Power Level Air Suspension from The Top Down

By Rick Denney, GMC Eastern States

The Power Level air suspension system used in most pre-1977 GMC motorhomes is remarkably simple and effective. (The Power Level system was the standard system in 1973 through 1976 coaches, though the Electrolevel system was optionally available in 1976 and some 1977 models had the Power Level system.) Without an understanding of its basic operation, however, it is easy to get lost in the details of the various pieces and parts. With that understanding, troubleshooting the system, which is a typical requirement for new (and long-time) owners, will be much easier.

This article will present the Power Level system starting with its basic theory of operation, and proceeding from there to troubleshooting and leak detection and repair strategies. Many of the principles in this article also apply to later Electro-Level systems, but the article does not attempt to address that more complicated subject.

Contents

Throughout the article, the positions of the control valves are typed capitalized, as in Raise, Lower, Travel, and Hold.

Source for repair parts mentioned in the article can be reached using the contact information provided on Billy Massey's web site, http://www.bdub.net/GMCLinks.html.

Theory of Operation

The compressor keeps the tank filled with an abundance of pressure. In Raise, that pressure is released to the air bags. In Lower, the air tank is sealed and the bags are vented to the outside (under the dash). In Hold, the tank and bags are sealed from the outside and from each other. In Travel, the pressure in the bags is regulated by the leveling valves.

In Travel mode, the leveling valves are put in the circuit between the tank and the bags. When a rear corner is low, the valve opens one way to connect the tank and the bag, raising the corner. When a corner is high, the leveling valves seal the tank and bleed air from the bag to the outside (into the wheel well), which lowers that corner. At proper ride height, the leveling valve seals both the tank and the bag.

The valve mechanism in the leveler is damped with a viscous grease so that it doesn't react to routine bumps, but variations in ride height that last more than several seconds will cause the valve

to operate. Thus, when driving in Travel mode, the leveling valves will be frequently adjusting ride height, especially if the route has lots of sweeping, long curves. Each adjustment cycle involves venting and refilling from the tank, so one should expect that the tank pressure will drop while driving in travel mode, unless the road is straight.

The pressure in the tank should always be higher than the pressure needed by the bags. If it isn't, the leveling valve won't have any way to raise the bag if needed. That's why the pressure switch's turn-on pressure should be higher than needed for normal driving. Typical running pressure in each bag is about 80 or 90 psi, though this varies with coach length and load. The most commonly used pressure valve starts the compressor when the pressure falls below 95 psi, and stops it when the pressure reaches 125 psi.

When the control valves are in the Raise position, the pressure in the bags will be trying to catch up to the pressure in the tank. As air moves from the tank to the bags, the pressures in the two will equalize. If they equalize at a pressure below 95 psi, the compressor will start and then fill both the tank and the bags at the same time.

It’s quite safe to let the bags fill all the way to 125 psi for extreme leveling needs at a campsite, but at that pressure, the rear of the coach will be high and the handling poor for highway driving. Many will use the Raise settings when they are approaching a driveway with a sharp breakover angle, to ensure maximum ground clearance, but this should only be done at low speeds.

If the tank and bags reach equal pressure in Raise at a pressure above 95 psi, the compressor will not start and the coach will not raise further. In this case, briefly move the control valves to Lower until the pressure drops enough to start the compressor, and then move them back to Raise to allow the compressor to fill both the tanks and the bags.

Troubleshooting

Finding problems in the air system is a process of elimination. Each of the following common scenarios limit the possible fault to the system components that are open to the air in the bags. First, check to see if the bags leak down in Hold. If they don’t, then see if they leak down in Raise (while parked for an extended period). If they still don’t, see if they leak down in Travel. Each step opens more of the system to the bags, and these steps are described below.

After checking for bags leaking down, check for tank leaking down when sealed from the bags in Hold, as described further down.

Finally, many new owners are concerned when their compressors run at periodic intervals while they drive, thinking that a fault is exposed. The scenario of tank pressure declining is described after the above scenarios to explain why this is not a fault.

Some owners are able to eliminate leaks (at least in the Hold circuit) so completely that the coach will maintain height indefinitely. This is not easy to achieve in practice, and most owners are content if the coach will maintain height for at least a week or two. This keeps them from having to frequently relevel in a campground.

But for extended parking, most owners still place 6" wood blocks under the bogie frames between the tandem rear wheels so that the bags can settle on their own. On early coaches with the Power Level system, the coach should never be allowed to go all the way down without those blocks, because the tires will contact the wheels wells, potentially breaking the seal between the wheel well and the floor.

Bags Leak Down in Hold

When in Hold, the bag pressure is open to a single run of nylon tubing (from each bag) to that bag's control valve. Thus, the leak is either in the bag, in that nylon tubing, in the fittings at the bag or at the control valve, or in the control valve.

The test procedure is to remove the hose adaptor from the end of the air bag and replace it with a Schrader valve that screws into the bag opening. Fill the bag using shop air. If the bag still leaks down, the leak is in the bag. If it doesn't leak down, the leak is in the tubing or the control valves.

Figure 1 shows the portion of the system that is being tested for leaks in Hold.

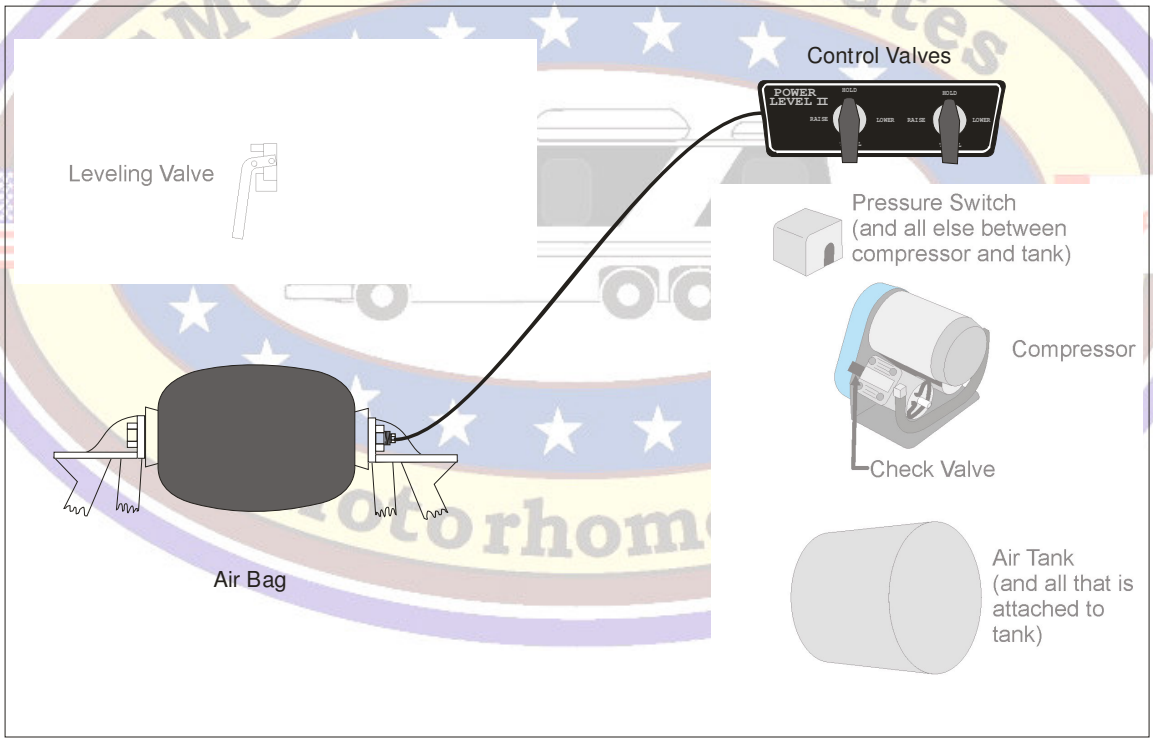

Figure 1. Portion of the system in use in Hold.

The leveling valves and tank apparatus have no effect on leaking when in Hold.

Bags Leak Down in Raise

While it is not normal to leave the coach in Raise for an extended period, doing so provides a means to check more of the system than is open to the bags in Hold. Thus, it provides a way to check the system in stages.

When in Raise, the bags are open to the tank and everything connected to it, and upstream from the tank to the check valve that is downstream of the compressor. If the bags do not leak down in Hold, but do leak down in Raise, then the leak is between the control valves and the compressor, which includes the tank.

Figure 2 shows the portion of the system that is being tested for leaks in Raise.

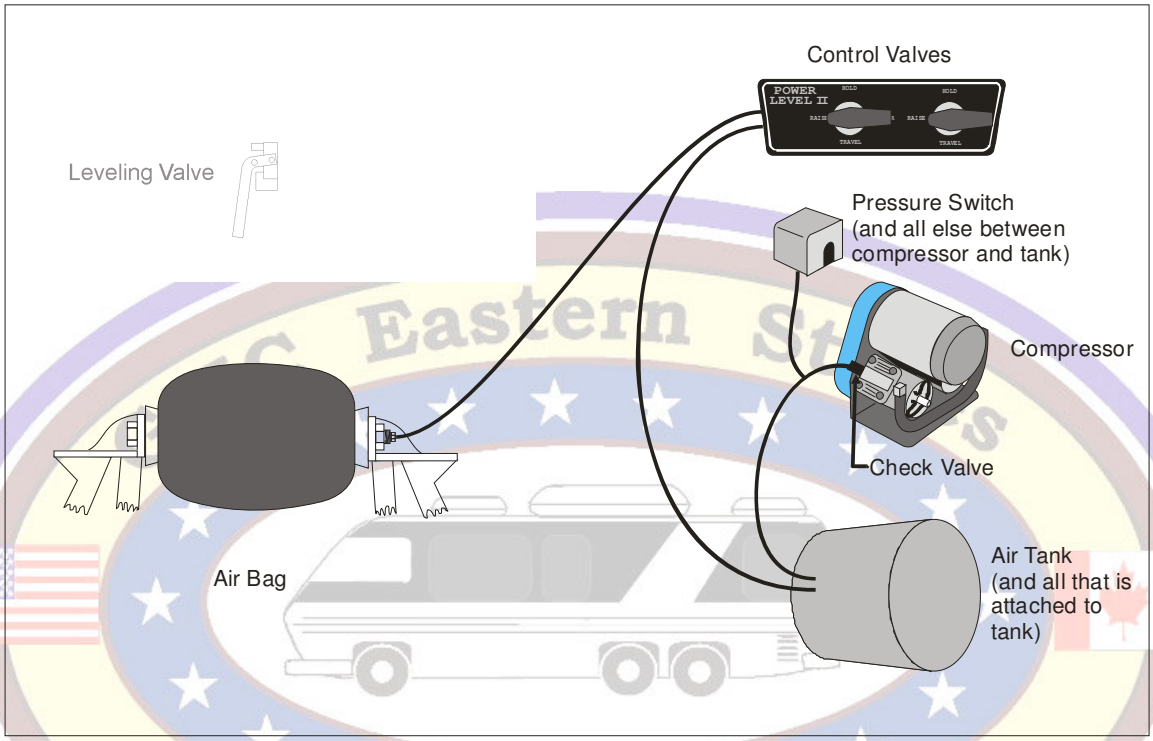

Figure 2. Portion of the system in use in Raise.

Bags Leak Down in Travel

When in Travel mode (while parked with the compressor turned off), the bags are open to the control valves, the leveling valves, three sets of tubing between the control valves and the rear of the coach (two for the leveling valve and one to connect to the bag), the tubing to the tank, the tank, and everything connected to the tank (including the compressor if there is no supplemental check valve, and including the pressure switch). Eliminating all possible leaks in this mode is a daunting task, and without a check valve on the output of the compressor, it is impossible. Most owners are happy if they can eliminate leaks in the much simpler Hold circuit. A leak in Travel mode has to be more than seepage to affect the use of Travel mode while driving, so it is not really necessary to completely eliminate the leaks found in this scenario.

If the bags leak down in Travel mode, but not in Raise mode (while parked with the compressor turned off), then the leakage is in the leveling valves or the tubing that connects them to the control valves. The leveling valves are the only thing removed from the circuit in Raise mode.

Figure 3 shows the portion of the system that is being tested for leaks in Travel.

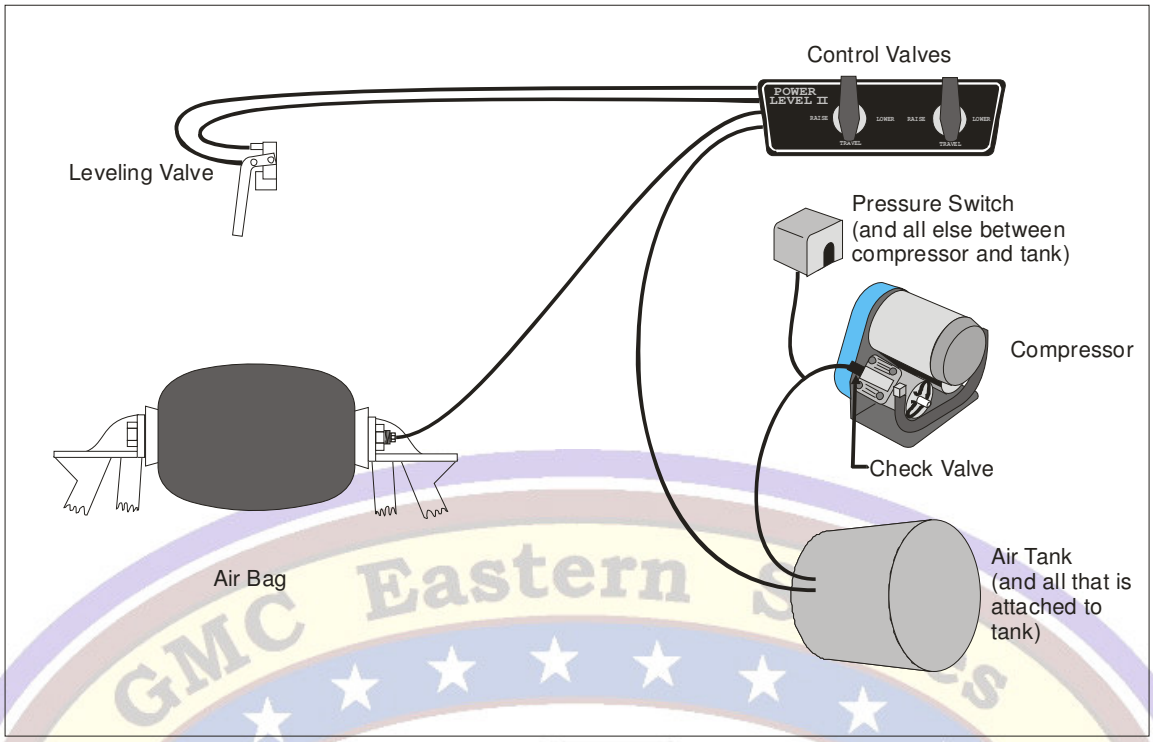

Figure 3. Portion of the system in use in Travel (while parked with compressor off)

One can also test the action of the leveling valves by filling the bags to 120 psi and then putting the coach in Travel. You should hear hissing from the leveling valves after a few seconds as they bleed off excess bag pressure. Likewise, when the bags are down, Travel mode should cause the rear of the coach to raise to proper ride height.

Tank Leaks Down in Hold

In the Hold position, the control valves completely isolate the tank from the tubing going to the rear of the coach. If the tank pressure drops, the leakage is in the tank, the check valve, anything fitted to the tank, the control valves, or the tubing and fittings connecting the above. Eliminating these leaks is a challenge. Since the tank is isolated from the bags in Hold, most owners are content if the air tank holds pressure for a day or two. That is sufficiently little leakage so that the system will work as designed in Travel mode while driving the coach.

Figure 4 shows the portion of the system that may leak on the tank side of the system while in Hold.

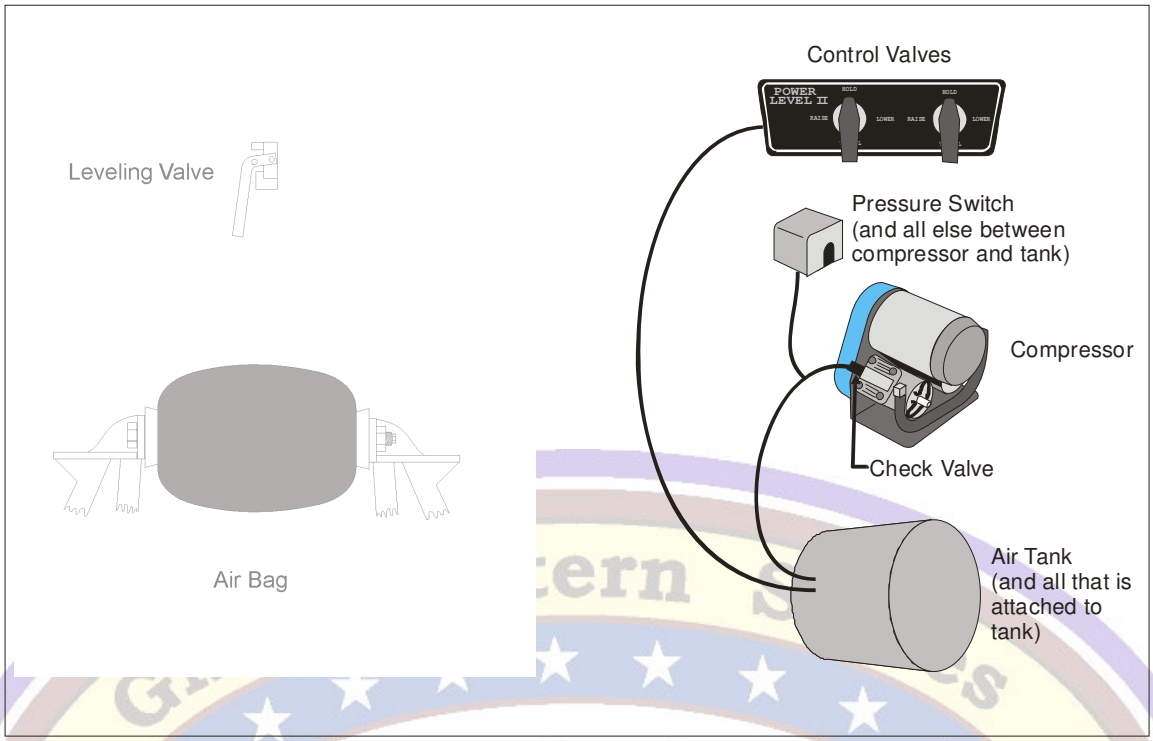

Figure 4. Potential locations for leaks that result in dropping tank pressure in Hold.

Tank Pressure Declines While Driving In Travel Mode

This is normal. The tank is a reservoir for pressure, to be supplied to the bags when the leveling valves call for it. Thus, pressure is frequently pulled from the tank in normal operation and can only be replenished by running the compressor. In hilly terrain, the compressor may run every half hour or hour if the road has long, sweeping turns. On a straight road, owners with reasonably well-functioning air systems report that their compressor runs every few hours. My system ran the compressor every half hour to an hour, until I repaired the leaks by replacing much of the tubing and by replacing the control valves. Now, it runs infrequently enough so that I haven't been able to keep track of it.

Modifications

Cinnabar Upgrade Kit

Cinnabar sells a kit for upgrading the air system. It contains a common compressor filter with a water trap, a stainless steel check valve, an undamped pressure gauge, and a replacement emergency relief valve. Near as I can tell, all can also be bought at any store selling air compressor stuff. The kit does not contain all the fittings necessary to install the system, which the instructions advise to "procure locally".

Check Valve

A check valve should be installed downstream of the compressor, where it isolates the pump from the rest of the system. This is one modification that is a must for eliminating leaks, because the Dana pumps do not have sufficient check valves to prevent seepage. In all the leak-removal

approaches discussed in this article, the check valve is a necessary starting point. Any check valve of decent quality will do, though valves made of corrosion-resistant materials such as stainless steel are recommended. These can be purchased from any source for compressed-air systems, including such large hardware suppliers as McMaster-Carr.

Gauges

The gauge in the Cinnabar kit is designed to be mounted on the tank, and without damping it needs the buffering effect of the tank to keep the pulsing of the compressor from causing early gauge failure. Instead of mounting that gauge on the tank, I purchased an Autometer in-dash air pressure gauge that is properly damped, and TEE'd it into the nylon tubing between the check valve and the tank. That allows me to monitor tank pressure while traveling, and in one case it revealed a leak caused by nylon tubing rubbing on the frame rail adjacent to the compressor just downstream of the check valve.

Cut-off Valves

One common modification is to mount valves on the bag fittings, making it possible to fill the bags with shop air and then close them off to the rest of the system. This has the same effect as running in Hold. As described above, the only parts of the system open to the bags in Hold are the control valves and a single run of tubing from each control valve to each bag. When I repaired the leaks in those circuits, I removed my cut-off valves. The cut-off valves can help a new owner defer troubleshooting and repair of the rest of the system for a time.

Cut-off valves can also provide leak opportunities. I had one that leaked profusely right out of the box.

Some care is needed in the design of the plumbing when adding such valves. There have been reports of failure of brass pipe nipples with "Christmas trees" of devices hung from them. This is a high-vibration area. Also, in the event of a tire blowout, the plumbing may be damaged, adding to the woes beside the road.

Compressor

The performance of the compressor has a big effect on the operation of the system. Many of the old Dana pumps still provide excellent service, but many are worn and do not build pressure as effectively as they once did. The Dana pump can be rebuilt using parts available from John Clement. It can also be replaced with one of several direct-drive automotive air compressors currently on the market, such as the Viair models available from Adohen Supply. I installed a Viair 350C in my coach, and its performance is a noticeable improvement over the Dana.

Power Relay

The air compressor is a high-current electrical device in the chassis 12-volt system, typically demanding as much as 20 amps of current. The factory wiring for the air compressor is marginal for this application, and often causes enough of a drop in voltage to reduce the effectiveness of the compressor noticeably.

The recommended modification to solve this problem is to power the compressor through a load-reduction relay. A 30-amp automotive relay should be mounted near the compressor. The existing compressor control wire can be mounted to the energizing coil of the relay.

Then, a new dedicated circuit, using 10-gauge wire, can be routed from the Vehicle Positive power terminal behind the passenger-side front hatch. The new circuit should include an inline fuse mounted close to that terminal, with a 30-amp fuse. This modification will ensure that the compressor gets a dedicated and abundant supply of voltage during operation.

Leaks, and How To Repair Them

Leak opportunities abound. The Dana pump uses a flap check valve which will leak. Tanks can perforate due to rust and leak. Nylon air hose can rub on edges and leak. The emergency pressure relief valve and water drain valve on the tank can leak. The nylon air hose fittings (especially the plastic ones) can leak. Fittings at air bags can leak. Leveling valves can leak. And, most of all, the rotary control valves can leak, not only to the outside, but also between the tank circuit and the bag circuit when they shouldn't.

Bag Leaks

The bags themselves can also leak. The fitting on the end of the bag is a separate piece that is screwed into the bag and sealed with an O-ring. During tightening of the bag to the bogies, this O ring can be damaged, especially if the nuts do not turn smoothly. If the fitting turns with respect to the bag during installation, then it's best to take it out, remove the fitting, and check the O-ring. After ruining an O-ring while wrestling with a nut that was binding, I have locked the threads in the bag using Loctite.

Fitting Leaks

The fittings used on many coaches are press-fit or plastic fittings. These fittings often fail with age. Eliminating leaks usually requires replacing these fittings with brass fittings made for truck air systems that use ¼" nylon tubing. These are available from hardware supply houses such as McMaster-Carr, as fittings for DOT Nylon Tubing. Fittings should include a sleeve for the inside of the tubing, and a compression ring for the outside. There are also fittings that have a spring lock, so that the tubing is merely inserted into the fitting, and can be released by pushing down on the lock collar. Both types are effective. Fittings made for copper tubing will also work, as long as the tubing inserts are used (these inserts are not usually provided with fittings intended for metal tubing).

Many recommend against using Teflon tape for sealing threaded connections in the system. I have found that Teflon tape is still the most effective means of preventing leaks, but it should be wrapped on the threads well back from the opening on the fitting so that shreds of Teflon cannot make their way into the system where they can clog the leveling valves.

Control Valve Leaks

The control valves can leak both externally and internally. It is possible to rebuild the valves and many have done so successfully. More owners, however, replace them with the Power Level II valves made by J. R. Slaten. These valves provide a complete replacement for the control valves,

the bezel on which they are mounted, and the knobs. Every aspect of the replacement is an improvement on the original.

Air Tank Leaks

The air tank itself is constructed of steel and is subject to leaks caused by the rust resulting from moisture condensing in the tank. Such moisture should be removed from time to time using the tank drain.

A tank with pinholes in it caused by rust is likely unsalvageable. Jim DaMaere sells a stainless steel replacement for the air tank.

The devices connected to the tank can also leak, including the pressure switch, the pressure relief valve, the Schrader valve in the tank (used for pressurizing the tank with shop air), and the tank drain. These are common parts that can be found at hardware stores that carry air compressors and accessories.

Tubing Leaks

Nylon tubing of ¼" outside diameter, meeting Department of Transportation requirements, is available from truck supply houses and large hardware suppliers such as McMaster-Carr (search on "DOT Nylon Tubing"). Rather than splicing into the tubing to repair a leak, it is better to replace the compete section to minimize future leak points. That said, a few inline tubing connectors can be handy to repair tubing that has been rubbed through.

Leveling Valve Leaks

If the leveling valves leak, they can be rebuilt or replaced. If rebuilt, do not use a standard Schrader valve insert, even though the valve in the unit appears to be the same. These will not vent properly and the bags will end up being filled to the maximum pressure of the tank. Also, the viscous damping fluid in the valve mechanism is required to achieve the delayed operation. Dave Lenzi rebuilds these to like-new condition; he also offers a more easily adjusted leveling valve linkage.

Also make sure that the leveling valve linkages do not rub on the suspension components throughout the range of travel. They should be "adjusted" (i.e., bent) to avoid those conflicts.