Converting a single master cylinder to a dual master cylinder

1964 Plymouth Valiant, before and after

How does it hook up?
What parts will I need?
Why should I care?

First, some theory, because it's easy: The hydraulic brake system has been in widespread use for the better part of a century. Not surprisingly, Chrysler Corporation was one of the first to adopt the technique (in 1924), while some other manufacturers were still using mechanical linkages even into the early 1930s. The operating premise is simple: hydraulic fluid (like most fluids) is not compressible, so if you have a tube full of it, and push more fluid into one end, the same amount of fluid will come out the other end. In practice, a piston/cylinder arrangement is used on each end, to convert fluid motion (or pressure) to mechanical movement. By attaching a foot pedal to a pump on one end, an amount of control can be gained over what happens at the other end (where the brake drums are.) Since the far end will always move in direct proportion to the near end, it's a very effective master-slave arrangement.

For most of automotive history, hydraulic brake systems used a single Master Cylinder reservoir, which pumped through a junction block to lines and hoses to distribute fluid to each of 4 wheels. This type of system works reasonably well, the vast majority of the time. The problem is that if any component fails or leaks, it is no longer possible to build up pressure anywhere in the system, and the result (as the pedal sinks to the floor and your heart leaps in your chest) is No Brakes! While this can happen even when the equipment is new, it becomes much more likely on systems that have been installed for several decades. Sure, it would make sense to perform maintenance such as flushing and replacing brake fluid every year or two, to minimze damage to rubber seals due to contamination, but how many people really do that? And even if you did, and even if you live in a part of the country where metal tubing doesn't rust, eventually the flexible rubber hoses will deteriorate. In a car nearly 40 years old, it's smart to take a very close look at the brake system, and even smarter to update it to more modern (relatively speaking) standards.

Modern, in this case, refers to a range of 1967-68, during which time the Federal government mandated quite a few safety improvements across the board. Among recommendations like shoulder belts and side marker lights was a "dual reservoir" hydraulic system. Sure, that was nearly 40 years ago, but this is not exactly an antique

technology. Apart from the recent proliferation of Antilock Brake Systems, not a whole lot has changed since then. And the fact that Chrysler already performed the engineering and then built a lot of dual reservoir systems shortly after our 1960-66 cars rolled off the assembly line provides an amazingly convenient place to start, in our quest for an upgrade.

With a dual reservoir, it's almost like having two different brake systems connected to the same brake pedal, one for the front brakes and a different one for the rear. If either system suffers a failure, the other can stop the car in a reasonably controlled fashion. This is especially true if the rear fails, since by far the vast majority of the braking is done with the front wheels, and the missing rear brakes will barely be noticed. But what if it's the front brakes that fail? Using only the rear brakes to stop a car is possible, but difficult at best, and will often result in skidding wheels (as the weight of the car shifts toward the front during a nose-dive.) To address that issue, by the early 1980s, some cars (notably Japanese) were split on a diagonal system, such that each hydraulic circuit would engage one front and the opposite rear wheel. The diagonal nature kept the car from swerving too violently to one side during a failure. Around the same time, Volvo decided to go one step better than that, in their early 240 series cars. The front calipers EACH had two separate hydraulic inputs, and each circuit of their design could therefore include three wheels (Front, Front, and one Rear). A failure was nearly unnoticeable, and required a dash warning light tripped from a pressure sensor, to indicate trouble. Of course, other cars have brake failure warning lights also, but they could arguably be considered optional since an attentive driver WILL notice a difference in pedal feel and road handling if a failure occurs. (Sadly, it seems most cars are made for the NON-attentive, but that's a result of our government hard at work.)

Does the newer dual reservoir design work? Yes, quite well. Is it safer? **Consider this:** the mechanical cable system that used to be called an Emergency Brake is now commonly referred to as a Parking Brake. Sure, hydraulic failures can still happen, but the consequences are much less life threatening.

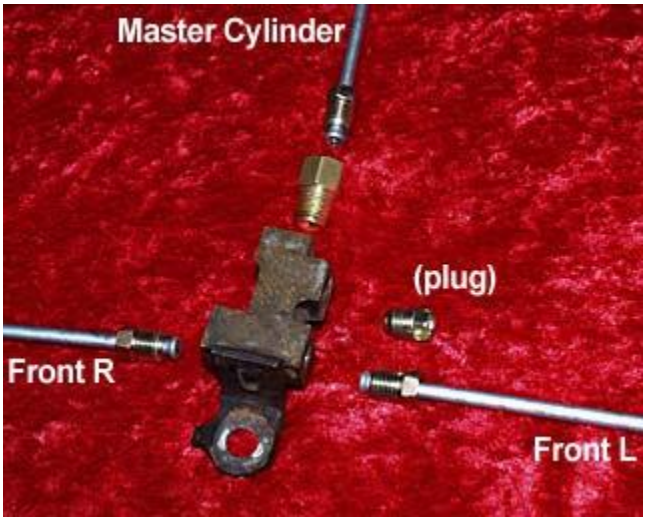
Because Chrysler offered a dual system in 1967-newer vehicles, updating an older car is as simple as walking into a parts store and asking for a master cylinder from a 67 (and if their books don't go that far back, know that it's pretty much unchanged through the mid 70s.) The new design attaches to the firewall with the same 4-bolt pattern, and uses the same pushrod from the brake pedal. You will want to make sure you get one that matches your car's configuration regarding disc or drum brakes, since there are internal differences in terms of residual pressure valves and front reservoir capacities. (If you're curious, an Internet search should teach you more than you ever needed to know about the specifics of drums vs. discs.) In these cars (among many), it's somewhat confusing that the front-most master cylinder outlet is plumbed to the rear brakes, and the rear-most outlet goes to the front brakes. It's a bit more understandable if you realize one important factor is plumbing the larger

reservoir to the front.

When you upgrade to a new master cylinder, it's also not a bad idea to follow the factory's example and roll a couple of curly spirals in the metal lines in the engine compartment. (You can use a tubing bender, or just carefully wrap them around a large pipe or socket.) The reason for this is simply to allow thermal expansion of the lines (for less stress on the fittings) as the engine compartment heats up, and that issue becomes more critical the more heat is generated and the more confined the space for cooling. For example, high performance V8s with exhaust manifolds in close proximity to the MC will obviously affect the brake fluid more than will a little slant six engine having an exhaust pipe more than a foot away. Note that with the earlier single-reservoir cars, Chrysler obviously thought a gentle loop of tubing was good enough, and it wasn't until engine compartments became habitually packed full of accessories that the curly loops became commonplace.

But the new master cylinder, by itself, isn't enough. With two hydraulic lines coming out of the master cylinder, you'd lose all the safety advantages if you simply tied them together with a T-fitting at the original brass junction block on the frame rail. There are a couple of better ways to accomplish the appropriate minor plumbing change. For 67, the factory upgraded their single junction block to a side-by-side distribution valve that kept the front and rear circuits separate but incorporated a pressure switch between them. If you can find one in a junkyard, great! But you don't need it unless you wish to add a warning light to your dash, since it serves no other function. The easiest (and cheapest) method is to continue to use the existing junction block for running one circuit to the front wheels, and plug the hole that formerly serviced the rear wheels. The rear brake line can be taken straight from the MC, without needing to be a part of the junction at all. For a drum brake car, this is sufficient. Here is a photo showing the routing I chose, to make the plumbing look more compact... feel free to choose your own routing, of course:

original junction block configuration



new configuration

Safety Update: this particular junction block has no restrictions inside it, so I can get away with interchanging the front and rear connections. In some applications there *would* be a difference, such that if I plumbed it as shown, the front left and right brakes would receive vastly different fluid flow, causing the car to swerve to one side as the brakes are applied. Check to make sure!

If you're changing to disc brakes on the front, you'll want to add a proportioning valve to limit the pressure in the rear brakes, so they don't lock up. In early years, the factory used a separate proportioning valve, and in later years they built it in to the combination valve... so depending on which junkyard piece you find, you might be

all set. On the other hand, an ADJUSTABLE valve is *highly* recommended, since it can be tuned to match the needs of your car, with your driving style, and your weight distribution habits. (The weight issue is much more critical in a truck or van where the rear loading can change considerably depending on how much stuff you carry around. Consider that Chrysler built in a body height sensor on the rear axle of their minivans, to modulate brake pressure depending on the need.) While an active sensor is definitely overkill for a passenger car application, an adjustable proportioning valve is very nice to have, and not terribly expensive. They can be obtained from Chrysler, or from racing houses like Jegs or Summit.

It's worth mentioning the fittings, since Chrysler used slightly different thread sizes for the front (1/2" threads) and rear (9/16") outlets of the MC, and neither matches the ones that come standard on a 3/16" line. The best way to accomplish this connection is to purchase the fittings separately and use a double-flare tool to "roll your own" lines. But if you absolutely cannot spare the extra $, adapters are available. A well-stocked store should be able to match up the right ones, or just ask your NAPA person for part numbers 7909 and 7910. You'll also need a small adapter to attach a new 3/16" line to the old junction block (7/16" threads), if you choose to use it. And obviously, you want to use the right type of wrench, to keep from rounding off the nuts as you tighten them. A"flare nut wrench" is pretty neat... notice it will slide over a hydraulic tube, and still contact 5 of the 6 points of the nut. Very well worth the investment.

Once you have everything installed, all the typical brake bleeding procedures (to eliminate air trapped in the lines) can be followed, as set out in the factory shop manual or most any Chiltons or Haynes manual. The brake shoes need to be adjusted so they're just barely touching the drum, and you'll be able to hear them scrape when you turn the drum by hand... the movement of fluid is not intended to move the shoes, but rather to simply apply pressure. Any significant movement at the far end of the hydraulic line will result in more travel at the near end, in other words the pedal will feel "low".

Most of the final testing can be done simply by gauging how the brake pedal feels. It should travel a short distance and then feel like it's hit a rock. If it feels spongy, that means you're compressing air trapped in the lines. If it feels solid but then slowly sinks to the floor as you hold it for about a minute, that means fluid is leaking somewhere, most likely from a threaded fitting, or possibly past a rubber seal at either the master cylinder or a wheel cylinder. It should go without saying that you want the system to be in perfect working order before driving anywhere.

The entire conversion can be done on a shoestring budget. Rebuilt master cylinders are less than $20, each rubber hose is about $30, and a handful of 3/16" (with SAE fittings, as opposed to metric or Japanese!) steel lines are a few dollars each. These prices are about the same as if you were merely rebuilding your single-reservoir system. A small point worth noting is the reliability of a "rebuilt" master cylinder: in theory, with all new internal parts and a quality control check, there's no reason it shouldn't be as good as a brand new one. In practice, I've heard stories of people needing to return a rebuilt unit and ask for another one, or even a third one, before getting a specimen that builds pressure appropriately in both ports. It all depends on how badly scored the cylinder bore was before they tried to rebuild it. To save yourself the headaches, it could quite easily be worth spending a few extra $ for a new one. I've even heard some people make a blanket recommendation to purchase new, which is certainly not bad advice.

If you prefer the concours approach, several places specialize in pre-formed tubing to fit the shape of your vehicle. Telling them what sort of conversion you're doing will usually be enough for them to mix and match parts to send you the right stuff. One hint from our mailing list: if you want a little bit more length on the lines to reach from the master cylinder to a new combination valve that you've installed farther back, simply ask for

parts to fit power brakes, which uses a MC installed a few inches farther forward.

If just plain-old concours isn't sufficient, follow Clif's example (documented in the Projects section.) He included not only the conversion to a dual hydraulic system, but custom-made stainless steel tubing throughout, a 4-bolt to 2-bolt adapter plate to use a newer style aluminum (lightweight) master cylinder, and huge 11" disc brakes with powder-coated calipers, custom-made 15x7 rallye rims... and as Gary Viola so aptly pointed out on our mailing list, leave it to Clif to build a bracket out of scrap metal and then anodize it. As usual, everything about the way Clif works on his car is impressive.

However you choose to rebuild your brake system, a dual reservoir system is an excellent idea, straightforward to install, and worth considerable peace of mind. Losing brakes is, at best, a scary proposition, and at worst... well, it wouldn't take much imagination to consider that. If you're lucky, your troubles will be limited to the inconvenience of an insurance claim, and replacing hard-to-find sheet metal, both of which will make the cost of brake improvements seem quite cheap. Don't wait for a failure to happen. Take care of your car, and it will take care of you.

Nov. 2003

Jan 2004 Newsflash! Take a look at the new April 2004 issue of Mopar Action, and you'll see much of the above information and even more details than you thought you ever needed. I highly recommend ordering a back issue, if you missed it.

The Early Valiant & Barracuda Club