25 – FREEHUB MECHANISMS AND THREAD-ON FREEWHEELS

ABOUT THIS CHAPTER

This chapter is about removing and installing freehub mechanisms, thread-on freewheels, and the cogs that go on freewheels and freehubs. These items are removed for cleaning, replacement, access to spokes, and in the case of thread-on freewheels, access to the axle set and hub bearings. Some cartridge-bearing hubs are freehubs, but the freehub design is unique to the hub. This section only covers conventional freehub-mechanism designs. Special freehub mechanisms are covered in the procedure for the hub that uses the special design (see the **CARTRIDGE-BEARING HUBS** chapter, page 13-1).

GENERAL INFORMATION

TERMINOLOGY

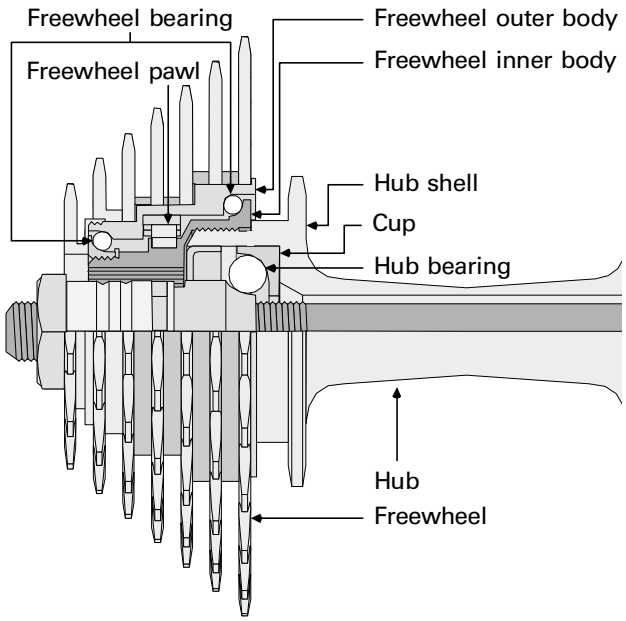
Some of these terms are confusingly similar, so it makes sense to spend a bit of time considering terminology and definitions before looking at the list of terms.

Thread-on freewheels

A thread-on freewheel is a mechanism consisting of a freewheeling mechanism and a set of cogs attached. The mechanism threads onto a hub shell, and is independent of the bearings of the hub. This means that the entire freewheel can be removed without disassembling the hub, and once it is removed the hub is still fully intact and functional.

The freewheel mechanism consists of a two-piece body, with the inner and outer body rotating independently of each other on sets of bearings. The inner body threads onto the hub shell and remains fixed to the hub shell. The outer body engages the inner body by means of pawls and a ratchet ring that cause the two body pieces to rotate as one when the chain drives the cogs attached to the outer body-piece. When the chain is not applying drive force and the bike is coasting, the pawls disengage the ratchet ring and allow the inner body to turn free of the outer body, so that the cogs do not drive the chain.

With this system, freewheeling-mechanism removal is generally required for hub-bearing adjustment or overhaul and for accessing spokes. Thread-on-freewheel/hub systems allow independent selection of hub and freewheel brands and models. This does not create all the versatility that might be imagined because many indexing-derailleur systems require specific cogsets in order to function at peak performance, and in some cases these cogsets might be available only on a freehub mechanism.



25.1 *A hub and thread-on freewheel in cross-sectional view.*

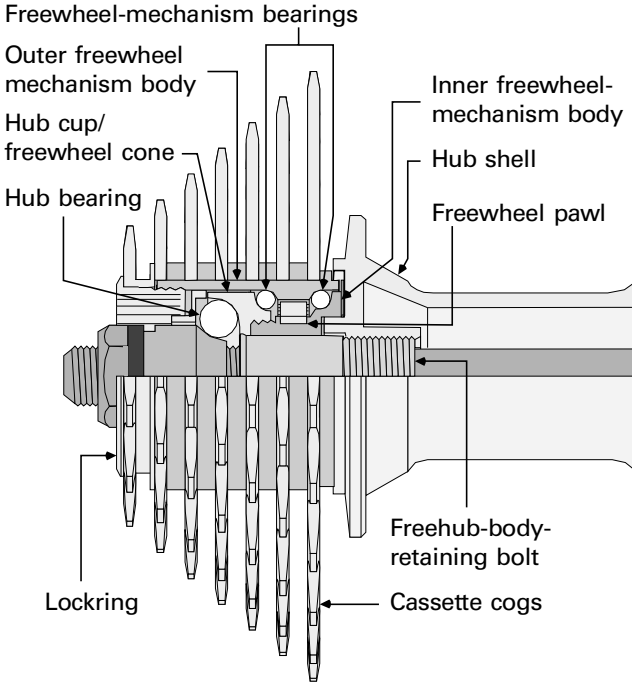
Freehubs (freehub mechanisms)

A freehub usually has the same freewheel-mechanism inner body, pawl and ratchet mechanism, freewheel-mechanism outer body, and cogs attached to the outer body. Some freehub mechanisms use alternative systems to the pawl and ratchet-ring design. The inner body still fixes to the hub shell, although not necessarily by threading on. When the hub has conventional cup-and-cone bearings, the inner body-piece has integrated into its outer end *the right-side hub-bearing cup*.

This means that the freewheel mechanism and the hub bearings are not independent systems. The practical consequence of this is that it is not necessary to remove the freewheel mechanism to service the hub bearings, but it is necessary to remove the hub axle and bearings to remove and service the freewheel mechanism. To access spokes on a freehub rear wheel, it is not necessary to remove the freewheel mechanism. However, the cogs must be removed from the freewheel mechanism.

Freehubs may be required for use with certain indexing-derailleur systems because compatible cogsets are only available on a freehub. Freehubs have an advantage in their design due to the repositioning of the right-side hub bearing. The different position reduces the stack of spacers on the right end of the axle, which reduces the occurrence of bent axles (something that is problematic on thread-on-freewheel/hub combinations, particularly when exceeding six cogs).

Freehubs are sometimes called "cassette hubs," but this is a misnomer; although, some freehubs have a cassette cogset. This means that the cogs are removed and installed as a group, rather than individually. Individual cogs can always be put back on where the cassette was removed, so there is no such thing as a cassette hub, or a hub that requires cassette cogs.



25.2 *A freehub in cross-sectional view.*

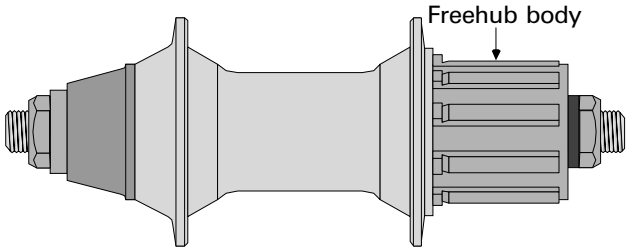
The following are the terms and definitions that are used in this chapter.

Freewheel: Used to describe a freewheel that threads onto a rear hub. (The freewheel mechanism and the hub bearings are independent systems.)

Freewheel mechanism: A mechanism that consists of two pieces that can rotate separately. Usually one has a ratchet ring and the other has pawls, so that they can rotate together when the outer piece is being driven, and independently when the inner piece is being driven. (See figures 25.1 and 25.2.)

Freewheel body: Used to describe the freewheel mechanism of a freewheel without the cogs attached.

Freehub: This applies to the complete integrated hub/freewheeling-mechanism with or without the cogs attached.



25.3 *A freehub.*

Freehub body: This applies to the freewheeling-mechanism portion of a freehub, without the cogs attached.

Cogs: Also *gears*, or *freewheel cogs*, this refers to the toothed gears that engage the chain, whether mounted on a freewheel body or a freehub body.

Pawl: A pivoting tooth that engages or slides over the teeth in a ratchet ring, depending on the relative direction of rotation.

Ratchet ring: A geared ring that has teeth pointing in one direction that engage a pawl if rotated one way and pass over the pawl if rotated the other way.

Cassette: Also *cassette cogs*. A set of cogs for a freehub that are removed, replaced, or installed as a set instead of individually.

Lockring: A threaded ring that holds cogs onto a freehub body.

PREREQUISITES

Wheel removal and installation

Wheel removal and installation is required for any type of freewheel or freehub work.

Rear-derailleur adjustment or replacement

Rear-derailleur adjustment or replacement may be required in several cases. If an identical model of freewheel or freehub cogs are being installed, but cog sizes

are different, derailleur adjustment will be required. If the derailleur's maximum capacity is exceeded, derailleur replacement will be required. Any time the brand, model, or number of cogs are changed, derailleur adjustment is required.

Axle removal and hub adjustment

Axle removal and consequential hub adjustment may be required for two reasons. The axle will need to be removed for certain difficult freewheel removals, and the axle will need to be re-spaced if changing the number of cogs when replacing a freewheel or freehub body.

Wheel dishing and truing

If the hub axle is re-spaced to accommodate a freewheel or freehub body with a different number of cogs, then it will be necessary to re-dish the wheel, and consequentially re-true the wheel.

Frame alignment

If the hub is being re-spaced to accommodate a freewheel or freehub body with a different number of cogs, then it is likely that the wheel will no longer fit the frame correctly. In this case, it may be required to align the rear triangle of the frame.

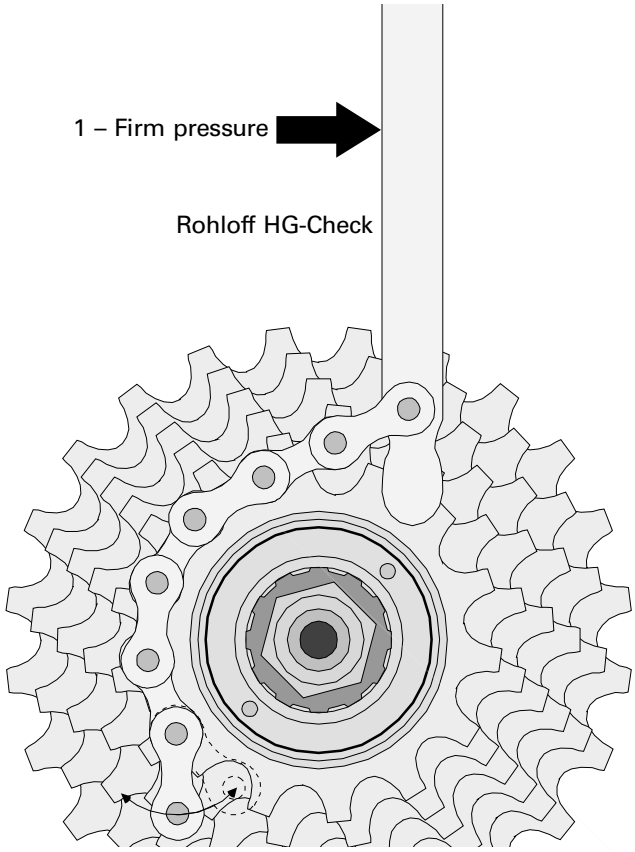
INDICATIONS

Maintenance cycles

There are two types of maintenance that need to be performed on freewheels/freehubs: external cleaning, and internal cleaning and oiling. External (cog) cleaning should be performed whenever the chain is cleaned. Differences in riding conditions make it impossible to put a time or mile value on this need. Internal cleaning and oiling should be done whenever there is a problem with the freewheel mechanism exhibiting symptoms of sticking (not freewheeling) or skipping (not engaging). In the case of freewheels, the internal cleaning will generally be done when cleaning the cogs because it is easiest to do both at once. In the case of freehubs, the cogs are generally removed from the freehub body to be cleaned, so internal cleaning and oiling is not done at that time. On the other hand, the freehub body is easiest to clean when doing a hub overhaul.

It is a common mistake to routinely oil the internals of the freewheel mechanism. This is a good way to introduce dirt to the inside. If there are negative symptoms, always assume that internal cleaning is needed, and only oil after cleaning. If negative symptoms are not present, there is no need for oiling.

It is recommended to periodically check the cogs for wear, particularly if replacing a chain or cogs, but not both at once. There is a tool (Rohloff HG-Check) that can be used for just this purpose. A shop should find this tool indispensable, but it is possible to determine cog wear without the tool. When putting a new chain on, pedal hard in every rear cog. If the chain jumps or skips, and the old chain did not, then the cog(s) that exhibits the symptom are worn out.



25.4 *Use a Rohloff HG-Check to check cog wear. If any resistance is felt when moving the last link in or out of the cog, the cog is worn out.*

Symptoms indicating worn-out cogs

If the chain slips or skips on a cog when pedaling hard, the cog or cogs may be worn out. With this problem, it may be possible to ride all day with the chain on a certain cog as long as pedal pressure is light. As soon as extra force is applied to the pedals, there is a loud metallic clunk that comes from the vicinity of the rear wheel and the pedals may seem to give way and then catch again after an inch or two of motion. Cog teeth wear from load, so that they eventually deviate from their original half-inch pitch (the distance from one tooth to the next). As long as the same chain is used,

there will probably be no symptom, because the chain wears to match the teeth. As soon as the worn chain is replaced, the symptom is more likely to occur.

When this symptom occurs, it calls for replacement of the worn cogs. If only a few cogs are worn and individual replacements are available, then it may make financial sense to only replace these cogs, but in general it is advisable or even necessary to replace whole freewheels, or cogs on a freehub in sets.

A similar symptom can occur when the pawl and ratchet mechanism inside the freehub-body/freewheel-body is malfunctioning. If the problem is cog-tooth wear, then the problem will happen on a specific cog or cogs. If it is a problem with the pawl and ratchet mechanism, it will happen in every gear but only when there is a high-level load.

A similar symptom may occur on a bike with an indexing rear derailleur when the indexing adjustment is borderline. In this case, what is actually happening is that the chain is jumping from one cog to the next when the shift lever is not being operating, and it should feel like the gear has changed after the symptom occurs.

Symptoms indicating need for internal cleaning or freewheel/freehub-body replacement

When freewheeling occurs when pedaling, constantly or intermittently, the freewheel mechanism may need internal cleaning or parts may have failed. The pawl and ratchet mechanism inside the freewheel body or freehub body is surprisingly delicate for the job it does of converting the pedaling load to the rear hub. Small parts are moved by hair-thin springs in tight, confining spaces. Dirt or rust can severely inhibit the motion of the pawls and create the symptom of the freewheel not engaging when pedaling force is applied. Cleaning and lubrication can potentially solve this problem. When they do not, it means the rust is too far advanced or the pawls or pawl springs are worn out or damaged. These parts are generally not available separately, so the normal solution is to replace the entire freewheel or freehub body.

Another symptom that may be experienced is when coasting, the cogs continue to turn with the wheel, pushing the chain. Dirt, rust, and worn or damaged pawls or pawl springs can cause this symptom. Sometimes this symptom is called "ghost rider" because while the rider's feet are off the pedals, the pedals continue to turn on their own. If cleaning and lubricating does not solve the problem, then the pawls or pawl springs have failed. These parts are generally not available separately, so the normal solution is to replace the entire freewheel or freehub body.

Symptoms indicating need of freewheel or freehub-body overhaul

Due to the lack of replacement parts availability, and due to the fact that freewheels old enough to have internal problems undoubtedly have limited life left in the cogs, overhauling the inside of freewheels or freehub bodies is not recommended. When cleaning and oiling does not eliminate symptoms, replace the freewheel or freehub body.

Symptoms indicating loose freewheel/freehub-body bearings

When a steady, light clunking sound comes from the freewheel in some gears more than others, and at some pedaling speeds but not others, it indicates the bearings are loose. If the freewheel/freehub-body-bearing adjustment gets too loose, it allows the outer body to float side-to-side and make a clunk when it reaches its limit each way. This happens in some gears but not others, and at some pedaling speeds but not others, because the direction and amount of load from the chain influences whether the outer body is free to float. All freewheel-mechanism bearings are designed to have some free play. It is too much only when this symptom occurs. The play in these bearings is not adjustable, so when the symptom occurs on a new mechanism it should be considered a warrantable failure, and when it occurs on an old mechanism it should be considered time to replace the freewheel or freehub body.

Symptoms indicating bad freewheel or freehub mounting

If the cogs appear to wobble side-to-side while coasting, it might seem as though there is a problem with the way the freewheel or freehub body is mounted. This is a normal condition due to a lack of precision in the freewheel/freehub-body bearings and is not a problem if the wobble does not occur while pedaling.

If the cogs appear to wobble side-to-side while pedaling, there may be a problem with the mounting of the freewheel or freehub body. This occurs for different reasons on thread-on freewheels and freehubs. It is only a problem if the degree of wobble interferes with making a good derailleur adjustment and getting the chain to run on one cog without rubbing on the next.

If the problem of wobbling-while-pedaling occurs on a hub with a thread-on freewheel, it generally indicates that the freewheel is cross-threaded, in which

case the hub is probably destroyed. If the freewheel-mounting threads are in good condition, it indicates that the spoke guard is mounted off-center (try a new one or none at all), or that the hub or freewheel was mis-threaded from the factory (generally warrantable). It never has anything to do with a bent axle.

If the wobbling-while-pedaling problem is on a freehub, it indicates that the bolt that holds the freehub body to the hub shell is loose. Immediate service is required. To tighten the bolt, the axle must be removed from the hub.

Thread-on-freewheel-hub service

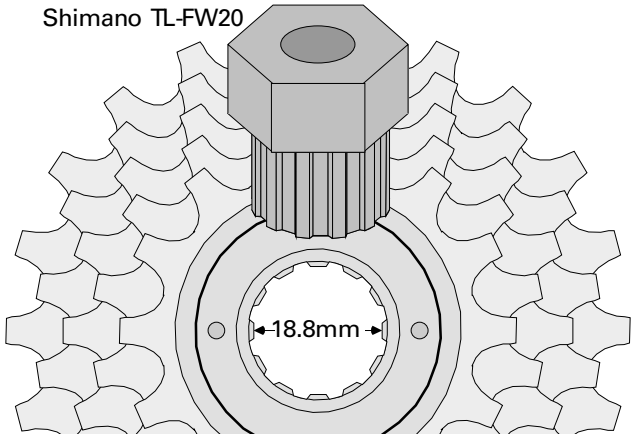
It is necessary to remove and re-install a thread-on freewheel if adjusting or overhauling a thread-on-freewheel hub.

Spoke access

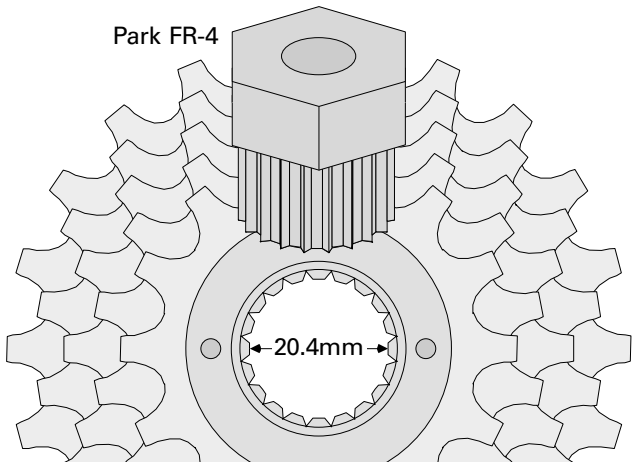
If replacing a spoke or rebuilding a wheel, the freewheel or cogs on the freehub block access to the hub flange. If it is a hub with a thread-on freewheel, the freewheel must be removed first. *It is important to note that there is no way to remove the freewheel reliably if the spokes are cut before the freewheel is removed.* If the hub is a freehub, the cogs must be removed from the freehub body to access the hub flange, but the freehub body need not be removed.

TOOL CHOICES

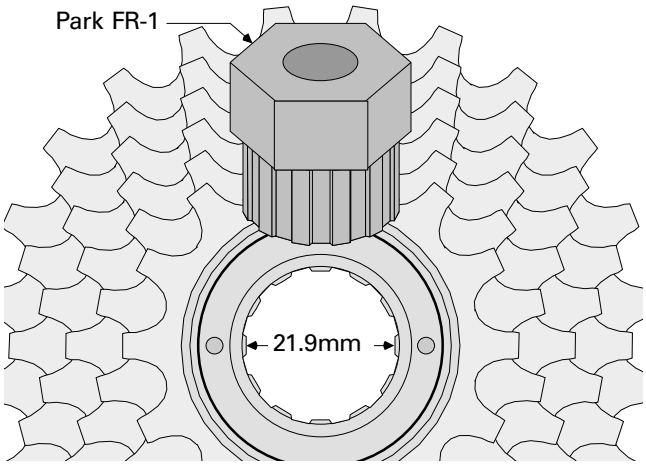
The design or brand of the freewheel/freehub will determine the tools needed. The preferred choices are in **bold**. A tool is preferred because of a balance among: ease of use, quality, versatility, and economy. When more than one tool for one function is **bold**, it means that several tools are required for different configurations of parts. (See table 25-1, page 25-6.)



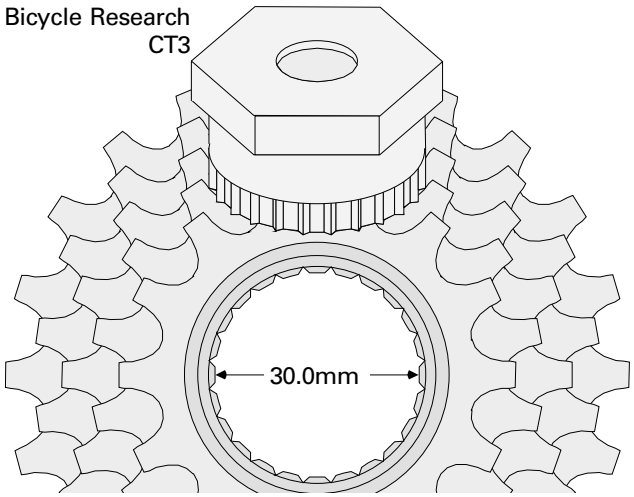
25.5 *This Shimano splined-freewheel with an 18.8mm hole is rare. The preferred tool that fits it is shown.*



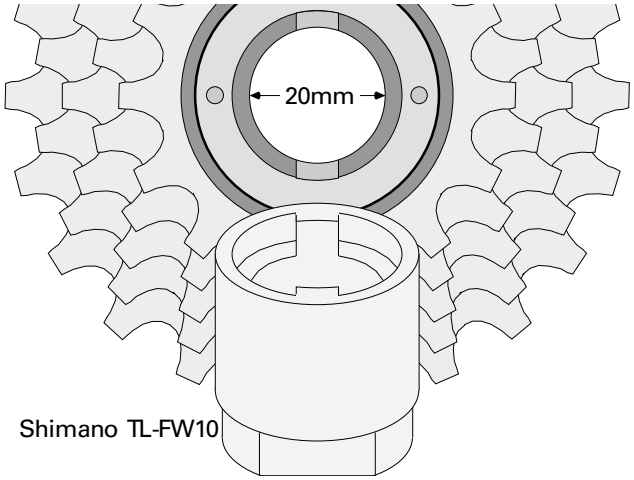
25.6 *This splined-freewheel with a 20.4mm hole is made by several manufacturers. The preferred tool that fits it is shown.*



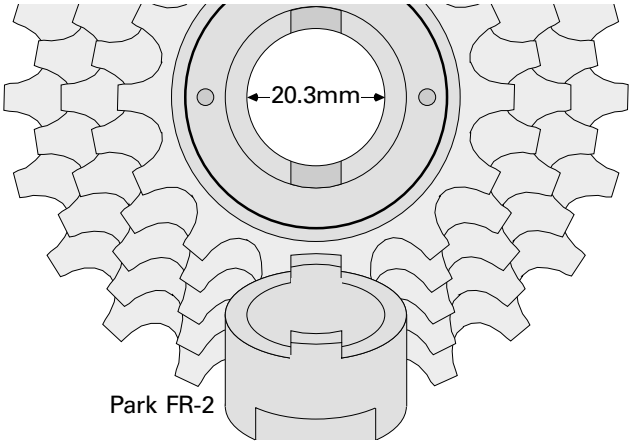
25.7 *This Shimano splined-freewheel with a 20.4mm hole is the most recent configuration. The preferred tool that fits it is shown.*



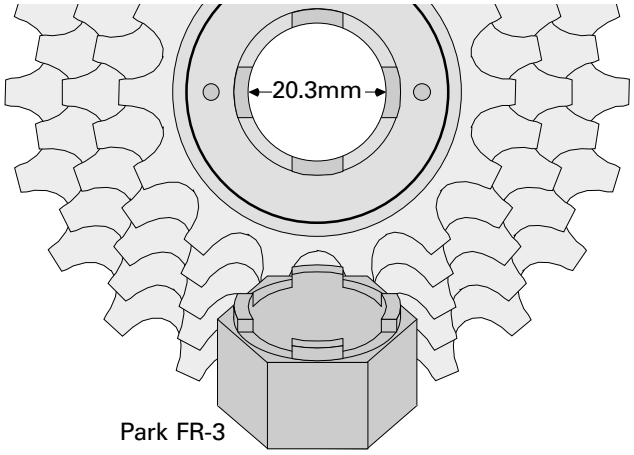
25.8 *This is a Maillard/Atom/Sachs splined-freewheel with a 30.0mm hole. The preferred tool that fits it is shown.*



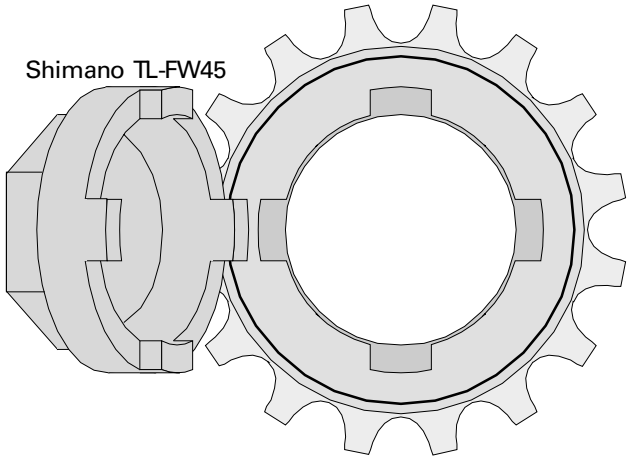
25.9 *This older Shimano notched-freewheel with a 20.0mm hole sometimes requires removal of a plastic dustcap before the tool will fit. The preferred tool that fits it is shown.*



25.11 *This two-notch freewheel with a 20.3mm hole is an older variety made by SunTour. The preferred tool that fits it is shown.*



25.10 *This four-notch freewheel with a 20.3mm hole is the last configuration made by SunTour. The tool that fits it is shown.*



25.12 *This four-notch BMX freewheel with a large hole has been made by Shimano and SunTour. The tool that fits it is shown.*

FREEWHEEL AND FREEHUB TOOLS (Table 25-1)

Tool	Fits and considerations
SPLINED-FREEWHEEL REMOVERS (see figures 25.5, 25.6, 25.7, and 25.8 on page 25-5)	
Bicycle Research CT2	Thick-wall tool fits Atom, Regina, & Zeus w/ 20.4mm hole (requires axle removal)
Park FR-4	Thin-wall tool fits Atom, Regina, and Zeus w/ 20.4mm hole
Phil Wood Atom tool	Thin-wall tool fits Atom, Regina, and Zeus w/ 20.4mm hole
Bicycle Research CT3	Fits Atom, Maillard, Normandy, Schwinn freewheels w/ 30mm hole
Bicycle Research CT4	Thick-wall tool fits old Shimano w/ 18.8mm hole (requires axle removal)
Shimano TL-FW20	Thick-wall tool fits old Shimano w/ 18.8mm hole (requires axle removal)
Bicycle Research CT6	Thin-wall tool fits Shimano and Sachs freewheels w/ 21.9mm hole
Bicycle Research CT6MB	Thick-wall tool fits Shimano & Sachs freewheels w/ 21.9mm hole (requires axle removal)
Park FR-1	Thin-wall tool fits Shimano and Sachs freewheels w/ 21.9mm hole
Shimano TL-FW30	Thin-wall tool fits Shimano and Sachs freewheels w/ 21.9mm hole
VAR 414	Thin-wall tool fits Shimano and Sachs freewheels w/ 21.9mm hole
Bicycle Research CT5	Fits rare TDC three-spline freewheel

Tool	Fits and considerations
NOTCHED-FREEWHEEL REMOVERS (see figures 25.9, 25.10, 25.11, and 25.12 on page 25-6)	
Bicycle Research CT7	Fits SunTour 2-notch freewheels
Park FR-2	Fits SunTour 2-notch freewheels
Bicycle Research CT10	Fits SunTour 4-notch freewheels
Park FR-3	Fits SunTour 4-notch freewheels
Bicycle Research CT1	Fits Shimano/Regina 2-notch freewheels, *not recommended*
Bicycle Research CT600	Fits Shimano/Regina 2-notch freewheels, *not recommended*
Shimano TL-FW10	Fits Shimano/Regina 2-notch freewheels (plastic dustcap removal sometimes required on some Shimano 600 models)
Bicycle Research CT-9	Fits Campagnolo 2-notch
Campagnolo 0520/40	Fits Campagnolo 2-notch
VAR 404	Fits Campagnolo 2-notch
Shimano TL-FW45	Fits Shimano and SunTour 4-notch BMX freewheels
Shimano TL-FW40	Fits Shimano and SunTour 2-notch BMX freewheels
COG-REMOVAL/INSTALLATION TOOLS	
Park FR-5	Fits Shimano HG/IG lockrings
Shimano TL-HG15	Fits Shimano HG/IG lockrings
Stein HLW-2	Fits Shimano HG/IG lockrings, works best used with Stein HLW-1 wrench
Campagnolo 7130036	Fits Campagnolo freehub-cog-retaining lockrings
Park BBT-5	Fits Campagnolo freehub-cog-retaining lockrings
VAR 414B	Fits Campagnolo freehub-cog-retaining lockrings
Bicycle Research CV1	Freewheel vise holds freewheel for cog removal
Stein HLW-1	"Hyperhandle" holds sprockets while using Stein HLW-2 lockring driver
Hozan C62	Strongest sprocket remover made, with good leverage and hand protection
Pamir TW-1	Strong sprocket remover with excellent hand protection, hex fitting fits Shimano cog and lockring tools
Park SR-1	Strong sprocket remover with fair hand protection, also acts as handle for Park freewheel removers
Park SR-2	Similar to Hozan C62, slightly more expensive, bolts hold chains to tool
Wheels CRT-A1	Strong sprocket remover with fair hand protection with 3/32" chain
COG/BEARING-SERVICE TOOLS	
Rohloff HG-Check	Excellent tool for check cog wear on ***all*** brands and models of cogs
Park GSC-1	Cleaning tool for cogs
Shimano TL-FH40	For securing race or disassembling freehub body
Park SPA-2	Red pin spanner fits certain freewheel dustcaps and bearing cones
Morningstar FHB1	Adapter allows flushing Shimano (except Dura-Ace 6- & 7-speed) freehub bodies with solvent and air
Morningstar FHB2	Adapter allows flushing Shimano Dura-Ace (except 8-speed) freehub bodies with solvent and air
Morningstar FHB3	Adapter allows flushing pre-1991 SunTour freehub bodies with solvent and air
Morningstar FHB4	Adapter allows flushing SunTour freehub bodies with solvent and air
Morningstar J4M	Removes dustcap from Shimano freehub body
Stein FWG	Adapter allows flushing most freewheels with solvent and air
FREEHUB-BODY REMOVERS	
Shimano TL-FH10	For removing Dura-Ace freehub body
Shimano TL-FH30	For removing rare Dura-Ace AX and 600 AX freehub bodies
10mm Allen-bit socket	For removing most Shimano and SunTour freehub bodies

TIME AND DIFFICULTY

Freewheel removal/installation

Once the wheel is off, it is usually a simple matter to remove and install a freewheel. It normally takes 2–3 minutes and poses little difficulty. In cases where the freewheel is damaged where it engages the remover, the nature of the job changes completely; freewheel disassembly is required, a job that may take 10–15 minutes and is moderately difficult. In cases where the freewheel is so tight that thin-walled splined removers such as the Park FR-1 and FR-4 are failing before loosening the freewheel, it is necessary to remove the axle set so that a heavier-duty remover (that can only be used with the axle out) can fit. Removing and replacing the axle set is an additional 10–15 minute job of moderate difficulty.

Freehub-body removal and installation

Freehub bodies are only accessible when the axle set is removed from the hub. Removing and installing the axle is a 10–15 minute job of moderate difficulty. While the hub is apart, the freehub body can be removed and installed in 2–3 minutes with little difficulty.

Freewheel/freehub-cog removal and installation

Cog removal and installation is a 5–10 minute job of little technical difficulty, but a great deal of exertion may be required. At times, the cog-removal tool will break or bend before the cog will break loose.

Freewheel, freehub-body, and cog cleaning

Once the parts to be cleaned are removed and accessible, the cleaning will take 2–10 minutes. It is not technically difficult, but can take a lot of elbow grease.

COMPLICATIONS

Identifying freehubs versus threaded hubs with thread-on freewheels

The first complication is just to know whether it is a freehub or a threaded hub with thread-on freewheel that is being dealt with.

When the wheel is off, look at the face of the freewheel/freehub body. If the axle appears to come out of a hole in the body and the edge of the hole has two or four indentations (notches) in its inner perimeter, then it is a thread-on freewheel that takes a pronged freewheel remover. If the hole has splines (about 20) and the splines do not move when turning the cogs backward, then it is a thread-on freewheel that takes a splined remover. If the splines turn with the cogs when the cogs are turned backward, then it is a freehub (probably a Shimano or Sachs). If it is none of these, it is probably a SunTour freehub or some lesser-known brand of freehub.

Damaged freewheel-removal system

Notched-freewheel-removal systems are prone to damage. The tool slips and the notches strip out. When this happens, the freewheel is a loss. Instead of removing it in the conventional manner, it will need to be disassembled for removal. This removal technique is described in detail later (page 25-12).

Prevention of this failure is always possible. Use of the correct removal tool and careful adherence to the recommended procedures will prevent virtually all failures.

Stuck freewheel won't break loose, or remover breaks

A freewheel can be so tight that it may take two people to remove. If the remover is the correct fit, properly secured, and the wheel is in a stable condition, then the worse that may happen is that the freewheel remover (thin-wall type) may break. If this occurs, there are heavier-duty removers that are more awkward to use, but effective.

Axle set interferes with freewheel remover

Thick-wall splined removers require locknuts and spacers to be removed from the right side first. Sometimes this hardware will just thread off the right side of the axle, but usually the axle must be stripped on the left side in order to be pushed out the right side.

Some cartridge-bearing hubs cannot have the hardware stripped off the right side and cannot have the axle pushed out the right side of the hub unless the freewheel is removed. In these cases, there are two options. The choices are to use a thin-wall remover, or to disassemble the freewheel to remove it without a remover (which destroys the freewheel).

No correct remover available for freewheel type

Almost all freewheels ever made still have removers available. In the unlikely event that there is no remover available, then the only option is to disassemble the freewheel to remove it without a remover (which destroys the freewheel).

Rim has been removed before freewheel

The leverage of the rim is required to turn the hub out of the freewheel. When the rim has been removed, there is a good likelihood that either the hub

or freewheel will need to be sacrificed. The section of this chapter about difficult freewheel removal describes all the options in detail (page 25-13).

Difficult threaded-cog removal

Threaded cogs are tightened by the rider's legs and consequently can be extremely secure. The result is that it can take the strength of two people or a large lever to break loose a cog. It is not unusual for the cog-removal tool to fail during removal of extremely difficult cogs. For this reason, it is important to never skimp on the quality of a cog-removal tool, and to always inspect it carefully before use. Furthermore, set the work up in anticipation of what might happen if something suddenly gave way.

Difficult lockring removal

Freehub-cog lockrings can be difficult to remove. Use of a proper tool and technique is critical. It is important to have the tool properly retained so that it does not slip out of place and it is necessary to resist the cogset rotation by using a cog-removal tool on the outermost cog. The larger inner cogs can easily warp if they are used to resist rotation during a difficult lockring removal.

Lockring will not engage after installing new cogset on freehub

If the lockring will not engage the freehub body after installing a new cogset, it usually means that the new cogset has more cogs than the freehub body is designed for.

Lockring secures, but new cogset remains loose on freehub body

Not all Shimano cogsets are compatible with all Shimano freehub bodies. In particular, installing a compact-drive cogset (usually with a 11 tooth cog) on a freehub body that was not originally designed for compact drive will result in this symptom.

ABOUT THE REST OF THIS CHAPTER

The rest of this chapter is divided into the following sections. First, ***FREEWHEEL REMOVAL, REPLACEMENT, AND INSTALLATION***. The next section is ***DIFFICULT FREEWHEEL REMOVAL***, which includes removing notched freewheels with stripped-out notches, and removing freewheels when there is no rim attached to the hub. This is followed by ***NON-LOCKRING FREEHUB-COG REMOVAL, REPLACEMENT AND INSTALLATION***. Next is the section ***LOCKRING-RETAINED COG REMOVAL, REPLACEMENT, AND INSTALLATION***. The next section is ***FREEHUB-BODY REMOVAL, REPLACEMENT AND INSTALLATION***. The next section is ***EIGHT- AND NINE-SPEED COMPATIBILITY.*** The last section is ***FREEWHEEL AND FREEHUB TROUBLESHOOTING***.

FREEWHEEL REMOVAL, REPLACEMENT, AND INSTALLATION

REMOVAL

1. **[ ] Use steps 1–16 of *WHEEL REMOVAL, REPLACEMENT, AND RE-INSTALLATION* (REMOVING A FRONT OR REAR WHEEL) to remove wheel (page 18-6).**
2. **[ ] Remove quick-release skewer or right-side axle nut from axle.**
3. **[ ] Mate freewheel remover to freewheel.**

In the next step, use the quick-release skewer or axle nut to retain the remover against the freewheel-body face. Freewheel removal is a very high-force procedure and the potential for damaging the remover or the freewheel is high. *Stabilizing the remover minimizes any chance of damage, so do not skip this step, regardless of how many times this has been successfully attempted in the past!*

4. **[ ] Install quick-release skewer or right-side axle nut and tighten to hold remover firmly against freewheel.**
5. **[ ] With wheel horizontal and freewheel-side down, put wrench flats of remover in vise and secure vise.**

In the next step, a great force will be applied to the wheel to break loose the freewheel. *As soon as it breaks loose*, stop turning the wheel and remove the skewer or axle nut. The reason for this is that as the freewheel threads further off, the skewer or axle nut will be in the way. If the retaining device is left in place and the wheel is turned much past the break-free point, then the hub, the skewer, or the axle may be destroyed.

6. **[ ] With hands positioned 180° apart, turn wheel counterclockwise *just until freewheel breaks loose*.**
7. **[ ] Remove wheel from vise and remove quick-release skewer or axle nut that is retaining freewheel remover.**
8. **[ ] Turn freewheel remover counterclockwise with fingers or wrench to thread freewheel off fully.**

CLEANING AND LUBING

Skip to **REPLACEMENT** (page 25-10) if installing new freewheel, or skip to **INSTALLATION** (page 25-11) after performing other operations, or if freewheel is just being removed to enable hub or spoke work.

Some sources state that it is a bad idea to submerge a freewheel in solvent. This is the only practical way to clean the inside. The only reason not to submerge a freewheel in solvent is that if it is not dried thoroughly, the remaining solvent will break down the lubricants added.

Most Sachs freewheels have a special port for injecting solvent, compressed air, or lubricant into the inside of the body. This port is hidden underneath the cogs, which must be removed. With a Sachs freewheel, it is preferable to use this port than to use the techniques described in the following procedure for cleaning, drying, and lubing.

9. [ ] **Submerge freewheel in solvent and let it soak for as much time as is available.**
10. [ ] **With freewheel still submerged, rotate freewheel-mechanism inner body back and forth to agitate solvent and break loose dirt inside freewheel body, or use Stein FWG to force solvent through freewheel body.**
11. [ ] **Use Park GSC-1 to scrub outside of freewheel, cleaning cog teeth and inner and outer faces of freewheel body thoroughly.**

The ideal way to dry the inside of a freewheel is by blowing compressed air through it. This can do the job in minutes. For really fast cleaning and drying, install a Stein FWG on the back of the freewheel and force solvent and then air through the port in the tool. If a compressor is not available for freewheel drying, then patience is required. Out in the sun on a hot day, the inside of the freewheel might dry out in an hour or two. Left on a bench top with no direct sunlight, count on it taking at least overnight.

Contrary to popular opinion, the only lubricant needed inside a freewheel is oil. Grease can actually damage a freewheel, or inhibit its ability to function normally. Another popular mistake is to put too much oil in the freewheel. This causes oil to drip out, which leads to more problems with dirt on the freewheel and to a mucky mess on the spokes and perhaps the rim. Using an aerosol lubricant that does not have a rapid-evaporation base is a sure way to over-lube the freewheel. Test the aerosol by spraying a small amount on a surface and checking in 10 minutes to see if it has obviously dried. If so, it should be fine in the freewheel. If using a non-aerosol oil, drip in just 10–15 drops of oil on each face of the freewheel.

12. [ ] **Dry freewheel thoroughly, then squirt small amount of oil into crack between inner body and outer body, both on outer and inner face of freewheel body.**

REPLACEMENT

Skip to **INSTALLATION** (page 25-11) if installing the same freewheel that was removed.

Replacing a freewheel with a different one brings up all kinds of issues about compatibility. There are compatibility issues with the thread of the hub and the thread of the freewheel; with the width of the freewheel and the space on the hub for the freewheel to fit; with the size of the cogs and the capacity of the derailleur; with the spacing of the freewheel cogs and the adjustment of the rear derailleur; with the spacing of the freewheel cogs and the incrementation of an indexing shift system; and with the spacing of the freewheel cogs and the width of the chain.

Thread compatibility

Thread compatibility is important, but rarely an issue. Older French bikes had hubs with a 1mm thread pitch, and the only replacement freewheels available today are a 24tpi pitch. There are actually several thread descriptions that have a 24tpi pitch, but they are all acceptable to interchange, so only pitch need be considered in regard to thread compatibility. The procedure provides an opportunity to compare pitch of the old and new freewheel.

Freewheel width

If the new freewheel has a different number of cogs, or if changing from a narrow-spaced six-speed to a wide-spaced six-speed (or the reverse), then there will definitely be an issue of whether the freewheel width will fit with the existing space on the hub for the freewheel and whether the derailleur will need re-adjustment. If modifying the hub to fit the new freewheel, then the wheel needs to be re-dished and the frame needs to be re-spaced. Even when the new freewheel uses the same number of cogs, and does not change in spacing from narrow to wide (or vice versa), the spacing might be slightly different if the new and old freewheels are different brands or models. A derailleur adjustment may be required. The procedure provides an opportunity to detect whether the width of a new freewheel will require any of the above modifications. But if the modifications are required, refer to the appropriate chapters for the procedures for performing the modifications.

Freewheel size and derailleur capacity

Derailleurs are made to fit certain maximum cog sizes, and to take up a certain amount of slack chain, which is a function of the size differential between the smallest and largest freewheel cogs and the smallest and largest chainrings on the bike. This is most likely to be a problem if the bike is a road bike with narrow "racing" type gearing and the freewheel is being changed to get lower gear ratios, or if putting a freewheel with a 34-tooth cog on any bike. The procedure provides an opportunity to check for a problem with rear-derailleur capacity, but not until the new cogs have been installed and the wheel is back on the bike. The means to correct the problems that might occur with chain length and rear-derailleur capacity are covered in the **CHAINS** chapter and the **REAR DERAILLEUR** chapter (page numbers are provided when needed in the following procedure).

Index compatibility and chain-width compatibility

Problems with index-shifting compatibility are covered in the **REAR DERAILLEUR** chapter (page 32-5).

Problems with chain-width compatibility are covered in the **CHAINS** chapter (page 26-2 and 26-16).

13. [ ] With pitch gauge, measure pitch of old freewheel and new freewheel. If pitches match, freewheels are thread compatible.

If old and new freewheel are not identical model and number of cogs

NOTE: Skip to step 16 if new freewheel is same model and number of cogs as old freewheel.

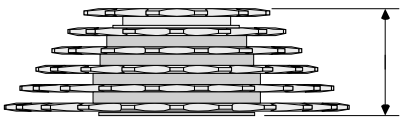
14. Perform following calculation to determine width compatibility:

[ ] Use caliper to measure width from inner face of inner cog to outer face of outer cog of old freewheel and record here: _____mm.

[ ] Use caliper to measure width from inner face of inner cog to outer face of outer cog of new freewheel and record here: _____mm.

[ ] Subtract first measurement from second measurement and record difference here: _____mm.

(Be sure to include negative sign if first measurement is larger than second.)



25.13 Measure freewheel width in this fashion.

15. Check one of following options to determine course of action, depending on type of width incompatibility:

[ ] Difference in step 14 is between .5mm and –.5mm, freewheel is width-compatible and will require no hub re-spacing, wheel re-dishing, or frame re-spacing.

[ ] Difference in step 14 is >.5mm, freewheel is not width-compatible and may require hub re-spacing, wheel re-dishing, frame re-spacing, and rear-derailleur adjustment.

[ ] Difference in step 14 is a negative value below –.5mm, rear-derailleur adjustment is required.

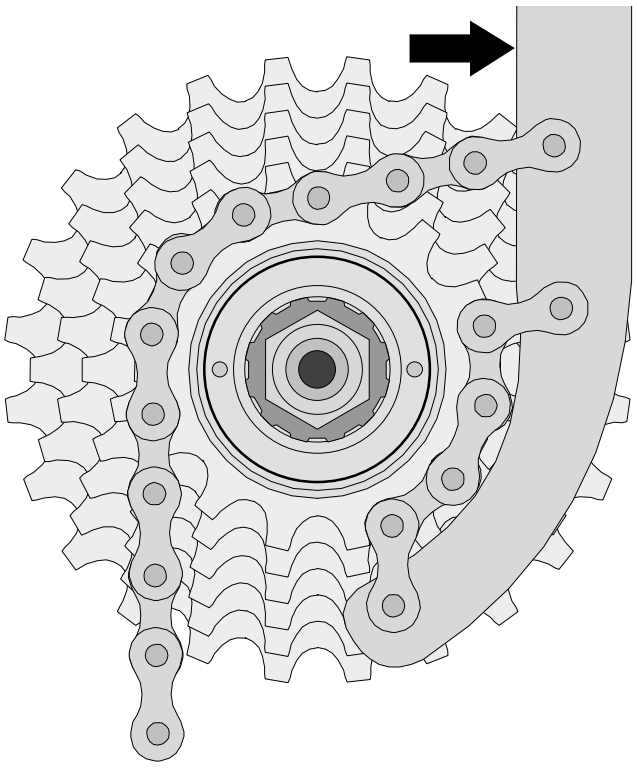
INSTALLATION

16. [ ] Thoroughly grease threads inside freewheel body.

It is easy to carelessly cross-thread a freewheel onto the hub. Once started wrong, it is very difficult to restart correctly. In the following step, you install the freewheel while the wheel is horizontal and with the axle visibly centered in the hole in the freewheel to help prevent this. It is also important to use fingers and not a tool to thread on the freewheel, so that if the freewheel does begin to thread in crossed-up, the damage will be minimized.

17. [ ] With wheel horizontal and right end of axle facing up, drop freewheel onto hub, center axle in freewheel hole, and use *fingers only* to thread freewheel onto hub.

Once the freewheel is hand-threaded on, it does need to be tightened with a tool, particularly if a derailleur adjustment is to be performed. In the next step, secure the freewheel so that it is ready for derailleur adjustment and also makes sure that the outermost cog is secure — a common need with new freewheels. There is likely to be some confusion the first time you use a cog-removal tool on a cog. There are usually two pieces of chain and both must engage the cog. One section of chain is short and fixed at both ends to the tool. Engage this to the cog first. The other section of chain is long and is attached to the tool at one end only. This piece wraps around the cog in the opposite direction than the cog and freewheel will be turning. See figure 25.14, page 25-12.



25.14 Place cog-removal tool on outermost sprocket as shown, to simultaneously tighten outermost cog and freewheel.

18. [ ] Use cog remover on outermost cog to simultaneously secure outermost cog to freewheel and freewheel to hub.

WHEEL INSTALLATION AND POST-INSPECTION

19. [ ] Use steps 9–20 of *WHEEL REMOVAL, REPLACEMENT, AND RE-INSTALLATION* (INSTALLING THE WHEEL) to install wheel (page 18-17).

The next step is needed only if the size of the outermost and/or innermost cogs has changed. These changes can affect chain length and derailleur capacity. The tests for chain length and derailleur capacity are given here without detailed explanation. If unfamiliar with these items, see **CHAINS** (page 26-6) and **REAR DERAILLEURS** (page 32-6).

20. *If replacement freewheel with different number of teeth on largest or smallest cog has been installed*:

[ ] Shift chain to outermost chainring and then shift chain to outermost freewheel cog to check and correct chain length. (See CHAINS, page 26-6.)

[ ] Shift chain to innermost chainring. Check whether chain hangs slack between top of freewheel and top chainrings, or whether chain touches itself or derailleur an extra time between lower jockey wheel and bottom of chainrings. Either condition indicates maximum-total-capacity of rear derailleur has been exceeded. (See REAR DERAILLEURS, page 32-7.)

[ ] Shift chain to innermost chainring (if not already). Shift rear derailleur to put chain on, and then off of, innermost freewheel cog and observe whether chain jams trying to go on or off innermost freewheel cog. If chain jams either way, rear-derailleur maximum-freewheel-capacity has been exceeded. (See REAR DERAILLEURS, page 32-6.)

DIFFICULT FREEWHEEL REMOVAL

Freewheels can be difficult to remove because the freewheel fails, the tool fails, or the rim is no longer attached to the hub. This section is actually three separate procedures appropriate for each of these conditions.

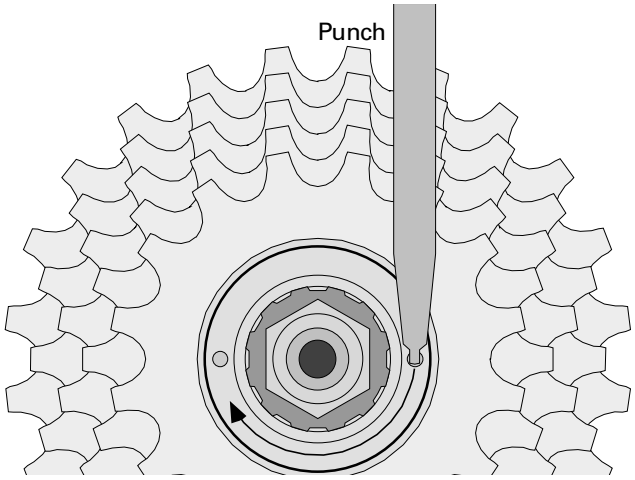
Notches stripped-out where pronged freewheel-remover fits

If the wrong remover has been used or the remover was not properly retained with the skewer or axle nuts, the notches in the innermost ring of the face of the freewheel can strip. First, try the correct tool properly retained to see if that will work. If further stripping occurs, the freewheel must be removed and replaced. To do this, the following procedure suggests disassembling the freewheel so that the inner body can be grasped directly in the vise to hold it while threading the hub out of the freewheel inner body.

1. [ ] Remove freewheel remover if still in place.

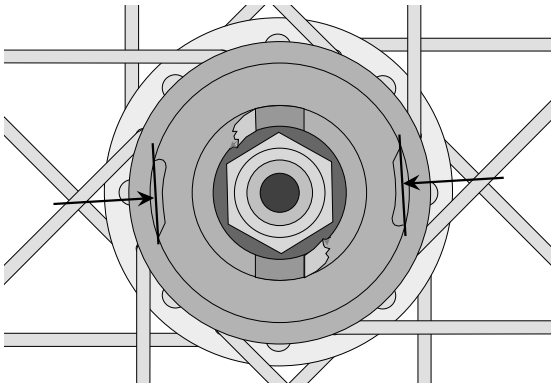
Most freewheels have a cone that is the flat ring just out from the innermost ring of the freewheel-body face (the one that has the removal notches). This cone typically has two small round holes in it for the engagement of a pin spanner. Although such pin spanners are made, they are rarely sturdy enough to remove a tight cone. A punch with a small pointed tip that will fit in one of the holes is the recommended tool. The cone is always a left-hand thread, so it must be turned clockwise to loosen it. Once the cone is off, there will be all sorts of tiny ball bearings and small pieces of metal called pawls that can be seen. Once

the freewheel has been pulled apart, these little things are going to go all over the place, but don't worry about it because a new freewheel will be installed.



25.15 *Removing the freewheel cone.*

2. [ ] **Use punch to drive cone clockwise to loosen it, then unthread completely.**
3. [ ] **Lift cogset and outer body of freewheel body off of inner body.**
4. [ ] **Remove pawls from inner body.**
5. [ ] **With wheel horizontal and freewheel on bottom side, grasp inner body of freewheel in vise jaws. Use recesses where pawls were removed to get best grip.**



25.16 *Grasp remaining piece of freewheel body (at points indicated) in vise, then turn wheel counterclockwise to unthread freewheel.*

6. [ ] **Turn wheel counterclockwise with both hands to break loose and unthread hub from freewheel inner-body.**
7. [ ] **Replace freewheel.**

Thin-wall-splined remover blows-up without breaking loose freewheel

Freewheels that require a thin-wall-splined remover can be a problem if the remover fails before the freewheel breaks loose. *Make sure the remover is fully engaged to prevent this from ever happening!* Once it has happened with the remover properly engaged, then more drastic measures need to be taken. Heavy-duty removers with thick walls are made that never fail, but they require removal of the axle set to be used, and that is a time-consuming inconvenience.

Some cartridge-bearing hubs with flanges on the axle require freewheel removal before the axle can be removed. Unfortunately, the only solution is to sacrifice the freewheel. In this case, just treat the freewheel as though it were one with damaged notches and disassemble the freewheel to remove it.

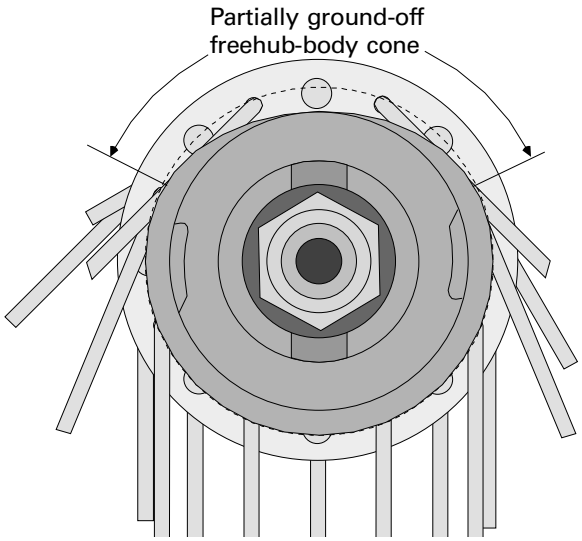
1. [ ] ***If hub has cartridge-bearing axle that requires freewheel removal before axle can be removed*, the freewheel will have to be destroyed. Use procedure under *Notches stripped out where pronged freewheel remover fits* (page 25-12).**
2. [ ] ***If hub is adjustable-cone type*, use steps 17–20 from *ADJUSTABLE-CONE-HUB OVERHAUL & ADJUSTMENT PROCEDURE* to remove axle from hub (page 12-9).**
3. [ ] **Use Bicycle Research CT2 (20.4mm diameter, 20-spline hole) or Bicycle Research CT6MB (21.9mm diameter, 12-spline hole) to remove freewheel in normal way, except without using quick-release skewer or axle nut to retain remover.**
4. [ ] ***If hub is adjustable-cone type*, use steps 55–83 from *ADJUSTABLE-CONE-HUB OVERHAUL & ADJUSTMENT PROCEDURE* (page 12-13) to install axle and adjust bearings.**
5. [ ] ***If hub is cartridge-bearing type*, use appropriate procedure for specific brand of hub from Chapter 13 to re-install axle.**

Rim has been detached from hub before freewheel has been broken loose

One of the worst bonehead mistakes a mechanic (or customer) can make is to cut the spokes or unlace a wheel before removing the freewheel from the hub. The leverage of the rim is required for freewheel removal. If the wheel is unlaced but the spokes have not been cut, it is worth the trouble to rebuild the wheel with the old spokes and rim and then remove the freewheel, because the only alternatives require sacrificing either the hub or the freewheel.

If the spokes are cut, decide whether to sacrifice the hub or freewheel, then pick the appropriate step. If the hub has large-diameter flanges, there is one alternative not shown in steps #1–#3; remove the cogs from the freewheel body, relace the hub and new rim together with new spokes, then remove the freewheel if necessary.

1. ***If spokes are still in hub and not cut*:**
   [ ] Rebuild wheel.
   [ ] Remove freewheel normally.
2. ***If saving hub and sacrificing freewheel*:**
   [ ] Use steps 1–4 under *Notches stripped out where pronged freewheel remover fits* to disassemble freewheel (page 25-12).
   [ ] Use grinder to grind conical flange off of inner body of freewheel to expose spoke holes in hub flange.
   [ ] Rebuild wheel.
   [ ] Use steps 5–7 under *Notches stripped out where pronged freewheel remover fits* to complete freewheel removal (page 25-12).



25.17 *Grind the inner body cone off as shown.*

In the next step, the hub is held in the vise while the freewheel is removed. It does no harm to initially grasp the hub flanges as hard as possible without crushing them, and then attempting the removal. If the freewheel removes and the hub flanges are fine, then both are reusable. If the hub slips and it must be clamped tighter, then nothing has been lost by trying removal without destroying the hub first.

3. ***If saving freewheel and sacrificing hub*:**
   [ ] Attach freewheel remover to freewheel and retain remover with quick-release skewer or axle nut.
   [ ] Grasp hub shell firmly in vise, crushing flanges if necessary.
   [ ] Use large adjustable wrench to turn remover counterclockwise to remove freewheel from hub.

NON-LOCKRING COG REMOVAL, REPLACEMENT, AND INSTALLATION

Cog removal for freewheels and non-lockring freehubs is similar, because in both cases some cogs slip onto the freewheel/freehub-body with a spline configuration, and these are retained by outer position cog(s) that thread onto the freewheel/freehub-body. Shimano Hyperglide freehubs and several others are different because all the cogs fit with a splined configuration and there is a lockring that threads into the freehub body to retain the cogs.

Depending on the specific model of freewheel/freehub, there may be from one to four cogs that thread on and the remainder will be splined. If the cogs are very dirty, it can be hard to see whether the one about to be removed is threaded or splined. After removing the first threaded cog, always assume that the next one is splined and attempt to remove it by pulling out on it. If it will not pull off, then it is a threaded cog.

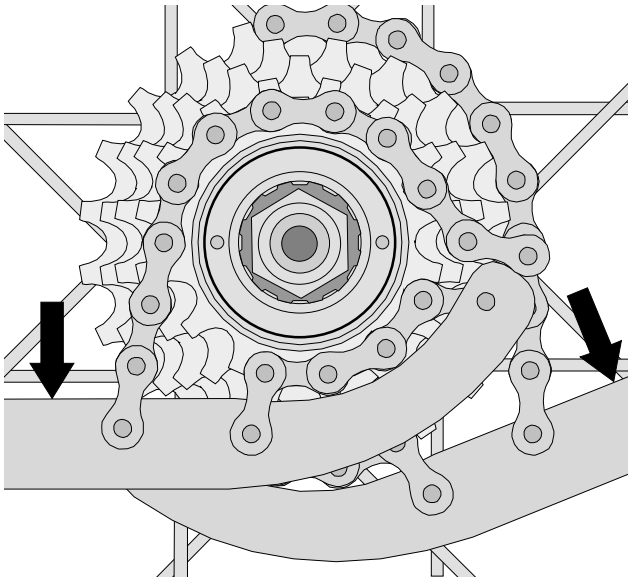
It is very important to maintain the orientation of the cog at all times while it is off. Most cogs can be installed facing either way, but only one way is correct. The differences may be very subtle and are not consistent enough from one brand to the next to be worth mentioning here.

Cogs from one freewheel brand or model are almost never interchangeable with another. It is even rare that cogs in one position on a freewheel are interchangeable with cogs in another position on the same freewheel. This means that if changing gear selection, a new cog generally must be installed in every position where changing the number of teeth. Some spacers are made to work specially with one size of cog. For example, if removing a 15-tooth cog in the second position and replacing it with a 14 tooth, it is likely that the spacer outward of the second position will also need to be changed. To help with all these problems, manufacturers generally make "maps" of their freewheels. Do not attempt customizing freewheels without a map or guide.

COG REMOVAL

1. **[ ] Use steps 1–16 of *WHEEL REMOVAL, REPLACEMENT, AND RE-INSTALLATION* procedure (REMOVING A FRONT OR REAR WHEEL) to remove wheel (page 18-6).**
2. **[ ] Put wheel on floor and lean wheel against legs with freewheel facing out.**

3. [ ] **Put one cog-removal tool on next-to-innermost freewheel cog with long free piece of chain wrapped counterclockwise around cog and short fixed piece of chain pinched between tool handle and cog.**



25.18 The correct setup for using the two cog-removal tools to break loose the outermost cog.

4. [ ] **Rotate wheel as necessary to position cog-removal tool so that it is parallel to floor and on left side.**
5. [ ] **Put second cog-removal tool on outermost cog so that handle ends up parallel to floor, with long free piece of chain wrapped clockwise around cog and short fixed piece of chain pinched between tool handle and cog.**

Cogs can be very difficult to break free. In the next step it is sometimes necessary to have a partner, each one pressing with two hands on one tool.

6. [ ] **Press down firmly on both cog-removal tools simultaneously to break loose outermost cog, then thread outermost cog off.**

Remember: as cogs come off, it is very important to keep track of where spacers came from, which way the cogs faced, and the order of the cogs. As cogs are removed, check for spacers stuck to the backside of the cog just removed and to the front side of the next cog to be removed.

7. [ ] **Place cog on surface with outer-face facing up.**
8. [ ] **Check for spacer on face of remaining outermost cog and remove spacer (if any). Put spacer on surface so that its outer surface is facing up.**
9. [ ] **With fingers, pull outward on remaining outermost cog to check whether it is a slip-on cog or a thread-on cog. If cog slips off, check if next cog is also a slip-on type. Check for spacers between each cog pair. Put all cogs and spacers on surface in order, with outer face of each facing up.**
10. [ ] **Repeats steps 5–9 for each remaining thread-on type cog, if any.**

COG REPLACEMENT

11. [ ] **Substitute each cog to be replaced in layout with its replacement cog, being sure to put replacement cog in same position and with same side facing up.**
12. [ ] **Substitute each spacer to be replaced in layout with its replacement spacer, being sure to put replacement spacer in same position and with same side facing up.**

COG INSTALLATION

13. [ ] **One at a time and in order, starting with the largest cog, put all slip-on cogs and spacers onto freewheel body, making sure upper face ends up facing out in each case.**
14. [ ] **Lubricate threads on thread-on cogs.**
15. [ ] **Install, in order, remaining spacers and thread-on cogs, making sure upper faces end up facing out.**
16. [ ] **Put wheel on floor and lean wheel against legs with freewheel facing out.**

Although thread-on cogs are self-tightening when the bike is ridden, if they are not deliberately tightened in the correct order, there can be problems the first time the bike is ridden after cog installation. *For this reason, secure each cog as best as possible as it is installed!*

17. [ ] **Put one cog-removal tool on innermost thread-on cog with long free piece of chain wrapped counterclockwise around cog and short fixed piece of chain pinched between tool handle and cog, then rotate tool clockwise to secure cog as best as possible. Moving out one at a time, secure each additional thread-on cog in a similar fashion.**
18. [ ] **Use steps 9–20 of *WHEEL REMOVAL, REPLACEMENT, AND RE-INSTALLATION* procedure (INSTALLING THE WHEEL) to install wheel (page 18-17).**

The next step is needed only if the size of the outermost and/or innermost cogs has changed. These changes can affect chain length and derailleur capacity. The tests for chain length and derailleur capacity are given here without detailed explanation. If unfamiliar with these items, see **CHAINS** (page 26-6) and **REAR DERAILLEURS** (page 32-5).

19. ***If replacement cogs of different sizes have been installed in the innermost or outermost position*:**
[ ] Shift chain to outermost chainring and then shift chain to outermost freewheel cog to check and correct chain length. (See CHAINS, page 26-6.)
[ ] Shift chain to innermost chainring. Check whether chain hangs slack between top of freewheel and top chainrings, or whether chain touches itself or derailleur an extra time between lower jockey wheel and bottom of chainrings. Either condition indicates maximum-total-capacity of rear derailleur has been exceeded. (See REAR DERAILLEURS, page 32-7.)
[ ] Shift chain to innermost chainring (if not already). Shift rear derailleur to put chain on, and then off of, innermost freewheel cog and observe whether chain jams trying to go on or off innermost freewheel cog. If chain jams either way, rear-derailleur maximum-freewheel-capacity has been exceeded. (See REAR DERAILLEURS, page 32-6.)

LOCKRING-RETAINED COG REMOVAL, REPLACEMENT, AND INSTALLATION

Shimano Hyperglide cogs (and other similar ones) have a special configuration to facilitate shifting under load. For this configuration to work, the cogs need to be synchronized with each other. For this reason, Shimano designed these cogs so that there is only one way that they can fit on the freehub body. This is done by means of making one spline fatter than the others and not centering it between the adjacent splines. This configuration makes cog installation simpler.

The complication comes if trying to replace individual cogs in a Hyperglide set. A 17-tooth cog marked S-17 is not compatible with a 17-tooth cog marked T-17. Only if all the cogs in the set have the same letter code is there assurance of compatibility. There are cases when letters can be mixed, but data on these are skimpy and subject to rapid change.

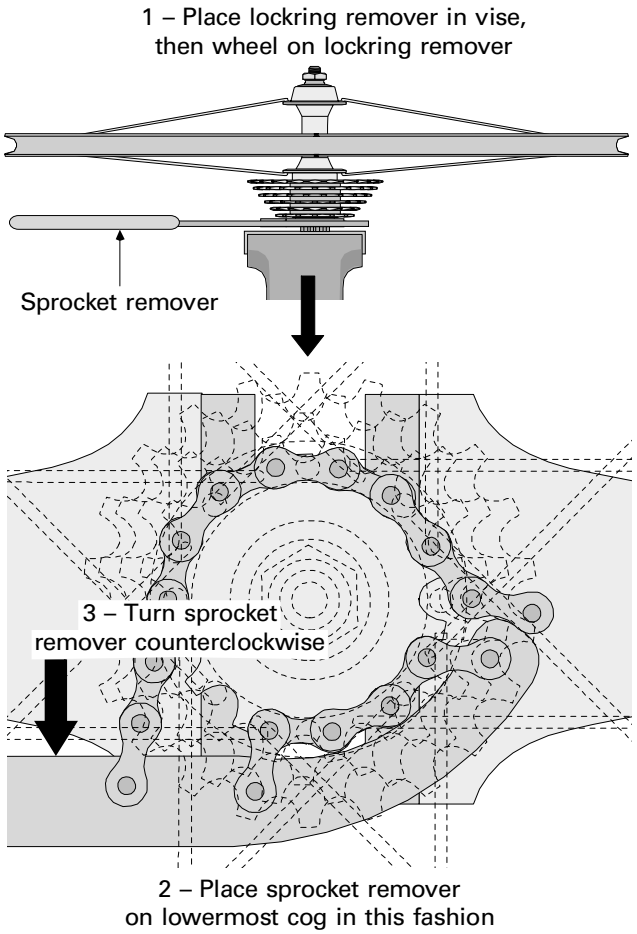
1. **[ ] Use steps 1–15 of *WHEEL REMOVAL, REPLACEMENT, AND RE-INSTALLATION* procedure (REMOVING A FRONT OR REAR WHEEL) to remove wheel (page 18-6).**

The Hyperglide tool closely resembles the most popular splined-freewheel remover, *but they are not interchangeable!* Make sure that if using a tool other than the recommended Park FR-5 that it is Hyperglide compatible. If the diameter of the splines on the tool is at least 23.5mm, then the tool is appropriate.

2. **[ ] Remove skewer and install Park FR-5 (or other Hyperglide-lockring tool) into splines of cog-retaining ring.**

Even with a properly fit tool, engagement is poor for the forces involved. Be sure that the tool is fully engaged and firmly secured with the quick-release skewer.

3. **[ ] Install skewer and thread adjusting nut until tight to secure FR-5 in place.**
4. **[ ] With wheel horizontal and cog-side down, grasp wrench flats of FR-5 in vise jaws.**
5. **[ ] Put cog-removal tool on next-to-outermost cog with long free piece of chain wrapped clockwise (viewed from above) around cog and short fixed piece of chain pinched between tool handle and cog.**



25.19 *This is a side-view and top-view of the proper setup for breaking loose a cog-retaining lockring. The top-view (at bottom) portrays the hub, cogs, and spokes in a see-through fashion with dashed lines so that you can see the proper orientation of the cog-removal tool.*

The retaining ring's back face is deeply serrated and the face of what it tightens against is also deeply serrated. It will make a loud snapping or crackling sound when it is being broken loose. This is alarming but normal.

6. [ ] **Apply force to cog-removal tool in counterclockwise direction (viewed from above) to break loose cog and continue rotating tool just until clicking noise stops.**
7. [ ] **Remove wheel from vise and remove skewer from wheel.**
8. [ ] **Facing cogset, turn FR-5 counterclockwise to remove ring completely.**
9. [ ] **Slip off cogs and spacers, placing them in order on surface with all outer-faces facing up.**

Some Hyperglide cogs come off one at a time, and others remove and install as a group held together by three bolts or rivets. The only reason they are grouped is to make factory installation quicker and easier. If not replacing individual cogs, there is no reason to separate the group. If replacing individual cogs, then separate the group but do not worry about reinstalling the bolts or rivets. To get the rivets out, grind or file off the head of each rivet and drive it out with a punch or nail.

10. [ ] **If replacing individual cogs and cogs came off as a cassette, unthread bolts from back of cogset to separate cogs and place them in order on surface with all outer-faces facing up.**

COG REPLACEMENT

11. [ ] **Substitute each cog to be replaced in layout with its replacement cog, being sure to put replacement cog in same position and with same side facing up.**
12. [ ] **Substitute each spacer to be replaced in layout with its replacement spacer, being sure to put replacement spacer in same position and with same side facing up.**

COG INSTALLATION

All the cogs have a fat, off-center spline that engages a fat, off-center groove in the freehub body so if a cog is rotated or facing the wrong way it will simply not go on. Stay out of trouble with spacers by making sure the three holes or notches in each spacer line up with the comparable holes or notches in each cog. If the spacers have tabs sticking out from one face, make sure that the tabs all face outward.

13. [ ] **Find fat spline on each cog and orient cog so fat spline is at 12:00. Find fat groove on freehub body and orient so fat groove is a 12:00.**
14. [ ] **One at a time and in order, starting with the largest cog, put all slip-on cogs and spacers in order onto freehub body, making sure fat splines go into fat groove.**
15. [ ] **Lubricate threads on retaining ring and thread into freehub body.**
16. [ ] **Put wheel on floor and lean wheel against legs with freewheel facing out.**
17. [ ] **Install FR-5 into retaining ring and install skewer to retain FR-5.**

In the next step, tighten the retaining ring. When it was removed, the FR-5 was held in the vise. The same thing could be done for installation but the potential to over-tighten the retaining ring is great. For this reason, in the next step, use a wrench with 8" of leverage (unless using a torque wrench) to minimize the potential of over-tightening.

18. [ ] **With large adjustable wrench or end of Park SR-1 tool on FR-5, tighten retaining ring to a torque of 265in-lbs (33lbs@8").**
19. [ ] **Remove skewer and FR-5, then reinstall skewer.**
20. [ ] **Use steps 9–20 of *WHEEL REMOVAL, REPLACEMENT, AND RE-INSTALLATION* procedure (INSTALLING THE WHEEL) to install wheel (page 18-17).**

The next step is needed only if the size of the outermost and/or innermost cogs has changed. These changes can affect chain length and derailleur capacity. The tests for chain length and derailleur capacity are given here without detailed explanation. If unfamiliar with these items, see **CHAINS** (page 26-6) and **REAR DERAILLEURS** (page 32-6).

21. ***If replacement cogs of different sizes have been installed in the innermost or outermost position*:**
    [ ] Shift chain to outermost chainring and then shift chain to outermost freewheel cog to check and correct chain length. (See CHAINS, page 26-6.)
    [ ] Shift chain to innermost chainring. Check whether chain hangs slack between top of freewheel and top chainrings, or whether chain touches itself or derailleur an extra time between lower jockey wheel and bottom of chainrings. Either condition indicates maximum-total-capacity of rear derailleur has been exceeded. (See REAR DERAILLEURS, page 32-7.)
    [ ] Shift chain to innermost chainring (if not already). Shift rear derailleur to put chain on, and then off of, innermost freewheel cog and observe whether chain jams trying to go on or off innermost freewheel cog. If chain jams either way, rear-derailleur maximum-freewheel-capacity has been exceeded. (See REAR DERAILLEURS, page 32-6.)

FREEHUB-BODY REMOVAL, REPLACEMENT, AND INSTALLATION

The only time it is necessary to remove a freehub body is when replacing it. It is easier to clean the hub when doing a hub overhaul and easier to clean the freehub body when the freehub body is removed, but it is not necessary to remove the freehub body for these purposes.

1. [ ] **Use steps 1–15 of *WHEEL REMOVAL, REPLACEMENT, AND RE-INSTALLATION* procedure (REMOVING A FRONT OR REAR WHEEL) to remove wheel (page 18-6).**
2. [ ] **Use steps 17–20 from *ADJUSTABLE-CONE-HUB OVERHAUL & ADJUSTMENT PROCEDURE* to remove axle from hub (page 12-9).**

These instructions cover only the specific brands and models of freehubs indicated. Other brands exist, but are far less common. The methods to remove freehub bodies from other brands may be completely different, especially if the other brand has cartridge bearings. This section specifically does not cover Ringlè, Hugi, Hope, or Mavic freehubs.

FREEHUB-BODY REMOVAL

3. [ ] ***If freehub is Shimano, non-Dura-Ace, 1985 or later*, insert 10mm Allen wrench into freehub body and rotate counterclockwise to release freehub. A hollow bolt will come out and freehub body will slip off.**
4. [ ] ***If freehub is Shimano Dura-Ace (any year, but excluding AX model)*, insert TL-FH10 into freehub body and rotate counterclockwise to release freehub.**
5. [ ] ***If freehub is SunTour brand*, insert 10mm Allen wrench through left side of hub shell and turn wrench counterclockwise to unthread retaining bolt. Freehub body will slip off right side.**
6. [ ] ***If freehub is Shimano, non Dura-Ace, pre-1985 (or Dura-Ace AX)*, remove cogs from freehub body, thread TL-FH30 onto freehub body, and tighten shaft of TL-FH30 to pull freehub body off of hub shell.**

FREEHUB-BODY CLEANING AND OILING

Skip to **FREEHUB BODY INSTALLATION** (page 25-18) if installing a new freehub body.

There is often a rubber seal in the back face of Shimano freehub bodies. It can be hard to see. It needs to be removed so that solvent, air, and oil can get into the freehub body. Once found, it can be pried out with a pin or needle. Be sure to get it back in before installing the freehub body on the hub shell.

7. [ ] **Remove any rubber seal ring from back face of freehub body and submerge freehub body in solvent and let it soak for as much time as is available.**
8. [ ] **With freehub body still submerged, rotate freehub-body-mechanism inner body back and forth to agitate solvent and break loose dirt inside freehub body, or use Morningstar Freehub Buddy to inject solvent through body.**
9. [ ] **Use Park GSC-1 to scrub outside of freehub body, cleaning cog teeth (if still installed) and inner and outer faces of freehub body thoroughly.**
10. [ ] **Dry freehub body thoroughly, then squirt small amount of oil into crack between inner body and outer body, both on outer and inner face of freehub body. Replace rubber seal ring, if any.**

FREEHUB-BODY INSTALLATION

When a separate bolt is used to hold a freehub body in place, unlike a regular freewheel, riding the bike will not tighten the body to the hub shell. For this reason, if the freehub body is held on by a separate bolt it is very important to tighten the bolt adequately. Loose bolts will loosen further, causing the cogs to wobble and ultimately leading to the rear wheel locking up.

11. ***If freehub is Shimano, non-Dura-Ace, 1985 or later*:**
    [ ] Slip freehub body onto hub-shell splines.
    [ ] Lubricate hollow-bolt threads and thread through freehub body and into hub shell.
    [ ] Use 10mm Allen wrench to tighten bolt to 310in-lbs (52lbs@6").
12. ***If freehub is Shimano Dura-Ace (any year, but excluding AX model)*;**
    [ ] Thread freehub body into hub shell.
    [ ] Use TL-FH10 to snug freehub body, pedaling torque will tighten freehub body fully.
13. ***If freehub is SunTour brand*:**
    [ ] Slip freehub body onto hub-shell splines.
    [ ] Lubricate hollow-bolt threads and thread through hub shell and into freehub body.
    [ ] Use 10mm Allen wrench to tighten bolt to 310in-lbs (52lbs@6").

14. [ ] ***If freehub is Shimano, non-Dura-Ace pre-1985 (or Dura-Ace AX)*;**
    [ ] Slip freehub body onto hub shell.
    [ ] Slip axle through hub and freehub body.
    [ ] Put installation washers from TL-FH30 onto ends of axle.
    [ ] Thread nuts or cones onto axle and tighten towards each other until freehub body is pressed fully on.
    [ ] Remove nuts, washers, and axle.

HUB ASSEMBLY AND WHEEL INSTALLATION

15. [ ] **Use steps 55–82 from ADJUSTABLE-CONE-HUB OVERHAUL & ADJUSTMENT PROCEDURE to install axle and adjust bearings (page 12-13).**
16. [ ] **Use steps 9–20 of *WHEEL REMOVAL, REPLACEMENT, AND RE-INSTALLATION* procedure (INSTALLING THE WHEEL) to install wheel (page 18-17).**
17. ***If replacement cogs of different sizes have been installed in the innermost or outermost position*:**
    [ ] Shift chain to outermost chainring and then shift chain to outermost freewheel cog to check and correct chain length. (See CHAINS, page 26-6.)
    [ ] Shift chain to innermost chainring. Check whether chain hangs slack between top of freewheel and top chainrings, or whether chain touches itself or derailleur an extra time between lower jockey wheel and bottom of chainrings. Either condition indicates maximum-total-capacity of rear derailleur has been exceeded. (See REAR DERAILLEURS, page 32-7.)
    [ ] Shift chain to innermost chainring (if not already). Shift rear derailleur to put chain on, and then off of, innermost freewheel cog and observe whether chain jams trying to go on or off innermost freewheel cog. If chain jams either way, rear-derailleur maximum-freewheel-capacity has been exceeded. (See REAR DERAILLEURS, page 32-6.)

EIGHT- AND NINE-SPEED COMPATIBILITY

Shimano has introduced nine-speed cogsets that fit on the same freehub body that fits eight-speed cogsets. No modifications of the hub or axle spacing are necessary to make this conversion.

Because the nine-speed cogset has less space between the cogs than the eight-speed cogset, it is necessary to change the chain to a nine-speed compatible model when making this conversion.

Although there are nine-speed specific derailleur models for MTBs, it is not always necessary to change the derailleur. The reason for this is that at the same time that Shimano introduced the nine-speed configuration for MTBs, the company also increased the maximum cog size to 34 teeth (from the traditional 32 teeth). If the nine-speed cogset being installed has a largest cog size of 32 teeth or less, then there is no need for a derailleur change.

Of course, any time the number of cogs is changed, it is necessary to replace the shift-control mechanism with one designed for the matching number of gears.

In the unlikely case that a nine-speed configured bike were being converted to eight-speeds, then the only change other than the cogs would be the shift-control mechanism. The nine-speed chain is compatible with eight-speed cogsets, and a nine-speed rear derailleur would be compatible, as well.

FREEWHEEL AND FREEHUB TROUBLESHOOTING

Cause	Solution
SYMPTOM: *Chain slips or skips on a cog when pedaling hard.*	
Fresh chain not meshing with worn cog.	Replace cog or cogs.
Pawls are not catching on internal ratchet ring because they are dirty, rusty, worn, or broken.	Clean and oil freewheel/freehub-body and replace if symptom persists.
SYMPTOM: *Freewheeling occurs while pedaling, constantly or intermittently.*	
Pawls are not catching on internal ratchet ring because they are dirty, rusty, worn, or broken.	Clean and oil freewheel/freehub-body and replace if symptom persists.
SYMPTOM: *While coasting, the cogs continue to turn with the wheel, pushing the chain.*	
Pawls are not riding over teeth of internal ratchet ring because they are dirty, rusty, fouled with grease, worn, or broken.	Clean and oil freewheel/freehub-body and replace if symptom persists.
SYMPTOM: *A steady light clunking sound comes from the freewheel in some gears more than others and at some pedaling speeds but not others.*	
Freewheel-bearing adjustment is loose because cone has come loose.	Turn cone ring on face of freewheel counterclockwise to secure it.
Freewheel-bearing adjustment too loose because bearing parts are worn.	Check for loose cone. If tight, replace freewheel.
SYMPTOM: *The cogs appear to wobble side-to-side while coasting.*	
Normal occurrence due to lack of precision in bearings.	Ignore it.
SYMPTOM: *The cogs appear to wobble side-to-side while pedaling and the derailleur cannot be adjusted to eliminate cyclic rubbing of the chain against adjacent cog(s).*	
Spoke guard has oversize hole and is off-center.	See if wobble goes away when spoke guard removed, and if it does replace spoke guard.
Freewheel is cross-threaded onto hub.	Remove freewheel and check threads on hub. Hub will probably need to be replaced.
If spoke guard and cross-threading are not the cause, hub-threading or freewheel-threading are defective.	Try substitute freewheel to determine whether hub or freewheel threads are bad and try to get warranty satisfaction for bad part.
SYMPTOM: *Cog teeth are broken.*	
Teeth are extremely worn and are being ripped off by chain when pedaling load is high.	Check cogs for wear and replace cogs or freewheel.
Extreme abusive shifting under load, or impact to teeth.	Avoid abusive behavior.
SYMPTOM: *Cog teeth appear to be bent or not in line with each other.*	
Normal condition for Hyperglide/IG teeth.	Ignore.
Teeth bent from impact.	Avoid abusive behavior.
SYMPTOM: *No matter how the rear derailleur is positioned, the chain seems to rub against the adjacent cog(s).*	
If happening on most cogs, particularly if after replacing chain or freewheel, wide chain is being used with narrow-spaced freewheel.	Use appropriate chain.
If happening on one cog only, particularly if cogs where removed and installed, improper spacer between cogs.	Check and replace spacers.
If happening in outer positions only, chainline is poor.	See **CHAINLINE** chapter to identify error (page 27-6) and correct chainline error (page 27-7).