

32 – REAR DERAILLEURS

ABOUT THIS CHAPTER

This chapter is about installing, adjusting, and servicing rear derailleurs. The procedures for installation and adjustment make references to installing the wheel, chain, shift-control mechanism, and cable. These items are fully covered separately in preceding chapters. This chapter also covers repair of derailleur-hanger threads.

The procedure assumes that the front derailleur is installed. The front derailleur need not be precisely adjusted, but must be capable of moving the chain to the innermost and outermost chainrings. It may seem like a good idea to install and adjust the front derailleur first, because of this. However, the front-derailleur procedure requires that the rear derailleur be able to shift the chain to the innermost and outermost positions, as well. Whichever is done first, to complete one derailleur adjustment it may be necessary to do some preliminary work on the other derailleur, as well.

There is some confusing and contradictory terminology used in regard to derailleurs, so be sure to become acquainted with the following terminology section to become clear on the terms used in *this* book.

GENERAL INFORMATION

TERMINOLOGY

High gear: With regard to rear derailleurs, high gear typically means the rear cog with the fewest number of teeth. It is called high gear because it results in the highest number when calculating gear ratios. It is confusing because the cog with the greatest number of teeth sticks up higher, and more teeth may seem to some to be “higher.” For this reason, this book will always use the more wordy alternative, *outermost gear*, or a letter code that is described in the following section **NAMING COGS AND GEAR COMBINATIONS** (page 32-3).

Top gear: Same as *high gear*.

First gear (or first position): Called *first gear* because it is the first one counted when counting cogs on the freewheel/freehub, this term is avoided because the innermost cog provides the lowest gear ratio, which might also be called *first gear*.

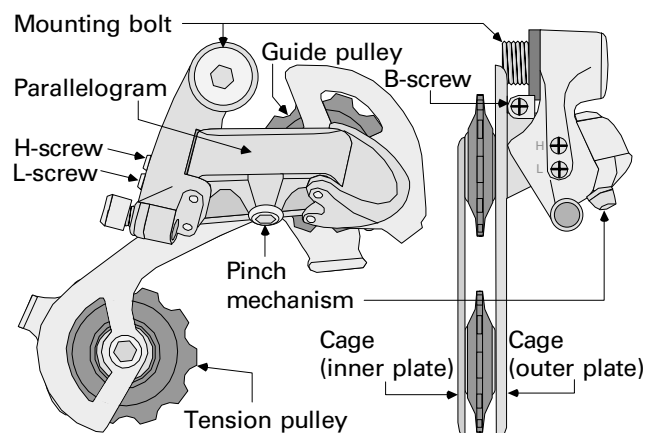
Outermost gear: The cog on the rear wheel that has the fewest teeth and is closest to the dropout. This term will be used instead of *high gear*, *top gear*, or *first gear*, or a letter code (described in the following section **NAMING COGS AND GEAR COMBINATIONS**, page 32-3) will be used.

Low gear: With regard to rear derailleurs, low gear typically means the rear cog with the greatest number of teeth. It is called low gear because it results in the lowest number when calculating gear ratios. It is confusing because the cog with the fewest number of teeth sticks up the least, and fewer teeth may seem to some to be “lower.” For this reason, this book will always use the more wordy alternative, *innermost gear*, or a letter code (described in the following section **NAMING COGS AND GEAR COMBINATIONS**, page 32-3) will be used.

Bottom gear: Same as *low gear*.

Last gear (or last position): A gear is called *last gear* because it is the last one counted when counting cogs on the freewheel/freehub, this term is avoided because the outermost cog provides the highest gear ratio, which might also be called *last gear*.

Innermost gear: The cog on the rear wheel that has the most teeth and is closest to the spokes. This term will be used instead of *low gear*, *bottom gear*, or *last gear*, or a letter code (described in the section **NAMING COGS AND GEAR COMBINATIONS**, page 32-3) will be used.



32.1 This side view and back view show the major parts of the rear derailleur.

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Limit screw: Adjustable stops that are used to stop the inward and outward motion of the derailleur at points that enable the chain to shift to the innermost and outermost cogs without going too far.

H-screw: A limit screw for stopping the derailleur from shifting the chain out past the outermost cog.

L-Screw: A limit screw for stopping the derailleur from shifting the chain in past the innermost cog.

B-Screw: A screw used to adjust the spring tension on the mounting pivot, which affects the distance between the cogs and the guide pulley.

Pulley wheel: A toothed wheel in the derailleur cage that the chain runs on.

Jockey wheel: An alternate name for a pulley wheel, generally the upper one. Guide pulley will be used instead.

Guide pulley: The upper pulley wheel in the derailleur cage that guides the chain from one cog to the next.

Tension pulley: The lower pulley wheel in the derailleur cage that pulls back on the lower section of chain to keep it under tension.

Derailleur cage: The assembly at the bottom of the derailleur that encloses the chain, consisting of two plates and two toothed wheels called pulley wheels.

Outer plate: The plate in the derailleur cage that is outward of the pulley wheels.

Inner plate: The plate in the derailleur cage that is inward of the pulley wheels.

Parallelogram: With regard to the rear derailleur, this is the part of the body between the mounting pivot and the cage pivot (consisting of two arms on four pivots) that actuates to move the derailleur cage inward and outward.

Adjusting barrel: A hollow screw in the derailleur that the inner wire passes through and the housing stops against. As the adjusting barrel is screwed in and out, the relative length or tension of the cable system is changed.

Pinch mechanism: The mechanism that attaches the inner wire to the derailleur. The inner wire is usually routed through a groove in a plate on the derailleur, and a bolt or nut presses a washer or plate on top of the inner wire to trap and compress it in the groove. The groove in the plate is often hidden by the pressure washer/plate.

Indexing: This describes a type of shifting in which the shift mechanism moves in distinct increments. These increments are designed to be just the right amount to get the chain to move precisely from one gear to the next. Indexing has virtually replaced friction shifting. In friction shifting, the lever moves

smoothly over its full range of motion without any incremented stops. It is up to the operator to decide what the correct amount of lever motion is to get from one gear to the next.

Derailleur hanger: The plate that the derailleur attaches to. Sometimes it is integral to the right rear dropout. Sometimes the right rear dropout is a two-piece construction so that the hanger can be replaced. On the most inexpensive bikes, the derailleur hanger is the plate that mounts between the dropout and the wheel-retention mechanism.

Stop tab: The tab near the bottom of the derailleur hanger that stops the forward rotation of the derailleur.

Mounting bolt: The bolt through the topmost part of the derailleur that attaches the derailleur to the derailleur hanger.

Mounting pivot: The derailleur pivots around the mounting bolt at the mounting pivot. This pivoting allows the derailleur to change position to accommodate changes in gear size as the derailleur moves in and out. This pivot also allows the derailleur to be rotated back to allow rear-wheel removal.

Return spring: When the tension on the inner wire is released, this spring inside the parallelogram causes the derailleur to move out as far as the outer-limit screw will allow.

Cage pivot: The pivot that the derailleur cage rotates about. The cage rotates so that the tension pulley can move forward or backward. This keeps the chain taught when its effective length changes as it is moved to gears of different sizes.

Cage stop screw (or pin): A screw (or pin) in the outer cage plate that bumps into the cage pivot housing to keep the cage pivot spring from completely unwinding when the chain is not in the derailleur.

Over-shift: When the chain moves too far, and does not align with the intended cog.

Under-shift: When the chain does not move far enough, and does not align with the intended cog.

In-shift: Any shift to a cog that is more inward than the one that the chain is currently on.

Out-shift: Any shift to a cog that is more outward than the one that the chain is currently on.

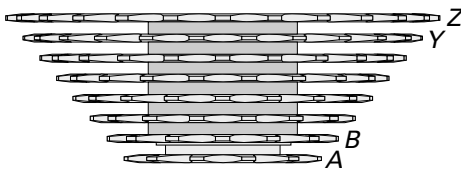
Up-shift: This term will not be used because there are two opposite ways that it could be understood. On a rear cogset, an up-shift could be an in-shift because the chain is moving up onto a cog of larger diameter. An out-shift could also be called an up-shift because the chain is being moved to a cog that will create a higher gear ratio. The terms in-shift and out-shift will be used to avoid this confusion.

Down-shift: This term will not be used because there are two opposite ways that it could be understood. On a rear cogset, a down-shift could be an out-shift because the chain is moving down onto a cog of smaller diameter. An in-shift could also be called a down-shift because the chain is being moved to a cog that will create a lower gear ratio. The terms in-shift and out-shift will be used to avoid this confusion.

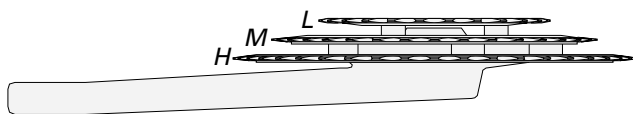
NAMING COGS AND GEAR COMBINATIONS

To perform certain adjustments, the chain needs to be in certain gear combinations. Numbering the gears to identify them does not work because rear cogsets have from 5 to 8 gears (so the innermost could be called 5, 6, 7, or 8), and cranksets have from 1 to 3 chain rings (so the innermost might be called 1, 2, or 3).

To avoid confusion, gears will be assigned codes as shown in figures 32.2 and 32.3 below.



32.2 “A” is always the outermost cog. “B” is always the next-to-outermost cog. “Y” is always the next-to-innermost cog. “Z” is always the innermost cog.



32.3 “H” is always the outermost chainring. “M” is always the middle chainring of a triple. “L” is always the innermost chainring.

Using the above diagrams, it should be easy to conclude that putting the chain in a gear combination of A/M would place the chain in the outermost position in the rear, and the middle position of a triple crank. Y/L would mean the chain was in the next-to-innermost position in the rear and the innermost in the front.

PREREQUISITES

Rear wheel installation

Part of a complete derailleur set-up is to align the derailleur hanger. The wheel must be installed in precise alignment to perform the derailleur-hanger alignment.

Shifter and cable installation

To adjust the rear derailleur, the shift-control mechanism and the cable system must be installed.

Chain sizing

Rear-derailleur performance is influenced by chain length. It is necessary to size the chain to optimized shift performance and to prevent derailleur damage.

INDICATIONS

Maintenance

Dirt accumulation and wear both affect derailleur performance.

The obvious dirt on the pulley wheels is a factor, but dirt hidden inside the mounting pivot and cage pivot can drastically influence shift performance. For this reason, normal maintenance of a rear derailleur should include disassembling and cleaning the entire derailleur.

Wear is a factor in the parallelogram pivots, the mounting pivot, and the cage pivot, but the most critical wear factor is a worn-out guide pulley. A normal part of derailleur service would be to replace the guide pulley. When the pivots are worn out, the derailleur must be replaced.

Changing freewheel/freehub cogset

Any time a freewheel or freehub cogset is replaced with anything other than an identical replacement, it is necessary to adjust the rear derailleur.

Replacing rear wheel

Any time a rear wheel is replaced with anything other than an identical replacement, it is necessary to adjust the rear derailleur.

Aligning rear dropouts

After aligning the rear dropouts, the derailleur-hanger alignment may have changed, which affects derailleur position and adjustment. Check and align the rear-derailleur hanger and adjust the derailleur.

Bent derailleur hanger

When bikes fall over on the right side, or when the derailleur is shifted past the Z cog and into the spokes, the derailleur hanger is likely to be significantly bent. This requires hanger alignment and derailleur adjustment.

Changing chain

Whenever a chain is changed, even if replacing a worn chain with an identical replacement, shift performance is affected. Fresh chains have less lateral flexibility than worn chains. Different chains

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have different performance characteristics. After replacing a chain, the derailleur adjustments should be checked.

Symptoms indicating adjustment is needed

There are a number of symptoms indicating a probable need for derailleur adjustment.

If the derailleur under-shifts or over-shifts when shifting to the *A* cog, or the chain makes excessive noise while on the *A* cog, the rear-derailleur H-screw may need adjustment.

If the derailleur under-shifts or over-shifts when shifting to the *Z* cog, or the chain makes excessive noise while on the *Z* cog, the rear-derailleur L-screw may need adjustment.

If any in-shift or out-shift to any cog between *A* and *Z* is hesitant, or results in excessive chain noise after the shift is completed, it indicates that the indexing needs adjustment.

If the shift performance is poor in several outer cogs but good in all the inner cogs, it may indicate that the B-screw or chain length need adjustment.

Symptoms indicating derailleur service is needed

There are several symptoms indicating that the derailleur should be cleaned or the guide pulley should be replaced.

Any time normal adjustments do not create acceptable shifting and all the components are known to be compatible, assume that disassembling and cleaning is needed and the guide pulley may need replacement.

When the derailleur body remains cocked back when shifting from the innermost cog out to the outermost cog, it is a good indication that the mounting pivot and cage pivot are fouled with dirt.

When the derailleur is obviously congested with dirt and gummed up, it should be disassembled and cleaned.

Symptoms indicating derailleur replacement is needed

The primary reason that derailleurs must be replaced is because they get bent. Other than adjusting barrels, pinch mechanisms, and pulley wheels, most parts are either unavailable or too costly to replace.

The most likely part of a rear derailleur to get bent is the cage. The symptom of a bent cage is that the two pulley wheels no longer share a common plane. When

sighting through the central plane of one pulley wheel towards the other, the further wheel should be hidden by the closer wheel. If not, the cage is probably bent. Although it is possible to improve this condition, it is difficult to eliminate it.

It is also possible that the parallelogram arms might be bent. It may be possible to see a twist along the length of the arm, or it may appear that the plate on the back of the mounting pivot is not parallel with the portion of the outer cage plate where it mounts to the cage pivot.

After a catastrophic shift of the derailleur into the spokes or spoke guard, it is possible that either the plate on the backside of the mounting pivot, or a tab on the mounting-pivot housing may be damaged. If the plate is bent, it can often be bent back. If the tab on the mounting-pivot housing is sheared off, the derailleur needs to be replaced.

The mounting pivot, cage pivot, and parallelogram pivots may all wear out to the point that shift performance is compromised. There is no way to quantify this wear, or point to a specific symptom that proves any of these pivots are significantly worn. When everything else is fine, but shift performance remains poor, consider these points for wear. Check the wear by jerking the bottom of the derailleur cage in and out and noting the amount of free play that is evident. Compare this to a new derailleur of similar brand and quality. If there is an obvious difference, then pivot wear may be the factor that is affecting shift performance.

TOOL CHOICES

Table 32-1 (page 32-5) shows most of the tools available for rear-derailleur adjustment. Preferred choices are shown in **bold** type. Choices are preferred because of a combination among: ease of use, versatility, durability, and economy. If more than one choice of a particular tool type is **bold**, it indicates that either different tools are needed to work on equipment with different configurations, or that several tools are equally preferred.

TIME AND DIFFICULTY

Rear-derailleur adjustment, including hanger alignment and cable-system setup, is a 12–16 minute job of moderate difficulty. Rear-derailleur removal, disassembling, cleaning, installation, and adjustment is a 30–35 minute job of moderate difficulty.

COMPLICATIONS

Component compatibility problems

See the following section, **COMPONENT COMPATIBILITY**, for the numerous complications that exist.

Damaged derailleur

Bent derailleurs are somewhat common, but not always obvious. It is not unusual to spend time adjusting the derailleur, only to find that it will never work well due to damage.

Damaged hanger

Derailleur-hanger damage can be very minor, or severe. Minor damage consists of slight bends or damaged threads. Slight bends can be aligned and damaged threads can be repaired or replaced. Major bends may require replacement of the dropout by a frame builder.

The recommended procedure starts all derailleur adjustments with a derailleur-hanger check. This eliminates the problem of getting most of the way through an adjustment procedure, only to find the hanger needs alignment and the adjustments will need to be redone.

Worn components other than derailleur

Worn chains, rear cogs, cables, and shift controls can all affect derailleur adjustment. It is usually not until the attempt to adjust the derailleur fails that these other factors will get considered, resulting in duplication of effort to adjust the derailleur.

Derailleur wear

Derailleur wear can be difficult to detect. The guide pulley is the most likely part to wear out, but removal is required to tell if the bearing is worn. The derailleur-mounting pivot, cage pivot, and parallelogram pivot can all be worn out without any clear evidence, but with a significant effect on the performance of the rear derailleur.

Dirty drive train

Dirt in the derailleur cage, pulley wheels, chain, cable system, shift-control mechanism, and rear cogs can affect shift performance. Adjusting a derailleur (particularly an indexing one) without cleaning all the related components has very limited potential for success.

COMPONENT COMPATIBILITY

As a rule, it is always best to follow manufacturer's recommendations when selecting components. If not following the manufacturer's recommendations, when non-compatible components are used together, it should show up as a shifting problem. Not all prob-

REAR-DERAILEUR TOOLS (table 32-1)

Tool	Fits and considerations
HANGER ALIGNMENT	
Campagnolo R	Sloppy pivot, not compatible with many wheel sizes
Park DAG-1	Low-play pivot, easy to use and to measure errors, fits all wheel sizes
Shimano TL-RD10	Expensive, complicated, sloppy pivot, allows hanger alignment without wheel in place in very limited circumstances
VAR 139	Even easier to use than Park DAG-1, but lacks Park's precision pivot
Wheels Mfg. GHT	Sloppy pivot, not compatible with many wheel sizes
FOURTH-HAND (CABLE-TENSION) TOOLS (These tools are same as used for front derailleurs and brakes.)	
Dia-Compe 556	Tends to let inner wire jam in tool
Hozan C356	Tends to let inner wire jam in tool
Lifu 0100	Consumer tool
Park BT-2	Least tendency for inner wire to jam in tool
VAR 233	Tends to let inner wire jam in tool

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lems are immediately obvious. If using non-matched components, do not assume that there are no compatibility problems until the indexing performance has been tested. There is a section in this chapter following the derailleur adjustment section about testing indexing performance (page 32-21).

Derailleur and hanger

These days, most derailleur hangers are of a relatively-uniform design. The variations that exist are in the thread type, the hanger length, and the angle of the stop tab on the hanger.

Almost all derailleur hangers have a 10 × 1mm thread, except Campagnolo dropouts, which have a 10mm × 26tpi thread. Fortunately, these two threads are a class B (acceptable) fit, in most cases. The problem comes if installing an aluminum mounting bolt into an aluminum hanger. The best solution is to always run a 10 × 1mm tap through the hanger before installing a derailleur or hanger-alignment tool. This will clean the threads if they already match, or convert a 10mm × 26tpi thread to the more common type.

Derailleur hangers differ in how far below the axle they position the mounting bolt of the derailleur. This affects two things: 1) The maximum-cog-size capacity of the derailleur (how large a rear cog can be accommodated). If the hanger is longer than normal, the derailleur may work with a larger cog size than it is rated for. If the hanger is shorter than normal, the derailleur may not work with the largest cog size that it is rated for. 2) The other problem created by hanger length is how it affects shift performance when it is longer than normal. An extra-long hanger will move the guide pulley further from the cogs (particularly outer ones). This means greater lateral motion of the derailleur is required for shifting, and can mean that an indexing derailleur will not perform adequately. A normal range of hanger length is approximately 24–30mm (axle-center to mounting-hole-center). Deviations from this norm are most often found on frames with aluminum dropouts.

Also, deviations in the angle of the hanger stop tab affect the distance from the guide pulley to the cogs. On many derailleurs, there is a body-angle-adjustment screw (B-screw) that compensates for these deviations. On some unorthodox dropouts, the angle of the stop tab may be beyond the capacity of the B-screw to compensate for. A normal range for this angle (measured from the vertical line through the center of the mounting hole) is 25°–35°, with larger values good for shorter hanger lengths, and smaller values good

for longer hanger lengths. Filing the stop tab can compensate for angles above 35°. Use of a longer B-screw may compensate for angles below 25°.

Derailleur and shift-control mechanism

With indexing systems, compatibility between the shift-control mechanism and derailleur is critical. This is because an indexing shifter will pull a specific amount of cable for each click. The derailleur must move in or out the right amount to line up with the next cog. If the amount of cable that is moved is wrong, then the derailleur will move the wrong amount.

The shift-control mechanism and derailleur should be brand-matched whenever possible. At the time of this writing, the only exceptions to this are a few aftermarket shift-control mechanisms that are made specifically for a different brand of derailleur, such as Grip Shift or Sachs controls made for Shimano derailleurs.

Even with brand-matching, there may be problems. Shimano Dura-Ace shift controls and derailleurs are not compatible with other models of Shimano equipment. A customer's 7-speed system may not be upgraded to 8-speed just by changing the shifter and the cogs. An 8-speed-compatible derailleur may be needed, as well.

Derailleur and cogset

In addition to being compatible with the shifter, the derailleur must be compatible with the cogset. For proper index performance, ideally the cogset should be a brand match with the derailleur. In addition, the derailleur needs to be suitable to the number of cogs in the cogset. In particular, 8-speed cogsets require derailleurs that have 8-speed capacity.

Inner wire and shift-control mechanism

The inner wire must be compatible with the shift-control mechanism because it is the combination of the shifter-drum diameter *and* the inner-wire thickness that determines how much cable is moved for a given amount of lever motion. See the **SHIFT-CONTROL MECHANISMS** chapter (page 30-2) for more information of shifter and inner-wire compatibility.

Maximum cog size

Every derailleur is rated for a maximum cog size. This number reflects the largest size cog that the derailleur can shift onto without jamming. The manufacturer's rating is based on an assumed derailleur-hanger length. If the actual hanger is longer than the assumed length, the derailleur may work on a cog that is a few teeth larger than the rating. If the actual hanger length is shorter than the assumed length, then the derailleur may not even work on a cog that is equal to the maximum-rated cog size.

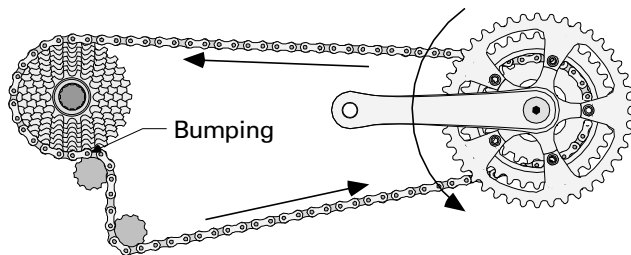
Ratings for derailleurs can be determined in several ways.

Manufacturer's literature: There is often an instruction sheet that comes with a new derailleur. This instruction sheet normally includes the ratings for the derailleur. In addition, some manufacturers can supply literature on request.

Sutherland's Handbook for Bicycle Mechanics: This book includes ratings for a wide variety of derailleur models, but is up-to-date for only a brief time after the date of publication. It is particularly useful if trying to figure out the capacity of an older-model derailleur that is currently on a bike.

Bike'alog: This computerized source reference for bicycle parts has capacity information for currently-available derailleur models.

Test method: To test if a derailleur's maximum-cog-size capacity is being exceeded, follow this procedure: Install the derailleur and size the chain normally. Shift the chain to the *L* chainring, then the *Z* cog. If the chain will not shift to *Z* (and the limit screw is loose enough), then maximum cog size has been exceeded. If the shift is completed, then tighten the B-screw (if any) all the way in. Backpedal and push up on the cage pivot housing. If the guide pulley moves closer to the *Z* cog, maximum cog size has not been exceeded.



32.4 If the chain length is correct and the B-screw is as tight as possible, this symptom indicates the maximum freewheel size of the derailleur has been exceeded.

Maximum total capacity

Every derailleur is rated for maximum total capacity. This number shows the derailleur's capacity to pull up slack chain when in the *A/L* position. The number (36T, for example) indicates the maximum sum for the rear-cog tooth differential added to the front-gear tooth differential. For example, a 12–30 cogset has a differen-

tial of 18 teeth. If the chainring set was 26–36–46, its differential would be 20 teeth. The sum of these differentials would be 38T. A derailleur rated 36T would not be able to pull up all the chain slack if used on a bike with these gears.

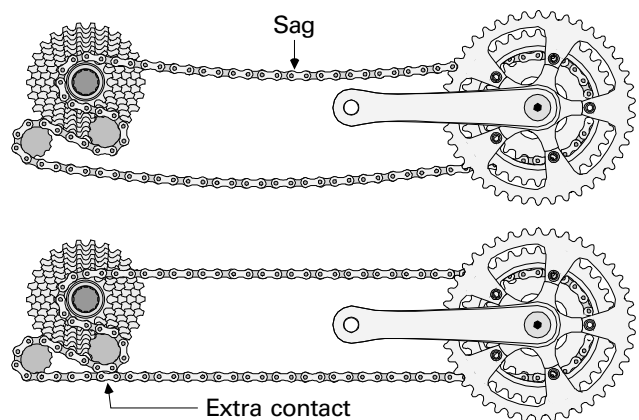
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Bike'alog: This computerized source reference for bicycle parts has capacity information for currently-available derailleur models.

Test method: To test if a derailleur's maximum total capacity is being exceeded, follow this procedure: Install the derailleur and size the chain at the shortest length that will allow the chain to keep a double bend through the derailleur cage when the chain is in the *Z/H* position. Shift the chain to the *A/L* position. Check if the chain hangs slack at the bottom or touches itself or the derailleur cage an extra time on its way from the tension pulley to the chainring.



32.5 These symptoms indicate the maximum capacity has been exceeded if the chain is not too long.

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Derailleur and first-cog position

The surface that the derailleur mounts to must be in a specified range of distance from the face of the *A* cog. If not, then indexing problems will be experienced. This relationship is a function of the thickness of the dropout/hanger and the right-side axle spacing. It can be adjusted by adding or subtracting spacers from the right side of the axle. In general, the shorter this dimension is, the better. The only limit is when the chain interferes with the frame or dropout when on the *A* cog, or when shifting between the *A* cog and the *B* cog. A typical distance from the face of the derailleur hanger to the face of the *A* cog is 11–14mm.

Derailleur and chain

Indexed derailleurs moved in fixed amounts. The chain must respond as expected for the shift to be completed. If the chain has more lateral flexibility than expected, then when the derailleur moves its fixed amount, the chain will not respond enough to complete the shift. Chains vary in lateral flexibility because of brand differences and wear. If manufacturer's recommendations are not adhered to, shift performance may be compromised.

Chain and cogs

The width of a chain must be suitable to the free-wheel/freehub cogset or it may rub against adjacent cogs. See the **CHAINS** chapter (page 26-2).

The shaping of the side plates of the chain affects the chain's ability to engage the cog teeth. When not using the manufacturer's recommended chain, shift performance may be compromised.

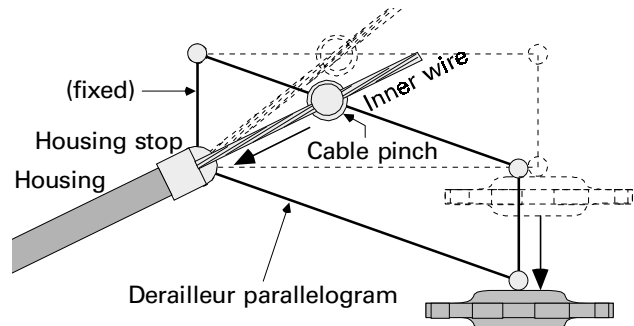
UNDERSTANDING HOW REAR DERAILLEURS WORK

The operation of a rear derailleur is relatively complex. By understanding what is happening in a rear derailleur, the sense of the procedures will become more apparent, and what to do when problems arise will be clearer.

How the cable moves the derailleur in and out

When the shift-control mechanism is operated in a way that pulls on the inner wire, the inner wire moves through the pieces of housing. This extra wire has to come from somewhere. That "somewhere" is the piece of exposed inner wire between the adjusting barrel and the pinch mechanism on the derailleur.

This piece of exposed wire is routed diagonally across the derailleur parallelogram. When the wire is pulled, the distance across the parallelogram is shortened, which deflects the lower end of the parallelogram inward. Figure 32.6 below shows this in a simplified form.



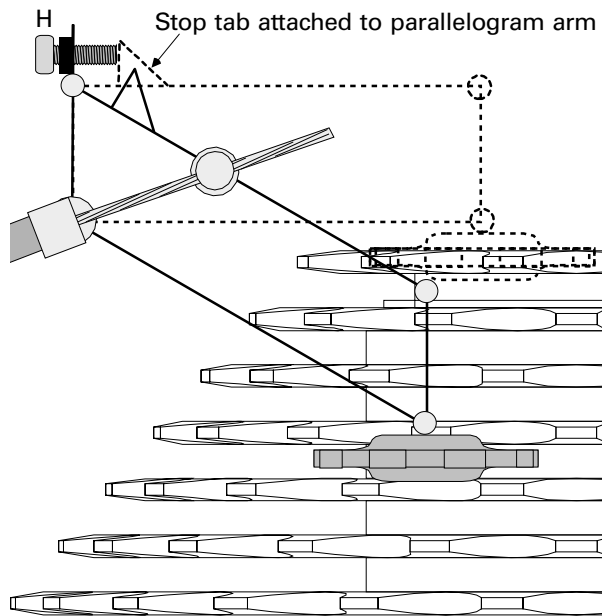
32.6 When the inner wire is pulled through the housing, it shortens the distance from the housing stop to the pinch mechanism, which changes the distance from one end of the parallelogram to the other. This translates into lateral motion of the derailleur cage.

When the tension on the cable is released, a spring in the parallelogram causes it to return in the direction of its starting point.

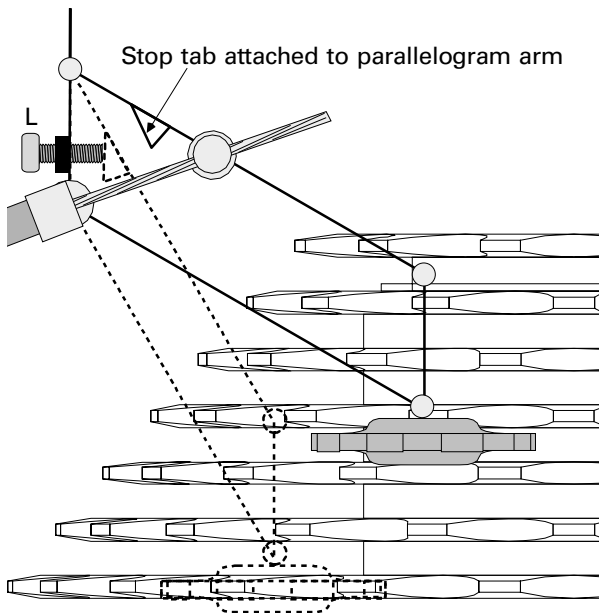
How limit screws work

The two limit screws are like two adjustable barricades. There is usually some projection or surface on a parallelogram arm that the limit screw butts up against. By adjusting one limit screw, the limit of the range of travel for the parallelogram in *one* direction will be altered. By loosening the H-screw, the barricade that stops the outward motion of the parallelogram is moved further out, so the parallelogram may move further out. By loosening the L-screw, the barricade that stops the inward motion of the parallelogram is moved further inward.

Changing the H-screw setting only changes the shift to the outermost cog. Changing the L-screw setting only changes the shift to the innermost cog. Figures 32.7 and 32.8 (page 32-9) shows a simplified and exaggerated model of how limit screws affect the range of motion of the parallelogram.



32.7 When the derailleur moves outward, a stop fixed on one of the parallelogram arms bumps into the end of the H-screw to stop the derailleur's motion.



32.8 When the derailleur moves inward, a stop fixed on one of the parallelogram arms bumps into the end of the L-screw to stop the derailleur's motion.

Why and how the guide pulley tracks close below the cogs

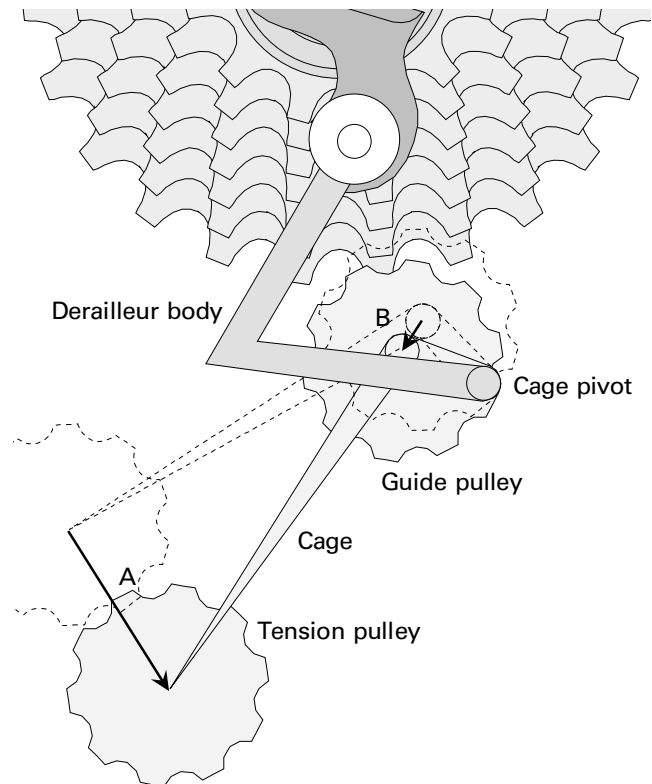
One of the most important factors in shift performance is the distance from the guide pulley to the bottom of the cogs. Between the guide pulley and the cog, there is an unsupported section of chain. When the

distance between the guide pulley and cog is short, it takes less lateral motion of the guide pulley to deflect the chain and get it to derail from one cog and engage another. For example: if 6mm of lateral motion of the guide pulley caused a 20° chain deflection when the length of unsupported chain was one link, then it might take 8mm of lateral motion of the guide pulley to cause a 20° chain deflection when the unsupported chain length was two links long. Consequently, for good index-shifting performance, the distance of the guide pulley from the cogs must be kept short and consistent.

This is done by a complex set of mechanical processes.

The simplest to understand is that the parallelogram is slanted. This is done so that the end of the parallelogram will move down as it moves inward towards the bottom of the larger cogs.

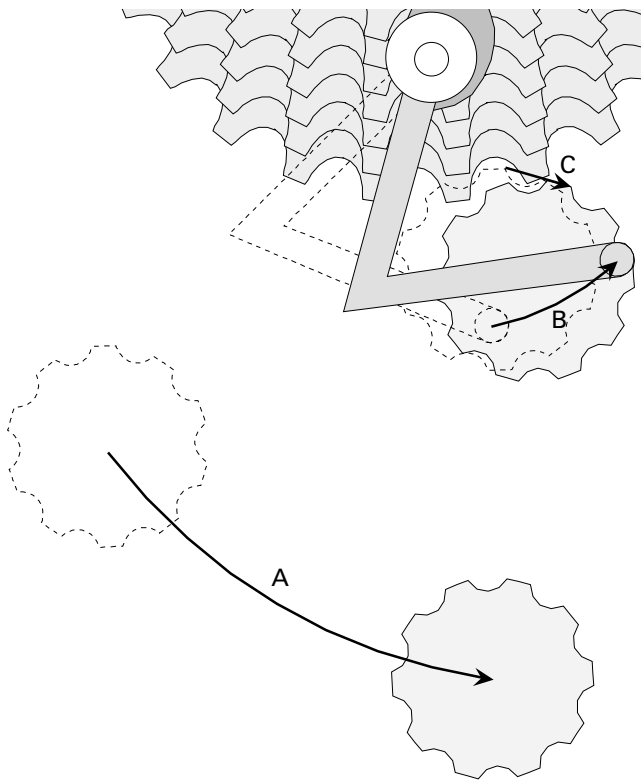
On most derailleurs, the center of the guide pulley is offset from the center of the cage pivot. The result of this is that as the cage rotates to take up more or less slack chain, the center of the guide pulley rotates around the cage pivot and changes its position relative to the cogs. It is this offset of the guide pulley to the cage pivot that makes chain length so important to shift performance.



32.9 If the chain is shortened a link or two, the tension pulley moves (A) and the pivoting cage moves the guide pulley away from the cogs (B).

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The last thing that affects guide-pulley position is the balance of the opposing springs in the mounting pivot and the cage pivot. One spring tends to move the guide pulley down, and the other moves it up. The mounting-pivot spring tension is adjustable by adjusting the B-screw. The cage-pivot spring tension is adjustable by disassembling the rear derailleur and moving the spring to a different mounting hole in the derailleur-cage plate. Consider this example: when the chain is shifted to the larger chainring, it pulls the bottom of the derailleur cage forward, which moves the guide pulley down. This counterclockwise cage rotation also increase the tension on the cage-pivot spring, which counterbalances the mounting-pivot spring more, and causes the derailleur body to rotate counterclockwise, moving the guide pulley back up.



32.10 When the chain is shifted to a larger chainring, the tension pulley moves (A), this moves the cage pivot counterclockwise (B). Due to the offset between the guide pulley and the cage pivot, the guide pulley moves less (C) than the cage-pivot moved.

ABOUT THE REST OF THIS CHAPTER

The rest of this chapter is divided into seven parts. The sections are:

INSTALLATION AND ADJUSTMENT

TESTING INDEX PERFORMANCE
REAR DERAILLEUR SERVICE
DERAILLEUR-HANGER THREAD REPAIR
REAR-DERAILLEUR TROUBLESHOOTING
SHIMANO RAPID-RISE DERAILLEURS
EIGHT- AND NINE-SPEED COMPATIBILITY

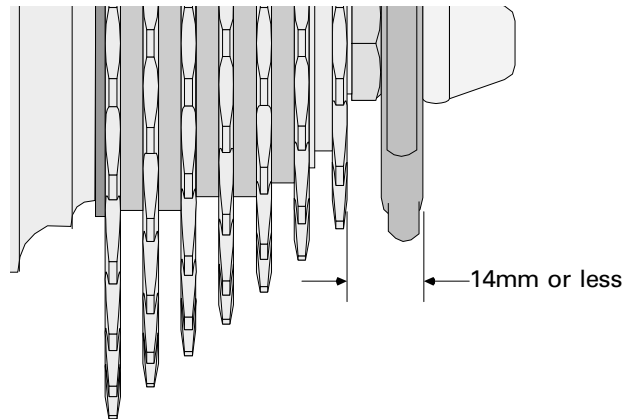
INSTALLATION AND ADJUSTMENT

INSTALLATION

NOTE: before proceeding further, be sure to be acquainted with the section, **NAMING COGS AND GEAR COMBINATIONS** (page 32-3).

Compatibility checks

1. [] Check reference information to determine that derailleur and shift-control mechanism are compatible.
2. [] Check reference information to determine that inner wire, housing, and shift-control mechanism are compatible.
3. [] Check reference information to determine that shift-control mechanism is compatible with brand of cogset and number of cogs.
4. [] Check reference information to determine if chain is compatible with cogset.
5. [] Check that face of A cog is no more than 14mm from face of derailleur hanger.



32.11 Measuring hanger face to A cog face.

Hanger alignment

The derailleur hanger is aligned to the plane of the rear wheel. For this to work well, the wheel should be correctly dished, reasonably true, and in the frame in good alignment. See the **WHEEL REMOVAL, REPLACEMENT, AND INSTALLATION** chapter (page 18-17) about install-

ing wheels. To measure whether the wheel is centered between a pair of stays, butt the end of the caliper up against a stay and extend the depth gauge to the rim. Get a similar reading from the opposite side, making sure the caliper is aligned in the same way and touches the rim at the equivalent point. If the readings are 1mm or less different, the wheel is well centered. If not, try re-aligning it by moving the axle slightly in the slots. The length of the slot allows adjustment in one direction, and the fact that the slot is wider than the axle allows some limited adjustment in the other direction. Lack of precision in the rear triangle may make it impossible to achieve the desired tolerance, in which case the wheel should be left as close as possible to centered.

6. [] Install correctly dished and trued rear wheel, so that there is $\leq 1\text{mm}$ centering error to seat stays and chain stays.

When aligning the hanger, measurements will be taken at the 12:00, 3:00, 6:00, and 9:00 positions on the rim. If the bike is tipped at the wrong angle, then the chain stay may interfere with getting the tool to the 3:00 position, or the seat stay may interfere with getting the tool to the 12:00 position. If the bike is positioned with the chain stay parallel to the ground or sloping slightly up to the front, then the tool will access all the points easily.

7. [] Put bike in position that puts chain stay parallel to ground or sloping up to front slightly.

NOTE: Some bikes have replaceable derailleur hangers that are brittle and prone to failure while being aligned. Do not align replaceable hangers unless a replacement is at hand.

8. [] Thread Park DAG-1 into hanger.

The Park DAG-1 can be adjusted to reduce play at the mounting-bolt pivot. This is done by means of tightening a small set screw in the portion of the tool that houses the mounting bolt. Reducing this play is critical to the accuracy of the tool, so do not skip the following step.

9. [] Check for excess play in tool pivot and adjust out play with set screw, if necessary.

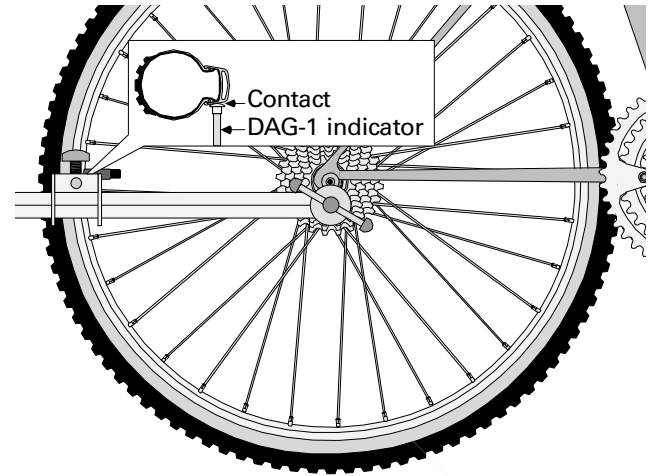
To reduce the significance of true errors, the rim will be rotated to the same four points as the tool, so that the reading is always being done to the same point on the rim. If the tire is installed, the valve stem makes a great rim reference point (RRP). If not, then put a piece of tape of the rim to make a RRP.

10. [] Put a piece of tape or a mark on rim for a rim reference point (RRP), or use valve stem.

Horizontal error is determined by measuring at the 9:00 and 3:00 positions. If there is error, there is no way to know in advance whether it will be a gap at 9:00 or 3:00. The procedure starts at 9:00, and then

goes to 3:00, anticipating that the gap will be found there. If there is a gap at 3:00, then it must be measured to determine if it is significant. If the tool indicator overlaps the rim at 3:00, then the tool should be reset at 3:00 and the gap should be checked at 9:00.

11. [] Adjust DAG-1 to just contact RRP at 9:00 position.

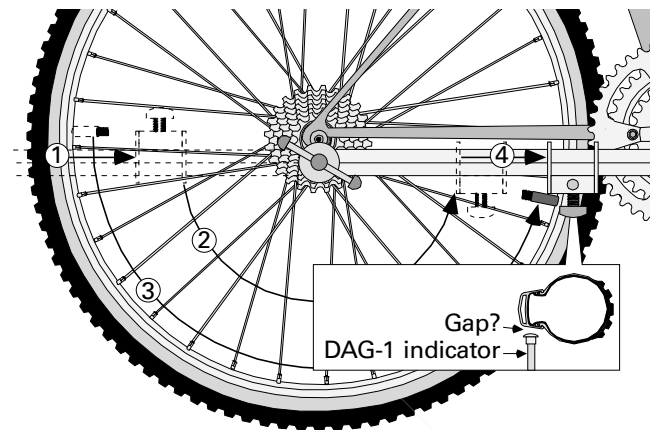


32.12 Set the tool to contact the RRP at 9:00.

To easily move the DAG-1 to 3:00, slide the indicator assembly in towards the tool pivot a few inches, then move the RRP and the end of the tool to 3:00. Once there, slide the indicator assembly out to the rim.

12. [] Move DAG-1 and RRP to 3:00 position (if tool overlaps rim, skip to step 14).

In the following step, use a 4mm stack of feeler gauges or a 4mm Allen wrench to check whether the gap is more or less than 4mm. If 4mm or less, the hanger alignment in the horizontal plane is good. If more than 4mm, then the error should be corrected.



32.13 1) move the indicator assembly in towards the wheel center, 2) rotate the DAG-1 to the 3:00 position, 3) rotate the RRP to the 3:00 position, 4) move the indicator assembly until the indicator is at the rim. Now, check the gap (or overlap) between the rim and indicator.

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To correct the error, slide the indicator along the main bar, away from the rim, then push in on the main bar of the tool. Keep in mind that a full correction will be done by pushing in enough to reduce the gap by half. If an over-correction is done, then the gap will switch to the position where the tool was initially set to have contact. It does not matter if the gap switches to the other position, as long as it ends up at 4mm or less.

13. If there is error, circle whether it is:

0–4mm gap, *minor error* — go to step 17

Overlaps rim, go to step 14

>4mm gap, *continue below*:

Correct by applying leverage to tool until gap is reduced by 50%.

Return tool and RRP to 9:00 and reset tool to just contact.

Return tool and RRP to 3:00 and check that gap is <4mm. (If overlap was created, correction was too much and should be reversed.)

Repeat correction as necessary until gap is <4mm, then go to step 17.

NOTE: If tool did not overlap rim at 3:00 in step 13, skip step 14–16.

14. Reset tool at 3:00 position to just contact RRP.

15. Move DAG-1 and RRP to 9:00 position:

16. If there is error, circle whether it is:

0–4mm gap, *minor error* — go to step 17

>4mm gap, *continue below*.

Correct by applying leverage to tool until gap is reduced by 50%.

Return tool and RRP to 3:00 and reset tool to just contact.

Return tool and RRP to 9:00 and check that gap is <4mm. (If overlap was created, correction was too much and should be reversed.)

Repeat correction as necessary until gap is <4mm.

After correcting the horizontal error, the vertical error needs to be checked and corrected. The procedure is exactly the same, other than the fact the two positions are 12:00 and 6:00.

17. Adjust DAG-1 to just contact rim at 12:00 position.

18. Move DAG-1 and rim reference point (RRP) to 6:00 position. (If tool overlaps rim skip to step 20.)

19. If there is error, circle whether it is:

0–4mm gap, *minor error, done*

Overlaps rim, go to step 20

>4mm gap, *continue below*:

Correct by applying leverage to tool until gap is reduced by 50%.

Return tool and RRP to 12:00 and reset tool to just contact.

Return tool and RRP to 6:00 and check that gap is <4mm. (If overlap was created, correction was too much and should be reversed.)

Repeat correction as necessary until gap is <4mm.

NOTE: If tool did not overlap rim at 6:00 in step 19, skip step 20–22.

20. Reset tool at 6:00 position to just contact rim.

21. Move DAG-1 and rim reference point (RRP) to 12:00 position:

22. If there is a gap, circle whether it is:

0–4mm gap, *minor error, done*

>4mm gap, *continue below*.

Correct by applying leverage to tool until gap is reduced by 50%.

Return tool and RRP to 6:00 and reset tool to just contact.

Return tool and RRP to 12:00 and check that gap is <4mm. (If overlap was created, correction was too much and should be reversed.)

Repeat correction as necessary until gap is <4mm.

While correcting the vertical alignment at 12:00 and 6:00, it is easy to mess up the horizontal alignment slightly. After correcting the vertical, check the horizontal again and correct whatever minor error may have been created. This need for a repeat correction can be reduced by achieving a near-perfect alignment when first doing the 3:00/9:00 alignment.

23. Recheck at 3:00 and 9:00 for a difference of 4mm or less, and correct as necessary in same fashion.

Lubrication of derailleur

24. Lubricate following points:

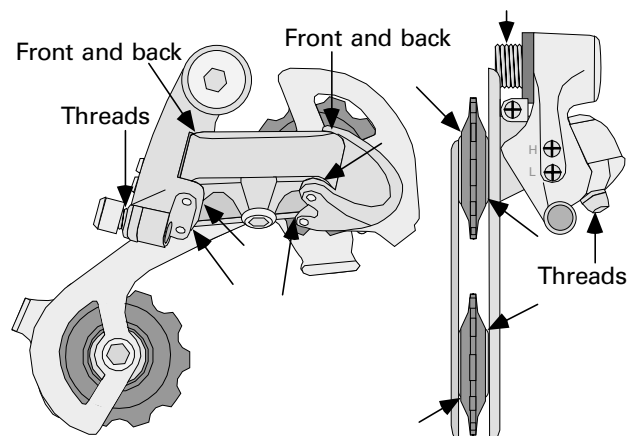
Edge of each pulley-wheel dustcap.

Both ends of all four parallelogram pivots.

Mounting-bolt threads.

Adjusting-barrel threads.

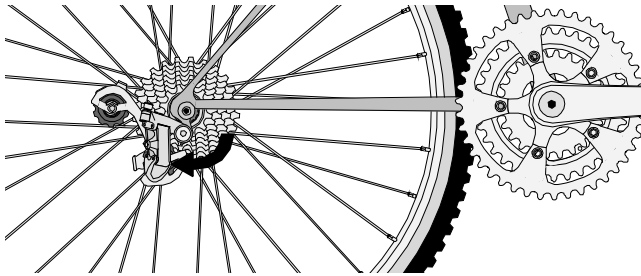
Pinch-mechanism threads.



32.14 Oil at all points indicated by arrows.

Attaching derailleur to hanger

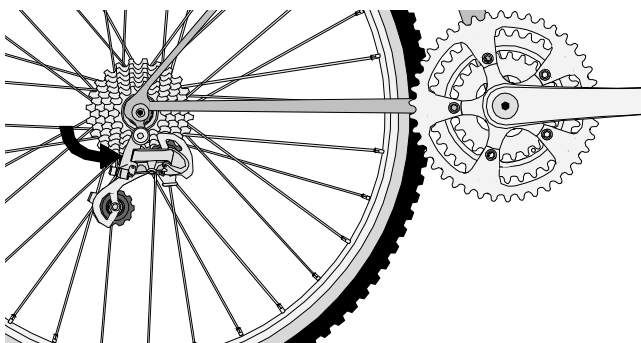
When mounting the derailleur to the hanger, it is easy to damage the derailleur or hanger if the derailleur is not lined up properly as the mounting bolt is tightened. To prevent this, rotate the derailleur considerably clockwise from its operating position, so that the stop tab or B-screw on the back of the derailleur is behind the stop tab on the bottom of the derailleur hanger.



32.15 The derailleur should be kept in this position while engaging and threading the mounting bolt into the hanger.

25. [] Line mounting bolt up with mounting hole in hanger.
26. [] Rotate derailleur clockwise until stop tab on mounting plate or end of B-screw is clockwise of stop tab on derailleur hanger.
27. [] Use T-handle Allen to thread mounting bolt into hanger, but do not secure.

Although it does not matter with most modern derailleurs, the derailleur should be rotated fully counterclockwise when the bolt is being secured. Some older derailleurs would hold any position they were in at the point the mounting bolt was secured. Rather than trying to figure out whether the derailleur being installed is one of the ones that holds whatever position it is secured in, just rotate all derailleurs fully counterclockwise just before the mounting bolt begins to tighten.



32.16 The derailleur should be kept in this position while securing the mounting bolt.

28. [] Rotate derailleur counterclockwise until stop tab on mounting plate or end of B-screw is against stop tab on derailleur hanger.
29. [] Secure mounting bolt to 70in-lbs (18lbs@4").

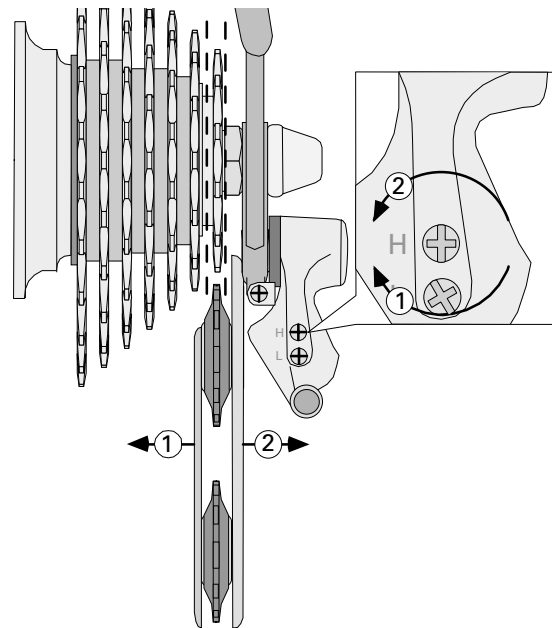
ADJUSTMENT

The processes of describing cogs by their relative positions and describing gear combinations involving different front chainrings and rear cogs can get very wordy and awkward. For this reason, all the following procedures use a code system to name different cogs and gear combinations. This code system is described in detail in the earlier section of this chapter, **NAMING COGS AND GEAR COMBINATIONS** (page 32-3). Become acquainted with this before attempting the following procedures.

NOTE: before proceeding further, be sure to be acquainted with the section, NAMING COGS AND GEAR COMBINATIONS (page 32-3).

Pre-setting limit screws

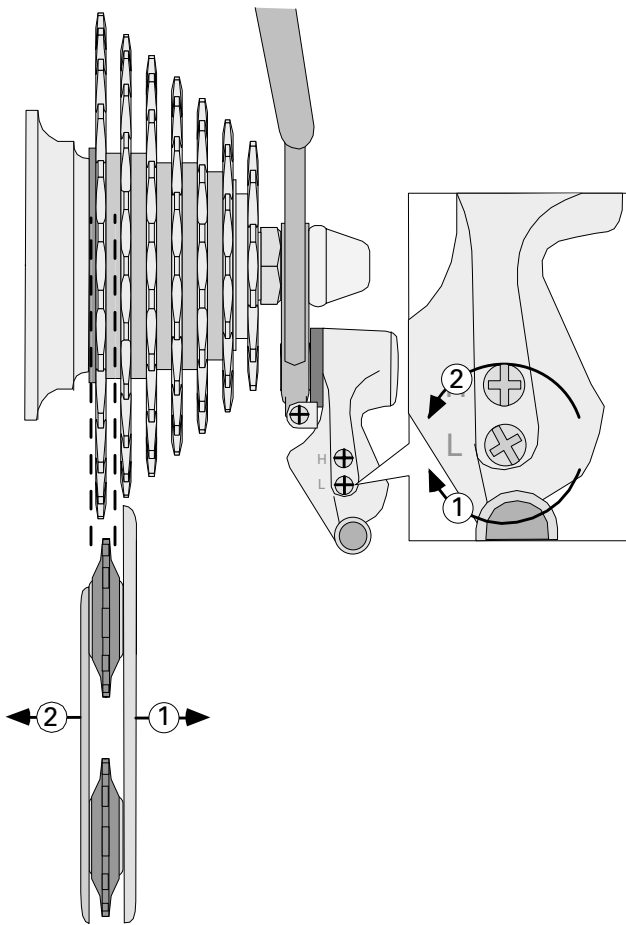
The limit screws need to be set in a very approximate fashion before the cable and chain are installed. The purpose of this is to keep the chain from shifting off the cogset while performing the final adjustments. *Precise adjustment of the limit screws is done later; do not waste effort doing step #30 and #31 too precisely!* When the H-screw is tightened, it reduces the outward range of motion of the derailleur. When the L-screw is tightened, it reduces the inward range of motion of the rear derailleur.



32.17 Turning the H-screw will change the derailleur's outward rest position in the direction indicated by the corresponding numbers. Adjust the screw so that the guide pulley ends up in the range indicated by the dashed lines.

30. [] Standing behind bike, check whether guide pulley is lined up below A cog. Tighten H-screw to move guide pulley in, or loosen to move guide pulley out.

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32.18 Turning the L-screw will change the derailleur's most inward position in the direction indicated by the corresponding numbers. Adjust the L-screw so that the innermost position of the guide pulley ends up in the range indicated by the dashed lines.

- 31.** [] Standing behind bike, move derailleur inward by hand to its limit of motion and check whether guide pulley lines up below Z cog. Tighten L-screw to restrict guide pulley from moving inward of cog, or loosen to allow guide pulley to move inward more.

Cable attachment

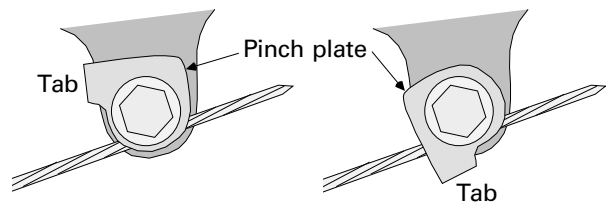
When adjusting an indexing derailleur, cable setup is critical to get good performance. Even if adjusting a derailleur on a bike with the cable already installed, removing the cable and setting it up by the procedures outlined in the preceding chapter, **DERAILLEUR-CABLE SYSTEMS** is highly recommended.

- 32.** [] Use procedures in **DERAILLEUR-CABLE SYSTEMS** chapter to install cable system.
- 33.** [] Loosen or disassemble pinch mechanism to find groove covered by pinch plate or washer.

Routing the inner wire through the pinch mechanism correctly can be counter-intuitive. The best procedure is to disassemble the pinch mechanism in order

to find the groove that the inner wire should sit in. The inner wire usually approaches the pinch mechanism in close to a straight line from the adjusting barrel, and goes through the pinch mechanism without bending.

Some pinch mechanisms have an irregularly-shaped plate that presses on the top of the inner wire. It is not always obvious how this plate is rotated. There are some that will fit in two different positions, but only one is correct. These plates typically have a narrow tab that hangs over one edge of the plate that is beneath the inner wire. See figure 32.19 for the correct orientation of this type of pinch plate.



32.19 The left picture shows correct orientation of the pinch plate, and the right one shows the wrong orientation.

- 34.** [] Lay inner wire into groove and gently secure pinch bolt/nut just enough to keep cable from falling out of pinch mechanism. If the pinch plate has a narrow tab that folds over edge of plate with groove, narrow tab always goes clockwise of section of wire entering pinch mechanism.

The inner wire needs slack removed, but not too much or it will interfere with the setting of the H-screw (particularly if the preliminary setting of the H-screw was somewhat too tight). In the next step, just pull *most* of the slack out of the inner wire before torquing the pinch nut/bolt.

- 35.** [] Pull most of slack out of inner wire by hand and secure pinch mechanism to 35in-lbs (12lbs@3") and check that inner wire is still in groove.

NOTE: Install front derailleur to roughly final position and attach front-cable system at this time, if front derailleur not already installed.

Chain length and capacity checks

- 36.** [] Install chain and size by procedure in **CHAINS** chapter (page 26-10).
- 37.** [] Shift chain to A/L position and check that chain does not hang slack or touch itself or derailleur cage an extra time, indicating length is too long or derailleur maximum capacity is exceeded.
- 38.** Check whether maximum-cog-size capacity of rear derailleur is exceeded:
[] Loosen B-screw fully.

- Shift chain to *Z/L* position.
- Backpedal and push up on cage pivot housing to check whether guide pulley is jammed against bottom of *Z* cog, indicating maximum-cog-size capacity is exceeded.

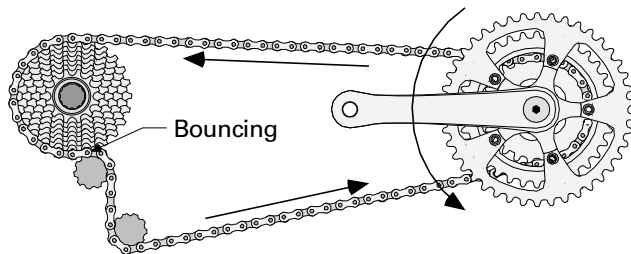
39. Check whether chain is too short:

- Shift chain to *Z/H* position
- Check whether chain has double bend where it passes through derailleur cage, indicating chain is *not* too short.

***B*-screw setting**

To maximize shift performance, the *B*-screw (if any) should be set to keep the guide pulley as close to the bottom of the cogset as possible. This procedure is based on starting with the *B*-screw as loose as possible, then turning it in if symptoms indicate that the guide pulley is too close to the *Z* cog.

The third check-off in step #40 suggests looking for a symptom that indicates that the guide pulley is too close to the *Z* cog. This symptom is described as *bouncing*. What will be experienced is either a grinding or rumbling noise, or it will appear that the derailleur is jerking up an down slightly at the guide pulley as each cog tooth passes by the pulley. It is possible that the symptom is caused by poor alignment of the guide pulley to the *Z* cog, because the *L*-screw and the indexing have not yet been finally adjusted. This can easily be checked. Rotate the derailleur body clockwise just enough to move the guide pulley 1/8" further from the *Z* cog. If the symptom goes away, the *B*-Screw needs adjustment. If the symptom does not go away, the guide pulley needs to be aligned more precisely with the *Z* cog before continuing with the *B*-screw check and adjustment.



32.20 With the chain in the gear combination shown, back-pedal and check for the bouncing symptom that indicates the *B*-screw is too loose.

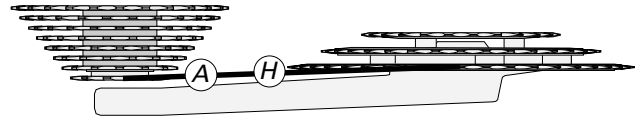
40. Adjust *B*-screw:

- Turn *B*-screw fully counterclockwise, if not already.
- Shift chain to *Z/L* position by using the shift control for front derailleur, and pulling on exposed inner wire with fingers to operate rear derailleur.

- While keeping rear derailleur in position under *Z* cog by maintaining pull on inner wire, backpedal to check whether guide pulley is bouncing off teeth on bottom of *Z* cog.
- Tighten *B*-screw by 1 turn increment if bouncing experienced, and repeat checks and adjustment until symptom is eliminated.

***H*-screw setting**

When the chain is on the *H* chainring, the rear-derailleur pulley wheel is pulled further from the *A* cog, making the shift more challenging. For this reason, the chain should *always* be on this chainring while performing an *H*-screw adjustment.



32.21 Proper chain position for beginning the check of the *H*-screw adjustment.

41. Shift chain to *H* using front-derailleur shift-control mechanism.

The shift-control mechanism should not be used to operate the rear derailleur because it can introduce variables that may make it appear as though the *H*-screw needs adjustment, when it does not. To bypass the shift-control mechanism, operate the rear derailleur by pulling out on the exposed inner wire at the down tube or top tube (wherever it is routed).

42. Shift chain to *B* by pulling on exposed inner wire at down tube or top tube with hand.

Pedaling cadence is very important when checking the shift to the *A* cog, because slow chain motion creates slow shifting. The normal time for a rider to shift to the *A* cog is when pedaling speed in the *B* cog has gotten too fast, so there is nothing realistic about checking the shift from the *B* cog to the *A* cog at low pedaling speed. The 60rpm recommended below is conservatively slow, so do not pedal any slower.

The inner wire should be released quickly, not gradually, because that is the way it will happen when the rider is using the shift-control mechanism to operate the rear derailleur. Slow release of the inner wire will create a false impression that the *H*-screw is too tight.

If the chain shifts promptly to the *A* cog when first checked, it does not mean the adjustment is acceptable. There is always a range of settings of the *H*-screw that will create an acceptable shift, but only the *tightest* setting that does so is a good one. The reason for this is that all settings of limit screws tend to change from tighter to looser with time and wear. By setting the screw at the tightest good setting, the longest time before the need

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for readjustment is assured. Consequently, if the initial check of the shift to the *A* cog shows no negative symptoms, then step #44 is done in order to *deliberately create a condition of the H-screw being too tight*.

When the H-screw is too tight, one of two symptoms will be experienced: either there will be unacceptable noise after completing the shift, or there will be a delay, hesitation, or failure to complete the shift.

Unacceptable noise after the completion of the shift can be subtle, and can be confused with normal noises that are always occurring as a chain feeds onto a cog. Two things will clarify whether the noise is normal, or from the H-screw being too tight. First, when the H-screw is too tight, the noise is created by the inner face of the chain rubbing against the outer face of the *B* cog while the chain is on the *A* cog. By standing behind the bike and looking under the cogset, this rubbing can be seen. If there is noise but no contact between the chain and the *B* cog, then the noise is not due to the H-screw being too tight. The second way to confirm whether the noise is because the H-screw is too tight is to loosen the screw one quarter turn more. If the noise is reduced, the over-tight H-screw was the cause. If the noise does not reduce, then the noise is normal chain noise.

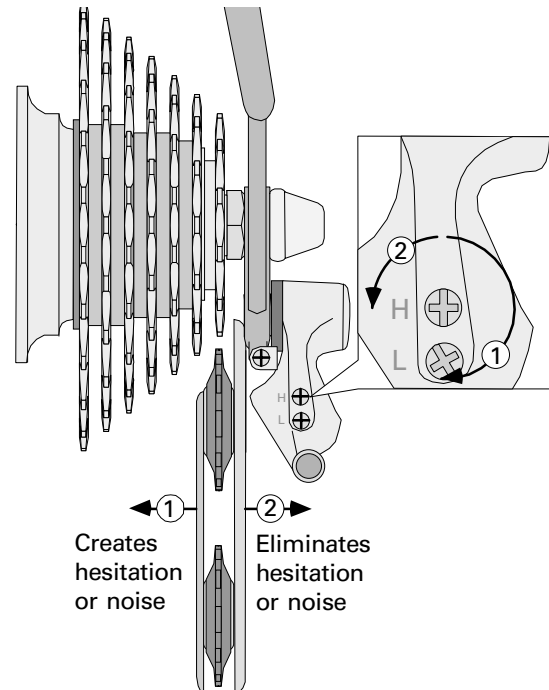
The other symptom that the H-screw is too tight is that the chain hesitates when shifting to the *A* cog. This hesitation can be a function of slow pedaling or slow release of the inner wire, so be sure these things are avoided. Not all derailleur systems shift equally quick, so this evaluation is somewhat subjective. The chain should *begin* to shift the instant the cable is released. If the cable is released and the shift happens half a pedal stroke later, that is definitely hesitation. Most modern derailleurs perform well enough that the primary symptom of a tight H-screw will be noise after the shift, not a hesitant shift. Obviously, if the chain will not shift to the *A* cog at all, then the H-screw is too tight.

When repetitive loosening of the H-Screw creates no progress, then the inner wire is probably too tight!

- 43. While pedaling at 60rpm or better, quickly release rear-derailleur inner wire and observe whether (check one):**
- Chain does not hesitate shifting to *A*, H-screw should be tightened, go to step 44.
 - Chain hesitates or clatters after shifting to *A*, H-screw should be loosened, go to step 45.

NOTE: Skip step 44 if chain hesitated or clattered after shifting in step 43.

If there was no symptom of the H-screw being too tight in step #43, then one must be created in step #44. There is no great precision needed when creating this symptom, so half-turn adjustments of the H-screw will get quick results. Later, when eliminating the too-tight symptom, greater precision is needed, so the H-screw will be loosened by quarter-turn increments.



32.22 Turning the H-screw will change the derailleur's outward rest position in the direction indicated by the corresponding numbers.

- 44. Turn H-screw 1/2 turn and repeat shift from *B* to *A*, checking for whether hesitation or post-shift clatter happens. Repeat this step as many times as necessary until either there is hesitation, or clatter after shifting.**

If the too-tight H-screw symptom was experienced when first checking the shift to the *A* cog in step #43, it could take any number of quarter turns of the H-screw to eliminate the symptom. On the other hand, if the too-tight symptom was deliberately created in step #44, then it should take either one quarter turn or two quarter turns of H-screw loosening to eliminate the symptom. This is because the H-screw was turned 1/2 turn to create the too-tight symptom from a setting that was not too tight in step #44.

- 45. Turn H-screw counterclockwise 1/4 turn and repeat shift from *B* to *A*, checking for whether hesitation or post-shift clatter is eliminated. Repeat this step as many times as necessary until symptoms are eliminated.**

A simple double-check can be done after the completion of the H-screw adjustment to check that it is not too loose. Tighten the H-screw 1/2 turn and check the shift. Too-tight symptoms should be *obvious* at this point, if the H-screw was set at the best possible setting.

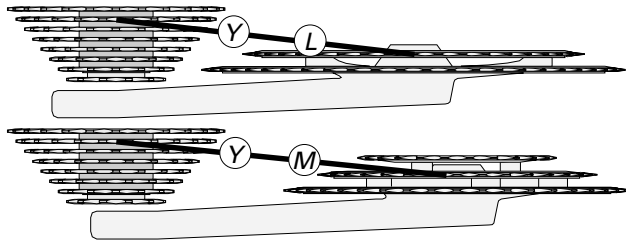
L-screw setting

Having the chain on the correct chainring when shifting to the Z cog to check the L-screw is important because the size of chainring changes the distance between the guide pulley and the Z cog. The largest chainring that would *normally* be used when the chain is on the Z cog is the M chainring on a triple-chainring set, or the L chainring on a double-chainring set. If the L-screw is set when the chain is on the H chainring, then the L-screw would end up even looser. On modern high-performance derailleurs this would usually be a small difference and only reduce the time before the L-screw would need readjustment by a small amount. On low-performance derailleurs the consequence would be more critical; setting the L-screw while the chain is on the H chainring could result in the chain shifting into the spokes, particularly when shifting onto the Z cog while the chain is on the L chainring (particularly on a bike with three chainrings).

46. [] Shift chain to M (triple chainrings) or L (double chainrings) using front derailleur shift control.

The shift-control mechanism should not be used to operate the rear derailleur because it can introduce variables that may make it appear as though the L-screw needs adjustment when it does not. To bypass the shift-control mechanism, operate the rear derailleur by pulling out on the exposed inner wire at the down tube or top tube (wherever it is routed).

47. [] Shift chain to Y by pulling on exposed inner wire at down tube or top tube with hand.



32.23 These are the correct positions for the chain when preparing to check the shift to the Z cog.

Pedaling cadence is very important when checking the shift to the Z cog because slow chain motion creates slow shifting. The normal time for a rider to shift to the Z cog is when the pedaling speed in the B cog has gotten too slow, so there is nothing realistic about checking

the shift from the Y cog to the Z cog at too high a pedaling speed. The 60rpm recommended here is somewhat fast, so do not pedal faster than 60rpm.

The inner wire should be pulled quickly, not gradually, because that is the way it will happen when the rider is using the shift-control mechanism to operate the rear derailleur. Slow pulling of the inner wire will create a false impression that the L-screw is too tight.

If the chain shifts promptly to the Z cog when first checked, it does not mean the adjustment is acceptable. There is always a range of settings of the L-screw that will create an acceptable shift, but only the *tightest* setting that does so is a good one. The reason for this is that all settings of limit screws tend to change from tighter to looser with time and wear. By setting the screw at the tightest good setting, the longest time before the need for readjustment is assured. Consequently, if the initial check of the shift to the Z cog shows no negative symptoms, then step #49 is done in order to *deliberately create a condition of the L-screw being too tight*.

When the L-screw is too tight, one of two symptoms will be experienced. Either there will be unacceptable noise after completing the shift, or there will be a delay, hesitation, or failure to complete the shift.

Unacceptable noise after the completion of the shift can be subtle, and can be confused with normal noises that are always occurring as a chain feeds onto Z cog. Two things will clarify whether the noise is normal, or from the L-screw being too tight. First, when the L-screw is too tight, the noise is created by the inner plates of the chain rubbing against the teeth of the Z cog as the chain feeds onto the Z cog. By standing behind the bike and looking under the cog set, this rubbing can be seen and the guide pulley should appear obviously outward from the Z cog. If there is noise, but the guide pulley lines up directly under or inward of the Z cog, then the noise is not being caused by a too-tight L-screw. The second way to confirm whether the noise is because the L-screw is too tight is to loosen the screw 1/4 turn more. If the noise is reduced, the over-tight L-screw was the cause. If the noise is not reduced, then the noise is normal chain noise, a too-loose B-screw, or even a *too-loose* L-screw.

The other symptom that the L-screw is too tight is that the chain hesitates when shifting to the Z cog. This hesitation can be a function of slow pedaling or slow pulling of the inner wire, so be sure these things are avoided. Not all derailleur systems shift equally quick, so this evaluation is somewhat subjective. The chain should *begin* to shift the instant the cable is pulled. It should not clatter while shifting. If the cable is pulled

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and the shift happens half a pedal stroke later, that is definitely hesitation. Obviously, if the chain will not shift to the *Z cog* at all, then the L-screw is too tight.

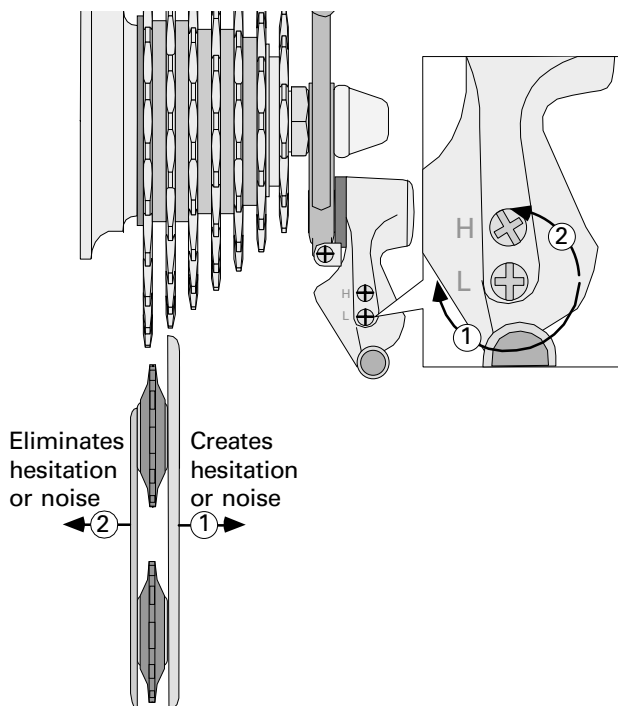
48. While pedaling at approximately 60rpm, pull rear-derailleur inner wire quickly and observe whether (check one):

Chain does not hesitate shifting to *Z*, L-screw should be tightened, go to step 49.

Chain hesitates or clatters after shifting to *Z*, L-screw should be loosened, go to step 50.

NOTE: Skip step 49 if chain hesitated or clattered after shifting in step 48.

If there was no symptom of the L-screw being too tight in step #48, then one must be created in step #49. There is no great precision needed when creating this symptom, so half-turn adjustments of the L-screw will get quick results. Later, when eliminating the too-tight symptom, greater precision is needed, so the L-screw will be loosened by quarter-turn increments.



32.24 Turning the L-screw will change the derailleur's most inward position in the direction indicated by the corresponding numbers.

49. Turn L-screw 1/2 turn and repeat shift from *Y* to *Z*, checking for whether hesitation or post-shift clatter happens. Repeat this step as many times as necessary until either there is hesitation on the shift, or clatter after the shift.

If the too-tight H-screw symptom was experienced when first checking the shift to the *Z cog* in step #48, it could take any number of quarter turns of the L-screw to eliminate the symptom. On the other hand,

if the too-tight symptom was deliberately created in step #49, then it should take either one quarter turn or two quarter turns of L-screw loosening to eliminate the symptom. This is because the L-screw was turned two quarter turns to create the too-tight symptom from a setting that was not too tight in step #49.

50. Turn L-screw counterclockwise 1/4 turn and repeat shift from *Y* to *Z*, checking for whether hesitation or post-shift clatter is eliminated. Repeat this step as many times as necessary until symptoms are eliminated.

A simple double-check can be done after the completion of the L-screw adjustment to check that it is not too loose. Tighten the L-screw 1/2 turn and check the shift. Too-tight symptoms should be *obvious* at this point if the L-screw was set at the tightest good setting.

Cable stressing

A frequently used term is *cable stretch*. There is never a great enough force on the inner wire to permanently change its length (stretch). Somehow, however, cable systems develop slack rapidly after installation. This development of slack can compromise the indexing adjustment. What causes this slack is the inner wire head seats into its socket, and the housing ends and fittings seat into their sockets. This can happen gradually as shifting loads are repeatedly put on the cable systems, or it can be simulated by stressing the cable system one time at a substantially higher load than normal. This over-load stressing also tests the cable system for integrity.

Since the systems will be over-loaded, it is important that the shift-control mechanism and the derailleur be in positions that can support the load. The derailleur should be at its innermost position, supported by the L-screw. The shift-control mechanism should be at its fully-released position, supported by its own internal stop. To accomplish this, the lever must be operated to put the chain on the *A cog*, and then the inner wire must be pulled manually while pedaling to put the chain on the *Z cog*. Once the chain is in place, stop pedaling and pull out hard on the inner wire a few times. Protect the hand from damage by using a multi-folded rag between your hand and the inner wire.

51. Make sure rear shift-control mechanism is fully released.

52. While pedaling, pull on exposed inner wire at down tube or top tube until chain is on *Z cog* and stop pedaling.

53. With chain still on *Z cog*, pull hard on exposed inner wire to seat cable heads and housing ends in stops and sockets, and to test integrity of pinch mechanism and cable system.

54. Pedal crank so chain returns to *A cog*.

Basic cable tensioning

Coarse adjustment of the inner-wire tension is done by pulling or releasing wire through the pinch mechanism on the derailleur. Fine tuning will be done afterwards by using the adjusting barrel on the rear derailleur.

55. [] Loosen inner-wire pinch mechanism.

The derailleur adjusting barrel should be turned back three full turns from fully in so that it can be turned in or out to loosen or tighten the inner-wire tension.

The shift-control-mechanism adjusting barrel should be turned back one full turn from fully in so that the rider can easily adjust the wire tension tighter or looser while riding.

56. [] Set derailleur adjusting barrel so that it is three full turns out from fully in, and shift-mechanism adjusting barrel so that it is one full turn out from fully in.

The fourth-hand tool is a very convenient tool for removing inner-wire slack, but it can easily be used to make the inner wire much too tight. If the inner wire is being tightened too much by the fourth-hand tool, it will usually show up as inward motion of the derailleur parallelogram. Watch for this while squeezing the fourth-hand tool.

57. [] Using fourth-hand tool, gently pull slack out of inner wire, being sure to stop before derailleur begins to move.

It is easy for the inner wire to slip out of its groove in the pinch mechanism while the tension is being reset. Be sure to check that the inner wire is in place before torquing the bolt/nut. If it is out of place, then the correct torque may not keep it secure.

58. [] Making sure inner wire is still seated in groove in pinch mechanism, secure pinch nut/bolt to 35in-lbs (12lbs@3").

59. [] Put chain in H/B position and check shift to A cog. If shift hesitates, inner wire was tightened too much in step 58.

Indexing adjustment

The concept of making an index adjustment is similar to a limit-screw adjustment. There is a range of adjustments that work, but only the tightest setting is best because it allows the greatest amount of deterioration to happen before the system becomes non-functional. The fundamental approach to the adjustment, therefore, is to deliberately create symptoms that the inner wire is too tight, then loosen the adjustment by small increments until the symptom is eliminated. The complication comes from the fact that when a shift is good to one cog, there may still be symptoms of a too-tight adjustment when shift-

ing to another cog. Consequently, the indexing adjustment consists of shifting into many different gear combinations, and loosening the index adjustment each time a too-tight symptom is encountered.

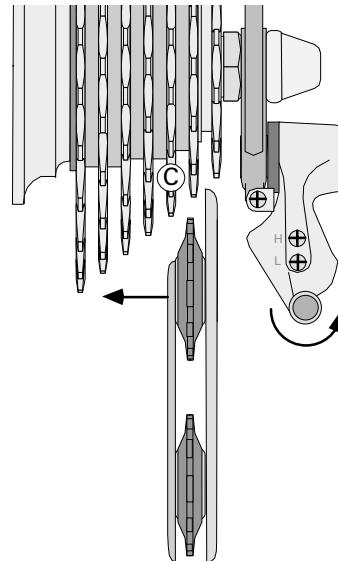
The index adjustment should start with the chain on the H chainring and the A cog.

60. [] Shift chain to H/A with shift-control mechanisms.

In the next step, the shift-control mechanism is used to move the chain to the B cog. One of three things may happen. First, the chain may fail to make the shift at all, indicating that the inner-wire slack was not adequately removed in step #57 (which should be redone). Second, the chain will complete the shift and it is time to continue with step #61. Third, the chain may shift all the way to the C cog, indicating that the inner wire was pulled too tight in step #57 (which should be redone).

61. [] While pedaling, move rear shift control one position to shift chain to B cog.

If the inner-wire tension was set correctly in step #57, the chain has just shifted to the B cog. Step #62 assumes that the chain is not rattling against the C cog and starts by creating that condition. If that condition exists from the beginning, just perform the portion of step #62 that loosens the adjusting barrel by 1/4 turn increments to eliminate the rattle.



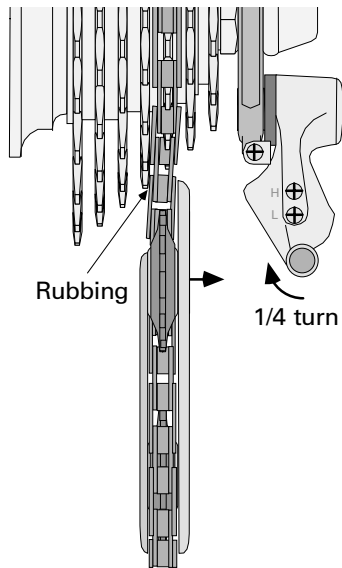
32.25 Turning the adjusting barrel counterclockwise to cause the chain the rub against the C cog.

62. [] While pedaling, turn adjusting barrel counterclockwise until chain begins to rattle against C cog, then turn in adjusting barrel by 1/4 turn increments to eliminate rattle. (At the point where rattle is detected, make a visual check from behind that the chain is touching the C cog.)

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Step #63 through #65 check whether there are any too-tight symptoms when shifting the rest of the way inward on the cogset (only to the *Y* cog) and all the way back out to the *A* cog. At any point a too-tight symptom is encountered, the adjusting barrel should be turned clockwise just enough to eliminate the symptom.

63. [] Shift chain to *C* cog and check for rattle against next cog inward. Turn in cable adjusting barrel by 1/4 turn increments to eliminate rattle if found.



32.26 Turn adjusting barrel 1/4 turn clockwise to eliminate rattle of chain against next cog inward. Repeat if necessary and check in all other gear combinations.

64. [] Continue in-shifts one cog at a time, eliminating any rattles found with 1/4 turn adjustments of the adjusting barrel, until the chain is on *Y* cog.

65. [] Shift out one cog at a time, eliminating rattles by turning in adjusting barrel in 1/4 turn increments, until chain is on *A* cog.

After all gear combinations with the *H* chainring have been checked and too-tight symptoms eliminated, it is time to run a similar check with the chain on the *L* chainring. The difference this time is that the chain needs to be shifted all the way to the *Z* cog.

66. [] Shift chain to *L* with shift control.

67. [] Pedal and check for chain rattling on *B* cog and turn in adjusting barrel to eliminate rattle if found.

68. [] Shift chain to *B* cog and check for rattle against next cog inward. Turn in cable adjusting barrel to eliminate rattle if found.

69. [] Continue in-shifts one cog at a time, eliminating any rattles found, until the chain is on *Z* cog.

70. [] Shift out one cog at a time, eliminating rattles by turning in adjusting barrel in 1/4 turn increments, until chain is on *A* cog.

If at any time during the index adjustment, symptoms that the cable is too loose are experienced at the same setting that creates symptoms that the inner wire is too tight, then something is set up wrong or parts are damaged, worn out, or not compatible. At this point, review the entire set up and refer to the troubleshooting information (page 32-29).

Inner-wire finish

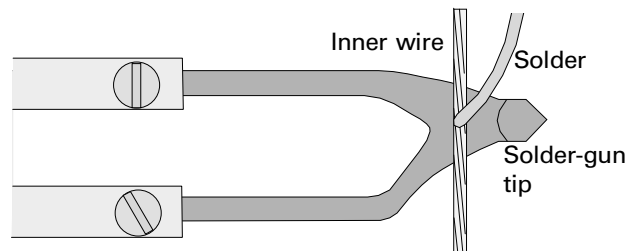
Excess inner wire should be trimmed and finished. Excess length is unsightly and may get caught in the chain. Soldering prevents fraying, which allows reuse of the cable whether a wire cap is being used or not. Wire caps do not prevent fraying, but they do prevent someone getting poked by the wire.

The fourth hand is put on the inner wire to act as a gauge to determine how much wire to leave. This remainder does not need to be any more than the fourth hand needs to grab.

71. [] Put fourth-hand tool on inner wire as if removing slack.

72. [] Trim inner wire with wire cutters just past fourth-hand tool.

The next step suggests soldering the end of the wire. This is easy to do and prevents fraying. To solder, a soldering gun, thin 40/60 rosin-core solder, and soldering flux are needed. Put flux on the inner wire. Hold the soldering-gun tip flat against one side of the wire until the flux sizzles away. Still holding the soldering-gun tip flat against one side of the wire, hold the tip of the solder against the other side of the wire, until the heated wire causes the solder to melt and flow into the wire. Some wires have a coating or are stainless steel and will not accept solder. In these cases, the wire will melt the solder, but the solder will not flow into the wire. Instead it beads up and runs off the wire.



32.27 Correct soldering technique.

73. [] Solder inner wire end.

Wire end caps are sometimes used instead of solder to prevent fraying. This will not work. Crimping the cap onto the wire frequently *causes* fraying. A soldered wire will not fray when the cap is crimped on. The real function of the wire cap is to cover the sharp end of the wire.

74. [] Put cap on end of inner wire if desired.

TESTING INDEX PERFORMANCE

The performance of any indexing-rear-derailleur system can be tested and measured. The procedures described above are designed to set the indexing adjustment at *the tightest setting that provides good shifting*. If the indexing system has normal performance, then there are probably looser settings for the cable that also enable shifting into all the gears. The range of adjusting-barrel positions from the tightest that provides good shifting to the loosest that will allow shifting into all the gears is called the *Functional Range of Adjustment* (or FRA).

The performance of all systems deteriorates with wear, a bent derailleur hanger, and the accumulation of dirt. When the FRA is narrow, then it will take only a small amount of riding before service is needed to restore acceptable shifting. When the FRA is extremely narrow, finding a correct adjustment at all is a challenge. When the FRA is broad, it will take much longer before service is needed. Consequently, it is to the rider's and the mechanic's advantage for the system to have a broad FRA.

There are two reasons to measure the FRA: first, it enables an accurate determination of whether parts might need replacement or cleaning on a used system; second, it permits an evaluation of whether a non-recommended part compromises indexing performance unacceptably.

There is no absolute value for an adequate amount of FRA. It varies with the brand and quality of equipment, as well as some other factors. For seven- and eight-speed systems, a FRA of at least three quarter turns of the cable adjusting barrel should be expected of new equipment. It is not unusual to get something more like four to six quarter turns.

If evaluating properly set-up used equipment that all meets manufacturer's specifications for compatibility and the FRA is not at least three quarter turns, then something in the system needs cleaning or replacement.

If evaluating any equipment, used or new, that *does not* meet manufacturer's specifications for compatibility and the FRA is not at least three quarter turns, then the non-matched equipment probably needs to be replaced.

If considering installing equipment in a system that may not be compatible, measure the FRA before the change, and again afterwards. If it is reduced, then the equipment change will downgrade shift performance. If it is still above three quarter turns, then it may be acceptable even though it is a downgrade of performance. This test process applies to mis-matching pulley wheels, chains, derailleurs and shifters, cable systems, and even mis-matching derailleurs with cogsets.

MEASURING THE FUNCTIONAL RANGE OF ADJUSTMENT (FRA)

1. [] Perform an index adjustment using steps 60–65 of the *INSTALLATION AND ADJUSTMENT* procedure for rear derailleurs.
2. [] Mark adjusting barrel at 12:00 so turns of adjustment can be tracked.
3. [] Turn adjusting barrel in (clockwise) 1/4 turn.

In the next step, a somewhat subjective evaluation of whether the adjustment is too loose must be made. As the adjustment is loosened, it is normal for performance to degrade *before* shifting actually is unacceptable. In an in-the-stand test, this loss of performance will be quite noticeable. It will even reach a point where a delay in releasing the shifter (after the click is reached) will be required to effect the shift. For the rider on the bike, this deterioration of performance will take place gradually over a long period of time, without being nearly so noticeable.

For this reason, consider a symptom of the cable adjustment being too loose to be either of the three following things: first, when an in-shift cannot be completed except by moving the shifter two positions, the cable adjustment is too loose; second, when moving the shifter one position to create an out-shift and the chain unavoidably moves two cogs, then the cable adjustment is too loose; third, if after completing a shift, the chain *clearly* is making a noise as a result of trying to shift to the next cog outward, then the cable adjustment is too loose. Before concluding that the adjustment is too loose based on chain noise after the shift, always look below the cogset to see that the chain is actually angled obviously out from the cog it is on.

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4. [] With chain on *H* chainring, shift chain from *A*, to *B*, to *C*, etc., until cog *Y* is reached, then out one at a time until back to *A*. Pedal several crank revolutions at each cog and check for symptoms of indexing adjustment too loose (circle result).

At 1 quarter turn in: too loose? No Yes
At 2 quarter turns in: too loose? No Yes
At 3 quarter turns in: too loose? No Yes
At 4 quarter turns in: too loose? No Yes
At 5 quarter turns in: too loose? No Yes
At 6 quarter turns in: too loose? No Yes
At 7 quarter turns in: too loose? No Yes
At 8 quarter turns in: too loose? No Yes

5. [] With chain on *L* chainring, shift chain from *A*, to *B*, to *C*, etc., until cog *Z* is reached, then out one at a time until back to *A*. Pedal several crank revolutions at each cog and check for symptoms of indexing adjustment too loose (circle result).

At 1 quarter turn in: too loose? No Yes
At 2 quarter turns in: too loose? No Yes
At 3 quarter turns in: too loose? No Yes
At 4 quarter turns in: too loose? No Yes
At 5 quarter turns in: too loose? No Yes
At 6 quarter turns in: too loose? No Yes
At 7 quarter turns in: too loose? No Yes
At 8 quarter turns in: too loose? No Yes

6. [] Repeat steps 3–5 as many times as necessary until first symptom of indexing adjustment being too loose is encountered. Record how many quarter turns it takes to reach this point here: ___ quarters.

7. [] If comparing performance between two equipment choices, install other equipment and repeat steps 1–6, but record new number of quarter turns needed to create symptom of indexing adjustment too loose in this blank: ___ quarters.

The resulting numbers in step #6 and #7 are not the FRA because the last adjustment made the shifting non-functional. The actual functional range of adjustment would be described as 1/4 turn less than the number in either of these steps. Thus, if the first symptom of too loose showed up at three quarter turns, then the FRA would be two quarter turns (truly poor).

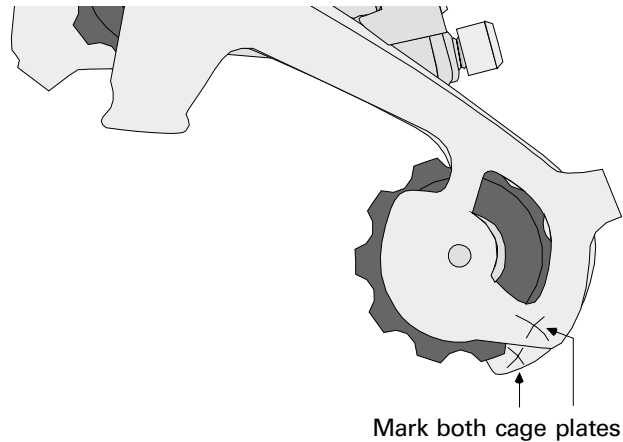
REAR-DERAILLEUR SERVICE

PULLEY-WHEEL REPLACEMENT AND CAGE CLEANING

The rear-derailleur cage and pulleys may need service when nothing else in the rear derailleur needs service, because of wear and the accumulation of grime that builds up in this area. This is a very simple service to do. It can be done without derailleur, cable, or chain removal; usually no adjustments are required (unless they were already needed).

Pulley-wheel removal

- [] Shift chain to *A/L* position, then manually drop chain off to inside of *L* chainring so that chain rests on bottom-bracket shell.
- [] Use marker or scribe to put mark on each derailleur-cage plate near bottom end so that marks line up with each other and are both visible from same side of derailleur cage.



32.28 *Mark both cage plates to make it easy to restore their correct orientation.*

When the tension pulley is removed (if it is an after-market cartridge-bearing pulley) there is a good chance that there are small washers between the pulley wheel and cage plates so that the cage plates end up correctly spaced from each other. Look carefully for these washers, as they are easy to loose and hard to replace.

- [] Remove bolt through tension pulley (lower) from either front or back of cage, and catch tension pulley as it falls out of cage. (Watch carefully for any washers that might be sandwiched between tension pulley and inner faces of cage plates.)

Tension pulleys and guide pulleys are often not identical on indexing derailleurs. The word “tension” or the letter “T” may appear on the tension pulley. The

only difference that may be seen, at this time, is that the tension pulley may have thinner teeth than the guide pulley, or there may be a wear difference. If any difference can be seen at this time, note it in step #4. If no difference can be seen now, it is still possible that a difference will be apparent once the guide pulley is removed. There will be another opportunity to note marks or features when the guide pulley is removed.

4. **Inspect tension pulley for any marks or features that might distinguish it from guide pulley, which is often different. Note features or marks here:** _____
5. **If bolt through guide pulley has head on outer face of cage, rotate cage counter-clockwise until bolt head is easily accessed.**
6. **Remove bolt through guide pulley and catch inner cage plate and guide pulley as bolt is withdrawn from them. (Watch carefully for any washers that might be sandwiched between tension pulley and inner faces of cage plates.)**

The guide pulley often has special features that enhance shift performance. It may be marked or have features that distinguish it from the tension pulley. The word “guide” or letter “G” may appear on the pulley. Shimano pulleys may have the word “Centeron” on the guide pulley, or the guide pulley may have a white ceramic bushing and sleeve inside the pulley. The guide pulley is likely to have thicker teeth than the tension pulley. The guide pulley may show more wear on the teeth than the tension pulley.

7. **Inspect guide pulley for any marks or features that might distinguish it from tension pulley, which is often different. Note features or marks here:** _____

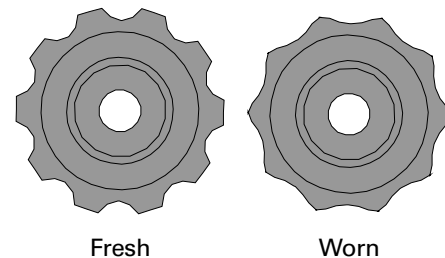
Shimano pulley wheels sometimes have soft rubber seals around the metal dustcaps. These seals have an inner and outer face, and it is not intuitive which face is which, so observe closely as the seals are removed. Sealed cartridge-bearing pulley wheels have a broad flat rubber seal and no dustcap. This seal can be carefully pulled out with a seal pick, so that the bearings can be cleaned and greased. Be careful not to bend the seals. The front sides are black rubber, but the back faces of these seals are thin metal plates that are easily bent.

8. **Carefully remove any dustcaps or seals from faces of pulley wheels.**
9. **Remove any bushings from inside of pulley wheels, noting whether bushings in guide and tension pulleys are different.**
10. **Clean all parts thoroughly, including both cage plates.**

Inspection of pulley wheels

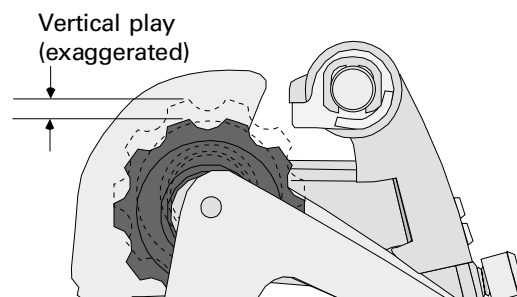
Conventional pulley wheels (with bushings) wear out two different ways, and both affect shifting performance.

Guide pulleys, in particular, develop tooth wear. The teeth are normally shaped like short plateaus. As they wear, the width of the top of the plateau is narrowed and the tooth may actually develop a point on top. See figure 32.29 below. When there is tooth wear on the tension pulley, it is usually more on one face of the teeth than the other. This often indicates a problem with chainline, hanger alignment, or a bent cage.



32.29 *A fresh guide pulley and a worn one.*

Pulleys also wear between the bushing and the hole in the pulley. This may show up two ways. When the pulley wheel is mounted in the cage, if it has obvious radial play then it is worn out. Radial play is detected by jerking the pulley wheel up and down on its pivot. See figure 32.30. Also, when the pulley wheel is apart, a groove may be apparent in the surface of the bushing.



32.30 *If the pulley wheel can be moved up and down, the bushing and sleeve are worn out and the pulley should be replaced.*

Cartridge-bearing pulleys fail regularly due to grease failure in the bearings. If, after removing the seals, cleaning out the grease and adding fresh grease, the pulley does not turn smoothly on its bearing, it should be replaced.

Replacement of pulley wheels

Always replace pulley wheels with original equipment. Even simple brand matching may not be enough. For example, an older Shimano Deore XT derailleur

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for use with 7-speed cogsets has pulley wheels that are fatter than the ones that are used on newer Deore XT derailleurs that are 8-speed compatible.

“Upgrade” pulley wheels are marketed heavily to the consumer. These products promote that they have more durable teeth and bearings, and that they provide lower friction. Their metal teeth often make the drive train noisier. Their “sealed” bearings are prone to seizure because of water-caused grease failure. However, their teeth are generally more durable. Some make claims of index compatibility, yet have none of the key features of the pulley wheels they are supposed to replace. If curious about index compatibility of pulley wheels, test for it by using the indexing performance test described earlier in this chapter (page 32-21).

Pulley-wheel installation

11. [] Oil bushings and inside faces of dustcaps lightly, or stuff bearings of cartridge-bearing pulley wheels with grease.
12. [] Assemble bushings into pulley wheels, and install dustcaps and seals to each pulley wheel.
13. [] Treat threads in cage plate for cage bolts with Loctite 222.
14. [] Hold inner plate and outer plate together and find orientation that puts marks together and visible from same side.
15. [] Insert bolt through upper hole in cage plate that has no threads in holes, and slip guide pulley over hole.

After torquing the cage bolt, the next step checks whether the pulley rotates freely. If it does not rotate freely, the bushing may have been left out or switched between pulleys, spacing washers on cartridge-bearing pulleys may be out of place, the dustcap or seals may be out of place, the inner cage plate may be upside down or facing backwards, or non-compatible pulley wheels are being used. *Failure of the pulley wheel to rotate freely is never caused by too much torque on the bolt!*

16. [] Line up other cage plate and thread bolt into hole, torquing to 35in-lbs (12lbs@3"). Check that guide pulley rotates freely.
17. [] If derailleur and chain are on bike, place tension pulley inside loop of chain and push tension pulley into lower end of cage.
18. [] Line up lower holes of cage plates and tension pulley, and insert bolt through holes.
19. [] Thread in lower bolt and torque to 35in-lbs (12lbs@3"). Check that tension pulley rotates freely.

There is often a keeper tab on one or both of the cage plates that helps keep the chain inside the cage. When assembling the cage, it is possible to get the chain

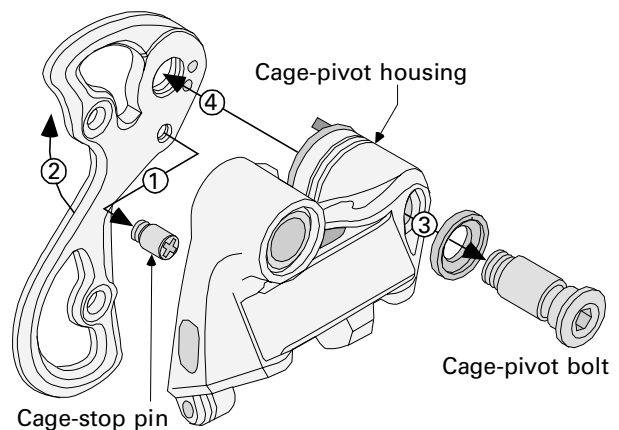
stuck *outside* this keeper tab. In the next step, check that the chain goes straight from the front of the guide pulley to around the back and bottom of the tension pulley, without interfering with any parts of the cage plates.

20. [] If derailleur and chain are installed, backpedal briefly and observe that chain runs over pulley wheels and through cage without interference.
21. [] If pulley wheels were replaced, check limit screws and indexing adjustment.

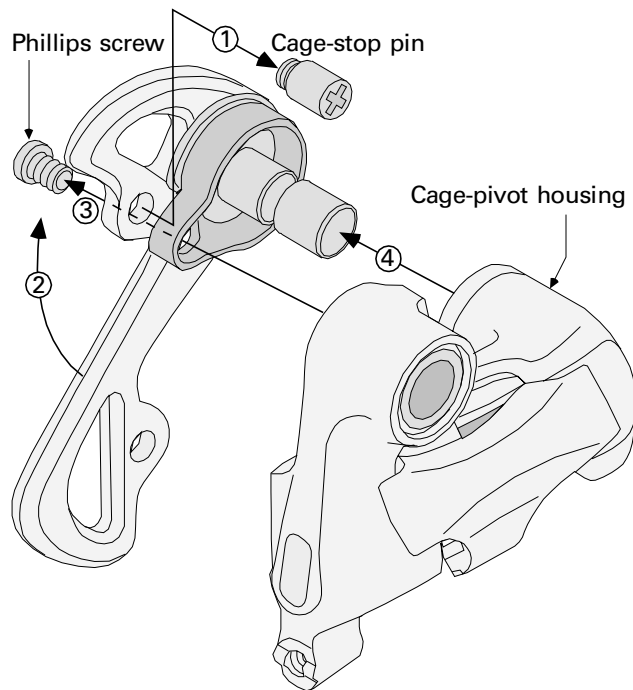
PIVOT SERVICE AND SPRING ADJUSTMENTS

It is important to service the mounting pivot and cage pivot because dirt and lack of internal lubrication can severely handicap derailleur performance. The sealed nature of the pivots makes it pointless to try to flush the mechanism with solvent and inject lubricant, without disassembling the pivots. Additionally, disassembling the cage pivot allows changing the cage-spring tension, which is useful when mounting the derailleur to an unconventional derailleur hanger (or other special circumstances).

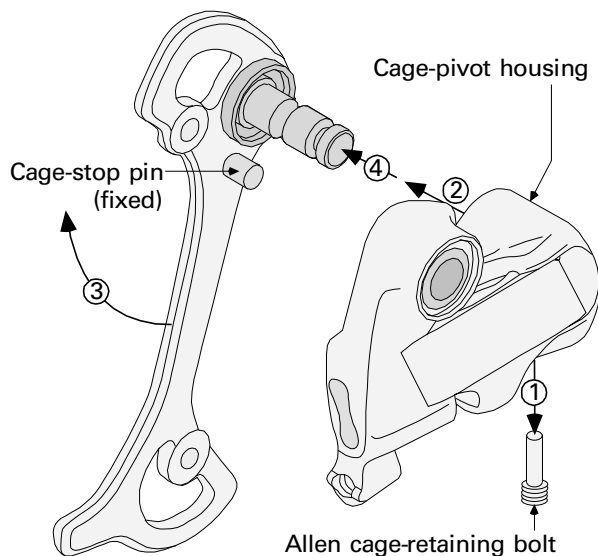
Over the decades there have been more models of derailleur made than anyone could ever remember. Many of them are still in use. Most of them require different techniques to service. It is not practical to write comprehensive instructions on disassembling and servicing rear derailleurs. The following procedure is suitable for a variety of modern Shimano derailleurs, which are both dominant in the market, and somewhat consistent to each other.



32.31 Blow-up of a typical Shimano derailleur with a cage-mounting bolt accessed from the front of the cage-pivot housing.



32.32 Blow-up of a typical Shimano derailleur with a cage-mounting screw accessed from the back side of the cage-pivot housing.



32.33 Blow-up of a typical Shimano derailleur with a cage-retaining bolt accessed from the bottom side of the cage-pivot housing.

Disassembling the cage pivot

The procedure assumes that the cage plates are separated and the pulley wheels are removed, which is covered earlier in this chapter (page 32-22).

1. The derailleur may have one of several configurations. Either there is a cage-stop screw in the face of the outer cage plate immediately adjacent to the cage-pivot housing, or the cage stop is a fixed pin that does not unscrew.

[] If cage-stop screw is fit by a Phillips screwdriver, wind derailleur cage slightly counterclockwise and unscrew Phillips screw.

[] If there was no Phillips screw in face of outer cage plate, look for 2mm Allen set screw recessed in bottom side of cage-pivot housing and remove screw completely.

2. Cage and derailleur body will separate in one of three ways:

[] If there is an Allen bolt head in hole in outward end of cage-pivot housing, turn bolt counterclockwise to remove it.

[] If cage-stop pin was unthreaded from face of outer cage plate, but there is no hole in outward end of cage pivot housing, look on backside of cage pivot housing for small Phillips screw accessible just past edge of cage plate.

[] If cage-stop pin did not thread out of cage plate, look for 2mm Allen screw to thread out of bottom side of cage-pivot housing. When this is removed, cage can be pulled away from back side of housing, at which time it will unwind.

[] If cage-stop pin is not removable and there is no Phillips screw accessible from back, no bolt head accessible from front face of cage pivot housing, or no 2mm Allen screw accessible from bottom side of cage pivot housing, then cage pivot assembly cannot be serviced.

There are usually two holes in the cage plate that the cage-pivot spring can engage in. Looked at from the outer face of the cage plate, the more clockwise hole is the normal position that creates the lower spring tension. The more counterclockwise hole creates an optional high-tension setting.

3. [] Remove cage from derailleur and observe which hole that cage return spring engaged in outer plate. Which hole? _____
4. [] Remove any seals from cage-pivot housing or face of cage plate.
5. [] Remove spring from cage-pivot housing, noting which end of spring inserts into housing.

32 – REAR DERAILLEURS

Disassembling the mounting pivot

The B-screw will get in the way of manipulating the mounting plate when re-assembling the mounting pivot. It should be removed now, but measured first, in which case the setting was correct and should be restored. Use a depth gauge to measure from either end of the screw to the face of the tab it is threaded into.

6. [] Measure length of B-screw protruding from plate on back of mounting pivot and record here so that B-screw can be removed and installed without having to readjust.

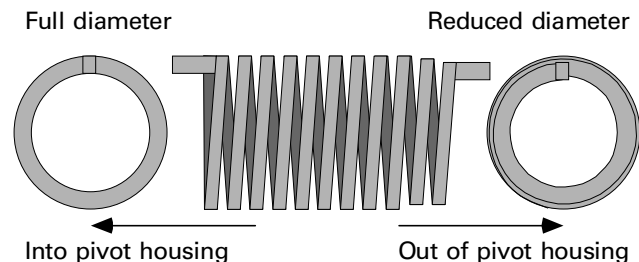
B-screw protrusion: _____mm

7. [] Remove B-screw from plate on back of mounting pivot, and pull off any plastic cover.

In step #8 through #10, the clip that holds the pivot assembly together is removed. The assembly is spring-loaded and prone to blowing apart once the clip is removed. The clip itself is prone to flying a long distance when it is removed. To prevent this, the removal is done with a rag draped over the derailleur and tools, so that everything will be trapped if the parts try to fly.

8. [] Find clip that engages groove in mounting bolt on back side of mounting pivot, and insert tip of small screwdriver between clip and mounting bolt to prepare to pry clip out of groove.
9. [] With screwdriver in place and ready to pry out clip, drape rag over hand and derailleur so that parts will be trapped inside rag when clip is pried out.
10. [] Pry out clip.
11. [] If plate and spring did not pop off when clip was removed, pull out on plate and allow to unwind clockwise.

Shimano mounting-pivot springs are not symmetrical. One end fits in the housing and the other end fits in the mounting plate. The difference is not obvious, but the illustrations below should make it clear. The end that has the spring leg set in from the full diameter of the spring never goes into a pivot housing.



32.34 *The end of the spring that goes in the housing is on the left. The spring ends shown on the right never go into the housing.*

12. [] Remove plate, seals, and spring from back-side of mounting-pivot housing, noting which end of spring was inserted in housing.

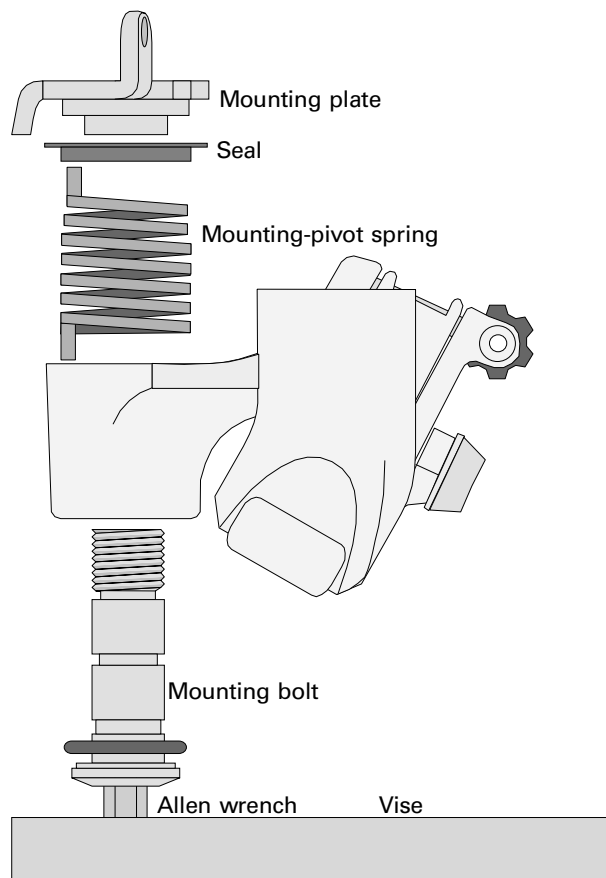
13. [] Remove mounting bolt from front of mounting-pivot housing.

Cleaning and lubrication

14. [] Soak derailleur and parts in solvent, then scrub with stiff brush to remove all dirt and grease. Dry thoroughly.
15. [] Grease springs, cage-pivot stud in outer cage plate, and smooth shaft of mounting bolt.
16. [] Oil parallelogram pivots, pinch-mechanism threads, and adjusting-barrel threads.

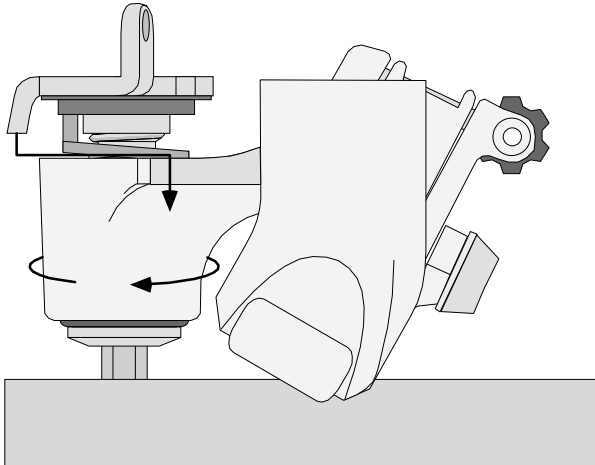
Assembling the mounting pivot

17. [] Place Allen wrench securely in vise with end pointing up, and place mounting bolt upside down on Allen wrench.
18. [] Install any seals in outer face of mounting-pivot housing and slip derailleur (outer face down) over mounting bolt.
19. [] Insert spring into mounting-pivot housing and engage end of spring in hole. Make sure that end of spring with reduced diameter coil is facing out of mounting-pivot housing.
20. [] Put seal in place between mounting plate and mounting-pivot housing.
21. [] Place mounting plate over bolt and engage end of spring in hole in mounting plate.



32.35 *Assembling the mounting pivot.*

22. [] Using pliers to hold mounting plate by the tab that B-screw threads into, press mounting plate down until it is against upper end of mounting-pivot housing.
23. [] Holding mounting plate down, rotate derailleur clockwise until tab on mounting plate stops against tab on outside of mounting pivot-housing.
24. [] Carefully pull up mounting plate with pliers so that tab on outside of mounting-pivot housing can rotate clockwise past tab on mounting plate, then push mounting plate back in.



32.36 Loading the mounting pivot spring.

25. [] Insert clip in groove in mounting bolt.

In the next step, the B-screw position is restored. If it was not recorded or correct to start with, thread the B-screw in just enough to engage the threads. It will be adjusted when the derailleur is installed and adjusted.

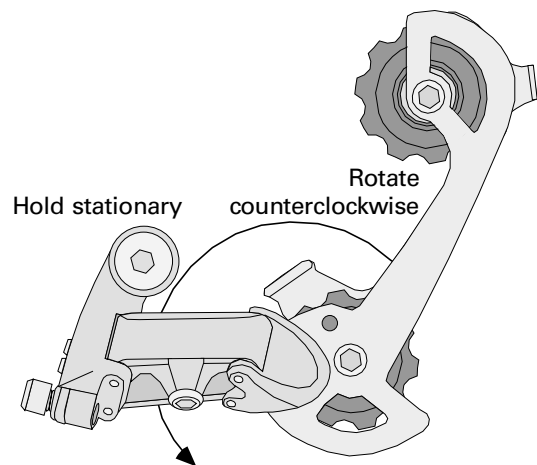
26. [] Put any plastic cover over mounting plate and thread in B-screw until protrusion equals measurement in step 6.

Assembling the cage pivot

27. [] Insert spring into cage-pivot housing and engage end of spring in hole. Make sure that end of spring with reduced-diameter coil is facing out of cage-pivot housing.
28. [] Put seal in place on outer face of outer plate, or on inward end of cage-pivot housing.
29. [] Place outer cage pivot into hole in cage-pivot housing.

Which cage hole the spring engaged should have been recorded in step #3. Facing the outer face of the outer cage plate, the most clockwise hole is the normal position that provides less tension for the cage-return spring. The most counterclockwise hole provides a high-tension setting for the return spring that compensates for age, small cogsets, and non-standard derailleur-hanger designs.

30. [] Rotate cage plate to align desired hole with end of spring and engage plate to spring.
31. [] Push outer cage plate firmly to end of cage pivot housing.
32. [] Except models where removal of 2mm Allen bolt disengaged cage from derailleur body, insert small Phillips screw from back, or cage-pivot bolt from front, to retain cage to derailleur body.
33. [] Holding derailleur *so that outer face is visible*, rotate outer cage plate counterclockwise until cage-stop pin or mounting hole for cage-stop screw clears tab on outside of cage-pivot housing. If cage-stop pin is still fixed to cage plate, cage plate will need to be pulled away from cage-pivot housing just enough to allow cage-stop pin to clear tab on cage-pivot housing.



32.37 Winding up the cage tension spring.

34. [] Thread in cage stop pin, or 2mm Allen screw into hole in bottom of cage-pivot housing.

DERAILLEUR-HANGER REPAIR

THREAD CHASING

Derailleur-hanger threads may be fouled with contaminants, or cross-threaded, leading to difficult installation of the derailleur-mounting bolt. To solve either, use a tap of the correct size (usually 10mm × 1mm) from the back side of the hanger to clean out the threads.

THREAD REPLACEMENT

There are several brands of thread-replacement coils. These work by enlarging the hole, tapping the hole to an over-size-thread description, and then using a tool that comes with the coil kit to insert a wire coil that matches the new thread description on the outside and creates a new set of original threads on the inside. The instructions that come with the kit should be adequate, and should differ depending on the brand of thread-repair kit being used. The following steps are generic, and may not exactly match the brand of kit being used.

1. [] **Drill or ream hole in hanger to 13/32" diameter.**
2. [] **Tap hole with oversize tap provided with kit.**
3. [] **Treat hole threads with heaviest grade of Loctite available.**
4. [] **Use tool that comes in kit to thread in coil from outer face of dropout, until end of coil is flush with outer face of hanger.**
5. [] **Remove coil-insertion tool.**
6. [] **Use diagonal side cutter to clip off excess coil length on back side of hanger.**
7. [] **Allow Loctite to cure before installing and securing derailleur.**

SLEEVE INSERTS

Sleeve inserts to repair damaged hanger threads are sleeve nuts that go into an enlarged hanger hole. At the time of this writing, the primary product available is the Wheels Manufacturing Dropout Saver (DS-1 and DS-2). When a sleeve insert is used, the hanger is basically being sandwiched between a nut on the inside face of the hanger and the derailleur on the outside face. The sleeve inserts are effective. The worst problem with them is a tendency for them to disappear when someone unfamiliar with the repair removes the derailleur at a later time. To perform the repair, the old threads should be drilled or reamed out to 15/32" diameter. The sleeve nut should be installed from the backside. Loctite RC680 can be used to reduce the likelihood of the sleeve nut falling out when the derailleur is not mounted, but this is no guarantee.

The nut should be held with a cone wrench while the derailleur-mounting bolt is being secured or loosened.

HANGER REPLACEMENT

A number of brands of bikes with aluminum dropouts now have replaceable hangers. These are entirely brand specific and cannot be used on any frame except the original one that they were designed for. The are usually held in place by small screws or bolts. The threads should be prepared with Loctite 222 or 242.

REAR-DERAILLEUR TROUBLESHOOTING

Cause	Solution
SYMPTOM: <i>The shift to the A cog is slow.</i>	
The H-screw is too tight.	Loosen H-screw; Look for rapid improvement if the H-screw is the source of the problem.
If the H-screw is not too tight, then the inner-wire tension may be too tight.	Turn in an adjusting barrel or let more inner wire through the pinch mechanism; expect instant improvement if inner-wire tension was the source of the problem.
If none of above, the B-screw may be too tight or the chain may be too short, causing the guide pulley to be too far below the A cog.	Check B-screw adjustment and chain length. Try setting chain at longest length that works to attempt to eliminate symptom.
If none of the above, the cable system may have too much friction.	Check for poor cable routing, housing damage, inner-wire damage, inner-wire rust, dirt on inner wires, or lack of lubrication.
If none of the above, the guide pulley may be worn out.	Check guide-pulley teeth and bushing for wear.
If none of the above, the chain may be worn out.	Check chain wear.
If none of the above, dirt may be fouling the cage and/or mounting pivot, the return spring, or the parallelogram pivots; causing the guide pulley to track too low below the cogset or the parallelogram to be hesitant to return to its outermost position.	Disassemble, clean, and lubricate the derailleur.
If none of the above, the derailleur may have too little return-spring force to pull the inner wire through the housing bends. This is most likely if the derailleur and shifter are not brand and model matched.	Try installing a spring over the inner wire between the rear-derailleur adjusting barrel and the pinch mechanism. Use a compression spring 1.75" long, with a 3/8" diameter, and .035 wire gauge (or larger).
Old-style Campagnolo pulley wheels with low-profile teeth are being used with a new-style low-profile chain that does not have side plates extending above the rollers.	Change pulley wheels to Shimano type.
SYMPTOM: <i>There is excessive noise when the chain is on the A cog.</i>	
If the guide pulley is offset inward of the A cog, then H-screw or inner-wire tension is too tight.	Check guide-pulley position, then loosen H-screw and/or inner-wire tension.
If the guide pulley is offset outward of the A cog, then H-screw too loose.	Check guide-pulley position, then tighten H-screw
If the guide pulley is close to centered under the A cog, check if the chain is rubbing against the B cog where the top section of chain goes forward to the chainrings. If this is the case, then the chainline is off or the chain is a wide chain being used on a narrow-spaced cogset.	Check chainline and chain/cogset compatibility
SYMPTOM: <i>The chain shifts past the A cog when shifting from the B cog.</i>	
The H-screw is too loose.	Tighten the H-screw until the symptom goes away.
If tightening the H-screw creates the symptom that the H-screw is too tight before the original symptom goes away, the guide pulley is too far below the cog.	B-screw adjustment is too tight, chain is too short, or the mounting and cage pivots are fouled with dirt.

(continued next page)

REAR-DERAILLEUR TROUBLESHOOTING (continued)

Cause	Solution
SYMPTOM: <i>The shift to the Z cog is slow.</i>	
The L-screw is too tight.	Loosen the L-screw 1/4 turn at a time. Rapid improvement should happen with very little adjustment.
If derailleur is indexing and the symptom only occurs when using the shift-control mechanism, inner-wire tension is too loose.	Tighten inner-wire tension with the adjusting barrel.
The chain is on the <i>H</i> chainring.	The shift combination should be avoided.
SYMPTOM: <i>There is excessive noise when the chain is on the Z cog.</i>	
If the guide pulley appears offset inward of the Z cog, the L-screw is too loose.	Tighten the L-screw.
If the guide pulley appears offset outward of the Z cog, the L-screw is too tight.	Loosen the L-screw.
If the guide pulley appears somewhat centered under the Z cog, then the B-screw may be too loose.	Tighten the B-screw.
If the B-screw cannot be tightened enough to eliminate the symptom, the chain may be too long.	Check if the chain can be shortened without creating a too-short condition.
If the B-screw cannot be tightened enough, the chain cannot be shortened, and adjusting the L-screw is no help, the maximum cog size capacity of the derailleur may have been exceeded.	Check derailleur capacity.
SYMPTOM: <i>The chain shifts past the Z cog when shifting from the Y cog</i>	
The L-screw is too loose.	Tighten the L-screw.
If the guide pulley appears far below the Z cog, and tightening the L-screw creates a slow shift, the B-screw is too tight.	Loosen the B-screw.
If loosening the B-screw does not move the guide pulley reasonably close to the cog, then the derailleur is being used on a cogset smaller than was intended.	Use cogset with larger cogs, change derailleur, or try changing the spring tension in the cage pivot.
SYMPTOM: <i>Some or all in-shifts are slow (rear derailleur is indexing).</i>	
Inner-wire tension is too low.	Turn adjusting barrel out.
Guide pulley is worn out.	Check guide-pulley teeth and bushing for wear.
Chain is worn out.	Check chain for wear and replace if necessary.
SYMPTOM: <i>Some or all out-shifts are slow (rear derailleur is indexing).</i>	
Inner-wire tension is too high.	Turn adjusting barrel in.
Guide pulley is worn out.	Check guide-pulley teeth and bushing for wear.
Chain is worn out.	Check chain for wear and replace if necessary.
Excess cable-system friction.	Check for poor cable routing, housing damage, inner-wire damage, inner-wire rust, dirt on inner wires, or lack of lubrication.
If symptom is progressively worse as the chain is shifted further and further out, the guide pulley may be too far below the cogs.	Check for too tight a B-screw, too short a chain, or dirt in the cage and mounting pivots. Correct any problem found.

<i>Cause</i>	<i>Solution</i>
SYMPTOM: <i>The chain moves out two positions when the shift-control mechanism is moved one position.</i>	
Inner-wire tension is too low.	Turn adjusting barrel further out, or pull more inner wire through the pinch mechanism if the adjusting barrel is running out of threads.
Shift-control mechanism is not compatible with derailleur and/or cogset.	Check component compatibility and test shift again after replacing any suspect components.
The shift-control mechanism had already been released one position when chain wasn't moving, so it had actually been moved two positions.	Recheck the shift.
SYMPTOM: <i>The chain moves in two positions when the shift-control mechanism is moved one position.</i>	
Inner-wire tension is too high.	Turn adjusting barrel further in, or release more inner wire through the pinch mechanism if the adjusting barrel is running out of threads.
Shift-control mechanism is not compatible with derailleur and/or cogset.	Check component compatibility and test shift again after replacing any suspect components.
The shift-control mechanism had already been moved one position when the chain was not moving, so it had actually been moved two positions.	Recheck the shift.
SYMPTOM: <i>The chain will not move inward to the next gear when the shift-control mechanism is moved one position, or the shift-control mechanism must be moved two positions to get the chain to move inward one position.</i>	
Inner-wire tension is too low.	Turn adjusting barrel further out, or pull more inner wire through the pinch mechanism if the adjusting barrel is running out of threads.
Shift-control mechanism is not compatible with derailleur and/or cogset.	Check component compatibility and test shift again after replacing any suspect components.
Chain is badly worn out.	Check chain wear.
Chain and cogs are not compatible.	Check manufacturer's chain recommendations.
SYMPTOM: <i>With an indexing rear derailleur, the chain makes noise against the next cog inward after an in-shift to a specific cog, but not after making an out-shift to the same cog.</i>	
Excess cable-system friction.	Check for poor cable routing, housing damage, inner-wire damage, inner-wire rust, dirt on inner wires, or lack of lubrication.
Excess friction in the shift-control mechanism caused by wear, dirt, or lack of lubrication.	Test by temporarily installing a different shift-control mechanism. Service the shifter if the test eliminates the symptom.

(continued next page)

REAR-DERAILLEUR TROUBLESHOOTING (continued)

Cause	Solution
SYMPTOM: <i>At one cable-tension adjustment, the shifting acts as though the cable is too tight for some shifts, but acts as though the cable is too loose for other shifts.</i>	
Excess cable-system friction.	Check for poor cable routing, housing damage, inner-wire damage, inner-wire rust, dirt on inner wires, or lack of lubrication.
Incorrect inner wire for shift-control mechanism.	Check inner-wire compatibility.
Distance from face of derailleur hanger to face of first cog is too great.	Reduce axle spacing to move first cog as close as possible to the dropout without chain-to-frame interference.
General system congestion from dirt.	Clean cogs, chain, inside and outside of . derailleur, and inside shift-control mechanism.
General component incompatibility.	Check that shift-control mechanism, derailleur, and cogset are all compatible.
General system wear.	Check chain wear, guide-pulley wear, and derailleur-pivot wear.
SYMPTOM: <i>The chain shifts out one position on its own when the shift-control mechanism is not being operated.</i>	
If derailleur is indexing, inner-wire tension is too low.	Check and adjust inner-wire tension by turning adjusting barrel out.
If derailleur is friction-type, shift-lever friction is too light.	Adjust shift-lever friction.
SYMPTOM: <i>When testing the FRA, the acceptable range is very narrow.</i>	
Parts are dirty.	Clean drive train, derailleur, and shift-control mechanism.
Parts are worn out.	Check chain wear, guide-pulley wear, or derailleur-pivot wear.
Excess cable-system friction.	Check for poor cable routing, housing damage, inner-wire damage, inner-wire rust, dirt on inner wires, or lack of lubrication.
Non-compatible chain is being used.	Check chain compatibility.
Non-compatible guide pulley is being used.	Use only manufacturer's original pulley.
Non-compatible cable system is being used.	Use only high-quality indexing inner wires of the correct diameter, and compressionless housing.
Shift-control mechanism is not compatible with derailleur or cogset.	Check manufacturer's specifications for compatible components.

SHIMANO RAPID-RISE DERAILLEURS

OVERVIEW

Shimano Rapid-Rise rear derailleurs differ from others in that they move outward when the cable is pulled, and move inward by means of the parallelogram spring when the cable tension is released. Their motion is the opposite of conventional derailleurs.

For many purposes, these derailleurs are no different to install, adjust, or service than regular derailleurs, but some of the sequences in which things are done need to be changed to make the procedures easier. The following procedure is very generalized for the purpose of illustrating the correct sequence to go through derailleur setup and adjustment. The assumption of this procedure is that you are already familiar with all the details of proper setup and adjustment as they are done on conventional derailleurs.

RAPID-RISE PROCEDURES

Derailler, cable, and chain installation

1. [] Align hanger, lubricate derailleur and install.
2. [] With derailleur at rest under Z cog, pull down on derailleur cage to allow upper pulley to clear cog, then preset L screw so pulley is centered under cog.
3. [] Pull outward on derailleur to move upper pulley under A cog, then check if pulley stops centered under cog and preset H screw as necessary.
4. [] With upper pulley pulled out to A cog and parallelogram positioned parallel to chain stay, size housing loop to rear derailleur.
5. [] With derailleur at rest position under Z cog (pull down on cage if upper pulley catches against outer face of cog), install cable system, pull slack out of cable with fingers, then secure pinch mechanism.
6. [] Using shift mechanism, move derailleur so upper pulley is under A cog, then install and size chain normally.

Limit screw and indexing adjustments

7. [] To set H screw, use shifters to put chain in Z/H combo, then pull on exposed wire to shift chain from B to A cog. Adjust limit normally, but pull on cable to check shift to A instead of releasing cable.

8. [] To set L screw, use shifters to put chain in Z/M combo (Z/L if double chainring), then pull on exposed wire to shift chain from Z to Y cog. Adjust limit normally, but release cable to check shift to Z instead of pulling cable.

Setting the cable tension and adjusting the indexing are where the most significant differences between Rapid-Rise and conventional derailleurs are found. Everything involving the cable is exactly reversed with Rapid-Rise. Consequently, the slack is removed when the chain is on the Z cog instead of the A cog. Less obvious is the fact that when the indexing is adjusted, the adjusting barrel should always be turned the opposite way from normal to correct any symptom.

9. [] Use shifter to put chain on Z cog, then pull on exposed inner wire while pedaling until chain reaches A cog, then stop pedaling and stress cable system.
10. [] Pedal until chain returns to Z cog, then release pinch mechanism, set adjusting barrels, pull slack from inner wire, and secure pinch mechanism.

As always, the best indexing adjustment is the tightest good setting. With Rapid-Rise, however, the tightest good adjustment is one just short of the point where the chain tends to shift outward one cog if the cable is tightened further (opposite of normal).

11. [] Adjust indexing to tightest good setting, turning adjusting barrel out (ccl) to improve shifts outward and in (cl) to improve shifts inward (opposite of adjusting conventional derailleur).

EIGHT- AND NINE-SPEED COMPATIBILITY

Because nine-speed derailleurs have the same actuation ratio (the amount the derailleur moves for a specific amount of inner-wire travel) as derailleurs that are not nine-speed, they are technically acceptable to mix. However, Shimano made other changes coincidental with introducing nine-speed systems that also affect interchangeability. The primary concern is the derailleur capacity. Most Shimano nine-speed MTB derailleurs work with up to a 34T rear cog. Most pre-nine-speed derailleurs have a maximum capacity of 32T. Consequently, if the bike has a nine-speed cog set with a 34T cog, a nine-speed derailleur must be used. Otherwise, there are no derailleur compatibility issues.

32 – REAR DERAILLEURS

When replacing pulley wheels, it is important to be aware that there are nine-speed-specific pulleys. The significant difference is not the thickness of the pulley, but the number of teeth. Using a pulley wheel with the wrong number of teeth can adversely affect the capacities of the derailleur. If the teeth numbers match, the pulleys are generally compatible.