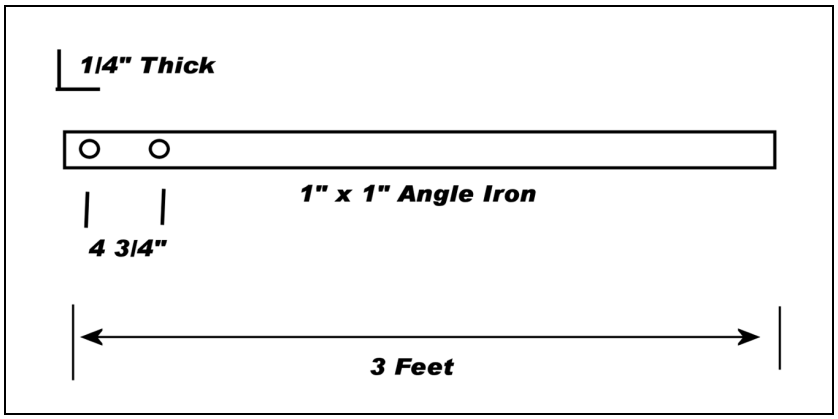
Windex
Rain-X
409 or Fantastik type cleaner

Tools

Same here. I will list by need, weighted by cost.

Standard tool set, with sockets, wrenches, pliers, screwdrivers, Allen wrenches, etc. (Metric and Standard through 5/8" and 19mm and ¾" for wheel lugs)
Tire Gauge (0 – 30 lbs.)
Feeler Gauges
Jack (preferably one of the available "quick jacks")
Small battery charger (12 Volt, 4 to 10 Amp)
Torque Wrench
Tape measure
Scissors
Flashlight (with spare batteries)
Small Air Compressor and/or Air Tank. (If you do not have a portable generator, you can use one of those small 12 volt compressors. They are slow, but adequate)
Automotive Dwell Meter with Tach (not needed it you use Pertronix)
Timing Light
12V test lamp or DMM
36mm Socket with large breaker bar, and drum locking device*
Pop Rivets and installation Tool
Drill and Bit selection (Preferably a good battery powered drill)
Small Portable Generator
Temperature Probe (for Tires and checking instruments)

* These will be required when you have to remove a rear hub, to fix brakes, replace rear seal, etc. The axle nut has probably been tightened to over 250 foot pounds, and along with a healthy socket and breaker bar, you will need a device to hold the wheel in place while loosening or tightening. You can make one yourself from a 3 foot long piece of 1" angle iron (1/4" thickness). At about 1 inch from one end, drill a ½" hole in one side of the angle iron. Measure exactly 4 ¾" from that one, and drill another ½" hole. Paint it a really neat color. You can now remove your wheel and then use two of the lug nuts to bolt the angle iron to the drum. This will stop the drum from turning when you turn the nut with the breaker bar.



Tool for Removing Rear Axle Nut

Parts Suppliers

Many of the standard VW parts (engine, suspension rolling gear) are available at parts dealers that specialize in VW or other foreign autos. Also, many items are available at vendors that advertise in VW Magazine, Hot VW's, etc. Before ordering parts from any of these after-market suppliers, be sure and check on the SCCA FV legality of the part(s). These same items, parts unique to the Formula Vee and tools are available at:

~~SR Racing / RaceCarSupply.com (859) 252-2496~~
~~(Web Site: http://www.sracing.com or http://racecarsupply.com)~~
EMAIL: SRACING@mindspring.com

~~We have a large on line inventory of parts and supplies. We also have many images and tech support items that may help you to understand the Vee better.~~

More Information

It is REMOTELY possible that there is something about Formula Vee that I did not include in this book. So, here is another resource where you can find all the additional help that you would need:

http://formulavee.org

This is a Formula Vee based discussion board. You can find help, classifieds, and lots of FV people to talk to and get help from. There is also a Formula Vee specific forum available at Apexspeed.com as well as the Left Coast FV board at http://norcalfv.proboards.com/board/12 although it hasn't seen much traffic lately.

Other Stuff I Didn't Know Where to Put

Here are some things I thought might help and didn't know where to put them. So, here they are…..

Numbers

You will probably want some neat Vinyl graphic numbers on your car (8" high with 1 ½" stroke), and unless your brother-in-law works at the print shop, you will pay lots of money for them. ~~(Unless you buy them from us at www.sracing.com.)~~

When you get to your first race, you may find that some schmuck entered before you and has YOUR numbers. Since this will happen at least once or twice, some planning should go into your numbers. (See your GCR also.) Get a font that is not too fancy and, if possible, some numbers that can be changed easily by adding or deleting a stroke or two (77, 11, 71, 17, 41, 14, etc.) One drawback to this is that these are the numbers that everyone else will have too!

Buy two rolls of vinyl shelf paper. One for the color of your numbers, and one for the color of your car. On your entry form, pick your primary and two or more alternate choice numbers, e.g., 71, 1, 7, and 77. You can then just cut an 8" X 4" piece of vinyl the color of your body and cover the necessary number, or cut some pieces from the other vinyl roll to modify a number. This looks better than racer's tape and comes off without wrecking your pricey graphics.

The real secret is to send your entry form in early, so you get 1st choice.

Once you become a National driver, you can register a number in your division, and this won't be as much of a problem. Some divisions allow registering of Regional numbers also.

Notes:

Take notes at the track. Note your suspension set-up, tire pressures, ambient air temp, lap times, race finish, and the name of the guy you borrowed the ¼ hp blue plug wires from, etc. Keep them in a notebook. They will come in handy someday.

Another thing you will want in this notebook is an inventory of tools and spare parts you want to take with you to the track. Use the one I have in "PARTS AND TOOLS", for now. You will develop a better one as time goes on.

Getting Through Tech

This has to go somewhere. Use your GCR and you will get through okay. However, here are the things they are **most** likely to check. For you newer guys, they are not looking here to see if you have a fuel injected V8 in it. They are just looking for safety issues. Although, if he counts the 8 header pipes, he may mention it. Bring your screwdriver with you to Tech. They may not have one, and you are going to have to pull the body off.

1. Positive side of battery cable. Cover with tape or silicone sealant. *The logic here is that in an accident, an exposed positive cable is very possibly going to get shorted to metal somewhere. It can very easily start a fire. If you have your kill switch located on the ground side of the battery,*

you may also want to tape or seal the negative side also. If it were to short against the frame, the kill switch would be ineffective.

2. A vent line from the fuel cell that terminates at or below the frame of the car. *You may also want to consider a check valve in this line. (They are prone to failure, though.) In the event of a rollover, it will help keep the fuel in the cell.*
3. Fuel lines and Oil lines shielded.
4. Two throttle return springs. *In case one breaks.*
5. Make sure that your Rain Light works and is connected through the kill switch. *They will normally ask you to turn the rain light on, and then turn the kill switch off to see if it also turns the rain light off.* The kill switch should also have the decal near its location on the side of the car.
6. Fire bottle mechanics and a level meter reading in the green. With an "E" sticker indicating the location of the fire bottle release.
7. Seat Belt dates. *Dated within 5 calendar years.*
8. Seat Belt condition. *Not worn badly and routed and laced correctly.*
9. Captive heimjoint bushings. *It is possible for the ball to come out of a heimjoint. You should have washers on your heimjoint bolts/nuts that are large enough to keep the heimjoint ball from slipping out of the heimjoint, and resulting in total loss of control.*
10. The inspector will usually shake the front end back and forth and give a very concerned look. After he realizes it's a Vee, he will probably pass you. But, just to be sure, check your wheel bearings, tie rods, steering gear, etc., before taking the car to Tech.
11. They may also check to see that you have your "FV" and SCCA stickers on the car as well as any other required decals. (READ THE SUPPS FOR THE EVENT.)
12. Support behind the head. There should be a **firm,** padded support behind your head. (36+ sq. inches and 1" thick). If you spin the thing into a concrete wall backwards, your head may weigh about 200 lbs. instantly and it better hit something soft, but supportable. (200+ lbs.) The fiberglass body or .040" aluminum firewall won't do it. You will break your neck. As often or not, this will not be checked closely by Tech. That is a shame. I have seen 2 neck injuries within the last 5 years that I think were, at least indirectly, caused by this lack of support item.
13. Helmet. (Acceptable Snell rating and in good condition, with personal information on the back side. (Name, Date of Birth, Blood Type, Allergies, and Date of last Tetanus shot.))
14. Fire suit, gloves, arm restraints, socks, shoes, and underwear, if needed. Should be in good condition – no rips or worn through spots. They may also check for the SCCA patch on the uniform.
15. Tech will check your logbook for pictures of your car posted in front, and for a Homologation Certificate if your car was built after 1983.

The hardest part of Tech inspection is waiting in line. The Tech guys are usually pretty good and if you're nice to them, they will probably reciprocate. Don't argue with them. Unless it is real difficult to fix and you have a real good legal case, it ain't worth the effort. Just put some more tape on the battery connector and shut up. Thankfully, this now only has to be done once per year. Back in the 'old days' it was required at EVERY event – WOW, was that a nightmare for everyone.

Seriously, the Tech routine is there to save your butt. While some of the Tech inspectors may get overzealous, you should follow their advice and your GCR to the letter, or better.

Technical Protests (Engine)

Conceivably, at some point a fellow participant may protest your engine. That's a compliment. He obviously thinks you're too fast. However, it's bad if Tech finds your engine to be illegal. (I will only cover the engine here, since variance in car designs would make it impossible to tell you what to look

for on every car.) Keep up to date on your GCR for class chassis technicalities. (Weight, rim size, dimensions, etc.) The GCR is now available as a 'living document' on the SCCA website for FREE!! Make sure you keep an updated copy on your computer at the track.

Obviously (or maybe not), you have a 1200cc engine. The items that most often get checked in an engine protest are carb, intake manifold, deck height, cylinder head displacement, and certain engine component weights. These are all covered in the GCR, and if you are legal, you are legal. *(The engine builders stay to legal tolerances and aren't about to destroy their reps by building an illegal one.)* However, there are a couple things that might get you even if you were legal when the engine was assembled.

1. Deck Height - Current rules specify a minimal deck height of .039". This is the distance from the top of the pistons, when at top dead center, to the top of the cylinder. The smaller the deck height number, the better your compression ratio. An engine builder will ensure that it is .042 or so, usually. To achieve this, paper shims are placed under the cylinders at the base, against the case. If you have removed your cylinder heads a couple times and/or re-torqued your heads, the shims can get squeezed a little. If your engine was built real close to the .039 number, and the paper shims have been squeezed a lot, you might now be illegal. All 4 cylinder deck heights are averaged for legality in this measurement. Thus, if you have three at .041 and one at .038, you are still legal.

2. Maximum Valve Lift. - Current rules call for a maximum intake valve lift (measured at the top of the valve) to be .354". Maximum exhaust valve lift is .3365". Again, engine builders try to get close to the maximums. However, any change in valve geometry can cause this to increase (or decrease). A rocker arm change, rocker arm tip wear and subsequent adjustment, change of push rod (swapping a couple when reassembling, etc.) can cause you to go illegal.

These are the only two things that I am aware of that can change and innocently make your engine illegal. Always check them after removing a head or doing anything to the valve train. Normally, if you have a professionally built engine and you get it periodically rebuilt, you will be fine.

Getting Started in Formula First

Formula First (Converted Jacer FV) 1

Formula First is a new entry-level class based upon most of the concepts of the Formula Vee. It, for the most part, brings FV up to more current technology and reduces costs and reliability by allowing the use of newer and many after-market components. Before jumping into Formula First, do some research into your area of the country to see if it has taken hold, and to determine if this is right for you. At the time of this writing, Formula First is a Regional class only, and can only run in Regional Races.

To find out more about Formula First and its activity in your area, check out the following web sites:

http://formula-first.org

This web site is the official Formula First web site that contains the rules, pictures, contracts, and more.

~~http://first.formulavee.org/exchange~~

~~This is a Forum for Formula First interested drivers and builders. The folks here can give you all kinds of help and information.~~

Formula First Basics

The rule package for "First" was designed to keep costs low (both purchase and maintenance), along with allowing a relatively easy conversion of an existing Formula Vee to a First. The wheelbase and weight was increased slightly also to allow for larger drivers.

Major Differences

The biggest single difference is the use of the 1600 Dual Port engine and 34PICT Bocar carb. All 1600 parts are still in production and certain allowed parts are available from after-market providers. All parts are less expensive than 1200 parts, for this reason. The front beam is now of the ball joint type and shock towers can be removed. This allows for a better looking car and some variability in suspension/shock methods.

The First is also a 4 wheel disc brake vehicle, bringing it into the 21st century. Rack steering is also allowed. In keeping with the concept of newer looks, after-market wheels and wider tires are used. The purchase price on tires is somewhat more, but in 5+ seasons of testing, it seems that they will last at least 3 to 4 times as long.

Buying a Formula First

At the time of this writing, there is one Formula First builder in full production, Campbell MotorSports. (http://www.campbellmotorsport.com) He is producing the Evolution Formula First. Pictures can also be seen on the Formula-First web site. **[Steve Note: Larry Campbell has recently retired from car building. His complete operation is FOR SALE at the time of this message, but will likely be taken over by someone in the future.]** There are two more builders gearing up to build Firsts. Check the First web site for the most current info, since interest is increasing daily. There have been a few Formula Vee conversions that have come up for sale once in a while. However, at this time in the class's life, there isn't too much resale activity.

If you like the "wrenching" part of racing, you may want to buy a "roller" or "slider" FV or even a used ready-to-race FV, and do the conversion yourself. Most First's running now are Vee conversions and there is no shortage of people to assist you on one of the above web sites. ~~Also, (www.racecarsupply.com) and SR Racing (www.sracing.com) sell kits for conversion, along with providing phone assistance.~~

Prices

Again, at this early time, it is difficult to estimate prices for used Formula Firsts. A new kit from any of the above manufacturers should be only slightly more than a new Formula Vee. Engines (1600), new or used, will be anywhere from ½ to 2/3 the price of a fresh 1200 engine. Rebuilds will run approximately the same as a 1200, but may not have to be done as often and, if needed, some major parts will be cheaper. Transaxles have a different gear ratio than most FV's (see rules), but run about the same price.

If you buy a used FV and convert it to a First with quality new parts, figure on spending somewhere in the area of $5000 for the conversion effort. This will include all the parts to get you to the track in Formula First configuration. (Some fiberglass work may be required.) However, If you do all the work and scrounge around a bit, you can do a conversion for as little as $1500. A used FV roller/slider can be had for as little as $2500, so as you can see, if you like the building part, it can be as easy to get into First as it is a FV.

Performance Differences

A Formula First is about 2 to 4 seconds a lap faster than a FV. Top speed is slightly more with low-end acceleration much greater. Corner speeds are about the same or slightly faster.
Rack and Pinion steering gives it a better feel with disc brakes giving more predictable stops.
The engines dyno at about 85 hp vs. the under 60 hp of a FV. Top RPM is about the same. (A restrictor plate is used in the First to limit top end and to help equalize engines slightly.)

Setup

To date the built Formula Firsts have all used suspension setups similar to FV. The major difference in setup is camber. The wider tires all enjoy less negative camber. –1 degree on the rear, (FV's are typically –1.5 and –5 degrees). While this makes best use of the tire patch, it also makes the rear look nicer and get slightly more HP to the track, due to less drive losses at the fulcrum plates in the gearbox.

Tune-up and Trouble Shooting

Similar trouble shooting (see miscellaneous maintenance) procedures can be used for the 1600 DP engine. The only major difference is the Ignition set. The First uses a drop-in points replacement kit, (Pertronix Igniter or Comp-U-Fire). Thus, no dwell adjustment is necessary. Timing will be about the same (see your engine builder or marks on the pulley degree wheel.)

Vintage Formula Vee (Vintage info provided by Bob Shedd)

Butch Deer Vintage FormCar 1

Vintage MotorSports is one of the fastest growing parts of MotorSports. Vintage Formula Vee (VFV) is a significant part of this. There are only 2 differences between a current SCCA Formula Vee and a VFV; some relatively minor equipment changes and most importantly – driver attitude.

Equipment: For the purposes of this discussion, we will use the Monoposto Racing rules for VFV – a Monoposto car can run anywhere in the country – some parts of the country are more lenient, but all will accept a Monoposto car. For a complete set of Monoposto rules for VFV, log on to http://VSCDA.org.

Vintage Formula Vees must be built in 1969 or before. Some parts of the country run Historic F/V with slightly different rules – check with your local club. Safety equipment is pretty standard, fuel cells, fire system, and belts (no more than 5 years old). The required engine changes are external: you are required to run a stock fan, fan shroud, and a working generator (6 or 12 volt). Rear suspension: you must run 2 shocks with coil over springs with a Z bar (or cable, etc.). No zero roll assemblies. You are required to run treaded tires, with Dunlop and Hoosier being the choices. Because the tires we have to use are of large diameter, a "short box" transaxle is the choice. Likewise, you will find that a motor with a "straight up" cam timing key is required. Long box transaxles and advance keys are legal, just not popular.

Driver attitude: maybe the most important difference, but the hardest to put in print. In vintage, we race – this is no parade – but we all do it to our own skill level and comfort level. Winning is not the objective – a safe, fun race is the objective. We often have 20 or more VFV's at an event, so it is possible to have a wonderful dice for 15th place and have a safe, memorable race. As a friend once said about vintage racing, "there is nothing to win, but everything to lose". Safety is utmost. Vintage Formula Vee racing is very social and family oriented – everyone knows everyone, and everyone helps each other when needed. Come out and join us. Info can be found at the following web site: http://VSCDA.org.

THANKS!

I hope this has helped you out. After a year or two, throw it away or pass it on to a friend. If you learned some more that you think should be included or corrected, let me know ~~and I will add it for the next revision. (I will give you credit.)~~

Feel free to call us for assistance, advice, or to argue with our logic.

Jim Schings
SR Racing / ~~RaceCarSupply.com~~
~~100 Mercer Ct, Suite 120~~
Lexington, KY 40511

(859) 339-7425 (cell)
sracing@mindspring.com

Steve Davis
WedgeRacing.com
Near Athens, GA
(770) 855-5577 (cell)
Steve@WedgeRacing.com