

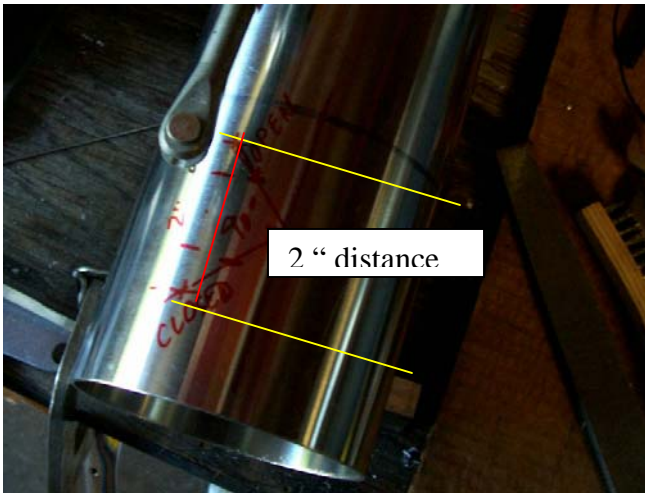
Exhaust Brake project from the cluttered shop of Penz Toy Racing-Oroville, Ca.  
[cdennyb@hotmail.com](mailto:cdennyb@hotmail.com) built for a Dodge Ram 3500 w/Cummins on March 29, 2006



This is the stainless 4"Ø tube used for the brake unit itself. You will be welding it into the existing exhaust system. Hopefully you have already installed a 4" system in your truck so this should fit fine. The disk is a 'punched' 16 ga. stainless (3.75"Ø) item. With this disk and tube I have approx. 9.7% open area for exhaust gasses to bypass the butterfly when fully closed. If you needed less, cut the disk a little larger. If you need more then just add a stop bolt to limit the amount of closing the blade makes, thus holding it a tiny bit open at full-on.



This shows a smaller Bimba Air Cylinder mounted to a stainless bolt I welded to the tube. (As it turned out I installed a larger unit.) Make sure it's perpendicular to the axis of the butterfly shaft. The shaft is assembled to the stainless rod after you mill a flat area to lay the disk on to weld. Be sure to weld it on the rod AFTER it's inside the tube. The clevis should be set slightly 'before' center and full open slightly 'after' center.



This shows the relationship between the open and closed position of the butterfly. In this view the butterfly would 'default' in an OPEN position. The angle is 90° between open and closed and thusly the distance from a point on the open line to the same point on the closed line would be a total of 2" (The stroke of the cylinder.)

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Once you get the pieces together, drill a hole slightly smaller than the butterfly shaft on center through the 4" tube. Hone to fit. Make sure it's in the center and comes out on the other side on the center. I used a drill press and a Vee-Block to make sure this happened. I had some scraps of stainless sheet laying around so I fabbed up an 'arm' and after making sure the position was correct, I welded it together. As you can see the butterfly is in the OPEN position with the cylinder retracted. I started using a Bimba cylinder that had spring return but learned the hard way, the spring rate was too much for my application. I decided to use an external spring return because of that.



This is what a fire extinguisher looks like after you wire brush the paint off and smooth it out in the lath with steel wool, and clear coat it. I was going to make one from a piece of 4" stainless tube but the hassle of finding ends, welding it up and getting it big enough was enough to make me use this old tank.

The bracket to hold it was also made from some scraps of aluminum I had in the shop floor. I had some 90 bends made from some 6061 x 1/4 thk plate. I used the arbor press to flatten it out a little more and there you have it...a tank cradle. I milled about 6 slots in the bottom of the angle to plug weld it to the base plate. Throw on some stainless band clamps and you have a mount.

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This is the only problem I had using it though. The threads in the end are -10 and I needed to go to 1/4- NPT for my 1/4" polyflo tube fitting. So, guess what... out comes the TIG welder and I stuck in a steel bushing that was 1/2 NPT to 1/4 NPT and fixed that problem. I pressure checked it to 20psi and I used glass cleaner to see the bubbles. As it turned out I did have a couple of pin-hole leaks so I fixed them and went on. That's why it looks burnt around the fitting.

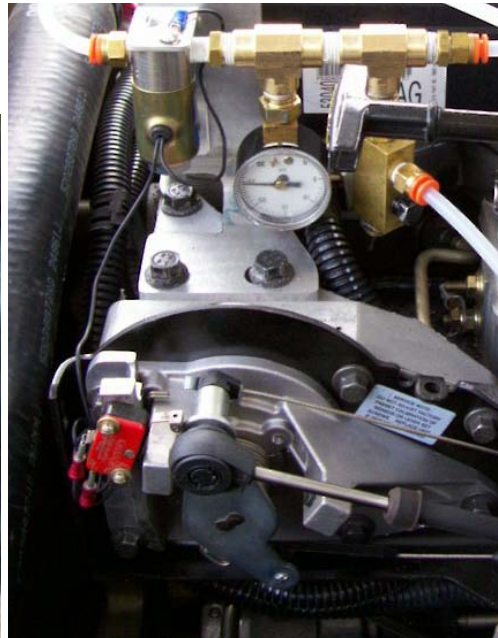


OK, here's the heart of the beast. The electric solenoid is like a nitrous unit except it has a 1/8" orifice instead of something around .060" in dia. The gauge is a simple air pressure gauge from Grainger for \$5.00 that reads 0-30 and the rest are brass fittings. The solenoid end line goes to the exhaust brake unit. The 90 fitting will go to the check valve. I put on the polyflo tee for testing when this picture was taken.

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Anyone know what this is?  
A TPS bracket assembly. But if you look closer you'll see the micro switch I mounted on a machined bracket that uses the front two bolts. I had to be creative and mill a little, test fit, mill some more, play with it, measure, etc. to get the right height for the roller to hit the return arm. Now it fits fine and has a little adjustment as well. Take your time, and it'll fit under the stock plastic cover as well.



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The day of installation. The finished brake unit is ready to weld in place. As you can see, I've added a few things since the initial build up. The cage is for protection from debris under the truck, 'cause you never know if you'll run over a FORD powerstroke or not. The port is for my back pressure gauge readings and the rest is pretty self explanatory. As you can see I've decided to place the butterfly downstream of the unit. This is so I didn't have to put another port in under the truck into the existing pipe.



Get it up in the air, 'cause it's going to be tight under there when you have three hands holding stuff, a welding hood to flip down and wire to feed into the weld!  
I had to use blocks to run the truck up on, 'cause it crushed my Kragen bought special car ramps I'd been using before. (They were plenty lightweight anyway.)

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It's dirty but it's stainless steel. Here's the marks of where I wanted to install the brake unit. I decided to put it here for the protection from the tranny cross-member and the ease of getting behind the tube to weld it in.



Enter, die grinder. Be sure to cut it square, or leave enough material that you can grind it square after the piece is out of the way.



OK, here's the down-pipe from the turbo. I'm cutting the upstream cut now to fit the brake unit in. It's lots easier to do out of the vehicle, let me tell you!

There you have it... a finished weld. Damn I hope I turned that the right way! Were those marks the center or the side?

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Now, after you 'fished' the tube back up into place, fought with the clamp one handed and got things almost under control, look what you have to align!

No big deal. Use the trusty tube clamp. Don't have one? Make one.



Here's the clamp in place. Be sure to get the joint as close as possible... 'cause any gap will be a real bear to weld up, especially on the top and outer edge where you might have to use a mirror to make the weld.

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Finished at last. I haven't wire brushed the weld yet but hey, it's on the bottom of a diesel pickup truck that doesn't go to many car shows. I have more fun things to do that buff it out.



OK, what the hell am I doing now?! Drilling holes in plastic tubing?  
Yep, since I used only one solenoid valve to actuate the cylinder, guess what? It won't open on it's own with air pressure on the line.  
Solution: put a small bleed hole in the line with a "tip drill". I used a .022 bit and it works fine. The release is soft and smooth. Takes about 1-2 seconds to release completely. I can live with that.

Gauge for tank pressure

To the Bimba cylinder / exhaust brake unit

Check Valve

To Air Tank

From Intake Manifold

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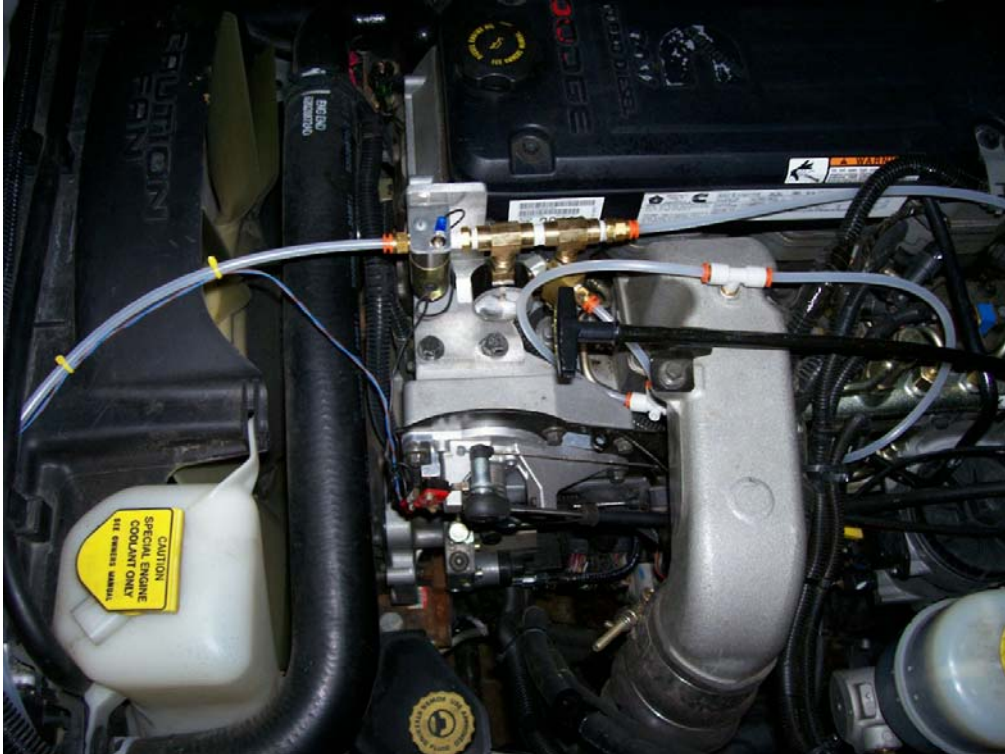


This isn't too bad of a job. Take out the screws that hold in the dash bezel. (Located up under the dash area, Phillips screws.) Then unsnap the associated dash pieces on the left and defrost grill area to the right, to remove it completely. Take it into the shop and chop a hole to fit your dash switch. Mine was a radio shack item with a round hole required and looked kinda square with a red LED on it. Hook up power from a key switched source.



This is the finished switch installation. It cost me about \$5.00 at Radio Shack and looks good, meaning it matches the interior pretty well. The other knob is obvious. It's for the horsepower stuff.

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Here are the finished items. The blue/brown is the trigger wire coming from the dash switch to the TPS switch. The lines are hooked up and the tee on the intake is for my new boost gauge I'm putting in next week. I just used a spare tee fitting and looped it around until I run a line into the cab.

All totaled, I'm into this brake setup for about \$150.00 It's hard to calculate what it would cost someone else to do, 'cause I had lots of items laying around and used scraps of stuff I already had. Stainless sheet, pieces of polished 4" tube, lots of fittings, etc. The solenoid is probably the most expensive store bought item and it was about \$50.00 The brass fittings and polyflo line were from Home Depot and ran around \$10.00 plus some change. I have two lathes and a milling machine, along with a 300 Amp Miller welding machine so I pretty much fabricate anything I set my mind to do, which some people won't be able to. The answer to that problem, call your buddies. Someone out there has at least some of the items here and will no doubt want to make one for themselves at the same time.

Good luck with your project. I figured I saved about \$600. And don't have a vacuum pump or other mechanical stuff to break down. If it stops working, there aren't too many places to look for the problem. It's simple, it's durable, it works, and... you made it yourself! It'll be easy to repair and you won't be scared to hit it with a hammer if the need arises!

Good job.

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March 31, 2006 update!! **Failure analysis of butterfly shaft assembly.**

I tested the brake and it worked flawlessly but as you can see from these pictures, it broke. (!?!?!). But why?

The shaft the butterfly disk was welded to just barber pole broke. Strange huh? I think it has a reason somewhere in the concept of thermal expansion inside the exhaust pipe tube. The strain of a “full apply” at high rpm caused such stress at the end weld area it just snapped in two when subjected to a bending moment.



The view I saw at the left made me think it was melted when I first took a glance in there... but the brake is almost 2-feet from the turbo outlet! How in the hell could it get hot enough at that distance? Relief at last, I used a magnifying glass, then needed my kids microscope hooked up to the computer to believe my eyes and found the shaft had snapped with a fracture, not melted. Here are 10X microscope pictures of the shaft & a penny for size.



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You can see from these pictures that the shaft saw some stress running the length of the rod and it was weakest just on top of the weld. It would appear that the weld had NO cause in the breakage but the thermal stress from running inside the exhaust pipe did provide enough to break it at the moment of full apply under load at high rpm! That's some kind of stress!



Here's the new parts all made up and ready to assemble. It took me about 2 hours to fab the arm and shaft, and tapping the 5-little tiny 10-32 holes! The disk is the same size as before and the shaft is .312" dia. instead of the .250" dia. Instead of welding up an arm assembly, I milled one out of scrap aluminum, added a setscrew to match the 'timing' flat on the shaft and used a 1/4-20 bolt to clamp the arm to the shaft.

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This is a close up of the new arm clamped to the shaft. I used a 1/4-20 bolt thru the heim joint and a locking aircraft nut to keep it all together. (It's the only 1/4-20 nut I could find, sorry. Any lock nut would do though.)



Here we are, all welded back in and all that's left to do is hook up the air-line and return spring. Should last a little longer than the first design. I'll probably use the die grinder and cut off a little more of the shaft sticking up after I'm happy with the performance.

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One more thing, notice I've placed the head of the screws on the 'downstream' side of the butterfly? Wonder why I did that? Me too. Maybe just unconscious thought processes at work keeping a future failure from entering the picture. Who knows. I don't think it really matters which side they're on but this works for me. I might flip them over to the upstream side after my next update/modification.

April 4, 2006, 2006 update!!

Modification and update of butterfly assembly.



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Here's a couple of pictures showing the seal ring assembly fitted up to my test tube. I'm using the butterfly disk 'blank' to setup the ring(s). As you can see the butterfly will only open one direction, hopefully the same way as the air cylinder wants to open it! As you can see on the right side picture, the disk will close up against the ring providing a sealed area much like a piston ring seals. The only air flow will be around the shaft area at the top and bottom of the tube.



Using the old bender, I rolled the square stock to form a ring that I cut in half and inserted inside the tube. With a little trimming and fitting skills, it will seat properly and not have a twist in it. Clamp it well and just put a tack weld around the perimeter of the ring. Enough that the thermal stress won't break it off and not so much weld that you distort the tube.



Here's the finished products. I tried it with a piece of 1/8" sq stock and a piece of 3/16" sq stock, I like the smaller one better. Now to tack it in and see if it'll hold up. I know the sealing ability will be much better and if I can get the total open flow area down to around 3-5% of total tube area, That should do the trick.

For moral support, some assistance, and pointers during your build up... contact me at:

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cdennyb on [www.oilburners.net](http://www.oilburners.net) message board