

37 – HYDRAULIC RIM BRAKES AND DISC BRAKES

ABOUT THIS CHAPTER

This chapter covers five specific brake models: the Hayes hydraulic disc brake, the Magura hydraulic rim brake, the Magura Gustav M disc brake, the Magura Louise (or Clara) disc brake, and the Shimano Deore XT disc brake. Unlike other chapters in this book, there is no general information preceding the procedural information for each of these items. There is little similarity between these brake systems other than that they use hydraulics at some point in their operation.

HAYES HYDRAULIC DISC BRAKE

ABOUT THIS SECTION

This section specifically covers the Hayes fully hydraulic disc-brake system. This does not include the Hayes cable-actuated disc brake system. The procedures covered in this section include wheel-building guidelines, rotor and wheel installation, lever installation, hose installation, filling and bleeding the system, caliper installation, caliper overhaul, and pad replacement.

TOOLS

No special tools are required for normal installation and adjustment. Hose replacement and bleeding and filling the system requires a Hayes bleed kit, which consists of a two hoses, a plastic fitting, and a squeeze bottle.

INSTALLATION

Wheel building guidelines

The recommended cross patterns are limited to 3X and 4X. Deceleration can occur much more rapidly than acceleration, so consequently the torsional loads from deceleration are much higher than those generated during acceleration. The recommended cross patterns are required to transfer the higher torsional loads that hub-mounted brakes can generate during rapid deceleration.

Although Hayes makes no recommendation regarding lacing patterns, other manufacturers require that the left-side head-out spokes radiate clockwise from the hub and that the right-side head-in spokes radiate counterclockwise from the hub. These are the same directions that result from following the wheel-lacing instructions in this manual. The vernacular terms for these patterns are that the “pulling” spokes are “head out” and the “pushing” spokes are “head in.” An alternate term to “pulling” is “trailing” and an alternate term to “pushing” is “leading.”

Rotor and wheel installation

NOTE: *Build wheel before installing rotor.*

1. [] Place rotor on hub with rotation arrow facing out from hub.
2. [] If rotor-mounting bolts are being reused, treat threads with Loctite 242 (not needed for first-time installation).
3. [] Using a Torx T25 wrench, thread in all six rotor bolts until heads just contact rotor.
4. [] Use marker to mark each bolt clockwise 1 to 6, then tighten each to 55in-lbs in a sequence of 1, 3, 5, 2, 4, then 6.

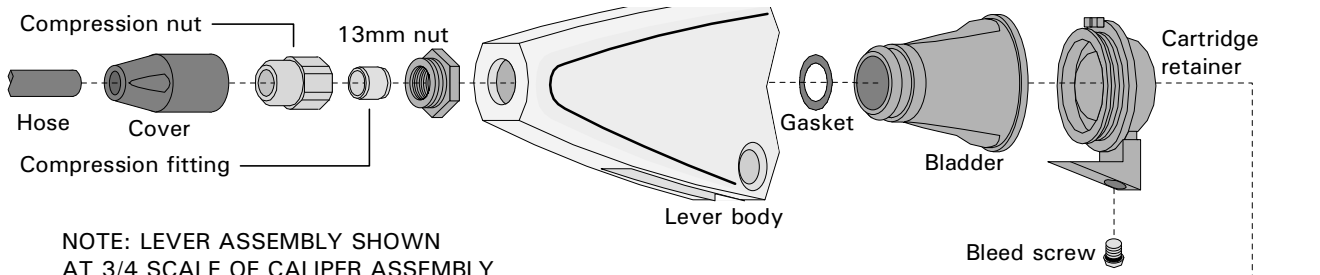
It is recommended that the quick-release skewer be installed opposite of normal. This insures that the quick-release lever, when fully closed, cannot interfere with the rotor. Although quick-release security is always of critical importance, wheel security is an even greater issue on a disc-brake hub than a hub with no brake. When securing the skewer, be sure to follow the guidelines in Chapter 18.

5. [] Install quick-release skewer into right end of axle (opposite of normal) then install adjusting nut on skewer.
6. [] Install wheel in proper alignment and with optimum quick-release security.

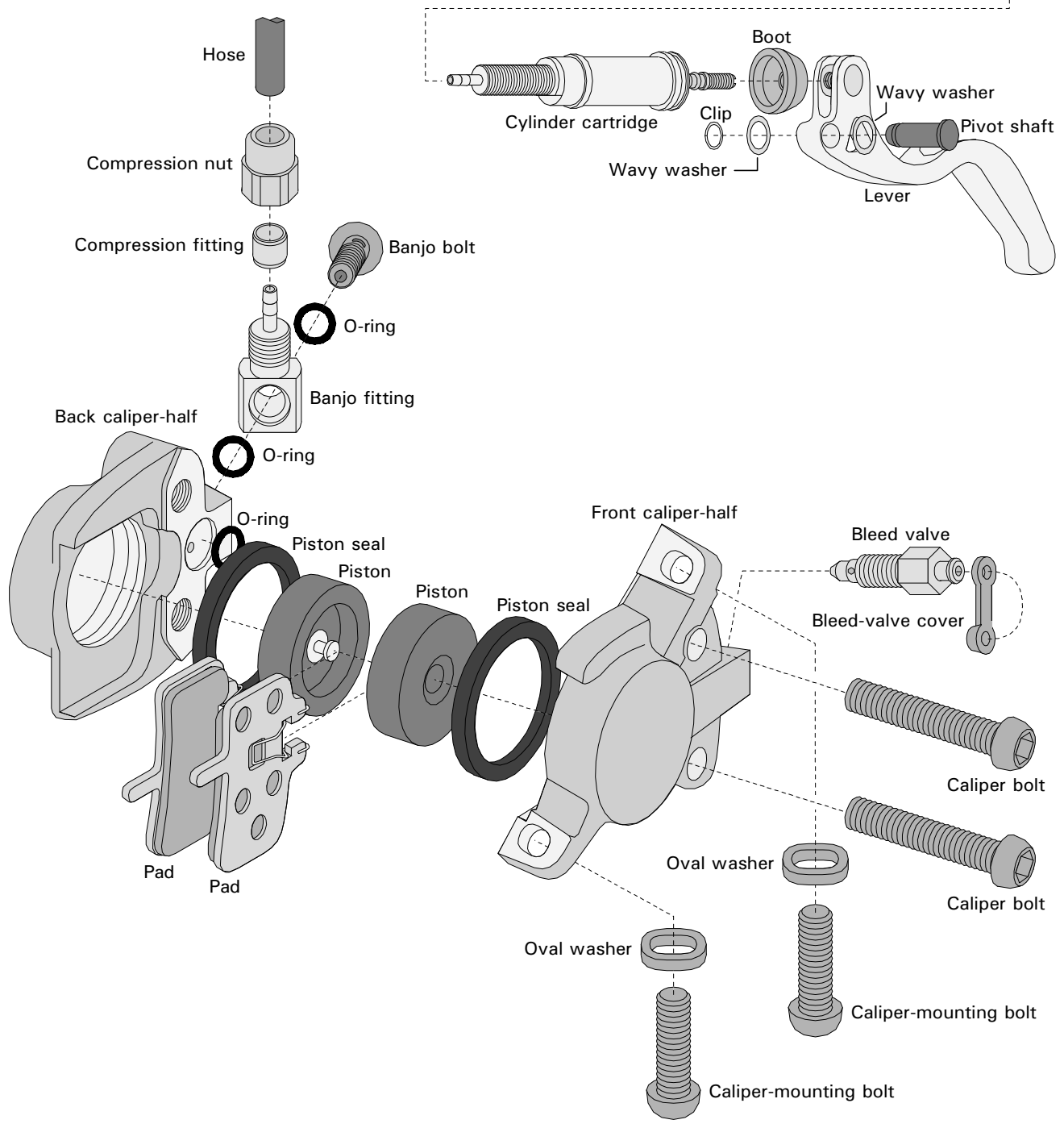
Brake-lever installation

7. [] Install brake lever in normal lateral and rotational position, then secure mounting bolts to 15–20in-lbs.
8. [] Use small slotted screwdriver to turn reach adjusting screw (in brass fitting at inner end of brake lever), fully counterclockwise, then back in two full turns. **Note:** *reach adjustment does not affect clearance adjustment or brake operation—this adjustment is only intended to make reach appropriate for average-sized hands.*

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NOTE: LEVER ASSEMBLY SHOWN AT 3/4 SCALE OF CALIPER ASSEMBLY



37.1 Hayes hydraulic disc brake caliper and lever.

Caliper installation and adjustment

NOTE: For frames or forks with International Standard mounting (bolt holes aligned perpendicular to bike, rather than parallel to bike), an adapter plate is mounted first. Install adapter and secure bolts to 110in-lbs (Loctite 242 on threads).

9. [] Treat threads of caliper-mounting bolts with Loctite 242.
10. [] Place caliper over rotor, align mounting holes in caliper with frame, fork, or adapter holes, then install and gently secure mounting bolts.
11. [] Squeeze brake lever firmly, then secure caliper mounting bolts to 110in-lbs. Release lever and check clearance between rotor and caliper pads. Rotor should be centered in slot between pads. If not, loosen bolts and align caliper to achieve equal pad clearance on each side of rotor, then secure bolts.

PAD REPLACEMENT

Theoretically, the pads can be used until just short of the point where the metal backing plates are exposed. However, if allowed to wear through to the metal the brakes will be unsafe and the rotor will be damaged. The braking material on new pads is approximately 1.8mm thick. When worn down to .3mm, the margin for safety is very narrow, so pads should be replaced if braking material thickness is .3mm or less. This means that each pad has a usable thickness of approximately 1.5mm. Remaining life can be calculated by determining the percentage of usable thickness that has been used up. If 1mm of thickness remains, then .8mm has been used up, and .7mm of usable thickness remains. The remaining life would be 47% ($.7 \div 1.5 = .466$).

1. [] Remove wheel.
2. [] Remove pads by pulling on tabs (pads are held in place by springs clips on back faces of pads).
3. [] Use depth gauge of caliper to measure remaining thickness (consider .3mm or less worn out).
4. [] Clean inside caliper around piston with water and detergent on brush. **CAUTION: Do not use automotive brake cleaners! Seal damage will occur!**
5. [] Use box end of 10mm wrench to depress pistons back into caliper. **Avoid pressing on studs in centers of pistons!** Pistons may need to be rocked back and forth until fully depressed.
6. [] Observe that one pad has tab in line with retaining spring, and other pad tab that is offset to retaining spring.
7. [] Install pad with in-line tab in outer side of caliper slot, then install other pad in inner side of caliper slot.
8. [] Install wheel.

HOSE INSTALLATION AND SIZING

If the caliper hose is damaged, too short, or too long, then it is necessary to install a new hose or re-size the existing hose. The same procedure suffices for both. A hose is too short if it must bend sharply at any time. A hose is too long only if it interferes with other components or snags on things during use of the bicycle. Performance of the brake system is unaffected by hose length.

CAUTION: This brake contains DOT 3 or DOT 4 brake fluid, which is a skin and eye irritant, damages paint, and destroys brake pads. Working with the hose means fluid will be released. Wear appropriate safety equipment to protect eyes and skin!

1. [] Remove wheel and brake pads.
2. [] Slide plastic sleeve on lever-end of hose away from brake lever, then unthread 10mm hose-nut fitting from brake lever.
3. [] **Only if replacing hose:** Unthread 10mm hose nut at caliper-end of hose and pull hose off banjo fitting.
4. [] **Only if replacing hose:** Install 10mm fitting removed from caliper-end of old hose onto new hose (round-end first).
5. [] **Only if replacing hose:** Place new compression bushing over caliper-end of hose, then press hose onto barbed fitting (long nipple) protruding from banjo fitting. Secure hose nut to 40in-lbs, plus one full turn.
6. [] Route hose to lever and decide on appropriate length. Use sharp razor knife to trim hose to desired length. End should be cut as square as possible.
7. [] Place plastic fitting cover (small-end first), hose nut (round-end first), then new compression bushing onto cut end of hose.
8. [] Press hose onto barbed fitting (long nipple) protruding from brake lever. Secure hose nut to 40in-lbs, plus one full turn.
9. [] Perform FILLING AND BLEEDING procedure.

FILLING AND BLEEDING

Filling and bleeding are normally done as part of hose replacement or sizing, or when repairing a leak in the system. Hayes does not recommend filling and bleeding as routine maintenance.

CAUTION: This brake contains DOT 3 or DOT 4 brake fluid, which is a skin and eye irritant, damages paint, and destroys brake pads. Wear appropriate safety equipment to protect eyes and skin!

1. [] Remove wheel from bike.
2. [] Remove both brake pads.
3. [] Put bike in position so that bleed fitting (brass fitting protruding from caliper) is pointing straight up. Remove rubber cap fully from bleed fitting.

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4. [] Position handlebar and brake lever so bleed screw (Phillips screw) in brake lever is at highest point of brake system. Lever body should be pointing up from handlebar and hose leaving lever should be pointing down approximately 45°.
5. [] Suspend waste-oil receptacle from brake lever.
6. [] Remove Phillips bleed screw from brake lever, then insert hose with conical fitting into brake-lever bleed hole. Other end of hose goes into waste receptacle.
7. [] Fill squeeze bottle from bleed kit with fresh oil from sealed and uncontaminated container of DOT 3 or DOT 4 brake fluid. *DOT 5 or mineral oil are not acceptable substitutes!*
8. [] Place remaining hose on nozzle of squeeze bottle.
9. [] Place other end of squeeze-bottle hose over bleed fitting, then secure hose to bleed fitting with zip tie.
10. [] Keeping squeeze bottle upside down, squeeze and release several times to release air bubbles in hose up into bottle.
11. [] Unthread bleed fitting 1/4 turn.
12. [] Squeeze bottle 5 seconds and release 3 seconds, repeating cycle continuously until no bubbles appear in bottle hose during release, then squeeze bottle continuously until fresh fluid with no bubbles is seen coming out hose at brake lever. *Maintain pressure on bottle at completion of bleeding cycle!*
13. [] While maintaining pressure on bottle, secure bleed fitting.
14. [] Remove bottle hose from bleed fitting, then install rubber cap on bleed fitting.
15. [] Remove waste line from brake lever and install bleed screw until O-ring begins to compress.
16. [] Clean caliper of any fluid, then install brake pads and wheel.
17. [] Operate brake and check for soft or spongy feel and leaks at hose fittings, bleed fitting, and bleed screw. Repeat bleeding procedure if brake feels soft or spongy.

CALIPER OVERHAUL

Hayes supports overhauling the caliper. If a leak develops at the pistons, then seals in the caliper need to be replaced. If the studs on the pistons that engage the pads are bent or broken, the pads will fall out. In this case, the piston(s) need replacement. An overhaul kit includes new pistons, piston seals, and a transfer-port O-ring. All new parts should be used when servicing the caliper. The O-ring is a special material, so no substitution should be made.

CAUTION: *This brake contains DOT 3 or DOT 4 brake fluid, which is a skin and eye irritant, damages paint, and destroys brake pads. Servicing the caliper will drain the entire system of brake fluid. Wear appropriate safety equipment to protect eyes and skin!*

1. [] Remove wheel from bike.
2. [] Remove pads from caliper.
3. [] Unthread bolt through banjo fitting so hose detaches from caliper. Rubber O-rings on bolt will retain bolt is banjo fitting.
4. [] Remove caliper from mount.
5. [] Unthread two bolts in outer face of caliper and separate caliper halves, watching for small O-ring that is sandwiched between caliper halves.
6. [] Thread a short 6 × 1mm bolt into hole where banjo-fitting bolt was removed.
7. [] Wrap rag around one caliper half, leaving transfer port (small hole in center of O-ring that was sandwiched between caliper halves exposed).
8. [] Place rubber-tipped air gun against transfer port hole, then use compressed air to blow piston out of caliper half. Piston should be caught in rag.
9. [] Repeat steps 7–8 for other side, then remove bolt that was threaded into banjo-bolt hole.
10. [] Remove seal from inside each slave cylinder.
11. [] Clean all parts with alcohol and dry with compressed air. Thoroughly blow out all holes, including bleed fitting, which should be loosened to blow dry.
12. [] Lubricate new seals with DOT 3 or DOT 4, then seat carefully in grooves.
13. [] Lubricate pistons with DOT 3 or DOT 4, then press carefully into caliper halves until pistons seat fully (below seals). Difficulty seating pistons indicates seals are not in grooves properly.
14. [] Place transfer-port O-ring into seat in one caliper half.
15. [] Place caliper halves together, then thread in bolts and secure to 90–120in-lbs.
16. [] Thoroughly clean outside of caliper. Alcohol is preferred.
17. [] Install caliper to mounts and gently snug mounting bolts.
18. [] Inspect O-rings on banjo bolt and replace if torn or damaged. Special O-rings are required that are part of a banjo service kit.
19. [] Place banjo fitting on caliper and secure banjo bolt to 55in-lbs.
20. [] Fill and bleed system.
21. [] Install wheel, then align and secure caliper.

LEVER (MASTER CYLINDER) SERVICE

Hayes supports servicing the master cylinder. If a leak develops at the master cylinder (not at the hose), then the lever should be rebuilt. This usually just requires a service kit, but may require replacement of the master cylinder cartridge. An overhaul kit includes a new boot, new bladder, a gasket, and special grease. All new parts should be used when servicing the lever.

1. [] Remove hose from lever (if not servicing whole brake system, fix end of hose pointing up to retain fluid).
 2. [] Unthread 13mm nut where hose came off (do not push in on shaft that nut is threading off).
 3. [] Pry clip of lever-pivot shaft and push out pivot shaft. *Watch for wavy washers sandwiched between lever and lever body!*
 4. [] Use very small slotted screwdriver to thread reach adjuster clockwise until it threads out of brass fitting in lever.
 5. [] Pull master-cylinder cartridge out back end of lever body.
- NOTE: The master cylinder cartridge may come out by itself, or with other pieces. The next step assumes the other pieces have remained in the lever body. If not, remove them in reverse order from the cartridge, instead.*
6. [] Remove cartridge retainer (plastic piece that bleed screw is threaded into) from lever body. Cartridge bladder may come out with cartridge retainer, or may stay inside lever body (remove it).
 7. [] Remove round gasket from inside of lever body where end of cylinder cartridge seated inside body.
 8. [] Remove small shaft boot from small shaft at end of cylinder cartridge.
 9. [] Thoroughly clean lever body and cylinder cartridge (unless being replaced) with alcohol and blow dry with compressed air.
 10. [] Insert cartridge shaft through small hole in shaft boot, making sure boot seats between raised rings on shaft, then seat large end of boot onto cartridge body.
 11. [] Grease shaft boot with special grease supplied with service kit.
 12. [] Insert cartridge into plastic cartridge retainer so cartridge body sticks out retainer the same way as the long plastic prong on retainer points, then seat cartridge into retainer with a "snap."
 13. [] Grease inside edges of both ends of cartridge bladder with special grease, then slide bladder (large-end first) over cartridge.

14. [] Line up oval shape of bladder end with oval shape of plastic cartridge retainer, then seat bladder onto ridges of retainer.
15. [] Seat small end of bladder onto end of cartridge and against ridge on cartridge.
16. [] Rotate cartridge in cartridge retainer so flat on end of cartridge faces same way as long prong on cartridge retainer.
17. [] Place new gasket over end of cartridge.
18. [] Insert cartridge into lever body fully. Check that flat on cartridge has engaged flat inside lever body by trying to rotate exposed end of cartridge. It should not rotate.
19. [] Thread on 13mm nut hex-end first and secure to 55in-lbs.
20. [] Engage brass bushing of lever to threaded shaft at back end of cartridge, then use small slotted screwdriver to thread shaft fully into brass bushing.
21. [] Start lever pivot into lever outer face of lever body, then place wavy washer over shaft once it just protrudes inside lever body.
22. [] Place lever inside lever body, then push lever-pivot shaft partially through lever.
23. [] Place second wavy washer between lever and lever body, then push lever-pivot shaft fully through and push retaining ring onto shaft.
24. [] Put new compression bushing on end of hose, then engage hose nut to lever. Secure hose nut to 40in-lbs, then tighten one full turn more.
25. [] Bleed system.

MAGURA HS SERIES HYDRAULIC RIM BRAKES

The Magura HS series brakes uses three hydraulic cylinders. One master cylinder is located at the brake lever. Hydraulic hose connects the master cylinder with two slave cylinders at the calipers. The brake pads are connected to the slave cylinders. The slaves are connected by hose, which equalizes pressure between the pads.

BRAKE INSTALLATION

Mounting

1. [] Lubricate brake-lever-mounting bolt.
2. [] Align rotational and lateral position of levers similar to other levers, then secure to 35in-lbs.

A 2mm Allen screw for micro-adjustment of the lever is located on the back side of the lever and behind the brake lever pivot. Locate it now. Some models have a knob at the base of the brake lever that is the micro-adjust. These models may not have a reach adjust screw.

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3. [] Loosen micro-adjuster fully counterclockwise.
Some models have a reach-adjustment screw located in front of the lever adjacent to the lever pivot.

4. [] Set brake-lever reach (if adjustable) to customer preference or shop standard.

The calipers consist of two slave cylinders, two cylinder rings, two pair of “Evolution” adapter brackets, two D-washers, one booster plate, two (or four) bracket-clamp bolts (5mm × .8mm), one bracket-mount bolts (6mm × 1mm), one quick-release stud (6mm × 1mm), and one quick-release mechanism.

The adapter brackets are offset, and may be switched from side to side. Changing the adapter brackets moves the cylinders laterally 10mm.

5. [] Treat all adapter-bracket-bolt threads with Loctite 242.
6. [] Install special quick-release stud into braze-on, then secure until shoulder contacts braze-on. (Quick release is mounted on left side of front brake and right side of rear brake.)
7. [] Place D-washer on each braze-on.
8. [] Assemble quick-release unit onto adapter plate.
9. [] Install booster plate on upper adapter bolt.
10. [] Assemble plastic rings over slave cylinders.
11. [] Place slaves between adapter brackets.
12. [] Slide quick-release unit onto bracket.

NOTE: If adapter bracket has adequate clearance to frame, D-washer may not be required. In some cases, more than one washer may be required for bracket to clear frame.

Some models use two 5mm bolts in the adapter bracket. Newer models replace the lower 5mm bolt with a hooking-tab system that holds the front and back evolution pieces together. The next step is written for the two-bolt system, but if the brake you are working with has a single bolt, the different technique required should be easily apparent.

13. [] Position slave cylinders in brackets so both are as far outward as possible.
14. [] Install and gently secure upper and lower 5mm bolts in adapter brackets. (It should still be possible to move slave cylinders in brackets at this point.)
15. [] Loosen both adapter-bracket bracing studs from back of adapter brackets by twisting stud flat with 13mm wrench.
16. [] Position non-quick-release cylinder and adapter plate to braze-on, then thread in 6mm braze-on mounting bolt.
17. [] Snug, but do not secure, all bolts in adapter bracket.
18. [] Put non-quick-release-caliper assembly onto braze-on and install bolt loosely.

19. [] Inspect backside of bracket so that curved portion of adapter bracket does not hit frame. (If clearance problem occurs, use supplied D-shaped washers to gain clearance. Flats on washers face up.)
20. [] Place lever of quick release in down (open) position, then slide other caliper onto braze-on fitting.
21. [] Pull upward on lever, which should be set too tight at this time.
22. [] Loosen quick-release stud 1/4 turn and attempt to close lever. Repeat until lever is properly set. Lever should have resistance through last half of swing, and should be pushed fully against cylinder. Lever must be parallel to adapter brackets.

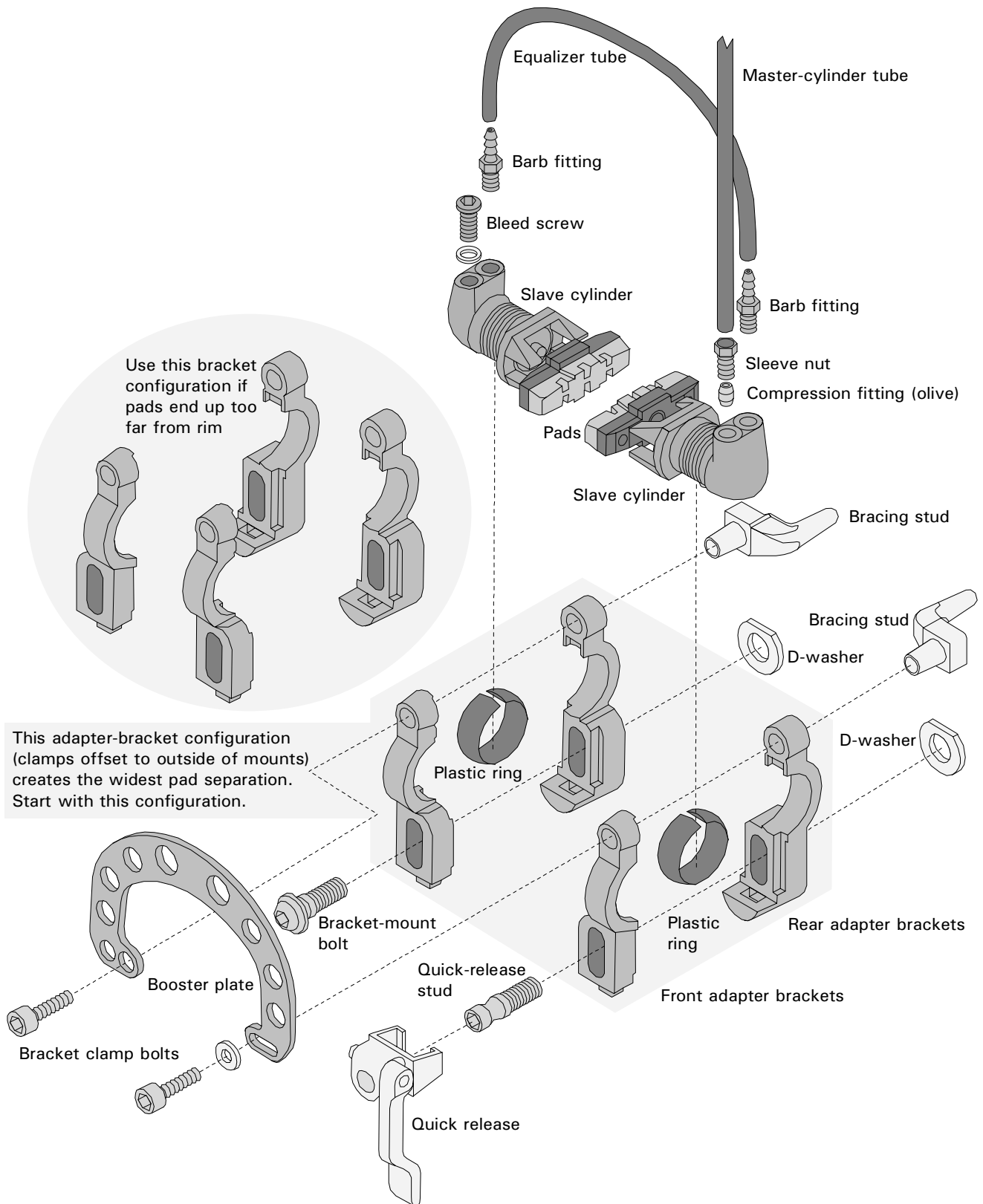
Bracket Adjustment

23. [] Install and center wheel to < 1mm difference between rim and each stay.
24. [] Loosen all bracket bolts, mounting bolts, and QR (if any),
25. [] Align each bracket to that it’s inside face is at same angle as braking surface of rim, then secure mounting bolt (or QR) to hold each in position (brackets should be symmetrical).
26. [] Rotate bracing stud on non-QR side up or down until it contacts stay or fork blade (while maintaining bracket alignment), then secure upper bolt to 35in-lbs.
27. [] Engage brake booster (arch) to upper bolt of non-QR bracket. It may be necessary to try both mounting holes in booster to keep from misaligning QR bracket.
28. [] Rotate second bracing stud up or down to match the first one, so that it contacts stay or fork blade while angle of bracket is maintained, then secure upper bolt to 35in-lbs.

Pad Adjustment

29. [] On each side of rim, clean a 3" section with alcohol, and fix a 2mm stack of Post-it Notes to cleaned section of rim so that top edge of each stack is tangent to rim.
30. [] Use a bungee cord to fix wheel rotation so stacks of Post-it Notes are between rim and brake pads.
31. [] Loosen all bolts (or bolts and QR) in one bracket, then push in on cylinder while pulling out on bracket until pad face contacts Post-its. **NOTE: DO NOT PUSH CYLINDER ENOUGH TO DEFLECT RIM!**
32. [] Align cylinder so pad is flush to Post-Its and tangent to rim, then secure clamp bolt(s) to 35in-lbs. and secure QR (or mounting bolt to 60in.lbs.) *Note: Pad height may be approximate at this time.*
33. [] Repeat steps 31–32 for other side.
34. [] Rotate rim and remove Post-its.

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37.2 Magura HS series hydraulic rim brake and lever.

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35. [] Operate brake and check both pad heights. If necessary, loosen mounting bolt or QR on each side and adjust pad heights to be fully contacting brake surface and symmetrical with each other.
36. [] Use micro-adjuster to adjust pad clearance to 2mm per side, or customer preference.

ROUTING AND SIZING HYDRAULIC HOSE

Magura uses 5mm O.D. hose. The hose secures to both the brake lever and the caliper slave cylinder with compression fittings. Slave cylinders are connected with the barbed fitting (like a fish-hook barb — a fitting that slides into the hose, but bites into the hose to resist sliding out).

1. [] Loosen compression fitting counterclockwise using 8mm wrench.
2. [] Place rag over caliper and pull hydraulic hose from caliper, then remove sleeve nut and compression ring. (It is always recommended to use new compression ring when servicing hydraulic line.)
3. [] Route hose as short as possible, however use care not to stress hose at either fitting. (Full-suspension bikes may require excess hose to allow for movement of rear stays. Route to avoid abrasions or rubbing of hose.)
4. [] Cut hose with Magura hose cutter #431-880, or very sharp knife. Do not use diagonal cutters. Clean cut is required for good hydraulic seal.
5. [] Install sleeve nut onto hose with threads toward cut end, then install new compression ring onto hose. (Rounded side of ring faces cut end of hose.)
6. [] Slide compression ring to within 3mm of end of hose, then place in caliper and thread in sleeve nut.
7. [] Secure sleeve nut to 40in-lbs.
8. [] If necessary, barbed fittings may be removed using 8mm wrench.
9. [] To press barbed fitting into hose, secure hose vertically in vise using Magura installer clamps #431 883. (Place approximately 20mm of hose above clamps.)
10. [] Place barbed fitting with threaded-side upward and barbed-side facing into hose.
11. [] Tap fitting with plastic mallet until hose is flush with shoulder of fitting. (Note: Magura tool "Intruder" is press that installs hose into barbed fittings.)
12. [] Secure barbed fittings to 24in-lbs. (Barbed fitting will rotate inside hose to allow threaded end to secure.)

FILLING AND BLEEDING MASTER AND SLAVE CYLINDERS

Note: Never use automotive or motorcycle brake-cylinder fluids. These fluids will damage seals and hydraulic hose of Magura system.

Use Magura Aseol Terra 60-789 brake fluid or any bicycle-suspension fluid.

The Magura bleeding kit comes with two pieces of hose that have the barbed fittings attached. The shorter piece needs to be attached to the tip of the syringe. It will be a lot easier to thread the syringe into the caliper if the hose is cut to three inches.

1. [] Back out reach-adjuster and micro-adjuster fully.
2. [] Attach short piece of hose with barbed fitting to tip of syringe.
3. [] Insert tube on syringe into container of fluid and pull out on syringe plunger to fill syringe with hydraulic fluid.
4. [] Hold syringe pointing up, let air bubbles float to top, then depress syringe plunger to push all air out of syringe.
5. [] Remove bleed screw at caliper.
6. [] Thread barbed fitting on end of syringe into bleed screw hole in caliper.
7. [] Remove bleed screw at lever.
8. [] Screw waste line (other longer tube with barbed fitting) into bleed screw hole in lever.
9. [] Depress syringe plunger to push fluid through system until clean fluid and no more air bubbles are coming out of lever into waste line.
10. [] Remove waste line from lever.
11. [] Replace bleed screw in lever with new washer.
12. [] Remove syringe assembly from caliper.
13. [] Repeat steps 2–12 if syringe empties before air and old fluid are pumped out of system.
14. [] Replace bleed screw in caliper with new washer.
15. [] Operate brake system and inspect for leaks at bleed screws and all other fittings.

NOTES ON SERVICING

Brake pads are removed by pulling the pad from the cylinder. Remove the wheel to access pads. New pads install by snapping them onto the stud in the slave cylinder. Color codes designate pad compound hardness: clear is softest, black is medium, and gray is hardest.

In very cold climates, lighter-viscosity fluid will work best. Use low-viscosity bicycle-suspension fluids.

Special routing is possible using two fittings in the brake levers. One lever may be made to operate both front and rear calipers. Alternatively, two levers may be made to operate same caliper.

MAGURA GUSTAV M DISC BRAKE

ABOUT THIS SECTION

This section specifically covers the Magura Gustav M disc-brake system. The procedures covered in this section include wheel-building guidelines, rotor and wheel installation, lever installation, hose installation, filling and bleeding the system, caliper installation, and pad replacement. This section does not cover rebuilding the caliper, which Magura does not support.

TOOLS

No special tools are required for normal installation and adjustment. Hose replacement and bleeding and filling the system requires a syringe, a bleed fitting, a hose, and a tool for holding the hose when installing the barbed fitting, all of which are part of the Gustav Service Kit.

INSTALLATION

Wheel building guidelines

The recommended cross patterns are limited to 3X and 4X. Deceleration can occur much more rapidly than acceleration, so consequently the torsional loads from deceleration are much higher than those generated during acceleration. The recommended cross patterns are required to transfer the higher torsional loads that hub-mounted brakes can generate during rapid deceleration.

Although Magura makes no recommendation regarding lacing patterns, other manufacturers require that the left-side head-out spokes radiate clockwise from the hub and that the right-side head-in spokes radiate counterclockwise from the hub. These are the same directions that result from following the wheel-lacing instructions in this manual. The vernacular terms for these patterns are that the “pulling” spokes are “head out” and the “pushing” spokes are “head in.” An alternate term to “pulling” is “trailing” and an alternate term to “pushing” is “leading.”

Rotor and wheel installation

Prior to the 2000 model year, the Gustav M rotor is compatible only with the Gustav M hub and Mavic Crossmax or CrossLink wheels, but not other Magura hubs or International Standard disc-brake hubs. As of the 2000 model year, the Gustav M brake is fully compatible with International Standard hubs.

NOTE: Build wheel before installing rotor.

1. [] Place rotor on hub with rotation arrow facing out from hub. Two-piece rotors should be installed with smooth rivet heads facing out.
2. [] If rotor-mounting bolts are being reused, treat threads with Loctite 242 (not needed for first-time installation).
3. [] Thread in all six rotor bolts until heads just contact rotor.
4. [] Use marker to mark each bolt clockwise 1 to 6, then tighten each to 35in-lbs in a sequence of 1, 4, 2, 5, 3, then 6.

It is recommended that the quick-release skewer be installed opposite of normal. This insures that the quick-release lever, when fully closed, cannot interfere with the rotor. Although quick-release security is always of critical importance, wheel security is an even greater issue on a disc-brake hub than a hub with no brake. When securing the skewer, be sure to follow the guidelines in Chapter 18.

5. [] Install quick-release skewer into right end of axle (opposite of normal) then install adjusting nut on skewer.
6. [] Install wheel in proper alignment and with optimum quick-release security.

Brake lever installation

7. [] Install brake lever in normal lateral and rotational position, then secure mounting bolts to 35in-lbs.
8. [] Adjust reach with 2mm Allen screw (at lever pivot) to middle of range (approximately two turns from either end of range). *Note: reach adjustment doesn't affect clearance adjustment or brake operation—this adjustment is only to make reach appropriate for average-sized hands.*

Caliper installation and adjustment

The caliper assembly consists of two basic parts, the caliper mount and the caliper. The caliper mount has two threaded holes that the bolts that go through the frame or fork mounting holes. There is a smooth stud fixed to the caliper mount that goes through a hole in the caliper, and a smooth stud fixed to the caliper that goes through a hole in the caliper mount.

There are several models of caliper mounts available. A bolt threaded into the end of the smooth stud fixed to the caliper mount retains the caliper to the mount. This bolt can be removed to separate the two. It should be reinstalled with Loctite #222 and torqued to 26in-lbs.

The caliper mount floats side-to-side on the two smooth studs. This floating design allows the caliper to move laterally to accommodate rotor wobble. Observe that there is a slot in the caliper mount that coincides with the slot between the two brake pads in the caliper.

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The Gustav M brake has no adjustments for pad clearance. It is not problematic if it rubs lightly at times, similar to motorcycle and automotive disc brakes.

NOTE: For frames or forks with Hayes-type post mounting (bolt holes aligned parallel to bike, rather than perpendicular to bike), an adapter plate must be mounted first. Install adapter and secure bolts to 55–70in-lbs.

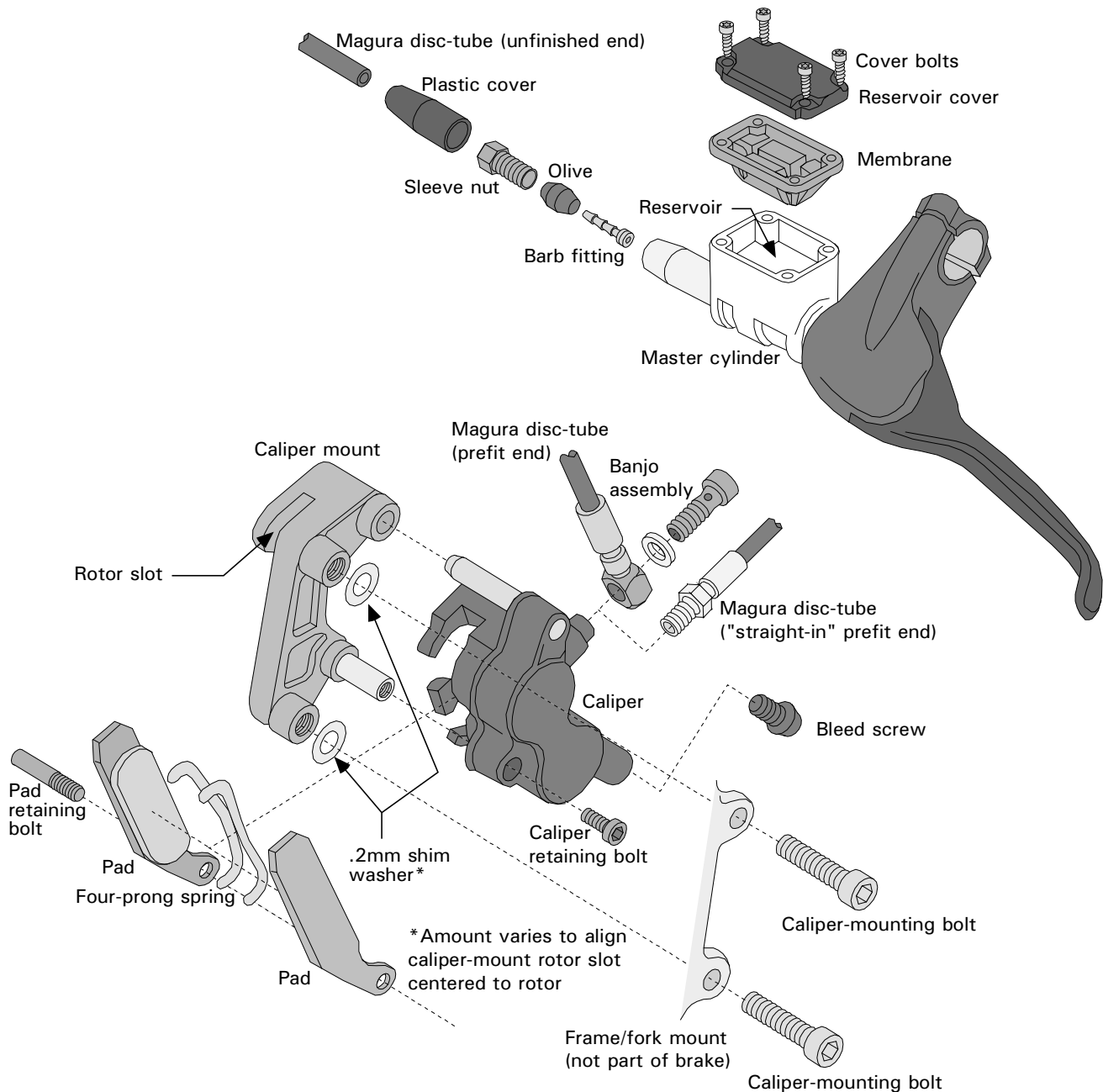
9. [] Remove plastic pad spacer (if any) from between brake pads, then slide caliper over rotor and align bolt holes in caliper with mounting holes of fork or frame.

10. [] If caliper-mounting bolts are being reused, treat threads with Loctite 242 (not needed for first-time installation).

11. [] Install and gently snug caliper-mounting bolts. Check clearance between rotor and slot in caliper mount. Rotor should be centered in slot. If rotor is closer to inside edge of slot, adjust clearance by remounting caliper with .2mm shim washer between caliper and each fork/frame mount. then check centering again.

12. [] Once centering is adequate, secure caliper-mounting bolts to 50in-lbs.

13. [] Secure hose to frame and/or fork, then turn handlebars and/or move suspension through its full range to check for interference with hose.



37.3 Magura Gustav M hydraulic disc brake caliper and lever.

PAD REPLACEMENT

The pads have “ears” at the end of the caliper opposite the hose. A shaft goes through the ears, which retains the pads in the caliper. With the brake operated to close the pads firmly to the rotor, measure the distance between the ears. If the measurement is 4.8mm or less, the pads must be replaced. With fresh pads in the caliper, this measurement is about 6.8mm. Remaining pad life can be estimated by calculating the reduction of the current measurement from the original 6.8mm as a percentage of the 2mm total wear life. In other words, if the current measurement is 5.8mm (1mm reduction from 6.8mm), then the pads have 50% of their life remaining (1mm is 50% of 2mm).

1. [] Remove wheel, then unthread bolt through ends of pad plates with 2mm Allen wrench.
2. [] Remove pads and four-prong spring out rotor slot in inner edge of caliper.
3. [] Clean inside caliper at piston with water and detergent on brush. **CAUTION: Don't use automotive brake cleaners, seal damage will occur!**
4. [] Assemble replacement pads and four-prong spring so braking-material sides face each other and spring is sandwiched between them, with prongs contacting metal plates (not contacting surface of braking material). When properly assembled, tips of spring prongs point to edge of pads that pad ears angle away from.
5. [] Install pad assembly into caliper slot so closed end of spring goes in first and ear-ends of pads are at end of caliper opposite where hydraulic hose attaches.
6. [] Treat pad-retaining bolt threads with Loctite 222.
7. [] Install pad-retaining bolt through hole in inner face of caliper and through holes in ears of pads, then secure bolt to 9in-lbs.
8. [] Face backside of caliper, put your thumbs into access holes on back face of caliper, then press firmly against inner brake shoe. This causes slave pistons to retract fully into caliper, which allows adequate clearance for the rotor.
9. [] Install wheel.

HOSE INSTALLATION AND SIZING

If the caliper hose is damaged, too short, or too long, then it is necessary to install a new hose or re-size the existing hose. The same procedure suffices for both. A hose is too short if it must bend sharply at any time. A hose is too long only if it interferes with other components or snags on things during use of the bicycle. Performance of the brake system is not affected by hose length.

1. [] Slide plastic sleeve on lever-end of hose away from brake lever, then unthread 8mm hose fitting from brake lever. It may be necessary to remove brake lever from handlebar if hose twists with fitting.
2. [] Only if replacing hose, unthread bolt through banjo fitting (or hex-fitting built into end of hose) at brake caliper.
3. [] Only if replacing hose, install bolt (with new washer) through banjo fitting (or thread in hex fitting built into end of hose) and secure to 35in-lbs. **Note: Use only hoses marked “Magura disc-tube.”**
4. [] Route hose to lever and decide on appropriate length. Use Magura hose cutter or sharp razor knife to trim hose to desired length. End should be cut as square as possible.
5. [] Place plastic fitting cover (small-end first), sleeve nut (hex-end first), then new Magura olive fitting (black, never brass) onto cut end of hose.
6. [] Press hose into slot in red tool (part of service kit) so approximately 20mm of hose extends past tool, then insert new barbed fitting into hose until fitting head contacts hose. If installation is difficult, sandwich red tool and hose in soft jaws of vise and tap barbed fitting in with plastic mallet.
7. [] Insert end of hose into hole in brake lever, then hand thread sleeve nut into brake lever.
8. [] After installing sleeve nut as far as possible by hand, secure nut to 35in-lbs.
9. [] Perform FILLING AND BLEEDING procedure.

FILLING AND BLEEDING

Filling and bleeding are normally done as part of hose replacement or sizing. Magura does not recommend filling and bleeding as routine maintenance.

CAUTION: At all times while working with oil, it is critical to keep oil off rotor surface and brake pads!

1. [] Remove wheel from bike.
2. [] Remove both brake pads.
3. [] Put bike in position so that head of bleed screw (at opposite end of caliper from hose) is at top of caliper.
4. [] Remove bleed screw with 5mm Allen wrench.
5. [] If necessary, attach hose and 6mm-thread bleed fitting to syringe, then fill syringe with Magura Blood hydraulic oil. With syringe upright, pump until all air bubbles are out of syringe and bleed hose. Other mineral oils such as Finish Line 5wt suspension oils are also suitable.
6. [] Thread bleed fitting into caliper where bleed screw was removed and gently secure fitting.

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7. [] Position bike and/or brake lever so that reservoir cap on face of brake lever is completely horizontal.
8. [] Use T7 Torx wrench to remove 4 bolts that retain reservoir cap, then remove cap and rubber membrane.
9. [] Slowly pump syringe contents into system, being prepared to catch overflow at lever. Continue pumping until no air bubbles are seen in reservoir.
10. [] Place rubber membrane into bottom face of reservoir cap, then insert four bolts into reservoir cap.
11. [] Place reservoir-cap assembly on top of lever so that overflow hole in edge of reservoir cap will be at top edge of cap when brake lever is in normal position.
12. [] Gradually tighten 4 bolts in crisscross pattern until all are tight to equivalent of 5in-lbs.
13. [] Return bike to position that puts caliper in same position as when bleed screw was removed, then unthread bleed fitting from caliper.
14. [] Install bleed screw into caliper and secure to 51in-lbs.
15. [] Clean caliper of any oil, then install brake pads and wheel.
16. [] Operate brake and check for soft or spongy feel and leaks at hose fittings and bleed screw. Repeat bleeding procedure if brake feels soft or spongy.

MAGURA LOUISE & CLARA DISC BRAKES

ABOUT THIS SECTION

This section specifically covers the Magura Louise and Clara disc-brake systems. Service techniques are identical for both systems. The procedures covered in this section include wheel building guidelines, rotor and wheel installation, lever installation, hose installation, filling and bleeding the system, caliper installation, and pad replacement. This section does not cover rebuilding the caliper, which Magura does not support.

TOOLS

No special tools are required for normal installation and adjustment. Hose replacement and bleeding and filling the system requires a syringe, a bleed fitting, hose, and a tool for holding the hose when installing the barbed fitting, all of which are part of the Louise Service Kit.

INSTALLATION

Wheel building guidelines

The recommended cross patterns are limited to 3X and 4X. Deceleration can occur much more rapidly than acceleration, so consequently the torsional loads from deceleration are much higher than those generated during acceleration. The recommended cross patterns are required to transfer the higher torsional loads that hub-mounted brakes can generate during rapid deceleration.

Although Magura makes no recommendation regarding lacing patterns, other manufacturers require that the left-side head-out spokes radiate clockwise from the hub and that the right-side head-in spokes radiate counterclockwise from the hub. These are the same directions that result from following the wheel-lacing instructions in this manual. The vernacular terms for these patterns are that the “pulling” spokes are “head out” and the “pushing” spokes are “head in.” An alternate term to “pulling” is “trailing” and an alternate term to “pushing” is “leading.”

Rotor and wheel installation

If installing the rotor on a 1999 Magura Gustav hub or Mavic Crossmax or CrossLink wheels, use the 3mm-thick spacer between the rotor and the hub. If using a Magura Louise Pro or Louise Comp hub, no spacer is needed behind the rotor.

NOTE: *Build wheel before installing rotor.*

1. [] Place rotor on hub with rotation arrow facing out from hub.
 2. [] If rotor-mounting bolts are being reused, treat threads with Loctite 242 (not needed for first-time installation).
 3. [] Thread in all six rotor bolts until heads just contact rotor.
 4. [] Use marker to mark each bolt clockwise 1 to 6, then tighten each to 35in-lbs in a sequence of 1, 3, 5, 2, 4, then 6.
- It is recommended that the quick-release skewer be installed opposite of normal. This insures that the quick-release lever, when fully closed, cannot interfere with the rotor. Although quick-release security is always of critical importance, wheel security is an even greater issue on a disc-brake hub than a hub with no brake. When securing the skewer, be sure to follow the guidelines in Chapter 18.
5. [] Install quick-release skewer into right end of axle (opposite of normal) then install adjusting nut on skewer.
 6. [] Install wheel in proper alignment and with optimum quick-release security.

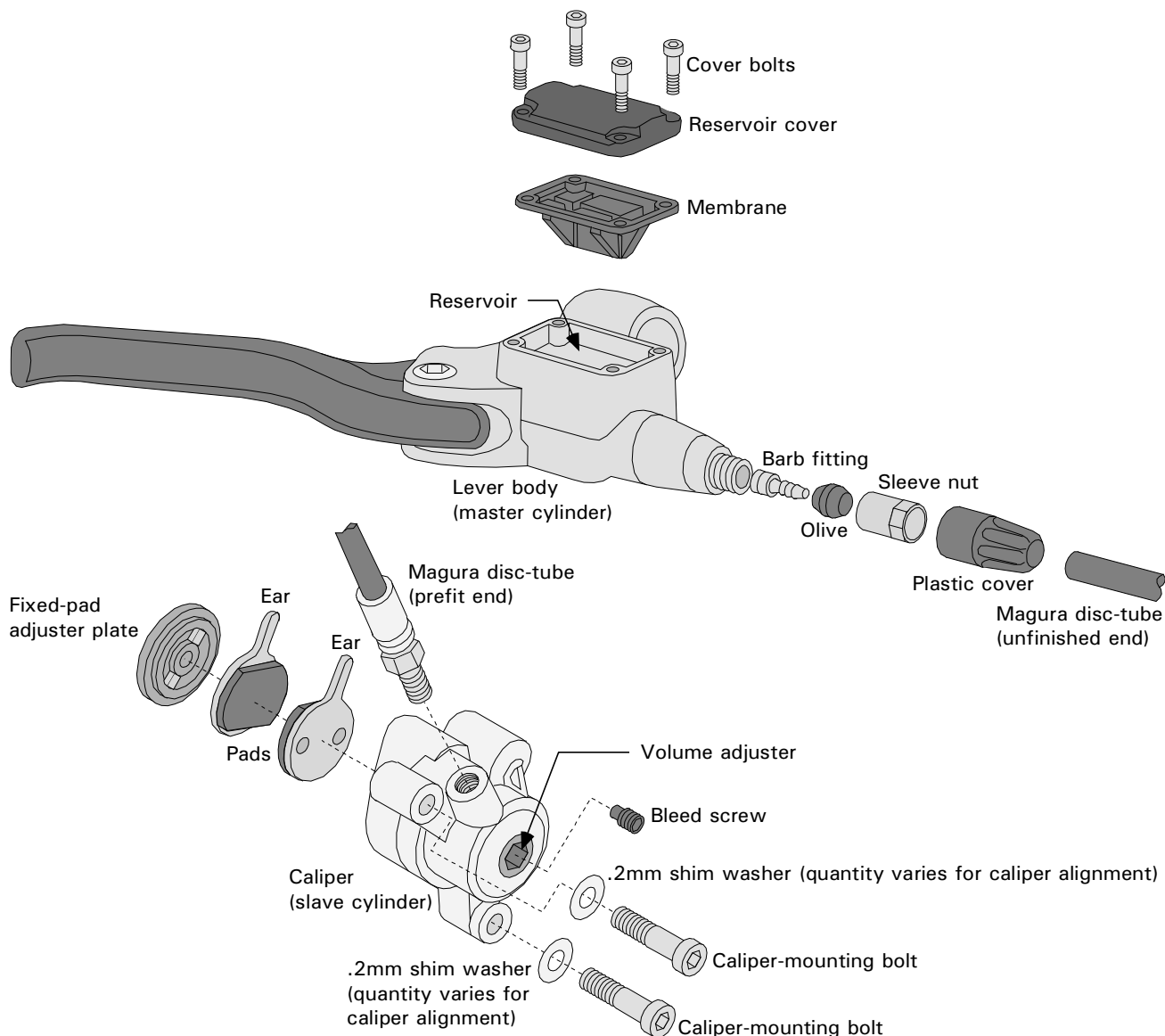
Brake lever and hose installation

7. [] Install brake lever in normal lateral and rotational position, then secure mounting bolt to 35in-lbs.
8. [] Adjust reach with 2mm Allen screw (at lever pivot) to middle of range (approximate two turns from either end of range). *Note: reach adjustment does not affect clearance adjustment or brake operation—this adjustment is only intended to make reach appropriate for average-sized hands.*

Caliper installation and adjustment

NOTE: For frames or forks with Hayes-type post mounting (bolt holes aligned parallel to bike, rather than perpendicular to bike), an adapter plate must be mounted first. Install adapter and secure bolts to 55–70in-lbs.

9. [] Loosen volume-adjusting bolt on outer face of caliper fully with 5mm Allen wrench.
10. [] Remove fixed-shoe adjusting plate from inside face of caliper with 5mm Allen wrench, treat threads with Loctite 242, then install plate until face is just flush with inner face of caliper.
11. [] Remove plastic pad spacer (if any) from between brake pads, then slide caliper over rotor and align bolt holes in caliper with mounting holes of fork or frame.
12. [] If caliper-mounting bolts are being reused, treat threads with Loctite 242 (not needed for first-time installation).
13. [] Install and gently snug caliper-mounting bolts. Check clearance between rotor and inner edge of caliper slot (spin rotor). If there is contact, remount caliper with a .2mm shim washer between caliper and each fork/frame mount and check for rub again.



37.4 Magura Louise hydraulic disc brake caliper and lever.

14. [] Once clearance is adequate, secure caliper-mounting bolts to 50in-lbs.
15. [] With wheel stationary, turn fixed-shoe adjusting plate on inner face of caliper clockwise just until gap between pad and rotor disappears, then loose just enough to see gap again. Spin wheel and check for rub. If rub occurs, loosen adjusting plate a tiny amount and check again.
16. [] With wheel spinning, slowly tighten volume-adjusting bolt on outer face until slight rub is heard, then loosen bolt just enough to eliminate rub.
17. [] Operate brake several times, then spin wheel to check for rub. If rub persists, only the volume adjusting bolt needs to be loosened.
18. [] Secure hose(s) to frame and/or fork, then turn handlebars and/or move suspension through its full range to check for interference with hose(s).

PAD REPLACEMENT

The pads have “ears” which protrude out a small slot in the outer edge of the caliper (opposite the slot for the rotor). With the brake operated to close the pads firmly to the rotor, measure the distance between the ears. If the measurement is 4mm or less, the pads must be replaced. With fresh pads in the caliper, this measurement is about 6.5mm. Remaining pad life can be estimated by calculating the reduction of the current measurement from the original 6.5mm as a percentage of the 2.5mm total wear life. In other words, if the current measurement is 5.25mm (1.25mm reduction from 6.5mm), then the pads have 50% of their life remaining (1.25mm is 50% of 2.5mm).

1. [] Remove wheel, then unthread fixed-pad adjusting plate from inner face of caliper.
2. [] Pull both pads out hole where adjusting plate was removed. A magnet can be used.
3. [] Clean inside caliper around piston with water and detergent on brush. **CAUTION: Do not use automotive brake cleaners! Seal damage will occur!**
4. [] Install first pad so braking material faces you and the pad “ear” goes out slot in outer edge of caliper.
5. [] Install second pad so braking material faces away from you and pad “ear” goes out slot in outer edge of caliper.
6. [] Loosen volume-adjusting bolt on outer face of caliper fully with a 5mm Allen wrench.
7. [] Treat threads of fixed-shoe adjusting plate with Loctite 242, then install plate until face is just flush with inner face of caliper.
8. [] Install wheel, then perform steps 15–17 of *Caliper installation and adjustment*.

HOSE INSTALLATION AND SIZING

If the caliper hose is damaged, too short, or too long, then it is necessary to install a new hose or re-size the existing hose. The same procedure suffices for both. A hose is too short if it must bend sharply at any time. A hose is too long only if it interferes with other components or snags on things during use of the bicycle. Performance of the brake system is not affected by hose length.

1. [] Fully loosen volume-adjusting bolt in outer face of caliper with 5mm Allen wrench.
2. [] Slide plastic sleeve on lever-end of hose away from brake lever, then unthread 8mm hose fitting from brake lever. It may be necessary to remove brake lever from handlebar if hose twists with fitting.
3. [] Only if replacing hose, unthread hose fitting from brake caliper.
4. [] Only if replacing hose, thread end of hose with pre-installed fitting into caliper and secure to 35in-lbs. **Note: Use only hoses marked “Magura disc-tube.”**
5. [] Route hose to lever and decide on appropriate length. Use Magura hose cutter or sharp razor knife to trim hose to desired length. End should be cut as square as possible.
6. [] Place plastic fitting cover (small-end first), sleeve nut (hex-end first), then new Magura olive fitting (black, never brass) onto cut end of hose.
7. [] Press hose into slot in red tool so approximately 20mm of hose extends past tool, then insert new barbed fitting into hose until fitting head contacts hose. If installation is difficult, sandwich red tool and hose in soft jaws of vise and tap barbed fitting in with plastic mallet.
8. [] Insert end of hose into hole in brake lever, then hand thread sleeve nut into brake lever.
9. [] After installing sleeve nut as far as possible by hand, secure nut to 35in-lbs.
10. [] Perform FILLING AND BLEEDING procedure.

FILLING AND BLEEDING

Filling and bleeding are normally done as part of hose replacement or sizing. Magura does not recommend filling and bleeding as routine maintenance.

CAUTION: At all times while working with oil, it is critical to keep oil off rotor surface and brake pads!

1. [] Remove wheel from bike.
2. [] Remove fixed-pad adjusting plate from inner face of caliper, then remove both brake pads.
3. [] Put bike in position so that outer face of caliper is pointing straight up.
4. [] Loosen volume-adjusting bolt in outer face of caliper fully with 5mm Allen wrench.

5. [] Use 2mm Allen wrench to remove bleed screw from center of volume-adjusting bolt.
6. [] If necessary, attach hose and bleed fitting to syringe, then fill syringe with Magura Blood hydraulic oil. With syringe upright, pump until all air bubbles are out of syringe and bleed hose. Other mineral oils such as Finish Line 5wt suspension oils are also suitable.
7. [] Thread bleed fitting into caliper where bleed screw was removed.
8. [] Position bike and/or brake lever so that reservoir cap on face of brake lever is completely horizontal.
9. [] Use 2mm Allen wrench (T7 Torx wrench for Clara model) to remove 4 bolts that retain reservoir cap, then remove cap and rubber membrane.
10. [] Slowly pump syringe contents into system, being prepared to catch overflow at lever. Continue pumping until no air bubbles are seen in reservoir.
11. [] Place rubber membrane in bottom face of reservoir cap, then insert four bolts into reservoir cap.
12. [] Place reservoir-cap assembly on top of lever so that overflow hole in edge of reservoir cap will be at top edge of cap when brake lever is in normal position.
13. [] Gradually tighten 4 bolts in crisscross pattern until all are tight to equivalent of 5in-lbs.
14. [] Return bike to position that puts face of caliper pointing up, then unthread bleed fitting from caliper.
15. [] Install bleed screw into caliper and secure to 8in-lbs.
16. [] Install wheel, then install pads and adjust clearance as per steps 3–8 of PAD REPLACEMENT.
17. [] Operate brake and check for soft or spongy feel and leaks at hose fittings and bleed screw. Repeat bleeding procedure if brake feels soft or spongy.

SHIMANO DISC BRAKE

ABOUT THIS SECTION

This section specifically covers the Shimano Deore XT M755 disc brake system. The procedures covered in this section include wheel-building guidelines, rotor and wheel installation, lever installation, hose installation, filling and bleeding the system, caliper installation, and pad replacement. This section does not cover rebuilding the caliper, which Shimano does not support. There are four bolts holding the two caliper halves together, but nothing can be accomplished by separating the halves.

INSTALLATION

Wheel building guidelines

Shimano specifies the cross pattern to be used when building a wheel with their disc-brake hub, and also specifies which way the pulling and pushing spokes should radiate.

The recommended cross patterns are limited to 3X and 4X. Deceleration can occur much more rapidly than acceleration, so consequently the torsional loads from deceleration are much higher than those generated during acceleration. The recommended cross patterns are required to transfer the higher torsional loads that hub-mounted brakes can generate during rapid deceleration. Shimano will not warranty failures when other cross patterns are used!

Shimano additionally requires that the left-side head-out spokes radiate clockwise from the hub and that the right-side head-in spokes radiate counterclockwise from the hub. These are the same directions that result from following the wheel lacing instructions in this manual. The vernacular terms for these patterns are that the “pulling” spokes are “head out” and the “pushing” spokes are “head in.” An alternate term to “pulling” is “trailing” and an alternate term to “pushing” is “leading.”

Rotor and wheel installation

Shimano makes a 160mm rotor and a 170mm rotor. The 160mm size fits most configurations, but when using the adapter plate on a Hayes-type post mounting on a front fork, the 170mm size is required.

NOTE: Build wheel before installing rotor.

1. [] Place rotor on hub with rotation arrows facing out from hub.
2. [] If rotor-mounting bolts are being reused, treat threads with Loctite 242 (not needed for first-time installation).
3. [] Place a tightening plate (thin plate shaped somewhat like a chain-link plate) over each pair of holes with flat side of each plate against rotor.
4. [] Thread in all six rotor bolts until heads just contact tightening plates.
5. [] Use marker to mark each bolt clockwise 1 to 6, then tighten each to 20–35in-lbs in a sequence of 1, 4, 3, 6, 2, then 5.

In the next step, the tightening plates are bent so that they work as a lock to prevent accidental loosening of the rotor bolts. If removing a rotor, it will be necessary to flatten the plate again before loosening a bolt. Repeated installation and removal of the rotor is likely to necessitate replacement of the tightening plates.

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6. [] Pry under raised edge of each tightening plate to fold plate up against one flat of each triangular bolt head.

Shimano recommends the quick-release skewer be installed opposite of normal. This insures that the quick-release lever, when fully closed, cannot interfere with the rotor. Although quick-release security is always of critical importance, wheel security is an even greater issue on a disc-brake hub than a hub with no brake. When securing the skewer, be sure to follow the guidelines in Chapter 18.

7. [] Install quick-release skewer into right end of axle (opposite of normal) then install adjusting nut on skewer.
8. [] Install wheel in proper alignment and with optimum quick-release security.

Brake lever and hose installation

9. [] Install brake lever in normal lateral and rotational position, then secure mounting bolt to 55–70in-lbs.
10. [] Adjust reach with 2mm Allen screw (at lever pivot) to middle of range (approximate six turns from either end of range). *Note: reach adjustment does not affect clearance adjustment or brake operation—this adjustment is only intended to make reach appropriate for average-sized hands.*
11. [] Check for O-rings in recess in each face of banjo fitting at each end of hose. O-rings should not protrude.
12. [] Slide rubber cover over banjo fitting at one end of hose.
13. [] Place covered banjo fitting over hole at inner end of brake-lever body, then thread in hollow bolt finger tight (do not secure). Check for protruding O-ring and correct.
14. [] With bike in on-ground position (axles equal height), align banjo fitting at lever to point straight down, then secure banjo-fitting bolt to 45–60in-lbs. Check for protruding O-ring again and correct.
15. [] Attach other banjo fitting to caliper and install but do not secure bolt. Check for protruding O-ring and correct.
16. [] Rotate banjo fitting at caliper to point away from caliper and to be parallel to plane of rotor slot (in or out 10° is acceptable), then secure to 45–60in-lbs. Check for protruding O-ring and correct.

Filling system with oil

This segment of the procedure describes both filling a new (empty) system, flushing and refilling a used system, and bleeding a system. Certain steps, as noted, apply to a limited number of these alternate proce-

dures. In step #17, the reservoir cover is removed. If the system is used, at this point inspect the brake fluid. If it is dark and discolored, it should be replaced.

CAUTION: At all times while working with oil, it is critical to keep oil off rotor surface and brake pads!

17. [] Position bike so plate on top of brake-lever reservoir is completely flat and parallel to ground, then remove reservoir cover-plate screws, metal cover, plastic cover, then rubber diaphragm.
18. [] Arrange hose and caliper so they dangle straight down from lever, without bends or kinks in the hose, with room for a waste-oil receptacle below. *Note: if bleeding an already-installed system, remove caliper and install pad spacer between pads!*
19. [] *Only if filling empty system:* Turn bleed valve 1/8 turn counterclockwise to open.
20. [] Flip rubber cap off bleed valve on caliper, then attach plastic tubing to bleed-valve nipple and route tubing to waste receptacle.
21. [] *Only if flushing and refilling system:* Open bleed valve 1/8 turn, pump brake lever repeatedly to clear oil from system, then allow several minutes for draining to complete.
Shimano recommends only using Shimano Mineral Oil in the brake at the time of this writing. In the following steps where oil is mentioned, it is assumed the recommended oil is being used. Shimano Mineral Oil comes in a one-use size container to eliminate concerns about contamination. Mineral oil (Shimano or other) that is left open can absorb moisture from the air, which can vaporize when the brake reaches high temperature. Do not use any mineral oil that is possibly contaminated with moisture!
NOTE: In the next step, it is critical to not allow the reservoir to become empty to keep from introducing air into the system!
22. [] *Only if filling empty system:* Fill reservoir with mineral oil, then compress brake lever repeatedly to prime system with oil, adding oil as necessary to keep reservoir full. Stop when oil is seen in plastic tubing and close bleed valve.
23. [] Compress brake lever repeatedly and watch for air bubbles rising in reservoir. Stop for a minute or two, then repeat. No further repetition is needed when bubbles cease to rise.
24. [] Compress brake lever firmly with Quick-Grip clamp or similar device.
25. [] Open and close bleed valve repeatedly for 1/2 second intervals (1/8 turn each time), watching for air bubbles in plastic tubing. Repeat two more times, or until no air bubbles are seen, then leave bleed valve closed. Remove clamp from lever.

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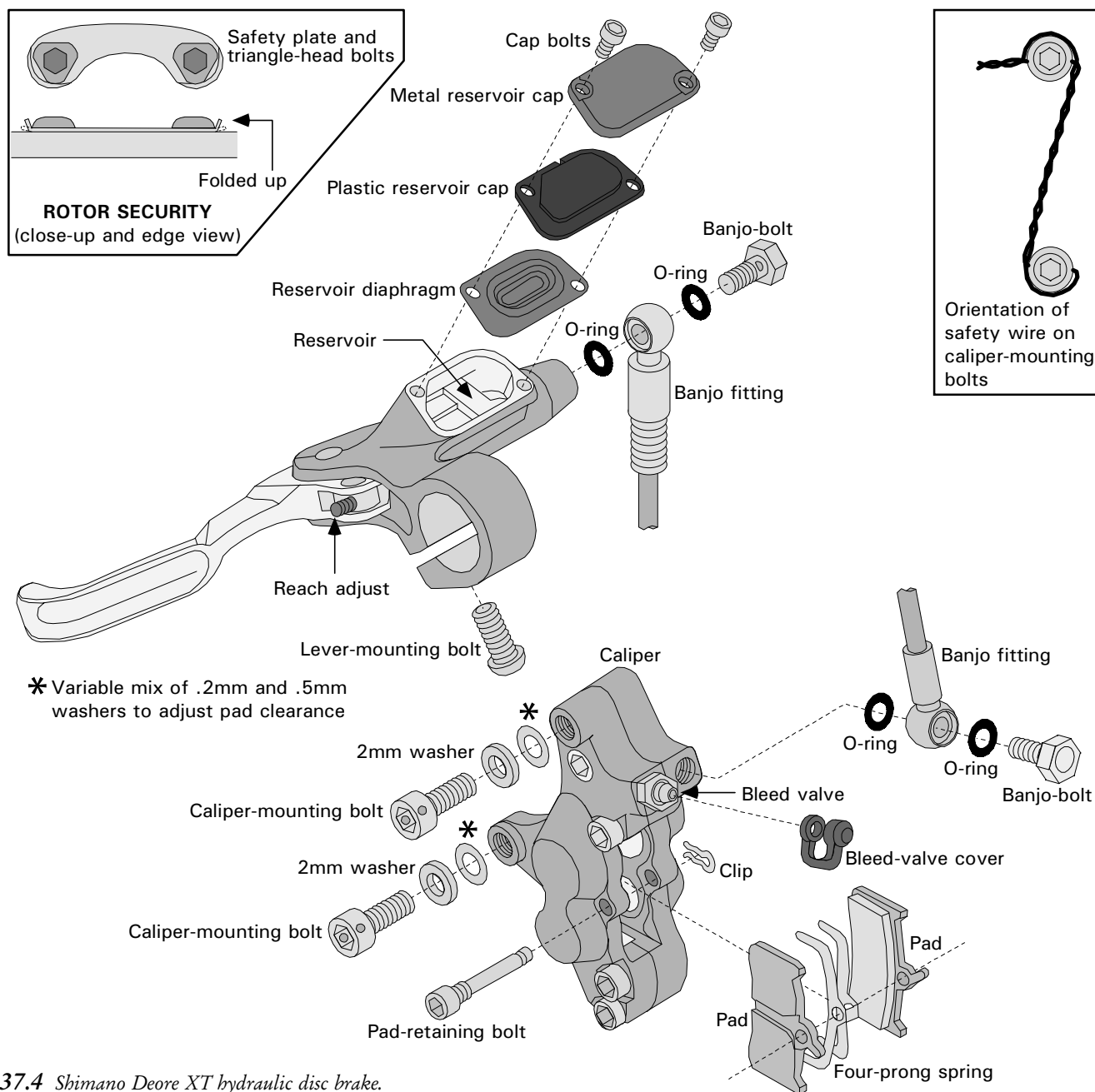
26. [] Move caliper to location where overflowing oil from brake-lever reservoir cannot drip on caliper.
27. [] Check and refill reservoir to overflow point as needed.
28. [] Assemble plastic reservoir cap to metal cap, then assemble rubber diaphragm to plastic cap.
29. [] Fill grooves in rubber diaphragm with oil, then quickly place cap assembly on reservoir and secure cap with screws.
30. [] Thoroughly wipe excess oil off of lever and all other parts. Rotor may be cleaned with alcohol or similar solvent, but all other parts should be cleaned with water and detergent to avoid degrading plastic and rubber parts and seals.

31. [] Squeeze brake lever firmly numerous times while checking at reservoir cap, banjo fittings, and bleed valve for oil leaks.
32. [] Remove plastic tube from bleed valve, then cap valve.

Caliper installation

NOTE: For frames or forks with Hayes-type post mounting (bolt holes aligned parallel to bike, rather than perpendicular to bike), an adapter plate must be mounted first. Install adapter and secure bolts to 55–70in-lbs, then use steps 41–45 before proceeding.

33. [] If caliper-mounting bolts are being reused, treat threads with Loctite 242 (not needed for first-time installation).



37.4 Shimano Deore XT hydraulic disc brake.

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34. [] Put longer caliper-mounting bolt through frame/fork mounting hole further from drop-out, and shorter bolt through other frame/fork mounting hole.
35. [] Put .5mm shim washer on end of each bolt on inner face of frame/fork mounting plate.
36. [] Remove plastic pad spacer from caliper, slide caliper onto rotor, align caliper mounting holes with mounting bolts, then engage mounting bolts and snug bolts finger tight.
37. [] Inspect for interference between rotor and ends of bolts. If interference exists, remove bolts and put 2mm washer under each bolt head and reinstall bolts finger tight.
38. [] Compress brake lever with clamp and rotate wheel in operating direction, then secure bolts gently with Allen wrench.

In the next step, inspect for rub between the pads and rotor. Light rub is tolerable, but increasing or reducing the .5mm shim thickness between the caliper mount and caliper can correct excessive rubbing. Rubbing is easy to hear, but locating whether it is against the outer pad or inner pad can be difficult. Try back-lighting the gaps between the pads and the rotor with a flashlight, or try a .05mm feeler gauge. Unlike some disc-brake systems, this brake is self-adjusting for pad clearance, so there is no manual adjustment to eliminate rub other than changing the shim stacks.

39. [] **Spin rotor and listen for rubs. If rubs are heard, inspect closely for whether they are at inner or outer pad, and which end of the pad the rub is occurring.**

When changing the shim stack to reduce rub, using different combinations of shims can make adjustments by as little as .1mm increments. It is acceptable to shim each bolt differently. Possible combinations are:

- 0mm – no shims
- .2mm – one .2mm shim
- .4mm – two .2mm shims
- .5mm – one .5mm shim
- .6mm – three .2mm shims
- .7mm – .5mm and .2mm shim
- .8mm – four .2mm shims

40. [] Use different combinations of .2mm and .5mm shims to move one end of caliper in or out, then check again for rub and redo shimming as necessary. *Note: use step 38 technique each time caliper is secured!*
41. [] When rub is minimized, torque mounting bolts to 55–70in-lbs. Check for change in rub and correct if necessary.

42. [] Feed 6" safety wire halfway through upper mounting bolt head, wrap one end clockwise around bolt head to meet other end, then twist ends together tightly with pliers until twisted section is approximately 50mm long.
43. [] Wrap twisted pair clockwise around bolt head less than one full turn, then pull wire to second bolt head so that it approaches second bolt head on opposite side from where it left first bolt head (wire goes on diagonal line from first bolt to second bolt). Insert one wire end through first wire hole in bolt head, then out second wire hole.
44. [] Wrap remaining wire end counterclockwise around second bolt until it reaches point first wire end comes out of second bolt, then tightly twist ends together.
45. [] Hook second twist around section of twisted wire between bolts so that loose end cannot get tangled in brake mechanism.
46. [] Secure hose(s) to frame and/or fork, then turn handlebars and/or move suspension through its full range to check for interference with hose(s).

PAD REPLACEMENT

Pads need to be replaced when the braking-material thickness is reduced at any point to .5mm. Since the braking material is originally 2mm thick, remaining life can be predicted by measuring pad thickness. For example, when the thickness is 1.5mm, two-thirds of the pad life remains, and when the thickness is 1mm, one third of the pad life remains.

Pad removal

1. [] Remove clip from end of pad axle bolt, then unthread bolt.
2. [] Pull out four-leg pad spring and pads.
3. [] Measure braking material thickness at thinnest point and replace pads if .5mm or less.
4. [] Clean inside caliper around pistons with water and detergent on brush. **CAUTION: Do not use automotive brake cleaners! Seal damage will occur!**

Pad installation

NOTE: If original pads are being reinstalled and brake lever has not been squeezed while pads or rotor was out, then skip the next step.

5. [] Insert stack of feeler gauges between pistons and one side of rotor to fill gap between pistons and rotor, then insert a slotted screwdriver between other pistons and rotor and press pistons back into caliper. Switch feeler gauge stack to opposite side and repeat. *Note: if wheel is removed, use box end of a small combination wrench to push pistons back into caliper.*

6. [] Install onto pad axle bolt in order: first pad (metal-side first), pad spring (with legs straddling braking material), then second pad (braking-material-side first).
7. [] Inspect all four ends of spring to verify spring ends are not beyond ends of metal shoe backs, or resting against face of braking material.
8. [] Squeeze pads together until gap between them is just enough to fit rotor, then insert pad stack partially into slot in caliper and remove pad-axle bolt.
9. [] Press pad stack in until holes in pads and spring line up with hole in caliper for pad axle bolt, then insert pad axle bolt (treat threads with Loctite 222).
10. [] Secure pad-axle bolt to 20–35in-lbs, then install clip in slot in end of bolt.
11. [] Operate brake, then spin rotor and check for unacceptable pad rub. Adjust shims as necessary to reduce rub.

