18 – WHEEL REMOVAL, REPLACEMENT, AND INSTALLATION

ABOUT THIS CHAPTER

This chapter is about removing and re-installing wheels, as well as installing a replacement wheel or rebuilt wheel.

GENERAL INFORMATION

TERMINOLOGY

Rim: The metal hoop at the outer perimeter of the wheel that the tire attaches to.

Wheel: The assembly of the hub, spokes, and rim. The word "rim" is sometimes misused to mean "wheel." When the tire is mounted to the rim, the word "wheel" can be used to refer to the hub, spokes, rim and tire.

Quick-release mechanism: When used in regard to a wheel, this term refers to a mechanism that attaches the wheel to the bicycle. It includes a quick-release lever, a skewer, and a quick-release adjusting nut. The quick-release mechanism is often called just the "quick-release."

Quick-release wheel: A wheel that is secured to the bike by the means of a quick-release mechanism.

Quick-release lever: The approximate two-inch lever that pivots 180° to apply the clamping force that holds the wheel to the bicycle. It may also be called a "cam lever," because the pivot of the lever is a cam that converts rotational motion to linear motion.

Skewer: The shaft of the quick-release lever that goes through the hollow axle in the hub. It connects the cam mechanism at one end to the tension-adjusting nut at the other end. The word "skewer" is sometimes used to refer to the entire quick-release mechanism.

Quick-release adjusting nut: On the opposite end of the quick-release mechanism from the quick-release lever is the quick-release adjusting nut. When the mechanism is loose, this nut is tightened or loosened to determine how tightly the quick-release mechanism will clamp.

Axle nut: A large hex nut that threads onto the axle that is *outside* the dropout that the wheel attaches to. The axle nut should not be confused with the *locknut*. The locknut is a nut that threads onto all threaded axles and locks the position of the cone on the axle. When looking at a mounted wheel, any nut inside the frame is a locknut, and any nut outside the frame is an axle nut.

Solid-axle wheel: A wheel that is secured to the bike by the means of axle nuts.

Dropout: The portion of the frame or fork that the wheel attaches to. It may also be called a *fork end* or *fork tip* (these terms apply to both front and rear dropouts).

Fork blades: The two tubes that join the frame to the front hub.

Seat stays: The two frame tubes that go from the rear dropouts to the frame joint just under the seat.

Chain stays: The two frame tubes that go from the rear dropouts to the frame joint that is between the pedals (usually at the bottom-bracket shell).

PREREQUISITES

Tire removal and installation

Before replacing a wheel, the tire should be removed. See the **TIRES AND TUBES** chapter (page 19-3) if unsure about tire removal and installation.

Freewheel removal and installation

To replace a wheel, it is necessary to remove the freewheel or freehub cogs. See the **FREEHUB MECHANISMS AND THREAD-ON FREEWHEELS** chapter for freewheel removal (page 25-9) and freehub-cog removal (page 25-16).

Hub re-spacing and adjustment

To improve the fit of an original or replacement hub, it may be necessary to add or subtract spacers from the axle set or change the amount that the axle protrudes past the outer locknut. These operations may require hub overhaul, and definitely require hub adjustment. See the **ADJUSTABLE-CONE HUBS** chapter (page 12-7) for hub overhaul and adjustment.

Wheel dishing

After spacing an axle set to improve fit of the wheel to the frame or fork, or fit of the freewheel to the wheel, chances are it will be necessary to re-dish the wheel (center the rim to the hub). See page 17-15.

Rear-derailleur adjustment

If installing a replacement rear wheel that does not exactly match the way the original hub positioned the rear cogs (or if in re-spacing the original hub the positioning of the rear cogs is changed), it will be necessary to re-adjust the rear derailleur. See the **REAR DERAILLEURS** chapter (page 32-1).

Brake adjustment

If re-installing an original wheel that was not correctly installed before removal, or if installing an original wheel that has been re-dished, or if installing a replacement wheel that has more correct rim dish than the original wheel, it will be necessary to center the brake pads to the rim. If installing a wheel with a different rim diameter or width, it will be necessary to adjust pad alignment and brake-cable length. See the **CABLE-OPERATED RIM-BRAKE CALIPERS** chapter (page 36-1) for brake adjustments.

INDICATIONS

Wheel removal and re-installation

Wheels need to be removed and re-installed for a variety of reasons, including flat-tire repair, tire replacement, wheel truing, wheel rebuilding, hub adjustment and overhaul, freewheel/freehub-cog servicing, and headset adjustment and overhaul.

Wheel replacement

Either during the course of repair, or even before attempting repair, symptoms might be experienced indicating that it would be better to replace the wheel than repair it. These are

- Multiple broken spokes, either all at once or one at a time over the last few hundred miles of use
- Multiple corroded nipples that won't turn
- Multiple damaged nipples (rounded-off wrench flats)
- Dents or bends in the rim that cannot be adequately straightened by normal spoke adjustment and unbending techniques
- Cracks in the rim
- Severe rim-sidewall wear, evidenced by a concave rim sidewall, or by rim beads that have become wider then they were originally

All these problems aside, you may also elect to replace the wheels in order to upgrade the bicycle's performance.

TOOL CHOICES

There are no special tools required to remove and install a wheel.

TIME AND DIFFICULTY

Wheel removal and re-installation is a 1–2 minute job of little difficulty. Fitting a new replacement wheel, which can include hub overhaul, wheel dishing, and brake adjustments is a 30–45 minute job of moderate difficulty. If brake adjustments or rear-derailleur adjustments are required after installing the wheel, these will add to the time of the job. See the appropriate chapters on these subjects to get an idea of what time might be involved in these operations.

COMPLICATIONS

Unsafe wheel installation

It is not unusual to find a wheel on a bike that has been unsafely installed, due to loose axle nuts or missing washers on nut-type hubs, or loose or mis-used quick-release skewers on quick-release hubs. It is the mechanic's responsibility to make sure that the customer gets informed about the problem and the correct way to install the wheel.

Wheel-mounting failure

There are five traditional methods used to determine whether a quick-release mechanism is adequately secure, and all are flawed. One traditional method is to base whether the quick-release lever is adequately secure is to adjust the mechanism so that the lever leaves an imprint on the palm of the hand from the effort of closing the lever. This is the "palm-imprint" method; any method that focuses on the closure effort is a variation of the "palm-imprint" method. Simply stated, there are too many variables that affect whether a properly adjusted quick-release mechanism would leave on imprint on the palm. The quality of fabrication, the presence of rust or dirt, the types of materials used, the type of surface on the lever, and the toughness of the mechanic's palm are just a few of the factors that could affect the outcome of the "palm-imprint" method. More importantly, the palm-imprint method leads the mechanic to focus on the wrong things; the right things to focus on are the point in the lever's motion where clamping begins, and the position at which the lever stops.

Another traditional method of determining whether a quick-release mechanism is adequately secured is the "dropout-imprint" method. With this

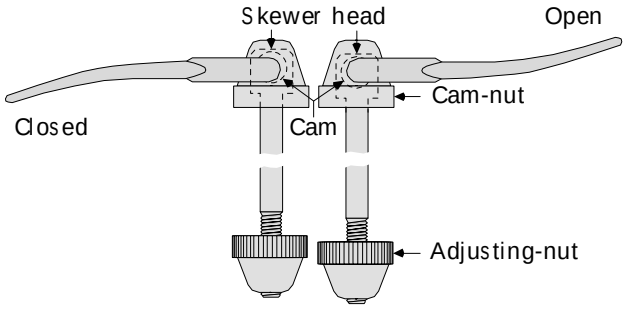
method, it is said that the quick-release mechanism is adequately secured when it leaves an imprint in the face of the dropout. The size of the clamping surface, the texture of the clamping surface, and the type of dropout material all affect what it will take to cause the quick-release mechanism to leave an imprint in a dropout. Furthermore, once the dropout has been imprinted numerous times from previous closings of the quick-release mechanism, there is no way to tell whether the quick-release mechanism at its current setting is creating a new imprint. Most importantly, this method leads the mechanic to focus on the wrong things; the right things to focus on are the point in the lever's motion where clamping begins, and the position that the lever stops at.

The third flawed method is the "release-force" method. In this method, the mechanic adjusts and closes the quick-release mechanism, then opens it again to subjectively evaluate the effort required to open, or release, the mechanism. This method has all the same limitations of the palm-imprint method.

The fourth flawed method involves striking the wheel to determine if it is secure. With this method, the mechanic simply strikes the tire with a fist to see if the wheel comes out. The CPSC (Consumer Product Safety Commission) requires that wheels resist a force of hundreds of pounds without coming out. A meaningful striking force applied with a fist would either break the mechanic's fist or put a flat spot in the rim.

The last traditional method (also flawed) involves setting the lever to a specific position, tightening the adjusting nut, then closing the lever. This method could be called the "nut-setting" method. In this method, the mechanic starts by setting the base of the quick-release lever to be parallel to the skewer, and then turns the adjusting nut until it is snug. After snugging the adjusting nut, the lever is closed. The problem with this method is that there are a number of factors that influence the point at which the adjusting-nut feels snug. If the dropouts are wider than the hub width, and the frame is reasonably stiff, then the adjusting-nut will get difficult to turn when it begins to compress the dropout width down to the width of the hub. In this case, closing the quick-release lever will do little more than reduce the dropout width further, closing the gaps between the inside faces of the dropouts and the faces of the hub locknuts. When this condition exists, it is not unusual to have to turn the quick-release lever like a big wing-nut, in order to tighten the adjusting nut enough; it is quite possible that several revolutions of the lever-end of the quick-release mechanism will be needed, after the adjusting nut has been turned as far as is possible with fingers. The shape of the adjusting nut (how easy it is to grasp), and whether the adjusting nut face is smooth or textured, also influence the point at which the adjusting-nut feels "snug."

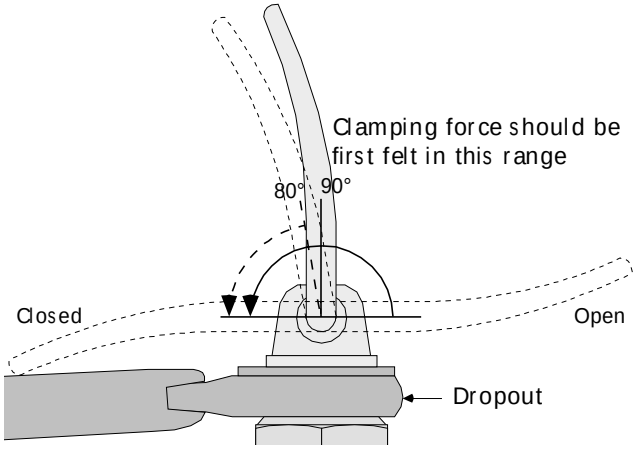
The method recommended in the following procedure is based on starting position and ending position of the quick-release lever. To understand why this method is best, it is necessary to understand how a quick-release mechanism works (see figure 18.1). The axle (pivot) of the quick-release lever is a cam. A cam is a cylinder that rotates around a point that is not at the center of the cylinder, for the pupose of converting rotational motion into linear motion. On a quick release, as the cam rotates, the skewer-head (which encircles the cam) is moved away from the dropout (linear motion). The cam turns inside the skewer-head, which is often hidden inside the housing that the quick-release lever pivots in (the cam housing). Rotating the quick-release lever rotates the cam, which changes the position of the skewer-head in the cam housing (cam-nut). The number of degrees of rotation determines the amount that the skewer head is pulled into the cam nut; when this happens, the distance between the cam-nut and the adjusting-nut decreases, which causes the two nuts to apply pressure to the dropouts. Since virtually all skewers are steel rods of a relatively constant diameter (all types of steel rods are equally elastic if dimensions are constant), the only factor that determines clamping force is the amount that the skewer-head moves after the clamping force begins. Virtually all traditionally-designed quick-release mechanisms have the same amount of movement differential over a 90° rotation.



18.1 *As the lever swings from the open to closed position, it rotates the cam, which moves the skewer-head further into the cam-nut, effectively moving the cam-nut and adjusting-nut closer together (which creates the clamping force).*

The recommended method for setting the quick-release mechanism is to start by setting the adjusting nut so that as the lever swings from the open position

to the closed position, the clamping force begins when the base of the quick-release lever is perpendicular to the dropout face. This ensures that the clamping force begins at a point that will allow enough rotation of the cam to create enough displacement of the skewer head after clamping begins. The lever is then closed until the base of the lever is parallel to the dropout (see figure 18.2). This does two things. First, it creates a 90° rotation of the cam after clamping force begins, which ensures that adequate skewer-head displacement occurs (pressure). Second, the "parallel-to-dropout" position ensures that the cam is rotated just past its high-point. This ensures that the force required to release the lever will increase slightly before it gets easier, which ensures that the quick-release lever has no tendency to open on its own. In case the above instructions were unclear, the recommended method for using quick-release mechanisms is this: set the adjusting nut so that as the lever is swung from the open position to the closed position, the clamping force begins at the point where the base of the lever is perpendicular to the face of the dropout, then close the lever at least until its base is parallel to the dropout (90° from starting point and perpendicular to the skewer, see figure 18.2). The force that is required to accomplish this can range dramatically, from minuscule, to beyond the capacity of human fingers (in which case the adjustment needs to be compromised). The amount of force that is required to close a properly-set quick-release mechanism is dependent on the surface-smoothness of the cam, the diameter of the cam, the smoothness of the cam-pivot surface, the length of the lever (and its shape and texture), the total surface-area of the cam, and the surface condition of the cam (wear, lubrication, rust, and dirt).



18.2 *When properly set, as the lever swings from the open to closed position, clamping force should first be felt when the base of the lever is 80-90°from the closed position (the base of the lever parallel to the dropout face).*

(A well-known former bike racer recently infuriated the bicycle industry by testifying that quick-release levers have a tendency to open on their own even when properly *secured*. He says that he has experienced this personally. It is quite probable that he was relying on closing force (palm-imprint method, or variation), not *position*, to determine when the lever was properly set. When the lever is not closed to the "parallel-to-dropout position," friction alone is resisting its natural tendency to achieve a state of greater relaxation [i.e. open]. When the proper position is achieved, the lever actually *wants* to stay closed, rather than trying to open. Its like the snap on your blue jeans. The moment of highest force is when the snap is halfway together. Once you overcome the point where the snap is halfway on, it actually helps itself go the rest of the way on. When you unsnap your jeans, at first the mechanism resists as much or more than it resisted going together, but once you force the snap to come apart to a certain point, it virtually pops itself apart. Quick-release mechanisms are like snaps, but without as dramatic and obvious a transition. Unlike a snap, it is possible to stop the quick-release at the point where it is halfway on [highest force]; this is not the point of highest security.)

Open-cam and other alternative quick-release mechanisms

The recommended technique for securing quick-release mechanism in this chapter applies to traditional, steel quick-release mechanisms with a cam enclosed inside a housing. There are a number of un-conventional designs in existence today that deviate enough in design that the recommended procedure may not be appropriate. Primarily, these alternative designs incorporate aluminum cams (or no cam at all), and the cam mechanism is exposed, rather than enclosed. Dimensions of these external cams also deviate from convention. Since these alternative quick-release mechanisms are not consistent with each other, or with conventional quick-release mechanisms, there is no general recommended procedure for their use; a mechanic should pursue information from the manufacturer of each of these alternative mechanisms.

Incorrect original wheel installation and brake setup

If the wheel was installed incorrectly, then the brakes may have been mis-adjusted to line up with the rim. On bikes with anything but cantilever brakes, it is a minor correction to center the brakes to the correctly-installed wheel, but on bikes with cantile-

ver brakes, the pads often must be repositioned if the rim position changes. A decision must be made as to whether to put the wheel back in wrong (to match the brake adjustment), or put the wheel in right and adjust the pads for free, or contact the customer and tell them additional brake work will be needed. The best solution is for the service writer to identify the problem and give the customer all the options before checking in the job.

Out-of-true wheels

When wheels are removed for tire or hub work, it may be the case that the rims are out of true and rub the brake pads intermittently. Although this is not the shop's responsibility, if the customer doesn't notice the problem until after getting the bike back, it will reflect poorly on the shop and may lead to a complaint. Usually, it is worth doing a few minutes of complimentary wheel truing before re-installing the wheel. The best solution is to spot the problem before the bike is checked in and to get the customer to agree to getting the wheel trued or to accept that the rim will rub the pads when they get the bike back.

Poor fit to dropouts

It is not unusual for a wheel to be too wide or too narrow for the dropouts, causing awkward removal and installation. Usually the customer would be familiar with the problem and it is nothing the mechanic cannot deal with. Complimentary repair of the problem by giving the stays or fork blades a squeeze or pull is not recommended because it could introduce handling or chainline problems. It is a good idea to contact the customer and see if they would like to pay for the additional work that required to make their existing wheel fit better.

Rear cog position changes

When replacing rear wheels, there is always a possibility that the new wheel will position the rear cogs slightly differently, causing problems with rear-derailleur adjustment. A derailleur adjustment should always be planned as part of a rear-wheel replacement.

Multiple axle thread standards

There are many different thread descriptions for axles. This is only an issue if re-installing an axle-nut-type wheel and a new axle nut is needed. Never use test-mating to determine if a new nut fits. See the **ADJUSTABLE-CONE HUBS** chapter (page 12-4) for information on axle-thread types, or compare inside diameter of new nut and old nut (if not stripped) and then test mate to determine thread compatibility.

Rounded axle nuts

Rounded axle nuts often require a vise-grip tool to remove. They should never be re-installed because a torque wrench should be used for installation.

Stripped axles

Stripped axle threads may be encountered on wheels with axle nuts. Minor damage can be repaired with a thread chaser, but stripped axles must be replaced. This means a simple flat-tire repair can turn into a hub overhaul as well. The customer must be informed and asked to authorize an axle replacement, but under no conditions should the wheel be re-installed with stripped axle threads.

Damaged quick-release skewers

Quick-release skewers can be damaged in several ways. The skewer shaft can be bent or elongated. The cam housing can be cracked or deformed. The cam lever may be bent. The cam lever may get sticky (due to cam-surface wear) and be difficult to close fully from a normal starting position. In all these cases, the quick-release mechanism *must* be replaced.

Different quick-release-skewer sizes

Quick releases can differ in length and shaft diameter. Length may be an issue if installing a replacement rear wheel that fits more cogs. Diameter of the shaft may be an issue for some "suspension" front hubs.

Protruding axles

If a quick-release axle protrudes too far from the face of the locknut, it can cause unsafe wheel installation. The axle should not protrude more from the locknut face than the thickness of the dropout it will be installed in. It is the mechanic's responsibility to check *every* wheel being installed for this condition and correct it. Fortunately, it can be corrected adequately by simply removing the skewer and holding the end of the axle up to a grinding wheel.

Broken axles

A broken axle may not show itself until the wheel is removed and the skewer removed from the hub. *Under no circumstances can the wheel be reinstalled without replacing the axle!* The customer must agree to axle replacement, or accept the bike back in pieces. A broken axle is usually a symptom of a mis-aligned dropout.

Bent axles

Bent axles are broken axles in the making. They should never be bent back because it just causes further weakening. Even re-installing the wheel with a

bent axle is a questionable choice. The customer should be advised of the problem and encouraged to agree to axle replacement.

Poor hub adjustments

When the wheel is removed, a tight adjustment, a loose adjustment, or loose cone locknuts may be discovered. Adjustments should not be altered, but the customer should be advised of the condition. Loose adjustments may interfere with installing the wheel in a fashion that the rim will not rub the brake pads.

Mis-adjusted brake pads

Mis-adjusted brake pads are a problem if they end up rubbing the tire or are at risk of deflecting below the rim when braking hard. Since it could appear that the shop was responsible if a problem relating to these conditions occurred after the wheel was installed, these conditions must be dealt with. In some cases it is simple, but the amount of work involved with some brakes ends up being almost a full brake job. In these cases, it would be best to contact the customer and get authorization to perform the additional work. The best solution is to look for problems with brake pads missing the rim whenever checking in a bike for any service that involves wheel removal.

ABOUT THE REST OF THIS CHAPTER

The rest of this chapter is divided into three parts. The first part is about wheel removal. The emphasis here will be on following a procedure that not only makes wheel removal easy, but on getting the right information before removing the wheel, which makes wheel installation easier. The second part is about the fit of the wheel to the bike and additional considerations when replacing a wheel. The third part is about installation of a wheel so that it ends up properly aligned and secure.

REMOVING A FRONT OR REAR WHEEL

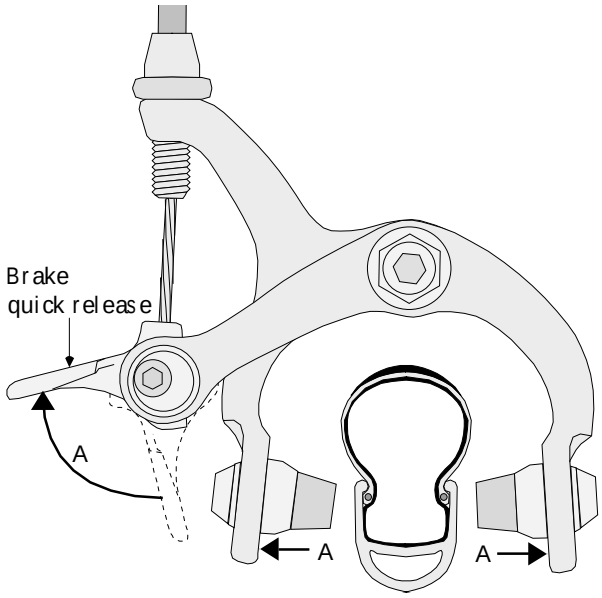
PREPARING ALL WHEELS FOR REMOVAL

1. [ ] Put bike in bike stand.

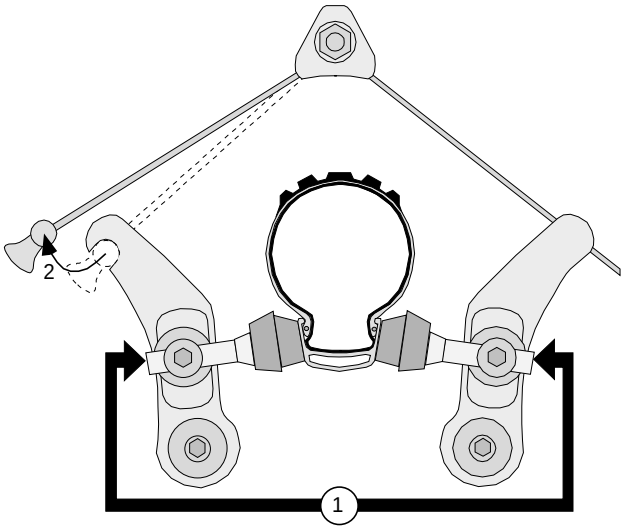
2. [ ] Operate brake once or twice, spin wheel, and observe whether rim or tire is rubbing on brake pads.

3. [ ] Observe whether rim appears centered between fork blades or seat stays (frame tubes from below seat to rear axle).

4. [ ] Spread brake pads by operating quick release on sidepull caliper or unhooking straddle wire on cantilever/U-brake/center-pull brake. If neither is possible, deflate tire if it is too fat to pass through brake pads.



18.3 *By flipping the quick release in direction A, the pads will move in direction A so that the tire will clear the pads more easily.*



18.4 *To release a straddle wire to improve brake-pad clearance, 1) squeeze the calipers in toward the rim, 2) then pull the end of the straddle wire out of the caliper arm.*

5. [ ] **Some front wheels have safety-retention mechanisms that hold wheel in place if quick release fails. Look for plates of metal sandwiched between quick release and dropout face and remove any screw/bolt that goes through plate.**

NOTE: Skip to step 8 if removing a front wheel.

PREPARING A REAR WHEEL FOR REMOVAL

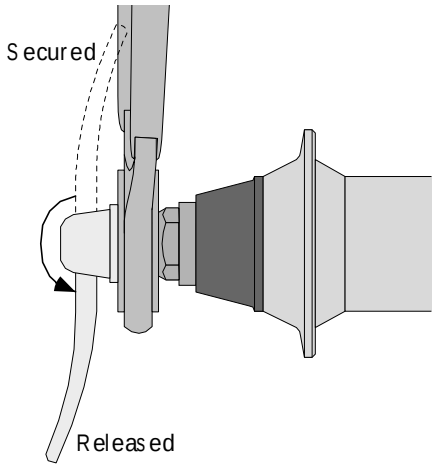
6. [ ] **Shift chain to innermost chainring in front and outermost cog in rear so that chain has as much slack as possible.**
7. [ ] **Observe whether tire appears centered between chain stays just behind the bottom bracket.**

LOOSENING QUICK RELEASES OR AXLE NUTS

NOTE: If wheel is held to bike by axle nuts, skip to step 10.

If the wheel is held to bike by a quick release

8. [ ] **Locate quick-release lever (generally on left side of bike) and flip lever (do not rotate) 180°.**



18.5 *Opening a quick-release lever.*

9. [ ] **If wheel does not want to easily slide out of dropouts, hold conical-nut end of quick-release mechanism on side opposite lever and rotate lever counterclockwise to loosen mechanism further, or simply loosen conical nut further.**

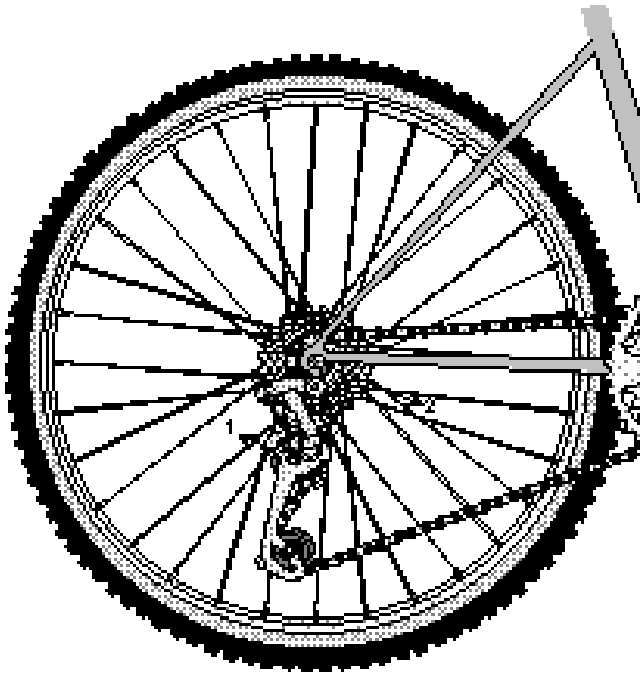
If the wheel is held to bike by axle nuts

10. [ ] **Turn either axle nut counterclockwise to loosen.**
11. [ ] **Turn second axle nut counterclockwise to loosen. If axle tends to turn with axle nut, re-tighten first axle nut just enough to fix axle while breaking loose second axle nut, then break loose first nut again.**
12. [ ] **If wheel does not slide out easily, loosen either or both axle nuts further.**

NOTE: If removing a front wheel, wheel removal is done. Ignore remaining steps.

CLEARING FREEWHEEL FROM DERAILLEUR AND CHAIN

13. [ ] **If removing rear wheel, it probably has come to a rest on top of rear derailleur. Rotate derailleur back (clockwise viewed from right side of bike) around its mounting bolt while pushing wheel forward and down.**



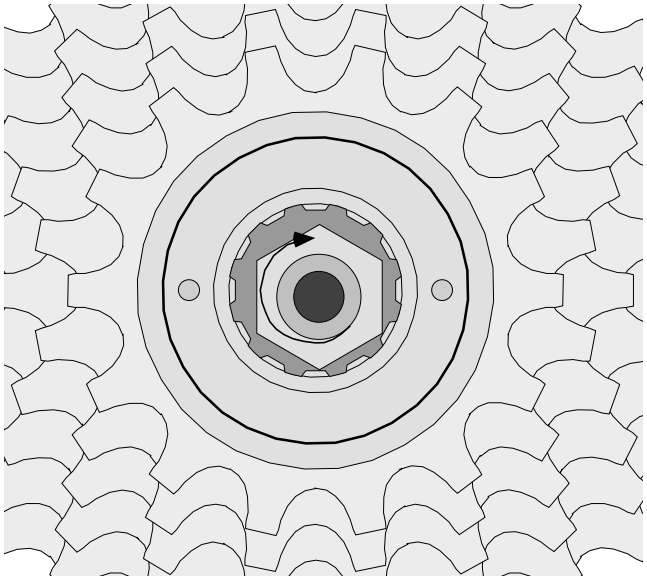
18.6 *Rotate the derailleur back so it will clear the wheel when the wheel is removed.*

14. [ ] **Once freewheel clears rear derailleur, drop wheel down and to bike's left to get rear cogs and right end of axle to clear lower section of chain.**

INSPECTING AXLE FOR BENDS

A number of the following steps might require hub work. Inspect now for whether the axle is bent. *A bent axle often indicates that the dropouts need alignment.*

15. [ ] Looking into each end of axle, rotate axle and observe whether there is any oscillation that would indicate either end of axle is bent.

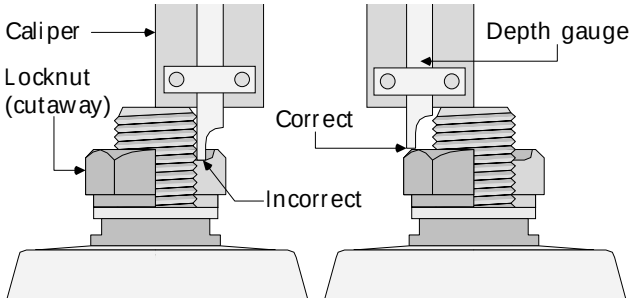


18.7 *Inspect the end of the axle for oscillation when rotated.*

FIT OF AXLE LENGTH TO DROPOUT THICKNESS

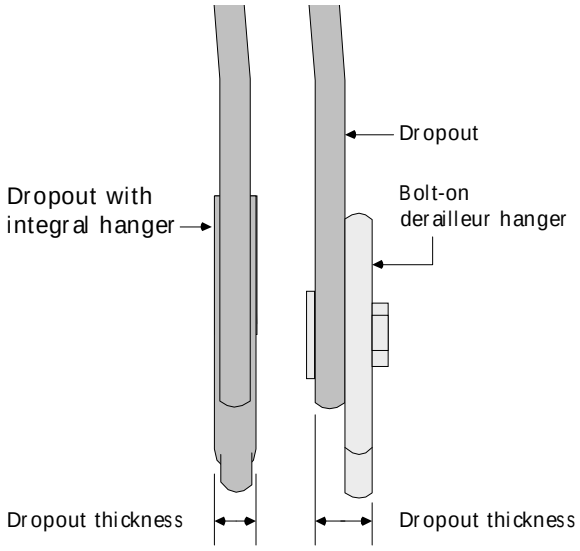
The amount that the axle protrudes past the locknut on the hub is important. If the wheel is a quick-release type and the axle is too long, it may prevent the wheel from securing properly. Simply, a quick-release axle should never protrude past the locknut by more than the thickness of the dropout that the axle will insert into. If the wheel is the type held on by axle nuts, the axle protrusion should be at least equal to the sum of the dropout thickness, the thickness of the axle washer (if any), and the thickness of the axle nut, or the axle nut may not engage the axle adequately.

1. [ ] Measure axle protrusion on each side of hub and record here:
Right-side protrusion: _____
Left-side protrusion: _____



18.8 *Measuring axle protrusion.*

2. [ ] Measure dropout thickness and record here. Right side (include derailleur-mounting plate that bolts on to the face of the dropout, if any):
Left side: _____



18.9 *Measuring dropout thickness.*

FITTING WHEELS, ORIGINAL AND REPLACEMENT

Whether reinstalling an existing wheel or installing a replacement wheel, check whether it fits. The following is a short list of fit aspects common to all wheels:

Fit of axle length to dropout thickness
Fit of hub width to width between dropouts

For replacement wheels the following additional aspects of fit should also be considered:

Fit of axle to dropout-slot width (particularly if replacing front solid-axle wheel with quick-release wheel)
Fit of thread-on freewheel or freehub-cog cassette to hub (if replacing rear wheel)

For replacement wheels and rebuilt wheels, these additional aspects of fit should also be considered:

Fit of rim width to brake-pad width
Fit of rim diameter relative to brake-pad height
Centering of rim to brakes
Fit of rim to existing-tire size

NOTE: If wheel is held on by axle nuts, skip to step 5.

If wheel is quick-release type

Axle-length protrusion can be too long, resulting in the quick-release mechanism clamping against the end of the axle instead of against the dropout. Axle-length protrusion cannot be functionally too short, it simply makes alignment of the wheel more awkward if there is no protrusion (wheel security is unaffected by axle-to-dropout engagement).

3. Subtract right-side axle protrusion from right-side-dropout thickness.
Record answer here: _____
[ ] If answer is a negative value, shorten axle by filing, cutting, or replacing. Excess length can also be shifted to other side if other side is too short.
[ ] If answer is ³0, axle protrusion is acceptable.

4. Subtract left-side axle protrusion from left-side-dropout thickness. Record answer here: _____
[ ] If answer is a negative value, shorten axle by filing, cutting, or replacing. Excess length can also be shifted to other side if other side is too short.
[ ] If answer is ³0, axle protrusion is acceptable.

If wheel is solid-axle type

Axle-length protrusion can be too short, resulting in inadequate engagement of the axle nut. Axle-length protrusion cannot be functionally too long, it is simply unsightly and hard on shins.

5. Subtract right-side axle protrusion from sum of right-side-dropout thickness, axle-nut thickness, and axle-nut-washer thickness. Record answer here: _____
[ ] If answer is a positive value, axle must be replaced unless enough excess length is found on left side.
[ ] If answer is £0, axle protrusion is acceptable. Extra length can also be shifted to other side if other side is too short.

6. Subtract left-side axle protrusion from sum of left-side-dropout thickness, axle-nut thickness, and axle-nut-washer thickness. Record answer here: _____
[ ] If answer is a positive value, axle must be replaced unless enough excess length is found on right side.
[ ] If answer is £0, axle protrusion is acceptable. Extra length can also be shifted to other side if other side is too short.

FIT OF HUB WIDTH TO WIDTH BETWEEN DROPOUTS

A good fit between the hub and the dropouts ensures that the wheel is easy to remove and install. In the case of suspension forks, a good fit is essential to keep the suspension working properly.

Tolerance for error

If the hub width differs from the dropout width by 2mm or more, awkward wheel installation or removal will probably be experienced.

If the hub is too wide, the wheel will always be difficult to install, regardless of how much the axle nuts or quick-release adjustment is loosened.

If the hub is too narrow, the wheel will come out relatively easily when the quick-release mechanism is released or the axle nuts are un-torqued; however, the frame will expand to a wider state after the wheel is removed. The expanded frame makes reinstalling the wheel a struggle without additional loosening of the quick-release mechanism or axle nuts, because otherwise the frame will need to be compressed to fit back between the quick-release parts or the axle nuts.

Modern front dropouts often have a recess in their faces or tabs that protrude from the tips so that the wheel is trapped even when the quick release is released. These require that the quick-release adjusting nut (on the non-lever end) be loosened further just so that the quick-release will clear these safety mechanisms. In this case, needing to loosen the quick release further to remove the wheel is not necessarily a sign that there is a problem with wheel fit. To adjust and readjust the quick release every time because of these safety devices is a pain. Every millimeter the dropouts are too wide adds to the pain.

With regard to the fit of the hub to a suspension fork, the tolerance for error is even less. The hub must be *less* than 1mm wider or narrower than the width between the dropouts on the suspension fork. If the fit is worse than 1mm, then the tubes sliding in and out of each other (as the suspension compresses and extends) tend to bind.

Quantifying error

To quantify of the width error between the hub and the dropouts, two measurements must be taken and a difference must be calculated. First, use a caliper to measure the width from the face of one hub locknut (the surface that presses against the inside face of the dropout) to the face of the other hub locknut. For rear hubs it will usually be necessary

to remove the freewheel or freehub cogs (see the **FREEHUB MECHANISMS AND THREAD-ON FREEWHEELS** chapter, page 25-9 and 25-16). Next, use a caliper to measure the distance between the inside faces of the two dropouts (the parts of the frame that the wheel attaches to). The width error is the difference between these two measurements.

Correcting error

To correct a width error, there are two basic approaches. It is possible to spread or compress the width between the dropouts. This is not an option with aluminum frames or forks, carbon-fiber frames or forks, or suspension forks (unless the suspension system is not part of the fork blades). The other option is to change the width of the hub. This is not an option with many cartridge-bearing hubs, which often do not have means to add or subtract spacers from the axle. In these cases, a new axle set may need to be installed.

Assuming that the hub is an adjustable-cone hub with a threaded axle, re-spacing the axle is simply a matter of adding, subtracting, or substituting spacers behind the locknuts on each end of the axle.

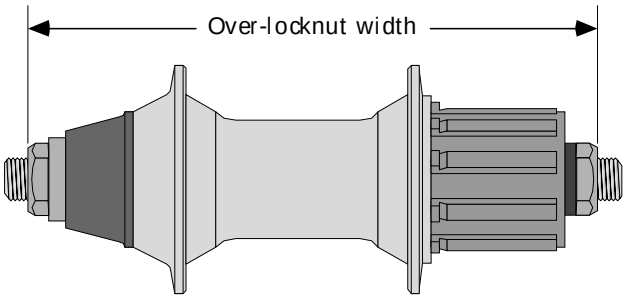
Consequences of hub re-spacing

Although the process of adding or subtracting space from the axle is relatively simple, the consequences can be quite complex. When adding, subtracting, or substituting spacers from either end of the axle, it will be necessary to re-adjust the hub bearings (see the **ADJUSTABLE-CONE HUBS** chapter, page 12-12). As long as changes made are equal on both sides of the axle, then there is no concern about wheel dish (centering of the rim to the hub). If at any time unequal spacing changes occur on the two ends of the axle, then the wheel will need to be re-dished (see the chapter **WHEEL TRUING AND REPAIR**, page 17-15).

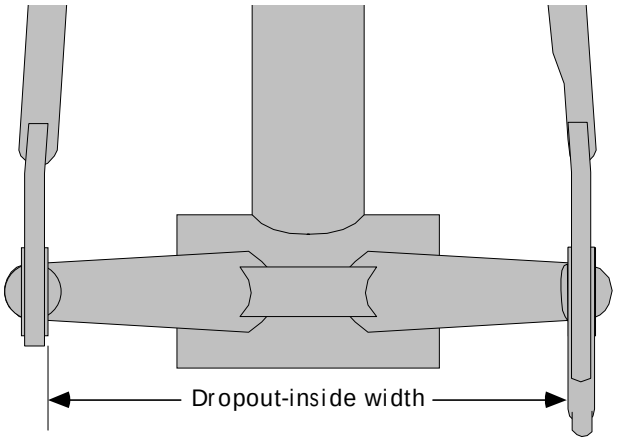
As long as spacers are being added to the right end of a rear hub, there is no concern about the fit of the freewheel cogs, but if subtracting space from the right end there is a possibility that the outermost cog may end up too close to the frame and that the chain might jam against the frame, either while on the outermost cog or while shifting on to or off of it. *Anytime* spacers are being added *or* subtracted from the right side of the rear hub, it *will* affect the rear-derailleur limit-screw settings and the index-cable-tension adjustment. See the **REAR DERAILLEURS** chapter (page 32-10) in order to adjust the rear derailleur.

The following steps enable calculation of the total change necessary to make the hub a perfect fit to the dropouts. To make the necessary corrections to the hub, the wheel dish, the freewheel fit, or the rear-derailleur adjustment, refer to the appropriate chapters on these components.

7. [ ] Measure over-locknut width of hub and record here: _____



18.10



18.11

8. [ ] Measure width between dropout inside faces, record here: _____

9. [ ] Subtract smaller number from steps 7 or 8 from larger number from steps 7 or 8 and record answer here: _____

10. Check one of following depending on answer in step 9:

- **[ ] Hub width needs to be increased by amount in step 9.**
- **[ ] Hub width needs to be decreased by amount in step 9.**
- **[ ] Hub width is acceptable (step 9 is <1mm for suspension forks or ±2mm for others).**

***NOTE: If just re-installing a wheel, skip following section* FITTING WHEELS, REPLACEMENT ONLY *and go directly to* INSTALLING THE WHEEL.**

FITTING WHEELS, REPLACEMENT ONLY

NOTE: Skip to FIT OF BRAKE-PAD WIDTH TO RIM WIDTH (following step 21) if re-installing an original hub built up with a new rim.

FIT OF AXLE TO DROPOUT-SLOT WIDTH

NOTE: Use this section only if replacing front solid-axle wheel with quick-release wheel.

If upgrading a front solid-axle wheel to a quick-release wheel, there may be a problem fitting the axle to the slots in the fork dropouts. Most road-bike front axles that use axle nuts are 5/16" diameter (7.95mm), and all quick-release front axles are at least 9.5mm diameter. Some forks are made with dropout slots just wide enough to accommodate the axle-nut-type axles. If upgrading to quick-release front axle, do the following steps. If the dropout axle slots are too narrow, they will need to be enlarged with a file. MTB front axles that use axle nuts are usually fatter, so the dropouts may not need this modification to accommodate a quick-release axle.

If replacing an axle-nut-type front wheel with a quick-release wheel

11. Measure width of slot in fork dropout and conclude one of following:

[ ] Slot width is ³9.5mm, quick-release axle will fit without filing axle slots.

[ ] Slot width is <9.5mm, axle slots must be filed to fit quick-release axle.

FIT OF FREEWHEEL TO HUB

NOTE: Use this section only if replacing a rear wheel equipped with a thread-on freewheel.

Rear wheels that fit thread-on freewheels (as opposed to freehubs, which have the freewheel built in) are not all made with the same space for the freewheel to fit (called freewheel space). Also, in rare cases, there is a possibility that the threads on the freewheel are not compatible to the threads on the hub. Even when the hub has adequate freewheel space, if it is not the identical amount as the original hub, it will be necessary to re-adjust the rear-derailleur limit screws and cable.

For every type of freewheel (five-speeds, narrow six-speeds, wide six-speeds, and seven-speeds), there is a minimum-freewheel-space value. In certain cases where the seat stay (tube from below the seat to the rear dropout) is bulky where it attaches to the dropout, the minimum freewheel space may not be adequate (the chain may rub against the end of the seat stay while on the outermost cog or shifting on and off of the outermost cog).

To determine whether the new rear hub has adequate freewheel space, take two measurements on the hub, add them together, and see if the answer is equal to or more than the space requirement for the specific freewheel. In the case of a six-speed freewheel, it will also be necessary to take a measurement on the freewheel to determine whether it is a narrow- or wide-spaced six-speed. An alternate approach is to compare the new hub's freewheel space to the old hub's freewheel space. As long as the new hub has equal to or greater space than the old hub, the freewheel space should be adequate. It is also possible to calculate the difference between the new and old hub's freewheel spaces to determine how much space to add or subtract from the right side of the new hub's axle set, in order to get an identical match and avoid having to re-adjust the rear derailleur.

If the freewheel space on the new hub needs to be modified, then it will affect the wheel dish and the fit of the hub to the dropouts (see above). See the chapter **WHEEL TRUING AND REPAIR** (page 17-15) to adjust the wheel dish. If the hub's fit into the dropouts is good, then whatever amount of spacing will be removed from the right side of the axle should be added to the left side of the axle. If adding spacers to the right side of the hub, the equivalent amount should be subtracted from the left side of the hub. If the freewheel space is wrong and the hub width is also wrong, try to fix both at the same time. See the **ADJUSTABLE-CONE HUBS** chapter (page 12-12) to add and subtract spacers from the axle and adjust the hub after doing so.

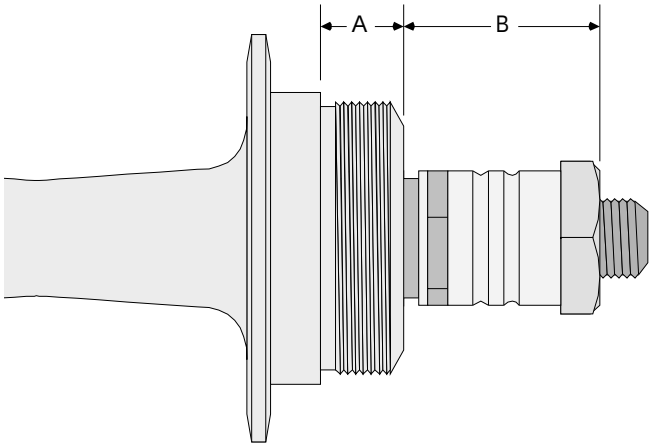
Older French bikes (before 1985) occasionally had freewheel threads that were a 1mm pitch. Just about any replacement wheel will have freewheel threads that are a pitch of 24tpi. These two pitches are not compatible. In such a case, the freewheel will need to be replaced along with the wheel.

If replacing a rear wheel equipped with a thread-on freewheel with a new wheel

12. [ ] Measure pitch of freewheel threads on freewheel and hub and make sure they match.

13. [ ] Measure distance from shoulder at bottom of hub's freewheel threads to end of hub shell and record: (new hub) _____
(old hub) _____

14. [ ] Measure from end of hub shell to face of locknut and record: (new hub) _____ (old hub) _____

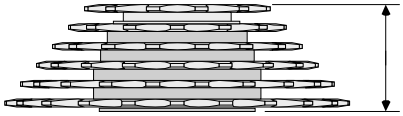


18.12 *Measure these two dimensions to determine freewheel space.*

15. [ ] Add both *new* hub numbers from steps 13 and 14 and record answer here: _____

16. [ ] Add both *old* hub numbers from steps 13 and 14 and record answer here: _____

17. [ ] If freewheel has six cogs, measure distance from outer face of outermost cog to inner face of innermost cog and record measurement here: _____



18.13 *If freewheel is a six-speed, measure the freewheel width.*

18. Check appropriate choice below, depending on freewheel to be installed on new wheel:
- **[ ] Five-speed freewheel, minimum freewheel space is 29mm.**
- **[ ] Six-speed freewheel width is <28mm, minimum freewheel space is 31mm.**
- **[ ] Six-speed freewheel width is >28mm, minimum freewheel space is 35mm.**
- **[ ] Seven-speed freewheel, minimum freewheel space is 37mm.**

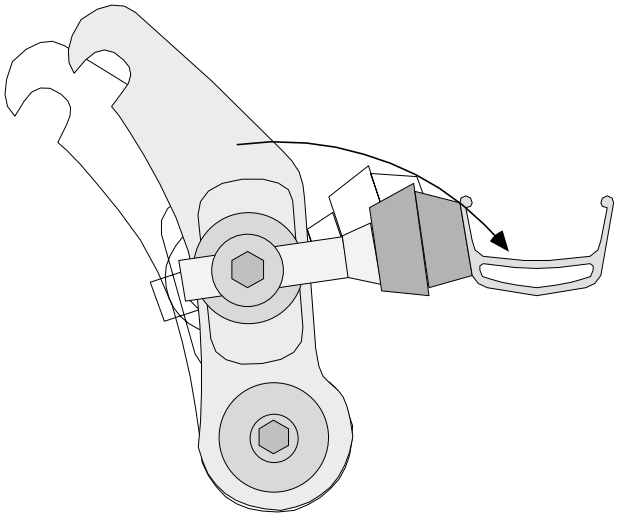
19. [ ] If new hub freewheel space (step 15) is less than minimum-freewheel-space requirement (step 18), add necessary spacers to right side of axle so that it equals minimum-freewheel-space requirement (derailleur adjustment will be required unless step 18 amount also equals step 16), or add or subtract necessary spacers on right side of axle so that new freewheel space equals step 16 (no derailleur adjustment will be required). (See ADJUSTABLE-CONE HUBS chapter, page 12-12.)

20. [ ] If necessary, subtract or add spacers to left side of rear axle so that over-locknut width equals step 8 (±2mm). (See ADJUSTABLE-CONE HUBS chapter, page 12-12.)

21. [ ] Re-dish wheel if spacers have not been added or subtracted equally on right and left sides of wheel. (See WHEEL TRUING AND REPAIR chapter, page 17-15.)

FIT OF RIM WIDTH TO BRAKE-PAD WIDTH

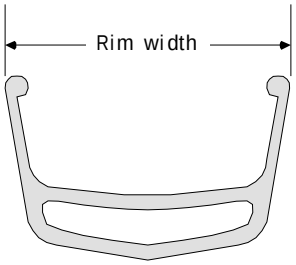
In many cases, if a replacement wheel has a different rim width than the original wheel, then nothing is needed other than a minor cable adjustment to change the brake pad-to-rim clearance. If the bike has cantilever brakes, U-brakes, centerpull brakes, or Shimano dual-pivot brakes, then even minor changes in rim width can have a major effect on brake-pad-height adjustment. The reason for this is that the above-listed brakes (all brakes other than conventional sidepull brakes) have a very short caliper-arm length. When the caliper arm is short, the pads move almost an equal amount up and down for the amount they move in and out. For example, a 21mm-wide mountain-bike rim might be replacing a 27mm-wide mountain-bike rim. Each pad will need to move 3mm further in to reach the rim. When a cantilever arm moves a pad 3mm further in, the pad ends up 1–2mm further down. This might end up with the pad partially below the rim. All this means is that the brake-pad height on the caliper arm needs to be adjusted, not that the narrower rim cannot be used.



18.14 *Brake pads change height as they move laterally.*

With sidepull and cantilever brakes, pads move down as they move in. If the replacement rim is narrower, inspect for pads that end up too low on the rim. If the replacement rim is wider, inspect for pads that end up too high on the rim. With centerpull and U-brake calipers, the pads move up as the move in. If the replacement rim is narrower, inspect for pads that end up too high on the rim. If the replacement rim is wider, inspect for pads that end up too low on the rim.

22. [ ] Measure and compare old and new rim widths.



18.15 *Measuring rim width.*

23. If new rim width is narrower, check one of following choices:
- **[ ] Brakes are cantilever or sidepull brakes, check if brake pads hit too low on new rim.**
- **[ ] Brakes are U-brake or centerpull, check if brake pads hit too high on rim.**

24. If new rim width is wider, check one of following choices:
- **[ ] Brakes are cantilever or sidepull brakes, check if brake pads hit too high on new rim.**
- **[ ] Brakes are U-brake or centerpull, check if brake pads hit too low on rim.**

FIT OF RIM DIAMETER RELATIVE TO BRAKE-PAD HEIGHT

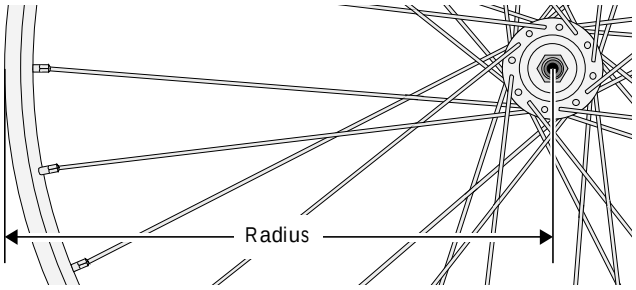
In almost every case, a wheel must be replaced with one of an identical size or the brakes will not reach the rim. The only exception to this is the 700C and the 27" sizes, which differ in radius by approximately 4mm. In most cases, even this small difference would mean that the brakes will not fit. If replacing a 27" wheel with a 700C wheel, and the brake pads are currently at the top of their height-adjustment range, then there is a possibility the 700C wheel will fit. If replacing a 700C wheel with a 27" wheel, and the brake pads are currently at the bottom of their height-adjustment range, then there is a possibility the 27" wheel will fit. (This example assumes the brakes are sidepull, not cantilever.)

If replacing a smaller wheel size with a larger size (for example replacing 700C with 27") there is also a question as to whether the tire tread will clear the frame or fork. If the new tire is of a similar fatness as the old one, then it is simply a matter of checking the old tire to see if there is at least 8mm clearance. If the new tire is skinnier or fatter than the old tire, factor in that difference as well as the wheel-radius difference. Ideally, try to end up with about 6mm clearance (without fenders), and 12mm clearance if fenders will be used.

NOTE: If replacing a wheel with one of the same size, skip to CENTERING OF RIM TO BRAKES.

If replacing a wheel with one of another size

25. [ ] Measure radius of old wheel, and write answer here: _____

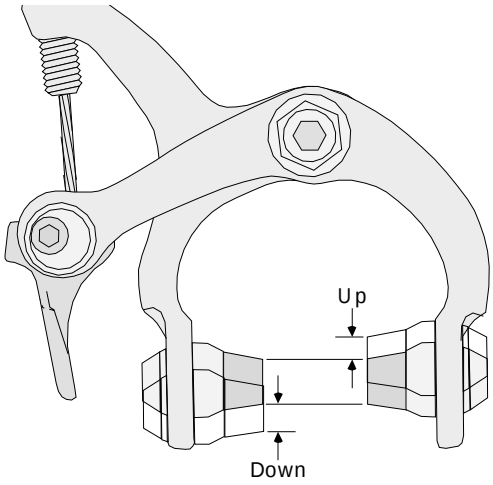


18.16 *Measure the rim radius.*

26. [ ] Measure radius of new wheel, and write answer here: _____

27. [ ] Subtract smaller of steps 25 and 26 from larger of steps 25 and 26 and write answer here: _____
This is amount brake pads will need to be adjusted up or down to reach new rim.

28. [ ] Measure amount brake pad can move down (if step 26 is smaller than step 25), or up (if step 26 is larger than step 25,) and write answer here: _____



18.17 *Vertical pad adjustment of a sidepull brake.*

29. Choose one of following choices:
- **[ ] Step 28 is larger than step 27, so brakes will accommodate new wheel size.**
- **[ ] Step 28 is smaller than step 27, so brakes will not accommodate new wheel size.**

30. [ ] If replacing a smaller wheel with a larger one, check clearance between tread and frame to make sure there will be room for a larger tire.

CENTERING OF RIM TO BRAKES

Assuming the wheel is correctly dished initially (and this may prove false later), if the axle spacing was modified in any way, dish should be checked and corrected. Assuming the original wheel centered correctly between the brake pads, if the new wheel does not center up well, either the brakes were mis-adjusted to a poorly-dished old wheel, or the new wheel is not correctly dished. When installing the new wheel, if it does not center to the brake pads, there is either a problem with the wheel dish or the brake adjustment. Use a dish gauge to check the dish of the new wheel (see page 17-15) before centering the brakes to the new wheel.

31. [ ] Install wheel temporarily and check if rim is centered between brake pads. If centered, skip steps 32 and 33.

32. [ ] If not centered, check and correct wheel dish if necessary.

33. If wheel dish is correct, brakes need centering.

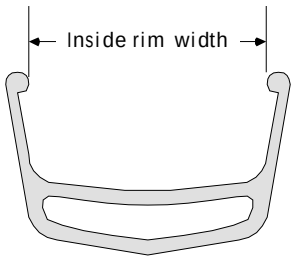
FIT OF RIM TO EXISTING TIRE SIZE

Assuming the replacement wheel is the same size category as the original and the plan is to re-use the old tire, check that the new rim width is compatible with the old tire. In a perfect world, it would be a matter of matching the named width of the rim to the named width of the tire, and all 26" MTB tires would be compatible with all 26" MTB rims. Unfortunately, the world isn't perfect, at least not as far as tires and rims are concerned. For any size (such as 26" MTB), there are a variety of rim widths and a variety of tire widths. To complicate matters, the actual width for two rims that are named the same can actually be quite different. The same holds true of tires. If combining the narrowest of rims with the widest of tires in a given size group, or vice versa, then there may be a problem. There are a few simple measurements that can be taken and calculations to make to determine whether the tire width is acceptable to use with the new wheel.

If the tire is too narrow for the new rim, there are several consequences. The height profile of the tire will be too low, which can lead to more rim damage and more pinch flats. Also, the shape of the tire will be deformed in a way that reduces cornering performance (particularly on road bikes). If the tire is too wide for the new rim, there is some risk of different consequences. If the tire is too wide for the rim and the bike has cantilever brakes, the brake pads often end up rubbing on the tire — resulting in its premature demise. If the bike in question has sidepull brakes, the pads probably will not spread wide enough to clear an oversize tire. Also, on road bikes where the tire is too wide for the rim, a squirmy feel in the handling might be experienced — depending on the tire design and the air pressure.

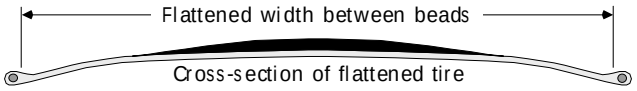
The following steps determine whether the existing tire is within the range of widths that is acceptable on the new rim.

34. [ ] Use a caliper to measure inside width of rim. Record measurement here: _____



18.18 *Measure inside width of rim.*

35. [ ] Measure width from bead-to-bead (edge-to-edge) of tire (flattened) and record width here: _____



18.19 *Measure flattened width of tire between the beads.*

36. [ ] Divide answer in step 35 by 2.5 to determine "section width" and record answer here: _____

37. [ ] Multiply rim-inside width from step 34 by 1.4 to determine the narrowest acceptable "section width" and record answer here: _____

38. [ ] Multiply rim-inside width from step 34 by 2.0 (road bikes) or 3.0 (MTBs) to determine the widest acceptable "section width" and record answer here: _____

39. Check one of following choices:
- **[ ] Step 36 is included in range of steps 37 and 38, so tire width is ideal for rim.**
- **[ ] Step 36 is outside of range of steps 37 and 38, so tire width is potentially unacceptable for rim. (See preceding text for description of possible problems.)**

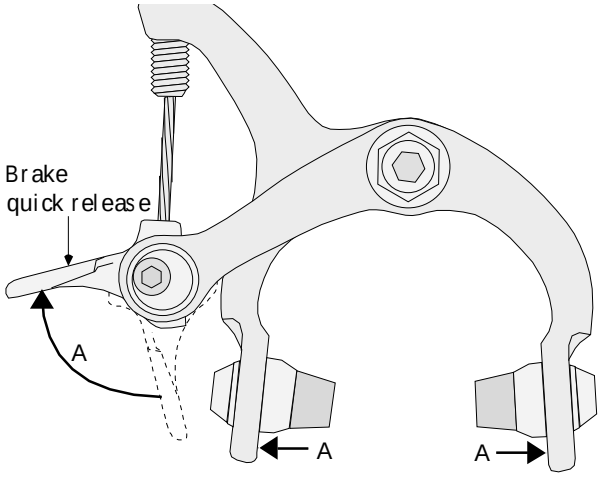
INSTALLING THE WHEEL

NOTE: If installing a rear wheel, skip to REAR WHEELS.

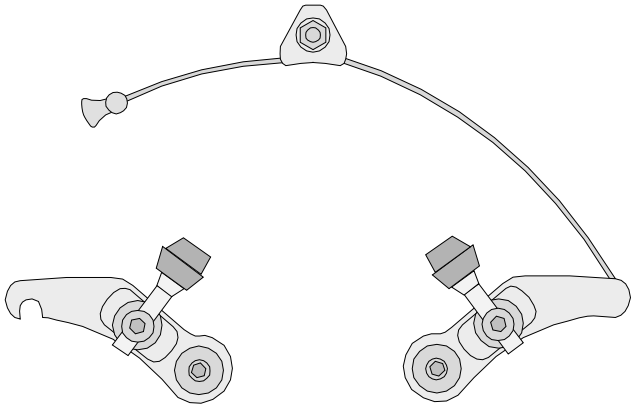
FRONT WHEELS

Installing a front wheel is relatively simple, but don't let the simplicity lead to carelessness. Nothing is more disastrous than a front-wheel-mounting failure!

1. [ ] Check that sidepull-brake quick-release mechanism is released, or cantilever/ U-brake/centerpull straddle wire is unhooked.



18.20 *A sidepull brake should be released before installing the wheel.*



18.21 *A cantilever brake should be released before installing the wheel.*

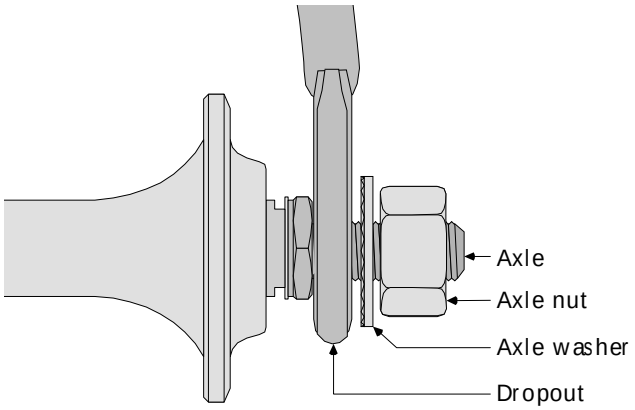
2. Check one of following choices, then perform lettered steps that follow checked choice:

[ ] If wheel is retained with axle nuts:

a) Remove axle nuts and washers, grease axle threads.

b) Install axle washers (textured face, if any, toward dropout).

c) Thread on axle nuts (any flange on axle nut faces toward dropout).



18.22 *Orientation of axle nut, washer, and dropout.*

[ ] If wheel has quick-release mechanism and quick-release mechanism has been removed from axle:

a) Lubricate skewer shaft and threads.

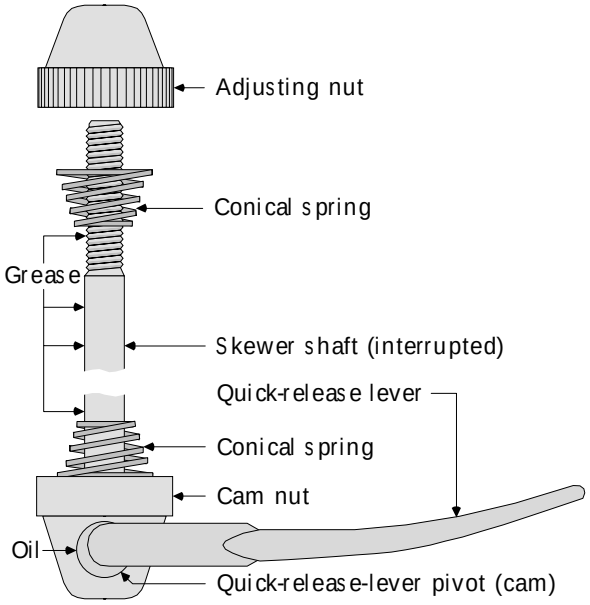
b) Lubricate pivot of quick-release lever.

c) Install conical spring so that small end points to threaded end of skewer (OK to omit both springs, but not one).

d) Install skewer in axle so that lever ends up on wheel's left side.

e) Install second spring over threaded end of skewer so that small end points inward (unless using no springs).

f) Thread on skewer adjusting nut.



18.23 *Parts identification and lubrication points of a quick-release mechanism.*

[ ] If skewer is already installed:
a) Lubricate quick-release lever pivot.
b) Check that there are two conical springs, or no conical springs (one is worse than none).
c) Check that small ends of conical springs point toward center.

3. **[ ] Slip wheel between fork blades and axle ends into dropout slots. For quick-release wheels, convention is that Q.R. lever is on bike's left.**
4. **[ ] Close sidepull quick-release mechanism or hook up cantilever/U-brake/centerpull straddle wire.**

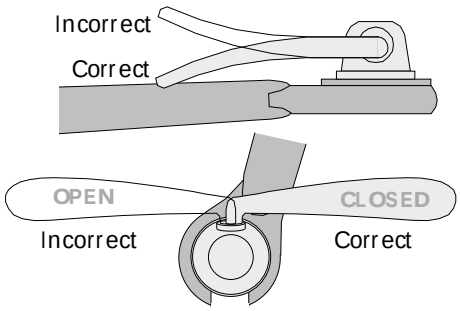
In the next step, make sure that the wheel is centered between the fork blades. This is not achieved automatically by shoving the axle fully into the dropout slots. Few manufacturers make forks so precisely that a properly-dished wheel will automatically center. It is possible to use a round file to extend the length of the axle slot in the dropout that is on the side of the fork that the rim ends up too close to. In most cases, this is not worth the trouble. A more practical approach is to make sure the wheel is dished, and install the wheel so that it is centered to the fork blades, center the brake to the rim, and from then on for all further wheel installations just install the wheel so that it ends up centered between the brake pads.

5. **Check one of following choices, depending on whether brake was centered to correctly dished wheel previously or not:**
   [ ] If brake was not centered to correctly dished wheel previously, position rim so that it is centered between fork blades. Secure wheel temporarily and recheck centering.
   [ ] If brake was centered to correctly dished wheel previously, position rim so that it is centered between brake pads. Operate brake several times to ensure pads are returning to their natural positions. Secure wheel temporarily and recheck centering.
6. **[ ] If quick-release wheel has safety-retention plates, install screws and tighten screws now.**

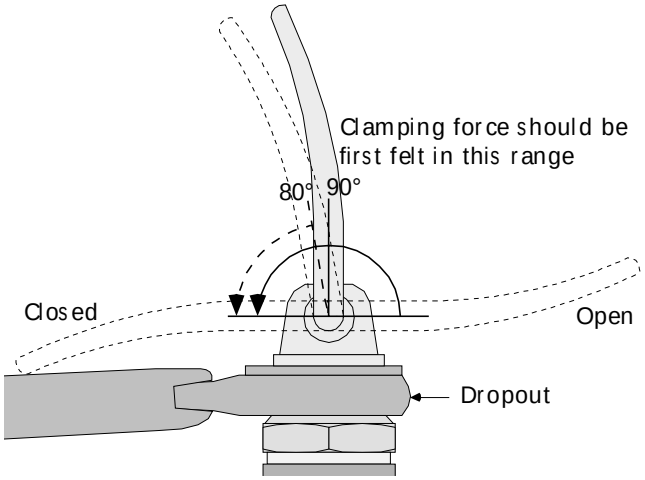
In the next step, the wheel is secured. There are few errors a mechanic can make that are more catastrophic than a wheel-mounting failure. If the wheel is retained by axle nuts, there is a simple procedure that guarantees a secure wheel: use axle washers, make sure the clamping surfaces of the axle fully engage the dropout surface, then use a torque wrench to tighten the axle nuts to the recommended torque.

If the wheel is retained by a quick-release mechanism, the solution is not so simple. Few manufacturers provide guidelines for use of the quick-release mechanisms; some of the manufacturers that do are simply quoting existing lore, rather than techniques that have been proven by research. "Existing lore" is the cause of many of the problems with quick-release mechanisms. It is strongly recommended that you read the earlier section, ***Wheel-mounting failure*** (page 18-2), before proceeding with wheel installation.

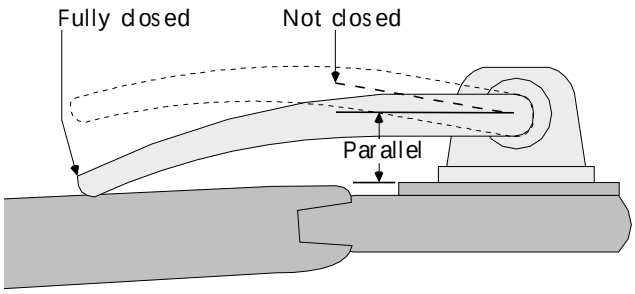
7. **Select one of following steps depending on whether wheel is retained by axle nuts or quick-release mechanism:**
   [ ] If wheel has axle nuts, secure nuts to a torque of 180–240in-lbs (30–40lbs@6") and check that rim is still centered as in step 5. If axle tends to rotate while securing axle nut, alternate tightening nuts on each side a little at a time.
   [ ] If wheel has quick-release mechanism:
   a) Flip lever from open position toward closed position and check if clamping force is first encountered when lever is close to pointing straight out (base of lever perpendicular to dropout face). If dropouts are wider than hub width, clamping force does not begin until both dropouts are contacting faces of axle hardware.
   b) If necessary, tighten or loosen adjusting-nut so that clamping force is first encountered when lever is close to pointing straight out (base of lever perpendicular to dropout face).
   c) Flip lever to open position and rotate skewer so that when lever is flipped to closed position, lever will end up adjacent to, but not overlapping, fork blade.
   d) Close lever so that base of lever ends up at parallel to dropout, or past point where it is parallel.
   e) If unable to close lever fully (base of lever parallel to dropout), open lever enough to be able to turn adjusting nut and loosen adjusting nut by *very* small increments until just able to close lever to parallel-to-dropout position.
   f) Check that rim is still centered as in step 5.



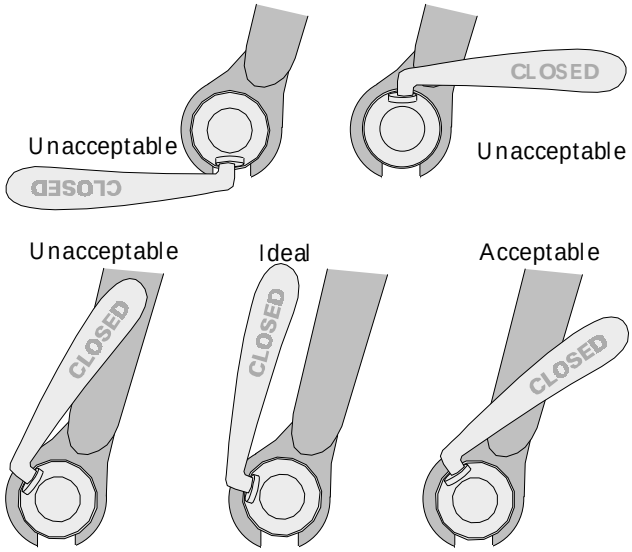
18.24 *The solid images are quick-release mechanisms as they appear when they have been closed properly by utilizing the cam (flipping the lever). The outlined levers are quick-release mechanisms as they appear when they have been secured incorrectly (as though the lever was a wing-nut).*



18.25 *When properly set, as the lever swings from the open to closed position, clamping force should first be felt when the base of the lever is 80-90°from the closed position (wih the base of the lever parallel to the dropout face).*



18.26 *When closed, the base of the lever* ***must*** *be parallel to the dropout.*



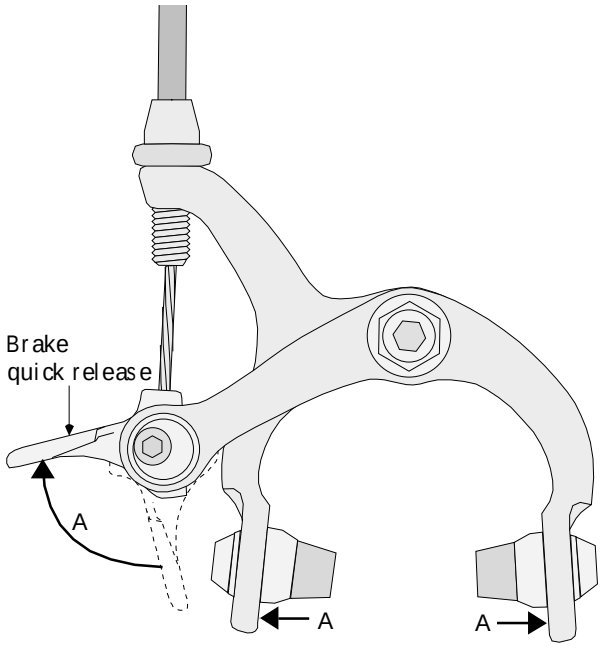
18.27 *When closed, the lever should be adjacent to, but not overlapping, the fork blade.*

8. [ ] Center brake pads as necessary (see chapter on brakes).

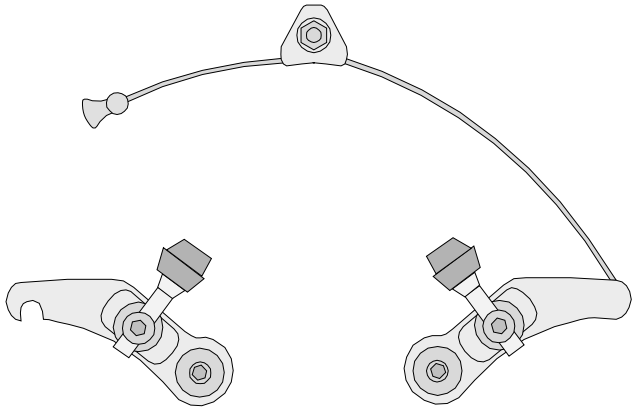
REAR WHEELS

Installing a rear wheel is relatively simple, but compared to a front wheel it is complicated by the chain and the fact that the wheel needs to be aligned between the chain stays (frame tubes between the crank set and rear axle) and the seat stays (frame tubes between the seat and the rear axle).

9. [ ] Check that sidepull-brake quick-release mechanism is released, or cantilever/U-brake/centerpull straddle wire is unhooked.



18.28 *A sidepull brake should be released before installing the wheel.*



18.29 *A cantilever brake should be released before installing the wheel.*

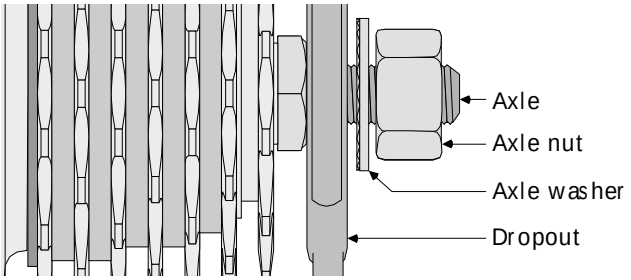
10. Check one of following choices, then perform lettered steps that follow checked choice:

[ ] If wheel is retained with axle nuts:

a) Remove axle nuts and washers, grease axle threads.

b) Install axle washers (textured face, if any, toward dropout).

c) Thread on axle nuts (any flange on axle nut faces toward dropout).



18.30 *Orientation of axle nut, washer, and dropout.*

[ ] If wheel has quick-release mechanism and quick-release mechanism has been removed from axle:

a) Lubricate skewer shaft and threads.

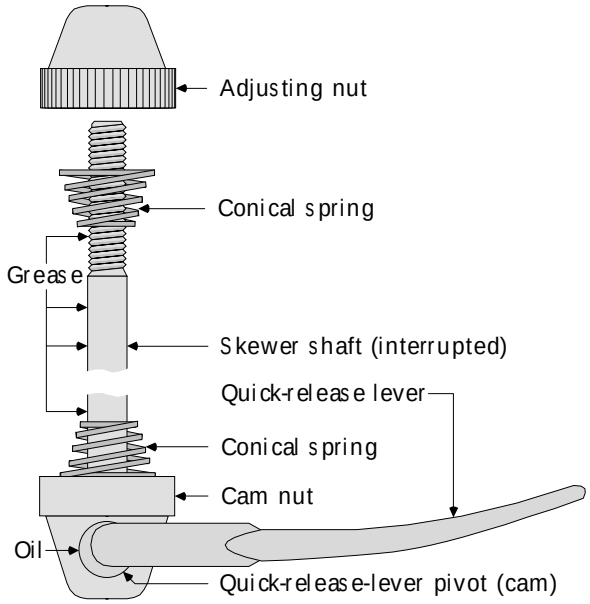
b) Lubricate pivot of quick-release lever.

c) Install conical spring so that small end points to threaded end of skewer (OK to omit both springs, but not one).

d) Install skewer in axle so that lever ends up on wheel's left side.

e) Install second spring over threaded end of skewer so that small end points inward (unless using no springs).

f) Thread on skewer adjusting nut.



18.31 *Parts identification and lubrication points of a quick-release mechanism.*

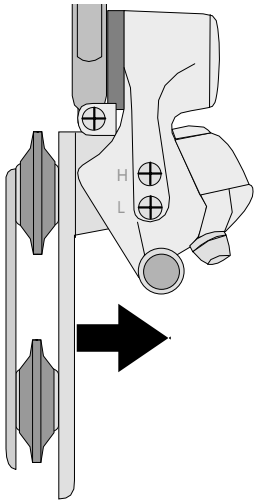
[ ] If skewer is already installed:

a) Lubricate quick-release lever pivot.

b) Check that there are two conical springs, or no conical springs (one is worse than none).

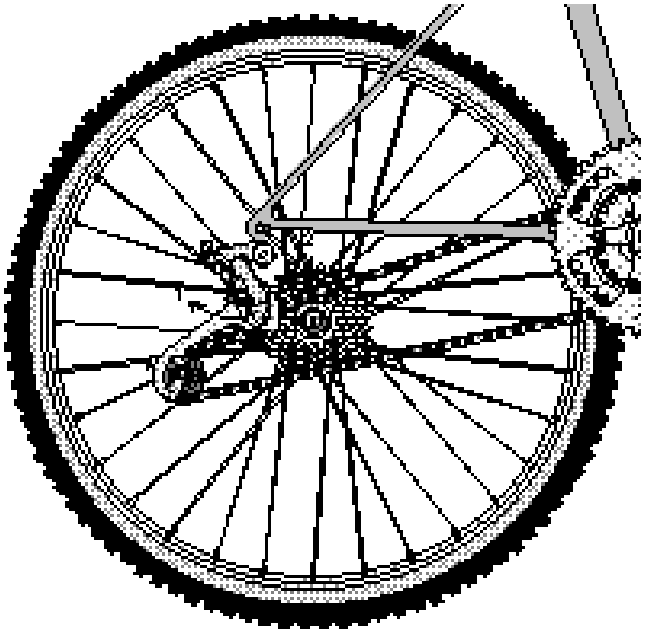
c) Check that small ends of conical springs point toward center.

11. [ ] Use right shift control to make sure rear derailleur is moved out as far as it will go.



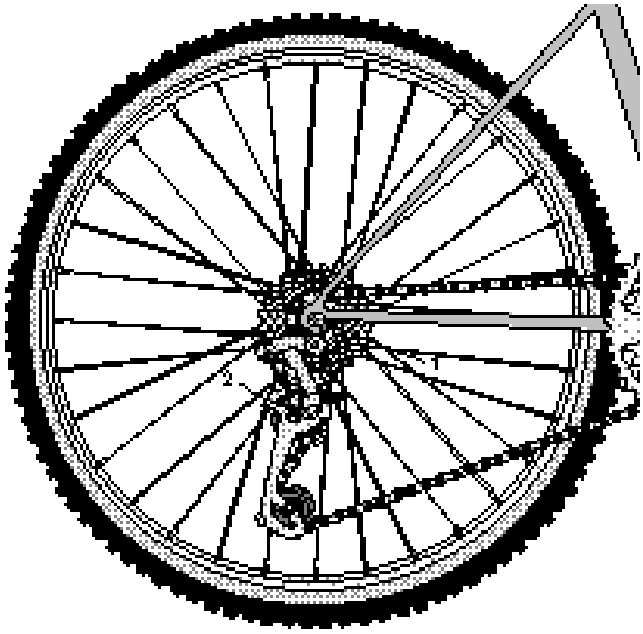
18.32 *Use the shift-control mechanism to position the rear derailleur fully out before installing rear wheel.*

12. [ ] Position wheel so that cogs are above section of chain running from bottom of crankset to bottom of derailleur and below section of chain running from derailleur to top of crankset.



18.33 *Rotate derailleur back, then place outermost cog of wheel between upper and lower sections of chain and engage outermost cog to upper section of chain.*

13. [ ] Pull back on derailleur and pull wheel up into dropout axle slots, making sure top of outermost cog engages chain.



18.34 *Pull wheel back and up so that axle seats in axle slots, then allow derailleur to swing forward.*

14. [ ] Temporarily secure wheel with quick release or axle nuts.

15. [ ] Close sidepull quick-release mechanism or hook up cantilever/U-brake/centerpull straddle wire.

In the next step, make sure that the wheel is centered between the seat stays and chain stays. This is not automatically achieved by shoving the axle fully into the dropout slots. Few manufacturers make frames so precisely that a properly-dished wheel will automatically center.

If the dropouts have horizontal axle-slots, then there will be ample adjustment to center the rim between the chain stays and a limited range of adjustment to center the wheel between the seat stays.

If the dropouts have vertical axle-slots, then there will be limited adjustment to center the rim between the chain stays and ample range of adjustment to center the wheel between the seat stays.

Because axle slots are often wider than the axle, it is usually possible to center the rim by moving the end of the axle at right angles to the direction of the slot. The slot may be filed wider to increase the amount of adjustment available. In most cases, this is not worth the trouble. A more practical approach is to make sure the wheel is correctly dished, then install the wheel so that it is centered as best as possible between the seat stays and between the chain stays. If the dropouts have vertical axle-slots, precise centering between the seat stays should be possible, but the potential to center the wheel between the chain stays may be limited; if the dropouts have horizontal axle-slots, precise centering between the chain stays should be possible, but the potential to center the wheel between the seat stays may be limited. After installing the wheel as best as possible, then center the brake to the rim. On subsequent wheel installations, the wheel should be installed so that it ends up centered between the brake pads.

Some dropouts with horizontal axle-slots have positioning screws in the dropouts that butt against the axle. Once the wheel is properly positioned, these screws can be adjusted so that both butt against the axle. To position the wheel when installing it at a later time, then just pull it back until both ends of the axle are against the positioning screws.

16. Check one of following choices, depending on whether the brake was centered to correctly dished wheel previously or not:

[ ] If brake was not centered to correctly dished wheel previously, position rim so that it is centered between seat stays and chain stays. Secure wheel temporarily and recheck centering.

[ ] If brake was centered to correctly dished wheel previously, position rim so that it is centered between brake pads and chain stays (unless brake is under chain stays, in which case rim should be centered between brake pads and seat stays). Operate brake several times to ensure pads are returning to their natural positions. Secure wheel temporarily and recheck centering.

In the next step, the wheel is secured. There are few errors a mechanic can make that are more catastrophic than a wheel-mounting failure. If the wheel is retained by axle nuts, there is a simple procedure that guarantees a secure wheel: use axle washers, make sure the clamping surfaces of the axle fully engage the dropout surface, then use a torque wrench to tighten the axle nuts to the recommended torque.

If the wheel is retained by a quick-release mechanism, the solution is not so simple. Few manufacturers provide guidelines for use of the quick-release mechanisms; some of the manufacturers that do are simply quoting existing lore, rather than techniques that have been proven by research. "Existing lore" is the cause of many of the problems with quick-release mechanisms. It is strongly recommended that you read the earlier section, ***Wheel-mounting failure*** (page 18-2), before proceeding with wheel installation.

17. Select one of following steps, depending on whether wheel is retained by axle nuts or quick-release mechanism:

[ ] If wheel has axle nuts, secure nuts to a torque of 240–300in-lbs (40–50lbs@6") and check that rim is still centered, as in step 16. If axle tends to rotate while securing axle nut, alternate tightening nuts on each side a little at a time.

[ ] If wheel has quick-release mechanism:

a) Flip lever from open position toward closed position and check if clamping force is first encountered when lever is close to pointing straight out (base of lever perpendicular to dropout face). If dropouts are wider than hub width, clamping force does not begin until both dropouts are contacting faces of axle hardware.

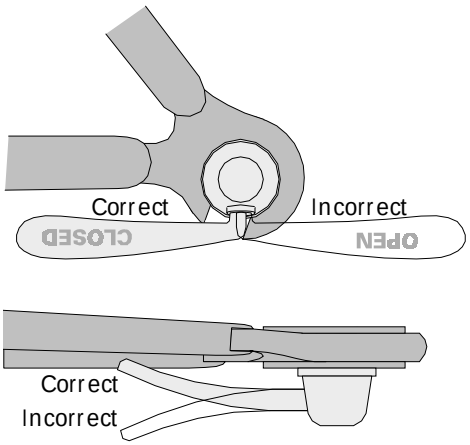
b) If necessary, tighten or loosen adjusting-nut so that clamping force is first encountered when lever is close to pointing straight out (base of lever perpendicular to dropout face).

c) Flip lever to open position and rotate skewer so that when lever is flipped to closed position, lever will end up adjacent to, but not overlapping, seat stay or chain stay.

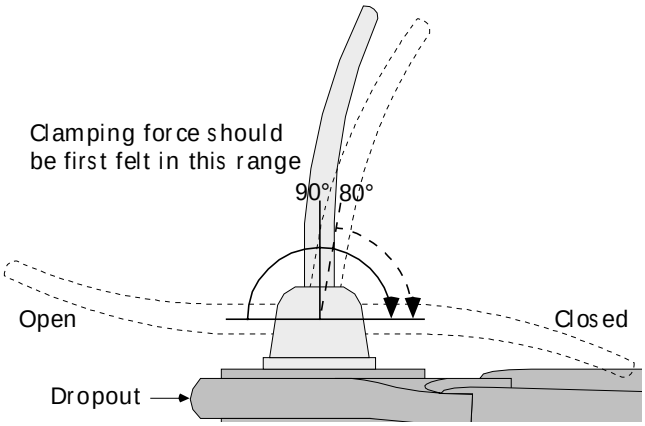
d) Close lever so that base of lever ends up at parallel to dropout, or past point where it is parallel.

e) If unable to close lever fully (base of lever parallel to dropout), open lever enough to be able to turn adjusting nut and loosen adjusting nut by *very* small increments until just able to close lever to parallel-to-dropout position.

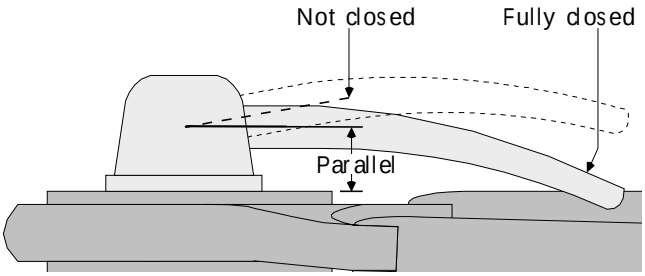
f) Check if rim is still centered as in step 16.



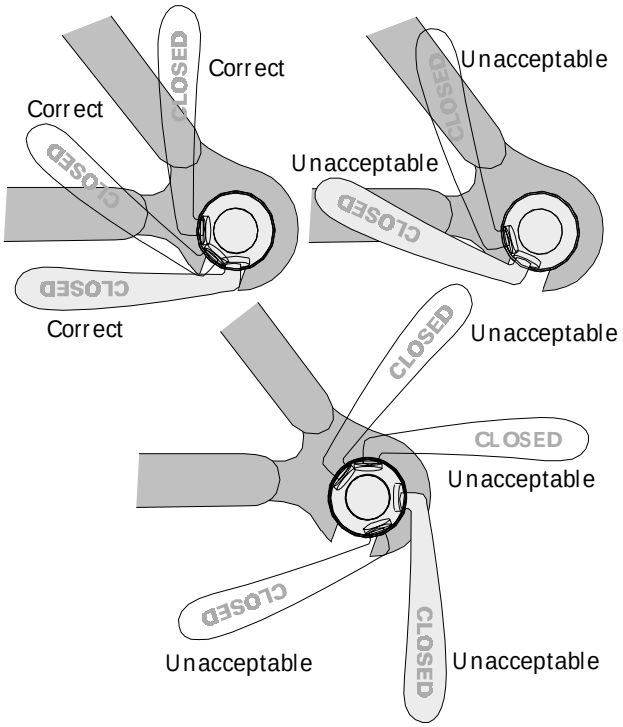
18.35 *The solid images are quick-release mechanisms as they appear when they have been closed properly by utilizing the cam (flipping the lever). The outlined levers are quick-release mechanisms as they appear when they have been secured incorrectly (as though the lever was a wing-nut).*



18.36 *When properly set, as the lever swings from the open to closed position, clamping force should first be felt when the base of the lever is 80-90°from the closed position (the base of the lever parallel to the dropout face).*



18.37 *When closed, the base of the lever* ***must*** *be parallel to the dropout.*



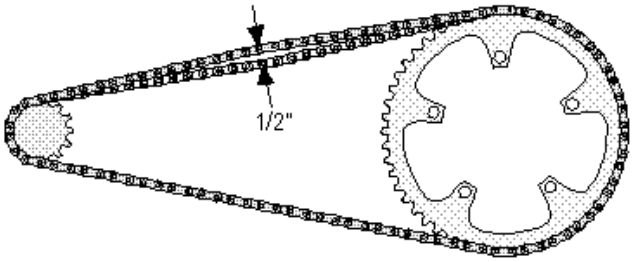
18.38 *When closed, the lever should be adjacent to, but not overlapping, the chain stay or seat stay.*

18.[ ] Center brake pads as necessary (see chapter on brakes).

19.[ ] Pedal cranks to make sure chain is running smoothly through derailleur and over free-wheel cogs, and shift chain to more inner freewheel cog so that the bike will be in an easier gear to get started in.

NON-DERAILLEUR-CHAIN TENSION

If the chain tension is too tight, it will not operate smoothly. If it is too loose, it will fall off. Because gears are not perfectly round, chain tension will vary depending on the point of rotation of the crank. Find the point at which the chain is tightest and adjust the wheel forward or backward until the chain will move up and down 1/2" at the point halfway between the front and rear gears.



18.39 *The chain should have 1/2" of free play when the crank has been rotated to the point that puts the chain under the most tension.*

WHEEL-REMOVAL AND INSTALLATION TROUBLESHOOTING

Cause	Solution
SYMPTOM: *Axle nuts or quick-release mechanism must be loosened further for wheel installation than was required for removal.*	
Dropout spacing is too wide for hub width.	Add spacers to axle set, or re-space the rear triangle or fork blades.
SYMPTOM: *Hands are needed to spread the dropouts in order to install the wheel.*	
Dropout spacing is too narrow for hub width.	Remove spacers from axle set, or re-space the rear triangle or fork blades.
SYMPTOM: *Wheel will not center automatically between fork blades when installed fully.*	
Axle is bent.	Remove wheel and inspect for bent axle.
Wheel is not properly dished.	Remove wheel and inspect wheel dish.
Dropouts are different height.	Live with the problem or use a file to change the axle slot in the dropout until the wheel centers properly.

Continued

WHEEL-REMOVAL AND INSTALLATION TROUBLESHOOTING (continued)

Cause	Solution
SYMPTOM: *Wheel cannot be centered between chain stays on bike with rear-dropout vertical axle-slots.*	
Axle is bent.	Remove wheel and inspect for bent axle.
Wheel is not properly dished.	Remove wheel and inspect wheel dish.
Chain stays are different lengths.	Live with the problem or use a file to change the axle slot in the dropout until the wheel centers properly.
SYMPTOM: *Wheel does not center between seat stays when installed fully in rear-dropout vertical axle-slots, or cannot be centered between seat stays at all (regardless of dropout type).*	
Axle is bent.	Remove wheel and inspect for bent axle.
Wheel is not properly dished.	Remove wheel and inspect wheel dish.
Dropouts are different height.	Live with the problem or use a file to change the axle slot in the dropout until the wheel centers properly.
SYMPTOM: *When axle is rotated, wheel changes position between fork blades or rear stays.*	
Axle is bent.	Remove wheel and inspect for bent axle.
SYMPTOM: *Wheel changes position after being installed.*	
Quick-release axle protrudes past axle locknut too far.	Remove wheel and make sure that axle protrusion is less than dropout thickness.
Quick release or axle nuts not adequately secure.	Secure quick release or axle nuts properly.
Axle nuts need washers.	Install washers between axle nuts and dropouts.
SYMPTOM: *Wheel is difficult to install when dropout width is good and wheel-retention mechanisms are adequately loose.*	
Dropouts badly misaligned.	Check and align dropouts.