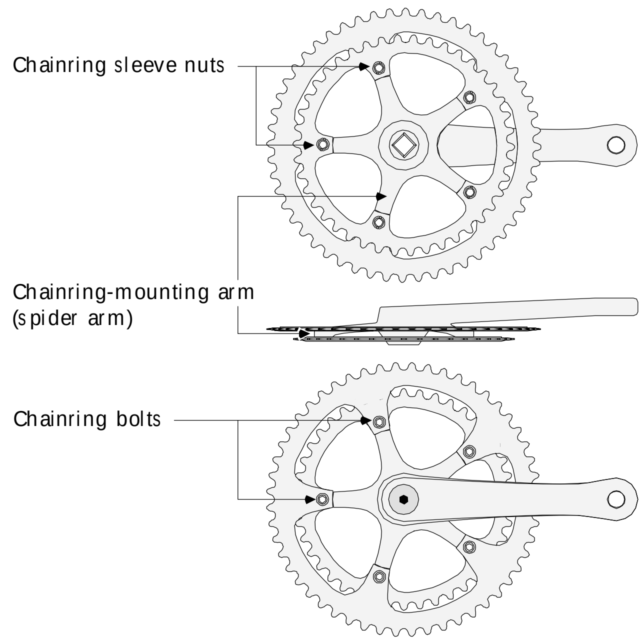
23 – CHAINRINGS

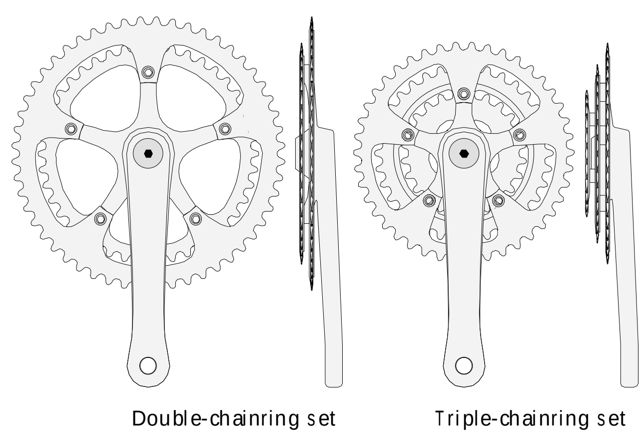
ABOUT THIS CHAPTER

This chapter is about removing and re-installing chainrings from the right crank arm. There are separate chapters about crank arms (**20 – TAPER-FIT CRANK ARMS**, and **21 – COTTERED CRANK ARMS**) which should be referred to if the crank arms will be removed, replaced, or secured.

Chainrings might be removed for cleaning or replacement. It is possible to clean chainrings adequately without removing them from the crank arm and without removing the crank arm from the bike. Replacement of worn and damaged chainrings is possible on most cranks, but some cranks may have permanent chainrings, or the chainrings may be in an unusual configuration for which no replacements are available. There are several critical issues of compatibility between crank arms and chainrings, so before beginning to replace chainrings with non-identical parts, become familiar with the section of this chapter on chainring/crank-arm compatibility (page 23-5).



23.1 *Parts of the chainring set.*



23.2 *Chainring sets.*

GENERAL INFORMATION

TERMINOLOGY

Chainring: A toothed ring that is part of the crankset. Other words used are "chainwheel" and "sprocket."

Chainring bolt: There are several chainring bolts that attach the chainring to the crank arm. These bolts may thread directly into the crank arm or directly into another chainring, but most likely thread into a sleeve nut. Usually the bolt has a broad flange for a head and is fit by an Allen wrench. It may at times just be called an "Allen bolt."

Sleeve nut: The thin-walled cylinder that the chainring bolt threads into.

Chainring-bolt set: A set comprised of the chainring bolt, the sleeve nut, and any spacers that fit between the bolt, nut, and chainrings.

Chainring-mounting arms: The arms (usually five), that go from the end of the crank arm out to the chainrings. The chainrings are attached to the end of the chainring-mounting arms. Chainring-mounting arms are also called "spider arms."

Double-chainring set: A set of two chainrings on a crank arm. Usually found on road bikes, particularly for racing bikes.

Triple-chainring set: A set of three chainrings attached to a crank arm. Usually found on off-road bikes and on road-touring bikes.

Bolt-circle diameter: A measurement used to describe the fit of a chainring to a crank arm. It is the diameter of the imaginary circle that goes through the centers of all the holes in the chainrings where the chainring bolts are inserted (see figure 23.5, page 23-6).

Hole-to-hole dimension: A measurement used to identify the bolt-circle diameter of the chainring. The hole-to-hole dimension is measured from the edge of one chainring-bolt hole to the opposite edge of the adjacent chainring-bolt hole (see figure 23.5, page 23-6). The hole-hole-dimension is located in a table (page 23-6) to be converted into the bolt-circle diameter.

Bolt pattern: The chainring-bolt pattern is the combination of the number of bolts that hold on the chainring and the bolt-circle diameter, such as "The bolt pattern is 5-hole, 130mm."

BioPace: A quasi-elliptical chainring designed by Shimano. Essentially, the shape is that of a generously rounded parallelogram, not a true ellipse. Other brands of non-round chainrings are simple ovals (ellipses).

SG/SGX/HyperDrive: Loosely interchangeable terms used by Shimano to describe a chainring design that features specially-shaped teeth and other features that allow a chain to simultaneously engage two chainrings while in the process of being shifted. With regular chainrings, the chain must disengage one chainring fully before it can engage another.

Chain stay: A frame tube that goes from the bottom bracket to the rear dropout, and comes close to the chainrings and crank arms. It is mentioned here because clearance between the chainrings and the chain stay is often a concern.

PREREQUISITES

Crank-arm removal and installation

Before removing chainrings, the right crank arm may need removal, particularly if the chainrings are a triple-ring set. See the **TAPER-FIT CRANK ARMS** chapter (page 20-6), or the **COTTERED CRANK ARMS** chapter (page 21-4) for crank-arm removal.

Chain sizing

If replacing the chainrings with ones of different size, then it may be necessary to re-size or replace the chain. See the **CHAINS** chapter (page 26-11).

Front-derailleur adjustment and replacement

If replacing chainrings with ones of a different size (particularly the outer ring), it will be necessary to adjust the front derailleur. See the **FRONT-DERAILLEURS** chapter (page 33-10).

Front-derailleur replacement is only required in two cases. First, if installing new chainrings, crankset, or right crank arm with chainrings that have less than an eight-tooth difference between the largest ring and the next smaller one, but the original front derailleur was designed to use triple-chainring sets with differences of 10 teeth or more, a new front derailleur may be needed. See the **FRONT-DERAILLEURS** chapter (page 33-4) to tell how front-derailleur capacity has been exceeded. Second, if installing a "micro-drive" or other crankset with reduced-size chainrings, there could be other problems with front-derailleur capacity.

Rear-derailleur replacement

When installing new chainrings of a different size, or a new crankset or a new right arm with different size chainrings than the original ones, it is possible to exceed the capacity of the rear derailleur to wrap up the slack chain when in the smallest-size-chainring and smallest-rear-cog combination. It is the difference in number of teeth between the smallest and largest ring that is important, not the absolute size of either chainring. See the **REAR DERAILLEURS** chapter (page 32-6) to determine if the capacity matches the new chainring set.

INDICATIONS

Maintenance cycles

Chainrings need periodic cleaning (whenever the chain is being cleaned), and the mounting bolts should be periodically checked for tightness.

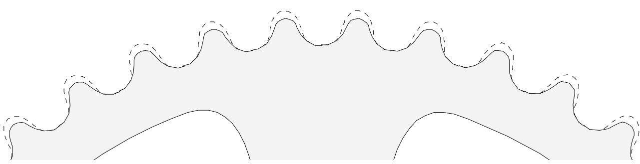
Chainrings wear out, affecting front-derailleur shifting and the tendency for the chain to remain attached to the inner ring and jam against the chain stay. These problems should be dealt with on a symptomatic basis, rather than as part of routine maintenance.

Chainrings can be damaged by striking objects in the trail (off-road riding) and by catastrophic shifting errors (derailing and jamming the chain). The chainrings should be inspected for damage after any such occurrences.

Symptoms indicating shift-worn chainrings

Shifting from a smaller ring to a larger ring slowly wears out the teeth on the larger chainring. When the teeth become significantly worn, they lose their shifting performance. This can also be caused by derailleur problems and chain wear. Check chain wear and check all derailleur adjustments. If the shifting cannot be restored to previous good performance levels, when the chain is not worn out and the derailleur adjustment is good, then the teeth are worn out and the chainring should be replaced.

With an experienced eye, visual inspection can determine whether this wear is getting significant. Worn teeth (from shifting) get shorter and thinner. If all teeth had a uniform shape when new, this would be simple, but they do not. Visual determination of wear is best done by comparing the used chainring to a fresh one of the same brand. In some cases, it is possible to compare teeth on one part of the ring to teeth on another part of the ring. This can work because most riders have a tendency to shift in the same part of the pedaling stroke every time, causing some teeth to wear out before others. The limitation to this is that not all chainrings start out with uniform teeth all the way around the ring. Specifically, Shimano BioPace and SG/SGX/HyperDrive chainrings do not have uniform teeth.

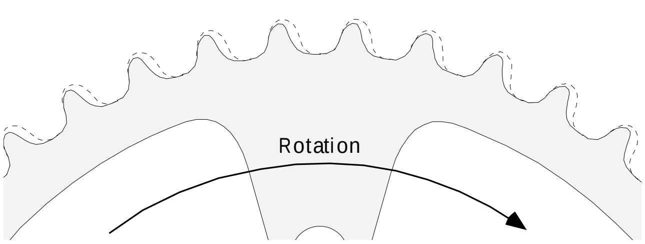


23.3 These chainring teeth are worn from shifting. The dashed line represents the original tooth profile.

Symptoms indicating load-worn chainrings

Chainrings can wear from the load of driving the chain. The symptom is sometimes called "chain suck." The worn teeth develop a hook that causes the chain to remain attached to the chainring at the six o'clock position, where the chain is supposed to be released to go back to the rear derailleur. When the chain is carried up far enough, it jams into the chain stay. This damages the stay and chainrings, and could lock up the crankset. This symptom can be caused by a dirty chain or chainrings, as well. Before concluding the chainrings are worn out, clean the chain and chainrings.

The visual indicator that this condition exists is a pronounced hook to the leading edge of each chainring tooth. Although it is easy to think of the force applied to the chain by the chainring to be a pulling force, what actually happens is that the leading edge of each tooth pushes against the backside of each chain roller. This is why the wear is on the leading edge of each tooth. Most chainring teeth have symmetrical leading and trailing edges, so detecting this wear visually is often just a matter of comparing the two edges.



23.4 This chainring is worn from load. The dashed line shows the original tooth profile.

Symptoms indicating bent chainring(s)

Bent chainrings wobble side-to-side when spun, but not all wobbling chainrings are bent. They can also wobble because the mounting arms are mis-aligned (see page 23-12) or because the crank arm needs to be mounted in a different position (steps #22 through #32 in the **CRANK-ARM INSTALLATION** procedure, page 20-10).

If the chainring is bent, it will wobble side-to-side independently of the other ring(s). If the mounting arms need alignment, or the arm needs to be mounted in a different position, all the rings will wobble in unison.

Although minor chainring bends are repairable, it is generally best to replace the damaged ring. When metal bends, its molecular structure elongates (the space between the molecules increases). Bending it back does not eliminate this elongation. What this means with a thin piece of metal like a chainring, is that the best that can be done when trying to repair a bend is to change a single large wobble into a series of smaller, less obvious wobbles. There are tools available that are for the purpose of bending chainrings, but they are little more than clamps with levers attached that grip the chainring. What really gets the job done is the finesse of the person using the tool. For the shop mechanic, there is no substitute for practice.

Symptoms indicating bent chainring teeth

Chainring teeth can be bent from impact, usually with a stone, curb, or log. The symptom that might be experienced will be a click or snap sound or feeling coming from the crank once per-revolution when the chain is on the affected chainring (usually the outer one). To find the bent tooth, close one eye, line the other eye up with the chainring so that only the teeth and neither face of the chainring can be seen, spin the crank slowly, and look for a tooth that jumps out of line from the others. Shimano SG/SGX/HyperDrive chainrings come from the factory with teeth that deliberately stagger back and forth to facilitate shifting.

If a bent tooth is found, simply grasp it with an adjustable wrench or pliers and bend it back into line with the other teeth.

Symptoms indicating misaligned chainring-mounting arms

When the mounting arms of the chainrings are misaligned, all the chainrings will wobble side-to-side in unison. This could also be because the crank arm is not mounted in the best of the four possible positions (steps #22 through #32 in the **CRANK-ARM INSTALLATION** procedure, page 20-10). The only way to isolate the source of the problem is to test-mount the crank in all four positions to see if it reduces or eliminates the wobble. Once this has been done and the wobble remains unacceptable, then it should be clear that the problem is with the chainring-mounting arms.

Wobbles of less than .5mm are insignificant. Wobbles larger than this but less than 1mm are tolerable under most conditions, but not with certain narrow-cage front derailleurs. Wobbles larger than these limits will always cause problems with the front derailleur.

There are steps for aligning chainring-mounting arms at the end of the ***CHAINRING REMOVAL, INSTALLATION, AND ALIGNMENT*** procedure (see page 23-8).

Symptoms indicating loose chainring bolts

When chainring bolts are slightly loose, there may be a creaking or snapping sound that comes from the crankset once per crank-revolution. With a triple crankset that has two rings held on by one bolt set and the third ring held on by another bolt set, the noise will follow the bolt set involved. In other words, if the noise occurs when using either of the rings held on by the first bolt set but not when using the third ring held on by its own bolt set, then the noise is likely to be the bolts.

In all cases, diagnosis by analysis is unnecessarily complicated. The simplest thing is just to check all the bolts for security whenever this symptom occurs.

Left unattended, a loose bolt can be catastrophic. Without the support of all the bolts, a chainring might collapse under pedaling load. At least, the chainring will be destroyed. It is quite likely the collapsed ring will interfere with the rotation of the crank and the rider will end up pushing the bike home. It is even possible the collapsed ring could jam into and damage the chain stay or front derailleur.

Similar symptoms can be caused by crank-arm-mounting problems, pedal-mounting problems, loose pedal parts, pedal/cleat-interface problems, and bottom-bracket problems (loose cups or retaining rings). If securing the chainring bolts does not eliminate the symptom, be sure to check all these areas until the cause of the problem is found.

TOOL CHOICES

Table 23-1 (below) covers all the tools for the job. 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 in **bold**, it means that several tools are required for different configurations of parts.

TIME AND DIFFICULTY

Chainring removal and re-installation is a 5–10 minute job of little difficulty, as long as the replacement rings are compatible and the same size. If different-size rings require front-derailleur adjustment or replacement, the job has a moderately-high difficulty rating and could take 25–45 minutes more. If the chain must be shortened or replaced due to a change in chainring size, add 5–10 minutes. If the rear derailleur must be replaced because of capacity problems, this is also a moderately-high difficulty job and another 25–45 minutes should be added.

CHAINRING TOOLS (table 23-1)

Tool	Fits and considerations
CHAINRING-BOLT TOOLS	
Campagnolo 768	Fits 12mm sleeve nuts
Shimano TL-FC20	Fits 12mm sleeve nuts, but preferred for use on Shimano crank dustcaps
Sugino 207	Fits rare 10mm sleeve nuts
Sugino 208	Fits 12mm sleeve nuts
VAR 352	Fits 12mm sleeve nuts, simultaneously secures sleeve nut while built-in Allen is used to tighten or loosen bolt.
CHAINRING-SIZING TOOLS	
Park CDG-1	Caliper-like tool easily measures chainring bolt-circle diameter
CHAINRING-ALIGNMENT TOOLS	
Bicycle Research LC1	Narrow engagement more likely to crease chainring
VAR 940	Wide engagement prevents damage, use two at a time for control

COMPLICATIONS

Stripped Allen fittings

Over-tightened chainring bolts often have rounded Allen fittings. The only solutions are to try to turn the sleeve nut instead, and if that fails, to drill out the bolt with an 8mm bit.

Spinning sleeve nuts

The sleeve nut may have a tendency to spin as the bolt is loosened or tightened. A sleeve-nut spanner or the VAR 352 (preferred) should solve the problem.

Missing spacers

If a chainring bolt falls out, a spacer between the chainrings is often missing. If an identical spacer cannot be found, then the whole set should be replaced with the closest-thickness spacers available.

Unique spacers

Some chainrings require spacers of unique thickness or configuration. Keep track of spacers at all times!

Bolt types

There are several types of chainring bolts, and several lengths of bolts of the same type. Sometimes a triple crankset will have two sets of bolts that are the same type but different lengths. The shorter bolts are used to hold on a pair of chainrings and the longer bolts are used to hold the single chainring. This runs contrary to what logic would dictate. If the longer bolts are put where the shorter bolts should be, they will usually extend through the back of the sleeve nut and interfere with the chain on the inner chainring.

Some triple-chainring-set inner bolts are a 6mm diameter thread. Some of these have a 1mm pitch and some have a .75mm pitch. Failure to note this difference could destroy the crank arm by stripping the threads in the chainring-mounting arms.

Reversing chainrings

Chainrings need to face a specific way in most cases. There are no universal rules of thumb about how to tell which way they should face. It's best to mark them or make clear notes before removal to prevent reversing them on installation.

Rotational position

Many chainrings are meant to be used at one specific rotational position. With others, it does not matter. Always assume that rotational position matters unless it is known for certain that it does not.

Chainring-to-arm compatibility

As many as four different things influence whether a chainring will fit a crank arm. These are number of bolt holes, diameter of holes, diameter of the bolt circle, and whether the arm will create the proper spacing between the chainrings. Chainrings can meet the first three factors (but not the fourth) and still be mounted on the crank arm. If the fourth is not dealt with, the results could be mysterious shifting problems and chain noise.

ABOUT THE REST OF THIS CHAPTER

The rest of this chapter has two sections. The first is **COMPATIBILITY AND FIT** and the second is **CHAINRING REMOVAL, INSTALLATION, AND ALIGNMENT.**

COMPATIBILITY AND FIT is about the fit of the chainrings to the crank-arm-bolt pattern, the offset (or spacing) between the chainrings, chainring size and derailleur capacities, and chainring compatibility with special shifting systems.

CHAINRING REMOVAL, INSTALLATION, AND ALIGNMENT is about removing the chainrings, installing them, and aligning them if necessary. It includes sections on checking compatibility if changing the size of the rings or brand. If these checks indicate a need to adjust and/or replace the front or rear derailleur, then it refers to the appropriate chapters to perform those procedures (page numbers are provided at these points). When checking chainring alignment, there will be a reference to checking the four mounting positions for the right crank arm. If this needs to be done, the appropriate page number is provided at that point.

COMPATIBILITY AND FIT

Compatibility and fit of chainrings is a complex and often ignored subject. As shifting systems become more sophisticated, the issue becomes more important. The issues of compatibility and fit can be broken down into six general areas:

1. Bolt pattern
2. Bolt-hole size
3. Offset (spacing) between chainrings
4. Derailleur capacity
5. Non-round chainrings
6. Special shift systems

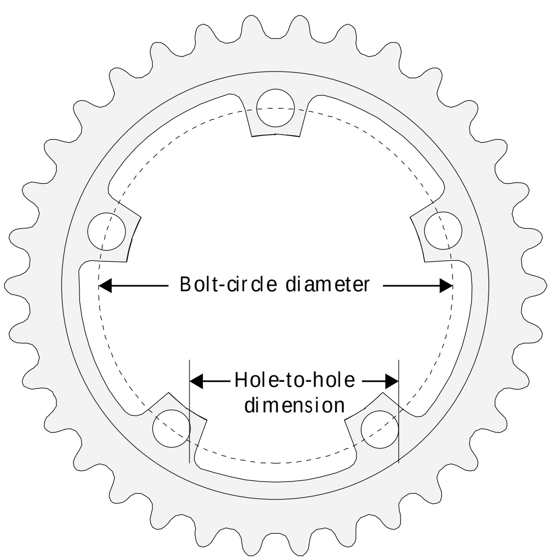
BOLT PATTERN

Chainrings and crank arms must have the same bolt pattern for the chainrings to fit. The bolt pattern is a function of how many bolts are used (almost always five), and the diameter of the circle that goes through the center of all the bolts (see figure 23.5).

Converting hole-to-hole dimension to bolt-circle diameter by using Table 23-2

Since the number of bolts is almost always odd, it is difficult to directly measure the bolt-circle diameter. Instead, the recommended method is to measure the distance from one bolt to the next and then look up the corresponding bolt-circle diameter on table 23-2 (below, right). This measurement is called the "hole-to-hole" dimension. If the measurement is not on the table, then use the formula method (top of column to right) to calculate the approximate bolt-circle diameter.

Even if using a caliper, it can be difficult to measure from the center of one hole (or bolt) to the center of the adjacent hole (or bolt) because the center is somewhere in the middle of a big hole. The same thing can be achieved by measuring from the edge of one hole (or bolt) to the opposite edge of the adjacent hole (or bolt) . If the chainring is not mounted, measure from the edge of one bolt hole to the opposite edge of the adjacent bolt hole (see figure 23.5). Whichever measurement method is used, look it up in the **Hole-To-Hole** column and then read across to the adjacent **Bolt-Circle Diameter** column on table 23-2.



23.5 *Chainring dimensions.*

Formula method for determining chainring bolt-circle diameter for five-hole chainrings

If the measurement of the hole-to-hole dimension was in millimeters, multiply the measurement by 1.699 and round the answer to the nearest whole millimeter (bolt-circle diameters are always in whole millimeters). For example, if the measurement was 71.6mm, calculate 71.6 × 1.699 = 121.65, then round 121.65 to 122mm.

Tool method for determining chainring-bolt pattern for five hole chainrings

Park makes a tool (CDG-1) that measures bolt-circle diameter. The two tips of the tool are placed in adjacent chainring-bolt holes, or chainring holes, and the corresponding bolt-circle diameter is read off a scale.

BOLT-HOLE SIZE

Perhaps the simplest issue of fit is bolt-hole size. The mounting arms on the crank arm have holes for the bolts to go through. The chainrings do also. The holes in both must be the same diameter. It is extremely

FIVE-HOLE-CHAINRING BOLT-CIRCLE DIAMETERS (table 23-2)

Approximate Hole-To-Hole Dimension	Bolt-Circle Diameter	Typical uses or common brands
32.9mm	56mm	SunTour Micro (inner ring)
34.1mm	58mm	Shimano SG/SGX/HyperDrive-C (inner two rings)
43.6mm	74mm	Smallest chainring of most triple cranksets
55.3mm	94mm	SunTour Microdrive (outer two) and Shimano SG/SGX/HyperDrive-C (outer ring)
55.9mm	95mm	Shimano SG/SGX/HyperDrive-C, (if stamped steel, less expensive models only)
64.7mm	110mm	Outer pair of chainrings on most triple cranksets
69.4mm	118mm	SR (Sakae) road (less expensive)
76.5mm	130mm	Double-ring cranks: Shimano, Sachs, Sugino, Mavic, SunTour
79.5mm	135mm	Current Campagnolo (1985 to present)
84.8mm	144mm	Double-ring cranks: Older Campagnolo, Mavic, SR, Sugino

rare that chainrings would share a common bolt-circle diameter and not share a common hole diameter. The only likely occurrence is on some older 10-speeds that had Sakae cranks with a 118mm bolt-circle diameter.

OFFSET BETWEEN CHAINRINGS

Offset between chainrings can be an issue for two reasons. The first reason is that not all chainrings are the same thickness, so manufacturers use a different spacer to achieve the correct positioning. The second reason is that some manufacturers have special or unique offset to suit special design considerations.

Measuring offset

The simplest approach is to use a stack of feeler gauges to measure the gap between chainrings, record it, and restore that dimension if installing non-identical chainrings. The problem develops when the new chainrings require different spacers. These are not broadly available in a full range of thickness. The most common offset between chainrings is approxiamtely 6.4mm.

Another problem develops when the chainring is not a simple flat piece of metal. Anytime the chainring has bulges or offsets, the issue is the distance from the teeth of one chainring to the teeth of another, and there is no simple way to measure this. The best way would be to put the crankset on a flat surface, face up; measure the distance from the teeth on one ring to the surface; measure the distance from the teeth on another ring to the surface; and subtract the difference to determine the ring-to-ring offset.

Common offset problems

There are two relatively common chainring offset problems to watch out for. The first can present itself if the ring being replaced is approximately 2mm thick and flat, and has a thin washer (1.5mm) between it and the mounting arm. Do not use the 1.5mm washer if the replacement ring is a more normal 3.5mm thick. If switching from the thick ring to the thinner, then a washer will need to be added. (Some thin rings have a 1.5mm offset just out from the mounting hole, in which case they do not need the thin washer.)

The second problem is specific to Shimano SG/SGX/HyperDrive chainrings. These chainrings require special offset that is built into the Shimano crank arms. Although the bolt-circle diameter of Shimano SG/SGX/HyperDrive chainrings is the same as many non-Shimano cranks and older non-SG/SGX/HyperDrive Shimano cranks, these chainrings can only be used on Shimano SG/SGX/HyperDrive style cranks. This problem usually is encountered when upgrading to some exotic, lightweight, high-tech crank arms. To further compound the problem, the derailleur and shift lever are designed to work specifically with the SG/SGX/HyperDrive chainrings. If the crank arms are upgraded, and non-SG/SGX/HyperDrive chainrings are put on, the front derailleur will not shift correctly. Normal offset for these chainrings is approximately 6.4mm from the outer to the middle chainring and 7.2mm from the middle to the inner chainring.

DERAILLEUR CAPACITY

Front derailleurs have both a minimum and maximum capacity. If changing the size of the chainrings, consider whether there will be a problem with capacity.

Maximum front-derailleur capacity is a rating of the largest difference between the smallest and largest chainrings that the derailleur can handle. If it is exceeded, the chain will drag on the tail end of the front-derailleur cage when the chain is in the small-front/small-rear combination. This symptom is only significant if it shows up when there is tension on the chain. If a slack chain dangles and rubs, it is not a serious problem.

Minimum front-derailleur capacity is a rating of the smallest difference between the largest and next-to-largest chainrings. It is generally only relevant on triple cranks, and then only if the gearing is a very unusual design called *half-step*. With half-step gearing, the difference between the chainrings will be as little as four to six teeth. If the derailleur is not compatible with half-step, the symptom will be that the bottom edge of the inner plate of the front-derailleur cage will rub against the middle chainring when the derailleur is in a position to put the chain on the outer chainring.

NON-ROUND CHAINRINGS

Although they are out of favor now, for a number of years in the late 1980s and early ’90s, non-round chainrings such as Shimano BioPace were popular. Mechanically, there is little concern with compatibility when mixing round and non-round rings on one crank. However, biomechanical concerns do exist. The muscular coordination required to pedal each type of chainring is different, and in each case it is a learned skill. When mixing types, the rider will be physically unable to take advantage of either (according to Shimano), so it is not recommended. If the bike has non-round chainrings and the customer is considering replacing some of them with round chainrings, replacing the whole set is recommended.

SPECIAL SHIFT SYSTEMS

Front indexed-shifting systems rely on compatible components to function correctly. The shift lever, cable housing, inner wire, front derailleur, chainring type, and chainring offset must all be correct for the indexing to work to its full potential. If the bike has front indexed shifting and the rider is considering replacing the chainrings, sticking with exact replacements (except, perhaps, number of teeth) is strongly recommended. If installing a front indexed-shifting system, it should include the correct crank arm and chainrings.

Shimano SG/SGX/HyperDrive chainrings have one other factor to consider: the chainrings are designed to work as matched sets. For example, if a bike has a SG/SGX/HyperDrive crank with original chainrings of 26, 36, and 46 teeth, and the rider would like to replace the 46 with a 48 SG/SGX/HyperDrive ring, *it will not be compatible!* The reason for this is that these rings have special teeth at specific locations for releasing and picking up the chain. The release teeth and the pickup teeth have to be the correct distance apart. When Shimano makes a 48, the pickup teeth have been designed to be the correct distance from the release teeth on a 38, not on a 36. Shimano makes chainrings available individually, so that worn ones can be replaced with identical ones, not for customizing gear combinations.

CHAINRING REMOVAL, INSTALLATION, AND ALIGNMENT

PREPARATION AND PRE-REMOVAL INSPECTIONS

In step #1, inspect the chainrings for side-to-side wobble. Too much wobble interferes with making a proper front-derailleur adjustment. If the chainrings wobble independently of each other, it indicates bent chainrings. If they wobble in unison, it means that the mounting arms need alignment, or that the right arm should be tried in all four possible mounting positions to find the one that creates the least chainring wobble.

A spindle-to-crank-arm mating is basically a square shaft that fits in a square hole. This mean that there are four possible ways that the crank arm can be mounted. In some of these ways, there will be more chainring wobble, and in other ways less. If starting with little or no wobble, then it would be nice to not have to go through a trial and error process to find the best of four positions. This is not a problem if not removing the left arm, because with it already installed there is only one possible position for the right arm. If removing both arms and starting off with acceptable chainring wobble, mark the spindle (paint-pen, piece of tape, scratch mark) so that the trial-and-error process of finding the best mounting position for the right arm can be avoided.

1. [ ] Rotate crank and check whether chainrings wobble side-to-side ³.5mm.
Yes? No? (circle one)

2. If yes to step 1, do they wobble in unison or separately?
[ ] Unison: Arm should be check for best-of-four mounting positions and/or mounting arms need alignment.
[ ] Separately: Wobbling chainring(s) should be replaced.

3. [ ] If left arm will also be removed, and if outer ring or all rings are rotating with <.5mm wobble, mark spindle so that arm can be re-installed in same position.

In step #4, check the distance between the chainrings and the frame. Later, when everything is back together, there will be an opportunity to check if this distance remained the same. This is important because it tells whether the front derailleur might need to be readjusted. A change here is only likely if the arm was on too tight or too loose, if changing the brand of chainrings, or if changing the position of some chainring spacers.

4. [ ] Use stack of feeler gauges to measure clearance between innermost chainring and chain stay (measure with calipers to seat tube if bike has raised chain stays). Record measurement here: _________mm

5. [ ] Remove pedal (optional). See *PEDAL REMOVAL, REPLACEMENT AND INSTALLATION* procedure (page 24-3).

6. [ ] Remove crank arm. See *TAPER-FIT CRANK-ARM REMOVAL AND INSTALLATION* procedure, steps 4–10 (page 20-6).

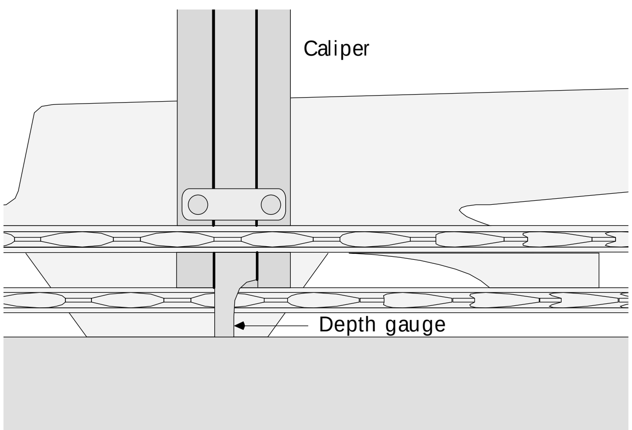
In step #7, mark the chainrings so that when they are re-installed, it will be easy to install them facing and rotated the same way. It is always mandatory that they face the same way. An “×” mark is suggested because it cannot be confused with a scratch.

In the case of non-round chainrings, outer chainrings with an over-shift peg, or chainrings that have special teeth at certain points to facilitate shifting, it is mandatory to maintain the rotational alignment.

(An over-shift peg is a protrusion built into the outer face of the outer chainring that is located behind the crank arm that prevents an over-shifted chain from dropping down between the chainring and the crank arm.) If the chainrings have none of these features, it may prolong chainring life to deliberately rotate the chainrings to a new position when re-installing them.

7. [ ] If re-installing any or all chainrings, put an "×" mark with scribe or indelible marker on back face of each ring, in line with crank arm.

Steps #8 through #13 are a method to measure and calculate the offset between the chainrings. By using the same procedure for re-installing the old chainrings (or identical replacements), it is possible to check that all the spacers are in correctly. By using the same procedure after installing non-identical chainrings, it is possible to check whether the offset has been altered in a way that will cause problems with shifting.



23.6 Measure first one chainring, then another, in this fashion. Subtracting the smaller number from the larger calculates the chainring offset.

8. [ ] Place crank assembly face up on flat surface and stabilize the crank so that chainrings are parallel to surface.

9. [ ] Using depth gauge of caliper, measure distance from front face of inner-ring teeth to surface and record here: _______mm

10. [ ] Using depth gauge of caliper, measure distance from front face of teeth of second ring to surface and record here: ________mm

11. [ ] Subtract measurement in step 9 from measurement in step 10 to determine offset from inner chainring to next chainring and record calculation here: ________mm

NOTE: Skip steps 12 and 13 if crankset has two chainrings.

12. [ ] If crank has three rings, use depth gauge of caliper to measure from front face of outer-ring teeth to surface and record here: ________mm

13. [ ] If crank has three rings, subtract measurement in step 10 from measurement in step 12 to determine offset from middle chainring to outer chainring and record calculation here: ________mm

REMOVING CHAINRINGS

When disassembling the chainring set, it is very important to keep track of the sequence of parts, differences between spacers, and differences between similar, but not identical, bolt sets. The following steps suggest loosening and removing bolt sets so that each chainring remains held on by only one bolt. Then, while removing the last bolt from each chainring, pay close attention to the sequence of parts and record the sequence.

NOTE: Skip steps 14–17 if crankset has a double-chainring set.

14. [ ] If triple-chainring set, loosen but do not remove 5 bolts retaining innermost chainring.

15. [ ] If triple-chainring set, remove 4 of 5 bolts retaining innermost chainring and remove 4 of 5 spacers/spacer sets (if any).

In the next step, measure the length of the bolt that comes out. On many triple-chainring sets, there are two bolt sets that are similar in every way except length. It is critical that they not get mixed up, and there have been countless times a mechanic — relying on logic or intuition, rather than measurement — has gotten it exactly backwards.

16. [ ] If triple-chainring set, measure and record length of one removed bolt here: ______mm

17. [ ] If triple-chainring set, measure and record thickness of spacer/spacer-set here: ___mm

18. [ ] Double *and* triple-chainring sets, loosen but do not remove 5 bolts of remaining bolt set that retains outer ring(s).

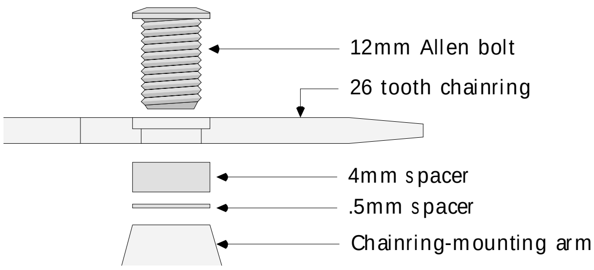
19. [ ] Remove 4 of 5 bolts retaining outer ring(s) and remove 4 of 5 spacers/spacer sets (if any).

20. [ ] Measure length of one of bolts just removed and record measurement here: ________mm

21. [ ] Measure and record thickness of spacer/spacer-set just removed here: ___mm

Step #22 is only for cranks with a triple-chainring set. Now that the inner chainring is retained by one bolt, it is time to remove it and carefully note the sequence of bolts, spacers, and ring in step #22. An example step #22 is included here to make what needs to be filled in the blanks clear. The notations that you would be add to the worksheet if your crank were identical to the example are written in `script`.

Example:
22.[ ] *12mm Allen bolt* , *26 tooth ring* ,
4mm spacer , *.5mm spacer* .



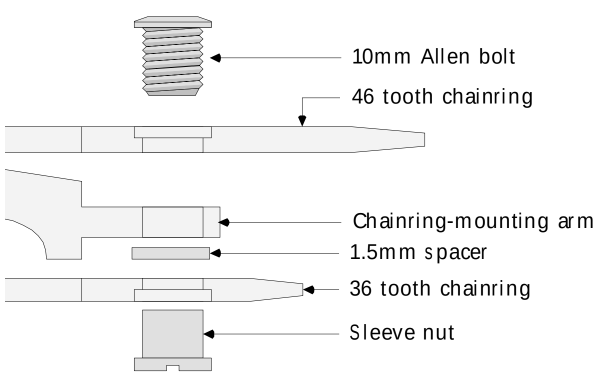
23.7 Possible sequence for inner chainring of a triple.

22.[ ] If triple-chainring set, remove remaining bolt that retains inner ring and note sequence of parts as removed here:
________________, ________________,
________________, ________________.

Step #23 notes the sequence of parts as the outer two chainrings (double or triple-chainring set) are removed. An example step #23 is written as the parts are removed from the outside to the inside. There are some parts that are outward of the chainring-mounting arms, and there are some parts that are inward of the chainring-mounting arms. In the example below, the notes that you would add to the worksheet if your crank were identical to the example are written in `script`.

Example:

23.[ ] Doubles and triples, remove remaining bolt that retains outer two rings and note sequence of parts as removed here:
10mm Allen bolt , *46 tooth ring* ,
________________ , **mounting arms** ,
1.5mm spacer , *36 tooth ring* ,
sleeve nut , ________________ .



23.8 Possible sequence for outer two chainrings.

23.[ ] Doubles and triples, remove remaining bolt that retains outer two rings and note sequence of parts as removed here:
________________, ________________,
________________, **mounting arms,**
________________, ________________,
________________, ________________.

CLEANING AND INSPECTION

For description and pictures of the visual nature of different types of chainring wear, see under the heading **INDICATIONS** (page 23-2).

24.[ ] Clean all chainrings thoroughly (if being re-used), particularly faces and edges of teeth.

25.[ ] Inspect outer ring for visible evidence of shift wear.

26.[ ] Inspect middle ring, if any, for visible evidence of shift and load wear.

27.[ ] Inspect innermost ring for visible evidence of load wear.

28.[ ] Inspect all rings for non-round design or special teeth that indicate rotational alignment of chainring must be maintained when re-installing.

29.[ ] Inspect outer ring for presence of over-shift peg on outer face that indicates that rotational alignment of chainring must be maintained when re-installing.

30.[ ] (Optional), clean and inspect crank arm for cracks and damage. See *TAPER-FIT CRANK-ARM REMOVAL AND REINSTALLATION* procedure, steps 13–17 (page 20-9).

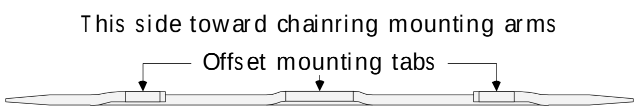
31.[ ] (Optional), inspect spindle flats for marks that indicate whether crank arm is worn out or bad fit to spindle. See *TAPER-FIT CRANK-ARM REMOVAL AND REINSTALLATION* procedure, step 11 (page 20-9).

ASSEMBLY OF CHAINRINGS TO CRANK ARM

In steps #32 and #33, new marks are put on the chainrings at the same location, but on the opposite face from, the "×" marks. Use an "O" for these new marks to stand for "outer face." These marks are needed because it is the outer face that will be seen when installing the outer chainrings of a triple or both chainrings of a double.

Obviously, if installing replacement chainrings, there will not be any "×" mark to place the "O" mark opposite of. If the chainrings have special rotational-position requirements, the manufacturer has probably marked them in some way. Sometimes there will be a triangular engraving or stamp mark that is supposed to be in line with the crank arm. Other times there will be a small tab at the inner perimeter of the ring that serves the same function. Sometimes, both these manufacturer's marks will be found on one chainring, in which case both will always be in the same location.

Determining which way a chainring should face is another matter. If there is a triangular mark, there is no consistency as to whether it faces in or out. There may be no marks on the face of the chainring other than brand, model, and tooth number, and these can face either way. The best clue is if there are recesses in a chainring face at each bolt hole. These recesses are for the bolt flange or the sleeve-nut flange. If they are there, they should face *out* on the outer chainring, and *in* on any inner chainring(s). Some thin inner rings (doubles), and middle rings (triples) have an offset to the mounting-tab portion of the ring where the bolt hole is (see figure 23.9). If this is the case, the ring should face in the direction that positions the chainring teeth the furthest away from the surface the ring mounts against. When there are not offsets or recesses around bolt holes, there is no choice but to guess. The best guess is that any brand markings on an outer ring will face out, and that any tooth markings on inner rings will face in.



23.9 *Cross-section of a chainring with offset mounting tabs.*

32. [ ] If re-installing inner ring of double or middle ring of triple, put an "O" mark on outer face of ring at same location as "×" on inner face. If installing new inner ring of double or middle ring of triple, put an "O" mark on outer face of same ring in line with any manufacturer's rotational orientation mark (if any).

33. [ ] If re-installing outer ring of double or triple, put an "O" mark on outer face of ring at same location as "×" on inner face. If installing new outer ring of double or triple, put an "O" mark on outer face of same ring in line with any manufacturer's rotational orientation mark (if any).

34. [ ] Double- and triple-chainring sets, place sleeve nuts flange-side down on flat surface at spacing that approximates holes in chainrings.

In step #35, replace the spacers between the flange of the sleeve nut and the next-to-largest chainring, *if there were any there originally*. There is no reason for spacers to be in this position, so if they were here before it is likely that they were moved from between the chainring and the chainring-mounting arms, rather than between the chainring and the sleeve-nut flanges. Typical offset between the outer chainrings is about 6.5mm. If there was a spacer in this position and the existing offset between the rings was below this range, then it is likely the spacer was misplaced.

35. [ ] Put spacers, *if any originally*, over sleeve nuts (see step 23 to check spacer position).

Lining the "O" mark up with the crank arm in steps #36 and #40 ensures that the original rotational position of the chainring is restored. This is often desirable, but not always. If the chainrings are round, do not have special teeth at certain points only to facilitate shifting, and do not have an over-shift peg, then it may be desirable to deliberately rotate the chainring(s) two to three positions either direction, so that the shift wear would continue on fresher parts of the chainring(s).

36. [ ] Place inner ring of double (or middle ring of triple) over sleeve nuts, with "O" mark up, then align sleeve nuts so they all fit through holes in ring.

37. [ ] Put spacers, *if any originally*, over sleeve nuts and on top of chainring (see step 23 to check spacer position).

38. [ ] Place crank arm (outer-face up), with arm over "O" mark, on top of sleeve-nut/chainring assembly.

39. [ ] Put spacers, *if any originally*, over sleeve nuts and on top of chainring-mounting arms (see step 23 to check spacer position).

40. [ ] With "O" mark facing up (or any over-shift peg facing up), slip outer ring over end of crank arm and rotate so "O" mark and/or over-shift peg is hidden behind crank arm and align chainring-bolt holes with sleeve nuts.

In step #41 and #46, oiling the chainring-bolt threads is recommended. This applies to steel chainring bolts. Treat aluminum-bolt threads with Loctite #242.

41. [ ] Oil chainring-bolt threads and thread all chainring bolts of correct length (see step 20) into sleeve nuts.

In step #42 and #46, the recommended torque minimum is 50in-lbs. This only applies to steel chainring bolts. Bolts of lightweight material should be torqued to a maximum of 35in-lbs (11lbs@3" or 9lbs@4").

42. [ ] Using Var 352 (substitute Shimano TL-FC20) to hold sleeve nuts from turning, snug all chainring bolts, then torque to minimum 50in-lbs (16lbs@3" or 12lbs@4").

NOTE: Skip steps 43–46 if crank has a double-chainring set.

43. [ ] If triple-chainring set, turn crank over on surface so outer face is down.

44.[ ] If triple-chainring set, put spacers, *if any originally*, over holes on inner face of chainring-mounting arms (see step 22 to check spacer position).

45.[ ] Place inner ring so "×" mark (if reinstalling original ring) is facing up and in line with crank arm. If installing new ring with manufacturer's rotational orientation mark, install so that mark is in line with crank arm. (Rely on manufacturer's information to determine whether marked face should be up or down.)

46.[ ] Oil chainring-bolt threads and thread all chainring bolts of correct length (see step 16) into crank arm. Torque to minimum 50in-lbs (16lbs@3" or 12lbs@4").

CHECKING OFFSET BETWEEN CHAINRINGS

In steps #47 through #54, re-measure the offset between the chainrings in order to compare the final result with the original conditions. Changes of .5mm or greater indicate that original equipment has been re-assembled wrong, or that changes need to be made to make replacement equipment work.

47.[ ] Place crank assembly face up on flat *surface* and stabilize so that chainrings are parallel to surface.

48.[ ] Using depth gauge of caliper, measure distance from front face of inner-ring teeth to surface and record here: ________mm

49.[ ] Using depth gauge of caliper, measure distance from front face of teeth of second ring to surface and record here: ________mm

50. [ ]Subtract measurement in step 48 from measurement in step 49 to determine offset from inner chainring to next chainring and record calculation here: ________mm

51. Compare calculation in step 50 to calculation in step 11 and check one of two following choices.

[ ] There is <.5mm difference, there is no significant offset change.

[ ] There is ³.5mm difference, spacer is positioned wrong or one of different thickness must be substituted.

NOTE: Skip steps 52–54 if crankset does not have three chainrings.

52.[ ] If crank has three rings, use depth gauge of caliper to measure from front face of outer-ring teeth to surface and record here: ________mm

53.[ ] If crank has three rings, subtract measurement in step 50 from measurement in step 52 to determine offset from middle chainring to outer chainring and record calculation here: ________mm

54. Compare calculation in step 53 to calculation in step 13 and check one of two following choices.

[ ] There is <.5mm difference, there is no significant offset change.

[ ] There is ³.5mm difference, spacer is positioned wrong or one of different thickness must be substituted.

INSTALLING CRANK ARM

55.[ ] If chainrings had no significant wobble (see step 1), then position crank arm in same position marked in step 3, then install crank arm by steps 33, 34, and 38–43 of *NORMAL CRANK-ARM REMOVAL AND INSTALLATION* procedure (page 20-11).

56.[ ] If chainrings had significant wobble (see step 10), or new chainrings are installed, then remove left arm also (if not removed already) and install crank arm by steps 19–43 of *NORMAL CRANK-ARM REMOVAL AND INSTALLATION* procedure (page 20-10).

CHECKING AND CORRECTING CHAINRING WOBBLE

Excess chainring wobble can cause problems with the front derailleur. At this point, bent chainrings and needing to mount the right crank arm in a better position should have been eliminated as causes of the problem. The only thing that can be causing chainring wobble is mis-aligned chainring-mounting arms. The condition has probably existed from the point the crank arm was manufactured. The following steps enable correction of this condition. The chainring-mounting arms should remain true unless they receive a direct blow from the side.

57.[ ] Position front derailleur so that nose of outer cage plate is directly over outer chainring teeth.

58.[ ] Rotate crank backwards rapidly and watch for wobbles, paying attention to whether they seem to deviate out or in from straight portion of chainring.

59.[ ] After finding wobbles and determining direction of error, slow down crank rotation to identify point wobble begins and ends.

60.[ ] Find chainring-mounting arm closest to center of wobble.

In step #61, it is recommended to use a specific wrench for leverage. If using an adjustable wrench, it *must* have smooth jaws at right angles to the handle. An adjustable wrench of this type is superior to any tool made specifically for chainring-mounting-arm alignment, because it can be adjusted to fit snugly on the chainring bolts rather than directly on the mounting arm (which inevitably scars the arm).

There are times when no tool will fit to apply leverage. Control is lost, but in this case there is no alternative but to use a plastic or rubber mallet directly on the chainring bolt or end of mounting arm.

61.[ ] Secure Diamond C79 (Headset-tool set) adjustable wrench to front and back end of chainring-bolt set on mounting arm at center of wobble, then lever up to correct outward wobble or down to correct inward wobble.

62.[ ] Remove wrench, spin crank again to check for under- or over-correction, or other wobbles that still need correction.

FRONT-DERAILLEUR ADJUSTMENT

If the number of teeth on the outer chainring has changed by any amount, the front derailleur needs to be moved up or down. This usually requires complete re-adjustment. If chainring offset has changed slightly (but acceptably), the limit screws and perhaps the cable tension for the front derailleur will need to be reset. If the offset between the chainrings is the same, but the whole set has moved in or out from the frame, then it is necessary to reset the limit screws and perhaps the cable tension for the front derailleur.

63.[ ] Adjust front derailleur if outer chainring size has changed, chainring offset has changed (steps 51 and 54), or chainring clearance has changed (compared to step 4).

CHECK FOR CHAIN-LENGTH PROBLEMS AND DERAILLEUR-CAPACITY PROBLEMS

Changing the size of the largest and/or the smallest chainring affects the capacity requirements for both the front and rear derailleurs. Operating derailleurs outside their capacities can damage them or cause poor shifting. Do not skip these steps if chainring sizes have changed.

64.[ ] If replacement outer ring of different size than original has been installed, position chain on outermost chainring and outermost rear cog to check chain length and correct as necessary. (See CHAINS chapter, page 26-11.)

65.[ ] If size of innermost or outermost chainring has changed, adjust chain length. Then, put chain in innermost-chainring/outermost-rear-cog combination to check that rear-derailleur capacity has not been exceeded. (See REAR DERAILLEURS chapter, page 32-7.)

66.[ ] If size of innermost or outermost chainring has changed, adjust chain length. Then, put chain in outermost chainring/innermost rear cog combination to check that rear-derailleur capacity has not been exceeded. (See REAR DERAILLEURS chapter, page 32-7.)

67.[ ] If size of innermost or outermost chainring has changed, reposition height of front derailleur (if outermost chainring size changed). Then, put chain in innermost-chainring/outermost-rear-cog combination to check that front-derailleur maximum capacity has not been exceeded. (See FRONT DERAILLEURS chapter, page 33-4.)

68.[ ] If size of middle chainring or outermost chainring of triple has changed, reposition height of front derailleur if outermost chainring size changed. Then, put chain on outermost chainring and check that front-derailleur minimum capacity has not been exceeded. (See FRONT DERAILLEURS chapter, page 33-5.)

CHAINRING TROUBLESHOOTING

Cause	Solution
SYMPTOM: *A popping sound or sensation is experienced once per crank-revolution, often on the down stroke of the right pedal.*	
Loose chainring bolt(s).	Check and secure chainring-mounting bolt(s).
Loose crank arm.	Check and secure crank arm.
Loose pedal-cage piece(s).	Check and secure pedal-cage piece(s).
Loose pedal mounting.	Check and secure pedal mounting.
Loose B.B. cups, lockrings, or retaining rings.	Check and secure B.B. cups, lockrings, or retaining rings.
SYMPTOM: *A popping sound or sensation is experienced once per crank-revolution, on one chainring.*	
Bent chainring tooth.	Inspect and bend back.

(Continued next page)

CHAINRING TROUBLESHOOTING (continued)

Cause	Solution
SYMPTOM: *A ticking or scraping sound is heard once per crank-revolution.*	
Chainring wobble is causing chain to intermittently rub inside of front-derailleur cage.	Check whether mounting arm in any of the other three positions reduces wobble. Check whether outer two rings wobble in unison and if so, align chainring-mounting arms. Replace bent ring if one ring is wobbling independently of all others.
Loose crank arm or bottom bracket is causing chainring wobble.	Check and secure crank arm.
Crank arm is hitting front-derailleur cage.	Re-adjust front-derailleur limit screws and/or rotational alignment.
SYMPTOM: *Chainrings, chainring-mounting bolts, or some other part of the crank-arm assembly is rubbing the chain stay continuously or intermittently when the crank is being spun when not under load.*	
Crank arms are worn out or a bad fit to the spindle.	Perform removal process, including fit inspections.
Bottom-bracket spindle is too short.	Replace spindle or cartridge bottom bracket with one that will position crank arm further out.
SYMPTOM: *Wear marks are found on the chain stay where they might be left by the chainrings, chainring-mounting bolts, or some other part of the crank-arm assembly, but no rubbing is evident upon visual inspection.*	
Clearance that is adequate without load is not adequate when crank assembly and/or chain stays flex under load.	Check for worn-out or misfit crank arm. Replace spindle or cartridge bottom bracket with one that will position crank arm further out.
SYMPTOM: *Chain shifts poorly from smaller ring to larger ring after checking chain for wear and checking that derailleur is properly adjusted.*	
Chainrings have excessive shift wear.	Replace ring(s) if substantial wear is evident.
SYMPTOM: *Chain suck occurs. Chain remains attached to chainring where it is supposed to release and return to the rear derailleur and jams into the chain stay.*	
Chain or chainrings are fouled with dirt.	Clean chain and chainrings.
Chainring is worn out from load.	Replace ring if substantial wear is evident.
SYMPTOM: *Chain is rubbing against sleeve-nut flanges of outer bolt set when chain is on innermost chainring of triple-chainring set.*	
Middle chainring is installed facing wrong way so that flanges are not fitting into recesses in chainring face.	Check for recesses in chainring face and reverse direction chainring is facing if recesses are not on side of chainring facing sleeve-nut flanges.
SYMPTOM: *Chain is rubbing against adjacent chainring.*	
Chainline is bad, with chainrings too far in relative to rear cogs.	Check chainline error. (See **CHAINLINE** chapter, page 27-5.)
Offset between chainrings is inadequate due to misplacement of spacers, chainrings facing wrong way, or replacement with non-compatible chainrings or crank arm.	Re-check offset measurements and add, remove, or move spacers to correct problem. Use compatible chainrings or crank arm, or modify with different spacers to eliminate compatibility problems.
SYMPTOM: *Chain is dropping completely in-between two chainrings when shifting.*	
Incorrect use of chainring spacers causing too much chainring offset.	Check and change location or use of spacers.
Non-SG/SGX/HyperDrive chainring used on SG/SGX/HyperDrive-type crank arm.	Replace with compatible chainring(s).
SYMPTOM: *Chain is rubbing against inner end of bolts of outer bolt set when chain is on innermost chainring of triple-chainring set.*	
Long bolts for inner ring have been used in location where short bolts for outer bolt set are required.	Switch bolts back if problem has been caused by reversing locations of the two bolt sets. Install new bolts if problem is caused by installation of wrong bolts.