DIY ALIGNMENT GAGES

If you thrash your Corvette around the track like I do, then frequent alignments are the norm for you. Costs vary, but $130 or more is what you usually face. This DIY article will show you how to make your own set of alignment tools and get you out of the shop, and end the need for strings. I won't go into detail about how to actually perform the alignments; David Farmer has already published that and David knows his stuff when it comes to alignment.

First the Camber/Caster/Thrust angle gage. The completed gage is shown below. This gage is adjustable for 16 to 20 inch diameter wheels.

Here it is taking a camber measurement on my C5 front:

This gage can be placed on the rear wheel in the horizontal position and the laser/level aimed at a target on the front wheel to measure thrust angle. Measuring caster using a device like this is described in many Youtube videos, and in David Farmer's how-tos

Step one, of course is gathering up all your materials. A Bill of Material is given at the end of this DIY. I bought everything for this gage, except the laser level at Lowes. The heart of the device is the laser level, and I bought it on Amazon, a Hammerhead HLLT10 for $50 delivered. Lowes has them, but I didn't like the looks of what they had, and I couldn't tell if the Lowes laser level had a thread mount in the base, which is how I attach it to the frame.

Next cut the aluminum to length.

- Cut 2 pieces of the 1 in sq. tube:
  - One pc 19 inches long
  - One pc 12 inches long
- Cut 2 pcs of the 2 inch wide alum strip 5 7/8 long.

I used a power miter saw with a carbide blade; makes nice cuts, but hold the stuff tight, saws grab aluminum.

Drill four 3/16 holes in each of the 2 inch wide 5 7/8 strips. These holes are where the rivets will go, but for now just drill the strips, don't worry about the tubes yet. I had two goals in spacing my holes, one to achieve some symmetry, and second to provide a location for attaching a cross-check level (later on this). I also stack-drilled but I taped the strips together so the holes would stack up and did it on a drill press. Set these aside for the moment.

Next, the square tube needs to be drilled and a slot routed for the stand-off screws. If you notice in the first pics of the gage, there are 3 socket head cap screws. The heads of these screws touch the wheel of the car during measurement, and there is a step later to make sure they stick out the same length from the tube steel.

The 12 inch piece gets two ¼ inch dia. holes each ½ inch from the end and ½ inch from the edge.

The 19 inch piece gets two ¼ inch diameter holes, one that is an inch from one end and the other that is 8 ¼ inch from the same end. Now you can wait on the second hole, it is the mounting hole for the laser level I used. If you buy a different brand then your hole may be in a different place, or you may be taping your level to the gage if there is no provision for mounting. I think tape would be perfectly OK.

Now to make the slot. You need a slot that is 4 inches long. If you have a good woodworking router, you are in business! I made a wood fixture out of a piece of scrap, seen below.

I made a groove in the wood to guide my aluminum tube and used a ¼ carbide router bit to cut the groove. You can see the tip of the bit in the center of the groove. The procedure was to use the ¼ inch hole drilled one inch from the end of the 19 inch piece of tube as a start point. After starting the router, I just fed the tube in the fixture groove for 4 inches.

Here is a completed groove: Note that the socket-head screw, the standoff screw is installed.

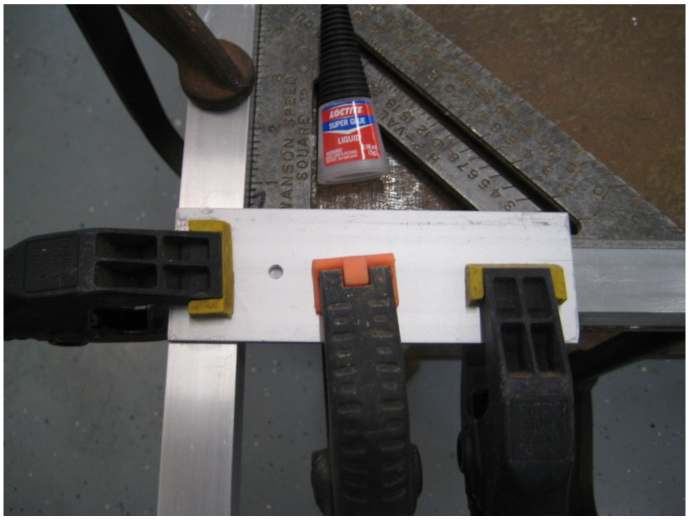
With the slotting chaos over it is time to de-burr all the holes, and the inside of the slot. The slot is where you adjust for different diameter wheels, so take time to make sure the inside is baby-butt smooth.

Assembly follows a good cleaning. I used some Super glue to aid in assembly, so it might be a good idea to lightly sand everything and give it a quick swabbing with a solvent like acetone or alcohol,

First square up the square tube members, forming a "Tee".

I clamped it to my welding table as you can see in this photo and used a square to get it where I needed it

The next step is to superglue a strip to one side. I scribed some reference marks on the tube and put drops of glue about an inch apart. Then I clamped with spring clamps.



Superglue sets up fast, but I gave it 10 minutes, flipped it over and glued the other strip opposite to this one.

Once the glue set on the second side, I began drilling (hand-held power drill) and riveting.

Now remember to make sure that the two holes of the 12 inch tube are on the same side of the gage as the slot, or you will be drilling more holes.

The last step is installing the stand-off screws. I bought stainless steel only because Lowes did not have socket head cap screws in carbon steel..

Installing the socket head cap screws involves first a nut on the screw, then a washer and a nylock nut inside the tube.

The nylock nut shouldn’t turn and forms the base for the measurement adjustment. Once you install all three standoff screws, use a caliper to adjust them as you see above. They all need to be the same installed length. The allowed runout on a Corvette wheel is something like 0.005 inches, so you really don’t need the precision these calipers are displaying.

For my convenience, I mounted a cross-check bubble level with some double stick foam tape. This will come in handy as you go from side to side making measurements.

Finally, you can mount the laser level on the gage and the tool is ready to go. If you plan to do caster measurements or toe measurements, you will need something to allow the front wheels (or the rears for that matter) to move. I bought 8 pieces of ¼ thick Polyethylene sheets 12"x12" and slip two under each wheel I think I got them on Ebay.

You should be able to use bungee cords to hold the gage to a wheel for caster measurements or for thrust angle measurements. The tube is stiff enough that it should not deflect, unless you make it Go-rilla tight.

Below is the Bill of Materials for the camber/caster gage The cost estimate for the miscellaneous hardware is approximate, but pretty close. Of course the biggest cost is the laser level, and if you don't need to do thrust-angle measurements, then a lesser expensive digital level will work. Also note that being a home-made tool, you may have to do a little math to get your answer. For example, the level will read 90° when vertical, so you will have to subtract the displayed reading from 90° to get your actual camber, and you will have to also assign the sign (positive or negative) to the value. I figure if you are interested enough to get this far in this document, then you have the craftsman skills to do this and the math skills to solve this kind of problem.

CAMBER/CASTER/TRUST ANGLE GAGE		
ITEM	**PART #**	**COST**
HAMMERHEAD 10" LASER LEVEL	HLLT10	$50.00
1PC 1X1X36 ALUM SQ TUBE		$10.00
1PC 1X2X.120 ALUM STRIP		$10.00
SWANSON CROSS CHECK LEVEL	119471	$3.50
3 1/4-20X1 1/2 SCK HD CAP SCREW		$1.00
3- 1/4-20 NYLOCK NUTS		$0.50
2 1/4-20 HEX NUTS		$0.16
1- EA 1/4 KNURLED STOP NUT		$3.00
1/EA 1 1/4; 1/4-20 CAP SCREW		$0.20
8 EA 3/16X3/8 LONG POP RIVETS		$0.30
Approx total		**$78.66**

TOE GAGE

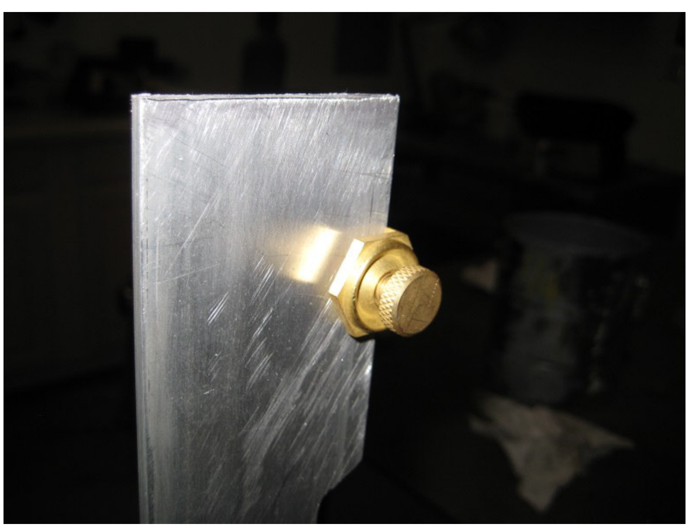
The cost of the toe gage came out a little higher than expected. The most expensive part is the long aluminum square tube, which was $30 alone. I ended up at just over $45 and used some stuff I had on-hand. I later found a source that was half that, but I had already built this one.

In effect, it is a giant caliper.

Here is the finished product (sorry about the gray on gray)>>>>>>

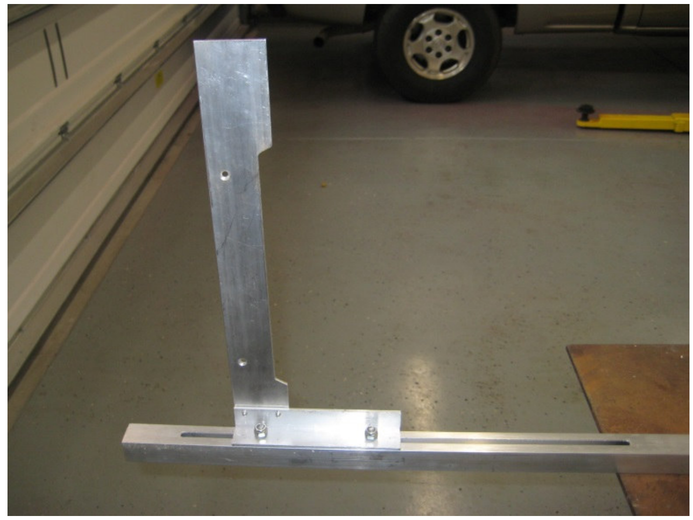
Basically there is a long horizontal base tube, 81” long and two vertical measuring arms, each 15”. One Vertical arm is fixed to the base tube and the other is adjustable along a portion of the base tube.
Here is the fixed arm:

The arm is 15 inches long and is made from 2 inch wide aluminum strip. I cut a section from the center so the arm would clear a tire bulge. This only enough cutout for a Corvette. The arm is riveted to the base tube with 3 pop rivets. I super-glued the arm to the base tube then drilled for the rivets to ensure the arm stayed perpendicular to the base tube. For the contact to the wheel to make the toe measurement I placed a Carpenter’s brass stair gage on the arm. This gives precise contact with the wheel.

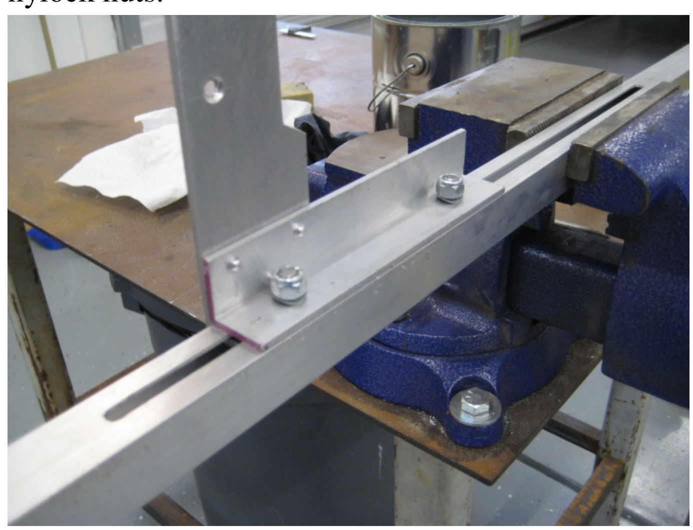


Now to the other end of the gage.

I cut a 1//4 inch wide, 16 inch long slot in the base tube. Then I cut a piece of 1x1/.125 aluminum angle 6 inches long and drilled two holes in it. Then I riveted the second arm (identical to the fixed arm except the rivet holes now go through the angle).



The angle is held in the groove by 2 ¼-20 by ¾ carriage bolts, a wave washer and a nylock nut. The nylock nut is tightened just enough so the wave washers put a little compression on the connection so this part of the gage does not “wiggle” but will slide along the tube. The wave washers are under the nylock nuts.



That’s about it. Now it is time to take a toe measurement.

Toe is a relative measure and the usual convention for measuring toe is to take the measure on the wheel at the location of the tire diameter, and at the wheel horizontal centerline. So two measurements are taken; one at the front of the wheels and one at the back. The difference is your toe measurement. Since we are dealing with very small differences, the introduction of error is very important. Even though this gage has good stiffness, the application of force may produce deflection. If you follow the method below, you should get accurate and precise measurements.

1. Set the moveable arm of the gage so that the distance between arms is about ¼ inch wider than the wheel bulge (that is, make sure when you rotate the gate in the next step it clears the tires to get to position).
2. Tighten the two nylock nuts on the moveable arm. Once you do this, you probably won't have to adjust the moveable arm again.
3. Slide the gage under the car at then rotate it to bring the arms vertical.

4. At the fixed arm end, adjust the brass stair gage height so it is the same as the wheel horizontal center

5. Move the gage until the brass stair gage touches the wheel at the fixed arm side
6. At the moveable arm side of the gage, take a measurement with a small tri-square from the back of the arm to the wheel. Use very light hand pressure; just enough to hold the fixed arm on the other wheel and the tri-square on this one.

7. Record the tri-square measurement.
8. Remove the gage and take a measurement at the other rim edges. The measurement will need to be taken on the other side of the car so that the gage tube does not interfere with the tires.
9. Take and record the second tri-square measurement. The difference between the two is your toe measurement.