Rebuilding Saginaw Rotary Valve Type Power Steering

This is a very common steering gear and was used in many vehicles until the rack and pinion steering became popular. The rotary valve directs the power steering fluid under pressure to either side of the rack piston, which converts the hydraulic power to mechanical force. When the vehicle is being driven straight down the roadway the driver is not exerting any force on the steering wheel. Both hydraulic lines provide the same amount of pressure to the steering gear. When the steering wheel is turned one way or the other it causes a torsion bar in the rotary valve to twist. The top of the torsion bar is connected to the steering wheel and the bottom to the worm shaft. As the torsion bar twists it changes the position of the valve spool and sleeve, directing fluid under pressure to the proper end of the power cylinder. The difference in pressure on either side of the piston which is attached to the rack helps move the rack to reduce turning effort.

The Saginaw rotary valve power steering is the basis for GM products and has also been used by AMCs, Jeep Cherokee, Wagoneer, Gladiator and J-series pickups, International Scout and Traveler and Ford. Ford units will not interchange with any other applications. There are two types and each can be identified by the type of side cover used. The larger steering gear is known as the 800-808 model and has a rectangular side cover retained by four bolts. The smaller one is designated as the 605 model and has a circular side cover held in place by a retaining snap ring. The adjustment and overhaul procedures are basically the same for both types. The larger gear box used on full-size vehicles has a steering ratio of 17.5:1 and the smaller gear box ratio is 14.4:1.

Power Steering Checks

Before you attempt any major service operation on the power steering system, the steering gear, steering linkage and front end should be checked for wear. Wear your safety glasses. Replace any worn parts and then lubricate any grease fittings (zerks). There may only be a few as sealed non-serviceable joints, and front end parts are becoming more common. Wipe each grease fitting clean with a cloth. Grease fittings have a one-way spring loaded check valve that allows the
grease to go in but not to get out. The tip of the grease fitting allows the grease gun to snap on to the fitting. Put in just enough grease to expand the boot around the joint. Do not break the boot because the grease will leak out and road debris will enter causing premature wear of the joint. If the boot is torn, add enough grease to force the old grease and dirt out, and grease the vehicle more often to extend the life of the joint. If you can find a good boot from an old joint, replace the torn boot.

The wheel alignment should be checked and the tires inflated to correct pressures. Check the power steering belt, and replace it, if needed. Tension the new or old belt to specifications. Start the engine, and turn the wheels back and forth a number of times to warm up the power steering fluid. Check the fluid level, and top up with the manufacturer’s recommended power steering fluid or Dexron III ATF if necessary. Oil foaming, a cloudy fluid color and a burnt smell are signs that the power steering pump is starting to degrade. If the fluid level is correct, turn the wheels to straight ahead position engine at idle. Using a spring scale, check the amount of steering effort necessary. Attach the spring scale to the rim of the steering wheel, and measure the amount of pull to turn the steering wheel clockwise and counter clockwise 1 ½ turns. If the reading exceeds 10 pounds at any point, there is a problem inside the steering gear. Check the steering wheel free play with the wheels in straight ahead position. If the play exceeds 1 inch, inspect the steering shaft coupler and the tie rods. If they check okay, the Pitman shaft may need adjusting.

Check the oil-flow and relief valve operation by turning the steering wheel from one extreme to the other with the engine idling. Do not hold the steering wheel in either extreme position for more than 2 or 3 seconds. The extreme high pressure can cause damage to the system, if the relief valve is not operating properly. If these valves are working properly, a slight buzzing noise should be heard. If no buzzing is heard, a sticking or faulty valve is the problem. If the pump produces a ‘chattering’ sound and a noise in the flow control valve, there is air in the system. Stop the engine, and check for a difference in fluid level. If the level is above the mark, the air must be bled out. With the engine idling, have a buddy turn the steering wheel slowly all the way to the left and then to the right 10 or 12 times and sometimes many more. Add fluid to the reservoir during the air bleeding. Continue the steering wheel turning until there are no air bubbles in the reservoir. Do not hold the steering wheel at the stop position any longer than 2 or 3 seconds. Check the fluid level.

Steering Gear Adjustments

If the steering linkage is okay and/or the worn parts have been
replaced and wheel alignment has been set but the steering is loose and the vehicle wanders on the roadway, the steering gear has to be removed for adjustment or repair. Loose steering can also be caused by internal leakage of fluid past the seals in the steering gear. Although you can adjust the Pitman shaft preload in the vehicle GM recommends the removal of the steering gear to make the adjustments at the bench. The steering gear also has to be removed, if it is leaking fluid. Disconnect the negative battery cable. Raise the front of the vehicle on safety stands. Disconnect both lines, and drain the fluid out into a container. Empty the pump reservoir. Cap the gear ports and lines to prevent contamination from dirt. Disconnect the Pitman arm by removing the nut and washer. Mark the position of the Pitman arm to the Pitman shaft with a center punch. Use a puller to pull off the Pitman arm. Disconnect the steering shaft from the steering gear stub shaft. Remove the attaching bolts, and work the steering gear free of the flexible coupling and the frame rail. Power wash the outside of the steering gear.

To adjust the worm thrust bearing preload clamp the steering gear in a vise with the stub shaft pointing up. Loosen the Pitman shaft adjusting screw locknut. Using a proper sized Allen wrench loosen the adjusting screw 1 1/2 turns and retighten the locknut. Loosen the adjuster plug locknut 1 turn using a chain wrench. Use a 3/4" 12 point socket to turn the stub shaft. Turn the stub shaft to the right stop, then back off 1/2 turn. Measure the drag torque with an inch-pound torque wrench and adapter on the socket. Bottom out the adjuster plug using long needle nose pliers. The proper tool to use is called a pin spanner wrench, and once you see one it is very easy to replicate. Back off the adjuster plug to add 3 to 4 inch-pounds stub shaft torque in excess of drag torque. Total torque should not exceed 10 inch-pounds. Tighten the adjuster plug locknut securely while holding the adjuster plug in position. Recheck the setting since preload torque changes when the locknut is tightened. If the preload is less or greater than required, the steering gear has to be disassembled for inspection and repair.

To adjust the sector shaft preload center the steering gear on the high point by turning the stub shaft 1/2 the number of turns required from lock-to-lock. The flat side of the stub shaft should face up and be parallel with the side cover. Loosen the locknut, and adjust the screw (3/16 Allen wrench) so the stub shaft turns freely except for a slight pressure at the over-center position. Back the adjusting screw out about 25 degrees, and tighten the lock nut. The over-center torque reading should be about 14 inch pounds. If the reading stays the same through the over-center position, the center teeth on the rack piston and/or the Pitman shaft are worn out and must be replaced. A rebuild kit will not solve this problem. This becomes the expensive side of repair.

Steering Gear Installation

Let's adopt the easy way and say the adjustments tightened up the steering gear and there are no fluid leaks. Turn the steering wheel to straight ahead position. Fit the coupling in place on the steering shaft, and center the stub shaft. Slide the stub shaft into the coupling and work the steering gear into place on the frame side rail. Install the attaching bolts and torque to specifications. (65-70 foot pounds Chevrolet). With the wheels in straight ahead position install the Pitman arm and torque to specifications (185 foot pounds Chevrolet). Replace the bolts in the coupling. Remove the caps, and reconnect and tighten the pressure and return lines. Fill the pump reservoir with fresh fluid, and start the engine. Bleed the air out by turning the steering wheel from side to side without hitting the stops. Check the fluid level, and add if necessary. Lower the vehicle off the safety stands. Connect the battery cable. Road test.

REMOVE AND INSTALL CHECK VALVE

1. Remove parts as shown
2. With small screwdriver, pry check valve from housing
3. Care should be taken not to damage threads when prying on edge of housing

Using a piece of 3/8 tubing, 4 inches long carefully drive the check valve into the housing

Install check valve

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Steering Gear Disassembly

Clean the outside of the housing, if you didn't do it before. Read and then follow the service manual for the steering gear you are rebuilding. Make notes on the disassembly of parts to help in assembly. The following is general information that will apply to many types of Saginaw constant ratio rotary-valve steering gear. Work on a clean bench. Handle the interior parts carefully. Do not drop them or mark them up in any way. Lay the housing in a plastic pan to catch the remaining fluid as you remove the Pitman shaft. Center the Pitman shaft. Then remove the 4 bolts from the top cover, and pull the Pitman shaft out with the top cover attached. Turn the input shaft back and forth, and the Pitman shaft comes out easier. The bearing in the cover supports the top bearing surface of the Pitman shaft. Generally this bearing does not get much wear. If the rebuild kit comes with this bearing, you can decide if the old bearing needs replacing. Clean up any corrosion on the bottom bearing surface with crocus cloth. Clean the Pitman arm splines.

Clamp the housing in a soft-jaw vise. There is an access hole at the housing end plug so you can push down on the retaining ring and work the ring out with a screwdriver. Lay the housing back in the pan, and rotate the stub shaft counterclockwise just enough to push the end plug out. Drain out any fluid. Continue to turn the stub shaft and the rack piston will come out of the housing. Mind the steel ball bearings and shake them all out. Remove the ball return tube. Count all the ball bearings now. Check the service manual for the correct number (24 or 26). Wash the ball bearings, inspect them for wear and measure diameters with a micrometer, if you wish. If they check okay, set them aside in a clean container.

At the other end of the housing count the number of threads outside the locking ring to help set the wormshaft preload during assembly. Loosen the bearing lock nut, and unscrew the adjuster plug. Set the housing horizontally and pull/twist out the rotary valve assembly and worm. Do not take anything else apart. Clean the inside of the housing, and inspect the inner bores for any sign of scoring that might affect the seal surfaces and cause internal leakage. Check for grooving at the rack piston and Pitman shaft teeth. Inspect the worm for scoring or burrs. If excessive wear is evident, a rebuild kit will not fix these problems.

Contact www.larescorp.com for an exchange unit (Reman) or rebuilding. You will need the casting number on the housing, if your plans include a visit to a recycler. If wear is minimal, order a complete rebuild kit that should include the O-rings, roller bearings, seals and gaskets.

Clean the inside of the housing with solvent, and blow the oil passages clean. Put the caps back on. When the rebuild kit arrives continue with disassembly. Remove the C-clip at the Pitman shaft end with a pair of circlip pliers. On some types the clip may be hidden under an outer seal and a dust shield. Remove the dust shield and the outer seal. Remove the snap ring and the washer (spacer) behind it. Pry out the second seal. Some types have a washer separating the seals. Press out the bearing using an inverted socket of the correct size. Wash the inside of the housing where the new bearing and seals will fit. Press or drive in the new bearing with the numbers facing up. Install the seals and the snap ring. Set aside. Take the valve body and slide the adjuster plug off the stub shaft. Remove the stub shaft. Remove the old Teflon seals and the O-rings with a seal pick. They are probably hardened up so be very careful not to scratch the valve body. Press the spool valve out of the valve body. Wash all these parts. Replace the O-ring on the spool valve. Use PS fluid as a lubricant. Lubricate the inside of the valve body, and press the spool valve into the valve body about half way. The top hole in the valve spool must be located 90 degrees away from the pin in the valve body. Insert the stub shaft so the pin on the stub shaft engages the slot on the spool valve. Press down slowly, and you will hear a click as the slot engages. Install the O-rings on the valve body using PS fluid as a lubricant, and then install the Teflon seals.

Set the adjuster plug on the bench screw threads down. Remove the bearing retainer using a small screwdriver. Lift the spacers and the thrust bearings off, and keep them in order. Remove the old O-ring. Turn the adjuster plug over, and remove the C-clip. Use a proper size socket to drive out the old bearing and seal. Wash the parts. Clean the threads on the adjuster plug. Drive a new bearing in place with the identification numbers facing up to a depth just even with the bottom of the bevel. Use lubricant, and drive the seal in with the lip facing down. Drive in the dust seal with the bevel side down. Drive in just deep enough to install a new C-clip. Turn the adjuster.
Plug over, and install the lubricated O-ring. Lubricate the new bearings, and set them in place in the proper order. If new bearings are not included in the kit, examine the old bearings, and if they are smooth and turn freely, install them in place with the races and spacer. Flatten the bearing retainer lip, if it was damaged during removal. Install the retainer. Lubricate the seals, and slide the adjuster plug over the stub shaft. Set aside.

Remove the end plug on the rack piston. Wash the rack piston and the ball return guides. Remove the Teflon seal and the O-ring with a seal pick, and clean the groove. Bring the rack piston to the bench. Lubricate the O-ring and Teflon seal with PS fluid and install them on the rack piston. Have a good look at the inside of the rack piston. The ball bearings fit in a circular pathway in the rack piston. Use wheel bearing grease to hold the ball bearings in place as you push the ball bearings into the feed holes. Some steering gear use two slightly different bearings (color and size). If the ball bearings are different, install them by alternating them. When you have 6 left take one-half of the ball return guide and plug the ends with wheel bearing grease. Lay the remaining 6 ball bearings in place in the ball return guide, and fit the other half of the ball return guide over the ball bearings. Fit the ball return into the feed holes, and tighten the clamp in place. Check that all the balls are in place. Set the rack piston aside.

Clean the wormshaft, and remove the O-ring. Inspect the thrust bearing, and if a new one came with the kit, install it on the wormshaft. Lubricate a new O-ring, and fit it on the wormshaft. Line up the valve body drive pin on the wormshaft with the pin slot in the valve body. Push the wormshaft into the valve body. Make sure the O-ring does not curl up. Lubricate the valve body end of the housing with plenty of PS fluid. Lubricate the wormshaft thrust bearing and the Teflon seals. Clamp the housing in a vise. Very carefully push this assembly into the housing with the stub shaft flat facing up. Support the wormshaft, and keep the assembly square with the housing. Do NOT push on the stub shaft. Screw the adjuster plug in to seat the thrust bearing, and back off 1/2 turn. Screw the bearing locknut onto the adjuster plug, and leave the same number of threads showing as you had counted. Snug up the locknut using a chain wrench. The rotation of the stub shaft should be smooth. Torque wrench reading should not be over 10 inch pounds.

Lubricate the Teflon seal on the rack piston, and check that all the ball bearings are in place. The easiest way to install the rack piston (ball nut) on the wormshaft and not disturb the bearings is to use a dummy shaft. A 5/8 inch dowel about 8 inches long and bevelled at one end that will fit through the end plug hole will hold the bearings in place. With the teeth facing the open side of the housing install the rack piston until it touches the worm shaft. Turn the stub shaft clockwise until the middle rack groove lines up with the center of the sector shaft roller bearing. Remove the dummy shaft.

Tape the splines on the Pitman shaft. Install a new gasket on the top cover. Some models use an O-ring seal in the top cover, and others use a metal gasket with a moulded rubber section that fits into the cover. Spray the gasket with sealant. Two metal tabs bend around the cover. Lubricate the Pitman shaft seals with PS fluid. Lubricate the Pitman shaft with PS fluid, and carefully insert it into the housing. Turn the cover out of the way, and mesh the center gear tooth with the rack piston. Pour some PS fluid into the housing. Turn the cover into position, and torque the bolts 40 foot pounds. Remove the tape off the splines. Replace the rack piston end plug, and torque 111 foot pounds. The sector shaft should be able to move from the front of the rack piston to the rear without much force. If too much pressure is required, rotate the rack piston a very small amount by turning the rack piston end plug. Reinstall the housing end plug using a new lubricated O-ring. Install a new retainer ring into the bore groove.

Center the steering gear. The flat side of the stub shaft should face up parallel to the cover. Check the sector shaft preload with an inch pound torque wrench. Turn the torque wrench from 45 degrees to 90 degrees each side of center. Total over center torque should not exceed 18 inch pounds for new gears or 14 inch pounds for used gears. Readjust if necessary by loosening the locknut and turning the adjusting screw clockwise a very slight amount with an Allen wrench. Check torque wrench reading, and if okay, hold the adjusting screw in place, and tighten the locknut. Remove any oil on the outside of the housing with paint thinner. Mask the openings, cover and shafts. Spray with gloss black. Install on the vehicle when the paint is dry. PS hoses can deteriorate from the inside out, and if you have any doubts about the hoses, replace them. Empty the power...
steering reservoir and fill it with fresh PS fluid recommended by vehicle manufacturer or Dexron III ATF. Synthetic PS fluid is available. Connect the negative battery cable. With the vehicle still on safety stands start the engine. Slowly turn the steering wheel lock-to-lock several times. Refill with fluid as needed until there are no more air bubbles in the reservoir. There should be no pump noise (whine). If there is, you may have to wait up to 24 hours until all the air exits the system. Road test. Happy motoring.

NEXT MONTH:
Rack and Pinion Power Steering

S.K.