

Overview:

This document is based upon an "ALFA Romeo Association Tech Session / Presented by Larry Dickman Jr., ALFA Parts Exchange" paper. Mike Nakamura used Larry's guide to upgrade a 1971 Montreal and I used the information provided by Mike to upgrade my 1972 Montreal. I have added to the information provided by Mike to provide a little more clarification and detail.

Larry developed this upgrade to fit within common 14" ALFA wheels and there are several routes one can follow to achieve the finished result. You can modify old 115 rotors creating iron hats and attach new rotors or you can have custom aluminum hats machined. The drawings provided are for custom hats.

I have made every effort to insure that the information included is correct and I have successfully performed this modification to my own Montreal. If you find any errors and/or omissions you can contact me at alfagene@adelphia.net.

The Wilwood 4 piston calipers provide much better braking than the stock ATE 2 piston calipers. As a result the car tends to dive quite a bit under braking and it is not too difficult to lock up the rear wheels. I still need to stiffen up the front suspension to counteract the dive and I will be replacing the brake regulating valve with an adjustable valve so that I can balance the braking.

Disclaimer:

Naturally, no one can take responsibility for modifications such as described on the following pages, except for you. Don't proceed if you expect Wilwood, Coleman Machine, ALFA Romeo, ALFA Parts Exchange, ALFA clubs or any other individuals to assume any responsibility.

You will notice that all suppliers noted in this paper have strong disclaimers attached to the sale of their products.

Brake knowledge:

Below are several key words and phrases with which you will want to become familiar.

Hat - Brake component that attaches the rotor to the hub. Most production cars have a one-piece rotor / hat combination, so called integral rotors. For this upgrade, you will make a separate hat and will attach it to the rotor using NAS bolts and nuts.

NAS shear bolt - A close tolerance and high strength bolt suitable for automotive brake applications. Use these to attach the rotor to the hat.

Jet nut - Lightweight-locking nuts commonly used on aircraft applications. These nuts have a slight deformation of the upper portion of the nut. Automotive uses are on three piece wheels and rotor to hat applications. Military spec (MS) 21042 are high strength nuts that should be safe for rotor to hat attachments.

AN Fitting – A fluid fitting standard developed by the U. S. Army and Navy in the 1940's. This is a 37-degree flare fitting available in a variety of sizes from 1/8 inch OD tubing to 2-inch OD tubing. Superior sealing over the SAE and ISO 45-degree flares. Standard in aircraft fluid connections and now used by many race car constructors.

Unless you are knowledgeable about brakes, check out (library) or purchase one or more of the books listed in the reference section.

The supplier section lists only a few of the many sources; the reference books have many more or search the Internet.

Cautions:

Regular SAE bolts are not sufficient for this type of application. They are primarily for tension applications and this application requires high shear strength.

One can find socket head cap screws with very high strength ratings in a wide range of sizes with rolled threads; these too are for tension applications.

Both SAE bolts and cap screws have the loose tolerances for diameter and further the cap screws are threaded far onto to shank. Where the maximum shear force is applied (at the rotor and hat interface), you want a solid close fitting shank. Threads concentrate the force and are a "starting" point for failure.

Use only all metal locknuts. Any nuts with a fiber or plastic (nylon) locking insert are not suitable for brake applications.

The bolts and nuts used to secure the rotors to the hats are National Aerospace Standard (NAS) items, and according to Coast Fabrications are "the brake hat bolt of choice for all serious race cars".

When connecting the brake hydraulic connections do not connect SAE, ISO, or AN fittings without the proper adapter. They are not made to connect together and they will fail!

Comments about specific parts**Rotors:**

Purchase vented rotors; use the drawing as a guide. Several options are available including gas vents, cross-drilling and curved vanes. I chose to go with the heavy duty curved vane rotors. Coleman Racing also offers light weight rotors (P/N L81-1100-150, \$76.45 each).

Hats:

Attached is a detailed drawing of the custom hat to adapt the Coleman rotor to the Montreal hub. These hats are made from aircraft grade 6061-T6 aluminum. Most hats for racing applications are made from this material, however they can also be made from steel. I had the hats polished and then clear anodized. This seals the aluminum to protect it from brake dust and corrosion. Be sure to use NAS bolts and nuts to attach the hats to the rotors.

The hat and rotor assembly can be used as a direct replacement for the stock Montreal rotor and will work with the original ATE calipers or any other caliper that will fit on the Montreal.

Calipers:

I went with the Wilwood Superlite IIA calipers with 1.75 inch (45 mm) pistons as recommended by Larry Dickman and Mike Nakamura. There are other calipers that would also work.

Clearances are tight around the rotor and hat so a small dimensional difference could cause interference. Wilwood calipers are well know and available at many racing shops. Note: these calipers are for 'racing use only' and come with a 'disclaimer of warranty'. That said, they are quality lightweight calipers with a proven track record. They weigh 3 kg. loaded with the pads.

These calipers do not have dust boots on the pistons and so they should probably be inspected and cleaned more often than the ATE brakes that came standard on the Montreal. In addition spacers can be purchased to go between the pistons and the pads to compensate for pad wear. By using these spacers the amount of the piston exposed to the elements can be minimized.

These calipers are setup for a trailing caliper installation (caliper at the rear of the rotor). For the Montreal it is necessary to swap the left and right calipers so that the bleed screws are at the top. Since all pistons are the same size this swap can be safely done. If the calipers that you use have different size pistons then the calipers can not be swapped left to right. Instead the bleed screws and the cross over pipe would need to be swapped to have the bleed screws at the top.

A word on piston size. The ATE calipers on the Montreal have two 50 mm pistons, for a total piston area of 39.3 cm² per caliper. The Wilwood calipers with four 45 mm pistons per caliper have a total piston area of 63.6 cm². This means that the brake pedal will have to move 60% further for the same pad movement. Wilwood also offers a caliper with 39 mm pistons that have a total piston area of 38.5 cm². These calipers would require the same pedal movement at the stock calipers. The ATE 4 piston calipers used in the BMW (a common upgrade for the Montreal) have 40 mm pistons for a total piston area of 50.3 cm² requiring 28% more pedal movement. Of course the larger piston calipers provide more braking and since the purpose of this brake upgrade is to get better braking the 45 mm piston calipers are the best choice.

Brake pads:

There are many brake pads available for the Wilwood Superlite IIA calipers running the full range from street performance to high speed racing. These pads are available from a number of sources and selection of the pad is left to the user.

Wheel Studs:

If you are using newly fabricated hats then you will need to press in wheel studs into the hats. Alfa, up to the mid 70's used left-hand threads on the wheel studs on the left side of the vehicle. If your vehicle has left-hand thread wheel studs you may want to take this opportunity to convert to right-hand thread studs. There are still some suppliers of left-hand thread studs, however the right-hand thread studs are easier to find. Also Alfa used different length wheel studs at different times so be sure to get studs that will work with your wheels. In particular, the Montreal uses wheel studs that have a shank length of 67 mm with 31 mm of it threaded. One thing to be aware if you are performing this upgrade on a car with solid rotors is that the caliper is wider with the ventilated rotor and you may run into an interference problem between the caliper and the wheel rim. If that happens you will need to put a spacer between the hub and the wheel rim. This may require longer wheel studs. Since the Montreal already uses ventilated rotors and has a spacer, this is not a problem.

If you need additional wheel studs and/or wheel nuts for the Montreal you can get them through Chris Slade (chrislslade@yahoo.co.uk)

Hydraulics

The Alfa Montreal hydraulic connections are ISO using fittings with M10 x 1.0 threads. The Wilwood caliper requires a fitting with a 1/8-27 pipe thread. The fitting on the Wilwood caliper can be placed at either the rear surface of the caliper or on the inside edge like the ATE caliper. To use the inside edge, just move the existing pipe plug from there to the hole on the rear surface.

The existing hard line from the rubber brake hose to the ATE caliper will not work with the Wilwood caliper and a new line needs to be fabricated. Due to the difficulty of getting metric fittings in the U. S. I chose to use a stainless steel braided line with AN-3 fittings for this connection. This required using a 1/8-27 pipe to male AN-3 adapter at the caliper and an M10 x 1.0 female reverse flare to male AN-3 adapter at the rubber brake hose. These adapters are made of steel; aluminum adapters and fittings should not be used for brake lines.

It is important that the hydraulic lines be routed in such a way so that they do not kink, get pinched or rub against other components through all suspension and steering movements. In addition, stainless steel brake lines will provide a firmer pedal since they do not expand like the rubber lines, however they do not necessarily have a longer life than the rubber lines. Also stainless steel lines are not typically DOT approved for road use and the Teflon lining may not be suitable for use in cold environments.

The web site <http://www.dimebank.com/tech/BrakePlumbing.html> has a very good write-up on fittings and lines used for hydraulic brakes.

Notes on procedure:

1. You will need to drill the mounting holes in the caliper to a larger size: a 15/32" (12.0 mm) drill is needed.

2. It is also necessary to trim the top and bottom of the splash shield slightly to clear the new caliper (see photo in Appendix I).
3. I found that I had to put a 0.140 (3.5 mm) spacer between the caliper and the mounting ears on the spindle in order to center the caliper on the rotor. Because of this I had to use a very thin washer between the head of the caliper mounting bolt and the caliper to insure that the caliper mounting bolts threaded all the way into the mounting ears. In some cases it may be necessary to get longer caliper mounting bolts. The stock bolts are 12 x 1.5 x 34 mm.
4. The clearance between the caliper top and bottom and the wheel rim is very close. I recommend that you install the new caliper in place of the ATE caliper and center it properly. Then install the wheel and make sure that there is sufficient clearance. I found it was necessary to file a little material off of the caliper body to clear the wheel rim.

Pricing

The prices listed in the bill of material are what I paid from the suppliers I listed at the end. There are many other sources and prices vary so shop around. The cost of the hats, being custom made, will vary depending upon who you have make them. I was fortunate in that a machinist friend made the hats for me at just the cost of the material.

Bill of Material (BOM)

Quantity	Part Number, Part Description, & Notes
1	DV90-1100-150 Right New Custom rotor, right, curved vanes Coleman Machine Part number (see drawing) Rotors \$86.05 each Balancing \$17.10 each rotor Gas venting \$5.40 each rotor
1	DV90-1100-151 Left New Custom rotor, left, curved vanes Coleman Machine Part number (see drawing) Rotors \$86.05 each Balancing \$17.10 each rotor Gas venting \$5.40 each rotor
2	Custom Hats L & R identical (see drawing)
1	120-3192 R/H Wilwood Superlite 11A caliper, right (4 pistons) 3-1/2" bolt pattern, 1.75 pistons, for .81" thick rotors. \$99.99
1	120-3192 L/H Wilwood Superlite 11A caliper, left (4 pistons) 3-1/2" bolt pattern, 1.75 pistons, for .81" thick rotors. \$99.99
1	WIL 15D-4332K Wilwood PolyMatrix D type brake pads Fits New Wilwood Calipers. Select brake pad compound of your choice \$58.99

- 16 NAS6304U08
1/4-28, 0.870" long, 0.500 grip length, A286 stainless steel hex bolt for attaching hat to rotor.
National Aerospace Standard part number
\$1.66 each
- 16 NAS1291C4
1/4 -28, 0.219" high, A286 stainless steel Jet nut for attaching hat to rotor.
National Aerospace Standard part number
\$0.51 each
- 8 Wheel Studs
Needed if using custom hats.
- 2 961603
1/8-27 male pipe to AN-3 male adapter
Earl's Performance Products
\$1.55 each
- 2 989545
M10 x 1.0 female inverted flare to AN-3 male adapter
Earl's Performance Products
\$4.14 each
- 2 63010112
Size 3 stainless steel braided hose with AN-3 female swivel at both ends.
Earl's Performance Products
\$11.46 each

Part Sources:

ALFA Parts Exchange Larry Dickman Jr. (209) 833-8330 http://www.apedirect.com	Coleman Machine / Racing Products N1597 US 41 Menominee MI 49858 (866) COLEMAN http://www.colemanracing.com
Coast Fabrication, Inc. 17748 Sampson Lane Huntington Beach, CA 92647 (714) 842-2603 http://www.coastfab.com	Wilwood Engineering 4700 Calle Bolero Camarillo CA 93012 (805) 388-1188 http://www.wilwood.com
PitStopUSA P.O. Box 7098 Petaluma, CA. 94955-7098 707-207-0193 http://pitstopusa.com	American Street Rod Performance Products 3340 Sunrise Blvd., #D1 Rancho Cordova, CA 95742 (916) 638-327 http://www.amstreetrod.com/
Earl's Performance Products http://www.earls.co.uk	Porterfield Enterprises 1767 Placentia Avenue Costa Mesa CA 92627 (949) 548-4470 www.porterfield-brakes.com

Reference Material:

Brake Handbook
HP Books
By Fred Puhn
ISBN 0-89586-232-8

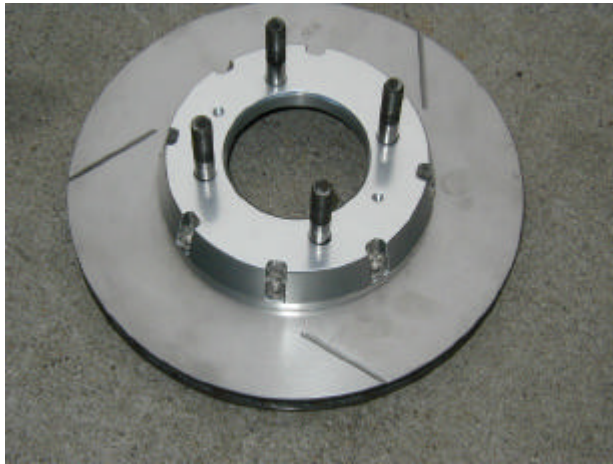
Brake Systems
HP Books
By Mike Mavrigian & Larry Carley
ISBN 1-55788-281-9

High Performance Hardware
HP Books
By Forbes Aird
ISBN 1-55788-304-1

Nuts, Bolts and Fasteners and Plumbing Handbook
Motorbooks International
By Carroll Smith
ISBN: 0-87938-406-9

Everything You Wanted to Know About Brake Plumbing, but Were Afraid to Ask
<http://www.dimebank.com/tech/BrakePlumbing.html>

Appendix I



Picture 1 Custom rotor and hat, front



Picture 2 Custom rotor and hat, rear



Picture 3 Custom rotor and hat, side



Picture 4 New brake line



Picture 5 Dust shield marked for trimming



Picture 4 dust shield and caliper installed

Appendix 2

National Aerospace Standard (NAS) information

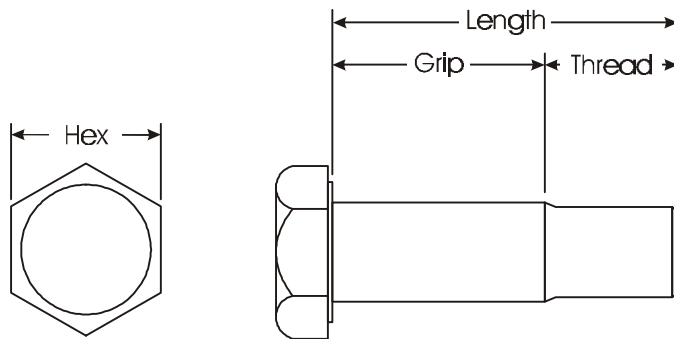
Hex Bolts

All NAS11XX / 62XX, NAS13XX / 66XX and NAS 63XX series hex bolts are 160,000 PSI minimum tensile and 95,000 PSI minimum shear strength fasteners. NAS 11XX / 62XX / 13XX / 66XX series are alloy steel rated for 450° F maximum temperature; NAS 63XX series are A286 stainless rated for 1200° F maximum temperature. To calculate actual capacities of a given sized fastener see the tech info section on our website.

All bolts in the above series are designated by grip length: the grip length is the full diameter unthreaded portion of the bolt beneath the head. Grips run in 1/16 (.0625) increments; dash number is grip in sixteenths. Adding thread length (constant for all bolts within a given diameter and series) to grip length yields the overall length (L) of the bolt (bottom of head to end of threads). Bolts with heads drilled for safety wire have an H prefix or suffix to the grip length (NAS1303-10H; NAS6603H10)

Listed below are hex head sizes and thread lengths for all bolts within a given series. Please ensure thread length is adequate to accommodate the locknut you desire to use. NAS 11XX / 62XX AND 63XX SERIES BOLTS SHOULD NOT BE USED IN TENSILE APPLICATIONS AS THREAD LENGTH IS INSUFFICIENT TO ENSURE ADEQUATE CLAMPING STRENGTH.

NAS 6304 bolts. Size: 1/4-28; hex head size: 7/16; thread length: .370



Jetnuts and Kaynuts

MS21042 and NAS1291 reduced dimension, all metal locknuts (jetnuts & kaynuts), inch and metric: These nuts feature a good combination of lightweight and high strength (160,000 PSI tensile). Available in steel (450°F maximum temperature) and stainless (900°F maximum temperature). Heights (HT) are given in nut descriptions; hex size is one size larger than nut up through 1/2 in inch sizes (i.e. #10-32 nut has 1/4 hex; 7/16-20 nut has 1/2 hex). 9/16 and 5/8 sizes have hex 2 sizes larger than nut (9/16=11/16 hex; 5/8=3/4 hex). Metric hex sizes are one larger (i.e. M5=6mm hex) through 7mm; sizes 8mm larger have hex 2 sizes larger than nut (i.e. 8mm nut has 10mm hex; 10mm nut has 12mm hex, etc.). Steel nuts are CADII (gold) or moly (gray) finish; A286 stainless steel nuts are silver-plated.

