

Sheppard

POWER STEERING



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SERVICE CATALOG
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How to use this manual.

This service manual will contain information covering all current and past model Sheppard Power Steering Gears. The Sheppard Short Series Steering Gear is used as the base line and earlier and later production models will be covered in this manual as variations.

Use the identification guide to determine which particular Sheppard Steering Gear you are working with. Follow the disassembly, cleaning and inspection, and repair procedures in this manual using the variation(s) procedures as they apply to your steering gear.

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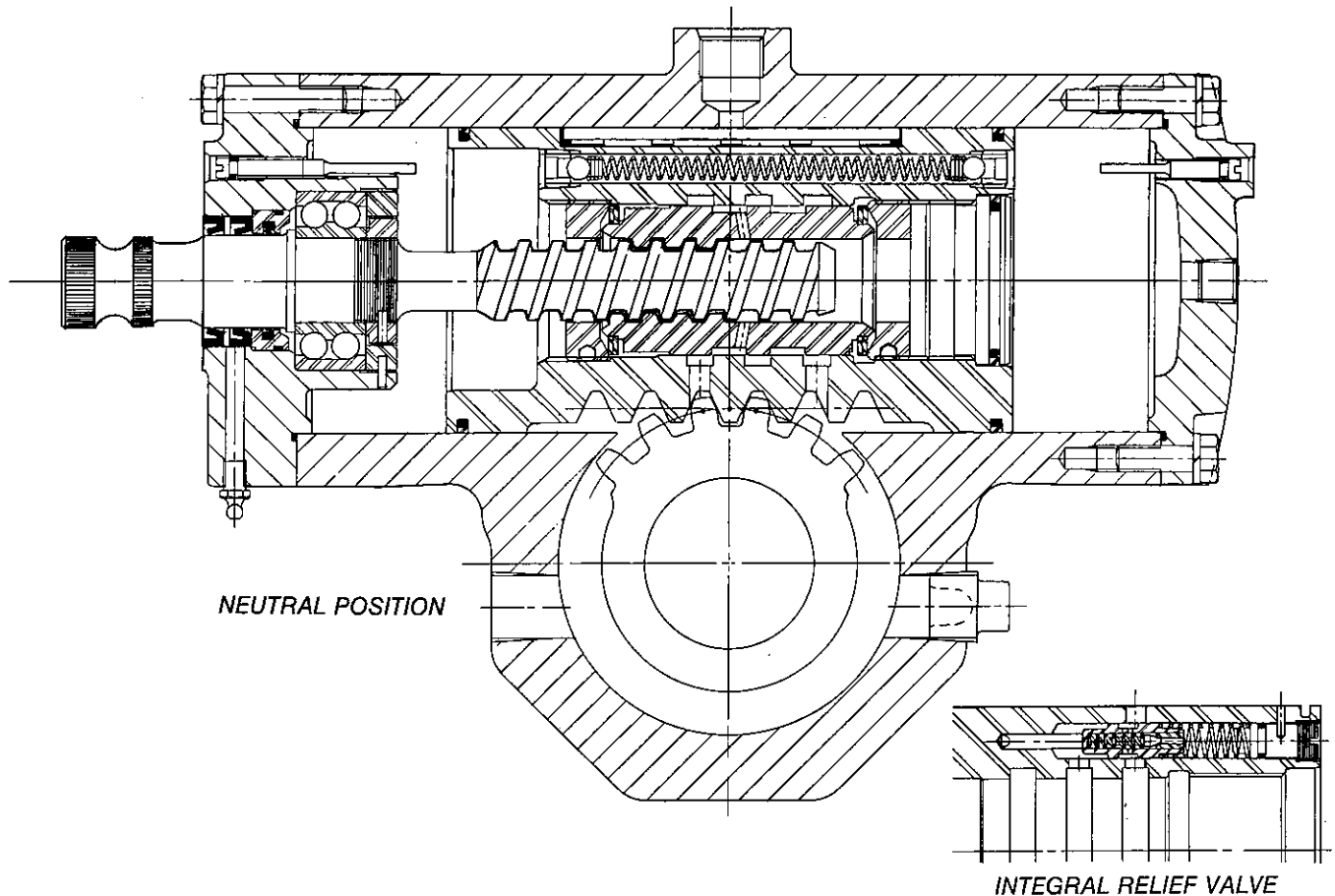
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X - UNDER MODEL DESIGNATES. E APPLIES TO THAT MODEL

DESIGN ADVANTAGES YOU GET WITH STATE OF THE ART SHEPPARD INTEGRAL POWER STEERING

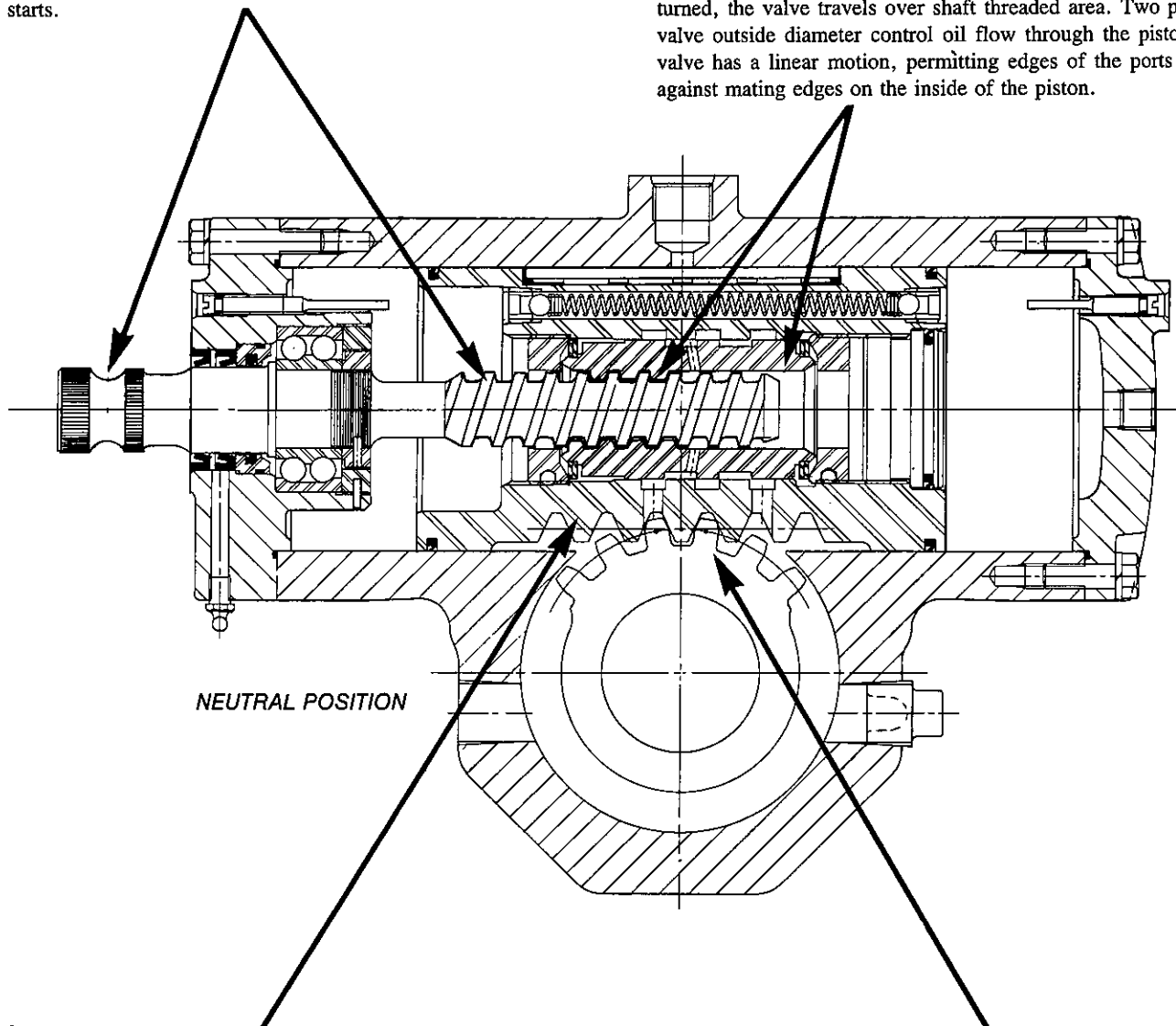


- 1** Dependable and trouble-free service. ADJUSTABLE STOPS prevent damage and unnecessary wear. When wheels are turned to a desirable extreme in either direction, adjustable stops automatically unload the complete hydraulic system. Thus all parts of the steering mechanism are protected from undue stress and damage. Oil in the hydraulic system is prevented from overheating. Service life of both pump and by-pass valve are prolonged.
- 2** Fast responsive steering control. With Sheppard integral design there is only ONE HIGH-PRESSURE LINE from pump to gear. This eliminates drift and mushy steering caused by the swelling and breathing of a complex of external pressure lines between separate valve, pump, cylinder and gear.
- 3** The Sheppard unit is mounted similar to the mechanical steering gear. Accidental snagging and damage over rough terrain is avoided because GEAR DOES NOT PROTRUDE below frame.
- 4** Parts wear is negligible because there are ONLY 4 MOVING PARTS.
- 5** With Sheppard integral design, steering response is immediate and precise because the CONTROL VALVE IS LOCATED WITHIN THE PISTON. This eliminates springy hydraulic pressure lines that can cause lag and hesitation.
- 6** In event of hydraulic malfunction, BUILT-IN MECHANICAL STEERING allows for safe control of the vehicle.
- 7** INTEGRAL PRESSURE RELIEF VALVE installed in the piston. An optional pressure relief valve is available which limits the maximum pressure in the steering system. This feature will avoid rapid temperature build-up caused by normal pressure relief and oil recirculation within the pumping chamber or pump body.

4 BASIC OPERATING COMPONENTS:

1. ACTUATING SHAFT is connected to the steering column assembly. It is threaded with a heavy Acme thread having multiple starts.

2. ACTUATING VALVE is contained within the piston and threaded to accommodate the input shaft. When the input shaft is turned, the valve travels over shaft threaded area. Two ports on valve outside diameter control oil flow through the piston. The valve has a linear motion, permitting edges of the ports to seat against mating edges on the inside of the piston.



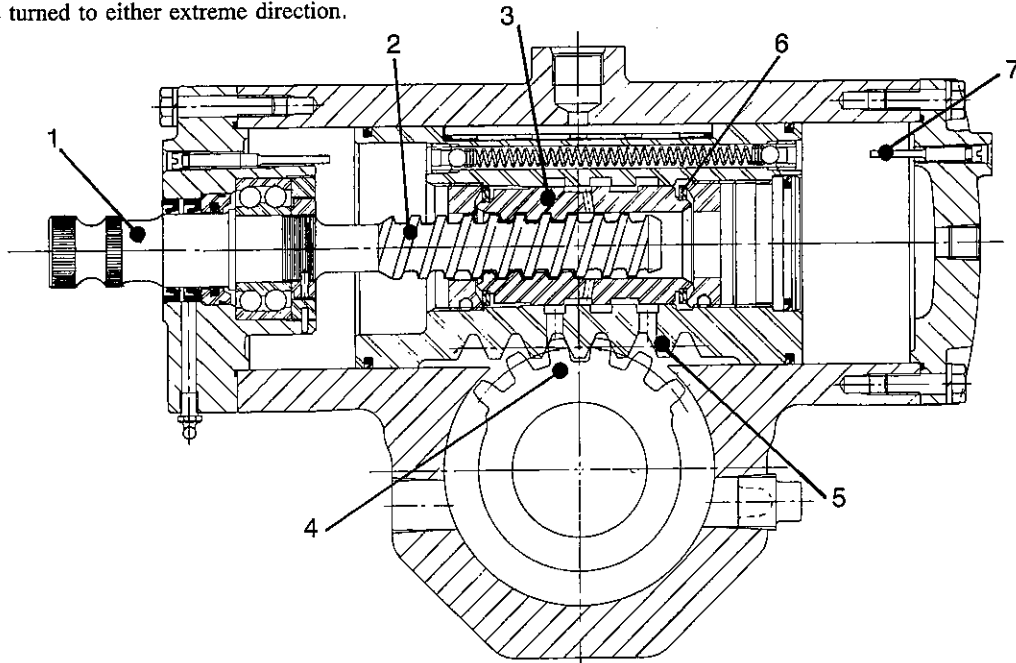
3. PISTON is located within the housing. A rack on the piston engages the pinion gear on the output shaft. Ports in the piston function for either pressure or exhaust depending upon direction of valve travel. The piston centers itself over the valve to provide steering action.

4. Sector shaft/output shaft and pinion assembly located in the housing is turned by the piston rack. This provides rotating action at the pitman arm connected to the steering linkage.

OPERATING PRINCIPLES

The Sheppard Integral Power Steering Gear provides full-time hydraulic steering which is light and responsive. Only sufficient manual input effort to overcome the reversing springs and close the control valve to cause a pressure build-up is required. Full rated axle loads can be steered with ease.

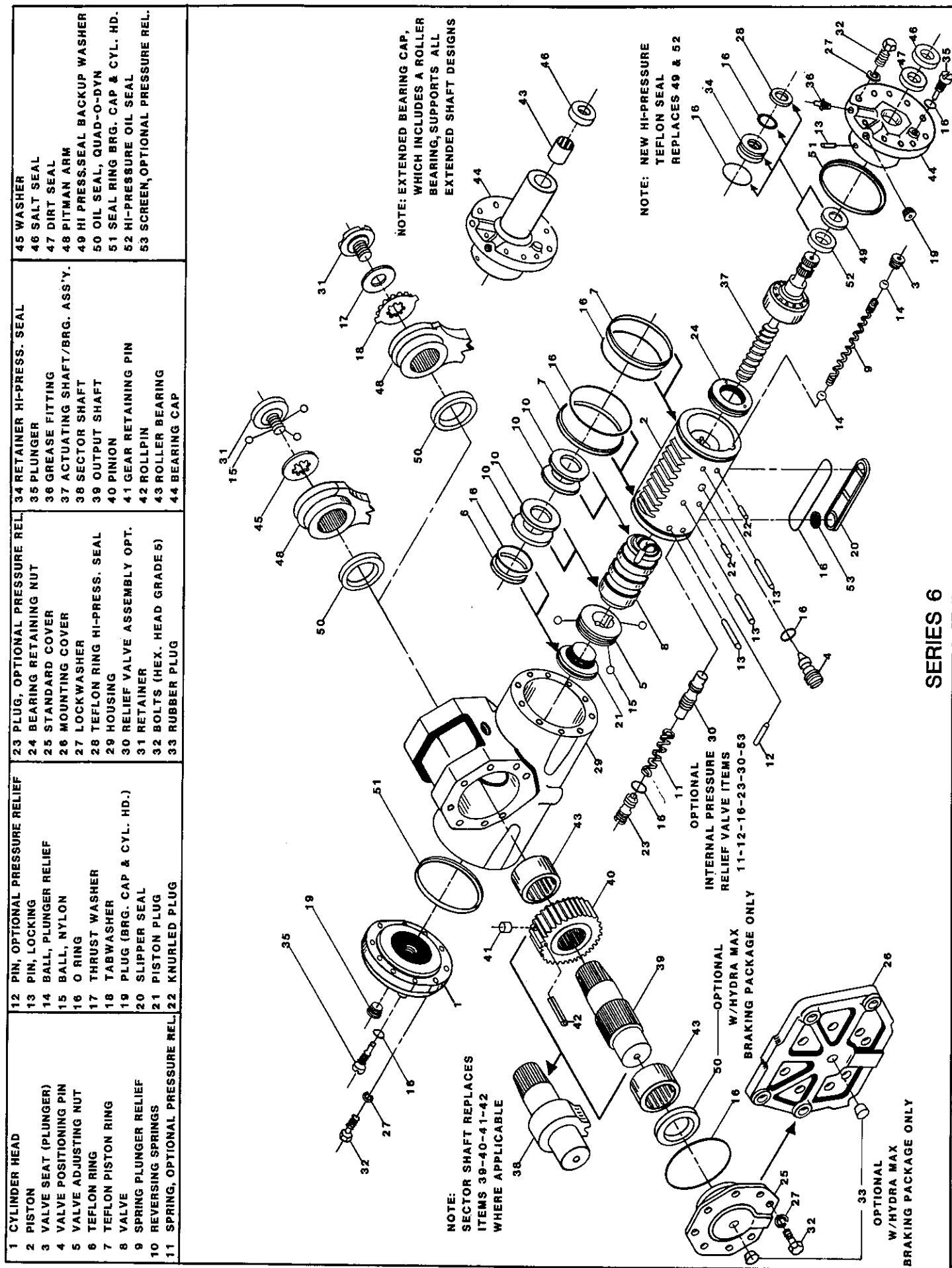
The actuating shaft (1) is connected to the steering column and is threaded with an Acme type thread. (2) The actuating valve (3) is threaded to accommodate the actuating shaft and is centered within the piston by reversing springs. The valve moves in a linear motion within the piston permitting the edges of the valve to overlap mating edges on the inside of the piston. This causes high-pressure oil to build up at one end of the piston. This higher pressure on one end of the piston causes the piston to move in the bore of the gear housing. The output shaft and pinion gear (4) are engaged to a rack gear (5) machined into one side of the piston. As the piston moves, the output shaft and pitman arm are rotated by the rack and pinion gear and steering operation is performed. When rotation or input from the actuating shaft ceases, pressure on, or movement of the actuating valve stops and the reversing springs (6) at the ends of the valve center the valve in the piston relieving the high pressure and power to the steering ceases. Movement of the actuating valve, to control oil pressure is controlled by the deflection of the reversing spring at either end of the valve. Total movement of the valve is approximately .040 of an inch. Relief valve plungers (7) or adjustable stops are provided at the bearing cap and cylinder head. When the plungers are adjusted properly, they will automatically unload the hydraulic system if the wheels are turned to either extreme direction.



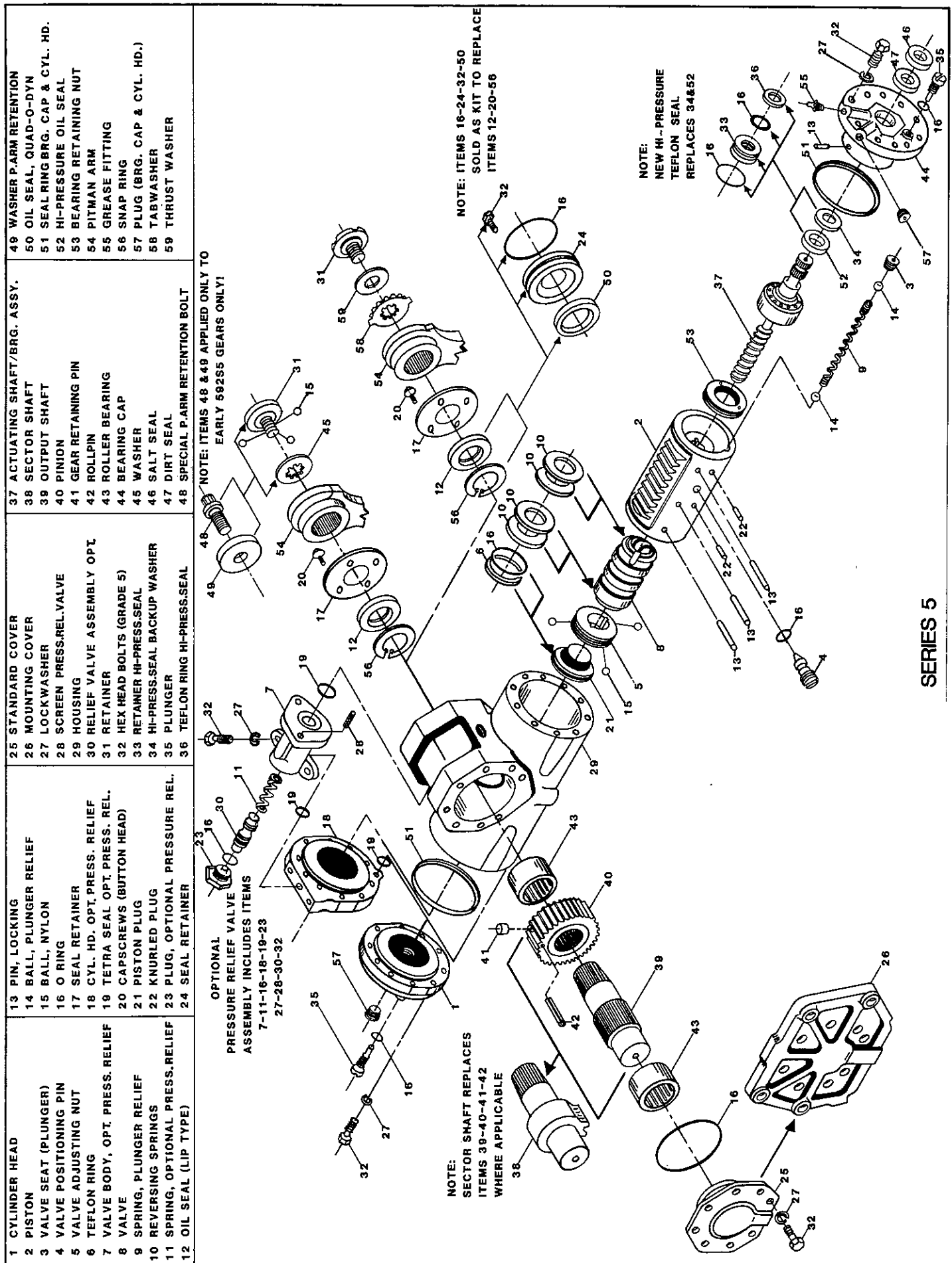
When the engine is running there is constant oil flow through the steering gear at low pressure. This constant oil flow provides for instant response and absorbs road shock to help eliminate steering wheel kick and protect the steering gear. Pressure is equal throughout the steering gear and oil cooling and lubrication are assured. Care should be used in towing or moving a vehicle where the engine or hydraulic supply pump are inoperative. In this instance the ability of the steering gear to protect itself is reduced and mechanical damages can be encountered.

An optional pressure relief valve integral with the steering gear is available on the Series 5 & 6 Steering Gears. This valve limits maximum steering system relief pressure at the steering gear, a point in the steering system which is farthest from the supply pump, pumping chamber. This effectively reduces system temperature by avoiding high-pressure by-pass and recirculation within the pump.

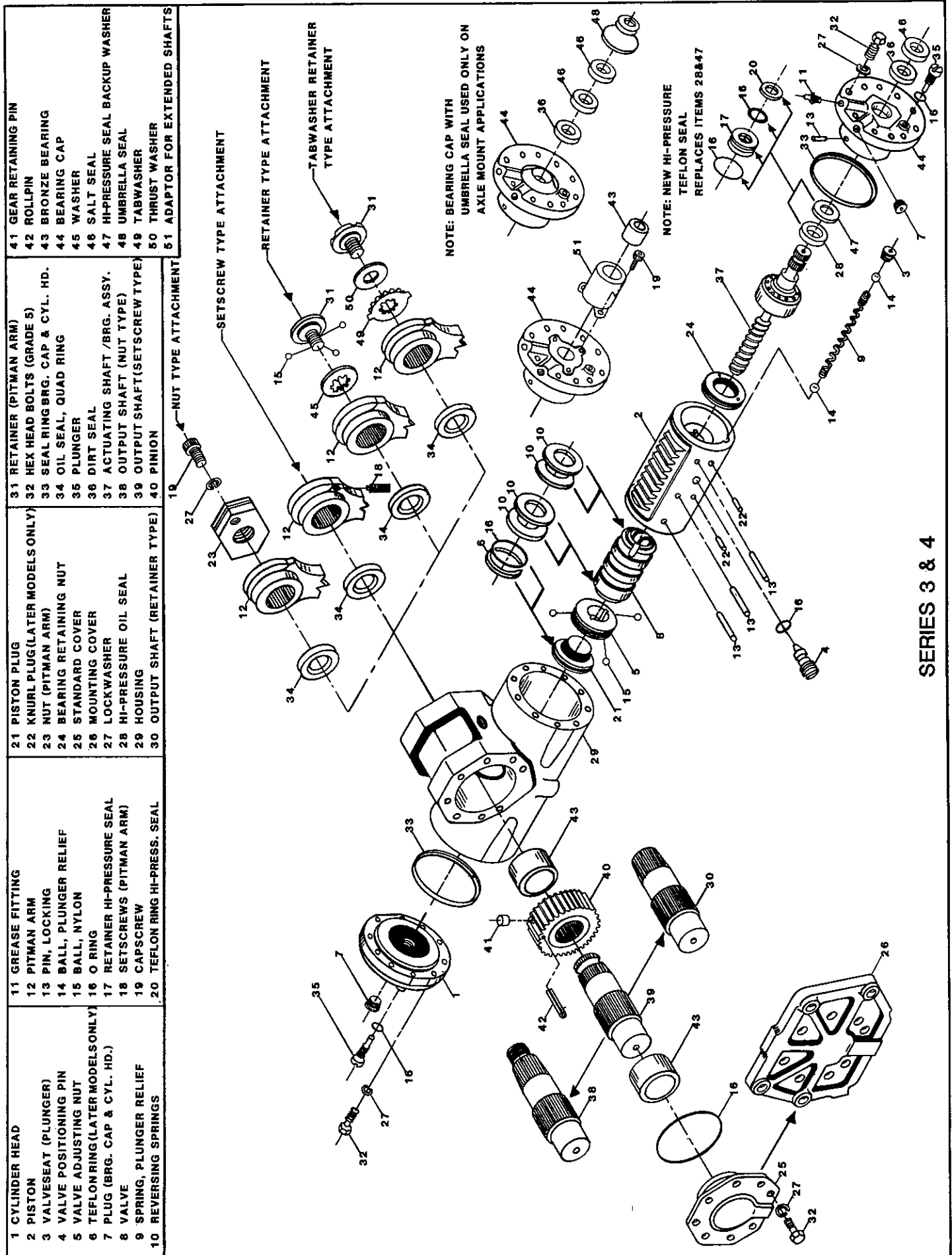
The Sheppard Integral Power Steering Gears have been designed to provide long service life and simple service repair. The rack and pinion gear set does not require adjustment. There is no center point adjustment. The high-pressure seal at the input/actuating shaft is the only seal which is exposed to high pressure and motion, unless the steering unit has the optional hydra max braking capability. With this option the output shaft/sector also has a high-pressure seal. The high pressure actuating shaft seal is protected by a dirt seal and salt seal which are separated by a grease pack that is flushed during lubrication. The clearance between the cylinder bore and the piston is closely controlled, and with the series 6 steering gears, piston rings were added to efficiently utilize the hydraulic oil supplied from the power steering pump. With reasonable care and limited maintenance the Sheppard Steering Gear will provide many miles of trouble free and effortless performance.



SERIES 6

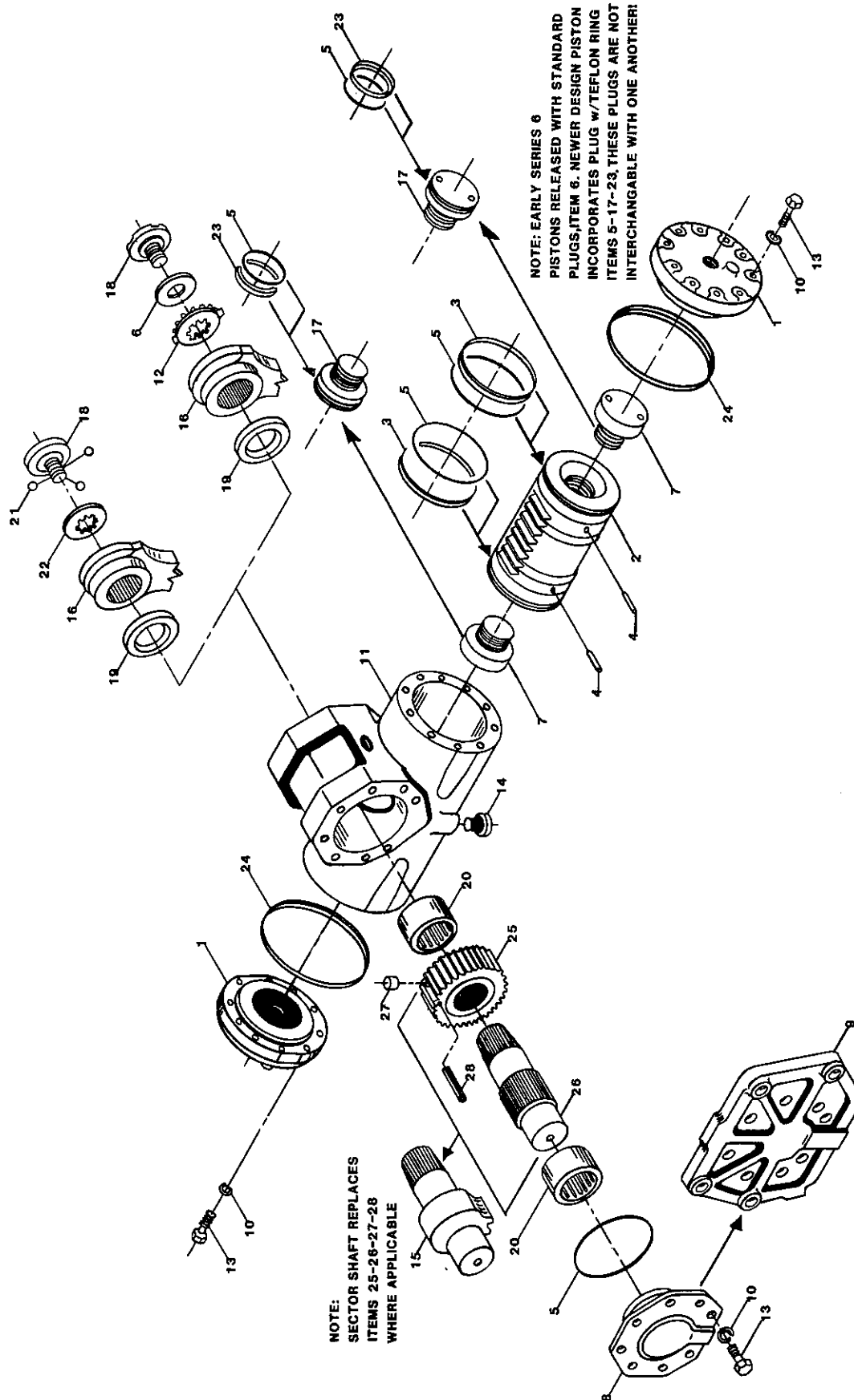


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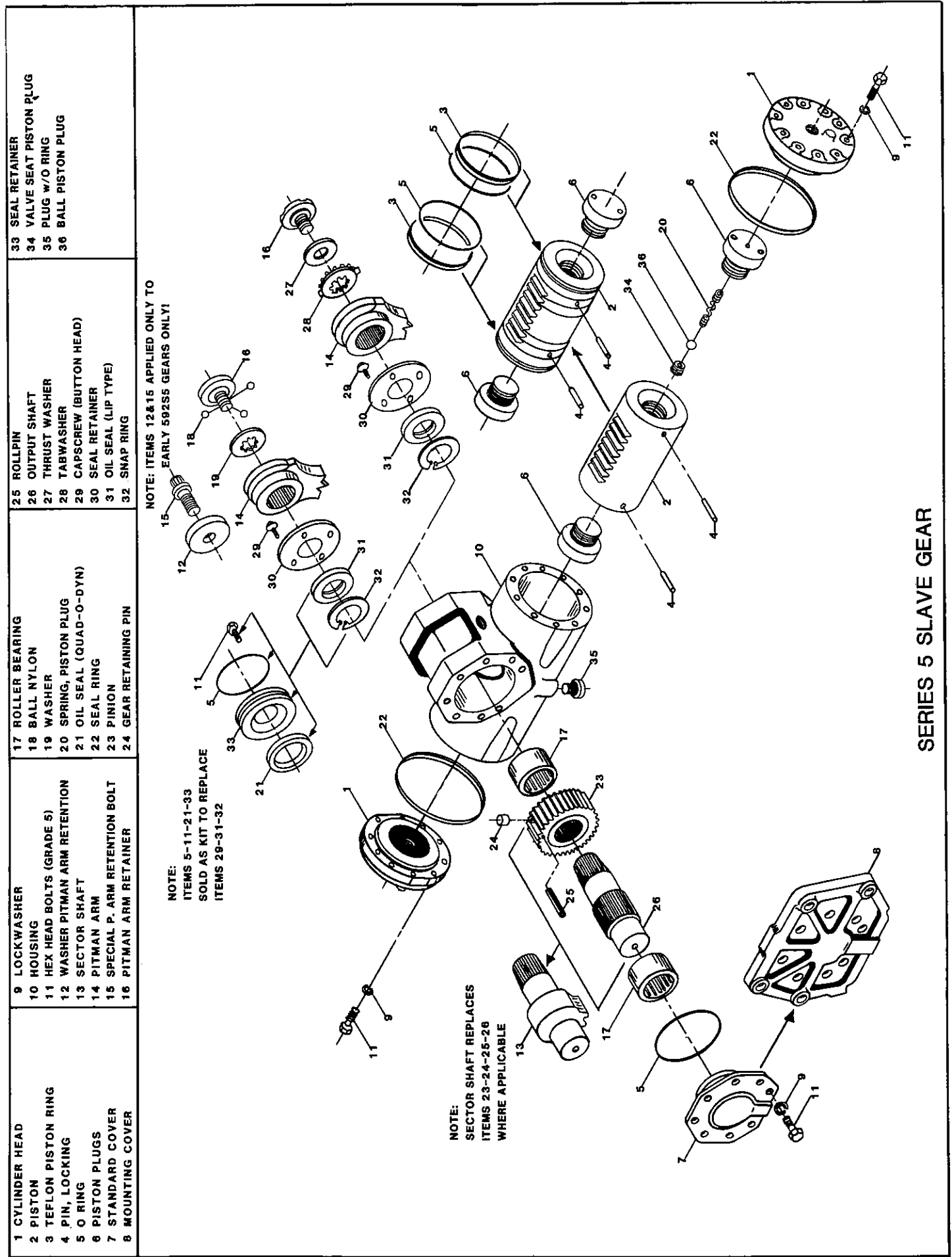


SERIES 3 & 4

1 CYLINDER HEAD 2 PISTON 3 TEFLON PISTON RINGS 4 PIN, LOCKING 5 O RING 6 THRUST WASHER	7 PISTON PLUGS 8 STANDARD COVER 9 MOUNTING COVER 10 LOCKWASHER 11 HOUSING 12 TABWASHER	13 HEX HEAD BOLTS (GRADE 5) 14 HOUSING PLUG w/O RING 15 SECTOR SHAFT 16 PITMAN ARM 17 PISTON PLUG w/TEFLON RING 18 PITMAN ARM RETAINER	19 OIL SEAL (QUAD-O-DYN) 20 ROLLER BEARING 21 BALL NYLON 22 WASHER 23 TEFLON RING 24 SEAL RING	25 PINION 26 OUTPUT SHAFT 27 GEAR RETAINING PIN 28 ROLL PIN
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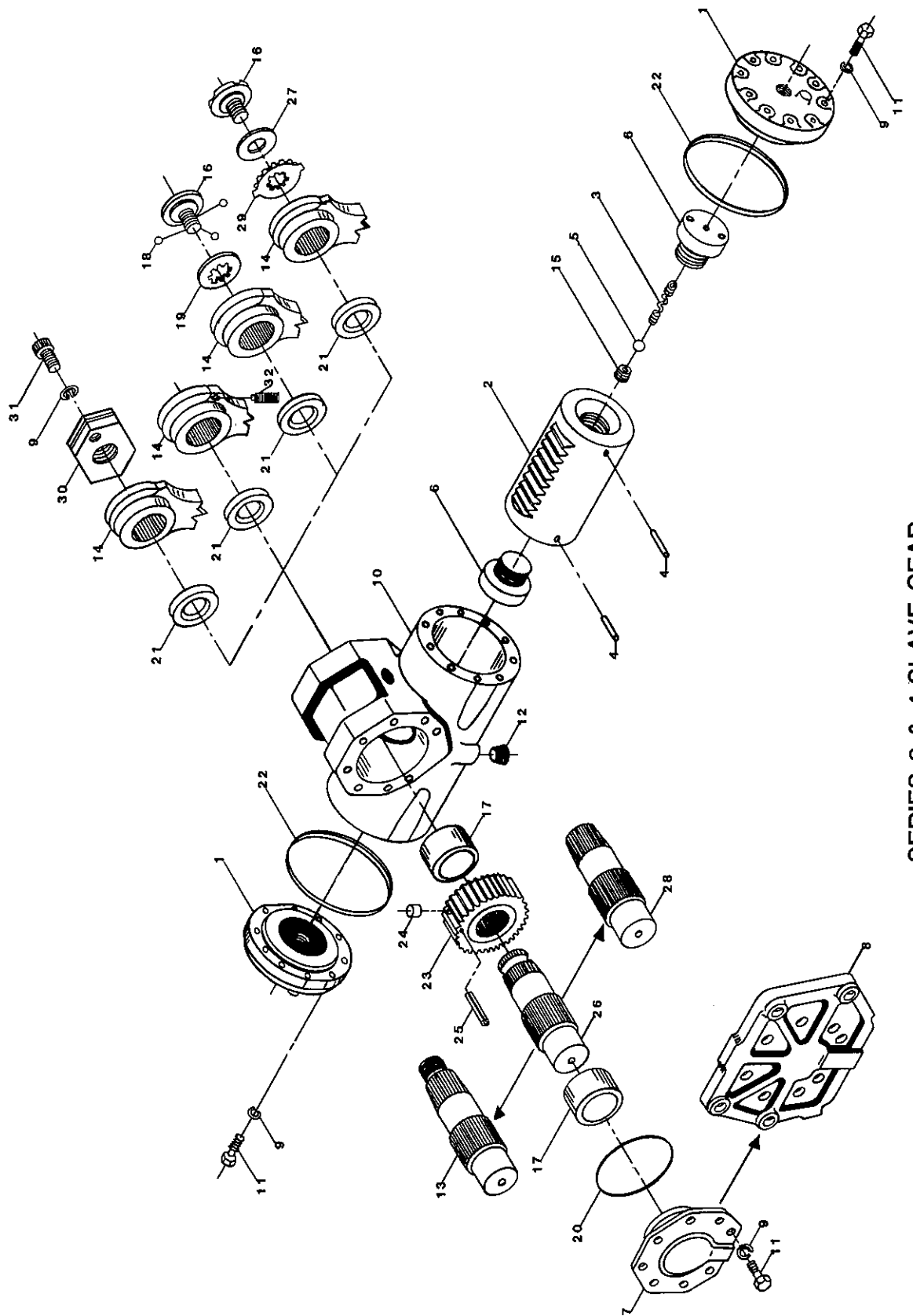
SERIES 6 SLAVE GEAR



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|----------------------|----------------------------------|--------------------------|---------------------------|---------------------------|
| 1 CYLINDER HEAD | 9 LOCKWASHER | 17 ROLLER BEARING | 25 ROLL PIN | 33 SEAL RETAINER |
| 2 PISTON | 10 HOUSING | 18 BALL NYLON | 26 OUTPUT SHAFT | 34 VALVE SEAT PISTON PLUG |
| 3 TEFLON PISTON RING | 11 HEX HEAD BOLTS (GRADE 5) | 19 WASHER | 27 THRUST WASHER | 35 PLUG W/O RING |
| 4 PIN, LOCKING | 12 WASHER PITMAN ARM RETENTION | 20 SPRING, PISTON PLUG | 28 TABWASHER | 36 BALL PISTON PLUG |
| 5 O RING | 13 SECTOR SHAFT | 21 OIL SEAL (QUAD-O-DYN) | 29 CAPSCREW (BUTTON HEAD) | |
| 6 PISTON PLUGS | 14 PITMAN ARM | 22 SEAL RING | 30 SEAL RETAINER | |
| 7 STANDARD COVER | 15 SPECIAL P. ARM RETENTION BOLT | 23 PINION | 31 OIL SEAL (LIP TYPE) | |
| 8 MOUNTING COVER | 16 PITMAN ARM RETAINER | 24 GEAR RETAINING PIN | 32 SNAP RING | |

SERIES 5 SLAVE GEAR

1 CYLINDER HEAD 2 PISTON 3 SPRING, PISTON PLUG 4 PIN, LOCKING 5 BALL, PISTON PLUG 6 PISTON PLUGS 7 STANDARD COVER	8 MOUNTING COVER 9 LOCKWASHER 10 HOUSING 11 HEX HEAD BOLTS (GRADE 5) 12 PLUG 13 OUTPUT SHAFT NUT TYPE 14 PITMAN ARM	15 VALVE SEAT, PISTON PLUG 16 PITMAN ARM RETAINER 17 BRONZE BUSHING 18 BALL NYLON 19 WASHER 20 O RING 21 OIL SEAL (QUAD-RING)	22 SEAL RING 23 PINION 24 GEAR RETAINING PIN 25 ROLL PIN 26 OUTPUT SHAFT SETSCREW TYPE 27 THRUST WASHER 28 OUTPUT SHAFT RETAINER TYPE	29 TABWASHER 30 NUT, PITMAN ARM 31 CAPSCREW (PITMAN ARM NUT) 32 SETSCREW
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SERIES 3 & 4 SLAVE GEAR

SHEPPARD POWER STEERING SERVICE MANUAL

Symptom	Possible cause	Remedy
Oil leaking at output shaft of steering gear	Clogged oil filter in reservoir (high back pressure)	Replace filter Increase change frequency
	Pinched or restricted oil return line	Locate and correct Check back pressure
	Damaged quad ring seal	Replace quad ring seal
	Damaged bronze bearings	Replace Bronze bearings Polish output shaft or replace to remove bronze deposits
	Damaged lipseal (Series 5 gears)	Replace with replacement seal assembly
	Damaged roller bearings	Replace roller bearings Polish output shaft or replace to remove pitting & grooving in seal area
Oil leaking at actuating shaft of steering gear	Worn or damaged oil seal	Replace seals
	Damaged actuating shaft seal surface	Replace damaged parts Lube bearing cap more often
Oil leaking at supply pump drive shaft	Damaged oil seal	Replace oil seal
	Oil seal-heat damaged	Check operating temperature
	Loose or damaged bushing on pump drive shaft	Repair pump per pump service instructions
Oil leaking between reservoir and pump body	Seal or gasket damaged	Replace damaged parts
Lubricant milky or white in appearance	Water entry through reservoir venting system	Clean vent system or replace cap assembly
Oil forced out of reservoir	Clogged oil filter	Change oil and oil filter Increase change intervals
	Loose pump drive belts	Adjust belts or replace
	Air in system	Bleed air from system Check for air leak on suction side of supply pump
	Faulty supply pump (Cavitation)	Check supply pump following "Hydraulic Supply-Diagnosis" Repair pump per pump service instruction
	Relief plungers of steering gear not adjusted properly	Adjust relief plungers (see final adjustments)
	Operating temperatures too high	Follow "Hydraulic Supply-Diagnosis" procedures
Engine Oil in power steering reservoir (Gear driven pump)	Faulty seal at pump drive shaft	Repair pump
	Faulty seal at accessory shaft driving supply pump	Repair accessory drive

SHEPPARD POWER STEERING SERVICE MANUAL

Symptom	Possible cause	Remedy
Lubricating Oil discolored or smells bad	Operating temperatures too high	Check and correct cause of overheating
	Change intervals too long	Increase oil change frequency
	Incorrect lubricant used	Drain, flush and refill with 10W-40 motor oil
High Operating Temperatures	Oil flow restriction	Check back pressure (see Hydraulic Supply – Diagnosis section of this manual)
	Oil flow too high	Check maximum oil flow (see Hydraulic Supply – Diagnosis section)
Oil in Reservoir – Foaming	Air leak in suction side of supply pump	Refer to pump servicing instructions
	Pump cavitating	Check for restriction in pump supply
	Oil overheating	See high operating temperatures
	Incorrect lubricant	Change to 10W-40 motor oil
No power steering on cold start	Hydraulic supply pump vanes not extending (Vane type pump only)	Increase engine speed momentarily to extend vanes and start pump action. Usually a temporary and infrequent occurrence and not cause for pump repair or replacement.
Excessive pump pressure with steering gear in neutral position.	Pinched oil return line	Relocate line
	High back pressure	
	Binding steering column	Repair steering column
Wheel cuts restricted	Damaged actuating shaft bearing	Replace damaged parts as required
	Relief plungers misadjusted	Adjust relief plungers (see final adjustments)
Erratic steering or no steering at all	Insufficient volume of oil being metered by flow divider to steering gear induced by foreign particles on flow divider valve, causing the valve to hang up in the bore	Polish flow divider valve to remove foreign particles and burrs
		Refer to pump servicing instructions
(Check supply system as detailed in “Hydraulic Supply – Diagnosis” section)	Flow divider spring takes permanent set because of fatigue, thereby, allowing flow divider valve to move easily and reduce oil volume	Replace flow divider spring Refer to pump servicing instructions
	Broken by-pass spring in flow divider	Replace with flow divider valve assembly, which includes by-pass spring Refer to pump servicing instructions
	Sticking pressure relief valve	Repair or replace relief valve as required Refer to pump servicing instructions

SHEPPARD POWER STEERING SERVICE MANUAL

Symptom	Possible cause	Remedy
Hard Steering	Loose belts	Tighten or replace belts
	Worn pulley(s) due to belt slipping	Replace pulley(s) and belts (keep belt tight)
	Faulty supply pump	Follow "Hydraulic Supply – Diagnosis" procedures Refer to pump servicing procedures
	Front axle overloaded	Correct loading practices
	Faulty steering geometry	Align front end
	High operating temperature	Locate and correct cause of overheating
Wheel steering hard in one or both directions	Bent or damaged king pins and tie rods	Repair or replace king pins and tie rods Refer to servicing instructions
	Front end load too great for rated axle capacity	Lighten load or install larger steering gear
	Fatigued by-pass valve spring in pump	Replace with flow control valve assembly Refer to pump servicing instructions
	Low oil level in steering system	Fill oil reservoir as required See "Lubrication"
	Air in system	Bleed system and check for cause of air (See final adjustments)
	Caster and camber degree incorrect	Correct to "Specifications"
	Metal or foreign material caught in actuating valve	Remove actuating valve Clean and check parts for damage
	Actuating valve worn or chipped by dirt	If damage is excessive replace damaged parts as required
Wheel steering hard in one direction	Broken reversing springs in steering gear	Replace reversing springs and damaged parts Refer to repair procedures to check for additional damage
	Metal or foreign material in relief ball seat in piston of steering gear	Remove piston and clean relief valve seats or replace damaged parts
	Foreign material in relief valve	Clean relief valve
Steering extremely light in one or both direction	Bent or damaged reversing springs	Check for impact or accident damage Replace damaged parts (see "Inspection" Paragraph)

SHEPPARD POWER STEERING SERVICE MANUAL

Symptom	Possible cause	Remedy
Steering input not smooth (seizing, binding)	Worn universal joint	Check and replace as required
	Lack of lubrication	Lubricate per vehicle manufacturer's recommendations
	Universal joint not phased properly	See paragraph last page this section
	Low oil flow	Idle speed too slow Drive belts slipping Supply pump not to specifications (see "Hydraulic Supply – Diagnosis")
	Pump cavitating	Correct pump supply
	Overheating	Correct cause of overheating
Darting, wandering (oversteering)	Oil flow too high	Supply pump not to specifications (see "Hydraulic Supply – Diagnosis")
	Air trapped in steering gear	Bleed system (see final adjustments)
	Looseness, worn front end parts Front end alignment not correct	Check and repair as required Align front end – Caster
	Radial tire sidewall flex	Check tire pressure Check for out of line tread Contact tire manufacturer representative
	Excessive wear or damage in steering gear	Check and repair as required
	Overloading	Reduce loads
	Steering column u-joint phasing incorrect	See note end of this paragraph
	Mechanical bind in steering gear	Check steering gear mounting for distortion Check for damaged or distorted steering gear components
	Tight tie rod ends & drag link sockets	Check rotational torque & replace if necessary

Note: Universal Joints

Universal joints are designed to operate best when the angle between the drive and driven shafts is a maximum of 20 to 25 degrees. Angles greater than this will cause undesirable velocity changes between the two shafts. This velocity change may upset steering performance. When two universal joints are used, it is in most instances possible to phase the two joints to match a high and low velocity in a manner that will provide equal velocity between the drive and driven shafts. A third universal joint in the shaft arrangement can upset the phasing of the first two joints and it is important that this third joints operating angle is limited to a maximum of 20-25 degrees.

Phasing of the universal joints in the steering column can be checked quite easily. Using an inch-pound graduated dial reading type torque wrench, read the variation in the torque reading while steering from lock-to-lock, with a socket on the steering shaft nut under the horn button. Variation of more than 15 in.-lb. indicates improper phasing. This reading is taken with the vehicle stationary and the engine running.

Phasing can usually be accomplished by rotating the two piece intermediate shaft one spline at a time until the torque reading remains the same all the way around the 360 degree rotation of the steering wheel.

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Symptom	Possible cause	Remedy
Excessive backlash	Worn universal joint	Replace universal joint
	Worn pins and keys universal joint to actuating shaft and universal joint to steering shaft	Replace pins and keys
	Low oil volume	Check flow divider and pump drive belts
	Pitman arm ball worn "egg-shaped"	Replace pitman arm assembly where riveted ball is used or only where bolted ball is used (vertical socket)
	Improperly adjusted drag link, pitman arm to drag link and steering arm to drag link	Adjust drag link, drag link to pitman arm and drag link to steering arm
	Loose bracket frame to bracket or bracket to gear	Remove bracket, clean frame and bracket check radius of frame making sure bracket is not bearing on radius surface Check bracket for wear from working Replace bracket and tighten to recommended torque rating according to size and grade of bolts If necessary, replace bracket with new one
	Rack on piston damaged	Replace parts as required
	Damaged pinion gear on output shaft	Replace pinion gear
	Damaged output shaft splines	Replace output shaft
	Worn output shaft bushings	Replace bushings and polish shaft to remove bronze deposits
	Worn pitman arm splines	Replace worn parts
	Worn actuating shaft and valve threads	Replace worn parts as required Follow "Hydraulic Supply Diagnosis" procedures to locate cause of wear
	Free play in miter gears of angle drive	Remove miter gear housing shims to mesh gears
No attempt to return straight ahead from turns	Damaged reversing springs	Check and repair as required
	Universal joint yoke loose on actuating shaft	Repair or replace damaged parts, check for spline wear
	No positive caster	Set to 4° to 6° positive caster
	Steering column bind	Check and repair U-joints and support bearings
	Steering gear mounting distorted	Shim mounting pads to correct piston to bore interference
	Linkage ball sockets seized or binding	Check and repair or replace

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Symptom	Possible cause	Remedy
No attempt to return straight ahead from turns (cont'd)	King pins seized or binding	Repair or replace
	Knuckle clearance misadjust	Adjust clearance to specifications
	Oil flow rate incorrect	Check and correct supply pump or controls

Note:

Acme thread wear generally comes from inadequate lubrication or excessive manual steering of the vehicle. Manual steering results from inadequate pump pressure or flow, or an overloaded front axle where you need steering forces in excess of the hydraulic design of the steering gear.

Note: Freeplay

The movement of the shuttle type actuating valve within the piston, along with the normal clearances required between operating parts in the steering gear will produce a certain amount of unresponsive motion at the rim of the steering wheel. This unresponsive motion is inherent to the design and must be considered normal. With recent advances in technology and manufacturing methods it has been possible to considerably reduce the amount of this unresponsive motion. Steering gears in service prior to July 1978 could be expected to have 3½ to 4 inches unresponsive motion. Current production Sheppard steering gears in service will have 1½ to 2½ inches of unresponsive motion. Various combinations of steering gear ratios and steering wheel diameters could effectively reduce these maximum allowances. Nominal unresponsive motion in Series 6 steering gears, measurable at ½ to 1½ inches.

Unresponsive motion is measured at the rim of the steering wheel. It must, therefore, be noted that any freeplay in the steering column and related components will affect your measurement. The steering gear mounting must be tight and steering linkage wear adjusted out or worn parts replaced.

The vehicle should be standing on a smooth shop floor with the engine idling when unresponsive motion is checked. Measurement is made at the rim of the steering wheel, from initial tire and wheel movement left steer, to initial tire and wheel movement right steer.

HYDRAULIC SUPPLY — DIAGNOSIS

The Sheppard Integral Power Steering Gear is dependent upon adequate supplies of oil pressure and volume of oil flow to enable the steering gear to operate as designed. Oil pressure reacting on a piston creates the force to cause the piston to move and assist steering effort.

As the piston moves it is displaced in the cylinder bore by a volume of oil under pressure. How fast the piston can be displaced is dependent upon adequate oil flow and volume.

Oil pressure and oil flow requirements are engineering considerations that are established during the design of a total power steering installation. When diagnosing power steering problems you must be able to determine that oil pressure and oil flow meet design specifications. Pressure and flow specifications vary considerably and the vehicle manufacturer's recommendations must be followed carefully at all times.

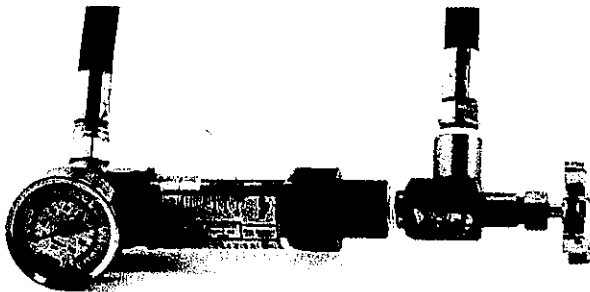
Back pressure and operating temperature are two additional factors that must be considered during the diagnosis of power steering problems. High back pressures will restrict the movement of the piston in the power steering gear and this back pressure must be overcome before steering power is available. Back pressure is caused by restrictions to oil flow. A clogged oil filter, undersized fittings and lines, pinched lines and high flow rates are possible causes of back pressure.

High system oil temperatures reduce the overall efficiency of the steering pump and the steering gear. High temperatures are caused by restriction to flow or inadequate system oil capacity to allow for heat dissipation during normal operation. A supply pump which constantly operates at maximum pressure relief will also generate more heat than can be dissipated.

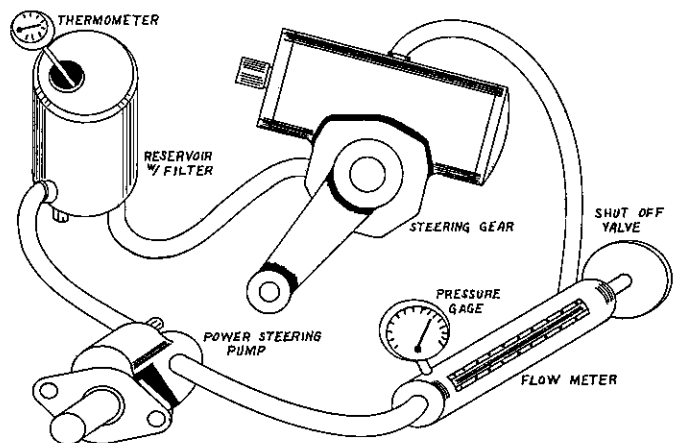
Various types of pressure gauges and flow meters are available and can be used to diagnose power steering problems. A pressure gauge which reads at least 3000 PSI and a flow meter with a capacity to 10 GPM are used to check pressures and oil flow. A shutoff valve downstream from the pressure gauge makes it possible to isolate the steering pump from the steering gear and by closing the valve, maximum pump relief pressure can be read.

A simple thermometer in the reservoir will indicate system oil temperatures.

The gauge set illustrated will indicate pressure (PSI) and flow (GPM) with a single connection in series with the high-pressure line to the steering gear. A shutoff valve is included.



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HYDRAULIC SUPPLY—DIAGNOSIS PAGE 2

Using the equipment available to you, proceed with your evaluation of the hydraulic supply system. Refer to the diagnosis chart for further assistance.

1. Make necessary gauge/meter connections.
2. Start engine and check system oil level assuring that oil flow is in proper direction through the flow meter.
3. Place thermometer in reservoir.
4. Run the engine at correct idle speed and steer from lock-to-lock several times to allow system to warm up. (140 to 160 degrees F.)

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5. Pump maximum pressure relief

With the engine running at specified idle speed, slowly turn the shutoff valve until closed and read the pressure at which the pressure relief valve opens. (Open the shutoff valve as quickly as possible to avoid heat build-up or possible damage to the steering pump.) This pressure reading should equal the maximum pump pressure specified by the manufacturer of your chassis. Check your specifications.

Caution: A malfunctioning pressure relief valve may not relieve pump pressure and closing the shutoff valve may cause severe pump damages or high-pressure hoses to rupture. Constantly observe the pressure gauge while closing the shutoff valve. If pressure rises rapidly or appears to be uncontrolled do not completely close the valve before inspecting the pump and pressure relief valve.

6. Flow Test — Minimum Recommended Flow

With the engine running at a specified idle speed, vehicle stationary on the shop floor and with a normal load on the front axle, steer the wheels from full right to full left turn and observe the flow meter. The flow must not fall below the minimum GPM flow specification.

Note: It is important that flow be checked at normal operating temperature and with a load on the front axle, or steering response complaints may not be found. Inadequate flow will cause binding, uneven or intermittently hard steering.

7. Flow Test — Recommended Maximum

Increase the engine speed to approximately 1500 RPM and note the flow rate with the steering wheel stationary. Check this reading against the maximum flow rate specifications. Excessive oil flow can cause high operating temperature, and sluggish heavy steering response.

8. Back Pressure

Normal system back pressure will be 50 to 75 PSI with the engine idling and the steering wheel stationary. Back pressure is checked with the system at normal operating temperature.

9. Operating Temperatures

Steering system oil temperature is best checked after two hours of normal operation. Ideal operating temperature should range between 140 to 160 degrees Fahrenheit. Normal operation in this range will allow for intermittently higher temperatures which will be encountered during periods of heavy steering usage.

10. Aerated Oil

Visually check for the presence of air mixed with the oil in the steering system. The oil should be clear. Any signs of frothing indicate air entry and steering performance will be affected. Carefully check for leakage on the suction side of the steering pump. Drain and refill the system and bleed for air following the procedure under final adjustments.

Before any steering gear repairs are attempted the above hydraulic supply evaluation must be completed and corrections made as required. Many times steering gears have been repaired or replaced needlessly because a hydraulic supply system evaluation had not been made.

Additional references to pressure and flow testing will be made in the diagnosis charts in the "General Diagnosis" section of this manual.

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OPERATING PRESSURE & OIL FLOW SPECIFICATIONS

The R. H. Sheppard Co. Inc., manufactures two series of steering gears. A low pressure series designed to operate in the range of 0-1300 PSI and a high-pressure series with design capabilities to 2000 PSI. Each vehicle manufacturer specifies the maximum operating pressure at which their various steering installations are to be operated. Refer to your vehicle manufacturer's specifications for correct relief settings for each of your vehicles. Do not increase the maximum operating pressure without consulting the vehicle manufacturer or serious damages can be encountered.

Oil flow for the Sheppard steering gears are outlined below by Model number. The indicated Model numbers correspond with the Model number cast into the steering gear housing. Oil flow requirements remain the same for all similar Models and do not change from installation to installation. Follow the O.E.M. Truck Manufacturer's recommendations.

Low Pressure Series (Obsolete Production Models)

Model	188	191	39	491	51	59
Oil Flow (GPM) U.S.						
Minimum*	1.9	2.2	3.6	4.3	4.8	5.7
Maximum	2.4	2.7	4.4	5.3	6.0	7.0

High Pressure Series (Obsolete Production Models)

Model	192	252	372,382,352
Oil Flow (GPM) U.S.			
Minimum*	2.2	3.2	3.6
Maximum	2.7	5.0	5.0

High Pressure Series

Model	292 ALL	392 ALL	492 ALL	592 ALL
Oil Flow (GPM) U.S.				
Minimum*	3.2	3.6	4.3	5.7
Maximum	5.0	5.0	6.0	7.0

High Pressure Series 6 Gears Only

Model	292S6	392S6
Oil Flow (GPM) U.S.		
Minimum*	2.9	3.3
Maximum	5.0	5.0

High Pressure Series Dual Systems

Model	292W/292 Slave		372-382W/292 Slave		392W/392 Slave	
Ratio	Low	High	Low	High	Low	High
Oil Flow (GPM) U.S.						
Minimum*	4.5	4.0	5.0	4.5	5.0	4.5
Maximum	5.5	5.0	6.0	5.5	6.0	5.5

Model	392W/292 Slave		492W/492 Slave		592W/592 Slave	
Ratio	Low	High	Low	High	Low	High
Oil Flow (GPM) U.S.						
Minimum*	5.0	4.5	6.5	6.0	8.5	7.5
Maximum	6.0	5.5	7.5	7.0	9.5	8.5

*Minimum flow is checked at operating temperature while steering from full left to full right with the engine at idle.

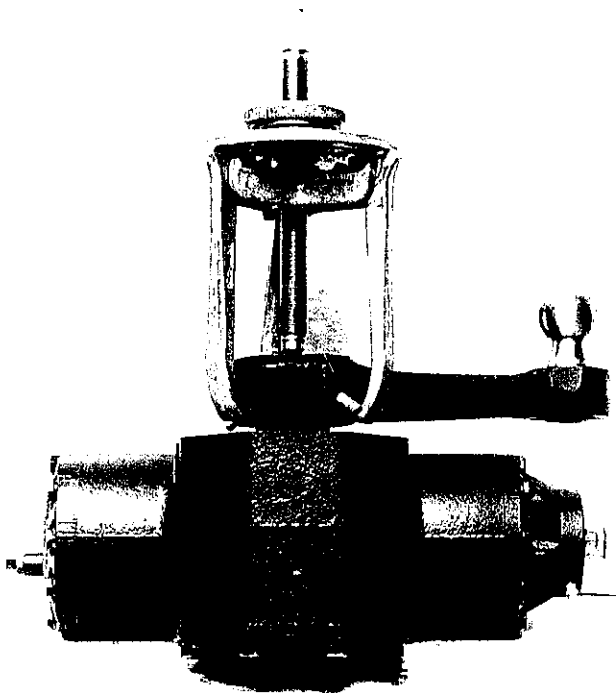
To determine low or high ratio, disconnect the master gear drag link, turn the steering wheel from full left to full right and count the number of turns. If total turns is 5 or less the ratio is low. Over 5 turns is high ratio.

DISASSEMBLY

Review your diagnosis

The diagnosis section of this manual has been placed in the front of the Sheppard Power Steering Service Manual to emphasize the importance of proper diagnosis. Repair time and down time as well as total repair costs can be reduced if needless disassembly and steering gear parts replacements can be avoided. Before removing the steering gear from the chassis you must be certain that the hydraulic supply system is operating correctly and that all mechanical components are in good repair.

Caution: The Sheppard Integral Power Steering Gear is a precision machined assembly and care must be taken during repair to keep it free of dirt and foreign material. All internal parts must be handled carefully to avoid damages to machined surfaces. Nicks or burrs can cause damages to mating parts and must be removed with a fine hand stone before reassembly. Working on a soft cardboard or plywood surfaced workbench is advisable. Follow disassembly procedures as required.

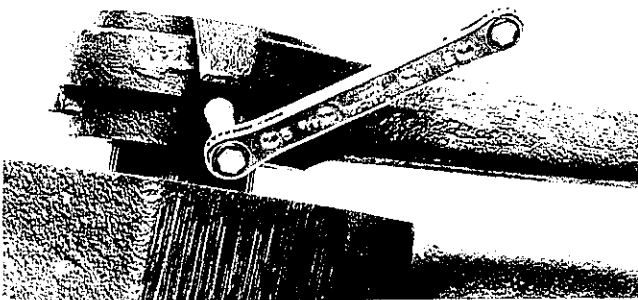


S-15

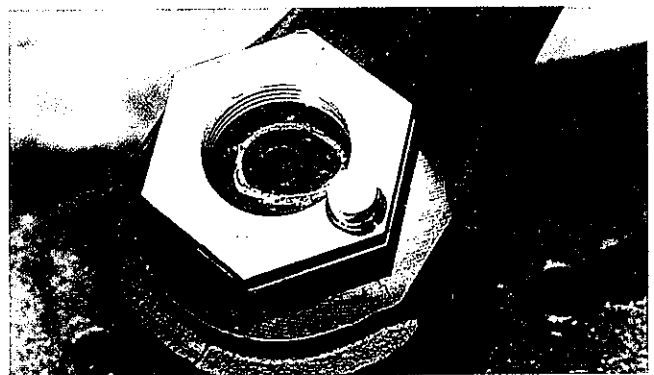
It may be necessary on some installations to remove the pitman arm before the steering gear is removed from the chassis. In all cases, it is important that a suitable puller is used when the pitman arm is removed. (Snap-on puller P/N CG 283)

The pitman arm may be located on the output shaft by two socket head retaining set screws, a self locking nut, or by a split nut and cap screw arrangement.

Caution: Do not pound on the pitman arm or apply excessive heat as damages to the pitman arm or output shaft could cause a serious accident at a later date. Welding of the pitman arm and shaft must be avoided at all times.

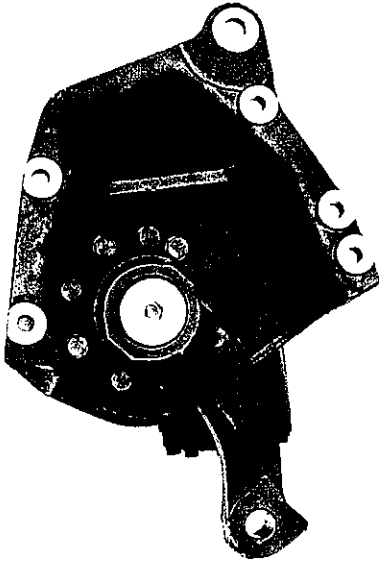


S-16



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S-18

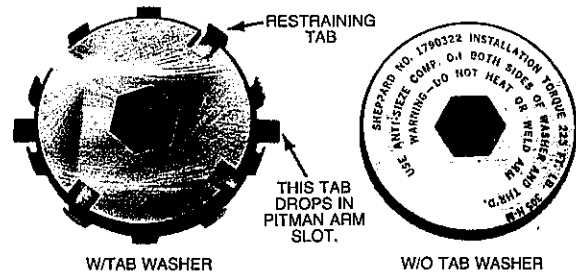
The pitman arm may also be drawn onto the tapered spline of the output shaft with a one-piece retainer, with or without tab washer (see photo S-22). The early 592 steering gears used a similar installation, however, it was of a two-piece design. See below. (S-23 – S-24)

To remove the retainer, a short piece of $\frac{5}{8}$ or $\frac{3}{4}$ inch hard steel hexagon stock is inserted into the retainer. If equipped with tab washer, bend the two restraining tabs out so the retainer can be removed.

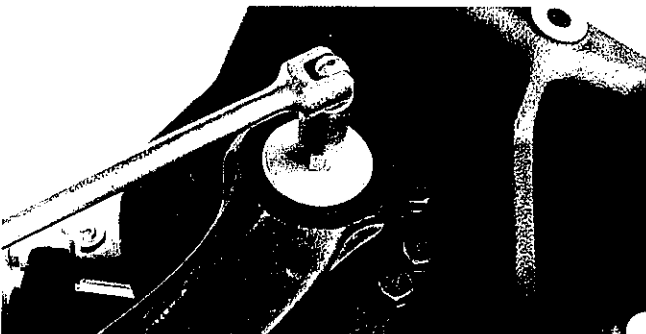
The retainer is now screwed out of the output shaft. The two-piece retainer used on the 592 steering gear is removed with a standard socket arrangement. (S-23 – S-24)



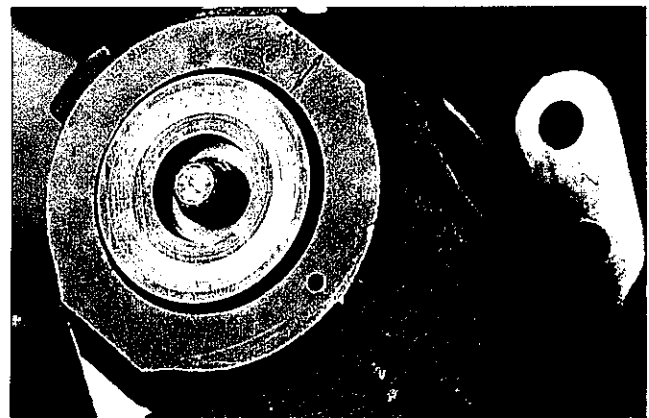
S-19



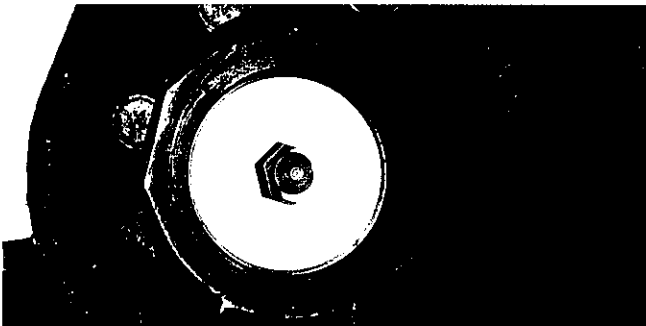
S-22



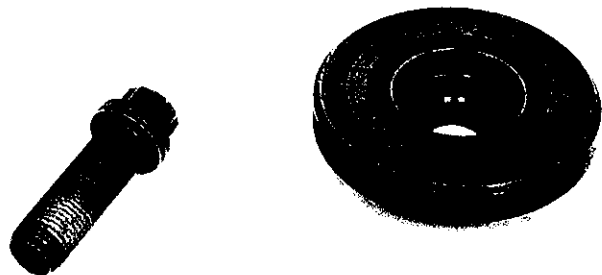
S-20



S-23

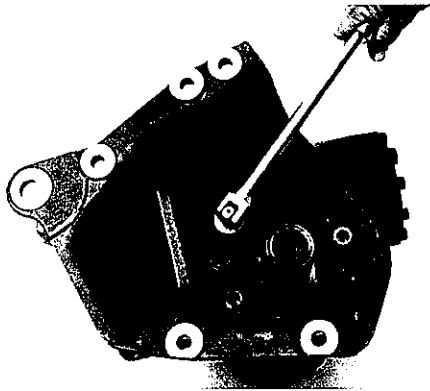


S-21



S-24

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S-25

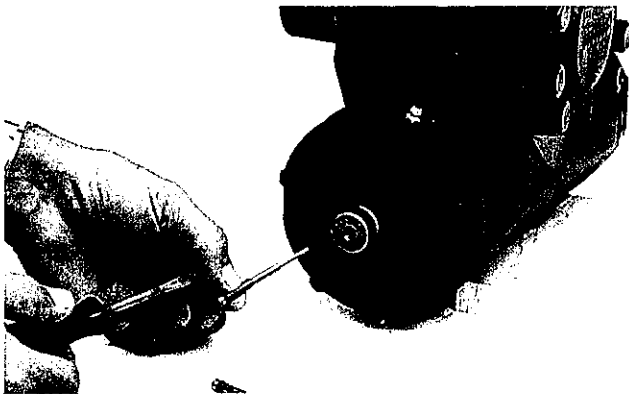
Separate the mounting bracket from the steering gear, if used.



S-26

Make reference marks on the bearing cap; cylinder head and housing so that the steering gear can be reassembled in the same configuration.

Note: The cylinder head and bearing cap will fit either end of the housing.



S-27

Remove the relief valve plungers from the cylinder head and the bearing cap. This will protect them from damage during repairs.



S-28

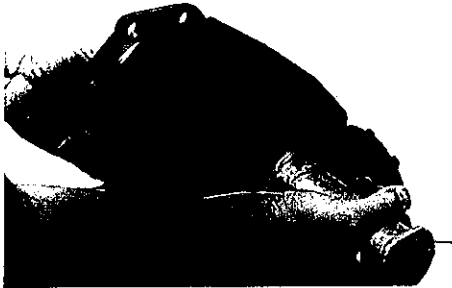
Clean the exposed portion of the output shaft to prevent damaging the bearing.

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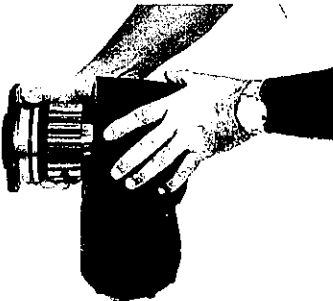
S-29

Remove the eight bolts attaching the pinion gear cover to the housing.



S-30

Using a soft hammer, tap on the end of the output shaft to loosen the cover.



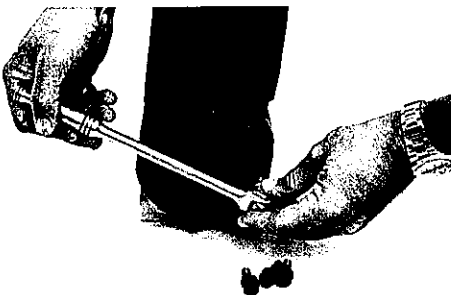
S-31

Carefully slide the output shaft, pinion gear, and cover through the housing. Pull the output shaft out of the cover. Remove and discard the cover "O"-ring seal.



S-32

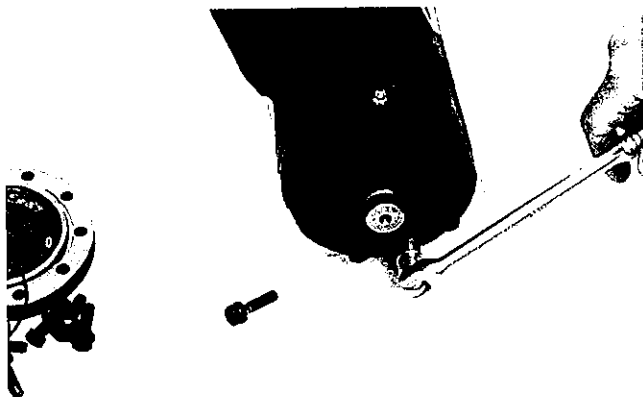
Note: Early 592 series 5 steering gears used loose needle roller bearings in the cover and housing to support the output shaft. On disassembly the needle rollers for the two bearings must be kept separate. See Series 5 variation.



S-33

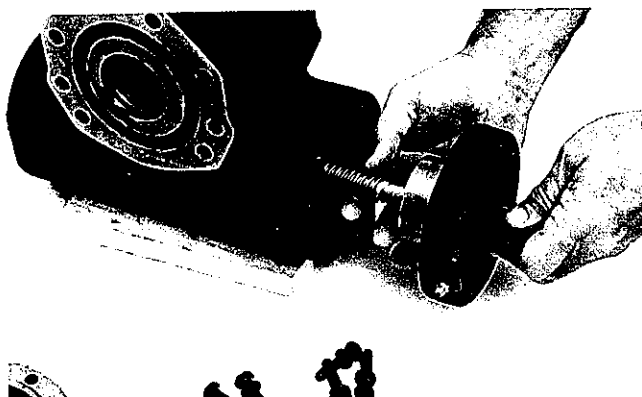
Remove the cylinder head and discard the seal ring.

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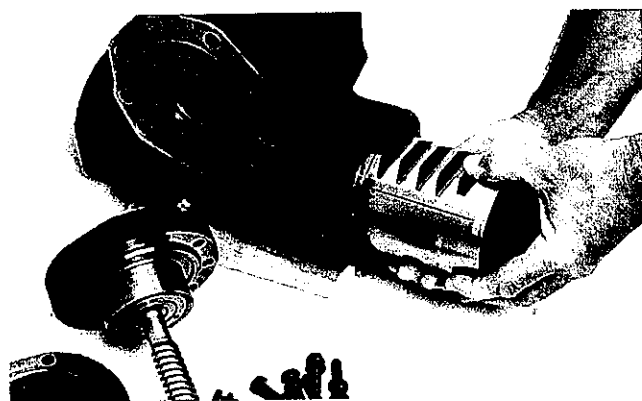
S-34

Remove the bolts from the bearing cap, and turn the actuating shaft to free the bearing cap from the piston and housing.



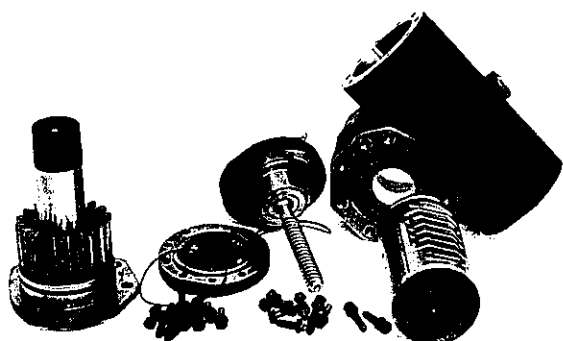
S-35

Support the bearing cap and turn the actuating shaft until it is free of the piston. Remove and discard the seal ring.



S-36

Carefully slide the piston assembly from the bore of the housing. **Note:** Series 6 gears are equipped with piston rings. Care must be taken not to damage piston rings when removing the piston from the housing.



S-37

The steering gear has now been disassembled into subassemblies which can be further disassembled and repaired as required.

CLEANING & INSPECTION

Cleaning

Cleanliness is of utmost importance. Dirt and foreign material introduced into the steering system during repair operations can cause damages and steering malfunctions at a later date. Due to the close tolerances between mating parts it is advisable to have all parts at the same temperature for reassembly.

Clean machined parts individually to avoid damage due to "bumping" together. Use clean solvent to wash parts. Dry parts with compressed air. Nicks or burrs must be removed with a fine hand stone before assembly. Use only clean motor oil to coat parts to ease assembly.

All "O"-rings, seals and gaskets should be replaced as a part of any repair.

All hoses, lines and the reservoir and filter should be cleaned before reinstalling repaired steering gear or after pump replacement.

Inspection

A careful visual inspection of all steering gear parts must be made. Worn parts as well as any parts that show signs of stress or fatigue must be replaced.

Caution: Steering gears that have been accident damaged should be considered suspect. Impact loads transmitted through the front axle and steering linkage into the steering gear can stress parts to a point just short of failure. Further use is unsafe and replacement of the steering gear assembly and pitman arm is strongly recommended. Distorted pitman arms, broken or bent reversing springs, twisted output shafts, broken or cracked rack and pinion gear teeth are some signs of impact damages. Broken or damaged mounting brackets should not be replaced without further investigation.

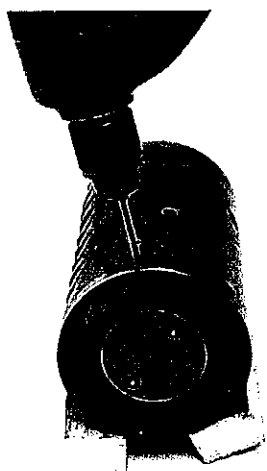
Steering Gear parts inspection may reveal problems in other areas of the steering system. To avoid repeat problems each clue gained from parts inspection should be followed to conclusion. Listed below are the more common observations you may make during steering gear inspection and their possible cause. This information should be considered carefully when repairing low mileage vehicles. Remember it is more important to repair the cause than to repair the results.

Parts discolored (blue)	<ol style="list-style-type: none"> 1. Operating temperatures too high 2. Flow rate excessive 3. System back pressure too high 4. Steering column binding 5. Actuating valve blocked 6. Hydraulic supply pump malfunctioning 	Actuating shaft bearing retaining nut stripped	<ol style="list-style-type: none"> 1. Impact or accident damaged 2. Air in system
Bronze bushing wear	<ol style="list-style-type: none"> 1. Incorrect lubricant used 2. Excessive temperature 3. Overloading 4. Contaminated oil 	Housing or piston scoring (Also see following NOTE)	<ol style="list-style-type: none"> 1. Foreign material entry 2. Severe overloading 3. Incorrect lubricant used 4. Excessive temperature (over 200°F.) 5. Pump damaged 6. Air in system
Actuating shaft and actuating valve acme thread wear	<ol style="list-style-type: none"> 1. Incorrect lubricant used 2. Overloading 3. Insufficient operating pressure 4. Insufficient oil flow 5. Continued operation at high temperature 	Roller Bearings (Pitted rough) (Bearing cage broken)	<ol style="list-style-type: none"> 1. Operating pressure too high 2. Foreign material in system 3. Excessive overloading
Broken or bent reversing spring	<ol style="list-style-type: none"> 1. Accident damaged 2. Air in system 	Roller Bearings Needles flattened Output shaft brinelled or dented	<ol style="list-style-type: none"> 1. Impact damages
Broken housing	<ol style="list-style-type: none"> 1. Accident damaged 2. Uncontrolled operating pressure 	Piston rings cut Pinched, sheered or worn	<ol style="list-style-type: none"> 1. Incorrect installation 2. Incorrect disassembly 3. Foreign material entry

Note on scoring

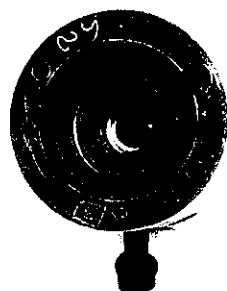
Minor scoring and scuffing of the piston and housing of the steering gear should not be cause for alarm. During operation at relatively high pressures and flow rates this minor scoring will not affect the safety or operation of the steering gear. Minor scoring should be polished with a fine hand stone or crocus cloth to allow free movement of mating parts. **The cylinder bore should not be honed or bored out as this will increase leakage.**

REPAIR — SHORT SERIES PISTONS



S-38

To remove the control valve from the piston, the piston plug must first be removed. The plug is locked to the piston with a $\frac{1}{8}$ inch soft pin. Use a $\frac{3}{64}$ inch drill to drill out the pin. See variation on early production gears and 372 and 382 step-bore steering gears.



S-39

Caution: The top adjusting nut which is exposed should never be removed or the reference to the valve center is lost.



S-40

Use a spanner wrench to remove the piston plug from the piston.

Note: The spanner wrench shown here can be fabricated using a piece of flat stock with two cap screws bolted in place with the proper spacing to fit the piston plug.



S-41

The seals on the piston plug can be removed and discarded if replacement is required.

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S-42

Mark the top adjustment nut and piston so that the nut can be reinstalled in its original position.

Caution: Misadjustment of the top adjustment nut could cause erratic steering.

S-43



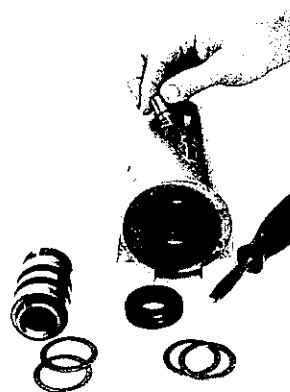
Use a 5/64 inch drill to drill out the adjusting nut lock pin. A piece of stock material is used to turn the adjusting nut out of the piston.

S-44



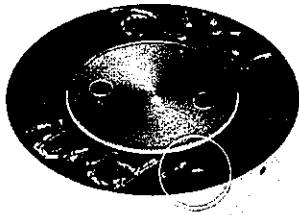
Carefully slide the control valve and reversing springs out of the piston.

S-45



The valve positioning pin can now be removed from the piston. Remove and discard the seal on the valve positioning pin. Remove the remaining two reversing springs.

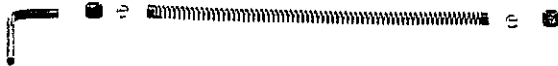
SHEPPARD POWER STEERING SERVICE MANUAL



S-46

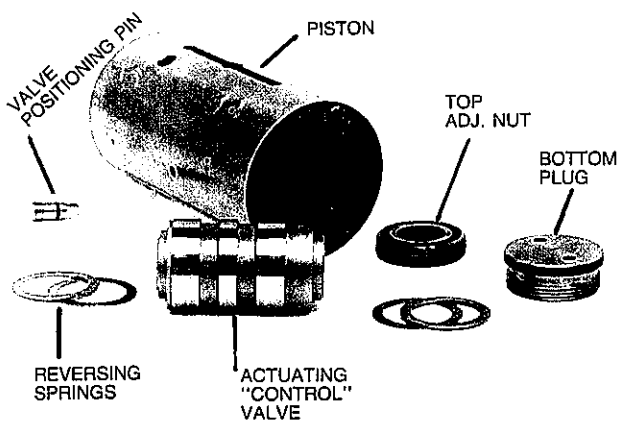
A 3/16 inch allen wrench is used to remove the relief valve seats. There is a slight spring tension on the relief ball valves.

Caution: Handle carefully to avoid loss or personal injury.



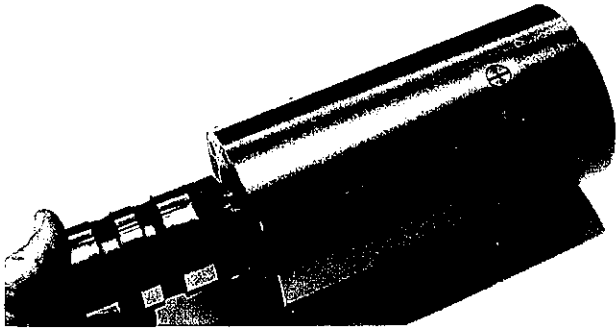
S-47

The relief passage is drilled through the piston from end-to-end. There is a ball valve and a valve seat at each end. The ball valves are held against their seats by a spiral spring.



S-48

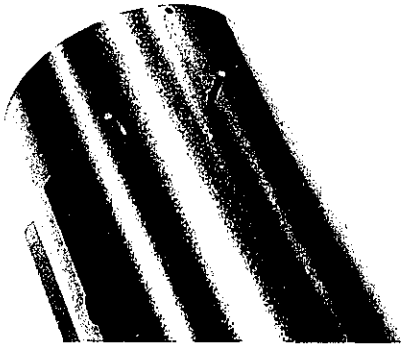
The components of the piston and actuating valve assembly can now be cleaned and inspected. The reversing springs and the relief system parts are the only replaceable parts in the piston. The reversing springs should be flat. Bent or dished springs are an indication of severe impact damages and all components of the steering gear should be inspected for damages.



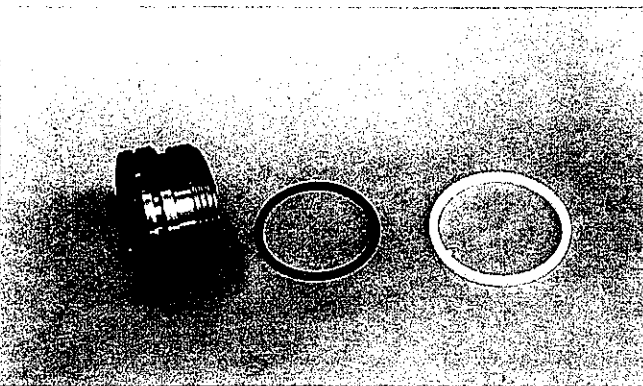
S-49



S-50



S-51



S-52

Carefully reassemble the piston. Place two reversing springs on the center of the adjusting nut in the piston. Put a new O-ring seal on the valve positioning pin and screw the pin into the piston until the top of the pin is below the surface of the piston.

Reinstall the actuating valve in the piston with the long locating slot in line with the valve positioning pin. Turn the valve positioning pin until it lines up with the slot of the valve and the valve slides into the reversing springs.

Note: Some 392 Short Series 3 and 4 pistons also use a tapered valve positioning pin, which is adjustable. These pistons can be identified by the piston plug which uses seal rings. These pistons will also have a control valve with a maximum inch and three quarter diameter (for adjustment, see variation tapered valve positioning pin, next page).

Place the two reversing springs on the nose of the valve. Screw the adjusting nut into the piston until the nut contacts the reversing springs and the valve has no end play. Now turn the adjusting nut to line up your reference marks and the locking pin will enter the original pin holes.

If the lock pin will not enter the original holes a second hole is provided and the adjusting nut can be drilled and the pin installed in this position. The tip of the pin must be below the surface of the piston.

Install a new O-Ring expander and a new square ring seal on the piston plug and install the plug in the piston. Tighten plug securely. Drill and pin the plug to the piston. The tip of the pin must be below the surface of the piston.

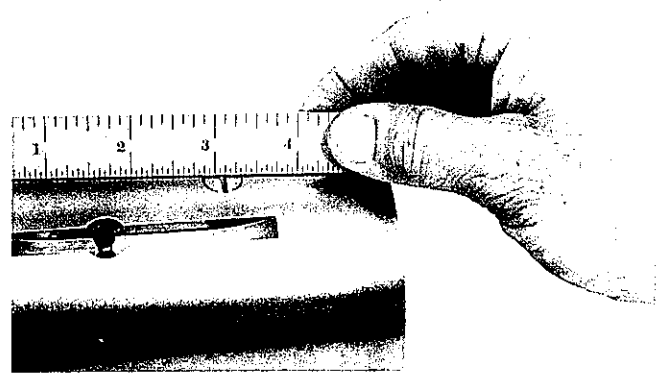
Reinstall the relief valve seats, balls and springs.

VARIATION – TAPERED VALVE POSITIONING PIN USED ON: LATE MODEL SHORT SERIES 3 & 4 AND ALL SHORT SERIES 5 & 6

Tapered Valve Positioning Pin Identification

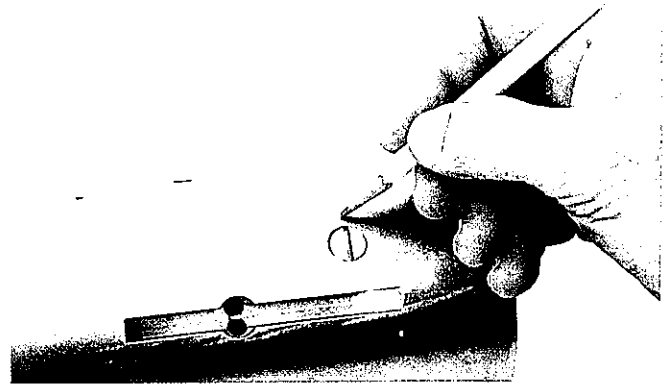
All series 5 and series 6 gears are equipped with tapered valve positioning pins. Late model series 3 and 4 pistons also use a tapered valve positioning pin, which is adjustable. These pistons can be identified by the piston plug which uses seal rings (see photo S-52 page 34).

The valve positioning pin which locates and guides the actuating valve in the piston of the Series 5 gear is tapered. This tapered valve positioning pin must be adjusted when the piston is reassembled. Install a new O-Ring Seal on the valve positioning pin and screw it into the piston until it is flush with the surface of the piston.



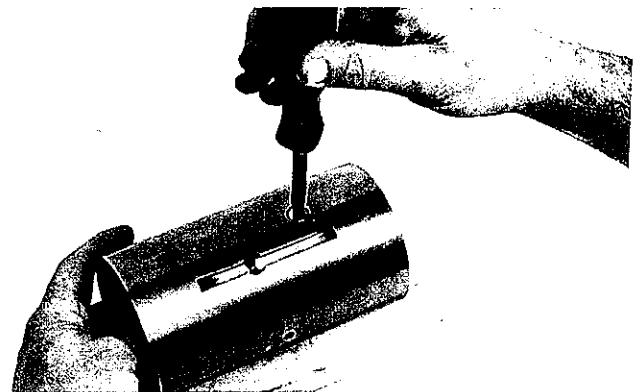
S-53

Make reference marks with a pencil on the piston and the pin and then install the actuating valve in the piston, lining up the long guide slot in the valve with the guide pin. When the valve positioning pin has entered the valve and the valve has bottomed, check the valve for radial movement and freedom of movement over the valve positioning pin.



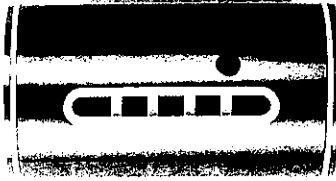
S-54

The valve positioning pin is adjusted 1/4 turn at a time until the valve has no radial movement and slides smoothly over the valve positioning pin. Each time the valve positioning pin is adjusted the actuating valve will have to be pulled out of the piston far enough to disengage the valve positioning pin. When the valve positioning pin is properly adjusted complete assembly of the piston as previously detailed for Series 5 Steering Gears.

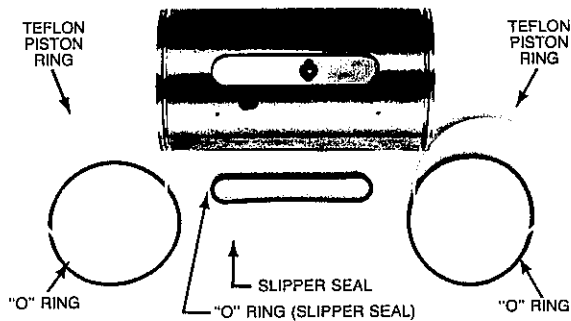


S-55

SERIES 6 – PISTON SEALS



S-56



S-57



S-58



S-59

Series 6 pistons use teflon rings with backup o-ring seal. In addition, a slipper seal and backup o-ring is used on the pressure supply orifice area.

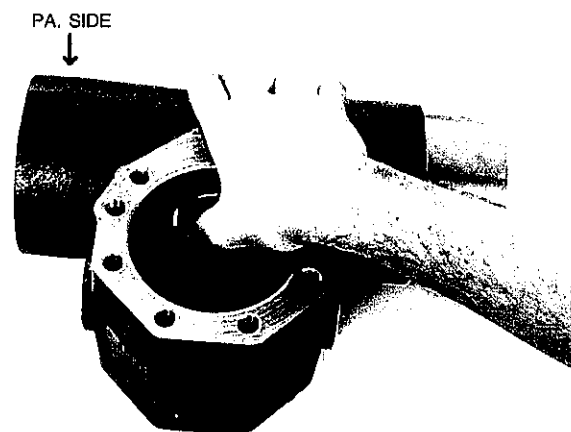
For servicing, remove the used teflon seals and backup o-rings, slipper seal and backup o-ring and replace with new seals and backup o-rings.

S-58 install backup o-rings on piston ends and slipper seal area. Carefully, place teflon seals and slipper seal in position on cylinder.

S-59 using a ring compressor, carefully install the piston in the gear housing.

Caution: You will have to carefully work the piston ring past the pinion gear opening in the cylinder bore. See S-60. While maintaining pressure on the end of the piston, use the blunt end of a wooden stick to press the piston seal into the ring groove. As the piston ring is compressed into the ring groove the piston will slide further into the bore until the piston ring has passed the pinion gear opening.

Note: Due to the nature of the seal material it will stretch as it is fitted to the ring groove. If you let the piston set with the seal rings in place they will contract and it will become easier to install it in the piston bore. When installing the piston in the housing bore, use the end of the housing with PA. cast onto the housing. See S-60. This end only contains a lead-in chamfer to help guide the piston and teflon piston ring into the housing bore.



S-60

SERIES 6 – OPTIONAL INTEGRAL PISTON RELIEF VALVE

An optional, integral, pressure relief valve is offered with the Sheppard Series 6 Steering Gear. This valve is mounted internally in the piston and limits the maximum operating pressure in the steering system. In most cases the hydraulic supply pump will have a maximum relief pressure setting several hundred pounds higher than the relief valve integral with the steering gear.

Therefore, when maximum relief pressures are reached in the steering system the excess pressure is relieved at the steering gear and the supply pump is not subjected to high temperatures caused by normal pressure relief and recirculation within the supply pump.

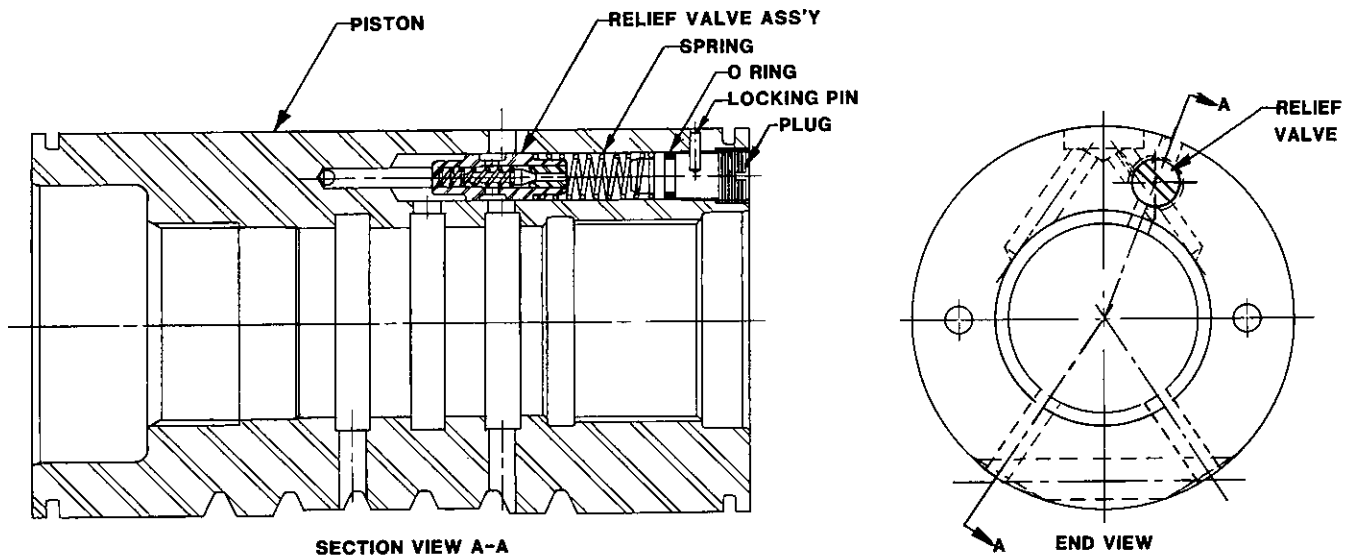
The optional pressure relief valve offered with the Sheppard Series 6 Steering Gear is an integral part of the piston. When oil pressure exceeds the maximum relief pressure setting of the pilot operated relief valve the valve opens and excess pressure is bled off into the oil return circuit through the pinion gear bore of the steering gear.

The valve is disassembled for cleaning and inspection by removing the valve end plug and withdrawing the relief valve and compensating spring. To remove the end plug it will be necessary to drill out the locking pin.

When the pressure relief valve is reassembled in the piston, realign end plug with the locking pin hole after inserting the relief valve and compensating spring into the relief valve bore. Install a new locking pin to re-secure the end plug.

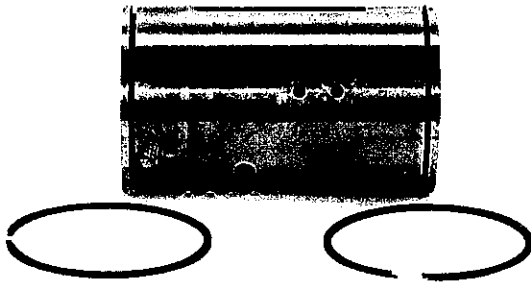
Test procedures for the integral relief valve are listed on page 55.

RELIEF VALVE INSTALLATION IN PISTON



Relief Valve Replacement Kits			
Kits at Right Include:	Part No.	Pressure Setting	
		PSI	Bar
1 – Relief Valve Ass'y	17600911K	1500	103
1 – Spring	17600912K	1739	120
1 – O Ring	17600913K	1850	127
1 – Locking Pin	17600914K	1884	130
1 – Plug	17600915K	2000	138
	17600916K	2100	145

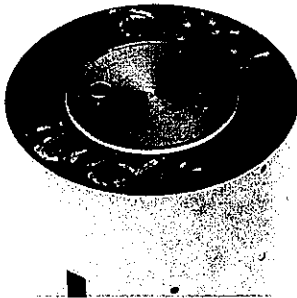
VARIATIONS – EARLY PRODUCTION PISTONS



S-61

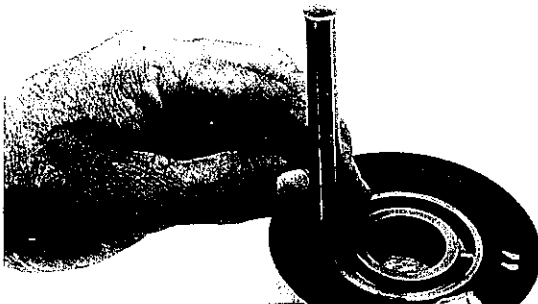
Note: Variations

Very early production steering gears may be fitted with piston rings. They can be removed and discarded as they are no longer required. The 372/382 series steering gears with the step-bore housing and piston flange will continue to use the piston ring.



S-62

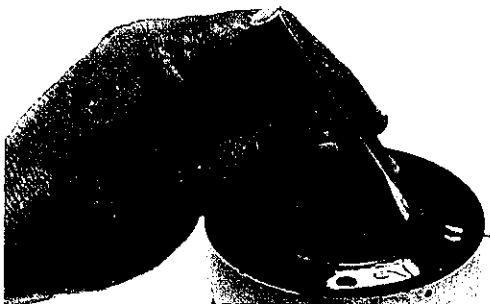
The piston bottom plug should not be removed except in cases of severe oil contamination, and for cleaning. On reinstallation the plug must be pinned. Pipe sealer should be used sparingly on the threads of the plug.



S-63

Mark the top adjustment nut and piston so that the nut can be reinstalled in its original position.

Caution: Misadjustment of the top adjustment nut could cause erratic steering.



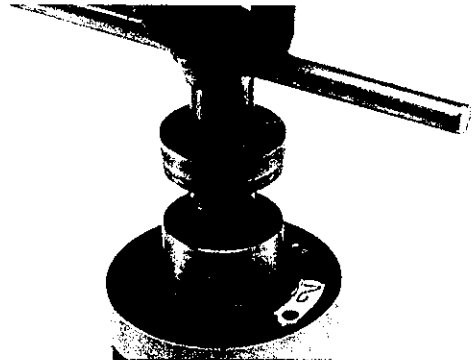
S-64

Carefully remove the pin locking the adjustment nut to the piston assembly.

SHEPPARD POWER STEERING SERVICE MANUAL

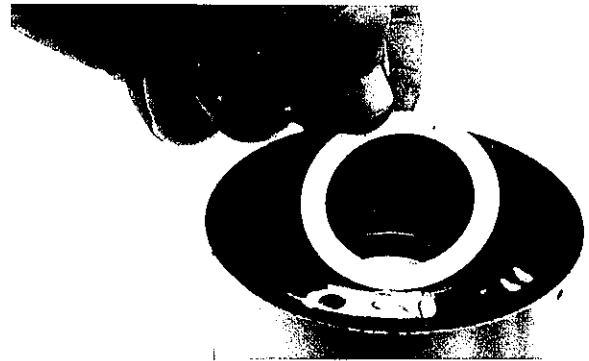
Using a spanner wrench remove the top adjusting nut from the piston.

Note: The bottom adjustment nut inside piston should never be removed.



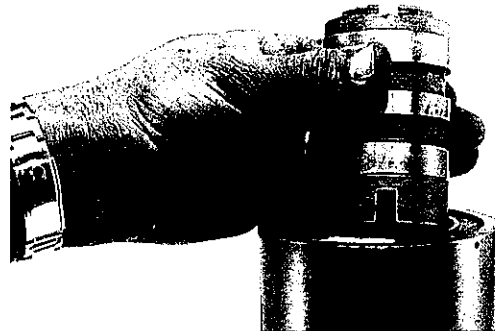
S-65

Remove the top reversing spring from the nose of the actuating valve.



S-66

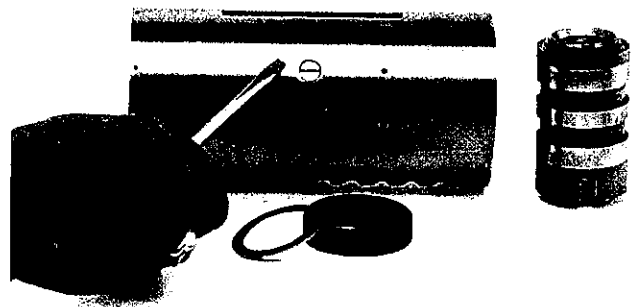
Pull the actuating valve from the piston. Do not force the valve from the piston bore. The actuating valve and piston are serviced only as an assembly due to the critical tolerances in this area.



S-67

Remove the actuating valve positioning pin from the piston.

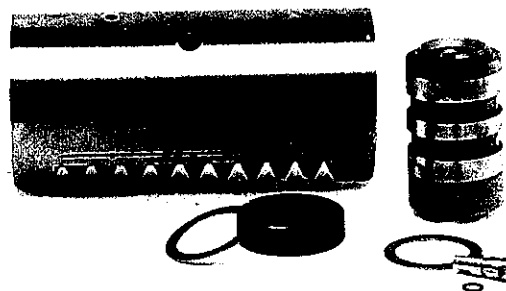
Note: The positioning pin on later production steering gears will have an "O"-ring oil seal.



S-68

SHEPPARD POWER STEERING SERVICE MANUAL

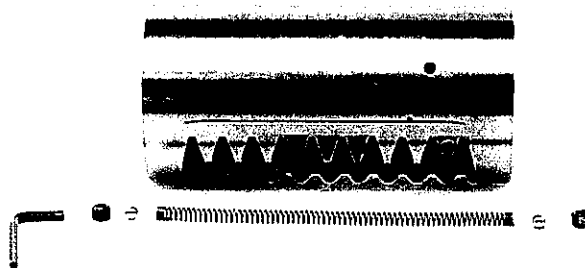
The reversing springs are the only serviceable parts in the piston assembly.



S-69

Use an allen wrench to remove the relief ball seats, relief balls and spring.

Caution: The balls are under slight spring pressure. Handle carefully to avoid loss or personal injury.



S-70

REASSEMBLY – EARLY PRODUCTION PISTONS

Position the relief valve spring and one relief valve ball into the valve bore. Then, using a 3/16" allen wrench, install one of the valve seats. The valve seats must be tight and flush with or slightly below the end surface of the piston.

Install the second relief valve ball seat in the same manner.

Position one of the reversing springs in bottom of valve bore. Be sure spring is centered. The end of the valve must enter the inside diameter of the spring.

Install the valve positioning pin in the piston. Turn pin inward with a screwdriver until it is below the outside surface of the piston. The flats must enter into the piston 1/4" to engage the mating slot in the valve.

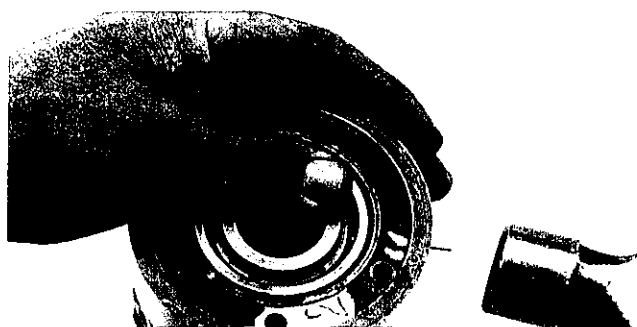
Carefully slide the actuating valve into the piston so that the slot on the end of the valve is positioned over the pin.

Position the remaining reversing spring on shoulder of the valve end.

Reinstall valve adjustment nut, turning it clockwise into the piston until it is against the spring. Align the reference marks on the nut and piston. Then, lock nut in place by installing the locking pin. Be sure pin is below the outside edge of piston.



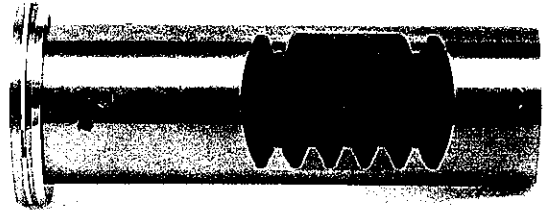
S-71



S-72

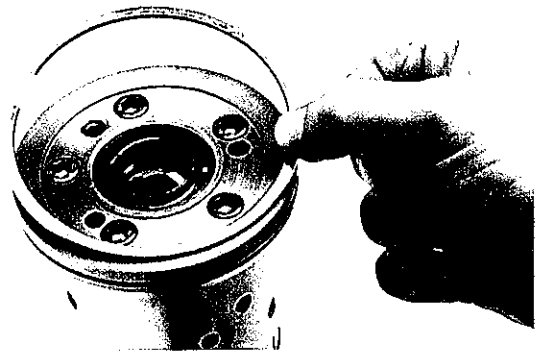
PISTON VARIATION – 372-382 SERIES – STEP-BORE

The step-bore 372-382 pistons are disassembled the same as the standard piston, except the piston ring flange is factory located and installed and must not be removed.



S-73

The piston ring is replaceable in the case of wear or breakage.



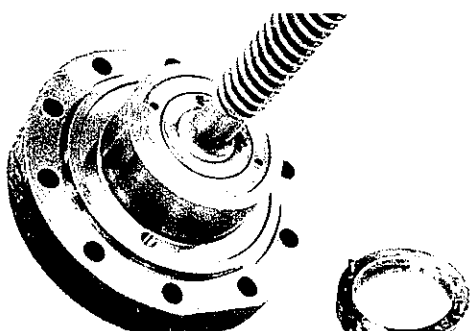
S-74

REPAIR SHORT SERIES — BEARING CAP ASSEMBLY



S-75

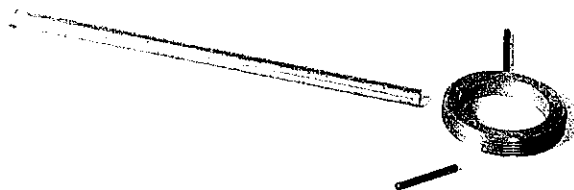
Separate the actuating shaft from the bearing cap. The actuating shaft retainer is pinned to the bearing cap. Use a 5/64 inch drill and drill through the pin.



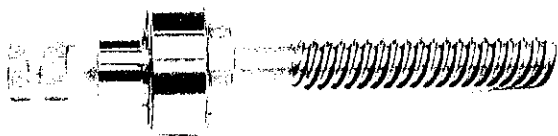
S-76

Use a spanner wrench to remove the retainer.

You can fabricate your own spanner wrenches as required using discarded retainers and a piece of stock as a handle and two roll pins. Drill through the retainer and drive the roll pins through the retainer. Weld the stock material as a handle to the retainer.



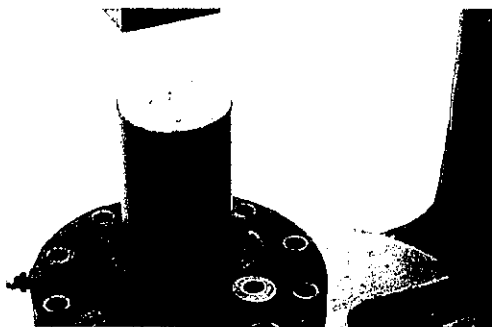
S-79



S-77

Carefully tap or press the actuating shaft and bearing out of the bearing cap.

The actuating shaft and bearing are not supplied separately. No attempt should be made to remove the bearing.

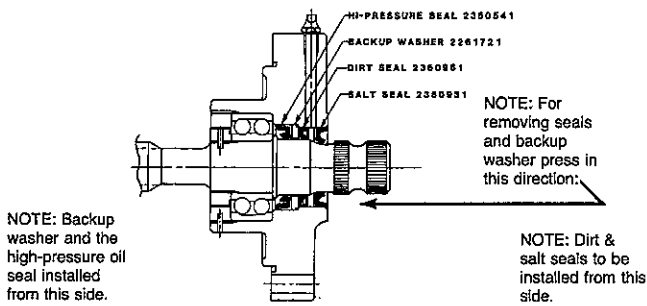


S-78

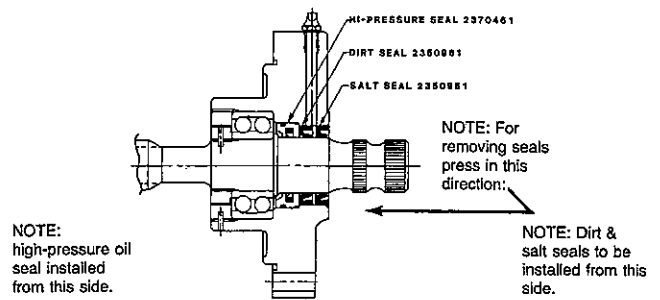
The bearing cap seals are removed by pressing them toward the inside.

Note: The high-pressure seal back up washer will also be displaced with the seals, and should be recovered for reinstallation with new seals, unless the hi-pressure seal is being replaced with hi-pressure seal kit No. 2370461 (see illustration on following page).

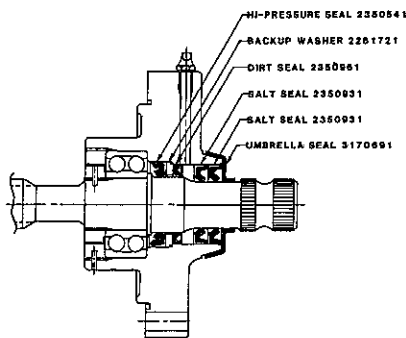
SHEPPARD POWER STEERING SERVICE MANUAL



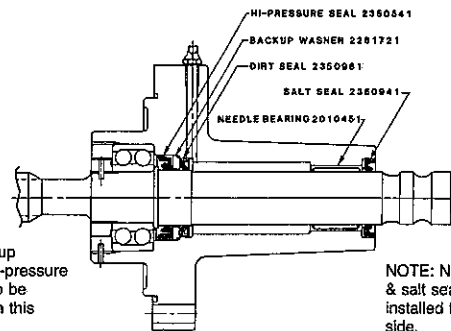
Series 3, 4, 5 and early 6 high pressure seal installation



Late model Series 6 high pressure seal installation



A second salt seal and an umbrella style seal are used on most axle mount steering gears. The illustration above details this seal arrangement. Seal replacement is the same as detailed above except the second salt seal is installed in the bearing cap.



NOTE: Backup washer, high-pressure & Dirt seal to be installed from this side.

NOTE: Needle bearing & salt seal to be installed from this side.

An extended bearing cap which includes a needle bearing supports all extended shaft designs.

Note: For seal replacement, remove actuating shaft, use a screw driver to pry out the salt seal. Insert a punch through the needle bearing bore and tap out the dirt and hi-pressure seals.

Reassembly procedure of actuating shaft and bearing cap seals are as follows:

1. Place the backup washer in the bearing cap with the undercut down as shown (S-80).
2. Take a piece of round stock 2" long and turn to 1.615 and smooth one end.

Put the piece of round stock in the bearing end against the backup washer, or against the shoulder area for the hi-pressure seal if a backup washer is not used. Set the bearing cap on a press and evenly install the dirt seal, lip out from the other end until it rests against the backup washer, or the round stock as shown (S-81).

Evenly install the salt seal, lip out, into the bearing cap until flush with top.

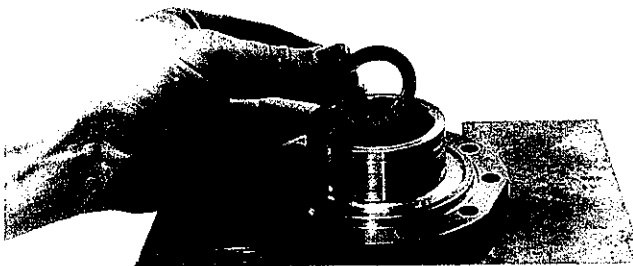
3. Turn bearing cap over, when replacing the high pressure seal 2350541 as pictured above with a duplicate seal. Backup washer 2261721 must be installed with the undercut down as shown (S-80).

When replacing hi-pressure seal 2350541, with hi-pressure seal 2370461, the original backup washer 2261721 must be *discarded*, as the new hi-pressure teflon seal kit 2370461 has the backup washer built in.

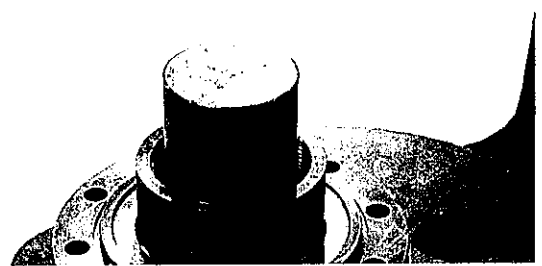
Evenly install the hi-pressure oil seal until it rests against the backup washer, or the shoulder.

Lubricate all three seals with grease before installing actuating shaft assembly.

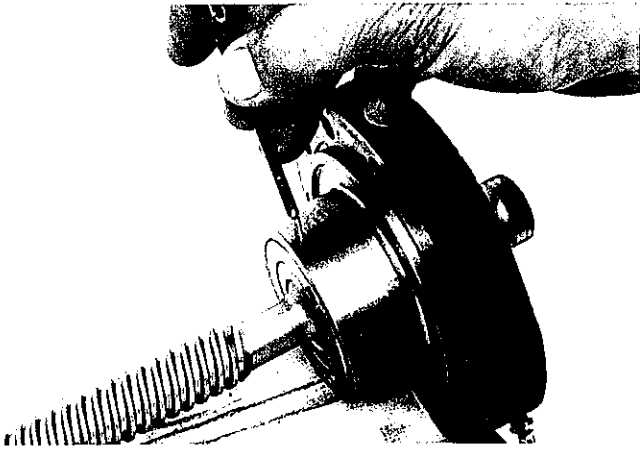
Caution: If the backup washer is not installed properly, an oil leak will occur on the first application of pressure.



S-80



S-81



S-82

Press the actuating shaft into the bearing cap. Reinstall the bearing retainer. Tighten retainer securely to keep the bearing from having end play. Install a new lock pin, and peen it in place.

VARIATION – VERY EARLY PRODUCTION – BEARING CAPS



S-83

Some early production steering gears used two seals in the bearing cap and the back up washer was machined in the bearing cap housing. Use a screwdriver to pry out the dirt seal.



S-84

With the dirt seal removed, two access holes to the high-pressure seal are uncovered. Use a punch to tap the high-pressure seal out of the housing. Care must be taken to avoid damage to the housing or oil leakage will reoccur.

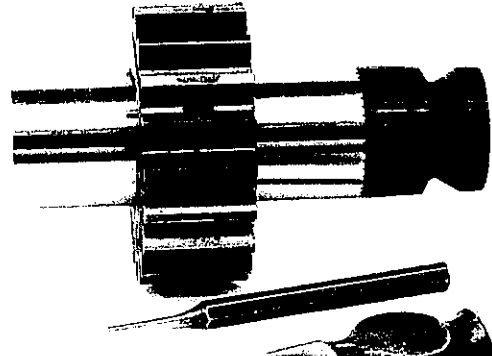
REPAIR – SHORT SERIES – OUTPUT SHAFT AND PINION

The pinion gear is located and held in place on the output shaft with a retaining pin. A roll pin through the pinion gear will keep the retaining pin from backing out of place. To remove the pinion gear, punch out the roll pin and drill out the retaining pin. Press the pinion gear off the output shaft.

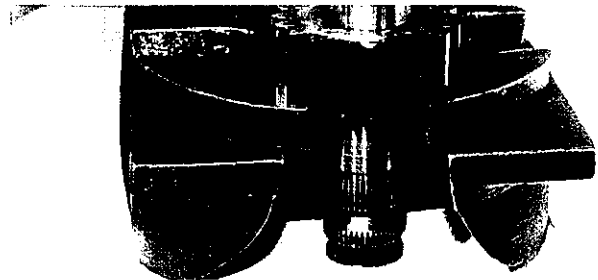
Note: If the retaining pin cannot be drilled out, it can be sheared off with approximately 10 tons of pressure on a press. Drive half the pin out of the pinion gear and now drill the remaining half out of the shaft.

Caution: Use safety precautions when shearing the pin under pressure.

To reassemble the pinion gear to the output shaft, align the timing arrows on the output shaft to the arrow on the pinion gear. Press the gear on to the shaft splines until the locating pin can be driven through the gear and into the locating hole in the shaft. Install the roll pin through the gear.



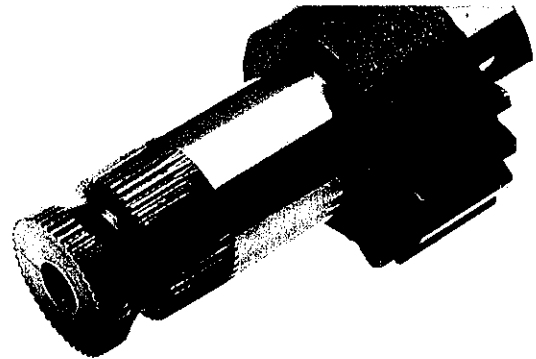
S-85



S-86

VARIATION – OUTPUT SHAFT SERIES 5 & 6

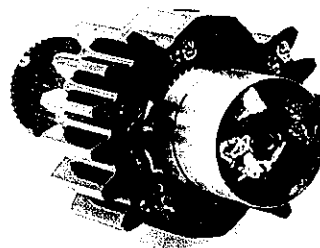
To provide 100 degrees of pitman arm travel some series 5 & series 6 steering gears use a one piece forged output shaft and pinion gear assembly. Service of this assembly is by replacement only.



S-87

VARIATION: 372/382 SERIES

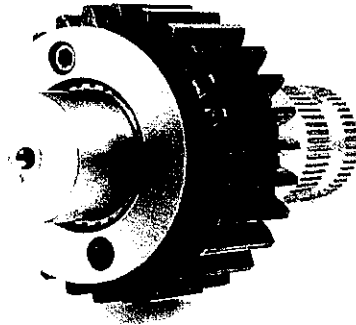
The 372/382 series output shaft and pinion gear are different in appearance but are serviced in the same manner as the high-pressure or short series gears.



S-88

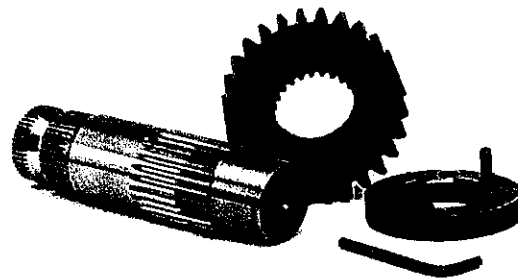
VARIATION: LOW PRESSURE SERIES OUTPUT SHAFT & PINION

Use an allen wrench to remove the cap screws. The retaining nut is now removed by turning it counter-clockwise off the output shaft. Press the gear off the shaft.



S-89

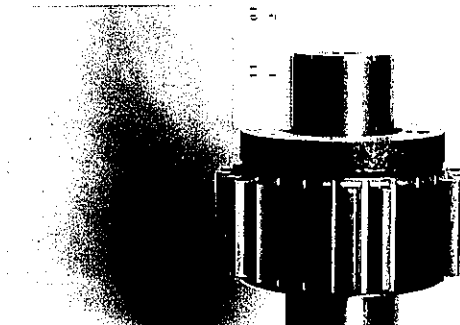
The pinion gear on low pressure steering gears is held to the output shaft with a retaining nut threaded to the output shaft and locked to the pinion gear with two cap screws.



S-90

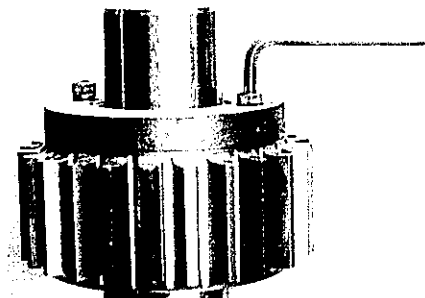
When the pinion gear is reinstalled on the output shaft the distance between the end of the shaft to the face of the retainer must be adjusted. Place the gear on the shaft splines, aligning the timing marks and thread the retainer onto the shaft against the pinion gear. The distance between the end of the shaft and the face of the retainer should be adjusted by moving the gear on the shaft until the following dimension is obtained:

- Model 39 - $1\frac{19}{32}$ "
- Model 59 - $1\frac{25}{32}$ "
- Model 491 - $1\frac{13}{32}$ "



S-91

Now the retainer is backed off until the drilled holes in the retainer align with the tapped holes in the pinion gear. Install and tighten retaining screws drawing the gear tightly against the retainer. It may be necessary to press the gear onto the shaft or back against the retainer.



S-92

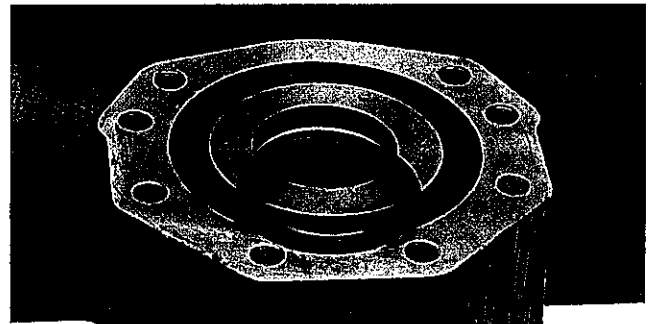
REPAIR – SHORT SERIES – HOUSING ASSEMBLY

The bronze bearings are presized and boring or honing are not required.



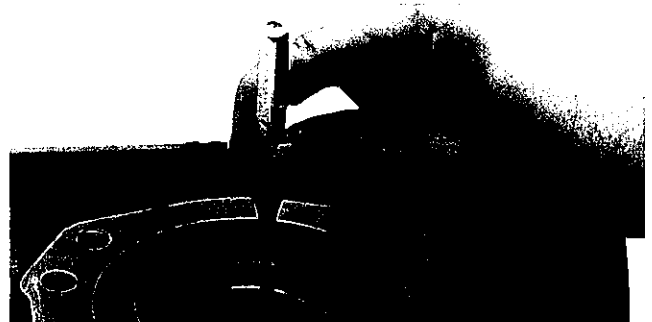
S-93

Remove the Quad ring oil seal from the gear housing and discard.



S-94

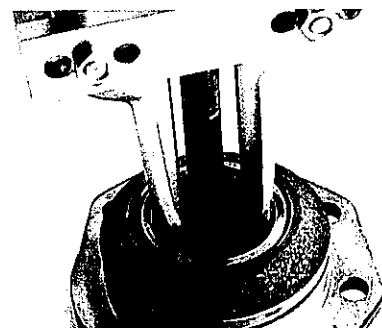
Use a drift punch to drive the bronze bearing out of the housing. Alternately tap one side of the bearing and then at an opposite side to keep it moving evenly.



S-95

Withdraw the bronze bearing from the cover with a suitable bushing remover.

Owatonna Tools puller illustrated



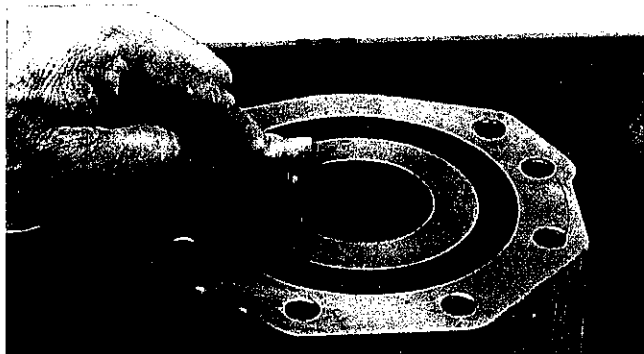
S-96

SHEPPARD POWER STEERING SERVICE MANUAL



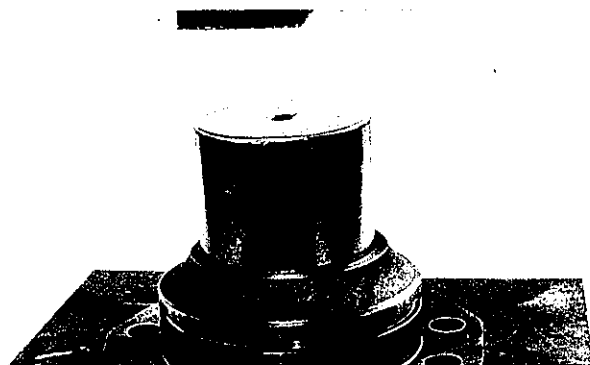
S-97

Install new bearings (if removed) in the gear housing and cover, using a press and a straight line pushing action. The bushing is pushed into the gear housing, so that the inside face of bushing is flush with inside face of gear housing.



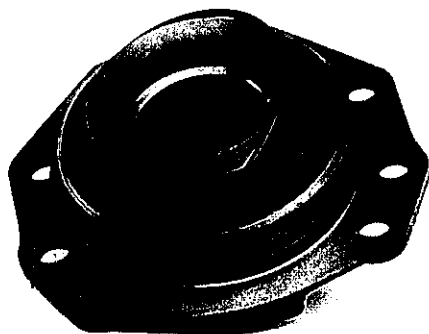
S-98

Install a new Quad ring in the groove in the gear housing. The quad ring is a "stuff-fit" and at first glance may appear to be too large.



S-99

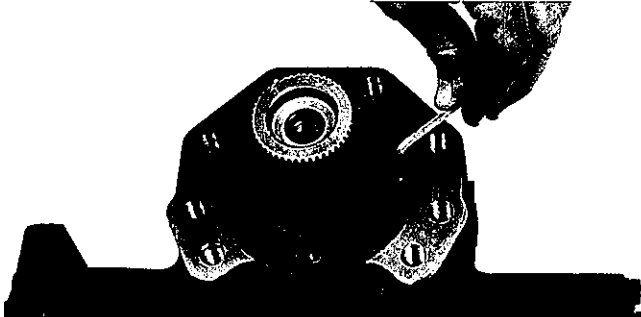
Press a new bronze bearing into the pinion cover.



S-100

The bronze bearing should be recessed $\frac{1}{2}$ inch below the face of the cover, on all 292, 392 and 492 steering gears. The 592 bearing is recessed $\frac{5}{16}$ ". All other bearings are installed flush with the face of the cover.

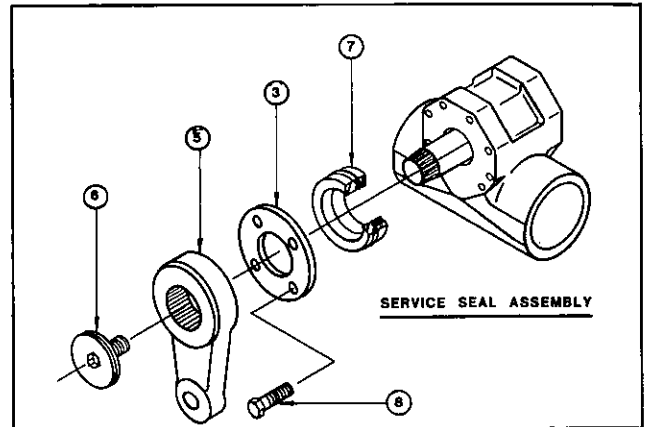
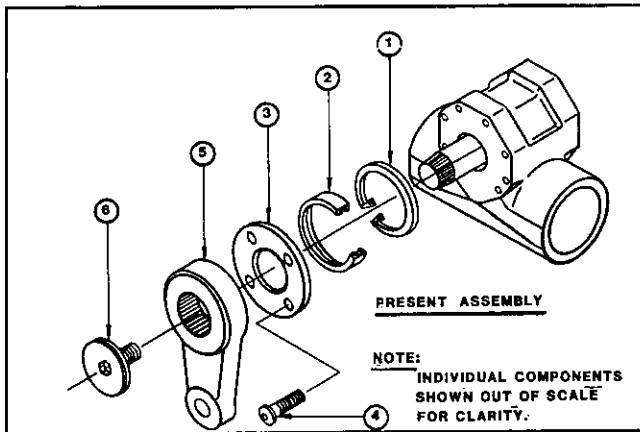
VARIATION – SERIES 5 – OUTPUT SHAFT SEAL REPLACEMENT



S-101



S-102



Procedure:

1. Remove pitman arm retainer, item 6, and pitman arm, item 5, from shaft.
2. Remove socket head capscrews, item 4, and discard. (S-101)
3. Remove retainer plate, item 3, clean and save for re-assembly.
4. Remove oil seal, item 2, and snap ring, item 1, from housing bore and discard. (not applicable to 592)
5. Lubricate the O.D. and I.D. of seal assembly, item 7, with chassis lube or equivalent. Wrap the splined end of shaft with greased paper and slide the seal into place over the shaft. (S-102) Carefully tap seal assembly into housing bore until it is flush with face of housing.
6. Install retainer plate, item 3, and (4) hex head capscrews, item 8, as shown. Bolt torque to be 10 to 14 ft./lbs. (1.4 to 1.9 KG-M). To facilitate future service both the retainer plate and hex head capscrews can be sprayed with undercoating. Care should be taken to avoid spraying the shaft and housing face on base mount applications.
7. Install pitman arm, item 5, by aligning timing mark on pitman arm with timing mark on shaft.
8. Install pitman arm retainer, item 6, by applying lok-cease, never seez or white lead between pitman arm and retainer, in the threads of the shaft, and on the threads of the retainer. Pitman arm retainer to be torqued to:
292-392 225 ft./lbs (31.1 KG-M)
492-592 450 ft./lbs (62.2 KG-M)

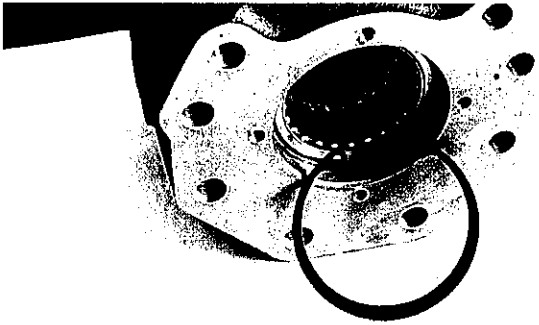
SERVICE SEAL REPLACEMENT KITS

292S5 & 392S5 – 2370481K

492S5 – 2370491K

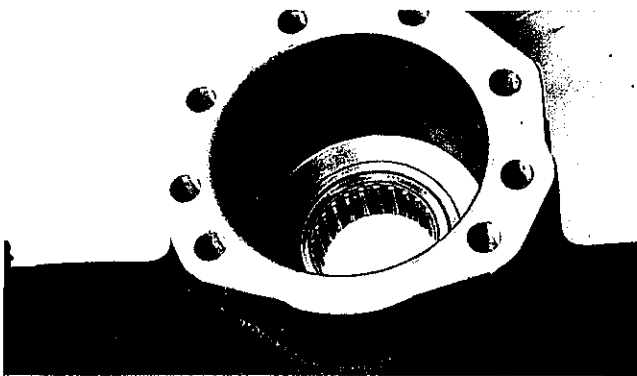
592S5 – 2370501K

VARIATION – SERIES 5 – HOUSING REPAIR



S-103

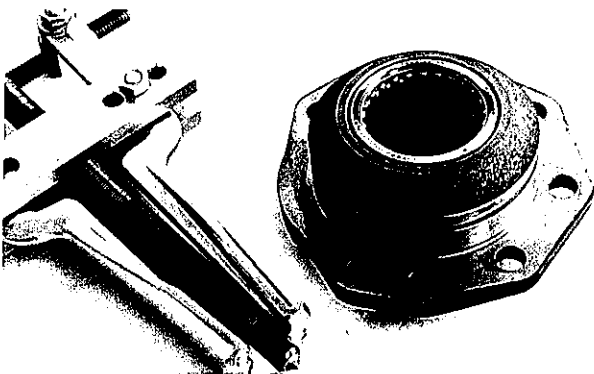
If the needle bearing in the housing is to be replaced, the output shaft seal and snap ring (if used) must be removed to gain access to the bearing. Remove the bearing from the housing by pressing it out.



S-104

On reassembly, press the bearing into the housing until it is flush with the inside surface of the housing.

Note: The 592S5 bearing has the snap ring on the bearing. In this case the bearing is pressed into the housing until the snap ring contacts the housing.



S-105

The needle bearing in the pinion cover is removed using a bushing removal tool similar to the Owatonna puller illustrated.

Note: The bearing should not be removed unless it is going to be replaced.



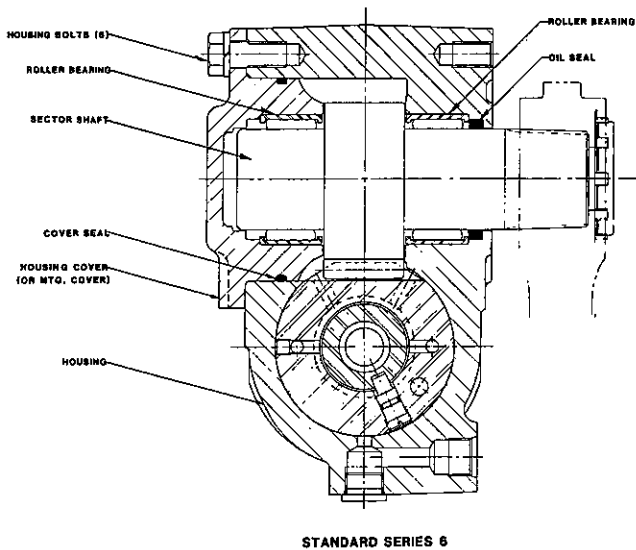
S-106

A new bearing is pressed into place flush with the face of the bearing bore and against the spacer in the bore of the pinion housing.

Note: Some 592 series 5 steering gears use a double row needle bearing where the needle rollers are loose. During service, care must be taken to ensure that the needle rollers are installed in the bearing housing which they came out of. Use chassis lube to hold the needle rollers in the bearing races during reassembly.

Note: The 592S5 bearing has the snap ring on the bearing. In this case the bearing is pressed into the cover until the snap ring contacts the cover.

SERIES 6 – COVER & HOUSING REPAIR



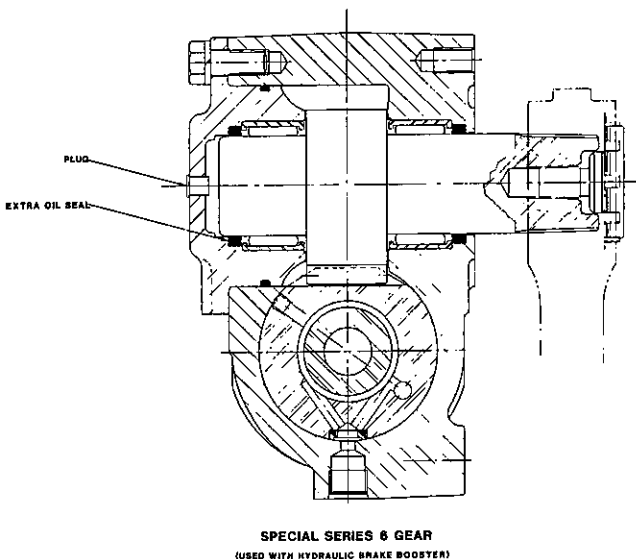
Procedures for Oil Seal and Bearing Replacement

1. Remove 8 housing bolts and housing cover.
2. Remove sector shaft assembly.
3. Remove the bearings from the housing and housing cover.

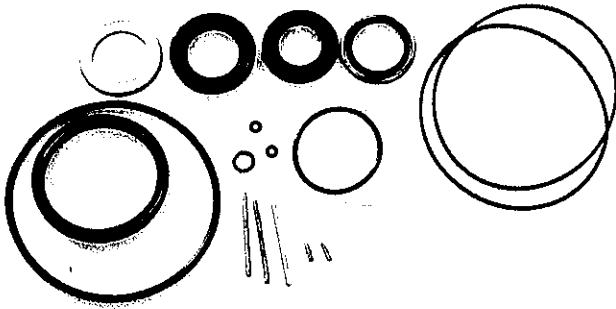
The needle bearings are removed using a bushing removal tool, similar to the Owatonna puller pictured in (S-105).

Note: The bearings do not have to be removed to replace the oil seals.

4. Remove and replace sector shaft oil seals from the housing, and housing cover if applicable. (Note: An additional oil seal is used in the housing cover if the gear is used in a hydraulic brake booster system.)

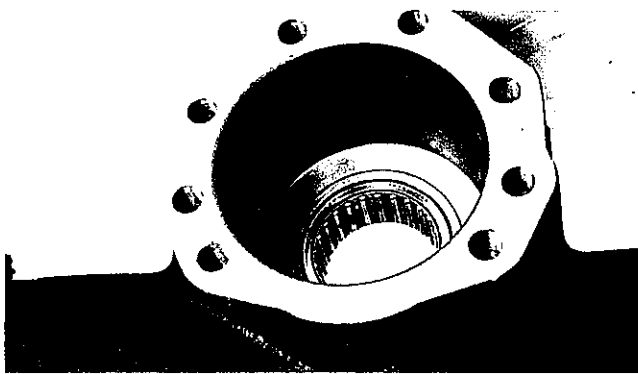


REASSEMBLY

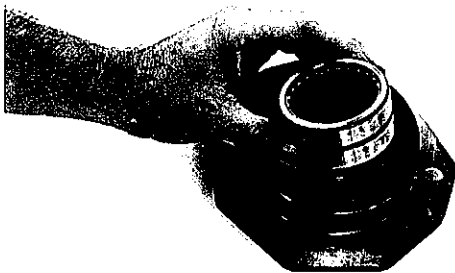


Typical overhaul seal kit

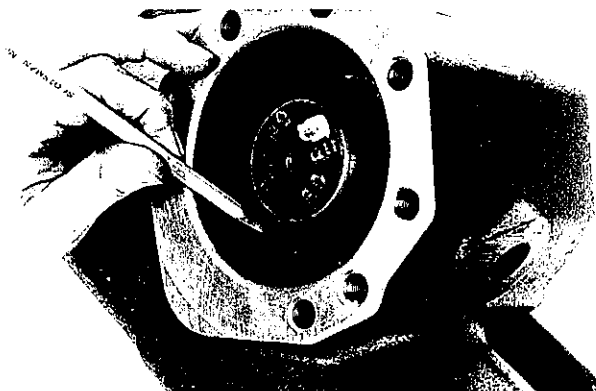
S-107



S-108



S-109



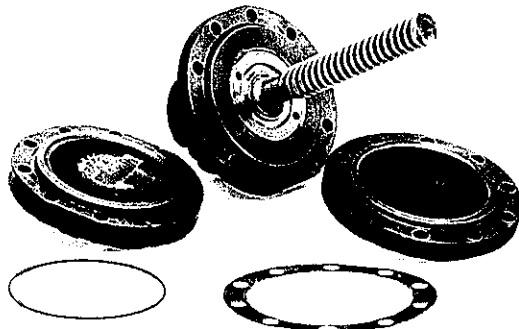
S-110

SERIES 6 – HOUSING REPAIR

Procedures for Oil Seal and Bearing Installation

1. Place the new sector shaft oil seals in the housing and housing cover if applicable. (See illustration on previous page)
 2. Press bearing into position in the housing and housing cover. The bearing should bottom out against a shoulder so the bearing is flush with the inside surface of the housing or housing cover.
 3. To protect the oil seal, cover the splines on the sector shaft with wax paper and lubricate the paper and sector shaft with motor oil. (similar to S-102)
 4. Align the timing mark on the piston and pinion gear. (See instructions on following page.)
 5. Carefully install the sector shaft in the housing. Take special care not to damage the oil seals or leave dirt or contamination in the gear.
 6. Align timing mark on piston rack with timing marks on sector shaft. (See photo S-110).
- Caution:** If the rack is not properly timed to the pinion gear of the forged one-piece shaft and gear assembly it is possible for the gears to disengage in service.
7. Proceed with final assembly per instructions on following pages.

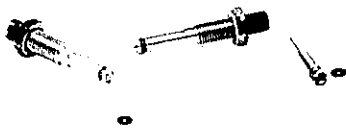
SHEPPARD POWER STEERING SERVICE MANUAL



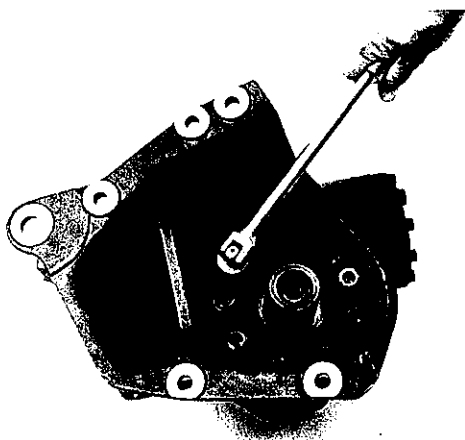
S-111



S-112



S-113



S-114

Install cylinder head with new gasket or seal. Align reference marks and tighten bolts to specified torque.

Using a new gasket or seal on the bearing cap, thread actuating shaft into the valve. Line up punch marks on gear housing and bearing cap. Turn shaft until cap comes into place on the end of cylinder. Check plunger hole alignment with valve seat in the piston. Tighten bolts to specified torque.

Note: Variation

Several steering gear models use square ring seals in place of gaskets on the cylinder head and bearing cap.

Position a new "O"-ring seal on housing cover. Install cover assembly. It may be necessary to use a soft hammer to tap the cover in place.

Install the bolts and torque to proper specifications.

TORQUE SPECIFICATIONS

APPLICATION	SIZE	FT. LBS.
CYLINDER HEAD AND BEARING CAP	5/16 - 24NF	20-30
CYLINDER HEAD AND BEARING CAP	3/8 - 24NF	35-45
STEERING GEAR COVER (MOUNTED)	7/16 - 20NF	55-65
STEERING GEAR COVER (MOUNTED)	1/2 - 20NF	85-95
STEERING GEAR COVER (MOUNTED)	9/16 - 18NF	120-130
STEERING GEAR COVER (MOUNTED)	5/8 - 18NF	170-180
STEERING GEAR COVER (MOUNTED)	5/8 - 11NC	150-160
STEERING GEAR COVER (STANDARD)	7/16 - 20NF	35-40
STEERING GEAR COVER (STANDARD)	1/2 - 20NF	50-55
STEERING GEAR COVER (STANDARD)	9/16 - 18NF	65-70
STEERING GEAR COVER (STANDARD)	5/8 - 18NF	100-110
STEERING GEAR COVER (STANDARD)	5/8 - 11NC	90-100
MITER ACT. SHAFT LOCK NUT		45-55

The relief valve plungers may now be installed, using new "O"-rings. Coat "O"-ring with lubricant before installation. Turn them approximately six turns. Final adjustment of the plungers are made when the steering gear is installed on the vehicle.

Note: Variation

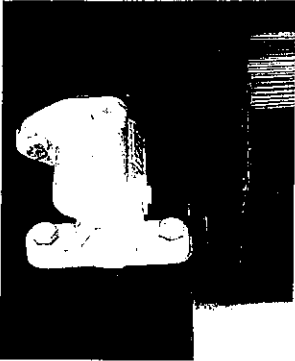
Later production steering gears may have slotted and recessed relief plunger. The later style plungers are removed or adjusted with a straight bladed screwdriver.

These plungers can be turned out until they are flush with the plunger boss. Turning them out beyond this point could cause an oil leak.

Reinstall the bracket on the steering gear and torque the bolts to specification.

OPTIONAL – INTEGRAL RELIEF VALVE SERVICING

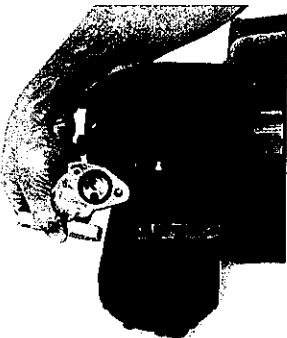
Note: Series 5 external pressure relief pictured.



S-115



S-116



S-117



S-118

An optional, integral, pressure relief valve is offered with the Sheppard Series 5 Steering Gear. This valve is mounted externally on the Steering Gear and limits the maximum operating pressure in the steering system. In most cases the hydraulic supply pump will have a maximum relief pressure setting several hundred pounds higher than the relief valve integral with the steering gear. Therefore, when maximum relief pressures are reached in the steering system the excess pressure is relieved at the steering gear and the supply pump is not subjected to high temperatures caused by normal pressure relief and recirculation within the supply pump.

The optional pressure relief valve offered with the Sheppard Series 5 Steering Gear bolts externally to the steering gear housing and connects the high-pressure supply circuit to the low pressure pinion gear area of the steering gear. When oil pressure exceeds the maximum relief pressure setting of the pilot operated relief valve the valve opens and excess pressure is bled off into the oil return circuit through the pinion gear bore of the steering gear.

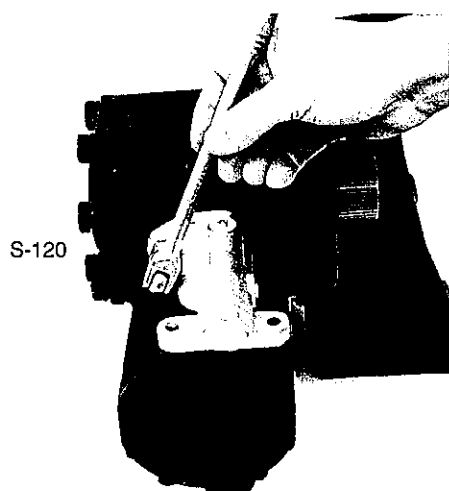
One bolt and a square ring seal connect the exhaust side of the valve to the pinion gear housing of the steering gear.

Two bolts and a square ring seal connect the high-pressure side of the valve to the cylinder head of the steering gear.

The valve is disassembled for cleaning and inspection by removing the valve end plug and withdrawing the relief valve and compensating spring.

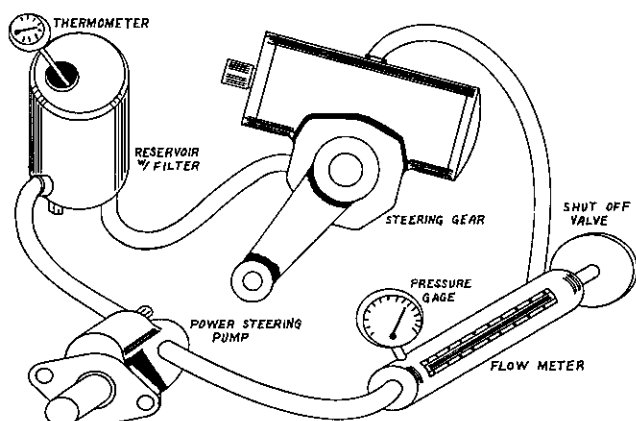


S-119



When the pressure relief valve is reassembled to the steering gear housing, it is important that attaching bolts are properly torqued to 20-30 ft. lbs. The single cap screw attaching the relief valve to the pinion housing of the gear must be installed and torqued to specifications first. The two cap screws attaching the relief valve to the cylinder head are then installed and torqued. This procedure will avoid causing distortion which could lead to binding of the relief valve in its bore.

TESTING – INTEGRAL RELIEF VALVE

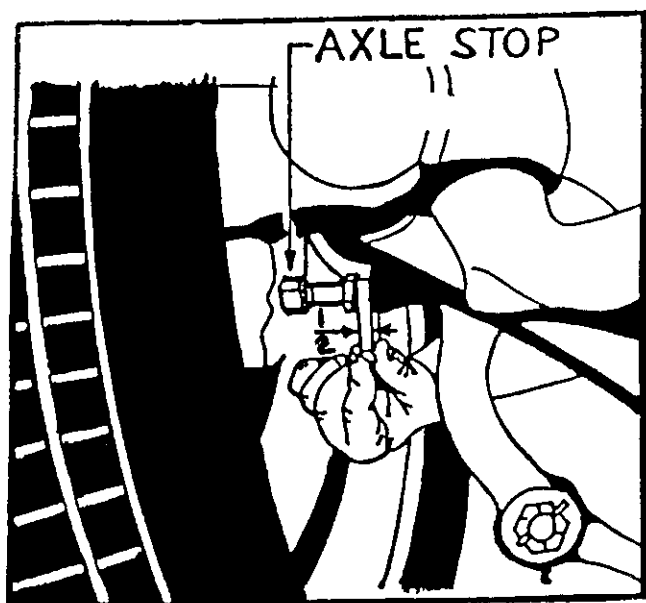


1. Connect pressure gauge and flow meter into the steering circuit as illustrated.
2. Close valve on gauge assembly and read supply pump relief pressure.

Caution: A malfunctioning pressure relief valve may not relieve pump pressure and closing the shutoff valve may cause severe pump damages or high-pressure hoses to rupture. Constantly observe the pressure gauge while closing the shutoff valve. If pressure rises rapidly or appears to be uncontrolled do not completely close the valve before inspecting the pump and pressure relief valve.

3. If supply pump does not meet specifications, repair pump.
4. If the supply pump is okay, place a 1/2-inch spacer between the axle stops on one side and turn the steering wheel hard in the direction necessary to pinch the spacer block. Record the maximum pressure reading.
5. Remove the spacer and repeat test in the opposite direction. Record pressure.
6. If pressure is equal on both sides, but not within specifications, remove and repair or replace the integral pressure relief valve.
7. Replacement relief valves for series 5 gears as pictured in S-120.

1760062	1740 PSI	120 BAR
1760072	1885 PSI	130 BAR



PITMAN ARM INSTALLATION INSTRUCTIONS

When the pitman arm is installed, the timing arrows on the arm and the output shafts must be aligned. If the pitman arm has two timing arrows marked "L" and "R" the same arm is used on both the master and the slave gear. The "L" arrow is used on the left or master gear and the "R" arrow is used on the right or slave gear.

The following charts detail the various pitman arm installation methods offered by The Sheppard Co.

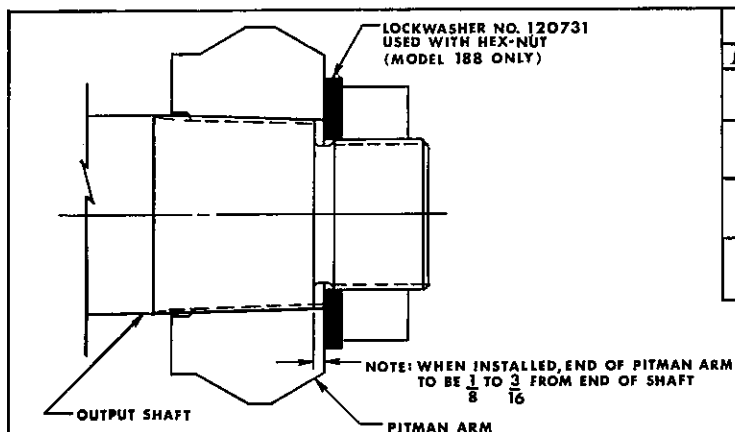
Follow these procedures for the attachment method you are working with. Correct torque values are very important. Use the lubricant where indicated.

Caution: If the pitman arm is not applied to the following specifications, the pitman arm could work loose. If this situation is found, inspect both the pitman arm and the output shaft for spline wear. If either part is worn, *replace* necessary parts.

Note: Do not weld arm or shaft.

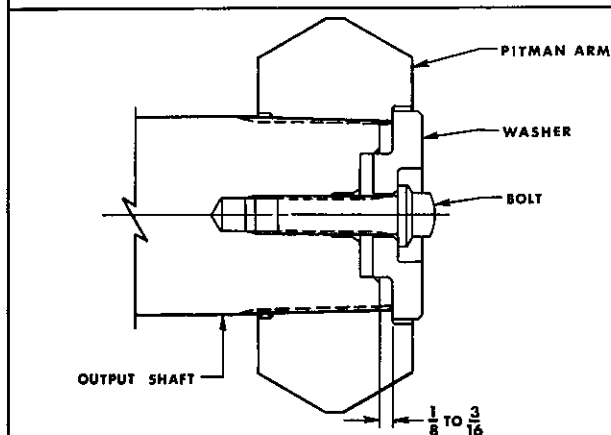


S-121



TORQUE SPECIFICATIONS			
MODEL NO.	LOCKNUT NO.	TORQUE NUT TO:	
188	HEX-NUT 219776	250 FT. LBS.	339 N·M
191 - 192 39	2415991	410 FT. LBS.	556 N·M
292 - 392 491	2410101	450 FT. LBS.	610 N·M
51 - 59	2410801	500 FT. LBS.	678 N·M

USE LOK-CEASE, NEVER SEEZ OR WHITE LEAD BETWEEN PITMAN ARM AND NUT, IN THE THREADS OF THE NUT AND ON THE THREADS OF THE OUTPUT SHAFT.



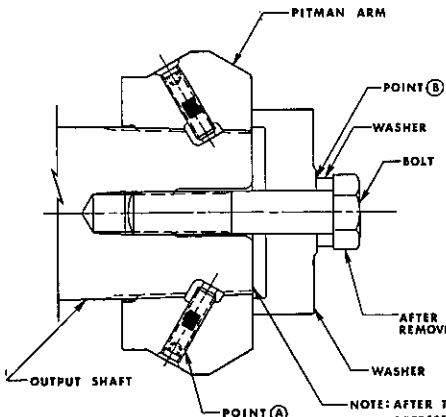
TORQUE SPECIFICATIONS				
MODEL NO.	BOLT NO.	WASHER NO.	TORQUE BOLT TO:	
592 S-5	2420891 1/2-20UNF, 1 1/2 LG. GRADE 8	2261811	150 FT. LBS.	203 N·M

USE LOK-CEASE, NEVER SEEZ OR WHITE LEAD BETWEEN BOLT AND WASHER, IN THE THREADS OF THE OUTPUT SHAFT AND ON THE THREADS OF THE BOLT.

R. H. SHEPPARD Co. INC.

SHEPPARD POWER STEERING SERVICE MANUAL

TORQUING ASSEMBLY- PITMAN ARMS



TORQUE SPECIFICATIONS

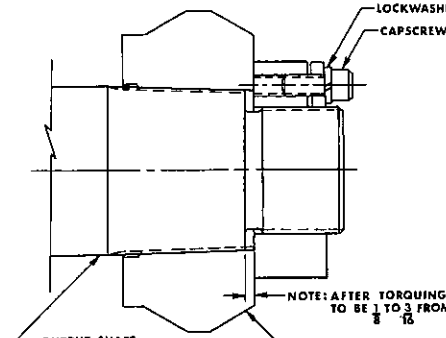
MODEL NO.	WASHERS	BOLT NO.	TORQUE BOLT TO:	
292, 292 S-1	2261521	181441	85 FT. LBS.	115 N·M
392, 392 S	2261611	1/2-20 UNF X 2 3/4 LG GRADE 5		
492	2261571 2261621	181463 9-18 UNF X 3 1/2 LG GRADE 5	160 FT. LBS.	217 N·M
592	2261581 2261631	271591 3/8-18 UNF X 3 1/2 LG GRADE 5	170 FT. LBS.	230 N·M

USE LOK-CEASE, NEVER SEEZ OR WHITE LEAD ON THREADS OF SETSCREWS (POINT A) AND BETWEEN WASHERS (POINT B).

TORQUE SET SCREWS TO 12 TO 15 FT. LBS. (16 TO 20 N·M)
SET SCREWS - PART NO. 2420791
HEX SOCKET HEAD
HALF DOG WITH ALLEN
NYLOK SPOT LOK.
2 REQUIRED AND SUPPLIED WITH PITMAN ARM

AFTER TORQUING PROCESS REMOVE BOLT AND WASHERS

NOTE: AFTER TORQUING, THE SHAFT MAY BE RECESSED OR PROTRUDING 3/64 MAX.



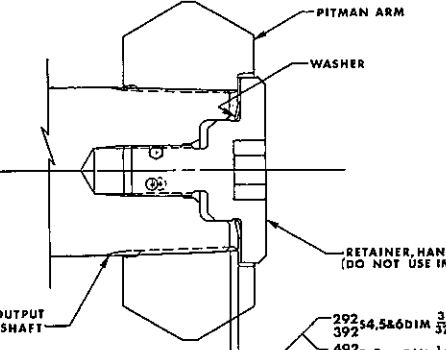
TORQUE SPECIFICATIONS

MODEL NO.	CAPSCREW	TORQUE TO:	TORQUE NUT TO:
292, 392, 392 S	12 TO 15 FT. LBS.	16 TO 20 N·M	285 FT. LBS. 386 N·M
492	" "	" "	675 FT. LBS. 915 N·M
592	" "	" "	775 FT. LBS. 1050 N·M

USE LOK-CEASE, NEVER SEEZ OR WHITE LEAD BETWEEN PITMAN ARM AND NUT; IN THE THRS. OF THE NUT, AND ON THRS. OF THE OUTPUT SHAFT.

NOTE: AFTER TORQUING, END OF PITMAN ARM TO BE 1/8 TO 3/16 FROM END OF SHAFT WHEN NEW.

CAPSCREW - HEX. SOCKET HEAD
5/16-24 UNF X 3/4 LONG



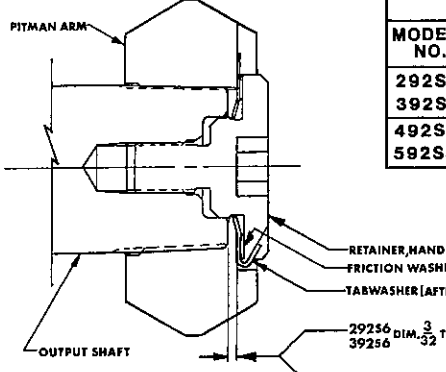
TORQUE SPECIFICATIONS

MODEL NO.	RETAINER NO.	WASHER NO.	TORQUE RETAINER TO:	
292S4, 5&6 392S4, 5&6	1790322	2261861	225 FT. LBS.	305 N·M
492S-5 592S-5	1790312	2261851	450 FT. LBS.	610 N·M

USE LOK-CEASE, NEVER SEEZ OR WHITE LEAD BETWEEN PITMAN ARM AND RETAINER, IN THE THRS. OF THE OUTPUT SHAFT, AND ON THE THRS. OF THE RETAINER, AND ON BOTH SIDES OF THE WASHER!

RETAINER, HAND TORQUE ONLY (DO NOT USE IMPACT WRENCH)

292S4, 5&6 DIM. 3/32 TO 5/32
492S-5 DIM. 1/8 TO 3/16
592S-5 DIM. 1/8 TO 3/16



TORQUE SPECIFICATIONS

MODEL NO.	RETAINER NO.	TAB WASHER NO.	FRICTION WASHER NO.	TORQUE RETAINER TO:
292S6 392S6	1790422	2262121	2262021	225 FT. LBS. 305 N·M
492S5 592S5	1790442	2262141	2262131	450 FT. LBS. 610 N·M

USE LOK-CEASE, NEVER SEEZ, OR WHITE LEAD BETWEEN PITMAN ARM AND RETAINER, IN THE THRS. OF THE OUTPUT SHAFT, AND ON THE THRS. OF THE RETAINER, AND ON BOTH SIDES OF THE FRICTION AND TAB WASHERS!

RETAINER, HAND TORQUE ONLY (DO NOT USE IMPACT WRENCH)

FRICTION WASHER

TAB WASHER (AFTER TORQUING RETAINER, BEND TABS INTO LOCKING POSITION AS SHOWN)

292S6 DIM. 3/32 TO 5/32
492S5 DIM. 1/8 TO 3/16
592S5 DIM. 1/8 TO 3/16

R. H. SHEPPARD CO. INC.

FINAL ADJUSTMENTS

Bleeding air from system

The steering gear by design is self bleeding; however, in some installations where the gear is positioned at an odd angle or where the piston does not make a full stroke in the cylinder bore air can be trapped in the steering gear. To avoid this possibility the air should be bled from the system anytime the oil has been changed or the steering system is repaired.

After reinstalling the steering gear on the vehicle but prior to connecting the drag link to the pitman arm, bleed the air from the steering system in the following manner:

1. Fill pump reservoir with recommended oil. It will be necessary to continue filling after starting the engine and during the bleeding operation until correct oil level is maintained.

2. Set parking brake or block wheels. Start engine and allow it to operate at fast idle speed.
3. With engine running, turn steering wheel from left to right and return making three complete cycles to remove all air from the steering system.
4. Stop engine. Reconnect the drag link.

Following these procedures will ensure that the piston bottoms in both directions of steer, opens the relief valve in the piston, and allows the air to escape to the reservoir and into the atmosphere. (A)

Check and adjust the relief valve plungers as required.

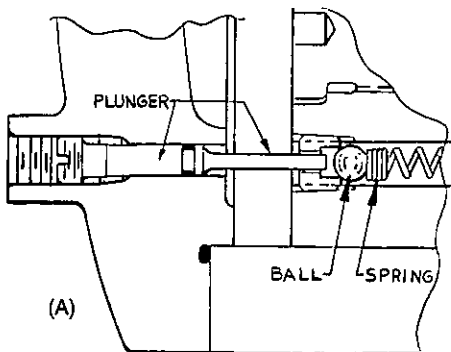
Adjusting relief valve plungers

The relief valve plunger adjustment is provided to automatically reduce the steering pressure when the road wheels have reached their limits of turn. This keeps the supply pump from operating at maximum relief pressure when the road wheels are at their steering limits. System temperatures are therefore reduced and high stress loads on the mechanical components of the steering system are relieved.

High-pressure oil at either end of the piston will push the relief ball valve off its seat and fill the relief passage with oil at high pressure. At the opposite end of this passage the relief ball valve is held against its seat and holds the high pressure in the relief passage. As the piston moves close to its limits of stroke, the adjustable relief plungers push the relief ball valve off its seat and the pressure is relieved. The distance the piston can move is dependent upon the total front axle/steering system geometry and tire size. The relief valve plungers are adjustable to allow for variations or changes in these areas.

Adjust the relief valve plungers as follows:

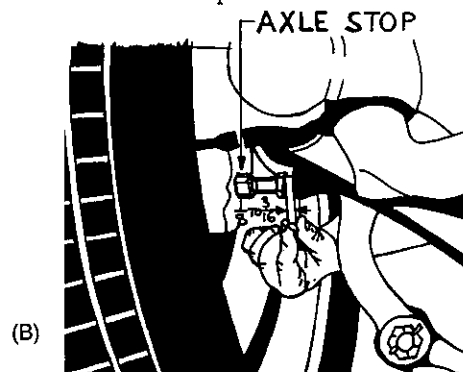
1. Start the engine and allow it to operate at idle speed.



2. With full weight of the vehicle on all wheels, turn the steering wheel in one direction until a high-pressure hiss is heard or the axle stops contact.
3. Turn the relief valve plunger in or out until the high-pressure hiss is heard when there is 1/8 to 3/16 inch clearance between the axle stops. (B)
4. Repeat this procedure for the opposite direction of steer, and adjust the relief valve plunger on the opposite end of the steering gear.

Turning the plungers in will increase the space between the axle stops. Turning the plungers out will decrease the clearance between the stops. Do not turn the slotted plungers out beyond flush with the plunger boss or a leak will occur. Axle stops should only be adjusted in accordance with the vehicle manufacturer's specifications.

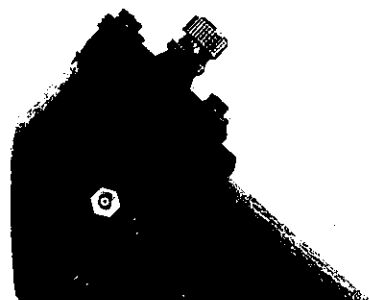
After relief valve plunger adjustment always check to ensure that the road wheels and tires have adequate clearance between suspension, brake and frame components.



FINAL ADJUSTMENTS – STEERING GEARS WITH MITER INPUT

Fixed Miter Gears – Relief Valve Plunger Adjustment

Steering gears using the fixed location miter gear arrangement have a nonadjustable relief plunger in the miter end of the steering gear. Proper relief adjustment can be made by lengthening or shortening the drag link. Relief plunger adjustment for the opposite end of the steering gear are made by adjusting the relief plunger as detailed in the foregoing paragraphs.



S-123

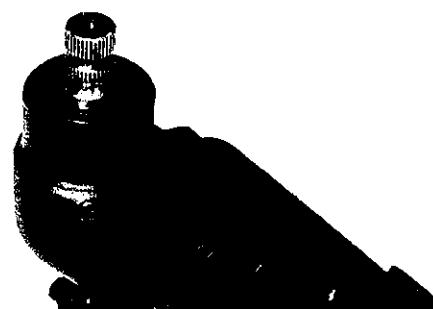
Swivel Miter and "T" Box Miter – Relief Valve Plunger Adjustment

The relief valve plunger used with the swivel and "T" box miters uses an adjustable relief valve plunger. Access to this adjustment is gained by removing the two housing retaining clamps and lifting the housing off the steering gear bearing cap. To make the adjustment, the retaining clamp bars are reinstalled and the bolts are torqued to specifications. Start the engine and turn the actuating shaft using a socket and ratchet on the actuating shaft nut. Use a screwdriver to turn the plunger in or out of the bearing cap until the proper clearance is obtained at the steering knuckle axle stop.

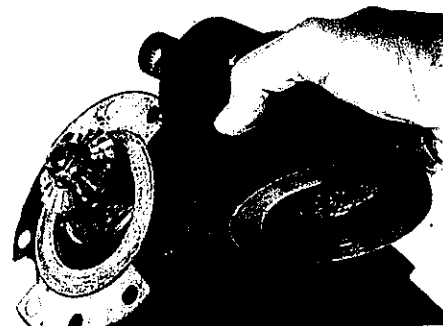
When the adjustment has been completed stop the engine and re-install the miter housing at its original location.

Note: The miter housing in most cases will be indexed to the bearing cap with a roll pin which passes through the clamping bar and enters a drilled hole in the miter housing. This ensures that the miter housing is placed in its optimum position. The locating pin will also keep the housing from turning in service. During re-assembly make sure that the locating pin is properly installed.

Caution: Retorque the actuating shaft nut to proper specifications as it may have loosened during the adjustment procedures. Torque the nut to 50 lb. ft.



S-124



S-125



S-122



S-126

DUAL STEERING SYSTEMS

Two integral steering gear units are sometimes used where high front axle loads or installation space limitations are encountered.

The secondary gear assembly differs from the master steering gear in that it does not have an actuating shaft, nor does the piston have an actuating valve. Both gears are connected to the steering linkage, drag links, pitman arms and rack and pinion gears.

Pressure to operate the secondary, or slave gear, is passed through ports in the cylinder head and bearing cap of the master gear and is routed through high-pressure lines to the proper end of the slave gear. Thus, as the actuating valve of the master gear is moved to cause pressure build up on the piston of the master gear, pressure is also directed to the slave gear piston. Fig. 1 illustrates a typical dual steering gear layout. Fig. 2 illustrates a typical master gear and slave gear used in dual steering gear installations.

Fluid exhausted from the low pressure end of the master gear is routed through the low pressure pinion gear area of the slave gear and then back to the reservoir.

Early production dual gear systems routed the exhaust fluid from the master gear pinion gear area directly to the reservoir. Later systems route the exhaust fluid from the pinion gear area of the master gear through the pinion gear area of the slave gear and then to the reservoir. The later production method of oil return flow provides faster warm up of the slave gear and offers further assurance that air entrapment in the slave gear is avoided. The pressure relief check valve in the slave gear piston also allows entrapped air to escape to the low pressure side of the piston and be purged from the system. Early slave gear pistons have two check valves. Present versions have only one check valve which might be found on either end of the piston, and is located in the piston end plug.

Pressure relief valve plungers are not required on slave gears as pressure relief is provided by the master gear.

Bleeding Air From System – Dual Steering

To bleed the air from the steering system on the vehicle after installing the steering gears, the pitman arms may be installed if there is no clearance problem with the pitman arm striking any object using the full travel of the gear. Install them by aligning the timing mark on output shaft with the timing mark on the pitman arm. For torquing see pitman arm torquing assembly. Then proceed in the following manner.

1. Fill pump reservoir with recommended engine oil. (Continue filling after starting engine and during the bleeding operation until correct oil level is maintained.)
2. Set parking brake. Start engine and allow it to operate at fast idle speed.
3. (See Figs. 1 & 2) With engine running, drag links disconnected, turn steering wheel to the left and hold until the secondary (slave) gear pitman arm moves the full travel. Then turn to the right and hold until the secondary (slave) gear pitman arm again moves the full travel, repeat this process three or more times.
4. (See Figs. 1 & 2) Connect the drag link to the master gear. Do not connect the secondary (slave) gear drag link at this time. Turn steering wheel to the left and hold until the secondary (slave) gear pitman arm moves the full travel. Then turn to the right and hold until the secondary (slave) gear pitman arm again moves the full travel. Repeat this process three or more times. Turn the steering wheel until the secondary (slave) gear pitman arm lines up with the drag link. Then install the pitman arm. (DO NOT move the pitman arm by hand or air will be pulled back into the system.)

Wheel Shake Condition – Dual Steering

When two integral steering gear units, of the same size, are applied to a single axle application, the geometry of the vehicle is critical. At no time may the effective length of the slave gear pitman arm be shorter than the master gear. If this situation does occur, the slave will surge power into the drag link and tie rod mechanism, creating a wheel shake, primarily on a left hand turn. To remedy the problem, contact O.E.M. for correct pitman arm timing and design drag link length necessary to balance the system.

DUAL SYSTEMS

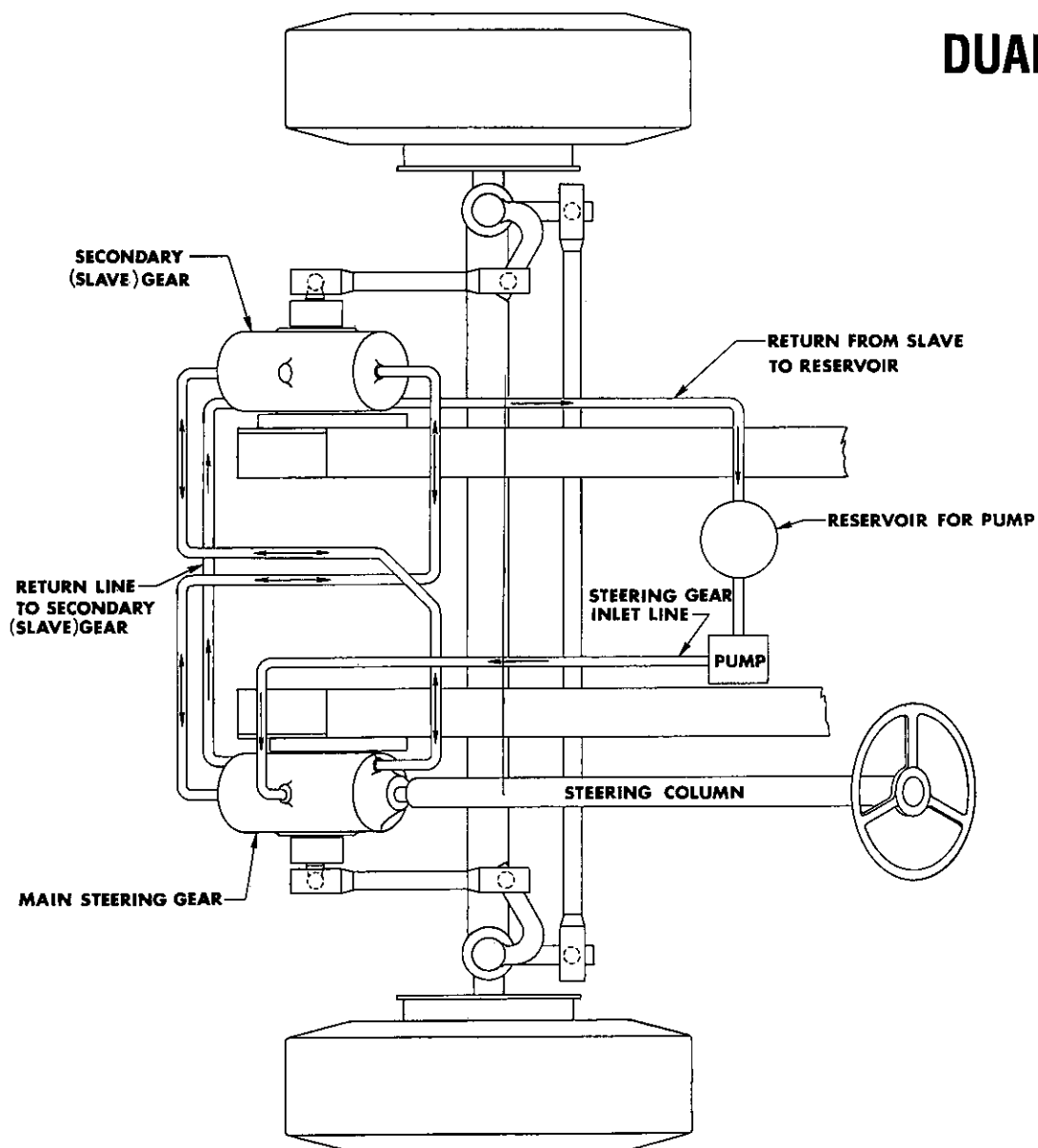
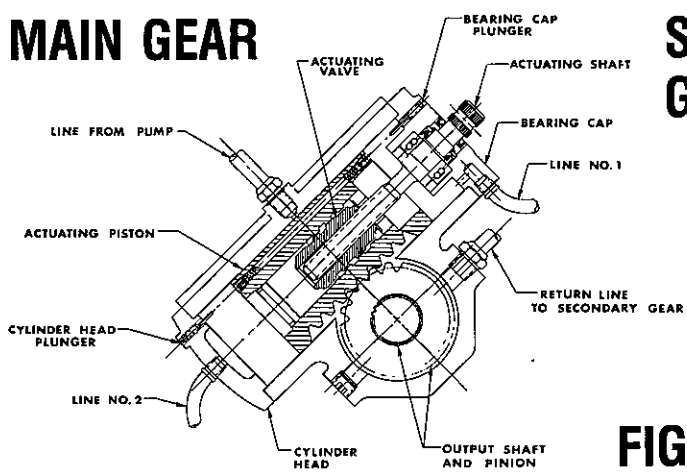


FIG. 1

MAIN GEAR



SECONDARY GEAR

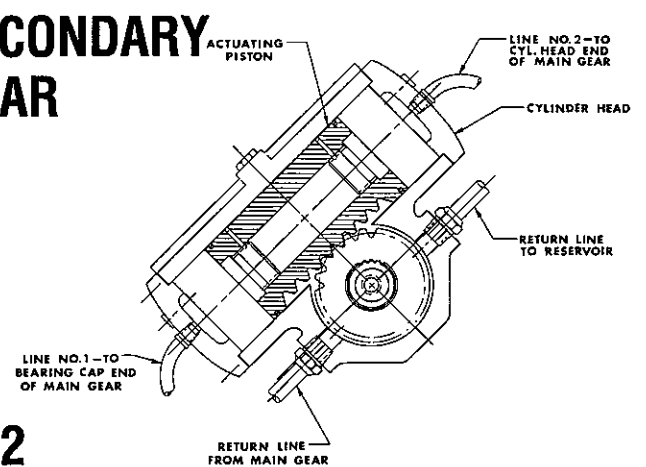


FIG. 2

FIXED MITER – DISASSEMBLY & REPAIR

Make reference marks on the miter cover and the miter housing to aid in realignment during assembly.

Remove the lube fitting and four bolts and lock washers from the miter shaft cover.



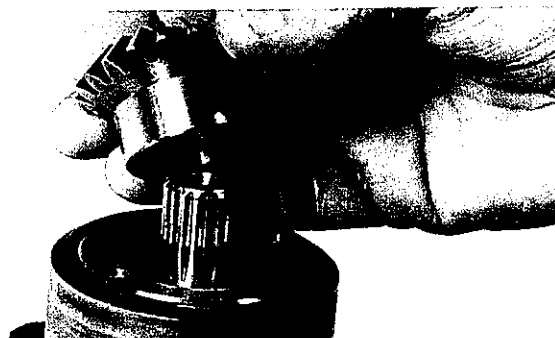
S-133

Carefully turn and pull miter shaft and cover from the miter housing.



S-134

Drive roll pin from miter gear and pull gear off miter shaft. Remove shims/gaskets and lay aside.



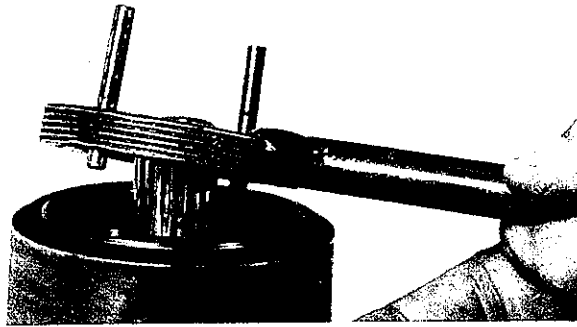
S-135

Pry locating pin out of the bearing retainer ring and pull from the cover.



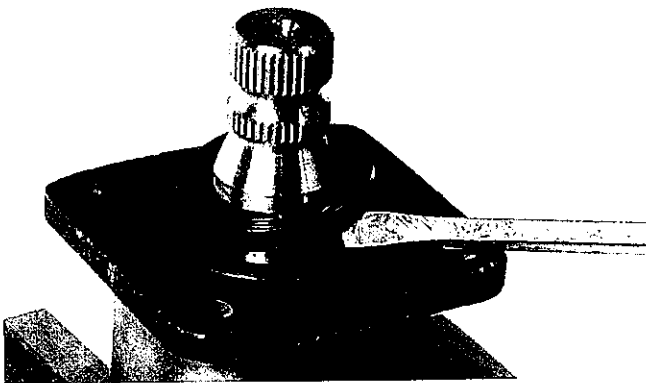
S-136

SHEPPARD POWER STEERING SERVICE MANUAL



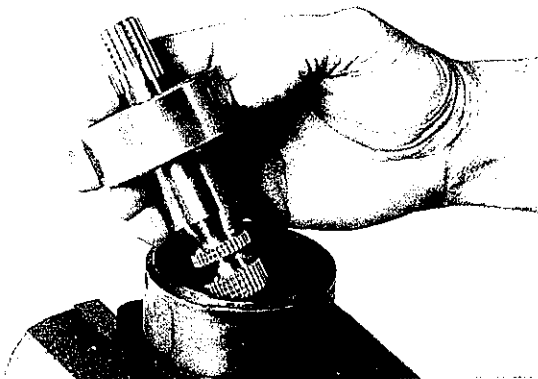
S-137

Turn bearing retainer counter clockwise to remove from the cover tap the miter shaft and bearing out of the miter cover.



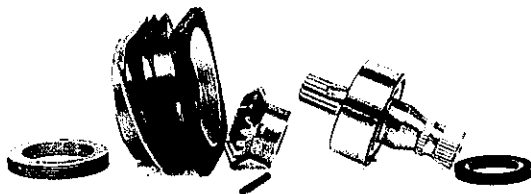
S-138

Remove seal from miter cover.



S-139

Carefully tap or press miter shaft out of the bearing.



S-140

For reassembly, reverse the order of disassembly, installing new parts as required. The bearing retainer is tightened to remove any possibility of end play or movement. Reinstall the locating pin to lock the retainer to the miter cap. It may be necessary to drill a new hole through the cover into the retainer.

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S-141

Remove the miter housing from the bearing cap by removing the bolts and lock washers which pass through the miter housing. Two bolts and lock washers are located inside the miter housing and must be removed before the housing can be separated from the bearing cap.



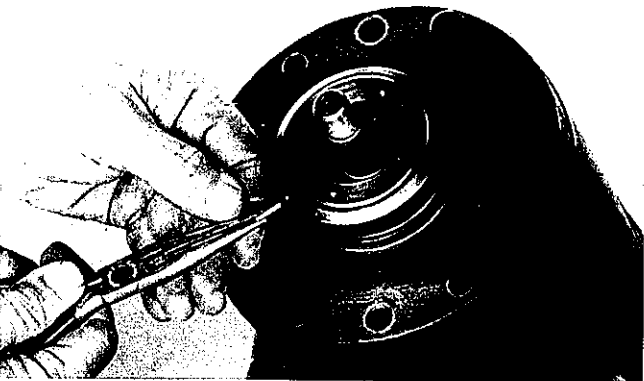
S-142

Carefully turn and with a soft hammer tap the housing off the bearing cap.



S-143

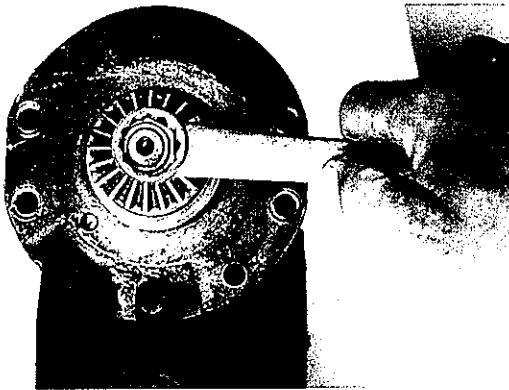
Remove the "O"-ring seal and the self-locking nut and washer from the actuating shaft, and remove the miter gear from the shaft.



S-144

Mark the bearing cap and bearing retainer to indicate the locking pin hole location and remove the retainer locking pin.

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S-145

Remove bearing retaining nut from the bearing cap.



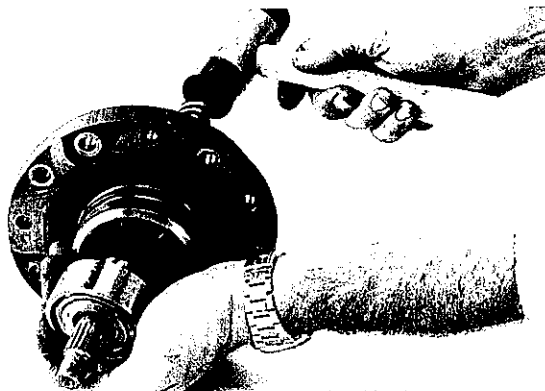
S-146

Remove the shims laying on top of the bearing and lay aside for reuse.



S-147

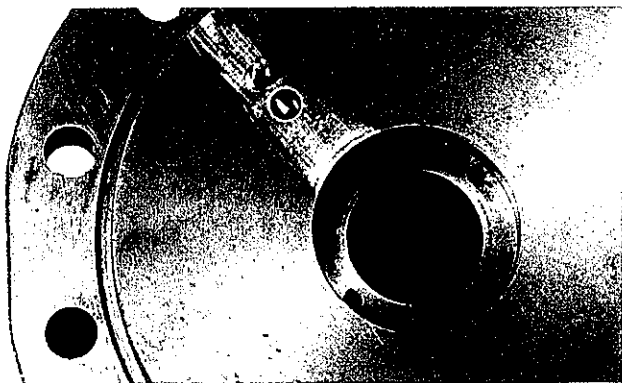
Remove remaining bolts and lockwasher attaching the bearing cap to the steering gear housing. Turn the actuating shaft and bearing cap out of the steering gear.



S-148

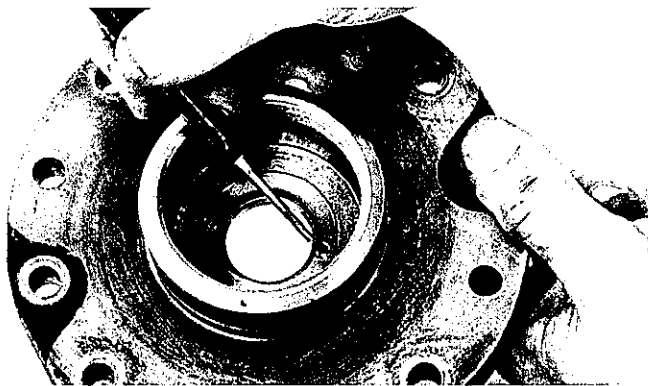
Carefully tap or press the actuating shaft and bearing out of the bearing cap. If necessary for replacement press the bearing off the actuating shaft.

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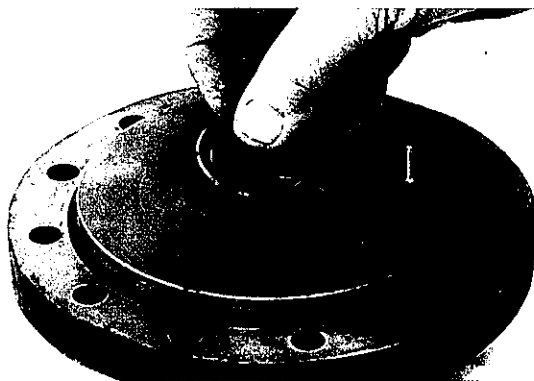
S-149

If the fixed plunger in the bearing cap is damaged it can be removed by pulling out the locking pin and pulling the plunger out of the bearing cap.



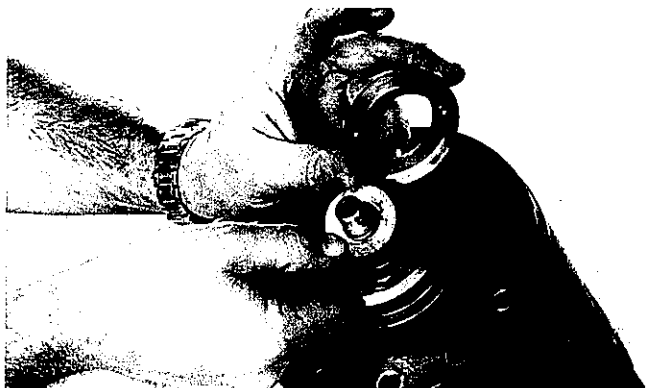
S-150

Tap the high-pressure actuating shaft seal out of the bearing cap if replacement is required.



S-151

Press a new seal in the bearing cap with the lip of the seal facing inside. Carefully install the actuating shaft and bearing through the seal and into the bearing cap. Replace bearing retainer and install locking pin.



S-152

Reinstall the shims on the bearing surface and install the miter gear and washer and retaining nut and torque to 60 ft. lbs.

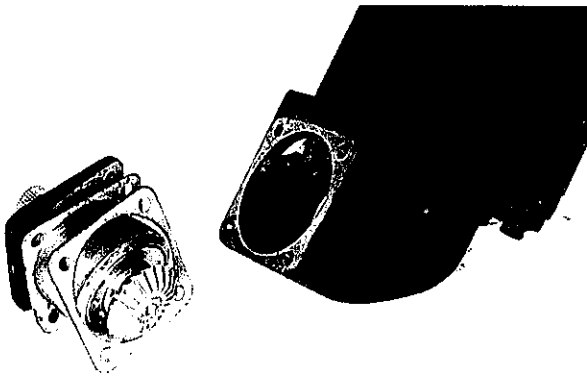
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S-153

Reinstall the miter housing to the bearing cap.

Caution: Do not neglect to reinstall the bolts and lockwashers inside the miter housing. Torque all bolts to specifications.



S-154

Reassemble miter housing cover using new gaskets and seals as required. Realign all reference marks made during disassembly and install all locking pins.



S-155

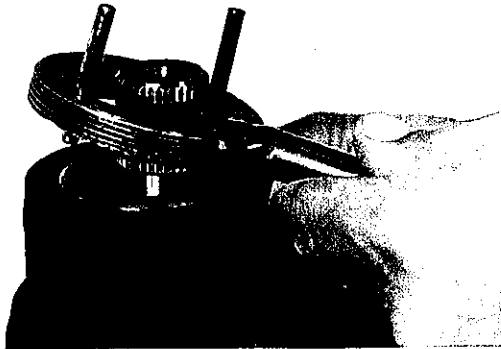
Install the reassembled miter cover into miter housing with shim pack/gaskets removed during disassembly and secure with two bolts and lockwashers.



S-156

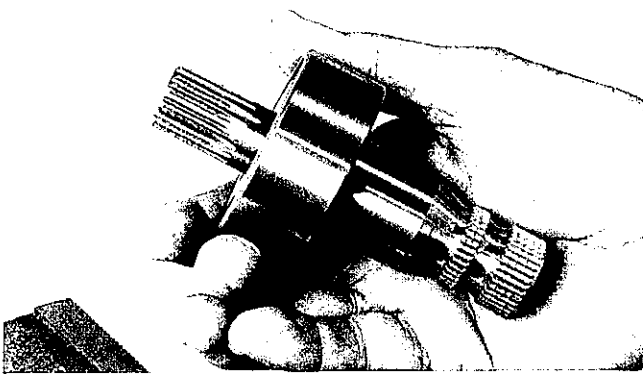
Check back lash between miter gears by turning the miter shaft with your fingers. Add or remove miter cover shims until zero backlash is obtained. The miter gears should be dry and free of grease for this adjustment.

SHEPPARD POWER STEERING SERVICE MANUAL



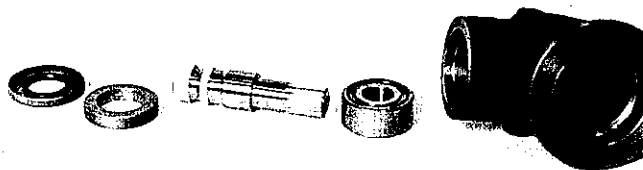
S-164

Use a spanner wrench to turn the bearing retainer out of the miter housing.



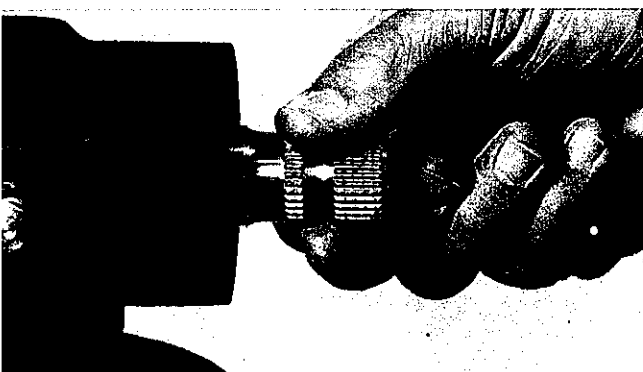
S-165

The double row bearing can now be drawn or tapped out of the housing for inspection or replacement.



S-166

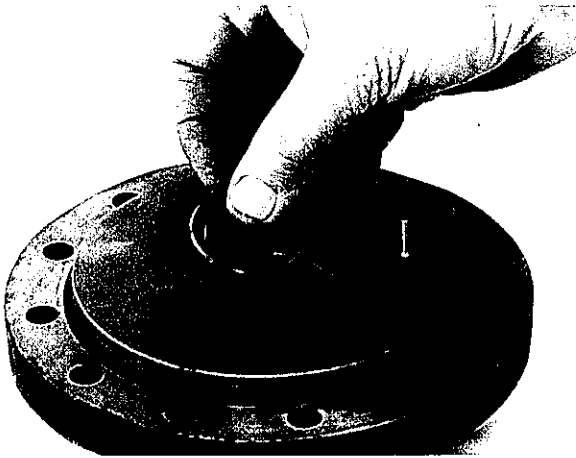
Reverse the order of disassembly to reassemble using new parts as required.



S-167

After reassembly of the complete miter housing to the bearing cap the backlash between the bevel gears must be checked. With the gears free of grease turn the input shaft with the fingers to judge the clearance between the gears. Add or remove proper shims to obtain zero clearance.

The miter housing should be filled with Fiske Multi Purpose Grease or an equivalent waterproof lubricant.



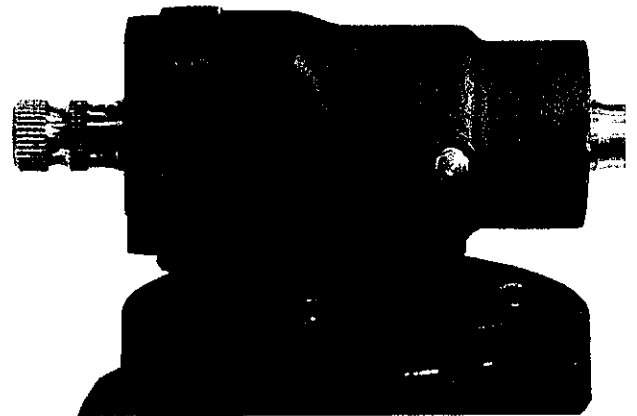
S-168

The steering gear bearing cap and high-pressure oil seal are serviced in the same manner as the fixed miter gear assembly. Refer to the fixed miter section of this manual for complete details.

T-BOX INPUT MITER – DISASSEMBLY & REPAIR

The Sheppard "T" box miter has two input shafts and is used where dual steering controls are desirable. The "T" box housing can be swiveled a full 360 degrees to place it in its optimum design position.

Note: The miter housing in most cases will be indexed to the bearing cap with a roll pin which passes through the clamping bar and enters a drilled hole in the miter housing. This ensures that the miter housing is placed in its optimum position. The locating pin will also keep the housing from turning in service. During re-assembly make sure that the locating pin is properly installed.



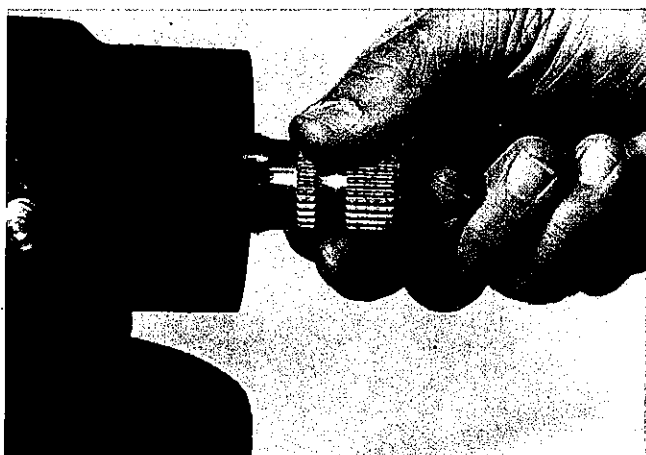
S-169

SHEPPARD POWER STEERING SERVICE MANUAL



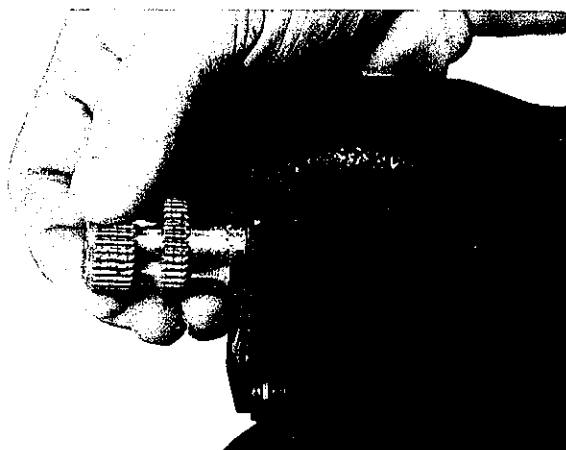
S-170

The two halves of the "T" box miter are serviced the same as the fixed miter cap and the swivel miter cap. Follow repair instructions previously outlined.



S-171

When the miter housing is reassembled to the steering gear the backlash must be adjusted to zero. Remove or install housing to bearing cap gaskets/shims to obtain zero backlash.



S-172

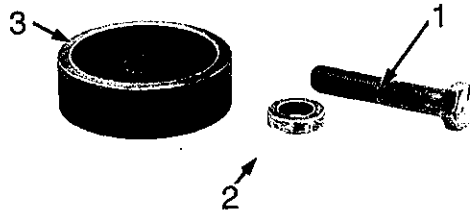
Once the miter housing is in place and the gear clearance has been checked and adjusted, the second input shaft and miter cap is installed. Again the gear clearance must be adjusted by removal or addition of gaskets/shims to obtain zero backlash.

Fill the miter housing with Fiske Multi Purpose Grease or an equivalent waterproof lubricant until a small quantity comes out the relief valve opposite the lube fitting.

SHEPPARD POWER STEERING SERVICE MANUAL

Available from the R. H. Sheppard Co. Inc.

Pitman Arm Installation Tool Set



S-173

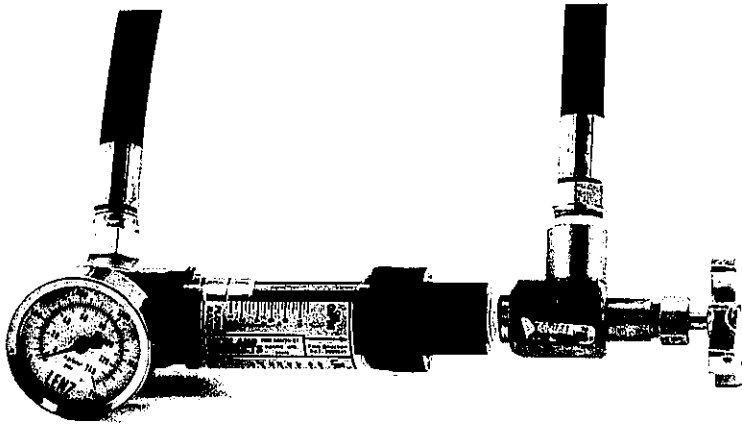
- Easy to use – Assures accurate torque settings
- Fill your requirements now!
- A must for the busy shop!

Model No.	Washer (Fig. 2)	Washer (Fig. 3)	Bolt (Fig. 1)	Part No.
191-192-292-39 252-292S-352-392S 372-382-392-491	2261611	2261521	181441 – 1/2 – 20NF x 2 3/4" Lg. Grade 5	5518211
492 51-59	2261621	2261571	181463 – 9/16 – 18NF x 3" Lg. Grade 5	5518221
592	2261631	2261581	271591 – 5/8 – 18NF x 3" Lg. Grade 5	5518231

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ITEM NO.	QTY. ORDERED	PART NUMBER	PART DESCRIPTION	UNIT PRICE	TOTAL
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Heavy-Duty Power Steering TEST KIT



This Tester is a self contained, direct reading device to check system, flow, pressure or both simultaneously. Requiring no electrical connections, it can detect worn components, verify flow and pressure control settings or monitor overall system performance.

LOW COST —

S-174

EASY TO USE —

Only one hose connection, is broken, either at the pump output or at the pressure input to the power steering gear housing.

★ **SHIPMENT FROM STOCK**
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- ★ Installs between pump and steering gear
- ★ Shutoff valve isolates pump from gear
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- ★ 1-10 G.P.M. flow meter
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ITEM NO.	QTY. ORDERED	PART NUMBER	PART DESCRIPTION	UNIT PRICE	TOTAL
		5517641	Pressure and Flow Test Kit		

Includes Sheppard service manual with operating instructions