TR250 & TR6 Brakes
Bleeding & Adjusting Brakes

These notes describe what I did on my car for my personal use and are provided here for entertainment; they are not meant to be instructions for others to do maintenance on their vehicles.

Once the brakes are assembled three operations are required:

1. The rear brakes must be adjusted.
2. The hand brake cables must be adjusted.
3. Fluid must be added and any air bubbles removed.

I'm at least a year away from putting the parts overhauled in the other sections onto my '70TR6. Rather than wait, I decided to wrap this subject up using my 76TR6 as the model.

Determining if Rear Brakes need Adjustment: The rear brakes must be adjusted as the the shoes wear. (Most modern cars that use the drum/shoe configuration on the rear wheels are self adjusting.) The symptom of out-of-adjustment brakes is reduced pedal margin when the brakes are applied. This develops slowly over time so I usually don't notice it. A second symptom is that the hand brake must be pulled further to engage the brakes. The simple test I use is to operate the brakes and get a rough idea of the pedal margin. I then pull the handbrake as far as I can, leave it on and then push the brake pedal twice and notice if the pedal margin increases when I push it the second time. The handbrake holds the shoes engaged and prevents the springs from pushing the pistons back into the rear cylinders when the pedal is released. Therefore, when the pedal is pushed the second time after the handbrake is operated, the pistons should require little movement. The amount of pedal margin increase is an indication of the movement of the wheel cylinder pistons required to push the shoes to the drums. The margin increase for properly adjusted brakes is about 1/2 inch. I adjust the brakes if the margin increase after the hand brake is operated is 1 inch or more.

Adjusting the rear brakes: This is a simple task that requires a jack and a brake-adjusting wrench. The brake adjustment screw had a 1/4-inch square head. I strongly recommend a brake adjusting wrench or an 8-point socket for this screw rather than a crescent wrench, pipe wrench or vise grips. I jack the side of the car up far enough so that the rear wheel to be adjusted is off the ground. The hand brake must be released and the gearbox in neutral. (I do this in the garage where the floor is level or on a level part of the driveway --- for obvious reasons.)

The adjuster screw is a right hand thread. I tighten the screw as much as as I can by turning clockwise. The photo or right shows the brake wrench on an adjuster screw. The screw should be hard to turn as the ridges on the cone end of the adjuster screw press against the tappets and then easier when the flat spots of the cone are against the tappets. Once it is as tight as I can get it, I try to turn the wheel. The wheel should be locked. I then push and release the brake pedal or pull and release the handbrake lever to make sure the wheel cylinder is centered. I then loosen the adjuster screw past one ridge to a flat spot and test the wheel again. I usually have to loosen it past two ridges before the wheel will turn freely. If this is a readjustment I test the handbrake while I have the wheel off the ground. I do this by applying the handbrake, checking the wheel to make sure the brakes are on and then release the handbrake and make sure the wheel will turn. If this is the initial adjustment I defer the handbrake test until after I've adjusted the cables. After one rear wheel is adjusted, I repeat the process on the other rear wheel.

Adjusting the Handbrake Cables: Recall that there is a compensator between the hand brake lever and cables to balance the force on the two cables. Because of this, care should be taken to adjust the two cables to the same length. Otherwise, the compensator might reach the extreme of the balancing capability and apply more force to one wheel. I adjust the brakes as described above before adjusting the cables.

After the cable are correct I test the handbrake by applying the brake, checking the wheels to make sure the brakes are on and then releasing the hand brake and make sure the wheels will turn.

The technique I use is to put the rear of the frame up on jack stands positioned under the rear cross members. I then remove both rear wheels to expose the end of the hand brake cables. I then remove the clevis pin on one

side and adjust the nut on the end so there is about one half the diameter of the clevis pin slack between the end of the cable and the lever, with the cable pulled tight, which should remove any slack from the other cable. This is shown on the right for my '76. Note that the that the lever has the lever extension provided after CC50,000. Also note that the adjustment is a little too tight. I had just adjusted the brakes so this is probably OK.

Once I have the cable slack correct, I then compare the position of the adjustment nuts on the two sides and turn the adjustment nuts as required (shorten one side and lengthen the other side an equal amount) so that the nuts on each side are the same distance from the end of the cable I then put one of the pins back in and verify the slack on the end of the other cable is about equal to one half clevis pin diameter.

The above assumes that the two cables are identical. If not, I remove the cover over the cables behind the hand brake lever and adjust the two cables so that when the hand brake lever is pulled, the compensator is orthogonal to the cables indicating both cables are adjusted to the same length. I readjust the cables as required to both maintain the ~ one half clevis pin diameter of slack with the cable lengths equal as indicated by the orthogonal position of the compensator relative to the cables.

If the handbrake is adjusted properly, there should be room to pull the lever several more notches after the lever had been pulled tight. This provides some allowance for rear shoe wear between adjustments. I've never had to readjust the handbrake cables after the initial adjustment.

Installing Fluid and Bleeding the brakes: The freshly rebuilt brake system has no fluid in it; all the cylinders and lines are filled with air. Fluid is added to the system at the top through the master cylinder reservoir. The fluid is heavier than the air, so the fluid should sink to the bottom of the system (the wheels cylinders and calipers) and all the air should go to the top (the master cylinder), right? Well, not quite. The surface tension of the fluid prevents the air and the fluid passing each other in the thin brake lines. The bleeding operation involves opening the bleed nipples at the wheels and forcing the fluid to the cylinders pushing the air ahead of the fluid and the air then escaping through the bleed nipples. The system should be purged of all the air once pure fluid with no air comes out the bleed nipple of each wheel cylinder,

I've done this many times with no difficulty. However, I frequently read of people having considerable difficulty getting the fluid to reach the wheel cylinders or calipers. Many employ various bleeding tools to assist the process. (Anecdotal evidence suggests that those attempting to use such tools have more problems than those using no special tools. That may be because the tool was purchased after trouble was encountered and the tool won't work until the trouble is fixed.) I've put together a little tool described later to speed up the process. This is a good idea for a club or for someone that does the job frequently. (If I refilled a dry system only once every five or ten years, I probably wouldn't be able to find the tool when I needed it.) All that is really needed is a willing helper and a 7/16" wrench to open the bleed nipples. I frequently substitute a short length of 2X4 for the willing helper because she usually wants me to do something for her in exchange for helping such as painting the house, going to a wedding, etc, etc.

The bleeding process involves manipulating the system such that the fluid is sucked into the lines, wheel cylinders and calipers. For this to work two conditions must exist:

1. The system must be airtight.
2. There must be no blockages in the system.

If I'm bleeding a dry system that has heavily worn pads, I force the pads away from the rotors as far as they will go and slip wedge-shapes wood shims between the pads and rotors. This pushes the pistons all the way into the calipers and reduces the volume of the system hence reducing the amount of air to be removed. If the pads are new, the pistons will be nearly all the way into the calipers and I don't bother with this step.

I start by very carefully filling the reservoir to near the top. I then open the right front and right rear bleed nipples. I proceed very slowly here to allow any bubbles that I introduced in the pouring operation to rise to the top of the reservoir (recall I'm using silicone fluid). The bubbles cause no problem at the top since it is the fluid on the bottom of the reservoir that enters the master cylinder and then on to the rest of the system. Usually quite a bit of fluid flows into the system at this time. I check very carefully around the master cylinder for any leaks. Once the fluid level in the reservoir is no longer dropping I slowly push the brake pedal down once and hold it down (helper or block pedal down with 2X4 against seat). **(I don't pump the pedal rapidly --- that might mix air with the fluid. I also keep the engine off so that the servo doesn't create high pressures in the system.)** When the pedal is pushed down, the input from the reservoir to the master cylinder is blocked and whatever is in the master cylinder (air or brake fluid) is pushed into the lines and air is pushed out of the bleed nipples. The bleed nipples are then closed and the pedal released after the nipples are closed. (Note: if the bleed nipples are not closed, air is merely sucked back through the bleed nipples when the pedal is released. Note also that if there is a leak in the system air is sucked back into the system via the leak.) Once the bleed nipples are closed, the pressure in the system drops (a slight depression is created) when the pedal and master cylinder pistons return to the relaxed position. Once the master cylinder pistons are all the way back, the inputs from the master cylinder

reservoir open (tipping valve and secondary piston supply valve) and the slight depression sucks some fluid into the master cylinder. If everything is going right, the fluid in the reservoir should be drop slightly.

The process is repeated as required until fluid flows out of the bleed nipples. This usually happens after a dozen or less pedal operations. Once fluid starts to flow from one of the nipples, I close that nipple and move to the other side and continue the open nipple - push pedal - close nipple - release pedal sequence. Once some fluid has exited from both wheel cylinders and both calipers I close all the bleed nipples, fill the reservoir and remove any shims I used to hold the pads away from the rotors. I then gently pump the pedal. This pushes the front pistons out of the calipers and fills the void with fluid. After several pedal operations there is some resistance as the pedal is pushed.

Once the fluid level in the reservoir stops going down when the pedal is pressed, I ask the helper to push the pedal down and hold it. I then open the right front bleed nipple. Some air and hopefully some fluid will exit. I then close that nipple and open the right rear nipple, let the air out and close the nipple. The pedal can then be released. I repeat this process until only fluid comes out when the nipples are opened. I then repeat the process on the left side. Once this process is completed there should be a firm brake pedal well off the floor when pressed. I then test the car in the driveway to make sure everything is in order. **If the brake pedal is not firm and well off the floor, I don't drive it until I figure out what is wrong!**

Before proceeding I check all the lines and hoses for any indication of a fluid leak. This is best done after the brakes have been tested with the engine running and the pedal pressed as hard as possible.

Once everything is in order I take a test drive. I find this is a good time to take the helper out to lunch. It is also a good time to mention how helpful she'd been (I avoid mentioning how many times she pushed the clutch pedal.) I don't over do these complements or I might find myself going to a wedding. (Why do woman enjoy weddings more than spending the time with a TR?)

After returning from a test drive, I let the car set for at least a half hour and then bleed each nipple again. I usually find at least one has a bit of air in it.

Since I'm using silicone fluid with a reputation for trapping small bubbles, I bleed the brakes again in about a week.

Plugged Lines: Plugged lines will prevent the bleeding of half the system. The only place I've experienced plugged lines is in the rubber hoses. If I'm able to get fluid out one of the wheel cylinders and not the other or out of one of the calipers and not the other, I look for a plugged line. I first open the line on the master cylinder side of the hose nearest the dry cylinder or caliper, and then press the pedal. If no fluid comes out, I close the line while the pedal is still down, let the pedal up and then press again, open the line, etc ---- using that line to hose connection as a bleed nipple. If I don't get fluid after three cycles, I work back toward the waster cylinder. If I get fluid, I work toward the dry cylinder or caliper until I can isolate the plugged section (fluid on one side and not the other). Don't be intimidated by the system, think of it as a bunch of garden hoses connected together. If there is no water coming out the end, most women (blondes included) can troubleshoot the problem in a few seconds. The plugged hoses I've encountered seem to be associated with a decomposition of the rubber. These have been on very old hoses and used with glycol fluids. Maybe the swelling got out of hand.

Final Bleeding: I've found the only satisfactory way to bleed the last bit of air is to use the operation described above. That is, have the helper push the pedal down and hold it down and then open the bleed nipple to let the last air bubble out and then close the nipple before the pedal is released. I repeat this until no air comes out the bleed nipple. I then repeat the procedure for the other three wheels.

Air Leaks: Air leaks sometimes present a problem. Recall that the bleeding operation described above required that the system be air tight so that the depression can be created to suck the fluid into the lines, wheel cylinders and calipers. It is very easy to find a leak once the system is full of fluid --- look for the fluid squirting out someplace. Unfortunately, it's difficult to see the air squirting out when the system is full of air. The tools that rely on suction to pull the fluid to the wheel cylinders or calipers have problems also when there is an air leak.

Bubbles: I've encountered two situations that caused what appeared to be plugged lines or an air leak. I couldn't get any fluid to flow into one half the system. In one case, I opened the line at the output of the PDWA and gently pumped the pedal. Nothing. I opened the line on the master cylinder side of the PDWA and fluid started flowing immediately. I connected everything back together and was then able to get fluid to all the wheel cylinders or calipers. This accomplished something similar to the bench bleeding described by Peter Zaborski http://www.vtr.org/maintain/brake-bench-bleeding.html My guess is that there was a fluid bubble in the PDWA with air on both sides. Surface tension provided enough drag so that the bubble stayed in the PDWA and it was impossible to get fluid through the master cylinder. Before you ask, this was a few years go and I was using DOT3 or DOT4 fluid. (I never bench bleed the master cylinder because I haven't figured how to then connect the master cylinder to the brake lines without opening the master cylinder output ports thus letting air back into the system and spilling fluid all over the place.)

Hung Servo: The other case was slightly different is that I couldn't get fluid to flow out of the line for the front brakes where it entered the PDWA. This was caused by a problem in the servo that prevented the primary piston from returning far enough to open the tipping valve. This happened a number of years ago and I can't remember the specific problem with the servo if in fact I knew. It's probable that I just replaced the servo with one of the spares I had laying around.

Bleeding Tool: The best technique I've found is to use very low-pressure compressed air to push the fluid out of the master cylinder. This was first suggested by fellow Buckeye Triumpher Jim Vanorder. He put a tire valve in a spare reservoir lid and uses low pressure air --- possibly from a bicycle pump, to force the fluid through the system. I drilled a 3/8 inch hole in an old master cylinder reservoir lid and connected another one of those old brake hoses I had laying around to the lid and screwed the other end into the air gun arrangement discussed earlier (see photo below). The hose is secured with a 3/8-24 TPI nuts on both sides of the lid. I fill the reservoir to the top of the partition separating the two parts, then put the lid on the reservoir and connect the air gun, adjust the regulator to a 5 -10 psi and give the reservoir a shot of air. (The lid is three inches diameter translating to about 7 square inches. The force on the plastic lid is the air pressure time multiplied by the area or in the case of 5 psi, 35 pounds. I'm very careful here to keep the pressure very low by using the regulator. Otherwise, something will give, most likely the lid will pop off the reservoir.) I then open and close the bleed nipple at one front wheel and one rear wheel. I then go back and refill the master cylinder reservoir. (If the lid is difficult to remove, I disconnect the air source to relieve any remaining pressure.) I repeat this process until I get fluid flow from each wheel cylinder when the bleed nipple is opened. The reservoir is then refilled and the final bleeding done with the help of an assistant as described above.

Brake Warning Lamp: It is not unusual for the brake warning lamp to come on when bleeding the brakes; at some point in the process one side had the air removed and the other side still had some air so a pressure differential developed when the pedal was pressed causing the PDWA piston to move to the low pressure side and operate the switch that turned on the lamp. To get the piston back to the center position I first remove the switch from the PDWA, then shine a flashlight into the hole where the switch goes and use a sharp instrument such as a scribe to push the piston back to the center. I then reassemble everything, make sure the brake lamp is not on bright, start the car, and push the brake pedal. If the warning light comes on bright again then the PDWA has sensed a pressure differential again. One side of the system still has some air --- the side that the piston moved to is the side with the low pressure. If the brakes seem to be working, the PDWA piston is centered and the warning lamp is still on bright, there is likely an electrical problem; see the troubleshooting section note for some tips.