# Part 1:

**In response to the question about what alignment operations can be performed at home, I decided to do a little piece on doing a complete alignment at home. I did not invent any of these procedures, but they have been time tested and depending on how much attention is paid to the details, it can actually be more accurate than an alignment done at a professional shop, and can definitely be more accurate than an alignment done by someone who neither cares nor knows about the specifics of the Vanagon. The added benefit is that once you know the ins and outs of the procedures and have established a good baseline alignment for yourself, you will be able to do little tweaks to your settings to suit the needs of your van and not have to rely on someone else to do it for you.**

**There are many adaptations and interpretations of these procedures and each one has its own level of accuracy as well its own level of complication. The more attention you pay to the details, the better your results will be, regardless of how complicated (or not) you choose to make your set-up. This is the way that I do it, but there is definitely room for modification and/or improvisation.**

**Since the Bentley manual does a fine job of showing you what to adjust in order to achieve the alignment specs, this article is only meant to give you an insight into the specifics of the set-up involved in doing an alignment and the tools needed for that set-up as well as how to interpret the specifications spelled out in the manual and is not a full step-by-step alignment how-to.**

## TERMINOLOGY -

**Alignment of the front of the Vanagon is comprised of three main specifications - caster, camber and toe.**

## Caster angle -

**The angle of the axis between the upper and lower ball joint, as viewed from the side, relative to 90º from earth, expressed in minutes, degrees, inches or millimeters. If you imagine a line drawn through the upper and lower ball joints, the difference between this line and a line drawn 90º to earth is the caster angle. Caster pointing toward the rear of the vehicle is considered positive while caster pointing toward the front of the vehicle is considered negative.**

**Negative caster angle makes the steering light but causes the vehicle to wander. Positive caster angle makes the steering heavier but also makes the vehicle track straighter. If the caster angle is different from side to side, the vehicle will pull to the side with the lesser amount of positive caster angle.**

## Camber angle -

**The measurement of the inclination, or tilt, of the front wheels, when viewed from the front, relative to 90º to earth, expressed in minutes, degrees, inches or millimeters. If the wheel(s) are pointing straight up, camber is described as zero. If the wheel(s) tilt inward at the top, camber is described as negative. If the wheel(s) tilt outward at the top, camber is described as positive.**

**Negative camber promotes tire wear on the inside edge but can also increase positive handling characteristics. Positive camber promotes tire wear on the outer edge of the tire and diminishes the positive handling effects of the suspension.**

## Toe angle –

**The difference in the distance between the front of the tire and the rear of the tire, measured in minutes, degrees, inches or millimeters. Incorrect toe angle can lead to excess tire wear and poor handling. When the measurement at the front of the tire is less than that of the rear, it is considered toe in. If the measurement at the front of the tire is more than that of the rear, it is considered toe out.**

**Those are the points that we will need to address and adjust when doing an alignment, but there is one other bit of information that we need to be consider and/or address when doing a basic alignment.**

## Thrust Angle -

**Thrust angle is the collective direction that the rear wheels are pointed relative to the centerline of the vehicle. When the collective direction of the rear wheels is pointed straight ahead, thrust angle is said to be zero.**

**However it is possible for the collective thrust angle of the rear wheels to be pointing either left or right of the vehicle's centerline.**
**When this occurs, the vehicle will want to go down the road sideways.**
**Have you ever seen those pickup trucks that "crab" down the road? That is**

**caused by the rear axle (and thus the rear wheels) pointing out away from the vehicle's centerline. Thrust angle will be mentioned again once we get into the set-up phase.**

**The proper sequence for doing an alignment is first caster, then camber and lastly, toe. The reason for this is that changing the caster can also change both the camber and the toe settings. Changing the camber can change the toe settings, but will not have an effect on the caster settings. Toe is always left for last since changing it does not have any effect on either the caster or the camber. In the following examples, I will always refer to the vehicle load as "empty" when referring to the specs described in the Bentley manual.**

**All alignment measurements should be checked with the vehicle at ride height and loaded in a typical fashion including driver weight. All measurements are taken with the vehicle "on the ground" and if adjustments are necessary, the vehicle must be lifted into the air, adjustments made and then let back down to re check the measurements. This is where the lube between the two last tiles comes into play. When you let the vehicle back down, you will want to bounce on vehicle a bit to help settle the suspension. The lube between the two tiles helps the suspension settle easier by allowing the tires to move freely left and right as well as front to back. If you don't settle the suspension, you will get false readings for whatever measurement you are taking.**

## PREPARATION -

**The first order of business is to be sure that your vehicle is ready for an alignment. Worn or loose components all need to be addressed prior to doing an alignment. I don't think that I need to tell you that doing an alignment on a vehicle with worn or loose components is not only a waste of time, but it will also yield inaccurate results. Tire pressures must all be checked and adjusted to specs if necessary.**

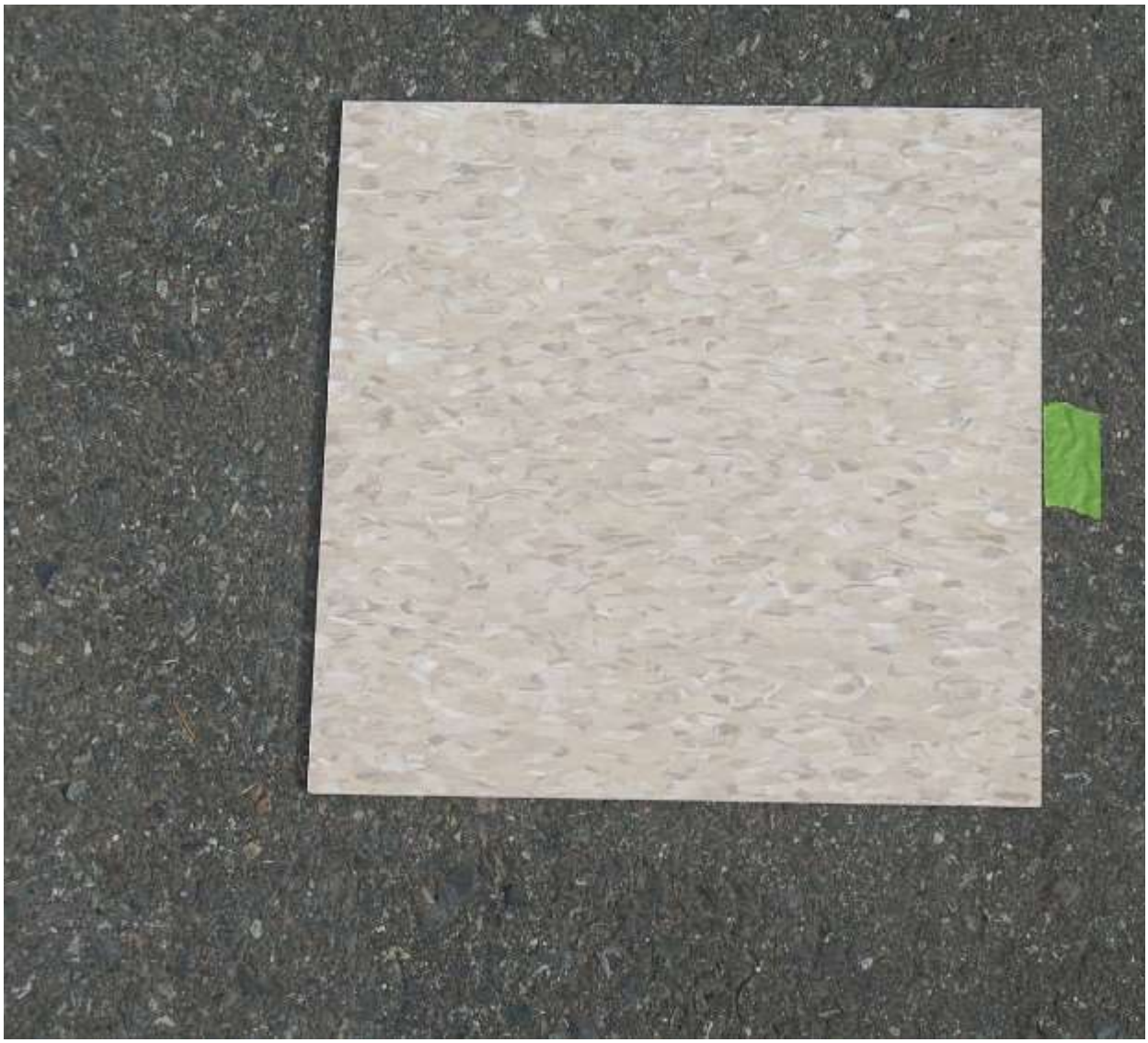
**Once the vehicle is ready, you will need to provide a nice level area for your alignment procedures. Doing an alignment on an uneven surface will lead to false readings. Although garage floors seem relatively flat, there is usually a fair degree of slope in at least one direction.**
**To compensate for any uneven ground and to be sure that the vehicle is**

**positioned on as level of a surface as possible, you can use 12x12 floor tiles or 12x12 Masonite to shim the areas of the floor in which the vehicles tires will be sitting. To demonstrate how to perform this leveling procedure, I have chosen to show you how it is done using my driveway as a semi-extreme example.**

**Position the vehicle where you want to do your alignment and mark the spot where all four tires make contact with the ground. A sharpie, tape, chalk or whatever will work fine, just as long as you have a reference point for where each tire sits on the ground.**

**Now you will want to roll the vehicle straight *backwards* away from the marks. The reason for moving the vehicle backwards, rather than forwards, is that when you move the vehicle forward into position again (you will see what I mean by this in just a minute), any tiny movements in the suspension components (flex in the rubber bushings included) will be taken up and the suspension components will be in nearly the same position as they are when you are traveling down the road.**

**With the vehicle out of the way, place *two* shims of whatever stock you choose (I use 12x12 floor tiles) in the exact positions where the tires will sit. Use your marks that you made previously to position your shims. The reason for two shims in each position will become clear shortly.**



**With two shims placed at all four tire positions, it is now time to find the highest point of your chosen location. To do this, I use a water level consisting of colored water, a bucket, some clear tubing and a carpenter's square. With your bucket containing at least one inch of colored water, make sure that the height of the water is such that it comes to at least the midway point of your carpenter's square. I raised my container up to achieve this.**

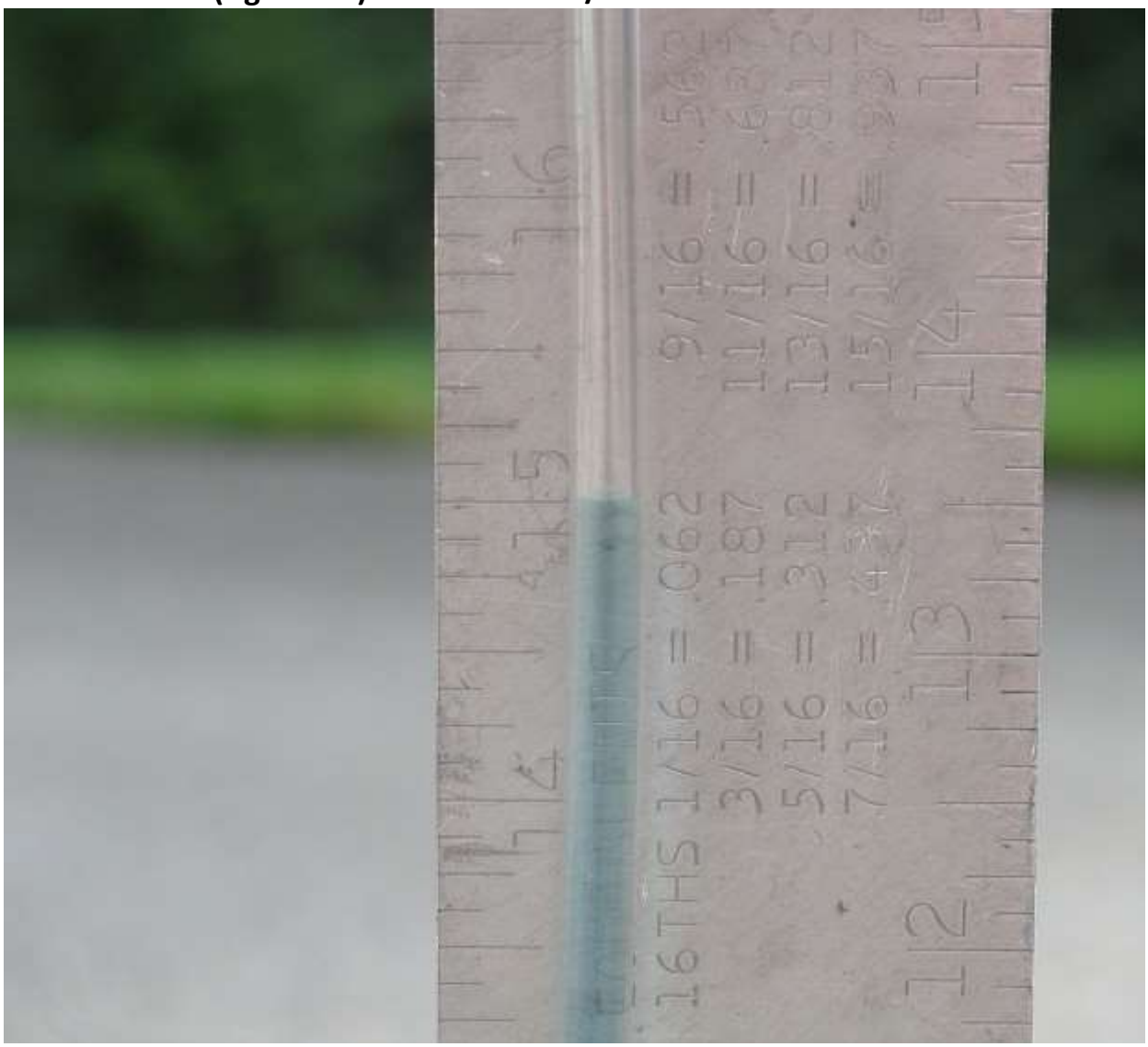
**Tape one end of the clear tubing into the water and secure it (duct tape) so that the end of the tubing remains submerged.**

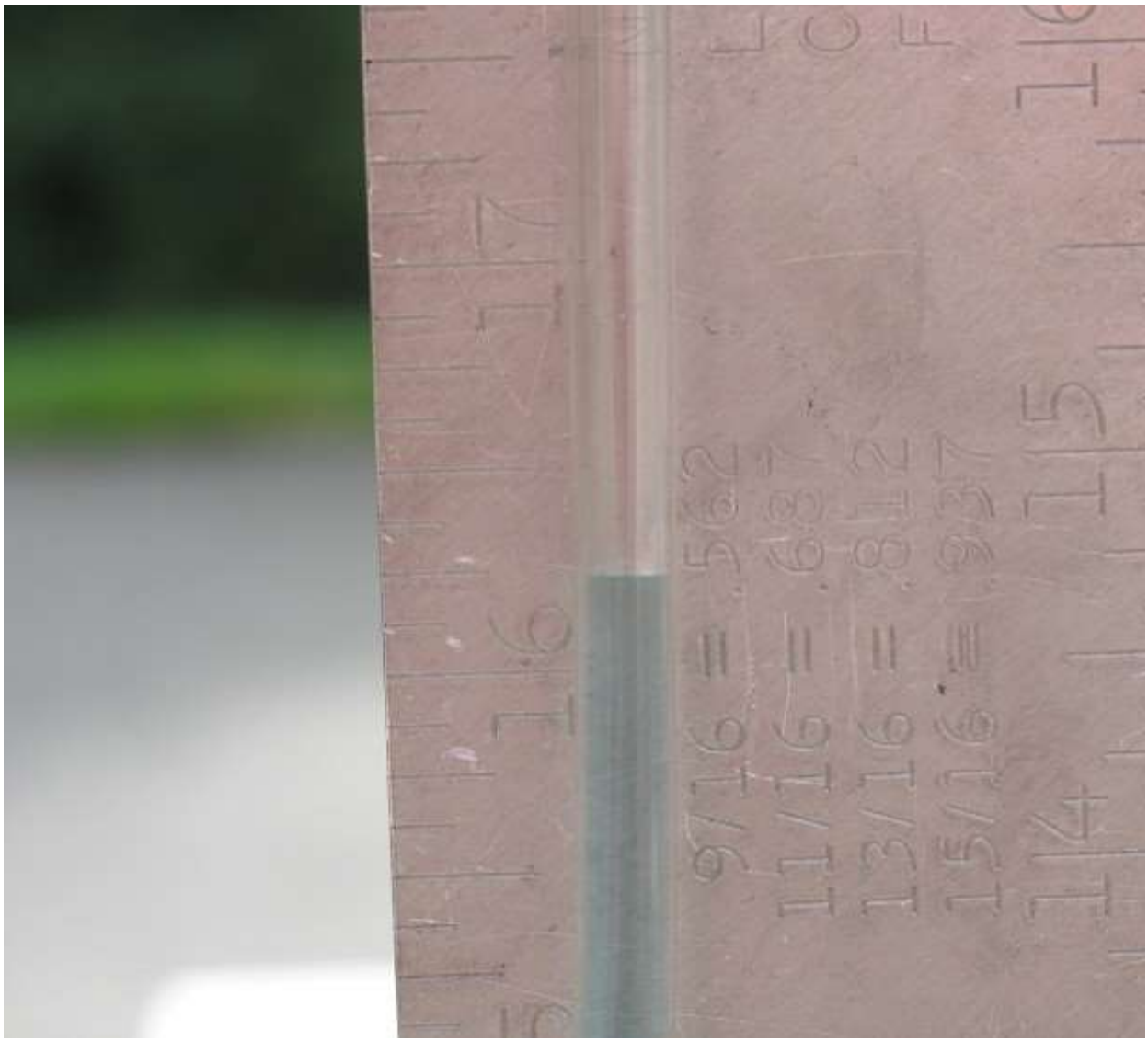
**Attach the opposite end of the clear tubing to the top of the long end of the square with duct tape and then attach the tubing to the square at the opposite end of the square (about 6-8 inches below the height of your water line) so that the tubing runs along the numbers on square and so that the numbers can be seen.**

**With the end of the square sitting on the ground next to your container of water, you can suck the water into the tubing (by mouth - be sure your water and container are clean) until it is higher than the level of the water in your container.**

**If you have done this correctly and there are no air bubbles in the tubing, the water level in the tubing will drop to match the exact height of the water level in your container (the photo makes the fluid in the tube look lower, but it's at exactly the same height as the water in the bucket).**

**With the water level created, you can now place the end of the square in the middle of each of your shims to determine which location is the highest. Remember that the highest location will read the lowest number on the square. My highest location (left front) measured right at 15" on the square and my lowest location (right rear) measured 16 1/4".**





**Using the 1/8" thick tiles, I stacked them in the three lowest locations until I achieved a level of 15" on the square of my water level at all four locations. Since the tiles are 1/8" each, it was very easy to figure out how many were needed for each location.**

**Remember that I mentioned placing at least two shims in each tire location? This allows the last tile to swivel on the one underneath it as well as lets the suspension settle easier should you need to jack up the vehicle for access to the suspension components while adjusting things. Being able to rotate the wheels during the caster adjustment procedure is where this comes into play the most.**

**To reduce the friction between the last two sets of tiles, I use a little talcum powder on the next to the last tile. I have heard of people using grease, vegetable oil, salt, wax paper, etc. Whatever it takes to reduce the friction is fine.**

**You now have a level surface worthy of doing your alignment on. It's now time to position the vehicle onto your leveled surface. If you only have a few tiles, like I do on the front, it is probably okay to simply drive the vehicle up onto them. However, if your stack is large, like my rears, it is much safer to move the tile stack, position the vehicle next to your marks, jack up the vehicle and place the tile stack under the tire. With the last two tiles lubed, it is *very* easy to shoot a tile or two out from under the tire while trying to drive up onto them. A flying tile could really cause some damage or seriously hurt someone. Please be careful.**

**When positioning the jack under the vehicle, it is best to use the control arm as your jacking point. This keeps the suspension loaded while lifting the wheel/tire off of the ground and minimizes any settling of the suspension. Keeping the suspension loaded is important to achieving an accurate alignment.**

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