Alternator pulleys seem like fairly simple parts compared to many of today’s high tech powertrain components. The pulley’s basic function is to turn the alternator using torque provided by a crankshaft driven belt. This function has not changed since the early days of the automobile when belt-driven generators were used to generate electricity for the ignition system, lights and to recharge the battery. What has changed is the way in which many alternator pulleys function.

A solid drive pulley is pretty fool-proof as there is not much that can go wrong with it – other than wear. But a solid pulley bolted rigidly on the end of the alternator shaft can’t dampen torque variations produced by the crankshaft. Nor can it allow the alternator to overrun the belt drive system and slowly spin down when the engine is shut off.

Many late model alternators are high output units with significantly heavier, denser rotors. More rotor windings are required to boost the alternator’s current output so it can keep up with the demands of the onboard electronics and other electrical accessories. With a solid pulley driving the alternator, this may require more belt tension and a larger, stiffer automatic belt tensioner to prevent a serpentine belt from slipping.

When the engine is shut off, the momentum of the spinning rotor inside the alternator will attempt to keep turning the drive belt. This can put added strain on the belt and tensioner, increasing both belt and tensioner wear. Increased belt tension can also shorten the life of other engine-driven accessories by placing a greater load on the shaft bearings in the water pump, power steering pump, A/C compressor and idler pulleys.

Overrunning Alternator Pulley (OAP)

One alternative to the solid alternator pulley is an Overrunning Alternator Pulley (OAP). This type of pulley contains a one-way clutch mechanism that allows the belt to turn the alternator in one direction, but allows the alternator to free-wheel and spin at its own speed if the engine suddenly decelerates, stalls or is shut off.

An OAP pulley will lock up when the drive belt is turning in its normal direction of rotation. In this mode, the pulley functions just like a solid pulley to transmit torque to the alternator. When engine RPM abruptly drops however, as when

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In this Issue

- Overrunning Alternator Pulley (OAP)
- Overrunning Alternator Decoupler Pulley (OAD)
- Mountings
- Applications
- Pulley Problems
- Replacement Precautions

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decelerating, braking or shifting gears, the overrunning clutch decouples the alternator and allows it to continue spinning until belt speed catches up with the speed of the rotor, or the alternator slows down to the same speed as the belt.

This may not seem like a big deal. But considering the fact that the drive ratio between the crankshaft pulley and alternator pulley is typically 3X (meaning the alternator spins roughly three times as fast as the crankshaft), sudden changes in engine RPM combined with the inertia effects of the spinning rotor inside the alternator can really jerk and jolt the belt drive system. The higher speed of the alternator can also amplify the torsional vibrations of the crankshaft, increasing the noise generated by the belt drive system.

Overrunning Alternator Decoupler Pulley (OAD)

An Overrunning Alternator Decoupler (OAD) pulley also has a one-way overrunning clutch to provide the same benefits as an OAP pulley, but adds a unique extra feature: the ability to dampen torsional vibrations in the belt drive system. This provides much quieter and smoother operation than either a solid pulley or an overrunning alternator pulley, especially at lower engine speeds (from idle to about 1500 RPM).

When an engine is running, the crankshaft experiences a slight increase in speed every time a cylinder fires. This produces torsional vibrations that are most noticeable at idle and low RPM, especially if the engine is under load or there is a high electrical demand on the alternator. At higher engine speeds, the inertia of the rotating crankshaft, flywheel and harmonic balancer reduce the intensity of these vibrations. But they may still produce harmonic vibrations in the belt drive system at certain speeds. Externally, OAP and OAD pulleys appear to be very similar. But inside an OAD pulley is a special torsion spring that transmits torque from the pulley to the alternator shaft. This torsion spring provides a cushioning effect that acts somewhat like a shock absorber to dampen speed variations between the spinning alternator and the belt drive system. Significant benefits include:

- Reduced belt flutter, vibration and noise, particularly on diesel engines which typically experience more variations in crankshaft speed than gasoline engines.
- Allows the use of LESS belt tension to drive the alternator, which in turn allows a narrower serpentine belt and a smaller and lighter belt tensioner.
- Less belt tension reduces the horsepower required to drive the belt, which results in better fuel economy.
- Less belt tension and vibration means longer belt, tensioner and pulley life (up to 2X longer life than with the use of a solid alternator pulley!).
- Less belt tension also reduces the load on the shaft bearings of the other engine-driven accessories extending their life.

Mountings

Solid pulleys are usually just bolted on the end of the alternator shaft with a large nut and lock washer. By comparison, OAP and OAD pulleys usually thread onto the alternator shaft. Removal and installation require a special splined tool that fits inside the pulley. These pulley tools...
Alternator Clutch Pulley Designs

Special tools such as these are required to remove and install OAP and OAD alternator pulleys.

are available from NAPA, and are required to change the pulley if a replacement alternator does not have a new pulley already installed.

A small protective cap covers the outside of an OAP or OAD pulley. This cap has to be removed to change the pulley. A small screwdriver can be used to pry off the cap.

Applications

OAP and OAD pulleys are used on a variety of late model applications, including Audi, Mazda, Mercedes Benz, Nissan, Porsche, Volkswagen (most TDI diesel engines from 1998 to 2006), 2007 and newer Toyota and Lexus, 2001 to 2005 Chrysler minivans with V6 engines, even 1997 and up Corvettes. Your NAPA dealer can tell you which type of pulley is required for a vehicle application. Order NBH brochure 474-0446 from your NAPA Heating & Cooling District Manager for a listing of all of the OAP/OAD applications and the required tools.

Pulley Problems

If an overrunning alternator pulley (either OAP or OAD) is worn out, it may produce a buzzing noise when the engine is decelerating or is shut off. To check for this condition, increase the engine speed to 2000 to 2500 RPM, then shut off the engine. If the pulley produces a buzzing noise for 1 to 5 seconds as the alternator spins down, the pulley is defective and needs to be replaced.

If the overrunning clutch inside an OAP or OAD pulley is not locking up, the pulley will slip and fail to drive the alternator when the engine is running. The belt will appear to be rotating normally, but the alternator won't be spinning and producing any current. This will cause a low voltage condition and allow the battery to run down. If the charging system is not producing any output, use a light to peer into the fan opening or vents on the front or back of the alternator to see if the rotor is turning. No rotation indicates the OAP or OAD pulley is not locking up and needs to be replaced.

CAUTION: Keep fingers, hair and clothing away from rotating parts when the engine is running!

An OAP or OAD pulley can be checked by prying off the cap on the front

continued on back

If an alternator pulley needs to be replaced, use the same type of pulley (OAP or OAD) as the original.

You can’t always tell what type of pulley is used on an alternator. OAP and OAD pulleys look much the same. Refer to the vehicle manufacturer’s service literature to identify the type of pulley that’s used so you can use the correct diagnostic procedure.
of the pulley, and inserting the splined tool into the pulley so it can be rotated in both directions. An OAP pulley should turn freely in one direction and lock up in the other direction. An OAD pulley should have a spring feel (a little give) in one direction, and turn freely in the other direction. An OAD pulley that has no spring feel (give) in one direction is defective and requires replacement.

If an overrunning clutch jams or fails to release, the pulley will behave the same as a solid pulley. On a vehicle with an OAD pulley, this can produce a noticeable increase in belt flutter, vibration and noise. If either type of pulley requires more than a small amount of effort (9 to 13 inch lbs. or 1 to 1.5 Newton meters, the metric measurement of torque, similar to foot pounds in the English system) to turn in the overrun direction, it is binding and needs to be replaced.

Replacement Precautions

Because the engine’s belt drive system is engineered to work with a certain type of pulley, replacement pulleys should be the SAME type as the original. Replace an OAP pulley with an OAP pulley, or an OAD pulley with an OAD pulley.

Do not replace either type with a solid pulley as this can cause noise, vibration and wear problems.

NOTE: Some new and remanufactured alternators that are sold by discount stores do NOT have the correct type of replacement pulleys. They may use a less expensive solid pulley instead of the required OAP or OAD pulley.

NAPA replacement alternators are available with the same type of pulley as the original. Replacement OAP and OAD pulleys are also available separately for all types of applications.

February ’11 Tech’s Edge Questions:
Alternator Clutch Pulley Designs

1. Technician A says an OAP pulley is used to reduce belt drive vibration and noise. Technician B says a standard pulley may be used to replace an OAD pulley. Which Technician is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

2. All of the following are reasons an OAD pulley is used EXCEPT:
   a. To reduce belt tensioner fluctuations
   b. To extend the life of the engine’s belt-driven accessories
   c. To extend belt life
   d. To increase charging output

3. Technician A says an alternator no charge condition may be caused by a defective decoupler pulley. Technician B says a special tool is required to R&R a decoupler pulley. Which Technician is correct?
   a. Technician A only
   b. Technician B only
   c. Both Technicians A and B
   d. Neither Technician A nor B

Answers: 1. a, 2. d, 3. c