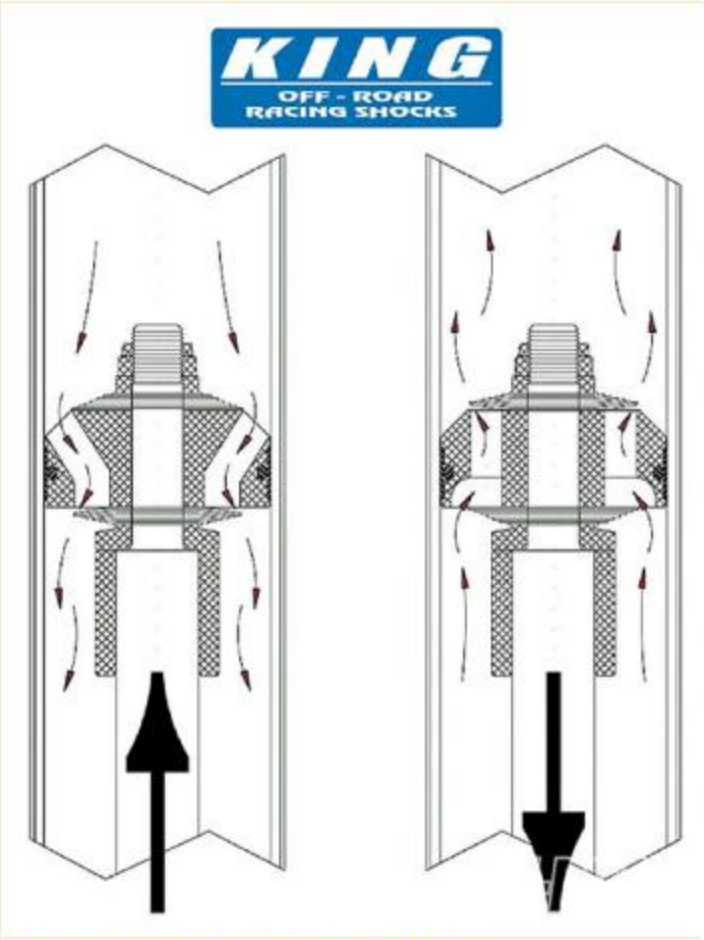
Off Road Race Shocks Explained - What's Inside A Rebuildable Shock?



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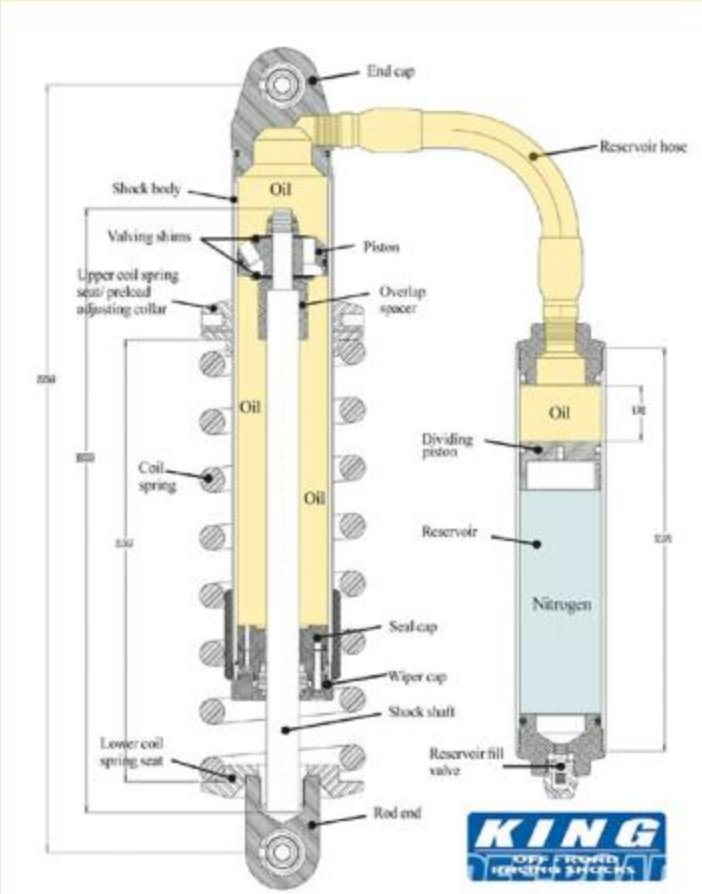
The simplest definition of a shock is that it's a device that turns kinetic energy (motion) into thermal energy (heat). Inside a shock you'll find oil, an actuating rod, a piston, and two sets of flexible shims that determine how fast the piston can pass through the oil. On the left, the piston is traveling upwards in compression. Holes (ports) in the piston head allow the piston to move through the oil. When the oil encounters the flexible shims on the underside of the piston, those shims flex away from the face of the piston. If the shims flex more, the piston can travel through the oil more quickly. If the shims flex less, the piston travels through the oil more slowly.On the right, the piston is traveling downwards during the rebound stroke. This time, the compression shims are forced closed against the face of the piston and the oil travels though a set of rebound holes (ports) in the piston head. A set of rebound shims on the top of the piston head now flexes open. The degree of flex determines how fast or slow the rebound stroke will be. View Related Article



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The reservoir fill valve is for nitrogen. Oil is found on the other side of the reservoir's dividing piston, and that same oil fills the hose and shock body. Oil expands as it heats up, and contracts as it cools down. The purpose of the nitrogen chamber is to take up the "slack" as the oil volume varies with temperature. The dividing piston floats between the oil and the nitrogen. View Related Article

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Here's a look at the top of a piston head. The holes around the edges are the compression ports, while the shim stack in the middle is the rebound stack. The rebound shim stack is covering the rebound ports in the piston. View Related Article

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A shim stack is made of thin, flexible washers of progressive diameters. King Shocks uses heat treated stainless steel to build its shim stacks. These shim stacks can handle inside shock temperatures up to 600 degrees Fahrenheit and only lose 2 percent of their strength. Lower-quality shim stacks will lose as much as eight percent of their strength at that temperature. These high-quality shims make King Shocks consistent over a greater range of internal shock temperatures. Brett King informed us that "Shocks are like engines. They need to run at around 200 degrees F to work properly. At that temperature, you can't touch the shock or it will burn you, but that doesn't mean it's overheated. At the same time, 300-degree shock oil is too hot. At that temperature the oil will break down. Besides overheating, another condition that degrades shock performance is cavitation. Cavitation can occur at any temperature, but is more likely to happen when the shocks are hot. During cavitation, the pressure inside the shock is greater than the pressure in the nitrogen reservoir. This collapses the nitrogen chamber, and no oil flows through the piston, so there's no damping control. The shock just bottoms out easily." If your shocks are heating up or are cavitating, you need to change your setup. A few options are available: (1) add a second in-line reservoir, (2) go to a larger-diameter shock, (3) add an additional shock per wheel, or (4) increase airflow around the shock. King can offer advice as to what course of action suits you best. View Related Article

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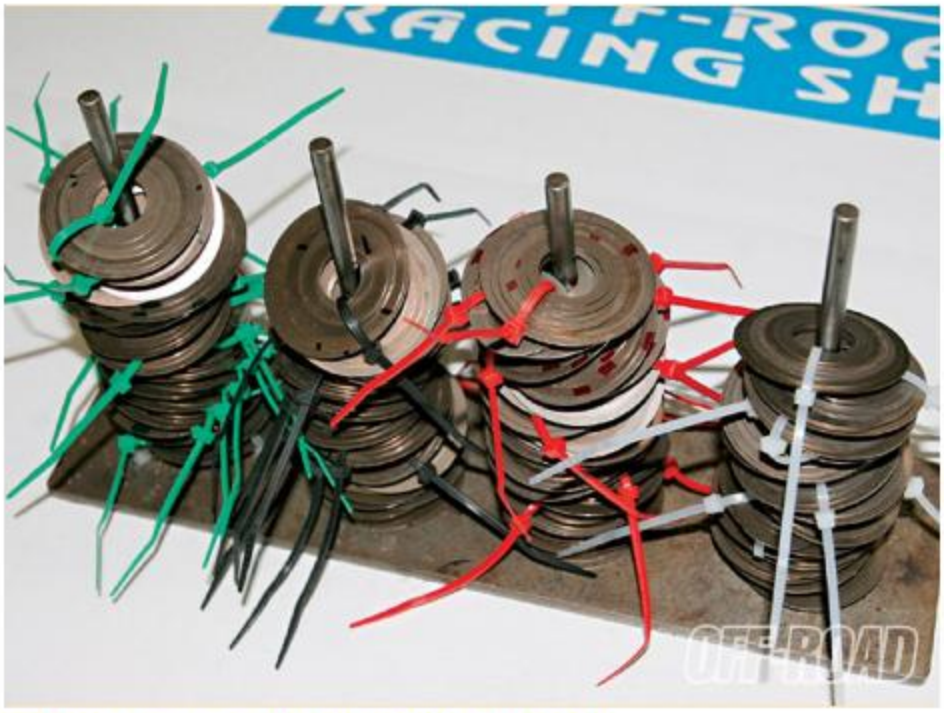
This shim stack is made of shims that are 0.020 (twenty thousandths of an inch) thick. You can't tell shim thickness just by looking, so a caliper is essential for an accurate measurement. Just as with leaf springs in a suspension system, thinner shims will flex more easily and thicker shims will flex with more difficulty. More flexible shims will produce a softer ride, but will not be able to offer the same control produced by less flexible shims. Choosing the right valving is a matter of picking the correct shim thickness for the control you need. View Related Article



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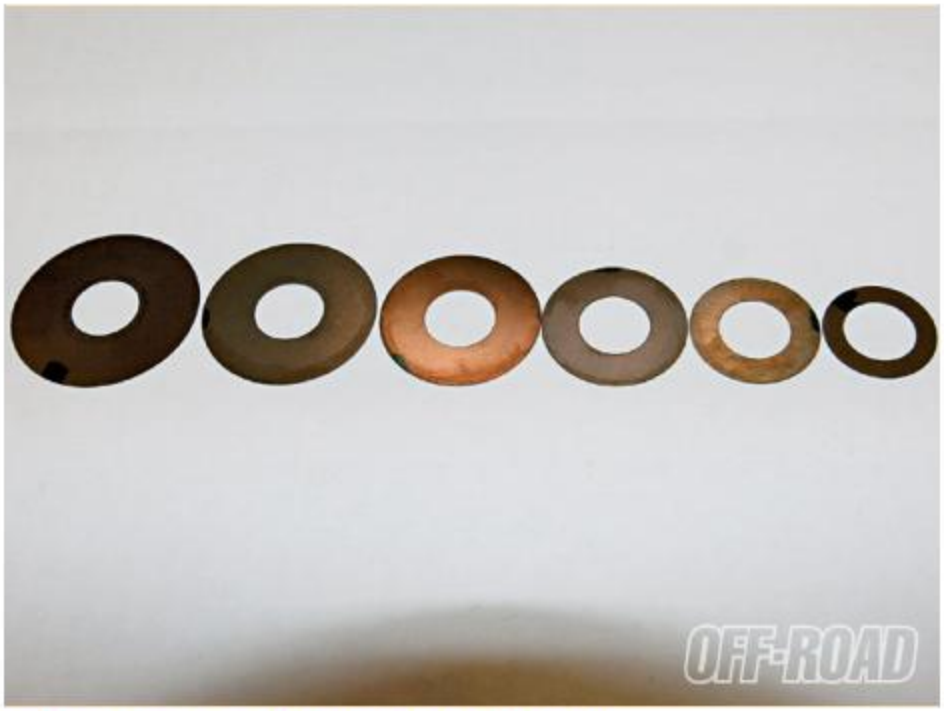
To make assembly easier, the shim stacks are color coded at King. Shim thicknesses are: .008, .010, .012, .015, and .020. Shim thicknesses are not mixed within a single shim stack. View Related Article



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Here are the shims that go inside a 2.5-inch diameter King shock. The diameters are the same no matter what the shim thickness is. Shim diameters in inches, left to right: 1.75, 1.60, 1.45, 1.30, 1.15, 1.00. View Related Article

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This shim arrangement is called a "flutter stack." Notice that the 1.00 shim is between the 1.75 shim and the 1.60 shim. This arrangement makes it so that the 1.75 shim can flex more easily and thus provide a softer ride over smaller stutter bumps. Before bypass shocks became common, a single coilover shock at each corner of the vehicle controlled the ride. The valving inside the coilover was more critical. These days, flutter stacks aren't used very often because many people use bypass shocks in addition to coilovers. Bypass shocks offer greater tune-ability because they are position-sensitive. King can still install a flutter stack in a coilover upon request. View Related Article

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On the left, there's a 4.0 piston head, while the 2.5 piston is on the right. Some of the same sized shims are used in the shim stacks, but the 4.0 has more total shims. The 4.0 holds more oil and therefore can handle more heat. It's also heavier and much more expensive. Most vehicles can use 2.5's or 3.0's. The big King Kong 4.0 is best matched with a full-sized truck that's got a lot of power and a lot of weight to control. View Related Article

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This shows both sides of the piston with a 1.75 shim in place. Note the way it blocks the inner holes, but not the outer holes. Also note the free bleed hole that is never blocked by a shim. View Related Article

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On the left is the top side of a 2.5 piston. The top side is the rebound side, and the rebound shim stack will sit against the six holes found close to the center. On the right is the bottom side of the same 2.5 piston. This is the compression side, and it faces downward. The compression shim stack sits against the three smaller round holes. You will also notice a tiny hole close to the outer edge. This hole is never covered by a shim, and is called a free bleed hole. Oil flows freely though this tiny hole, whose function is

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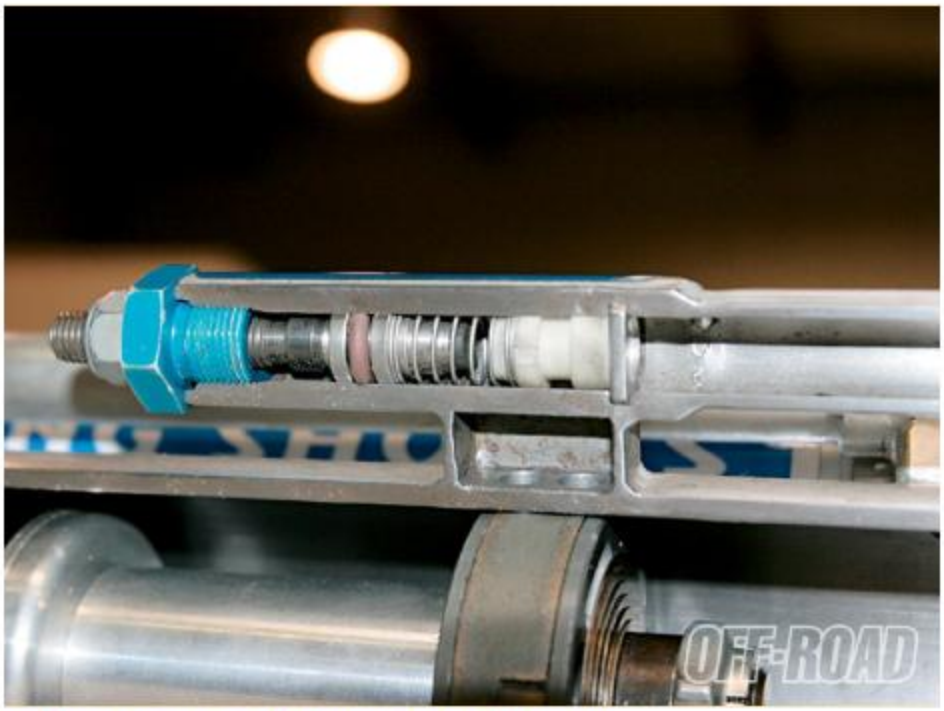
Check out this assembled piston head inside a cutaway bypass shock. A nut holds the piston and the valve stacks onto the rod. At full droop, all the downward pressure goes to the nut. The nut is the only thing holding the rod inside the shock. King uses a 0.625-inch nut which is larger than the industry standard. Still, the best way to protect your shocks from pulling apart is to use external limit straps. Valving shims used in bypass shocks are usually thicker and stiffer than those used in coilover or smooth-body shocks. Since the bypass tubes control much of the shock's action, the valving shims need to be stiffer in order to force more oil though the bypass tubes. View Related Article



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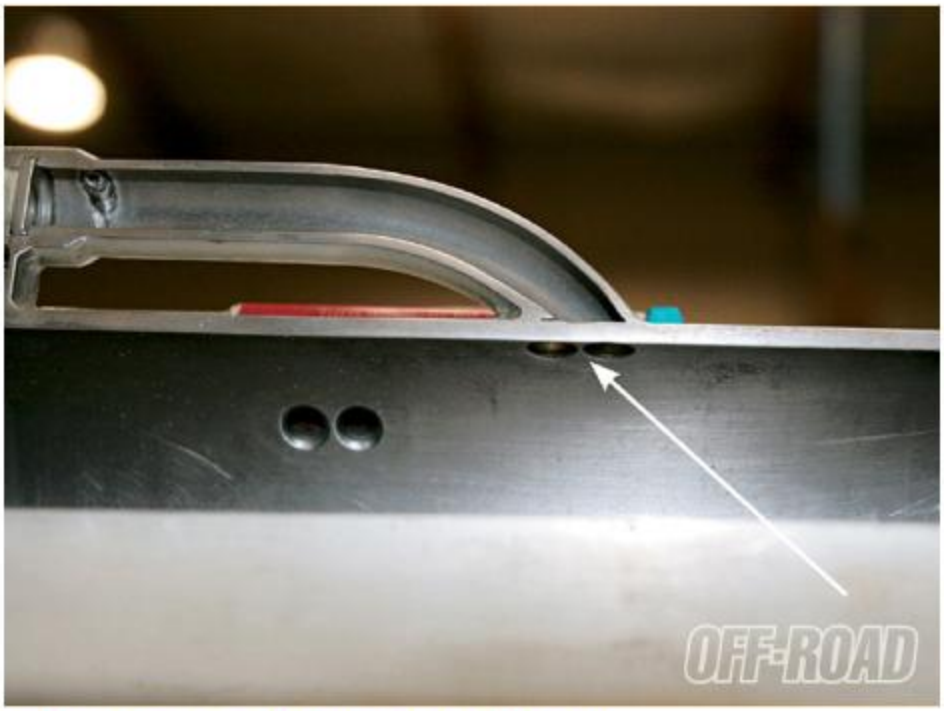
Here's a bypass tube and its internal check valve. Oil travels from the right, through the check valve, and then perpendicularly back into the main shock bore. Spring preload can be adjusted to determine how easily the check valve will open. The positioning of these bypass tubes make the shock responsive to the position of the piston head, and the valve shims on the piston head make the shock responsive to the speed of the piston. The ability to tune a shock's sensitivity to piston speed as well as piston position means that the shock can allow free and easy suspension action over small bumps as well as greater resistance to the hard hits. This comes at a price: noise. The check valve emits a clicking noise that can be obnoxious on a daily-driven vehicle. There are two possible solutions: one, turn up the volume on the audio system to drown the clicking out or two, preload the check valve so tightly that it never opens. When you hit the dirt, you can back off the check valve preload and voila, the bypass function works again. View Related Article



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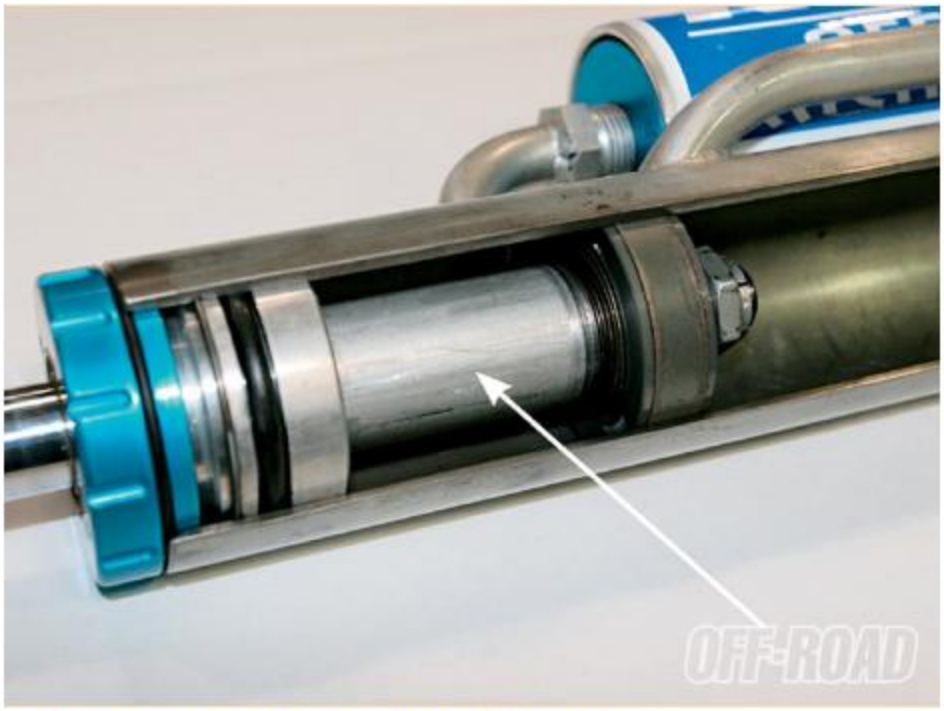
Here's the intake port of the bypass tube. Note the chamfered holes. This prevents the piston from sticking on the bypass port holes. Although we keep saying that oil flows from one place in the shock to another, that's not quite accurate. Since the whole shock is filled with oil, the oil is somewhat static. Energy flows, not oil. Think of a set of dominoes toppling over, one pushing against the next, and you have the right idea. View Related Article



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Mounted to the outside of the rod between the piston head and the seal cap there's a tubular overlap spacer. The overlap spacer is used on longer-stroke shocks to retain a certain amount of overlap between the shock shaft and the shock body. This overlap reduces side-to-side shaft play, and thereby reduces oil leaks and bent shafts. View Related Article

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Here's the top end cap. It seals to the shock body with an O-ring, and also houses a spherical bearing through which the mounting bolt is passed. View Related Article

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On the left is the piston wear band. This has the same function as a piston ring in an engine. The wear band is made of Teflon-coated brass. View Related Article

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The wear band on the right is worn out and needs replacing. View Related Article

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To change the valving in your own shocks, you'll need a few tools. Fortunately, most of these tools are commonly available. This is a special set of vise jaws that clamp around the shock rod without damaging it. They are available from King Shocks. When the shock rod is clamped, the piston nut can be loosened and the valving shims changed. View Related Article

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Here are the other tools used to change valving shims. A socket and socket handle, a pick, a spanner wrench, a hex key, and a set of calipers round out the list. You'll also need new shock oil, which is available through King. Of course, if you'd rather not mess with any of this, King Shocks is ready and equipped to re-valve your shocks to suit your vehicle, the terrain, and your driving style. View Related Article

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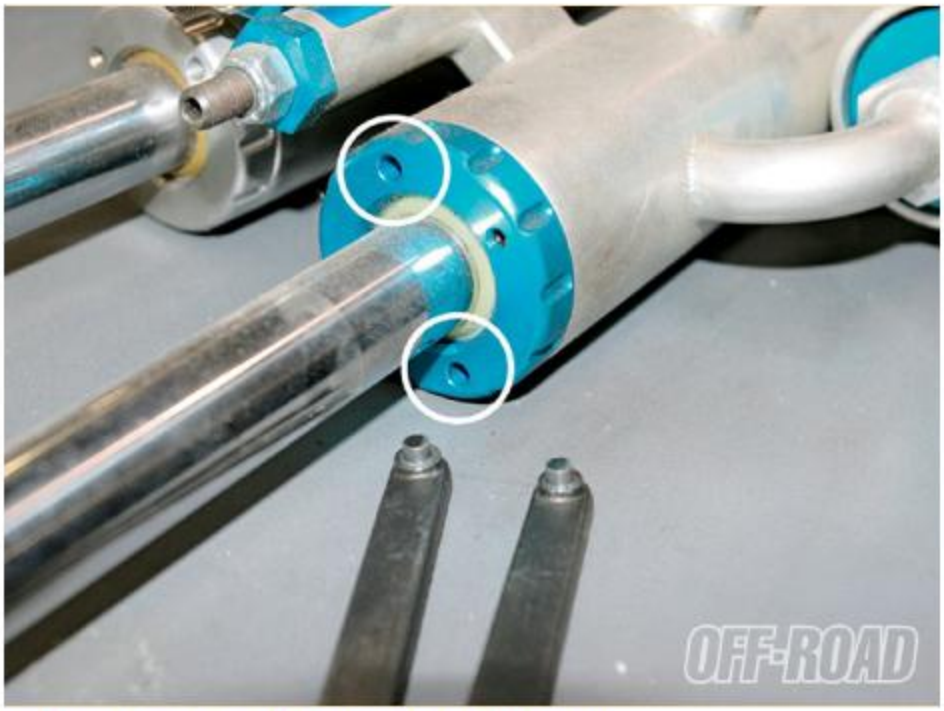
You'll need to let the charge out of the reservoir before you disassemble the shock. The schraeder valve will let you re-charge the reservoir without losing pressure when it's disconnected. Nitrogen is preferred, but you can get away with using atmospheric air in a pinch. The problem with atmospheric air is that it's got water vapor included. Water vapor inside a reservoir can rust it from the inside out. King makes their reservoir bodies from aluminum so they can't rust. Still, nitrogen is the safest bet. View Related Article



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The spanner wrench indexes into the two large bores in the wiper cap. The small bore is for a set screw. Make sure to loosen the set screw before attempting to loosen the wiper cap. View Related Article

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Desolate Motorsports' 7sx Ford Ranger is equipped with a dual-reservoir setup offered by King. The second reservoir increases the nitrogen capacity, and makes the nitrogen pressure more stable in the face of varying shock oil temperatures. This in turn makes the shocks run more consistently. View Related Article

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.....With the suspension moving in ways it wasn't supposed to, the shocks became collateral damage. Fortunately, King can replace individual parts, and most of the time can save a damaged shock. View Related Article

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King uses a shock dyno to help develop some of its application-specific shocks, and for quality control testing. The shock dyno can run a shock for hours on end to check for leaks and other possible issues. Data about internal temperatures and internal forces is fed into a computer and analyzed. The resulting information saves lots of trial-and-error field testing. For hard-core race applications, on-vehicle testing is still used because this dyno doesn't develop the sort of forces that are encountered in racing conditions. View Related Article