

# *The Formula Vee Handbook*

*A guide to maintaining your  
Formula Vee*

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This Handbook is available for download from the Formula Vee website, at:

<http://fvee.home.ml.org>

## FOREWORD

Formula Vee is one of the longest surviving categories in the sport of motor racing in Australia. Its principle is to place the emphasis on drivers' ability rather than bankroll. The rules are derived to be fair and cost effective to each competitor.

This publication aims at giving the reader an overview of Formula Vee Racing by describing various aspects and language used in our category. It is not a "how to do it guide", but we hope it can help to guide you in the right direction.

Throughout this publication the reader will find all the attributes one would expect to find in a sporting body. The total input is wholly and solely voluntary, and all articles are provided by Formula Vee members with a great deal of experience and love for our category. If any members should choose to follow and apply the practical and technical details in this publication, they will have a smoother introduction to Formula Vee and most importantly find the initial learning curve much easier.

THIS BOOKLET was created by a consortium of Formula Vee Association members. Their combined contributions have enabled the publication to be produced for the benefit of all members.

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### DISCLAIMER

The information provided in this handbook is intended to be used as a guide only. Actual experiences by users of this Handbook may differ from those described, as a result of different operating conditions and variations in other external conditions from those in effect at the time of publishing. Further knowledge and skill is also required by the user of this Handbook in order to safely carry out the various tasks necessary for reasonable operation of a Formula Vee.

The publishers therefore do not accept any responsibility in the event that any results claimed by users of this Handbook do not coincide with the opinions expressed within this Handbook, or in the event that a maladjustment of a mechanical component by a user of this Handbook has resulted in damage or loss.

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# SO YOU WANT TO BECOME A RACING DRIVER

You've been watching Alan Moffat, Peter Brock, Craig Lowndes, Larry Perkins, Damon Hill, Alan Jones etc, on the box for as long as you can remember. Reading about Formula 1, V8s, Brabhams, Karts, Apexes, understeer, oversteer, brake balance etc. "Yes I can do better than all of them! Hill couldn't pass a car if they moved over and waved him through! But of course I've got nothing to prove either." But maybe you've been driving karts since you were 2 years old and now you're 15 it's time to think of making the big move into real racing cars. Like Formula Vee, Well regardless, the time has come to take the plunge, to fulfill your dreams – to become a racing car driver.

## **HOW TO BEGIN BEING A RACING DRIVER**

To be a racing driver you need to know a couple of things and you need to own a couple of things.

### **How does circuit motor racing work in Australia?**

You need to know about the structure of motor racing - in this particular case, of circuit type motor racing. This will help you to understand how a single person fits into the motor racing world. The key people or bodies involved in circuit motor racing, starting from one end to the other, are as follows:

#### **CAMS:**

CAMS (formerly the Confederation of Australian Motor Sport) is the regulating body for many forms of motor racing, including rallying, motorhomas, superkarting and of course circuit racing. CAMS is comprised of thousands of members, all of whom are members of car clubs and associations which are affiliated to CAMS, the Formula Vee Association is one of these. CAMS is in turn affiliated to the FIA, the international motor racing body. Starting with Formula Vee, through CAMS and the FIA, you could go on to be Formula One world Champion. CAMS don't actually organise any race meetings, (other than the Melbourne Formula One Grand Prix) they give permission for the race meeting to proceed by issuing a permit, and they provide Stewards who ensure that the meeting complies with all CAMS standards. CAMS does not oversee speedway, karting, and drag racing. CAMS also look after all the administration to do with all racing car drivers, such as licensing (yes, you do need a racing license, just like you need a license to drive on the road), racing car registrations, medical tests, race meeting permits, safety standards, apparel, etc. More about these later.

#### **THE PROMOTERS:**

The Promoters are the people who organise the race meetings in which you will drive. There are many promoters across Australia. Some promoters are private businesses, some are non-profit clubs, some own their own motor racing tracks, some promoters have to hire racing circuits or tracks. The best known NSW promoters are the Australian Racing Drivers Club (ARDC) who run the Bathurst 1000, Eastern Creek and Amaroo Park. Oran Park Motorsport run many meetings at Oran Park, but they also lease Oran Park out to clubs like the NSW Road Racing Club, who then run their own race meetings.

#### **CAMS AFFILIATED CLUBS:**

Then there are the clubs that are the members of CAMS, (like the Formula Vee Association of NSW) to which all racing car drivers must belong. There are hundreds of clubs affiliated to CAMS, some of which only deal with motor racing, some with road events, and some being marque clubs, like the Porsche Club. To be a member of a club like the Formula Vee Association of NSW, you have to get the secretary of the club to send you a membership form, which you will return with the dues, and you then automatically become a member of the club and of CAMS.

## **THE MEMBERS:**

The members of CAMS belong to the car clubs affiliated with CAMS. They are you and I.. You don't have to be just a racing car driver to be a member of a CAMS affiliated Club. The members drive and maintain their racing cars, they are the office bearers and committee members of the clubs, they are the families of racing car drivers, they are the social directors of the clubs, they are the flag marshals who stand by the side of the race tracks all day in the hot sun and the rain -they can be anybody. But they all share one thing in common, they love motor racing. Through these thousands of people, CAMS keeps rolling: race meetings take place, Formula One comes to Australia.

## **SO WHAT DO I NEED TO DO TO BECOME A RACING DRIVER?**

To get a CAMS competition license you need to do several things:

Have two passport photos made

Ring CAMS and ask them to send you a CAMS General Competition License application form.

Ask CAMS when their next lecture night is, and attend it, making sure you sign the attendance form on the night.

Make an appointment with a CAMS approved Doctor (the list comes with the application form) and get checked out, making sure that the Doctor fills out the CAMS medical form.

Fill out the license application form and return it, along with the medical form, your passport photos and your money, to CAMS.



## **CAMS LECTURE NIGHT:**

The lecture mentioned above will require you to sit for a couple of hours with the lecturers being some of the most respected racing personalities in NSW. The lecture will cover all aspects of motor racing, from the required apparel, flag signals, on and off track behavior, and many other issues you will learn about when you attend one. But you must attend or no license. From the lecture night, you will also get a good idea on what kind of racing suit, gloves, shoes, helmet etc. are available, and at what cost.

Sooner or later, CAMS will send you out a CAMS unendorsed provisional General Competition License. This license will look like a full racing license, but you will not be able to race with this unendorsed license, because you will have to have it endorsed. You will be able to go private practicing with this license. Private practice involves going to one of the tracks on a private practice day where you can test your car or practice your driving, along with possibly many other cars at the same time. You can hold an unendorsed license for as long as you want, there is no time limit to get your license endorsed.

## GETTING YOUR UNENDORSED LICENCE ENDORSED

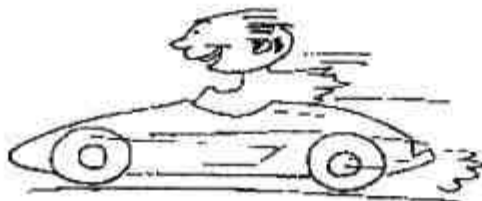
There are two main methods of getting your CAMS license endorsed. One is through a CAMS approved private racing drivers school, the other is through an official CAMS Observed License Test. The private schools have their sessions almost every week, giving a wide range of tuition, but they can be more costly than the official test. If you attend a private school, they will put you through all their routines and observations for a day or two, then assess your suitability to be a racing car driver. They cannot actually endorse your license, but they can recommend that your license be endorsed, which is almost always done by CAMS.

CAMS Observed License Tests (OLTs) are held every two or three months at one of the local racing tracks. To attend one of these tests, just ring up CAMS and they will send you out the application form for the next one. Once you have returned the form with all your unendorsed license details, car details, and the dues, (typically about \$80.00) your name is on the list for the test. At the test, your car (which can be almost anything as long as it is safe) will be scrutineered (or checked out for safety) by officials at the track. Your license will also be checked, as will your apparel. During the day, you will be observed by about five experienced racing car drivers, positioned around the track, during a pretend practice session for about fifteen minutes and also during a simulated race for about the same time. There will then be discussion sessions with all the drivers before final judgements are made regarding their suitability. If successful, the chief observer will then endorse your license, and you will then be allowed to go racing from that point on. But your license is still only a provisional General Competition License, but more on this later. If you are not successful, try the next OLT. Many current well known drivers have not passed their first, or even second OLT.

## SO, HOW DO I GO RACING

Once you have had your unendorsed license endorsed, and you are the proud owner of a CAMS Provisional General Competition License, now, of course, you want to go racing. To start at club level, you should ring up all the promoters (the Association can tell you which ones) and get them to put you on their mailing list. You will then automatically receive an entry form for a race meeting as soon as entries open. When the entry arrives, just fill it out with your license details and the vehicle's log book number and send it back with the entry fee, which could be anywhere from \$120.00 for a club meeting to \$250.00 for a national level meeting.

A week or so before the race meeting, you will receive in the post the supplementary regulations (lots of specific details about the race day which you must read and know), the entry list, a programme, and free admission tickets. From there, just roll up at the track on the day with your license, apparel, car and log book and yourself. But there are a few things you need to know about your car!



## YOUR RACING CAR:

Just as you need a license, your car also has to be approved by CAMS for racing. CAMS do not do this directly, but through your car club. The Formula Vee scrutineer, for instance, will have checked your car out when it was built to ensure that it complies with all the Formula Vee technical rules, as found in the CAMS Manual. If everything is OK with the car, then the club scrutineer will fill out a CAMS vehicle log book application form, which you will send back to CAMS, along with photos of the car and a CAMS registration fee. Sooner or later you will receive a log book for your car which will have the owners details, photos, and log book number. If you buy a car, you cannot race it unless it has a log book with it and it is registered for racing.

## AT THE TRACK:

So, you have arrived at the track with your car, yourself, and your paperwork. For all entrants, there are many things to do before you can get straight out on the track, but being a provisional license holder, there are one or two additional procedures. At the allotted time, as specified on the program, you should line your car up at the scrutineering bay to get your car scrutineered by the official scrutineers. Your car should be fully clothed, as it is intended to race. The scrutineers will ask for your car's log book, and may check your apparel out as well. If everything is OK, then they will return your logbook along with a scrutineering slip.

Once you have wheeled your car out of the way, you should then go to the administration office near the scrutineering bay and take with you your CAMS provisional license, your log book, and your scrutineering slip. The administration officer will then confirm your details, and then return the paperwork along with a "Permit to Practice" slip and a "Permit to Race" slip. Guard these slips with your life because without them, you will not be able to get onto the track at all!

Another compulsory requirement is your attendance at drivers' meeting with the Clerk of the Course (the man in charge of the race meeting). These meetings often take place when your car is being scrutineered, but you must attend and sign an attendance form and being a provisional driver, you must then be briefed by the Clerk of the Course before the first race on specific track conditions. No meeting with the Clerk of the Course, no racing!

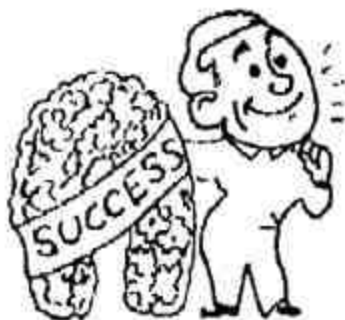
## GETTING ON THE TRACK:

The program will tell you in which numbered sessions your category will run. Qualifying always takes place first, of course. So, with plenty of time to spare, you have put your racing suit, gloves, helmet, etc on, strapped yourself into your car, warmed up the engine (taking care not to overheat it), and made your way down to the dummy grid (the compound where the cars are assembled prior to going out onto the track). But you will not be allowed to enter the dummy grid without your "permit to practice" slip, remember! Once you have passed your permit to the dummy grid official, just take one of the places in the dummy grid and get ready to be moved out onto the track by the promoters officials when ordered so.

Congratulations. You've now finally made onto the track. During qualifying, you'll go around and around until a checkered flag is shown, then you will slow down and proceed in single file back to your parking area. Soon, the qualifying times will be issued and you will be given a place on the grid for the races. The above procedures for qualifying will then also apply for racing, but this time you will need the "permit to race" to enter the dummy grid.

But all is not over. Because you are a "Provisional" driver, you will have "P" plates displayed on your car, just like on the road. To get off the P plates, you will have to get endorsed signatures from the Clerk of the Course for five race meetings, and only one signature per race meeting. To get a signature, you will basically need to be well behaved on the circuit during your events, and not be responsible for any negligent or malicious incidents.

Once you have received your five signatures, you can then apply to CAMS to have your provisional license withdrawn and replaced with a full CAMS National Competition License. By this time, you will have experienced all the usual hardships, obstructions, and frustrations, associated with motor racing. But you will also have a great time getting there!



# THE PACKAGE

If you had to divide up the competitive components of a successful Formula Vee, it would go something like this:

50% Driver	40% Handling	10% Horsepower
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Dogs excluded, in a field of Formula Vees there would be less than 10% difference in HP (3 or 4 Horses). Horsepower can mean the difference between coming 1<sup>st</sup> and 2<sup>nd</sup> but has very little influence on doing a high 61 sec instead of 60 sec neat at Amaroo. This was best shown at the 1995 Nationals at Eastern Creek when one of our top drivers blew his "good" race engine in qualifying. With a "what the heck" attitude he threw in a sad old motor that was waiting for a rebuild. On the compression test the cylinders measured from 30 to 90 psi; this translated to about 30 HP at the rear wheels. The driver then took the car from 26th grid position to finish 9th in the final, passing many cars with 4 to 5 HP more.

There is an old adage in motor sport "fast in ..... **SLOW OUT..** ...".  
I've lost count of the number of times I've heard "I need more horsepower like Joe Bloggs at the front. I pulled him in at stop-go corner then he blew me away coming out."

Formula Vees are not about horse power.  
Formula Vee Racing is about driver skill and race craft.

Joe Bloggs knows that to be successful in Formula Vee you must be able to carry the car's momentum through and out of the corner. This involves slowing the car **before** the corner, turning in and getting back on full throttle as **early** as possible and driving the car out of the corner.

Meanwhile Harry (*the late*) Braker has buried the car deep into the corner in a very spectacular style, washed off all the car's momentum and emerges 500 to 600 RPM down on Joe and is left wondering why he is getting blown away. Joe carries the extra 600 rpm with him to the end of the straight while Harry, even with the assistance of the tow, is struggling to make up lost revs to pass Joe. Very frustrating, hey.

What is it that attracts you to motor racing? Are you just a motor sport fanatic, is it the excitement, the adrenaline buzz, camaraderie over a few beers, the pretty "Shell" girls or all of the above. One thing that most drivers have in common is the desire to win!!

To be able to achieve this, the race must start the week before with **car preparation**.

- Check**  The wheel alignment, ride heights, bump steer, shock absorbers, steering, link pins etc, FOR HANDLING, you need to get the "power" down early in a corner.
- Check**  The wheel bearings, adjust the brakes, throttle opening etc, FOR PERFORMANCE, it's no use going onto the race track with an anchor.
- Check**  The brake drums, throttle linkages, gear linkages, tyres and steering, FOR RELIABILITY, it's no good having the fastest car if you can't finish the race.

Even though they rarely admit it ("I just threw it on the trailer") front runners spend at least four to five hours on race preparation before each meeting.

**Test as often as you can afford.**

- Try different braking points, race line apexes etc, using your tat & stop watch as indicators once you're down to consistent times.
- Try different car set ups - shock adjustments, toe-in, toe-out at the front and rear of the car, to find your optimum car/driver setting for a particular track.
- Test in the wet as well. Yes it will rain one day at a race meeting and you'll have to drive in it. (It can be fun in a properly set up car).
- Test with a mate and practice towing, it's the only way to go.....

# RACE DAY



**Qualifying** is extremely important, as the further up the grid you can get, the better quality of drivers you will find and you will have less cars to pass to get to the front. Qualifying well also gets you away from the "mid-field brawl" for 13<sup>th</sup> place in the race. Try to go out with a friend or someone you trust. By working together with another driver you can tow each other around the circuit and pick up valuable time. Your mate may be lucky and out-qualify you by a couple of 100<sup>ths</sup> but the  $\frac{3}{4}$  of a second you both picked up has taken you six places up the grid. If you come across Harry "...the late braker" during qualifying and he is trying to dive beneath you under brakes or is wanting to "race" you, slow down or pit to get away from him, he will only waste your time.

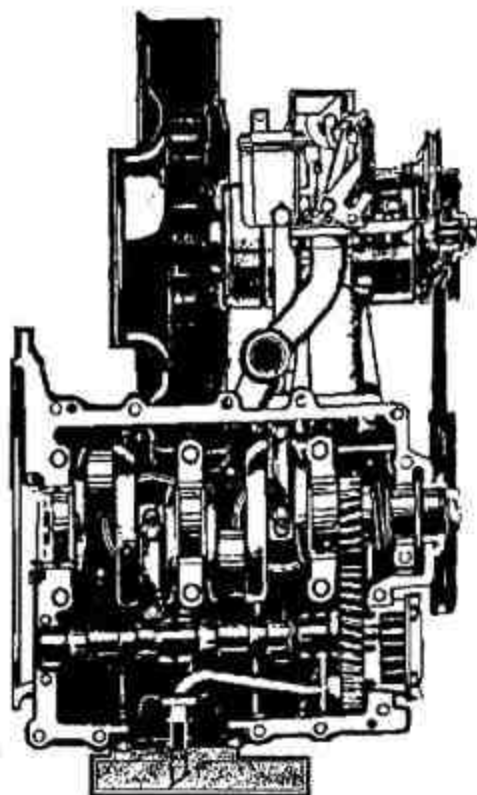
The **Preliminary Race** should be used to check out your final race set up and also check out the opposition. Look for their strengths and weaknesses and if it happens to be a long race try and note if they are cooking their tyres or their engine goes off song around lap 6 or 7. This is all useful knowledge for the main race.

The **Trophy Race**. Well you've made it to the top ten on the grid, you've got a good start, passed three cars off the line, into the first corner and you're stuck out too wide and one of the cars has got back under you. Don't panic - no race has ever been won in the first corner (except in F1). By lap three, things have settled down and everyone is travelling Indian File on the race line through the corners. Meanwhile back in the pack *Harry* has started a carve-up, poking his nose in where it not wanted and having the door slammed in his face. This has slowed his pack down and the front runners have pulled away at over two seconds a lap, while trading places slip streaming on the straight. At half race distance, the car behind you gets frustrated and dives under you two corners from the straight. You and another car overtake him up the straight. The only problem is the front four have opened a small gap. You're in luck - the front four are trying to consolidate their positions and the car with you is willing to work in and tow up to the front bunch. Then you've finally caught them coming onto the straight, they appear to be bunched up and travelling a bit slower than usual. With a quick double tow, your in the lead, only to have your pit crew show the 'two laps to go' board (oh shit!). There's a clear track in front of you and your stomach knots up, you over-run braking points, miss apexes and it's the worst lap of your life. Yet nobody passes you (are they scared of you? probably not). You look into you mirrors coming onto the straight and there they are, lined up like a pack of vultures waiting to pick you off. Out comes the last lap board as the third car in the tow sails past you. Hero to zero in a couple of hundred metres. For the remainder of the last lap the leader covers every corner while trying to keep up reasonable speed. All you can do is follow him to the flag.

- Finally, be cool, be calculating, be cunning but most importantly be CAREFUL. You're not racing for sheep stations.



# FORMULA VEE MOTOR



## Agenda for a race motor

- # Double horsepower and RPM from standard
- # What makes a motor go -
  - # Friction
  - # Balance
  - # Compression
  - # Carby
  - # Manifold
  - # Exhaust

Always refer to CAMS manual, Formula Vee technical manual & VW manual at all times.

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1. General
  2. Parts & preparation of parts.
  3. Dummy build.
  4. Motor tune - Rocker geometry
    - Cam timing
    - General tune; Carby , distributor etc.
  5. Running in a motor
-

## 1. GENERAL

The rules applicable to Formula Vee appear in many CAMS publications. It is your responsibility, as a competitor, to know these rules and make sure your car complies.

- **CAMS "REPORT"**

This is a periodical which is sent to all competitors and contains articles on safety issues as well as new rule changes. On the last page there is also a column titled "Rules & Regulations" which list the CAMS BULLETINS published since the last edition of CAMS "REPORT". These bulletins are CAMS way of updating rules during the year and are available from the CAMS State Office.

- **CAMS MANUAL of MOTOR SPORT** (Better known as "The Bible")

In each years edition all new rule changes are shown shaded. Not only should you read the section on 1<sup>st</sup> Category - Racing cars & Formula Vee but also the relevant schedules A to N which give the rules on such items as Roll Bars, Coachwork, etc. Probably the most important rule in the manual is Rule 1.2 which basically states that all mechanical VW parts must be of unmodified VW specification unless authorised within the regulations.

- **FORMULA VEE TECHNICAL MANUAL**

This manual defines the approved interpretations of the Formula Vee Regulation as specified in the CAMS Manual, and where appropriate it specifies the procedures through which compliance with specific regulations shall be measured & certified. At the time of writing the latest issue No. is 2.3, and update No.s are published in the National Vee News. The present document is 25 pages in length plus two drawings of sealing equipment.

The contents of the manual are: -

Revision History: - Issue 2.3

Section 1: - Introduction, Interpretations, Policy & Authority.

Section 2: - Standard equipment required for Scrutineering.

Section 3: - Standard Scrutineering Procedures.

Section 4: - Sealing & Certification Procedures.

Appendices A to D - Forms & Measuring Equipment details.

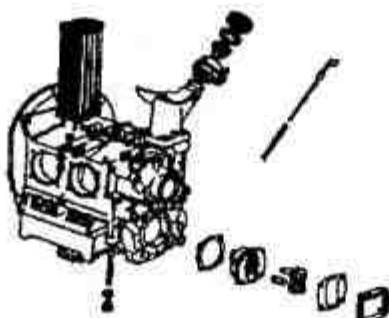
Note - Section 3 contains all the relevant information on methods & interpretations of sealing relating to the CAMS Manual.

The only other publication needed to work on a Formula Vee is a VW maintenance manual. There are various publications available, the best are old copies specifically for 1200 VW Beetles found in 2<sup>nd</sup> handbook stores, they contain all the manufactures information on mechanical components that is not available in any of the above publications.

## 2. PARTS & PREPARATION

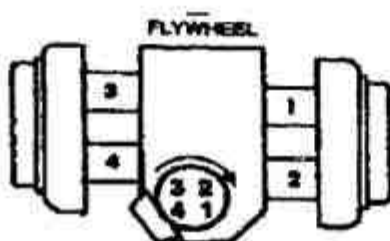
### • CRANKCASE

- 3x Types
- Early (round oil filler hole)  
Some existing motors work well, not advised for new motor due to metal age, Replace head studs for late model heads.
  - Late (D shape oil filler hole)  
Extra webbing in case makes it stiffer, needs matching for cam bearings.
  - Universal (000 part No. On side of case)  
As above, cam tunnel bearings fitted, bigger oil galleries, may need sleeves for 1200 barrels, some with duel oil relief valves, manufactured in Germany, Brazil, & Mexico. Rare to find second hand, best to use on new motor.



### • BAFFLING AND SUMP EXTENSION

A sump baffle and a sump extension are required to prevent oil surge in high speed corners. Both are commercially available.



**Type 1 & Early Type 2**

Firing order    **1 4 3 2**

#### Bolt torque setting

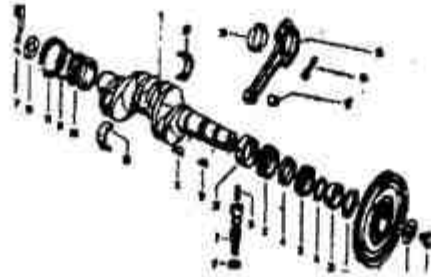
# Case m12	-25 ftlb	# case m8	-14ftlb	# Conn. rod	-35ftlb
# Head (1 <sup>st</sup> )	-14ftlb	(2 <sup>ND</sup> )	-25ftlb.		

- BLUE PRINT CASE

- # Line bore -- Crank tunnel  
-- Cam tunnel
- # Machine spigot faces
- # Hone cam follower tunnels to slide fit.
- # Extend oil pick up pipe for sump extension.
- # Fit sump baffle
- # Clean case.

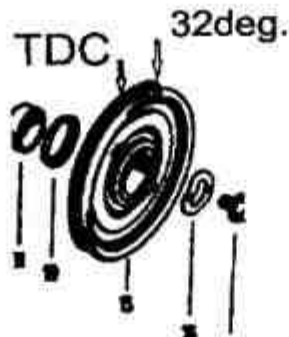
- CRANKSHAFT

Have it ground for maximum stroke and index. maximum grind to 40 thou.  
Balance from front pulley to flywheel.



- FRONT PULLEY

Mark 32 degrees, tdc & bdc  
Two sizes available, use the smaller diameter to slow fan.

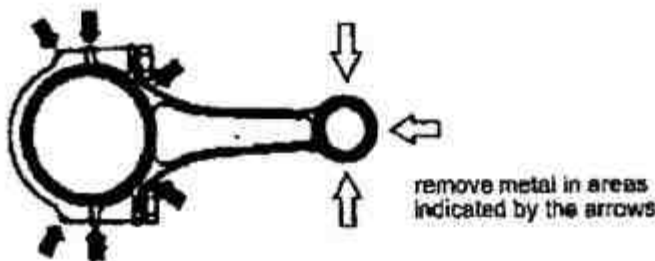


- CONROD

2 types- older 100 series  
- Bar / offset little end.

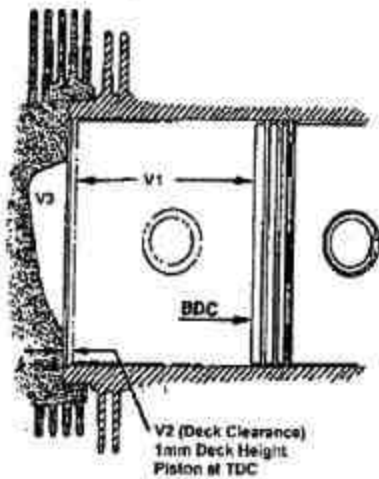
Both can be lightened to minimum weight. (Keep minimum to 10 gms over for future machining)  
close and hone if needed.

Metal removed from both little and big end . not from beam. Balance all little ends then  
All big ends to within 1 gm.



• **PISTON**

Balance to within 1grm of each other. Remove metal from inside skirt and head of piston.  
 15 GMS can be removed from inside of gudgeon pin. Minimum weight not critical. Watch for wear in ring grooves.



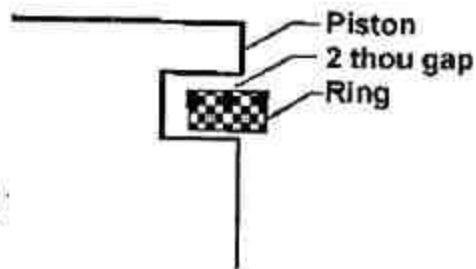
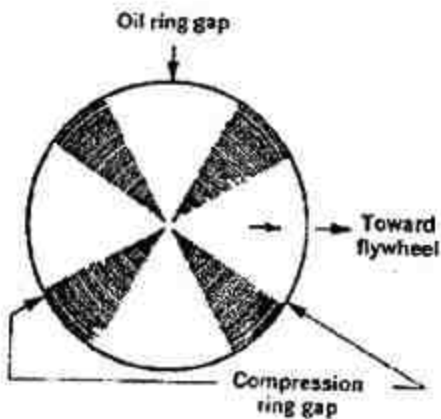
V1 = 300 cc Stroke Volume  
 V2 = 5.96 cc Deck Height Volume  
 V3 = 43 cc Head Volume

Max. Compression ratio 7.1: 1

• **RINGS**

- Types - Cofab (wear in quick, wear out quick, do not use chrome rings (never wear in)).
- NPR Give good results, replace twice a year.
  - 2 Piece "total seal" long lasting and can be reused after barrel hone.
  - Always use three piece oil rings.

Top ring gap towards inlet valve, second ring gap 180 degrees from the top ring gap

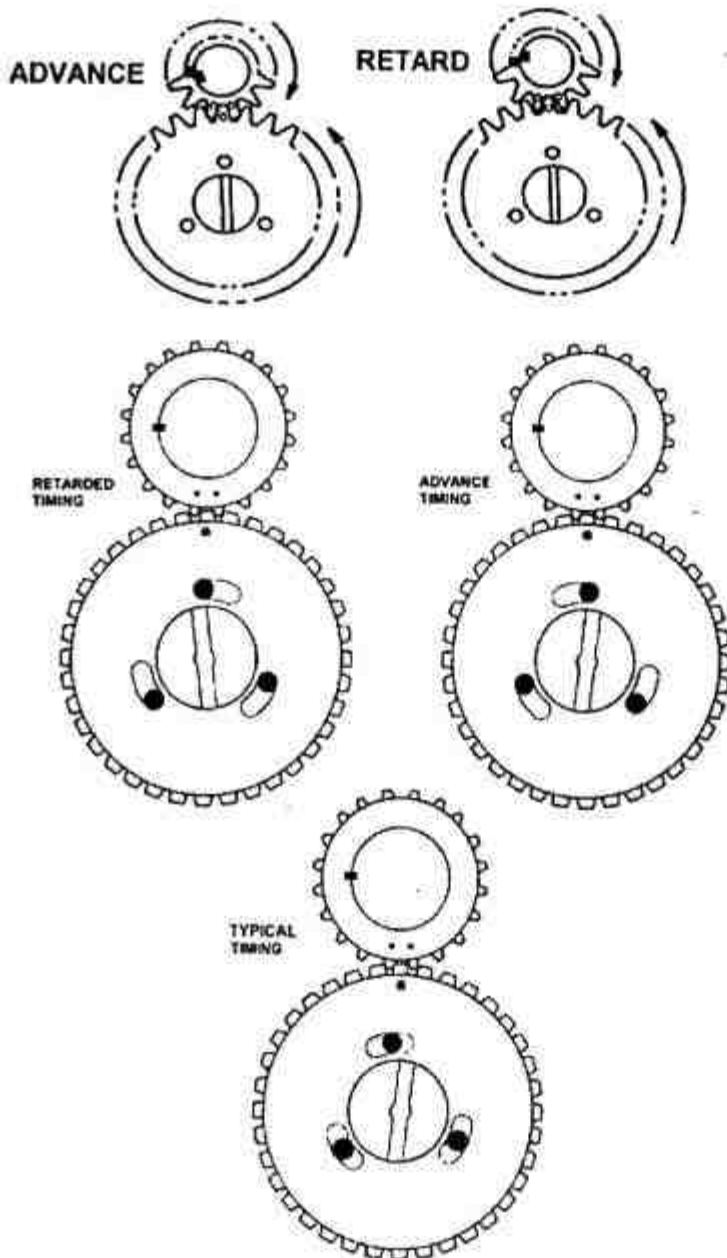


- **CAM SHAFTS**

- # Ground by Wades
- # Check for burs on gear
- # Check camshaft in case, for friction.
- # Check for backlash with crank gear
- # Adjust cam gear (see section on cam timing).

**2 METHODS TO CHANGE CAM TIMING-**

1. USE OFFSET KEY
2. USE A ADJUSTABLE CAM GEAR

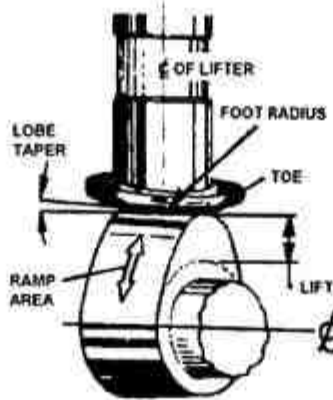


• CAM FOLLOWERS

2 types – One piece weight between 85 and 100grms each.

- 2 piece lightweight approximately 70 gms each.

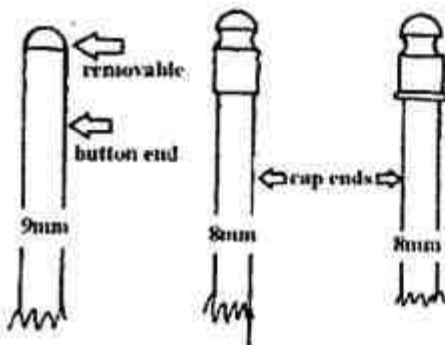
Less weight helps valve bounce. Make sure face is convex with a straight edge (48 " radius) otherwise it will ruin the camshaft.



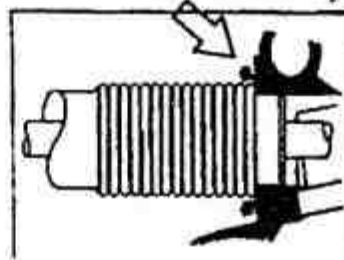
• PUSHRODS

2 types - Cap end, bend @ 3800 rpm, do not use.

- Button end. Stronger, can be shortened (see section on rocker geometry).

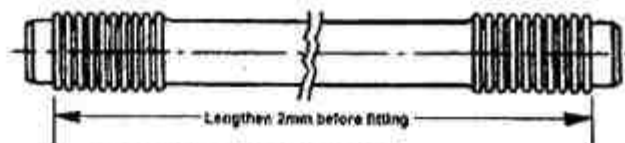


make sure seals sit correct before tensioning head



**PUSHROD TUBE FITMENT**

THIS TYPE CAN BE ADJUSTED FOR LENGTH. THIS THICKER 9mm ROD HAS LESS FLEX @ HIGHER REVS.



**PUSHROD TUBE**

**\* NOTE IT IS ALWAYS ADVISABLE TO CARRY AN ADJUSTABLE PUSHROD TO THE RACE MEETING IN CASE OF DAMAGE OR OIL LEAKS .IT COULD SAVE YOU PULLING OUT.**

- **BARRELS**

Mharl or Cofab use fine fin for better heat distribution than course fin. Be sure to lap to head.

ON REBUILD, BARRELS SHOULD BE CHECKED FOR WEAR, ROUND, SEALING SURFACES AND THE CORRECT HONING PATTERN.

HONE WITH A PARRALLEL HONE TO REMOVE SCRATCHES THEN USE A BOTTLE BRUSH HONE FOR FINAL 45 DEGREE CROSS HATCH.

- **HEADS**

# 373 A,B & C round rocker post, less Finns for heat diserpation, can be made to flow OK.

# 373 square rocker post, most commonly used.

# 371 D same as above, slightly better for porting.

# 371 F after market similar to 373, avoid Mexican (poor casting).

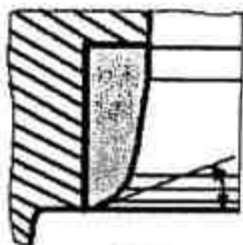
Note: If you are using round post heads and want to fit square post "D" or 373 heads, you will have to fit longer studs to your case.

- **PORTING**

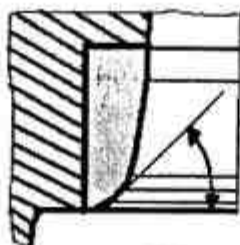
Read books!, big is not always best, be prepared to do a lot of experimenting and hard work or leave it to an expert to give you the best results quicker and in the long run probably cheaper.

- **VALVE SEATS**

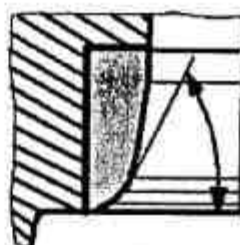
3 cuts @ 15°, 45°, 75°.



**15**



**45**



**75**

- **VALVE GUIDES**

2 types, shoulder and straight. Shorten to regulation length.

- **CC ING**

CC chamber to correct volume but keep secondary cut to minimum as it adversely effects the chamber squish.

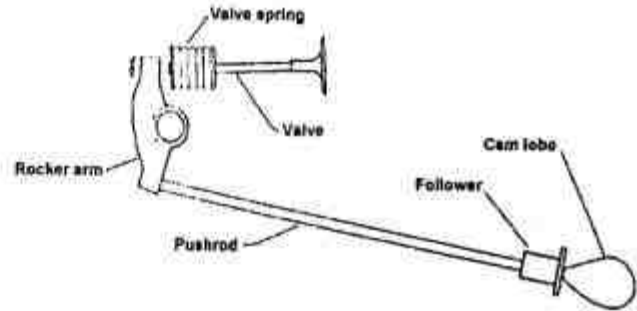
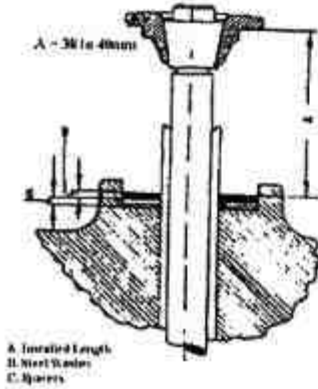


- **VALVES**

Inlet & Exhaust use genuine VW or TRW, forget the rest.  
Lap in - Inlet seat on edge 0.75mm wide.  
- Exhaust seat 1mm min, 1.5 wide.  
Check valve stem for wear.

- **VALVE SPRINGS**

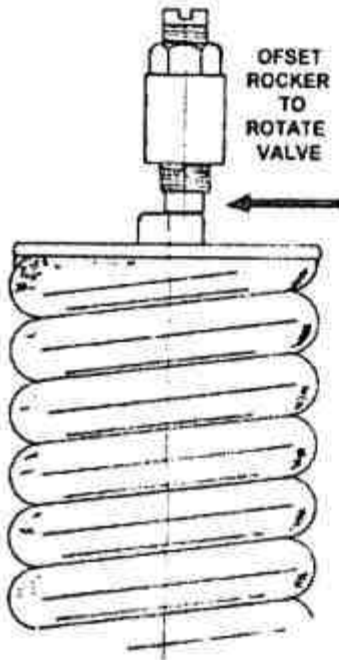
Use good quality, test within 2lb of each other. Set seat pressures to 70lbs with shims.



Any good quality spring is OK since we can shim them up to the pressure required. Seat pressures between 65lb. to 70lb. are fine, any higher or lower is a waste of horsepower. Pressure must be even.

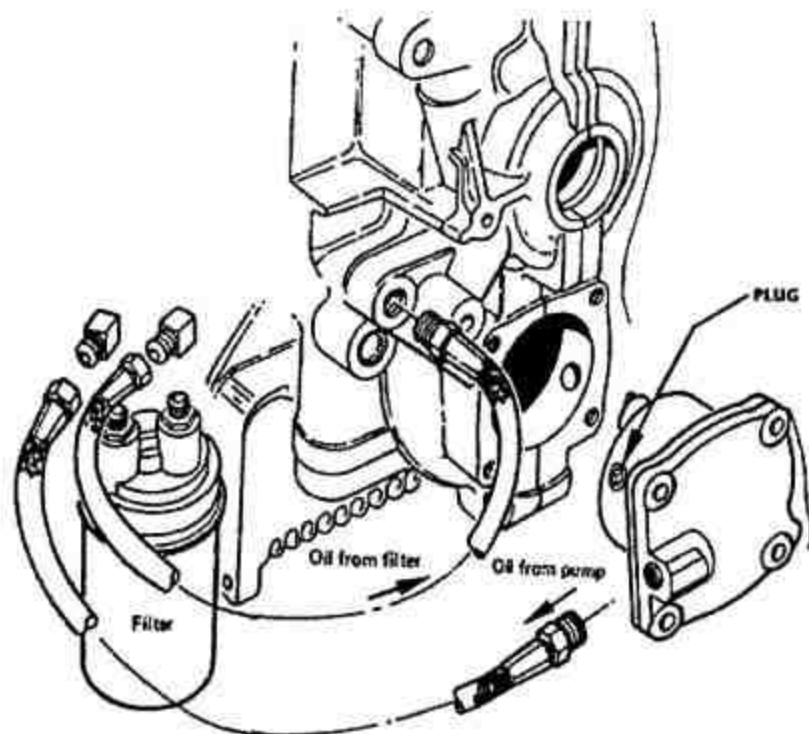
- **ROCKERS AND SHAFTS**

Replace wave washers with spacers.



## AUXILIARIES

- **FLYWHEEL**  
Lighten to near min. weight. Remove as much metal from outer edge as possible for best effect.  
12 volt cannot be used with 6 volt starter motors.
- **CLUTCH**  
DISC more direct  
SPRING slightly lighter
- **FAN & HOUSING**  
Use early type slim line (no heater tubes attached)  
Early type fan has less blades, uses less HP.
- **GENERATOR**  
Gut & remove brushes, run total loss elect. system.
- **FAN BELT**  
Run as loose as possible, gives better acceleration when it slips.
- **OIL FILTER**  
Run oil line from front of pump scot adaptor throughout filter back to oil gallery drilled and taped in front of engine, filters oil from cold start up.



- **OIL PUMP**  
Use 1300/1500 high volume pump watch out for 1600 dish cam gear type.
- **OIL COOLER**  
EXTERNAL allows cold air to No.3.
- **DISTRIBUTOR**  
Use Bosch 009, standard VW relards No3.

## CARBURETOR

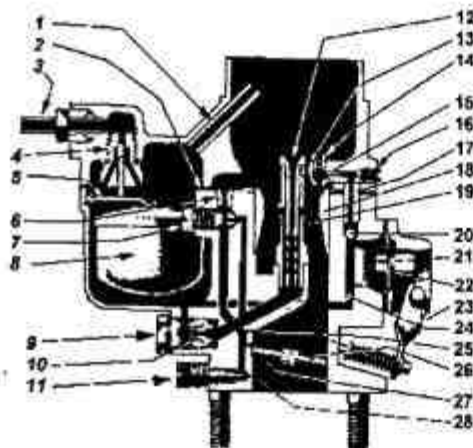
5 tops. Worst, screw in accelerator pump.

3 bottoms, best type has pipe casting on side.

Emulsion tube, watch out for ring-ins from other Solex carbs.

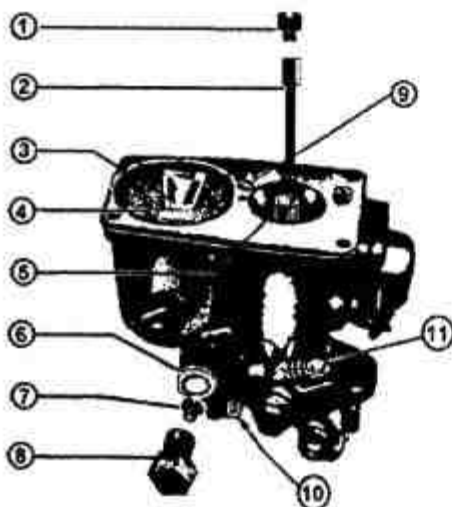
Venturie's narrowest point is at the holes in the Emulsion tube.

Butterfly shaft. Thinnest has notch shaft.



**SOLEX 28 PCI CARBURETOR.**

1. Breather tube
2. Gasket
3. Fuel pipe
4. Float needle valve
5. Float needle valve lever
6. Slow running air bleed
7. Slow running jet
8. Float
9. Main jet carrier
10. Main jet
11. Slow-running volume screw
12. Air correctin jet
13. Emulsion tube
14. Pump air jet
15. Pump jet
16. Screw
17. Tube
18. Venturi
19. Spraying well
20. Ball check valve
21. Accelerator pump
22. Pump diaphragm
23. Pump operating lever
24. Ball check valve
25. Slowrunning air passage
26. Butterfly
27. Accelerator port
28. Slow-running port



**Jet Locations:**

1. Air Correction Jet
2. Emulsion tube
3. Float lever
4. Float
5. Spraying well
6. Gasket
7. Main jet
8. Main jet carrier
9. Slow-running air bleed
10. Slow-running jet

## • EXHAUST

Primary 1.5" diameter 36" to 45"

1 3/8" hard to find bends but gives you more bottom end.

Collector 7" long merge stinger.

Secondary 1 5/8" x approx. 13" long.

Muffler minimal or megaphone. (Experiment)

### **3. THE DUMMY BUILD**

#### **Should be done before booking a sealer.**

- # Fit bearings to case
- # Assemble crank and check the swing of the rods.
- # Fit assembled crank to case, watching out for location dowels.
- # Fit cam followers.
- # Fit camshaft making sure timing marks line up.
- # Check camshaft gear backlash
- # Check dizzy drive and shim to correct measurement.
- # Fit the two halves of the case together.
- # Check for easy rotation of crankshaft.
- # Fit pistons (without rings)
- # Fit barrels and check deck heights (important both barrels are the same height)
- # Check stroke
- # Fit heads and do the rocker geometry, and check valve timing.
- # Tension (make sure no head studs pull)

#### **• FOR SEALING PROCEDURE**

- # Pre assemble crank with rods except 1
- # Assemble rings onto pistons except 1
- # Layout parts for assembly in logical order so as to notice if any things get missed. i.e.  
eight  
piston circlips, sealing nuts with holes already drilled and air  
deflector shields.
- # Keep area clean

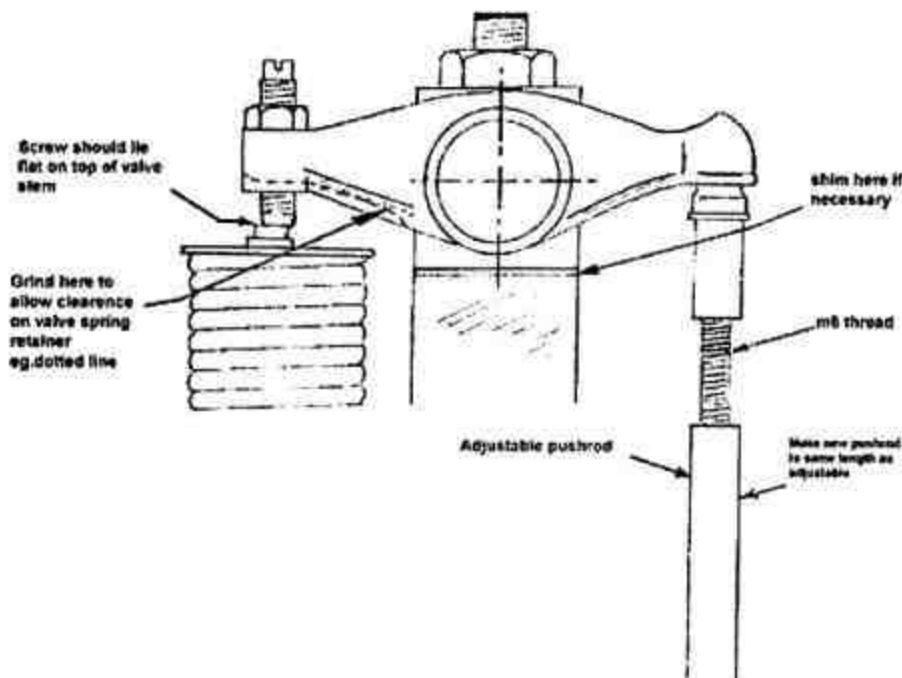
#### **• THE SEALER WILL CHECK**

- # Camshaft for grind and phase angle
- # Crank for stroke
- # Rods for weight
- # Pistons for size and weight
- # Cam followers
- # Heads for correct cc, port sizes, valve dimensions, valve guide measurements  
and valve springs.
- # Check deck height.

## 4. MOTOR TUNE

### • ROCKER GEOMETRY

To give you an idea a bad geometry would be around 7.9 lift. To achieve the correct rocker geometry you will need to have, say four ( to do one side at a time ) adjustable pushrods made up. Setup your dial indicator to read the lift from the valve side. You may have to grind the bottom of the rocker to achieve the clearance from the rocker to the collet. Then shim the shaft and adjust the adjustable pushrod to allow the rocker adjusting screw to sit flat on top of the valve stem. When you get the setting you want, make new pushrods and number them, i.e. 1E, 1I, 2I, 2E, etc. Try to achieve a lift of around 8.2 on exhaust and 8.5



on inlet.

### • CAM TIMING

1. Get No. 3 rockers on rock i.e. No. 1 on TDC.
2. Fix degree wheel to front pulley and zero on TDC, No. 1 piston.
3. Fit dial gauge to head and zero it on top of No. 1 inlet spring retainer.
4. Remove all rocker lash (gap).
5. Rotate the crank in a clockwise direction and note max. lift (say 8.6mm.)
6. Keep rotating the crank till you're 0.5mm. (8.1mm. on dial gauge) from max. lift.
7. Note the degree wheel reading (say 87°) then keep rotating crank till you're gone past max. lift and back to your mark on the dial gauge (8.1mm.) and note the degree's (say 127°).
8. Add your two degree wheel measurements together and divide by 2. (107°).

This should give you your peak lift.

**Note: -107° is standard cam timing.**

110° would be 3° of retard, which would take power from the motors bottom end and place it up in the top of the motors RPM. 104° would be 3° of advance, which would give more bottom end power.

### • GENERAL TUNE

1. Spark plug gap - .026"
2. Points gap - .012"
3. Distributor timing - 32° at 3500 RPM.
4. Rocker gap, Inlet - .002", Exhaust - .004"
5. Carby - Check colour of spark plug, center electrode tells if it's rich /lean up top, outer ring tells if it's rich /lean down low, both should be a light gray colour. Bigger main jet will richen up down low, Bigger air correction jet will lean Carby off up top. Check for full throttle. Check float level, with the top removed lightly touch the float, fuel should immediately appear at the holes in the spraying well. If not bend float lever to suit.

## 5.ENGINE RUN IN

After hours of preparation and work the car is now set to go back out onto the track with it's new engine. Oil in, bolts tight, settings all correct and ready to go, but the last part of your engine preparation is still to come, The Running In. This can undo all the careful measurements, preparation of parts and assembly

of your engine if you stuff it up here. Most engine builders have their own way they prefer to run their engines in, and if you have someone build your engines for you, ask them the way they prefer for it to be done. This is usually correct as they will advise you from years of proven performance.

***Following is a guide to running an engine in.***

Before taking the car out check all bolts and nuts in case you left one loose on reassembly. Check oil levels and fluid levels.

***First Run*** - keep load on engine at all times, don't run revs too high (under 3000rpm.) e.g. pull out of corners in top gear instead of changing down. Do around 20 or so laps keeping an eye on the gauges, on the last lap come in real slow to start cooling engine. Come into pits and allow at least half an hour for the car to cool down. Check engine oil level again.

***Second Run*** - Do the same as the first except you can drive a bit more relaxed, whilst still keeping the engine r.p.m. under 4000. Watch all the gauges and don't get tempted to put in a flying lap yet. Return to the pits and allow the car to cool down again, check levels again.

***Third Run*** - this time go out and drive at about 8/10ths being as smooth with the car as possible. The occasional quicker lap at around 9/10ths won't hurt but don't over do it. Slow down after about the 20 or so lap mark and return to the pits. It's now time to get rid of the running in oil and put in the good oil you use all the time, and don't forget to change the oil filter as well. It should be time now to let the car have it's head.

*Remember this is a guide only, talk to your engine builder for any specific instructions.*

## GEARBOXES

There are three types, split case, long and short.

### SPLIT CASE .

Came out of the very early Beetle (36hp) . Could be described as a "very long box".

Not a desirable unit but usable. Called a split box because the box comes apart in two halves.

### LONG BOX .

Designated by the diff ratio as long box. A 4.12: 1 diff ratio came out of the 1500 beetle, 1200 Kombi and early type 3. This box is used at high-speed tracks like Eastern Creek & Phillip Island. At 6000 r.p.m in top gear they are good for around 200 k.p.h. 1st & 2nd gear ratios are the same in both boxes. 3rd and 4th gears are different in the boxes. 3rd gear in the 1500 and type 3 box is 1.26: 1, good and usable. The 1200 Kombi and much sought after 1.22: 1 ratio. It can be checked by removing the drain plug under the gear set to inspect. It has a groove around the outside of the gear. ( 3rd is the gear directly above the drain plug ) . Top gear in the 1500 and type 3 was a 0.89:1, use it. The 1200 had a 0.82:1 top. Throw it away and don't think about it.

### SHORT BOX

Has a 4.37:1 diff ratio. 3rd gear is a 1.32: 1 and is only good somewhere like Winton, replace it with a 1.22 or a 1.26. Top is a 0.89, leave it in. Good box for somewhere like Amaroo or Oran Park.

### GEARBOXES

In a beetle the gearbox travels in a different direction. The crownwheel and pinion must be taken out of one side of the gearbox and set up in the other side. Easy to remember is that when viewed from the back the diff is on the left, whichever direction it is travelling. It can be set up in your garage with a bit of luck but is best left to some one who knows and has proper set up equipment. A good engine should produce around 60hp at the flywheel but only produce around 38hp at the rear wheels. So a gearbox consumes a heap of hp. There are many tricks to building a good gearbox. You may fluke a good one yourself. Some may do everything right and still have a problem. Save tears and let someone do it for you if you can afford it.

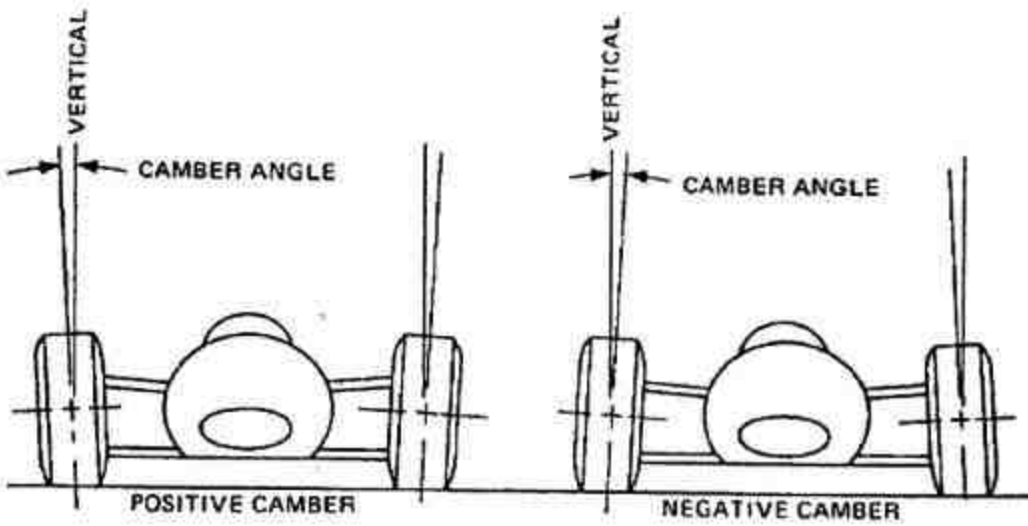
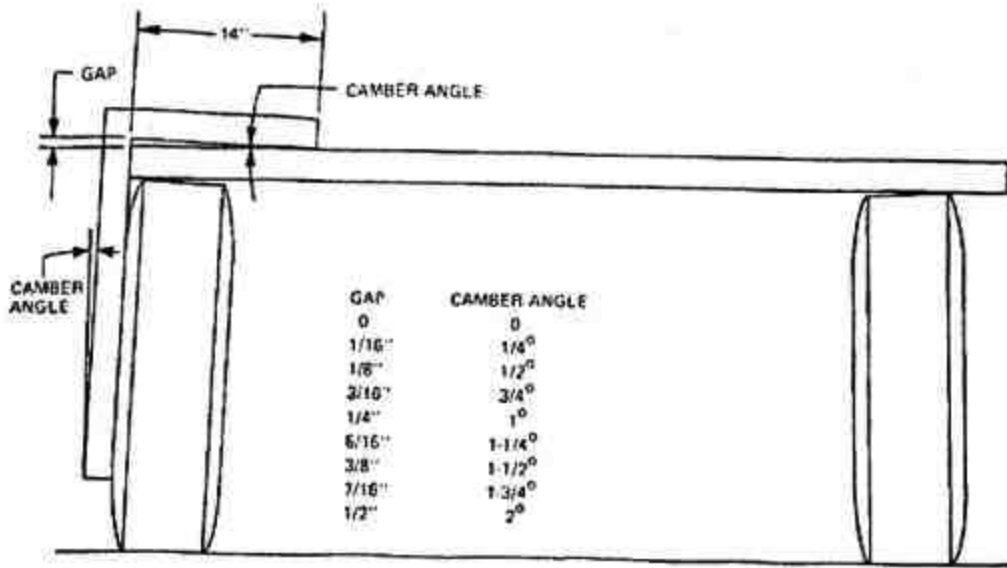
### GEAR RATIOS

One of the seemingly difficult things when buying a car is trying to figure out the true gear ratios in the transmission. Here is an easy way to figure this out. Start with one rear wheel jacked up and the other firmly on the ground. Put the transmission in the gear you want to check. If the engine is in the car, it will be easier if the spark plugs are removed. If there is no transmission, then an old clutch disk on the input shaft will work fine make a mark on the top of the tire and on the pulley or clutch disc. Rotate the tire 3 times and count the number of rotations of the engine (clutch disk) to the closest 1/8. Divide engine count by axle then multiply by 2. Convert this figure to a decimal and look for the closest value in the chart below.

		Gear Ratio	Long 4.125	Short 4.375
1	10 38	3.80	15.69	16.64
2	17 35	2.06	8.50	9.02
3A	22 29	1.32	5.44	5.77
3B	23 29	1.26	5.21	5.52
3C	23 28	1.22	5.03	5.33
4A	27 24	0.89	3.67	3.89
4B	28 23	0.82	3.39	3.60

For example: Engine (8 2/8) / axle (3) x 2 = 5.50 = 1.26 third / short box

# MEASURING CAMBER





# FORMULA VEE SUSPENSION, SETUP & HANDLING

Whether you've been racing for years, just beginning, or want to know more about Formula Vee suspension, setup and handling, the following is a simple guide to introduce some ideas to help you gain the most out of your Formula Vee.

The article will explain the importance of being comfortable in your car, and it's advantages. Explain some different Formula Vee suspension configurations, and define the jargon that goes with them! It will also cover hints on chassis preparation, such as wheel alignment methods, and how to adjust everything from shocks to camber and corner weights. What do my shocks, tyres, springs and front end do? . Theory is provided to give you a better understanding of your car, along with methods of setting up your car for different weather and track conditions.

## DO I REALLY KNOW HOW MY CAR IS HANDLING?

A talented front running driver has the ability to come in off the circuit and tell every detail of what their car is doing, because they can feel their car. Many legends of motor sport have said "To be a winning driver, you must become your car, it must be an extension of you". So how does this relate to you? Simple! If you are uncomfortable in your car, chances are you won't be able to feel everything your car is doing. A driver who is loose in his seat will slide around from corner to corner, which means they will never know whether their car is sliding or they are! Same story goes for the drivers who are tightly cramped into the car. They are either numb, in so much pain they're not sure if they're still conscious, or continually concentrating on everything but feeling their car and driving it to it's potential.

Here are some hints on getting comfortable in your car. Firstly, undo your seat and place it in your car, so that you can easily slide it around. Make sure you can at least see the top of the tyres or shock towers. Check that your arms are close enough to the steering wheel. A good length is when your wrist rest upon the top of the wheel with your arms stretched in front of you. Next, make sure your legs are comfortable. Your knees should be slightly bent while holding any of the pedals down (depressed) with either leg.

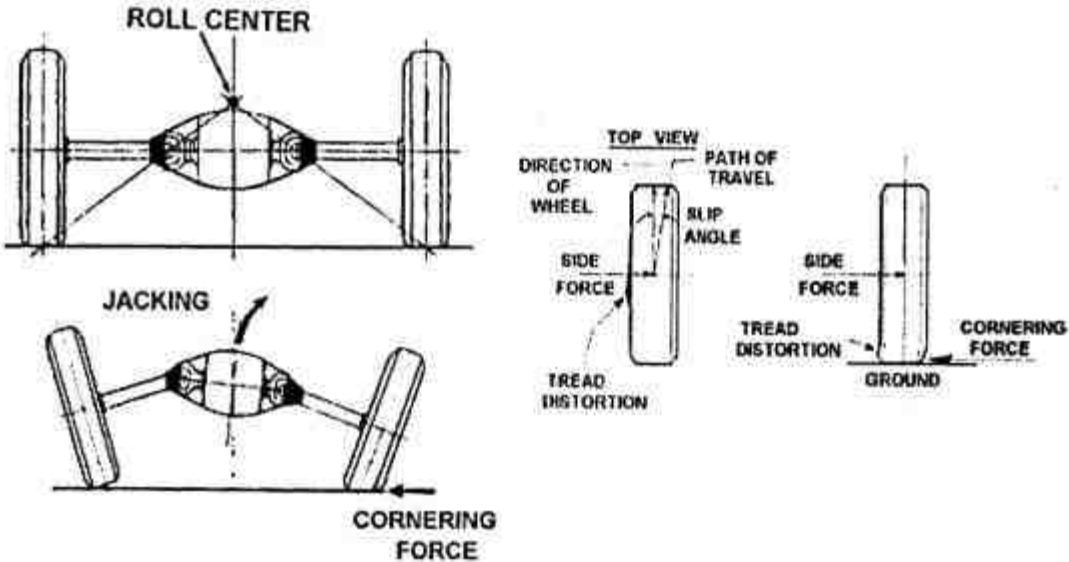
How about your seat. Make sure it actually fits your body. If its too big, you can make your seat fit your body snugly by using some expandable foam, for example Selleys space invader. Simply grab an old sheet and lay it over your seat. While you are in your car, in the driving position which suits you, and wearing enough clothing to simulate your race suit and seat upholstery, spray the foam down into all the gaps between your body and the seat, underneath the sheet. The foam will take about 40mins to set, and once it has you can upholster it or whatever you choose. Once its finished, your seat will be perfect for good race driving and car analysis.

Now that you've found the right seating position, tighten your seat and pedals etc, throw on your race suit and check the comfort of your harness. Your harness is extremely important, if adjusted improperly, it could cause serious damage, even just over bumps.

Does your clutch strap fit properly? When tightened it must be at least taught, definitely not loose. Do your shoulder straps sit on your shoulders? They should be far enough apart not to rub against your neck, and no higher or lower than a vertical plane inline with your shoulders.

## WHAT DO MY TYRES DO?

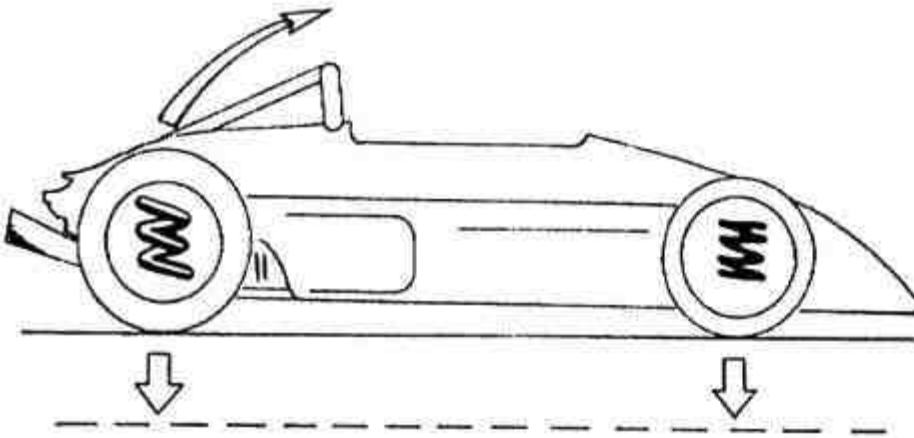
Obviously tyres are for your car to ride on and to grip the road surface (track). A new tyre has not yet had a heat cycle, and has more grip than an old one. It is also quicker on the long straight because its diameter is larger than a worn tyre. Tyre pressures are important for several reasons, they control how much tyre is on the road and also how much the tyre will roll or flex on the rim. They can also contribute to the rate at which a tyre heats up.



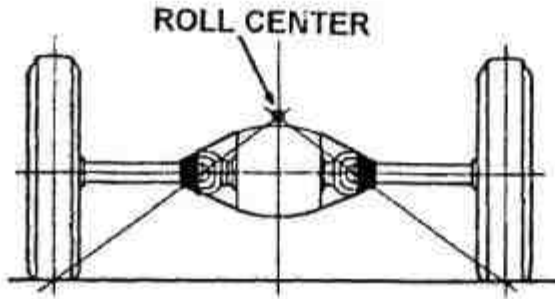
### • DEFINITIONS:

**RAKE:** The attitude of the car between front and rear. The difference in ride height between the front of the chassis to the ground plane and the rear of the chassis to the ground plane. Rake influences weight distribution of the car under braking and acceleration. e.g. High at rear = more rake, low at rear = less rake relative to front.

**RIDE HEIGHT:** The distance the car's chassis is from the road surface. It is measured at the front and at the rear of the car. The difference between the two measurements gives the car's rake.



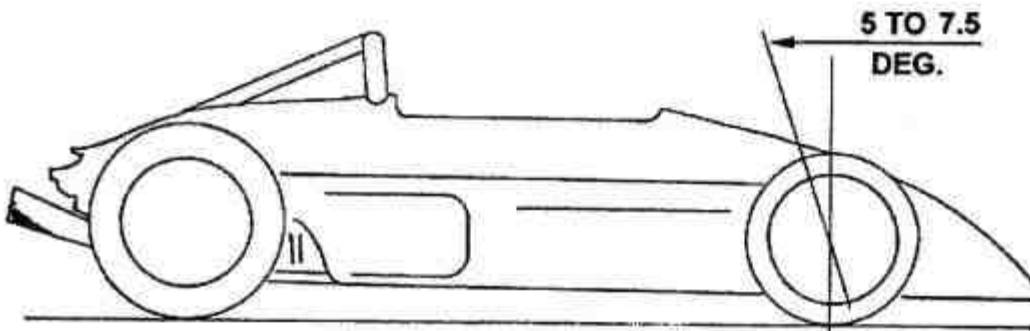
**ROLL CENTRE:** is the axis about which the centre of gravity rolls the car in a corner. It is located as per the diagram at the rear and at ground level at the front.



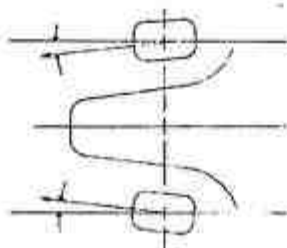
Jacking is eliminated by a camber cable, jack rear of car off the ground, and adjust cable till the wheels are vertical.

**CAMBER:** Each wheel has camber, which is the attitude of the wheel in the horizontal plane. E.g. Negative camber is when the top of the wheel is closer to the chassis's centre line than the bottom of the wheel. Measured in degrees.

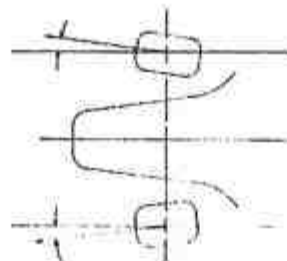
**CASTOR:** The attitude of the wheel in the vertical plane. Castor on a Formula Vee is (approximately) determined by the angle at the H-Beam mounted to the chassis. Measured in degrees.



**TOE IN:** The distance between the front of the wheels is less than the distance between the back of the wheels.



**TOE OUT:** The distance between the front of the wheels is more than the distance at the back of the wheels.



## FRONT SUSPENSION

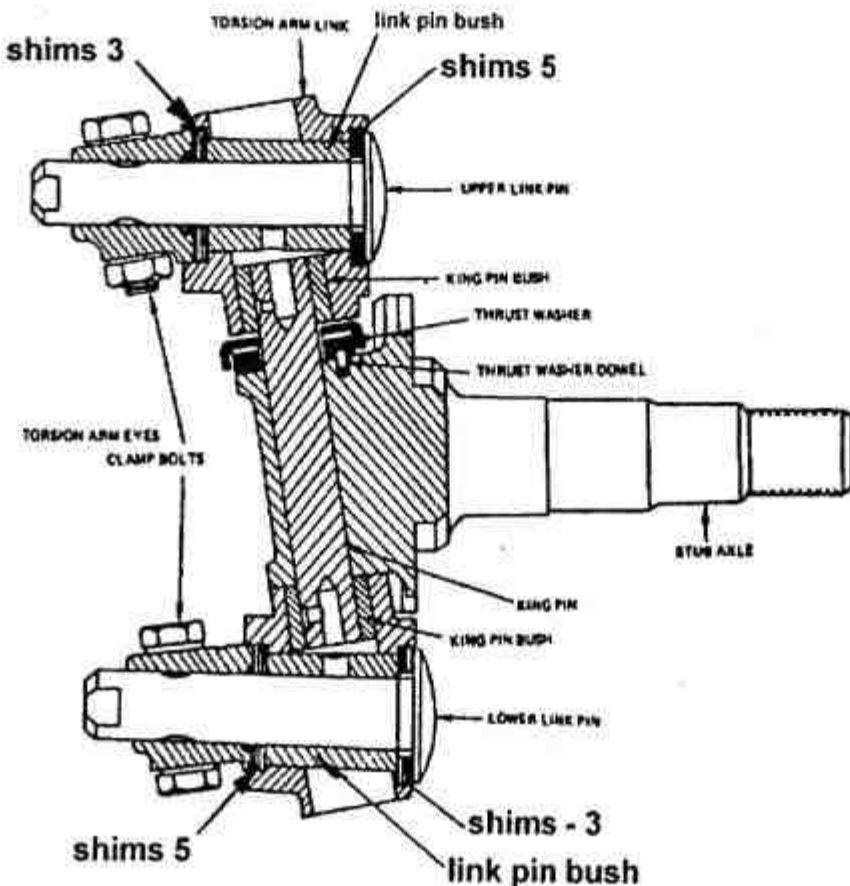
### • BUILDING UP A H BEAM

1. Clean outside of H Beam (steam clean is easiest).
2. Dismantle H Beam as per VW manual and remove grease.
3. Make up a new spring pack by removing unwanted leaves and replacing them with spacers consisting of 50mm. Long sections of the removed leaf cut with a angle grinder. Note: - the end and middle sections of the spring pack must be built up to the same dimensions as the full pack with the grub screw notches intact. The spacers are held in place by lightly tack welding them, then immediately quenching the area to maintain the springs temper. Spring packs will vary from 3 full plus 1 half for a light driver to 5 full for a heavy driver.
4. Fit the new spring pack to top of H Beam and tighten center grub screw, then fit rubber bushes and top trailing arms and tighten grub screws.
5. Slide 3/4" Dia. Roll bar into bottom of H Beam, replace rubber bushes with similar shaped brass bushes and fit bottom trailing arms and tighten grub screws. The roll bar should rotate freely with very little side movement.

**NOTE:** - If a load were to be placed on the end of a spring pack the leaves would bend out and the spring end would move inwards, therefore by placing the spring pack in the top of the H Beam the spring pack is kept in tension during cornering which helps to prevent the loaded wheel from going into positive camber.

### • SETTING FRONT CAMBER

Adjustment of camber is done by moving shims from one side of the torsion arm link to the other, on the link pin. Starting with 3 shims on the inner and 5 on the outer at the top link pin and 5 shims on the inner and 3 on the outer on the bottom link pin, lock up the link pins then back of a 1/4 turn and tighten the clamp bolts. Then bounce the front end up and down. If it moves freely then try moving more shims at the top to the outside and to the inside at the bottom to gain more camber. If not then do the reverse. **HINT:** - use worn link pin bushes.

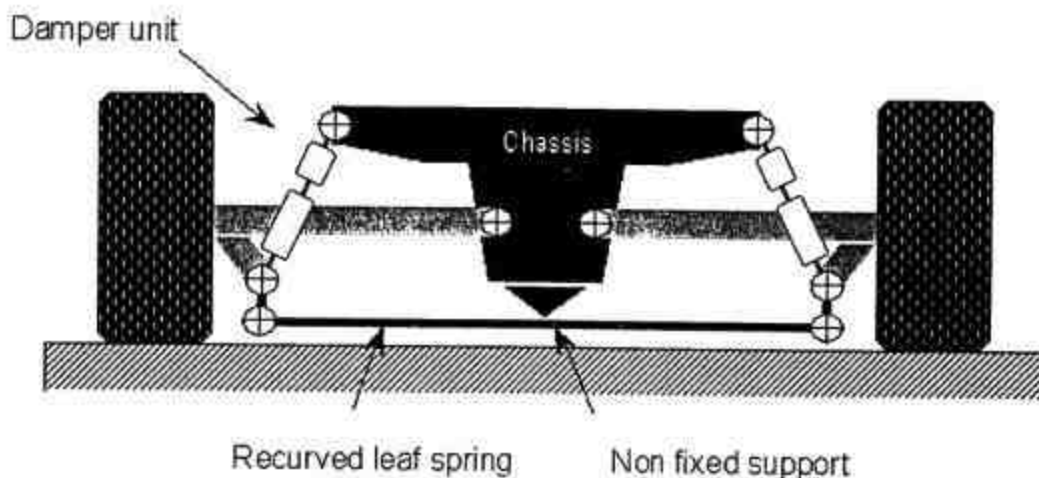


## FORMULA VEE REAR SUSPENSION CONFIGURATIONS

Since the beginning of Formula Vee there have been many different suspensions, doing many weird and wonderful things. In this article we will cover the modern style suspensions and discuss the different characteristics. Obviously the front suspension has little variation from car to car, so to begin with, the rear suspension will be discussed.

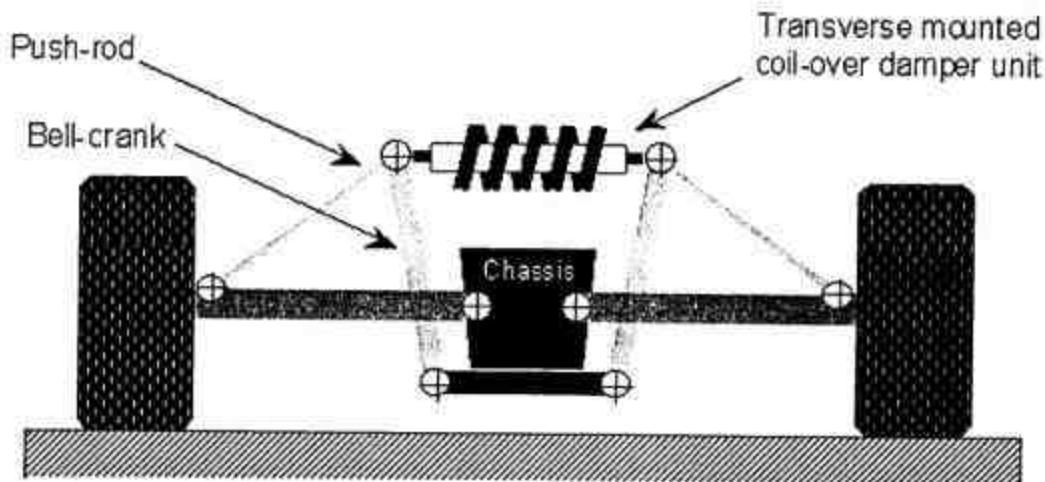
### LEAF SPRING

The leaf spring is the most conventional and widely used Formula Vee rear spring. It consists of a 10-12 mm thick x approx. 75mm wide leaf spring, hanging from either axle by rod ends, pivoting under the centre of the diff. Shock absorbers connected to either shock horns (axles) and to the chassis provide roll dampening and ride (bump/rebound) dampening. Adjustment is made by tightening (stiffen spring) or loosening (harden spring) the rod ends to raise or lower the rear end of the car. Used on Elfins, Spectres, Polars, Renmax Mk2 (some), Kestrel, Avanti.



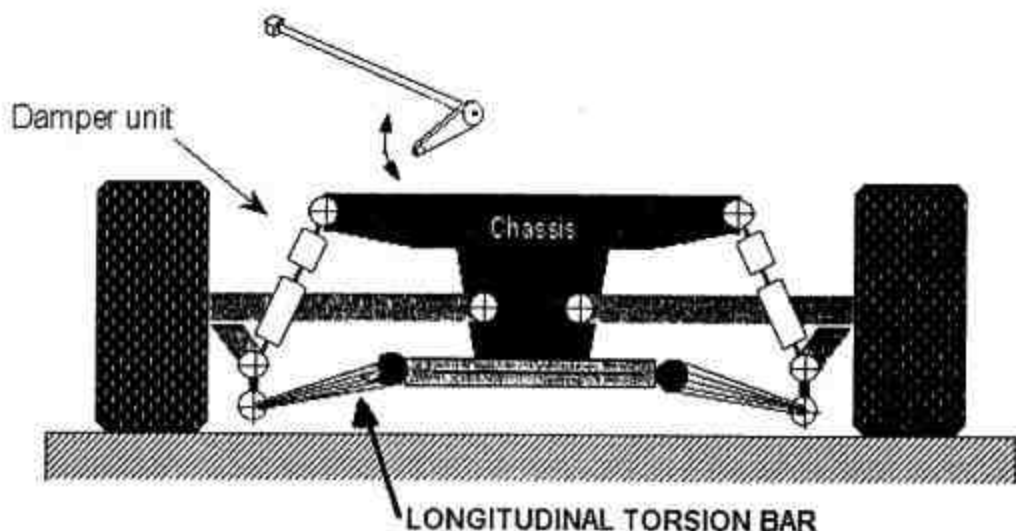
### MONO SHOCK COIL OVER

Consist of a single shock absorber with coil over spring, activated via pushrods and or rockers. The shock pivots on two rockers, which pivot off a rocker mount connected to the chassis. Bump/Rebound shocking is provided by the mono shock, but no body roll dampening is present. An additional shock can be added to the mono shock to provide a body roll control mechanism. This is a usually done by connecting the shocks to the rockers, and the chassis.



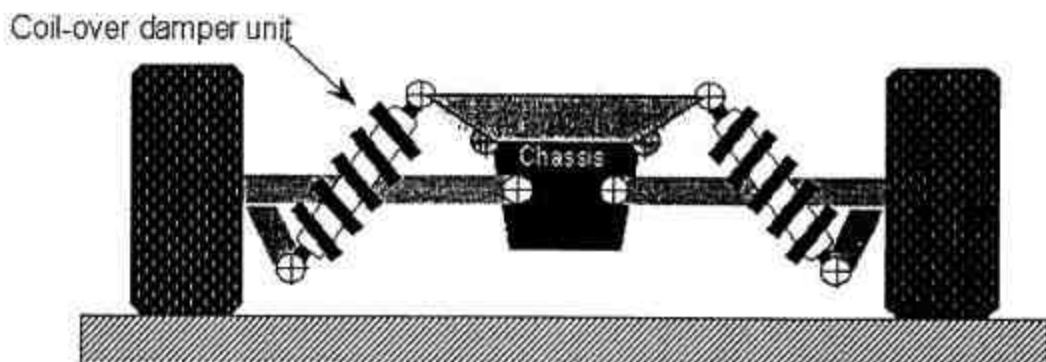
## TORSION ARMS

All modern Mako Formula Vees utilize torsion arm suspension. The system consist of a long torsion arm extended from a solid mount on the chassis to a lever-pivot which connects to the axle via the leading arms or some other method. As the axle travels up, the lever twists the torsion arm, which provides the springing. Torsion arm suspension is IRS. Body roll dampening and bump/rebound dampening is provided by a shock either side of the car between the axle and the chassis.



## COIL OVER

Coil over suspension is used on most Concept and some Renmax cars. It simply consists of a coil over shock absorber on either side which provides body roll dampening, bump/rebound dampening and springing all in one. The only major difficulty with coil over suspension is a sturdy rear chassis is needed to suppress all the forces produced by the suspension through the chassis.



## SETUP METHODS

Nothing is more beneficial to a car or driver than testing and tuning. A good guide to setting up your car is to try and test the car the day before the race meeting. This way the track is as close as possible to the conditions you will experience on race day.

One thing I like to do is a simulated qualifying at the same time of day as the one the following day. This allows us to know what the car is capable of at that time of day, and gives a good indication of what the circuit is going to be like, so the car can be set up as quick as possible for qualifying. After all, a good qualifying session gives you the advantage of getting ahead of the mid field fighting and obviously a better chance of victory.

Let's get down to the nitty gritty though, actually setting the car up for maximum speed and comfort. One thing that is most important to remember is that your car should be set up for **you!** You will be the one who has to drive it fast, so it makes sense to set it up that way. A good benchmark for your car's setting is to set it up in a way similar to a car the same as yours. Then, fine-tuning will produce your desired settings. The way I set a car up is as follows:

- . Have a pad of paper and a pen ready!
- . First set all shocks half way, set everything else to manufacturer's recommendations.
- . Do 4-6 laps. Note what your car was doing and what settings you had then.
- . If the car oversteers, adjust rear shocks full soft, if it understeers, adjust shocks full hard.
- . Do 4-6 laps. Note what your car was doing and what setting you had then.
- . If there is a complete change, i.e. Understeer to oversteer etc, adjust rear shocks to half way again, in other words  $\frac{3}{4}$  soft or  $\frac{3}{4}$  hard.
- . Do 4-6 laps. Note what your car was doing and what settings you had then.
- . Is there an improvement? If there is, then continue the way you were heading, halving the setting again. Keep checking the car on the track.
- . If there is no improvements, try going the other way with the rear shocks.

If results in performance are not found, then further fine-tuning is required. Is your wheel alignment correct? Are your cambers properly set? Are your link pins and front end so loose that the car is flopping about everywhere.

## SYMPTOM CHART-TROUBLESHOOTER

### UNDERSTEER

- : Raise rear end
- : Stiffen front shocks
- : Decrease front tyre pressure
- : Lower front end
- : Increase body roll

### OVERSTEER

- : Soften rear end
- : Decrease rear shocks
- : Increase front shocks
- : Reduce body roll
- : Camber cable to loose?

### BUMP STEER

- : Too much front brake
- : Level out tie rods
- : Check ackerman angles

### BRAKE SLIDE

- : Too much rear brake
- : Adjust all brakes
- : Renew tyres

### HARSH RIDE

- : Spring too hard
- : Shocks bottoming out
- : Camber cable too tight

### CAR WON'T STOP

- : Turn idle down
- : De-glaze brakes
- : Adjust brakes

### OVERTSTEER ON TURN IN

- : Too much body roll
- : Increase all shocks equally
- : Increase roll resistance
- : Reduce front suspension travel

### UNDERSTEER ON TURN IN

- : Not enough weight transfer to front

- : Decrease front shocks
- : Increase front suspension travel
- : Stiffen rear end

### BOUNCY

- : Increase rebound adjustment on the rear shocks
- : Soften rear spring

### WHEELSPIN

- : Not enough shock travel
- : Front sway bar too soft
- : Camber cable too tight

## WEATHER EXTREMES!

**COLD:** New tyres are better in cold conditions. The car is likely to be "skatey", wanting to slide around a lot. It is difficult to get heat and therefore grip out of older tyres. New tyres heat up quicker and are more responsive than older tyres. In cold conditions the driver is better off taking a little longer while warming up before driving at ten-tenths. A softer set up allows the car to get more grip, although it will not heat the tyres completely.

**RAIN:** New tyres expel water far better in wet conditions than old tyres (worn tyres), and again heat up quicker. The car should be set as soft as possible, to create understeer whilst off the throttle, and slightly oversteer while on the throttle. This allows the driver to manipulate the car safer and more confidently. It also allows the driver to get out of trouble easier because the car is less likely to spin when no power is applied. Wet weather driving is very intense. The driver must treat every action with respect and do everything less abruptly. In wet races the warm-up lap should still be used to warm tyres; yes, they do warm up, and yes, they do help in the wet when they are warm. Some drivers disconnect a front shock to produce more body roll and suspension travel to create a more neutral car in wet conditions.

**HEAT:** Older tyres are more consistent in the heat. New tyres tend to go too gooeey, and get too hot, which not only makes the car handle badly on this occasion but also makes the tyres worse next time they are heated on the track (next race meeting perhaps). Often a harder tyre can produce better grip because they heat up more progressively. A harder set up is often quicker in the heat in the early laps, a softer set up is more consistent over many laps.

**NEUTRAL WEATHER:** New tyres are obviously better. Your car's optimum setup should produce the best results in this weather.

## THE USE OF BALLAST:

Different chassis prepares have different ideas on the use of ballast in Formula Vees. In safety terms, ballast, if not properly secured, can be quite dangerous. Imagine hitting a barrier and 15kgs of lead (or whatever) catapulting into your legs or body - the result could be very serious.

In most cases where weight is needed, it is recommended that you utilize it by strengthening existing areas of your car rather than bolting weight in. Either that or ensure that the ballast is securely fixed. Often weight distribution is a problem in terms of handling, and correctly positioned ballast can help cure the handling problem. In wet races, it doesn't hurt you car's speed too much to bolt weight over the front of the car to reduce understeer, for example.

## SPRINGS

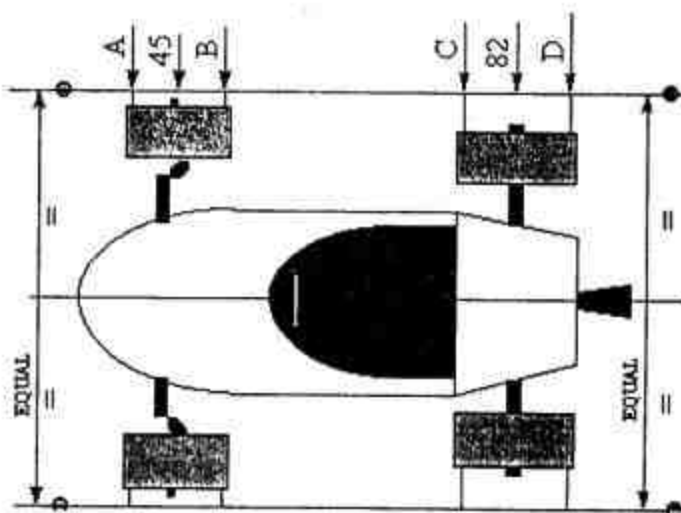
Springs control your car's ability to negotiate the road surface and it's extremes. They hold the car off the road, maintain an average ride height. In terms of handling, the springs rate (usually in lbs./in) determines how fast or slow your car's weight negotiates the undulations in the road surface. For example, a high rated spring will not react as much to a bump and return to set height faster, giving a harsh bumpy ride. A low rated spring will react a lot to a bump (compress a lot) and then take longer to come back to normal, giving a lumbering, soft ride.

Overall, when a car's weight is "thrown" when cornering, the spring will negotiate the amount of body roll the car has as well as the undulations in the road surface. This is the only thing that separates zero roll cars from IRS, leaf spring, and torsion spring cars. The zero roll cars only control the oscillations, not the body roll, which is allowed to pivot between the rear wheels.



## HOW TO DO A WHEEL ALIGNMENT

- Use or manufacture some stands where cotton thread can be attached at the same height as the axles on your car. (You'll need four stands.)
- Insert dummy weight equal to the driver into the cockpit.
- String the cotton from front to back between the stands on both sides of the car.
- Knock the dust caps off the front drums.
- Set the strings so that the two sides are parallel to each other and to the centrelines of the car.
- Set the cotton 45 mm from the front axle on either side, 82 mm from the rear axle on either side.
- Measure between the strings - are they parallel? If not, then change the distance evenly on either front or rear until they are parallel. When adjusting string widths, adjust even amounts from the axles on either side.
- Adjust the front first. Make sure the steering wheel is straight, and adjust either side by measuring the distance from the front of the tyre (sidewall) to the string, and the rear of the tyre to the string. The wheel is straight ahead if these distances are even.
- Do this for other side, but keep checking that the strings are parallel.
- Adjust the rear by using the same method.
- Always bounce your car after each adjustment, then reset the string lines to allow the suspension to settle, otherwise you will get false readings.



### **HINTS:**

- When the wheels are all straight-ahead, the car will be unhindered in straight-line speed.
- Toe out on the rear wheels slightly helps the car four-wheel steer/drift for better high-speed circuits.
- Toe in on the rear wheels makes the car slightly understeer under acceleration.
- Toe out on the front wheels makes the car turn into slower tight corners better.
- Toe in on the front wheel (to much) means you've hit another car or wall (keep to min.).

### **BUMP STEER:**

- Bump steer is when the front wheels go from toe in to toe out as the car goes over bumps. This can lead to a very nervous car in corners.
- With dummy weight in driver's seat, check the steering arms with a spirit level, they should be horizontal. Add more weight until the front ride height has been lowered 20 mm, then check toe in, then remove dummy weights till ride height is 20 mm above driver-on-board ride height, and then re-check toe in. Total toe in should not vary more than 1 mm. Bump steer is eliminated by changes the spacer on the end of the steering arms.

# DORIAN TX8000 TRANSMITTER

The Dorian TX8000 transmitter (blue) is the timing device used in competition at present and is designed to give out lap times electronically . The idea being to make timing more accurate , easier and quicker for the promoters to get the lap times out .The Dorian TX8000 transmitter (blue) is a sophisticated ,highly accurate vehicle identification and timing system . The transmitter unit on the car emits an identifying signal , which is picked up by the antenna loops embedded in the track. The antenna loops are connected to a receiving unit which analyze the signal and stores the identification and timing information for each vehicle crossing the loops . The information is then gathered by a supervisory computer .After being analyzed and sorted the information is further processed by scoring and results computers . This system is accurate to 1/10,000th of a second . The Dorian TX8000 incorporates it's own charger and lamps to indicate battery and charging status , this allows the transmitter to be brought to the track fully charged .

Transmitters must be mounted where they can see the track ,the signal will not pass through aluminum or sheet .The transmitter must be mounted as close to the track as possible and less than 250mm to the track surface . The transmitter must be mounted with the label marked top facing forward and the arrows pointing to the front and rear of the vehicle . The transmitter is designed to withstand heat up to 70oC. Do not install in areas where the ambient temperature will be higher than that . (i.e. the exhaust system ) .

## LOOKING AFTER THE DORIAN TX8000

The Dorian TX800 transmitter should be charged for at least 9 hours  
The red and green lights actually tell you what is happening with your TX800 transmitter .

### WHILE YOUR TX8000 IS ON THE CHARGER

Red and Green light flashing .....Battery is dead flat ! Leave on charger . Should go to green in under 2 hours . If Red and Green light continue to flash after the 2 hours the unit is possibly faulty .  
Green light is constantly on ..... Charging ( leave at least 9 hours )  
Green light is flashing ..... Now fully , charged and is now being trickle charged . Preferably leave on the cradle until you are ready to race.

### WHILE THE TX8000 IS OFF THE CHARGER

Green light flashing every 2 seconds ..... Has been fully charged within the last 24 hours . Unit is ready for racing and will last at least 6 days from the time it was taken from the charger.  
Green light flashing every 6 seconds ..... Fully charged more than 24 hours ago . Ready for racing and will last at least 6 days from the time it was taken off the charger.  
Red light flashing every 6 seconds ..... Only has around 1 hour life left to go.  
No light on ..... Power dead . Charge for at least 9 hours the night before you go racing.  
Red light flashing every second .....Not left on the charger for the full 9 hours . Can be used for racing but cannot tell you how long it will last . Either take a risk or put back on charger until the green light flashes .

**AFTER A RACE MEETING REMOVE THE TRANSMITTER FROM THE CAR AND MAKE SURE IT IS COMPLETELY DRY BEFORE STORING IT AWAY. ALLOW THE BATTERY TO GO COMPLETELY FLAT .**

# PREPARATION

Ever looked at the Vee out in front and thought ,that car handles so well and goes quick . You can bet your life the competitor is fanatical about preparation of their car . There is no way you can over prepare your car , but it is possible to under prepare . So following is a basic check list to go by , and of course to add any of your own ideas is a good idea .

1. Jack car up and remove all brake drums.
2. Clean brake linings and backing plates with hot water.
3. Inspect backing plates for unusual wear. Check backing plate bolts.
4. Inspect wheel cylinders for leaks.
5. Service front wheel bearings
6. Check oil seals at rear wheels
7. Fit brake drums and adjust brakes (with wheels attached)
8. Check brake flexible lines
9. Check tyres for damage.
10. Check master cylinders for leaks and fluid levels.
11. Check all steering rod ends and bolts .
12. Check steering box bolts (including pitman arm) and steering box bracket bolts.
13. Check all link pins and bolts
14. Check H beam locating bolts including wear on the solid spacers on the sway bar
15. Check steering joints for condition.
16. Check accelerator cable for adjustment and condition
17. Check clutch mechanism (hydraulic or mechanical) for adjustment and condition .
18. Check over chassis for any creaks or signs of fatigue. To clean by hand is a good way to check the chassis ,as you wipe , you see.
19. Check fuel lines for leaks and condition. Replace if any doubt. Also. Replace or overhaul fuel filter.
20. Check wiring harness for any damage, loose wires etc. Make sure no wires are near hot parts and properly tied. Check battery, & recharge preferably at a slow rate. Check all warning lights are working.
21. Charge Dorian timer.
22. Check all shock absorbers mounting points.
23. Check leading or trailing arm location points and spherical condition.
24. Check plugs , points , distributor cap & leads ; set correctly & replace if unsure. Make sure high-tension leads are secure. Set timing
25. Check for oil leaks and inspect all oil lines & fittings
26. Check compensatory cable or anti-dive mechanism.
27. Check fan belt.
28. Do wheel alignment.
29. Change oil and oil filters.
30. Check drivers seat is secure and seat belts are clean and tight.
31. Rear view mirrors are tight
32. Isolation switch is clean & working. Check fire extinguisher is secure.
33. Fit body and make sure all location devices are secure and tight .
34. Clean body and present car with pride.

## PIT TOOLS

This a suggestion of some of the tools you may need to have in the pits.

- |                               |                               |                                  |
|-------------------------------|-------------------------------|----------------------------------|
| 1. Jack                       | 8. Timing & tuning equipment  | 15. Spare oil & fuel lines       |
| 2. Stands min 2               | 9. Feeler gauges              | 16. All entry passes & licenses. |
| 3. Wheel brace                | 10. Battery charger           |                                  |
| 4. Hand tools                 | 11. Spare front & rear tyre   |                                  |
| 5. Tape                       | 12. Oil, fuel , brake fluid . |                                  |
| 6. Try pressure gauge & pump. | 13 Rags, cleaning equipment.  |                                  |
| 7. Fuel filling equipment     | 14. Chairs, broom.            |                                  |

# TEST LAP CHART

DATE .../.../...  
 SESSION .....  
 TRACK.....

TEMP.....  
 PRESSURE.....  
 HUMIDITY.....

**INITIAL SETTINGS**

CARBURETOR    MAIN JET .....AIR JET .....

SUSPENSION    TYRE PRESS.    SHOCK    TOE    CAMBER

FRONT				
REAR				

LAP	TIME	CHANGES	LAP	TIME	CHANGES
1			1		
2			2		
3			3		
4			4		
5			5		
6			6		
7			7		
8			8		
9			9		
10			10		
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**COMMENTS**.....  
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