

DISASSEMBLY AND ASSEMBLY GENERAL INSTRUCTIONS



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GENERAL INSTRUCTIONS

The following instructions will prove helpful to disassemble and assemble machine components. The information should be read and then referred to as necessary.

SAFETY

The safety symbols  or  in the manual indicate an item or procedure where the use of caution and safety is necessary. ALWAYS heed these symbols.

Your safety and that of others is always the number one consideration when working around machines. Safety is a matter of thoroughly understanding the job to be done and the application of good common sense; not just a matter of "do's" and don'ts."

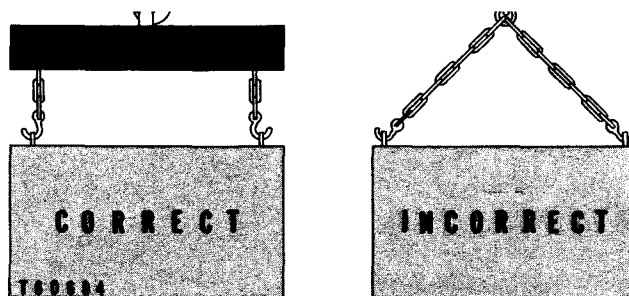
CLEANLINESS

Whenever hydraulic, fuel, lubricating oil or air lines are disconnected, clean the point of disconnection and the adjacent area. As soon as the disconnection is made, cap, plug or tape the line or opening to prevent entry of foreign material. The same recommendations for cleaning and covering supply when access covers or inspection plates are removed.

Clean and inspect all parts. Be sure all passages and holes are open. Cover all parts to keep them clean. Be sure parts are clean when installed. Leave new parts in their containers until ready for assembly.

REMOVAL AND INSTALLATION

Unless otherwise specified, all removals should be accomplished using an adjustable lifting beam. All supporting members (chains and cables) should be parallel to each other and as near perpendicular as possible to the top of the object being lifted.

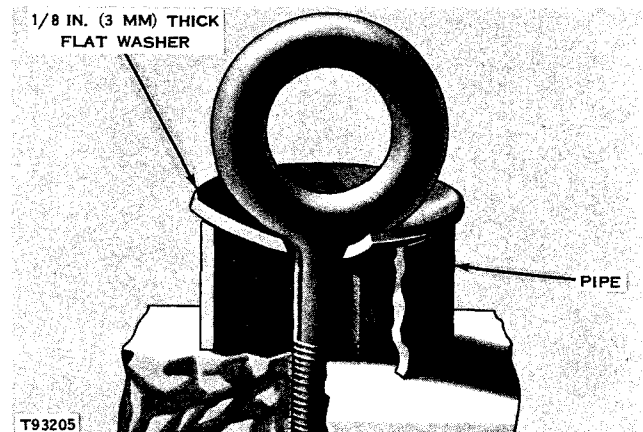


When it is necessary to remove a component on an angle, remember that the capacity of an eyebolt diminishes as the angle between the supporting members and the object becomes less than 90°.

Eyebolts and brackets should never be bent and should only have stress in tension. A length of pipe and a washer can be used, as shown, to help relieve these stresses on eyebolts.

Forged eyebolts are available. Each size eyebolt has a maximum load recommendation.

EYEBOLT LOAD RECOMMENDATION			
SIZE	PART NO.	MAXIMUM LOAD	
		lbs.	kg
¼"-20	1P7403	600	272.3
5/16"-18	1P7404	1125	510.6
3/8"-16	1P7405	1625	737.6
7/16"-14	1P7406	2250	1021.3
½"-13	1P7407	3000	1361.7
5/8"-11	7L660	5000	2269.5
¾"-10	1P7409	6250	2836.9



Some removals require the use of lifting fixtures to obtain proper balance and to provide safe handling.

If a part resists removal, check to be certain all nuts and bolts have been removed and that an adjacent part is not interfering.

DISASSEMBLY AND ASSEMBLY

When assembling a machine, complete each step in turn. Do not partially assemble one part and start assembling some other part. Make all adjustments as recommended. Always check the job after it is completed to see nothing has been overlooked.

FIRST OPERATION OF A REBUILT ENGINE

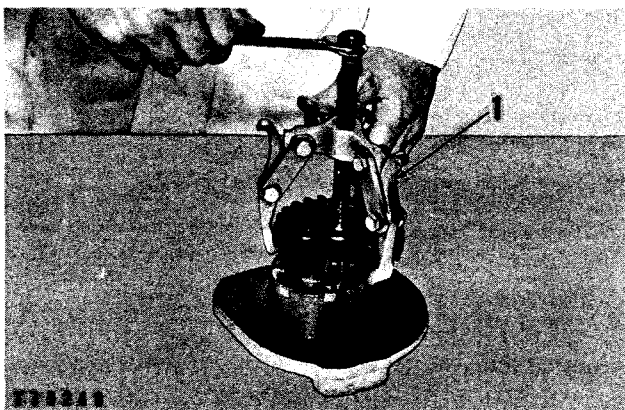
Use the following procedure:

1. If the diesel engine has a starting engine, use the starting engine to make the engine turn for 10 minutes.
2. Start the diesel engine, then run the engine at low RPM for 10 minutes. Make correct low idle governor adjustment. Check the pressure of the cooling system and the lubrication system. Look for leaks of water and of oil.
3. Run the engine at $3/4$ of full RPM with $1/2$ load for 15 minutes.
4. Run the engine at full RPM and make correct high idle governor adjustment, then run engine at full RPM and with full load for 30 minutes.

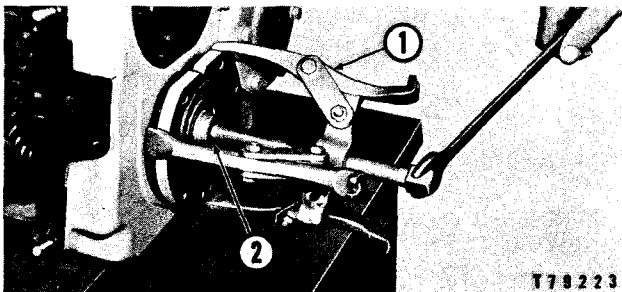
SERVICE TOOLS

Puller Assembly (2 or 3 Arm)

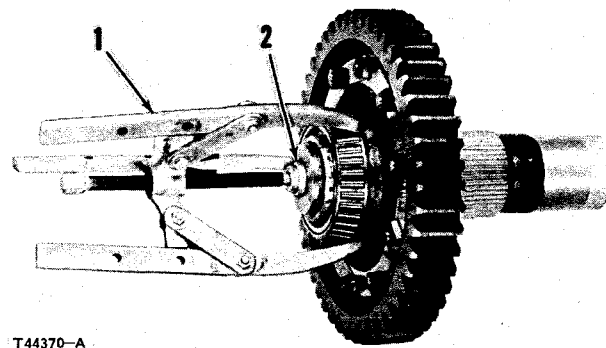
Two or three arm puller assemblies can be used to remove gears, bearing cages, hubs, bearings, shafts, etc.



1—Puller.



1—Puller. 2—Step Plate.

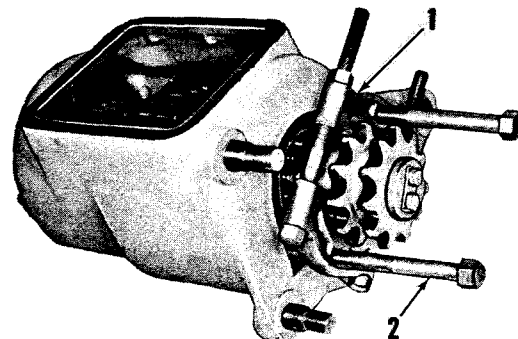


T44370-A

1—Puller. 2—Step Plate.

Bearing Pulling Attachment

Bearing Pulling Attachments can be used with forcing bolts, to remove shafts, bearings, gears, etc. They can be used with Push Pullers to provide a variety of pulling combinations.

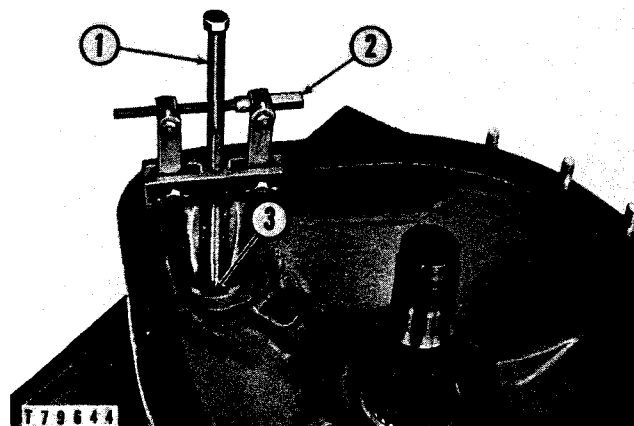


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1—Bearing Pulling Attachment. 2—Forcing Bolts.

Bearing Cup Pulling Attachment

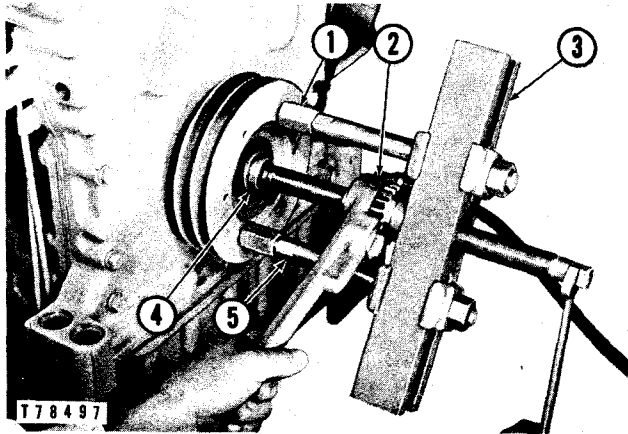
Bearing Cup Pulling Attachments are used to remove bearing races or cups, sleeve-type bearings, bearings, seats, etc. and can be used with Push Pullers.



1—Screw. 2—Bearing Cup Pulling Attachment. 3—Step Plate.

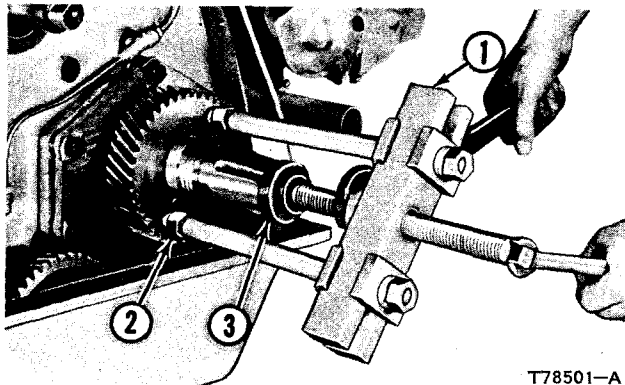
Push Pullers

Push Pullers can be used to remove pulleys, gears, shafts, etc., and can be used in a variety of pulling combinations.

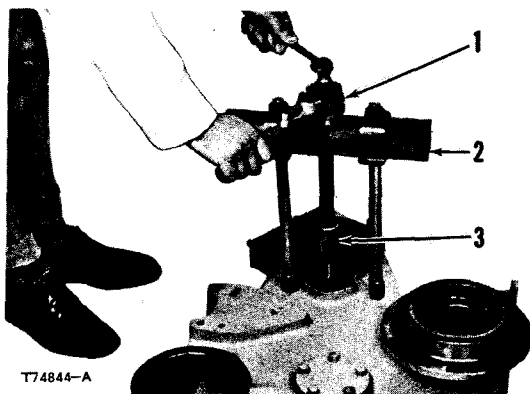


*1-Adapters. 2-Ratchet Box Wrench. 3-Push Puller. 4-Step Plate. 5-Legs.

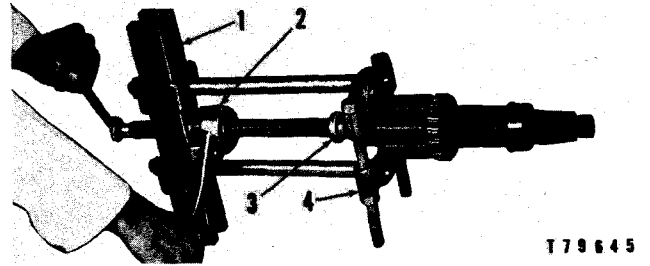
*Use as required.



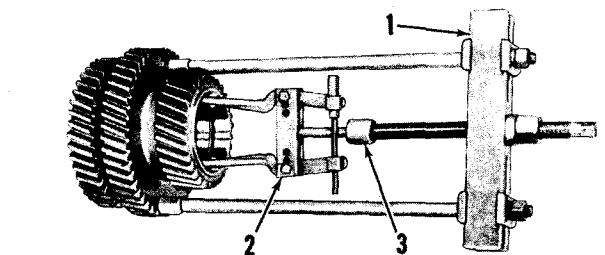
1-Push Puller. 2-Adapter. 3-Step Plate.



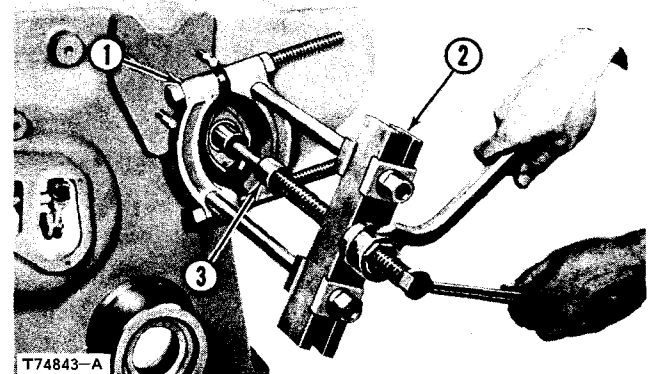
1-Ratchet Box Wrench. 2-Push Puller. 3-Reducing Adapter.



1-Push Puller. 2-Ratchet Box Wrench. 3-Step Plate. 4-Bearing Pulling Attachment.



1-Push Puller. 2-Bearing Cup Pulling Attachment. 3-Reducing Adapter.



1-Bearing Pulling Attachment. 2-Push Puller. 3-Reducing Adapter.

TOOL SAFETY



- RULE 1—Always use safe tools.
- RULE 2—Keep tools in safe condition.
- RULE 3—Use the right tool for the job.
- RULE 4—Safety sense with tools pays off.

PRESSING PARTS

When pressing one part into another, use 9M3710 Anti-Seize Compound or a molybdenum disulfide base compound to lubricate the mating surfaces.

Assemble tapered parts dry. Before assembling parts with tapered splines, be sure the splines are clean, dry and free from burrs. Position the parts together by hand to mesh the splines before applying pressure.

If parts which are fitted together with tapered splines are not tight, inspect the tapered splines and discard if worn.

BOLTS AND BOLT TORQUE

A bolt which is too long may "bottom" before the head is tight against the part it is to hold. The threads can be damaged when a "long" bolt is removed.

If a bolt is too short, there may not be enough threads engaged to hold the part securely.

Apply proper torque values to all bolts and nuts when assembling Caterpillar equipment. When a specific torque value is required, the value is listed in the SPECIFICATION section of the Service Manual. Tighten all other bolts and nuts for general usage, hydraulic valve bodies, or taperlock studs to the torque values given in the charts.

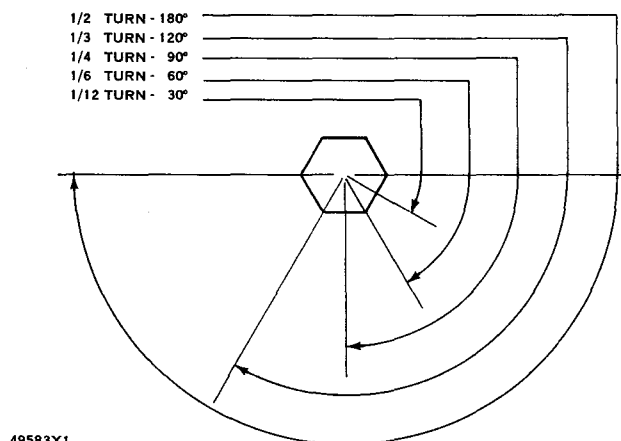
T-T-T Procedure

A torque-turn-tighten (T-T-T) procedure is used in many specifications and instructions.

1. Clean the bolt and nut threads.
2. Put lubricant on the threads and the seat face of the bolt and the nut.
3. Turn the bolt or the nut tight according to the torque specification.
4. Put a location mark on the part and on the bolt or the nut.
5. Turn the bolt or the nut tighter the amount of degrees according to the specifications.

TURN TIGHTER CHART	
TURN (BOLT OR NUT)	TURN DEGREES
1	360°
1/2	180°
1/3	120°
1/4	90°
1/6	60°
1/12	30°

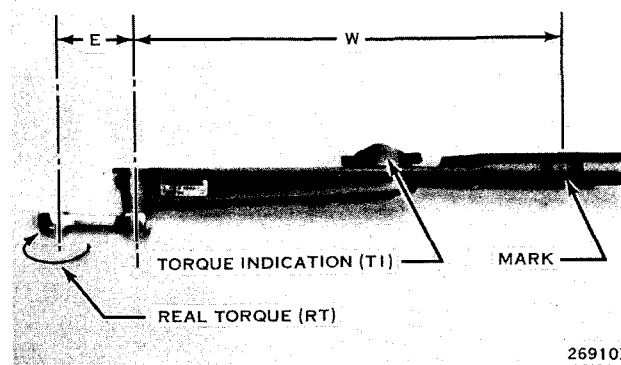
NOTE—The side of a nut or bolt head can be used for reference if a mark can not be put on.



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Torque Wrench Extension

When a torque wrench extension is used with a torque wrench, the torque indication on the torque wrench will be less than the real torque.



26910X1

TORQUE WRENCH WITH TORQUE WRENCH EXTENSION

E—Torque wrench drive axis-to-torque wrench extension drive axis. W—Mark on handle-to-torque wrench drive axis.

1. Put a mark on the handle. Measure the handle from the mark to the axis of the torque wrench drive (W).
2. Measure the torque wrench extension from the torque wrench drive to the axis of the torque wrench extension drive (E).
3. To get correct torque indication (TI) when the real torque (RT) is known: $TI = \frac{RT \times W}{W + E}$

Example: W = 12 in. (304.8 mm); E = 2.56 in. (65.0 mm); RT (from specifications) = 125 lb. ft. (17.3 mkg).

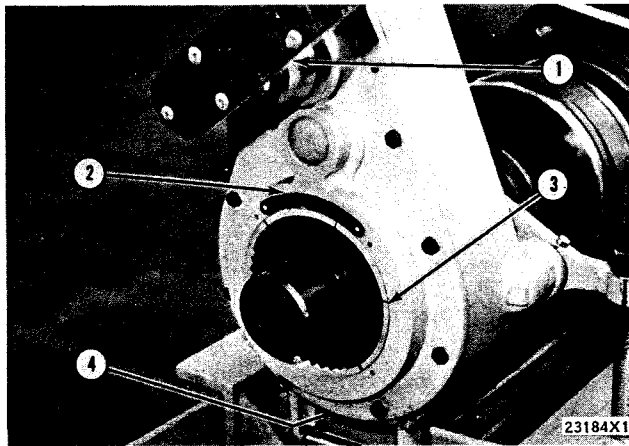
$$TI = \frac{125 \times 12}{12 + 2.56} \text{ or } 103 \text{ lb. ft.}$$

$$= \frac{(17.3 \times 304.8)}{(304.8 + 65.0)} \text{ or } (14.2 \text{ mkg})$$

4. Hold the torque wrench handle with the longest finger of the hand over the mark on the handle to get the real torque (RT) with low torque indication (TI) on the torque wrench.

1P850 Torque Multiplier

A torque wrench capacity is increased when the torque wrench is used with 1P850 Torque Multiplier. An 8H8561 Adapter will be needed when a torque wrench with 1/2 inch (12.7 mm) drive is used with 1P850 Torque Multiplier.



1P850 TORQUE MULTIPLIER

1—Torque wrench. 2—60° Protractor. 3—Six marks (60° apart). 4—Chart (under handle).

A chart (4) under the torque multiplier handle has the torque wrench input torque and the torque multiplier output torque.

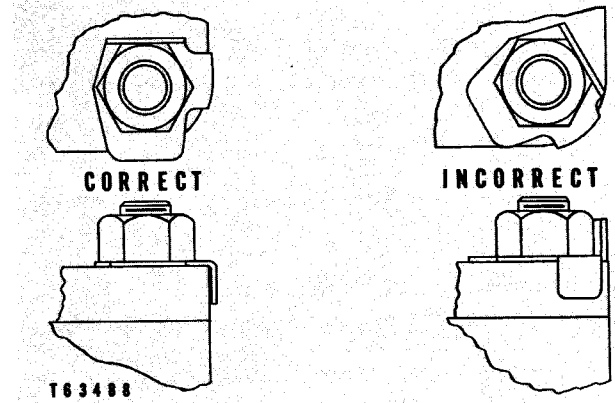
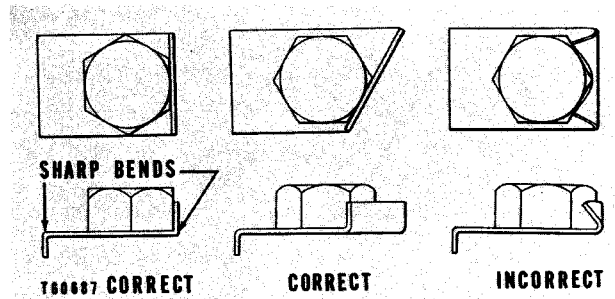
When the T-T-T (torque-turn-tighten) procedure is needed a 60° protractor (2), on the torque multiplier face and six marks (3), on the output drive, are used.

LOCKS

Flat metal locks must be installed properly to be effective. Bend one end of the lock around the edge of the part. Bend the other end against one flat surface of the nut or bolt head.

Always install new locks in compartments which house moving parts.

When installing lockwashers on housings made of aluminum, use a flat washer between the lockwasher and the housing.



LINES AND WIRES

When removing or disconnecting a group of lines or wires, tag each one to assure proper assembly.

LUBRICATION

Where applicable, fill the compartments of the components serviced with the amount, type and grade of lubricant recommended in the Lubrication and Maintenance Information part of this Manual.

RUST PREVENTIVE COMPOUND

Clean the rust preventive compound from all machined surfaces of new parts before installing them.

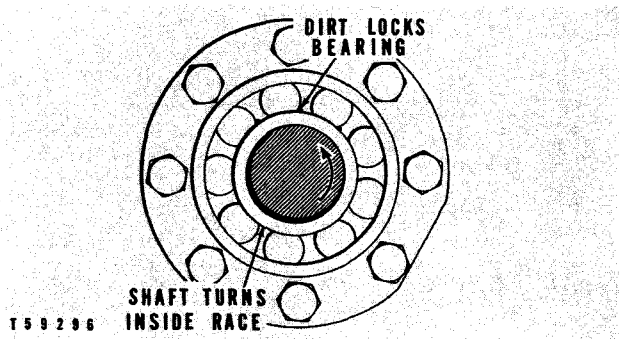
SHIMS

When shims are removed tie them together and identify them as to location. Keep shims clean and flat until they are reinstalled.

BEARINGS

Anti-Friction Bearings

When an anti-friction bearing is removed, cover it to keep out dirt and abrasives. Wash bearings in nonflammable cleaning solution and allow them to drain dry. The bearing may be dried with compressed air but DO NOT SPIN THE BEARING.



Discard the bearings if the races and balls or rollers are pitted, scored or burned. If the bearing is serviceable, coat it with oil and wrap it in clean paper. Do not unwrap new bearings until time of installation.

The life of an anti-friction bearing will be shortened if not properly lubricated.

Double Row, Tapered Roller

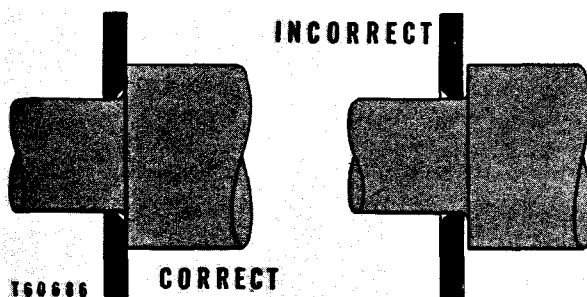
Double row, tapered roller bearings are precision fit during manufacture and the components are not interchangeable. The cups, cones and spacers are usually etched with the same serial number and letter designator. If no letter designators are found, wire the components together to assure correct installation. Reusable bearing components should be installed in their original positions.

Heating Bearings

Bearings which require expansion for installation should be heated in oil not to exceed 250° F. (121° C.). When more than one part is heated to aid in assembly, they must be allowed to cool and then pressed together again. Parts often separate as they cool and shrink.

Installation

Lubricate new or used bearings before installation. Bearings that are to be preloaded must have a film of oil over the entire assembly to obtain accurate preloading. When installing a bearing, spacer or washer against a shoulder on a shaft, be sure the chamfered side is toward the shoulder.



When pressing bearings into a retainer or bore, apply pressure to the outer race. If the bearing is pressed on the shaft, apply pressure on the inner race.

Preload

Preload is an initial force placed on the bearing at the time of assembly.

Determine preload or end clearance from the SPECIFICATIONS. Care should be exercised in applying preload. Misapplication of preload to bearings requiring end clearance can result in bearing failure.

Sleeve Bearings

DO NOT INSTALL SLEEVE BEARINGS WITH A HAMMER. Use a press if possible and apply the pressure directly in line with the bore. If it is necessary to drive on a bearing use a driver or a bar with a smooth flat end. If a sleeve bearing has an oil hole, align it with the oil hole in the mating part.

GASKETS

Be sure the holes in the gaskets correspond with the lubricant passages in the mating parts. If it is necessary to make gaskets, select stock of the proper type and thickness. Be sure to cut holes properly. Blank gaskets can cause serious damage.

BATTERIES

Clean batteries by scrubbing with a solution of baking soda and water. Rinse with clear water. After cleaning, dry thoroughly, coat terminals and connections with anti-corrosion compound or grease.

If an engine is not to be used for a long period of time, remove the batteries. Store them in a warm, dry place, on wooden shelves. Never store on concrete. A small charge should be introduced periodically to keep the specific gravity rating at recommended level.

BRAKE LININGS

Replace brake linings before they have worn enough for rivet heads to contact and score the brake drums.

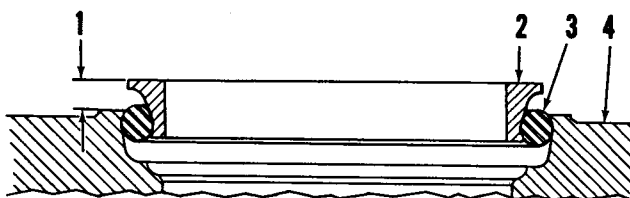
SEALS

Duo-Cone Floating Seals

Floating ring seals have highly finished surfaces and are held together by toric sealing rings. The flexibility of the toric sealing rings makes the

floating ring seals self aligning and compensates for wear on the metal faces.

During disassembly, tape the metal floating ring seals together so they will be kept in matched sets. Always install the metal floating ring seals in pairs; that is, two new seals together or two seals that have previously run together. Never reinstall a used toric sealing ring.



T87199

CORRECT INSTALLATION

The illustration shows the dimension (1) to be checked, the metal floating ring seal (2), the rubber toric sealing ring (3) and the toric sealing ring retainer (4). The dimension must be uniform around the entire circumference of the floating ring seal. Check the dimension at 90° intervals.

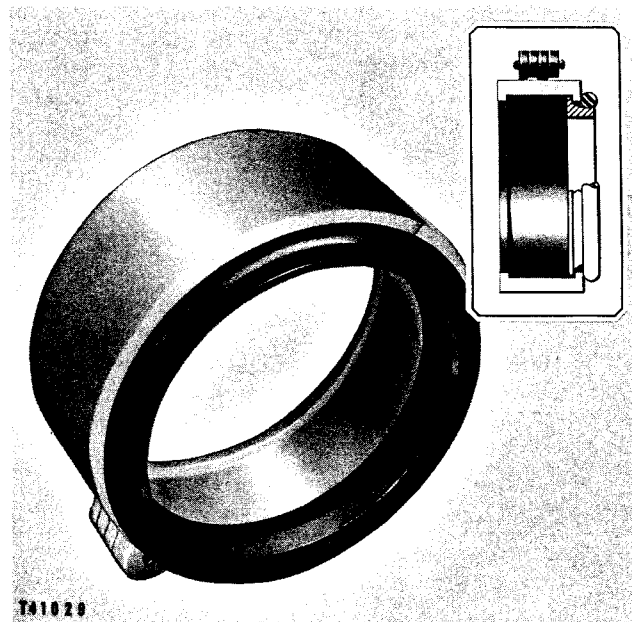
Handle all parts with care to avoid nicks. File smooth any parts, other than the sealing faces, that have nicks that may make assembly difficult or questionable. Wash used parts. Use a wire brush to clean dirt or rust from the bore of the seal retainers to assure they are clean and smooth. Remove all oil or the protective coating from floating ring seals and retainers with a nonflammable cleaning solvent. Be sure the ramp on the retainers and on the floating ring seals are dry.

Check the ramps for tool marks and nicks. On used parts, remove dirt or rust deposits from the ramps. Smooth the surface with emery cloth.

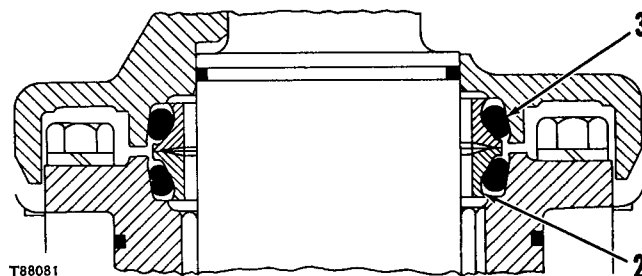
SEAL INSTALLING TOOL SELECTION CHART			
DUO-CONE SEAL GROUP	METAL RING SEAL	TORIC SEALING RING	SEAL INSTALLER
4D4510	4D4471	4D4472	1S4320
4D8960	4D8959	4D3472	7S3128
4K6049	4K174	4K173	1S8966
5K1078	5K1069	5K1075	2S8027
5K5288	5K5126	5K5129	5S4276
1M8746	8H2230	8H2265	5M2160
1M8747	8H2229	8H2262	5M2158
1M8748	8H2231	6H1309	5M2162
2M2858	1M3098	1M3097	5M2196
5M1176	4M2621	2M344	8M7911
5M1177	4M659	4M660	8M7912
5M7294	4M735	4M736	8M7913
5M8647	1M9012	1M9011	8M9395 (1S576)
7M481	7M480	7M475	9M5143
2N4074	2N4073	8M2265	5M2160
2N4080	2N4079	5K5129	5S4276
3S303	2S9754	3S302	7L4949
4S5001 & 7S1527	4S5002 & 7S1528	3S4672	5S4275

Install new toric sealing rings or floating ring seals. Seat the toric sealing ring uniformly in the relief of the ring seal. Be sure the toric sealing ring is not twisted. It must set straight against the lip which keeps it from falling off the floating ring seal.

Duo-Cone floating seal installation tools are available for various size seals. A typical installation tool is shown in the illustration.



T81020



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Duo-Cone floating seals installed with metal floating ring seal (2) and toric sealing ring (3) properly positioned.

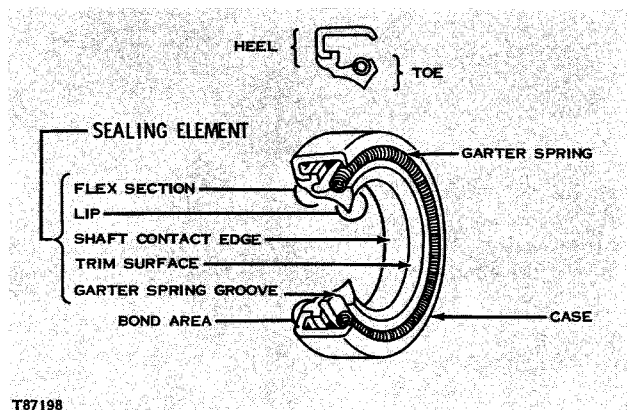
If an installer tool is not used, install the toric sealing ring and floating ring seal as an assembly by pressing on the toric sealing ring. Use finger pressure only. Be sure the toric sealing ring is seated uniformly in the recess of both the floating ring seal and the retainer. Make sure it sets in the bore straight and against the lip that keeps it from falling out of the retainer. **DO NOT USE A SCREWDRIVER OR STICK TO ASSEMBLE THE TORIC SEALING RING IN THE RETAINER.**

Before assembling floating ring seals together, wipe faces of seals with lint-free tissue to remove

any foreign material and fingerprints. Place one drop of oil on the cleaning tissue and coat the sealing surfaces of the seals. Be careful to prevent any oil from contacting the toric sealing ring or its mating surfaces.

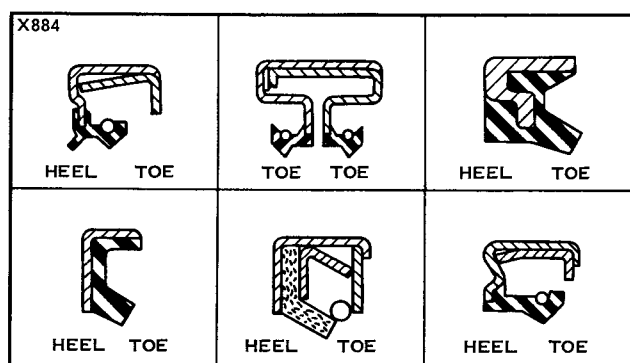
Lip-Type Seals

Generally the toe or spring-loaded lip of an oil seal faces the oil being sealed or the oil having the higher pressure. The toe or lip of a grease seal faces away from the lubricant being sealed. Unless otherwise specified, use the preceding rules for installing lip-type seals.



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The main parts of a lip-type seal are the case, sealing element, and garter spring. The picture illustrates the construction of a simple lip-type seal. The cross sections show the terms "heel" and "toe" used to identify the sides of various types of seals.



Lubricate the lips of lip-type seals before installation. Use the same type lubricant in which the seal will be operating. Do not use grease on any seal except a grease seal.

If, during installation, the seal lip must pass over a shaft that has splines, a keyway, rough surface or a sharp edge, the lip can be easily damaged. Shim stock or other such material can be formed around the area to provide a smooth surface over which to slide the seal.

HYDRAULIC SYSTEMS

Cleanliness

- ... When removing components of a hydraulic system cover all openings in both the component and the machine.
- ... If evidence of metal or rubber particles are found in the hydraulic system, flush the entire system.
- ... Disassemble and assemble hydraulic components on a clean surface. Clean all metal parts in a nonflammable cleaning fluid. Then lubricate all components to aid in assembly.

Safety

Before servicing the hydraulic system, **NEUTRALIZE THE HYDRAULIC PRESSURE.**

PROCEDURE:

1. Lower all implements to the ground. In some instances a removal procedure may require the implement to be blocked in a certain position.
2. With the engine shut off, move the hydraulic control levers to all positions to insure there is no pressure in the system.
3. Place all control levers in HOLD position.

NOTE—When attached hydraulic equipment is removed from a machine which will continue to be used, the hydraulic system lines must be securely blocked. High pressure protective covers are available. The following chart lists the protective covers for various size hydraulic hoses. One O-ring seal is required with each protective cover.

APPROXIMATE HOSE SIZE				PRO- TECTIVE COVER	O - RING SEAL	TWO BOLT FLANGE	SPLIT FLANGE
INCHES		MILLIMETERS					
O.D.	I.D.	O.D.	I.D.				
1.00	.50	25.4	12.7	5H4017	5F7054	5F6804	1H5278
1.06	.62	26.9	15.7	8S7668	4J8996	—	6K3253
1.25	.75	31.7	19.0	5H4013	5F1678	5F2046	2K190
1.50	1.00	38.1	25.4	5H4019	4F7391	5F2442	1H3305
2.00	1.25	50.8	31.7	5H4020	4F7952	—	3H3667
2.25	1.50	57.1	38.1	2J2668	7F8267	—	3H4330

CAUTION—Do not use the thin sheet metal covers designed for shipping and storage. These covers can rupture when high pressure is applied.

Sealing Elements

Inspect all sealing elements (O-rings, gaskets, etc.) when disassembling and assembling hydraulic system components. Install new elements if necessary.

Always use the recommended Caterpillar part number when installing new sealing elements. Seals may resemble one another but will not necessarily be compatible in a given application.

Hydraulic Lines

When installing metal tubes, tighten all bolts finger-tight. Then, in this order, tighten the bolts at the rigid end, the adjustable end, and the mounting brackets. After the tubes are mounted, install the hoses. Connect both ends of the hose with all bolts finger-tight. Position the hose so it does not rub the machine or another hose and has a minimum of bending and twisting. Tighten bolts in both couplings.

Due to manufacturing methods there is a natural curvature to a hydraulic hose. Install the hose so any bend is with this curvature. In case of replacement hoses with angled-stem and reusable fittings, the hose curvature must be taken into consideration when assembling and positioning the angled stems.

After the hoses are installed, follow this procedure: With the diesel engine running, move the appropriate control levers to move the implement to every possible position. Observe the hoses during the cycle. Then lower the implement to the ground. Shut off the diesel engine and eliminate any twisting, rubbing, and/or excessive drooping of hoses by rotating the stem of the hoses.

Hydraulic Fittings

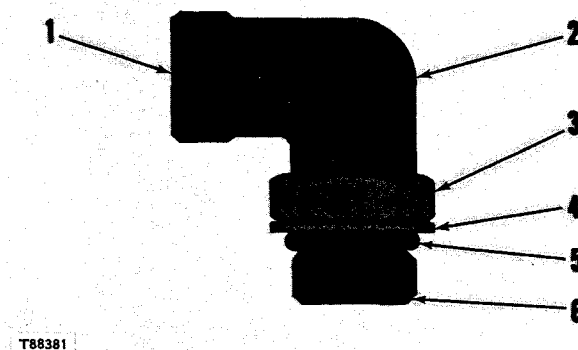
Fitting Bodies with Straight Threads and O-ring Seals

This type of fitting is used in several applications. The tube end of the body will vary in design depending upon the application. However, the installation procedure of the fitting body into its mating boss will be the same. If the tube end of the fitting body is as illustrated (either elbow or straight body) a presetting procedure is necessary to assemble the sleeve onto the tube before connecting the tube to the end. See the topic **ASSEMBLY OF SLEEVES ONTO TUBES, TYPE A**.

1. Place the nut, washer and seal as far back on the fitting body as possible. Hold the components in this position and screw the fitting into its boss until washer just contacts the face of the boss.
2. Place the fitting assembly in its correct angular position by turning the body out (counter-clockwise), a maximum of 359°. Tighten the nut finger-tight.

NOTE—If the fitting is a connector (straight fitting), the hex on the body takes the place of the

nut. Install this type fitting by tightening the hex against the face of the boss.



ELBOW BODY ASSEMBLY

1—End of fitting body (connects to tube). 2—Fitting body. 3—Locknut. 4—Backup washer. 5—O-ring seal. 6—End of fitting (screws into mating boss).

3. Install the assembled tube onto the tube end of the body, finger-tight. Tighten the nut positioning the body. Then tighten the nut on the tube assembly.

Flared and O-ring Fittings

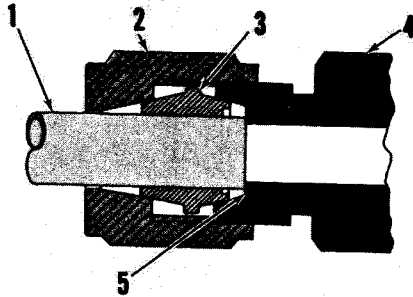
The nut on flared or inverted flared fittings used with steel tubing, swivel nuts, O-ring plugs and O-ring fittings are tightened to torque specifications. See **CHART**.

SWIVEL NUT, O-RING FITTING OR PLUG AND FLARED FITTING TORQUE				
THREAD SIZE	TUBE DIAMETER		TORQUE	
	in.	mm.	lb. ft.	mkg
5/16	.125	3.17	3 to 5	0.4 to 0.7
3/8	.188	4.77	5 to 7	0.7 to 1.0
7/16	.250	6.35	8 ± 2	1.1 ± 0.3
½	.312	7.92	12 ± 3	1.7 ± 0.4
9/16	.375	9.52	15 ± 5	2.1 ± 0.7
5/8	.375	9.52	15 ± 5	2.1 ± 0.7
¾	.500	12.70	30 ± 5	4.1 ± 0.7
7/8	.625	15.87	40 ± 5	5.5 ± 0.7
1-1/16	.750	19.05	55 ± 5	7.6 ± 0.7
1-3/16	.875	22.22	65 ± 5	9.0 ± 0.7
1¼	.875	22.22	65 ± 5	9.0 ± 0.7
1-5/16	1.000	25.40	80 ± 5	11.1 ± 0.7
1-5/8	1.250	31.75	100 ± 10	13.8 ± 1.4
1-7/8	1.500	38.10	120 ± 10	16.6 ± 1.4
2½	2.000	50.80	230 ± 20	31.8 ± 2.8

Assembly of Sleeves onto Tubes Type A

It is necessary to preset this type of sleeve onto the tube before the tube assembly is installed on the fitting body.

1. Lubricate the sleeve and the threads.
2. Place the nut on the tube with the threaded end of the nut toward the end of the tube.



T88382

SLEEVE-TYPE FITTING

1—Tube. 2—Nut. 3—Sleeve. 4—Fitting. 5—Shoulder.

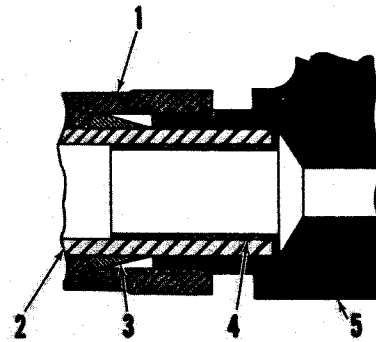
3. Place the sleeve onto the tube so the short-tapered heavy end faces the fitting as illustrated.

NOTE—Fitting is used when a presetting tool is not available.

4. Bottom the tube end against shoulder of the fitting.
5. Turn the nut and turn the tube at the same time. When the tube can not be made to turn, turn nut one more turn tighter.
6. Remove the tube from the fitting. Check to be certain sleeve does not move longitudinally. (The sleeve can rotate on the tube.)
7. When the tube assembly is assembled onto the fitting body, tighten the nut until the threads on the body are no longer visible. Refer to the topic FITTING BODIES WITH STRAIGHT THREADS AND O-RING SEALS for the installation of the fitting bodies.

Type B

1. Place the nut and sleeve onto the tube. Install the sleeve so the thick end faces away from the body.
2. Install the insert into the tube.
3. Bottom the tube and insert the body as illustrated.



T88383

SLEEVE AND INSERT-TYPE FITTING

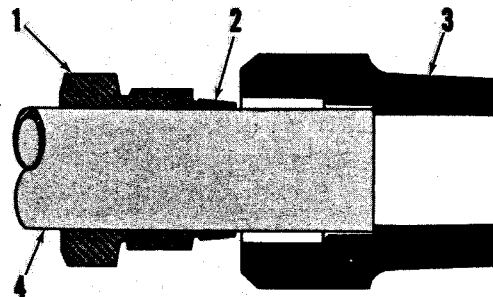
1—Nut. 2—Tube. 3—Sleeve. 4—Insert. 5—Fitting body.

4. Tighten the nut $1\frac{1}{2}$ turns past finger-tight.

Type C

With the nut and sleeve installed loosely in the body, install the tube through the nut and sleeve until the end of the tube is seated against the shoulder in the fitting body.

Grip the tube firmly to prevent twisting or turning and tighten nut until a slight "give" or decreased resistance is felt. The "give" indicates that the sleeve has been sheared from the nut. Tighten the nut an additional $1\frac{1}{2}$ turns. It is not necessary to tighten the nut all the way down.



T88384

SHEAR-TYPE FITTING

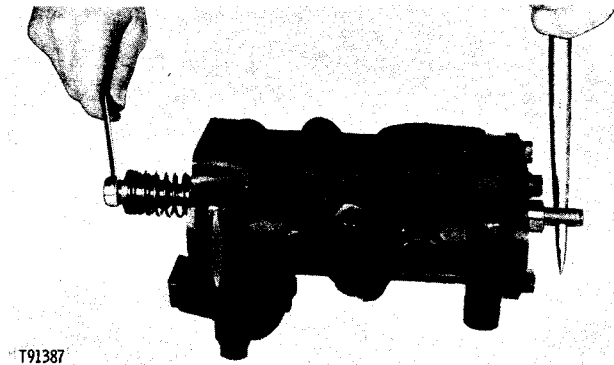
1—Nut. 2—Sleeve. 3—Fitting body. 4—Tube.

Hydraulic Valves

Examine all valves, valve bores and valve seats for nicks, burrs and/or scratches. (Rough spots may be removed with a crocus cloth or fine emery cloth.) All valves which operate in bores must slide freely in their bores. Be certain all passages are clean and open.

Springs

On control valve spools having bolt-retained centering or return springs, the bolt should be removed while the valve spool is in the valve body. This procedure will prevent spool distortion and possible damage to the spool lands.



Check all springs to be certain they meet the values listed in the SPECIFICATIONS.

Shims

When installing shims to adjust pressure settings, always place the thick shim or spacer against the spring.

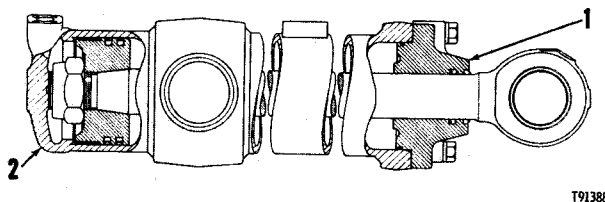
Cylinders

Rod End or Head End?

The "rod end" (1) of a cylinder is that end that has the rod extending.

The "head end" (2) is the other end of the cylinder — the blind end.

The rod end line directs oil to the rod end of the cylinder to retract the rod. The head end line directs oil to the head end of the cylinder to extend the rod.



Removal

The hydraulic system need not be drained to remove any or all cylinders. Only the oil in the lines between the cylinder and its control valve will be lost. However, the control lever must remain in HOLD position or oil can drain from the tank in some instances.

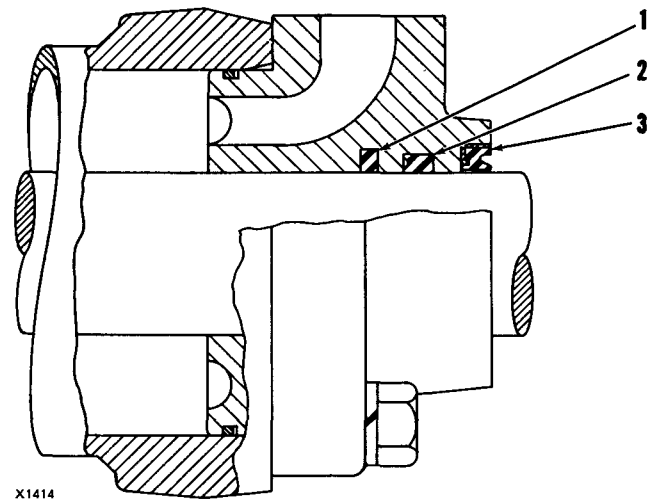
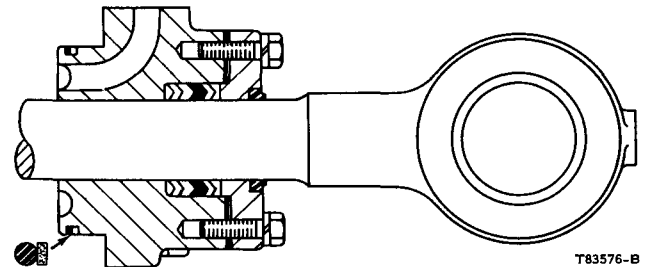
Disassembly and Assembly

Remove and install the bolts securing the cylinder head to the cylinder with the piston rod fully extended.

Cylinder Head Seals

The rubber O-ring seal and the back-up ring which form the seal between the head and cylinder bore are all assembled as illustrated.

Note that the toe or lip of all wiper seals (3) on all cylinders faces away from the cylinder head.



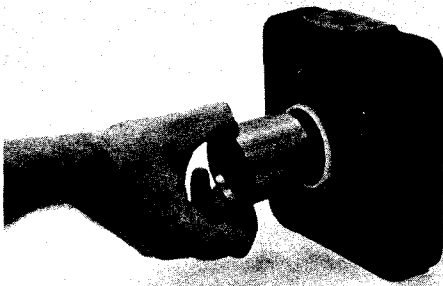
THREE SEAL CYLINDER HEAD

1—Buffer seal. 2—U-cup seal (always installed with lip facing the oil). 3—Wiper seal.

Seal Guide for Installation of Cylinder Head.

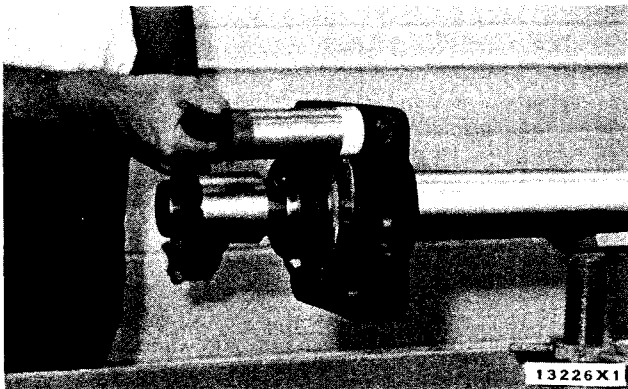
A hydraulic cylinder rod with a sharp edge, on the thread end of the rod, needs a seal guide to put the cylinder head on the cylinder rod.

1. Put lubricant on the seals. From the outside face of the cylinder head, push the small diameter end of the seal guide into the seals.
2. Place the thread end of the rod in the seal guide and push the cylinder head on the rod.



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TYPICAL SEAL GUIDE AND CYLINDER HEAD



13226X1

PUSH CYLINDER HEAD ON ROD

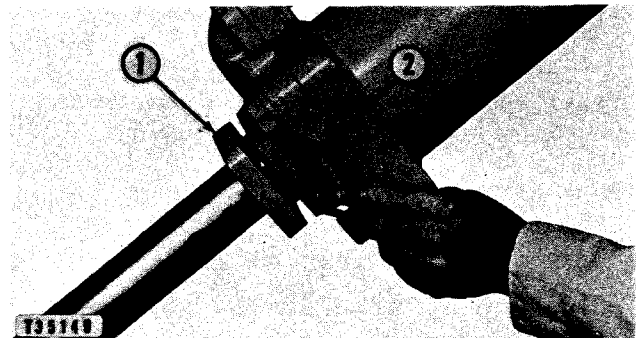
Cylinder Head Packing Adjustment

Oil leakage between the rod and the hydraulic cylinder packing can be the result of worn, cut, and/or distorted packing. Leakage can often be stopped by removing shims (2) located between retainer (1) and the cylinder head; this will allow the packing to be compressed against the rod when the retainer is tightened.

Remove the bolts securing retainer (1) to the cylinder head. Move the retainer away from the cylinder head to allow the shims to be cut and removed.

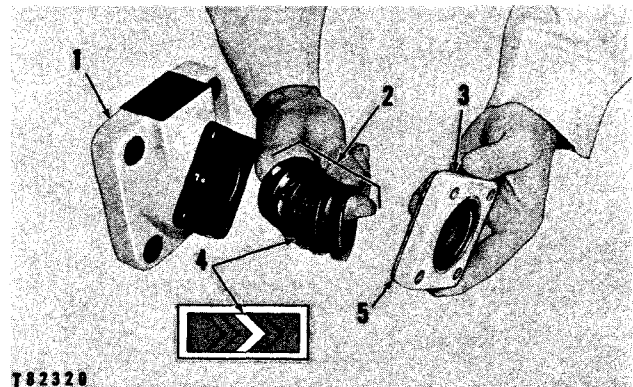
Remove one shim (2); install retainer (1) and operate the cylinder. If leakage is still apparent, repeat the procedure. If the cylinder leaks after removing two shims, remove and disassemble the cylinder and replace the packing.

NOTE—Remove only the shims (2) which measure .010 in. (0.25 mm) in thickness. The thicker shims should not be removed to adjust the packing.



REMOVING SHIMS
1—Retainer. 2—Shims.

Installing Packing and Shims in Head



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HEAD ASSEMBLY

1—Head. 2—Packing. 3—Retainer. 4—Rubber pressure ring.
5—Shims.

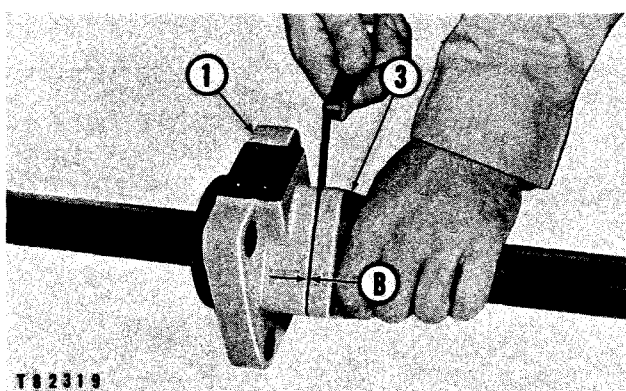
1. Place retainer (3) on rod (6). Separate and oil all the rings of packing (2). Place the packing

SEAL GUIDE	CYLINDER ROD		
	DIAMETER		THREAD DIAMETER
PART NO.	in.	mm	
1P762	1.50	38.10	1.00
1P763	1.50	38.10	1.25
1P764	2.00	50.80	1.50
1P765	2.25	57.15	1.50
1P766	2.25	57.15	1.75
1P767	2.38	60.32	1.75
1P768	2.50	63.50	2.00
2P8284	2.75	69.85	2.00
1P769	2.75	69.85	2.25
1P770	3.00	76.20	2.25
1P771	3.00	76.20	2.50
1P772	3.25	82.55	2.25
1P773	3.25	82.55	2.50
1P774	3.25	82.55	2.75
1P775	3.50	88.90	2.75

81900X1

on the rod so the open part of the V will be facing toward head (1) when the head is installed. Be sure rubber pressure ring (4) is located as shown.

2. Place the head on the rod and insert one ring of packing at a time into the head.
3. Tap packing firmly into the head with the retainer (3).
4. Hold retainer (3) firmly against the packing and measure clearance (B) between the retainer and head with a thickness gauge. Sufficient shims (5) must be installed between the retainer and head to obtain a total thickness of .010 in. to .015 in. (0.25 to 0.38 mm) less than the measured clearance (B). The shims will preload the packing properly when the retainer bolts are tightened.

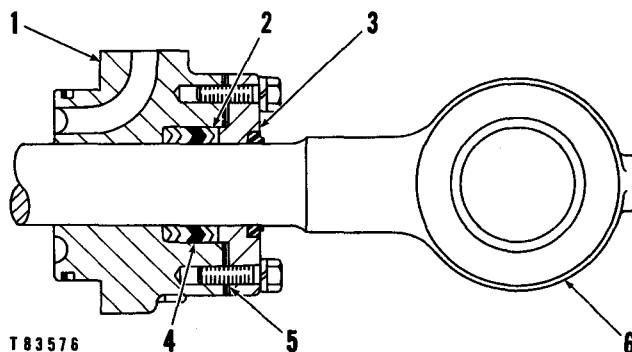


MEASURING CLEARANCE

1—Head. 3—Retainer. B—Clearance to be measured between head and retainer.

5. Remove the head and contained packing from the rod. Install the correct amount of shims and reinstall the head.

CAUTION—Be careful not to damage packing (2) when reinstalling head (1) on the rod.



PACKING AND SHIMS INSTALLED

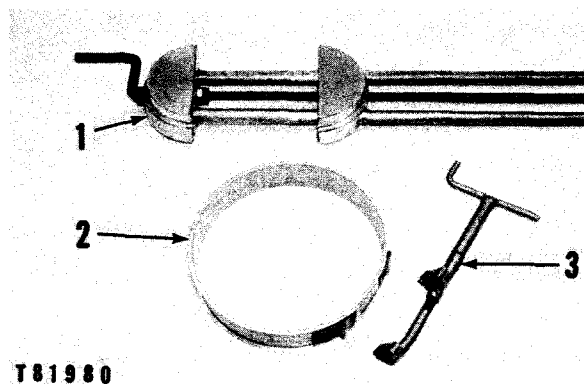
1—Head. 2—Packing. 3—Retainer. 4—Rubber pressure ring. 5—Shims. 6—Piston rod.

Solid Seal Assemblies

Each solid seal assembly consists of a solid, rubber, inner expansion ring and a solid, plastic outer seal. Since these seals are continuous rings (no split joint), special tools and procedures are required for installation.

The following is a typical installation procedure for the solid seal assemblies. This procedure can be used for all hydraulic cylinders which use the solid seal assemblies. A piston may have one or two seal assemblies.

The tools needed to install the outer seals of the piston seal assemblies are: one 4S9181 Expander Assembly, one 4S9446 Clamp Assembly (two clamp assemblies are required on the larger diameter pistons), and one seal compressor. Measure the diameter of the piston to select the correct seal compressor. See the COMPRESSOR SELECTION CHART for the seal compressor to be used.



SOLID SEAL INSTALLATION TOOLS

1—4S9181 Expander Assembly. 2—Seal Compressor. 3—4S9446 Clamp Assembly.

Compressors are marked for nominal ranges shown in the chart. The actual usable range can be calculated by reducing the low figure 1/16 in. (1.5

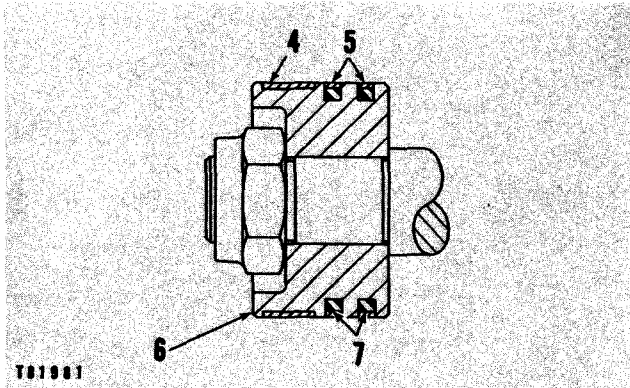
COMPRESSOR SELECTION CHART		
PISTON DIAMETER		SEAL COMPRESSOR
(IN INCHES)	(IN MILLIMETERS)	PART (NO.)
1.50 to 3.00	38.1 to 76.2	9S289
3.00 to 3.25	76.2 to 82.5	4S9447
3.50 to 3.75	88.9 to 95.2	4S9448
4.00 to 4.25	101.6 to 107.9	4S9449
4.50 to 4.75	114.3 to 120.6	4S9450
5.00 to 5.25	127.0 to 133.3	4S9451
5.50 to 5.75	139.7 to 146.0	4S9452
6.00 to 6.25	152.4 to 158.3	4S9453
6.50 to 6.75	165.0 to 171.4	4S9454
7.00 to 7.25	177.8 to 184.1	4S9455*
8.00 to 8.25	203.2 to 209.5	4S9456*
9.25 to 9.50	234.9 to 241.3	4S9457*
10.25 to 10.50	260.3 to 266.7	9S2419*

* TWO 4S9446 CLAMP ASSEMBLIES REQUIRED.

mm) and increasing the high figure 3/16 in. (4.7 mm).

NOTE—Be certain all hydraulic cylinder components have been inspected and new components installed where necessary before installing the seal assemblies. The installation of the seal assemblies is the last step before the piston is installed in the cylinder.

1. For ease of seal installation, remove the wear ring.
2. Install the inner expansion rings on the piston.



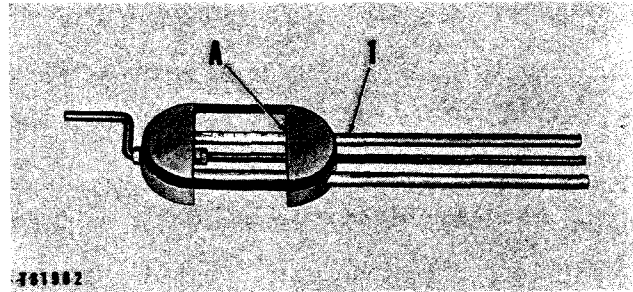
SOLID SEAL ASSEMBLIES INSTALLED ON PISTON

4—Wear ring. 5—Solid, plastic, outer seals. 6—Piston.
7—Solid, rubber, inner expansion rings.

3. Measure the diameter of the piston to determine the diameter to which the seal must be expanded. The outer seals of the seal assembly must be expanded to a diameter slightly larger than the diameter of piston to allow the seal to be placed over the piston. Be careful not to over-expand the seals or they can be ruined.

NOTE—The bars of the expander are graduated, representing piston diameters. If the seal can be slipped off the expander when the inside face of the movable block is at point (A) (indicated piston diameter) the seal is expanded sufficiently.

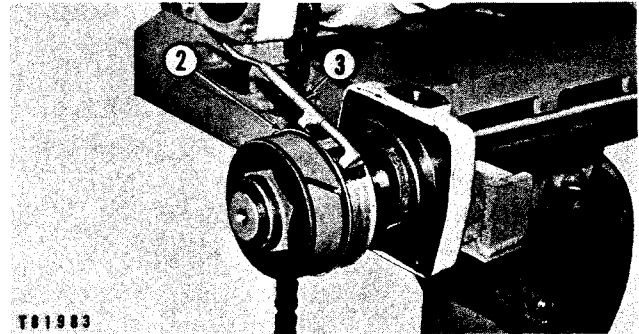
4. Place a seal on the expander. Turn the crank on the expander until the inside face of the movable block is slightly past point (A). Then return to point (A). Rotate the seal 90° on the expander and expand again. Check to see if the seal will slip off the expander. If not, repeat the procedure, expanding the seal farther each time, until the seal will slip off the expander when block is returned to point (A).
5. Lubricate the outer seals and place them on the piston. Install and lubricate the wear ring.



SEAL ON EXPANDER

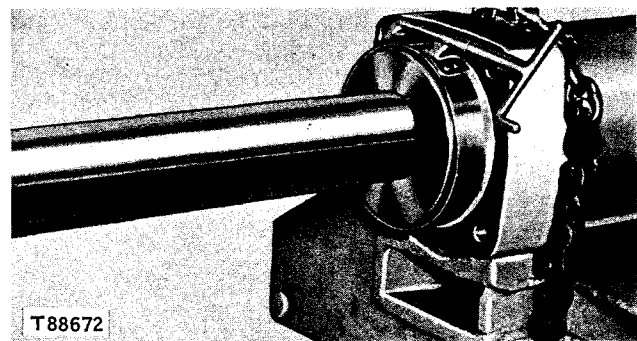
1—4S9181 Expander Assembly. A—Indicated piston diameter.

6. Select the applicable compressor from the **COMPRESSOR SELECTION CHART**. Install the clamp on the compressor. Place the compressor loosely over the outer seals. Place the compressor on the piston so the rolled side of the compressor will be facing the cylinder when the piston is installed in the cylinder.



COMPRESSING SEALS

2—Seal compressor. 3—4S9446 Clamp Assembly.



INSTALLING PISTON

7. Slowly turn the handle on the clamp and force the seals into their grooves. Be certain the seals are being seated in their grooves as they are being compressed.
8. Place the piston assembly into the cylinder

bore as illustrated; be certain the piston is square in the bore.

9. Drive on the piston rod until the entire piston assembly is in the cylinder bore. Remove the clamp and the compressor.
10. Install the bolts securing the cylinder head to the cylinder with the piston rod fully extended. Tighten the bolts to the torque value in the SPECIFICATIONS.

Cylinder Installation

Before installing a hydraulic cylinder, apply 9M3710 Anti-Seize Compound to the cylinder pins and pin bores to aid in future removal.

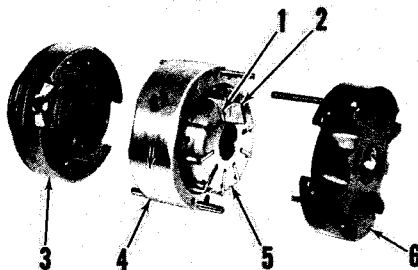
After the cylinder has been installed, start the engine and operate the cylinder to remove air from the hydraulic system. When the system is functioning properly, check the level of the oil in the hydraulic oil supply tank.

CAUTION—Under no circumstances should welding be done on the wall of the cylinder except the welded area at the head end of the cylinder. Welding on the cylinder wall can cause enough bore distortion to cause interference between the piston and the cylinder wall and can result in severe scoring of the cylinder wall.

Pumps

Assembly of Insert Vane-type Pumps

Before disassembling a pump, mark the pump body and cover to insure correct assembly with respect to port relationship.



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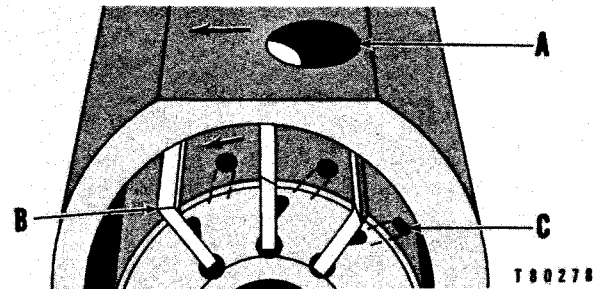
PUMP CARTRIDGE

- 1—Inserts. 2—Vanes. 3—Pressure plate. 4—Ring. 5—Rotor.
6—Wear plate.

Assemble the vanes (and inserts) in the rotor and the rotor into the ring as illustrated. The sharp edges of the vanes and the arrows on the ring and

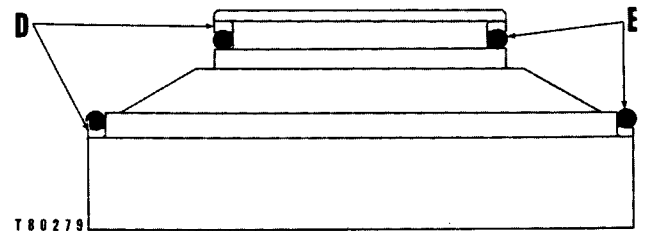
rotor must point in the direction of PUMP ROTATION when the cartridge is installed in the pump cover. Note that the passage (A) and passages (C) are angled toward the direction of pump rotation.

If new O-ring seals and back-up rings are to be installed on the pressure plate, they must be installed as illustrated. Lubricate the components. Then install the back-up rings so the concave side faces the mating O-ring seal.



RING, ROTOR AND VANE INSTALLATION

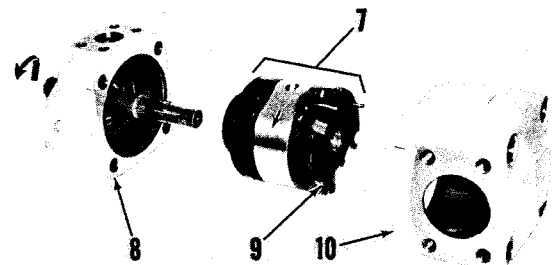
- A—Passage in ring. B—Sharp edge of vane. C—Passage in rotor.



BACK-UP RING INSTALLATION

- D—Back-up rings. E—O-ring seals.

Be certain the pins in the cartridge align with the holes in the pump cover. The arrow on the pump cartridge must point in the same direction as the pump shaft turns.



T91391

TYPICAL PUMP

- 7—Pump cartridge. 8—Pump body. 9—Pins. 10—Pump cover.

Rotation

The direction of pump rotation, clockwise (CW) or counterclockwise (CCW), is the direction the pump turns when viewed from the drive shaft end. Refer to the TESTING AND ADJUSTING or the SPECIFICATIONS sections of the service manual for the rotation of a particular pump.

General

Put lubricant in a rebuilt pump. The pump shaft must turn easily by hand. Check the seals of a rebuilt pump for leaks before installing the pump.

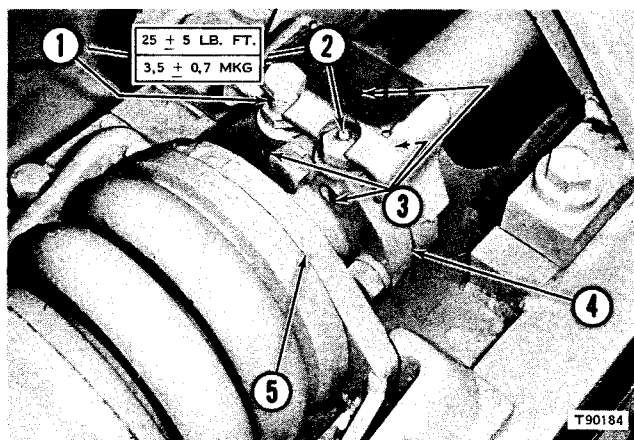
1. Close the outlet port of the pump.
2. Use air or oil at 30 PSI (2.11 kg/cm²) pressure to check the seals of the pump for leaks. Make the connection for the supply of air or oil at the inlet port.

RELIEVING TRACK TENSION

Hydraulic Adjusting Type

Remove any dirt or debris that could prevent retraction of the idler. Clean the track adjuster vent holes thoroughly.

WARNING—Before attempting to separate the track or remove any part of the track adjusting mechanism, be certain the hydraulic pressure in the track adjusting cylinder is completely relieved and the cylinder (4) can be moved to the rear into the recoil spring front pilot (5).



Items indicated are: 1—Relief valve. 2—Fill valve. 3—Vent holes. 4—Cylinder. 5—Recoil spring front pilot.

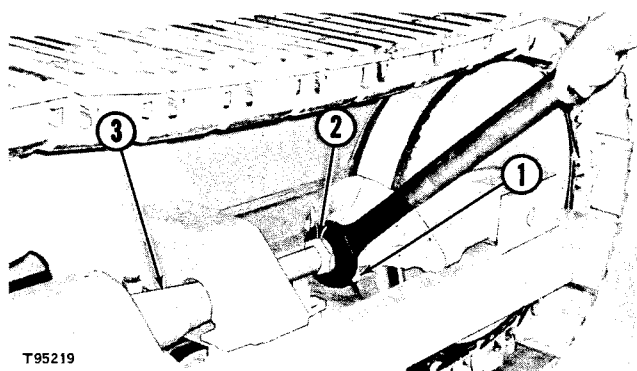
Relieve the pressure in the hydraulic track adjuster cylinder, WITH CAUTION as given in the following steps:



WARNING—Because of the hydraulic pressure in the track adjuster cylinder, never visually inspect the vent holes (3) or valves to see if lubricant is escaping. Always watch the cylinder (4) to see if it moves to the rear into the recoil spring front pilot (5).

1. Loosen the RELIEF valve (1) one turn. Lubricant should escape from the vent holes just below the RELIEF valve. Wait momentarily. If the cylinder (4) does not retract, loosen the FILL valve (2) one turn.
2. If the cylinder has not retracted, loosen the RELIEF valve until it contacts the underside of the guard. If the cylinder does not retract, loosen the FILL valve until it contacts the underside of the guard.
3. If track tension is still evident, start the machine and move it backward and forward.
4. If moving the machine has not relieved all the tension, put a drawbar pin between the sprocket and track. Back the machine slightly putting additional tension on the track to force the lubricant out of the vent holes.

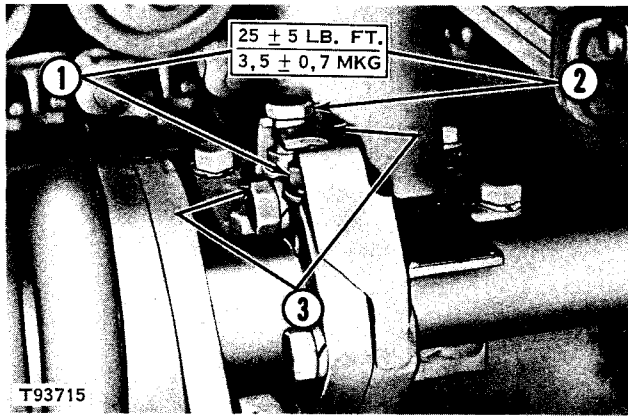
Screw Adjusting Type



Typical example. 1—Clamp bolts. Loosen the bolts. 2—Screw assembly. Turn the screw assembly into the recoil spring adjusting nut (3) to loosen the track.

FILLING AND BLEEDING THE HYDRAULIC TRACK ADJUSTER

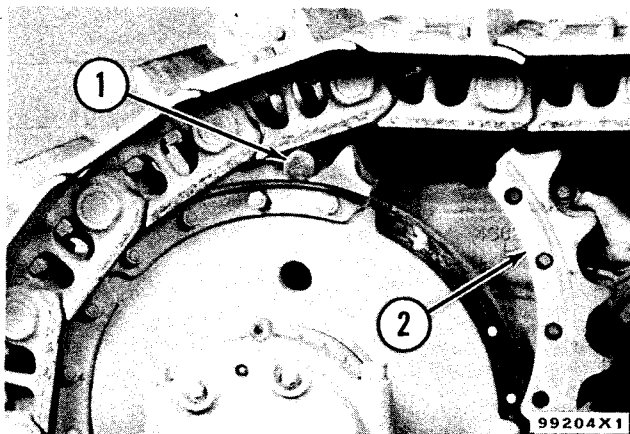
Use the following procedure to bleed the air on the initial filling of the hydraulic track adjuster cylinder.



1—Fill valve. 2—Relief valve. 3—Relief valve vent holes.

1. Loosen the relief valve (2) one turn. Force SAE 30 lubricating oil through the fill valve.
2. When the oil flowing out the relief valve vent hole (3) no longer contains air bubbles, close the relief valve. Continue filling the cylinder with oil until the track sag is to the dimension listed in the SPECIFICATION section of the service manual.
3. Move the machine backward and forward to equalize the adjustment. Recheck the adjustment.
4. Make subsequent track adjustments as outlined in the Lubrication and Maintenance Guide part of this manual.

SPROCKET SEGMENT REMOVAL AND INSTALLATION



SEGMENT REMOVED
1—Solid pin. 2—Sprocket segment.

1. Remove sprocket guards.

2. All tension must be removed from the track. See subject RELIEVING TRACK TENSION.
3. Place a solid pin (1) between two front teeth of sprocket segment.
4. Move the vehicle backward to lift the track from the sprocket.
5. Remove nuts, bolts and sprocket segment (2).
6. Install sprocket segment with word "OUT" to outside. Put lubricant on bolt and nut threads and tighten all nuts on any one segment to torque in SEGMENT BOLT AND NUT SPECIFICATION chart.
7. Then turn nut tighter 1/3 turn (120°).

SEGMENT BOLT AND NUT SPECIFICATION		
VEHICLE	lb. ft.	mkg
D5, D6, 561, 955, No. 6	100 to 160	13.8 to 22.1
D7, 571, 572, 977	180 to 260	24.9 to 35.9
D8, 583, 983	200 to 300	27.6 to 41.5
D9, 594, DD9, SxSD9	200 to 300	27.6 to 41.5

8. Move vehicle forward and remove solid pin (1).
9. Install guards and adjust track.

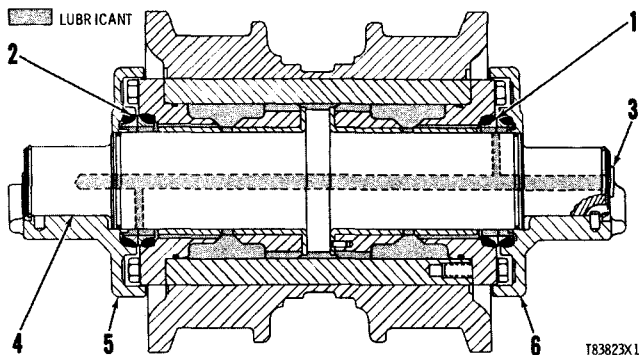
LUBRICATION OF TRACK ROLLERS AND IDLERS

Lubrication of Track Roller Assembly (with Duo-Cone seals)

A rebuilt track roller needs lubricant. Install collars (5 and 6) before the lubricant is put in the track roller assembly.

1. Put the track roller assembly in a horizontal position. Turn shaft (4) and collars (5 and 6), to the position needed to install the track roller assembly on the roller frame.
2. Remove plug (3) from shaft (4).
3. Install a 5M2080 Nozzle in the plug hole in shaft (4).

- Put lubricant through 5M2080 Nozzle into the track roller assembly until the lubricant, with no air, will flow out the plug hole around the relief on the threads on the 5M2080 Nozzle.



TYPICAL TRACK ROLLER CROSS SECTION

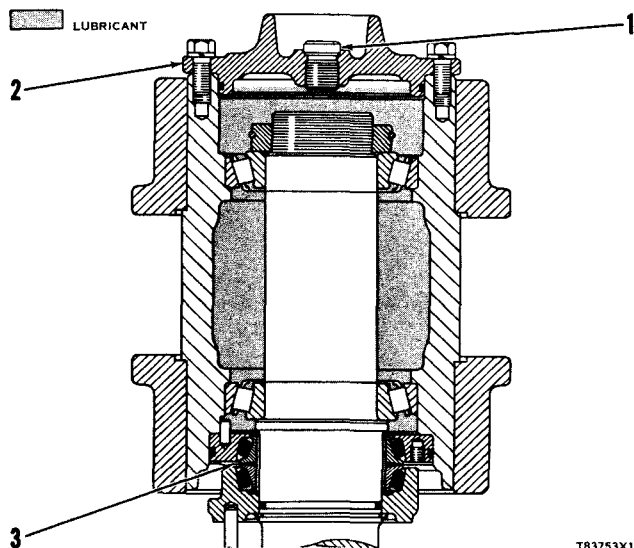
1—Duo-Cone seal. 2—Duo-Cone seal. 3—Plug. 4—Shaft.
5—Collar. 6—Collar.

- Remove the 5M2080 Nozzle and install plug (3) immediately. Plug (3) torque is 125 ± 15 lb. ft. (17.3 ± 2.1 mkg).

NOTE—Lubricant can be put in a track roller assembly installed on the roller frame.

Lubrication of Track Carrier Roller Assembly (with Duo-Cone Seals)

A rebuilt track carrier roller assembly needs lubricant before installing the roller on the vehicle.



TYPICAL TRACK CARRIER ROLLER CROSS SECTION

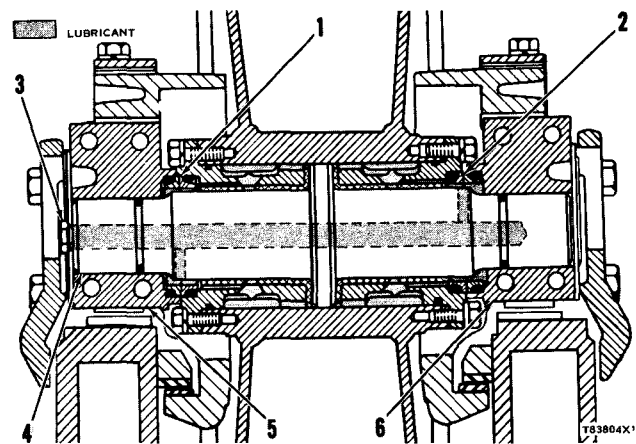
1—Plug. 2—Cover. 3—Duo-Cone seals.

- Remove plug (1) in cover (2).
- Put the carrier roller assembly in a vertical position.
- Put lubricant in the plug hole, in cover (2), until the lubricant level is to the bottom of the plug hole threads. The lubricant level will lower as the lubricant flows through the roller bearing to fill the compartment. Add more lubricant to keep the lubricant level to the bottom of the threads in the plug hole.
- Install plug (1) in cover (2). Plug (1) torque is 125 ± 15 lb. ft. (17.3 ± 2.1 mkg).

Lubrication of Front Idler (with Duo-Cone seals)

A rebuilt front idler shaft and bearings need lubricant. Install bearings (5 and 6) before lubricant is put in shaft (4).

- Put the front idler in a vertical position. Shaft (4) will then be in a horizontal position.
- Turn shaft (4) and the bearings until the thin parts of the bearings (5 and 6) are under the shaft (4).
- Remove plug (3) from shaft (4).



TYPICAL FRONT IDLER CROSS SECTION

1—Duo-Cone seal. 2—Duo-Cone seal. 3—Plug. 4—Shaft.
5—Bearing (thin part under shaft). 6—Bearing (thin part under shaft).

- Install a 5M2080 Nozzle in the plug hole in shaft (4).
- Put lubricant through the 5M2080 Nozzle

until the lubricant, with no air, will flow out the plug hole around the relief on the threads on 5M2080 Nozzle.

6. Remove the 5M2080 Nozzle and install plug (3) immediately. Plug (3) torque is 125 ± 15 lb. ft. (17.3 ± 2.1 mkg).

NOTE—Lubricant can be put in a front idler installed on the roller frame if the thin parts of the bearings (5 and 6) are under the shaft (4).

FRACTIONS, DECIMALS AND MILLIMETERS CHART

inches	mm	inches	mm
$\frac{1}{64}$.....	.016 0.40	$\frac{33}{64}$.....	.516 13.10
$\frac{1}{32}$.....	.031 0.79	$\frac{17}{32}$.....	.531 13.49
$\frac{3}{64}$.....	.047 1.19	$\frac{35}{64}$.....	.547 13.89
$\frac{1}{16}$.....	.062 1.59	$\frac{9}{16}$.....	.562 14.29
$\frac{5}{64}$.....	.078 1.98	$\frac{37}{64}$.....	.578 14.68
$\frac{3}{32}$.....	.094 2.38	$\frac{19}{32}$.....	.594 15.08
$\frac{7}{64}$.....	.109 2.78		.600 15.24
$\frac{1}{8}$.....	.125 3.18	$\frac{39}{64}$.....	.609 15.48
$\frac{9}{64}$.....	.141 3.57	$\frac{5}{8}$.....	.625 15.88
$\frac{5}{32}$.....	.156 3.97	$\frac{41}{64}$.....	.641 16.27
$\frac{11}{64}$.....	.172 4.37	$\frac{31}{32}$.....	.656 16.67
$\frac{3}{16}$.....	.188 4.76	$\frac{43}{64}$.....	.672 17.07
$\frac{13}{64}$.....	.203 5.16	$\frac{11}{8}$.....	.688 17.46
$\frac{7}{32}$.....	.219 5.56	$\frac{45}{64}$.....	.703 17.86
$\frac{15}{64}$.....	.234 5.95	$\frac{33}{16}$.....	.719 18.26
$\frac{1}{4}$.....	.250 6.35	$\frac{47}{64}$.....	.734 18.65
$\frac{17}{64}$.....	.266 6.75	$\frac{3}{4}$.....	.750 19.05
$\frac{9}{32}$.....	.281 7.14	$\frac{49}{64}$.....	.766 19.45
$\frac{19}{64}$.....	.297 7.54	$\frac{55}{64}$.....	.781 19.84
$\frac{5}{16}$.....	.312 7.94	$\frac{51}{64}$.....	.797 20.24
$\frac{21}{64}$.....	.328 8.33	$\frac{1}{2}$.....	.812 20.64
$\frac{11}{32}$.....	.344 8.73	$\frac{53}{64}$.....	.828 21.03
$\frac{23}{64}$.....	.359 9.13	$\frac{27}{32}$.....	.844 21.43
$\frac{3}{8}$.....	.375 9.53	$\frac{57}{64}$.....	.859 21.83
$\frac{25}{64}$.....	.391 9.92	$\frac{7}{8}$.....	.875 22.23
	.400 10.16	$\frac{59}{64}$.....	.891 22.62
$\frac{13}{32}$.....	.406 10.32		.900 22.86
$\frac{27}{64}$.....	.422 10.72	$\frac{49}{32}$.....	.906 23.02
$\frac{7}{16}$.....	.438 11.11	$\frac{59}{64}$.....	.922 23.42
$\frac{29}{64}$.....	.453 11.51	$\frac{1}{2}$.....	.938 23.81
$\frac{15}{32}$469 11.91	$\frac{61}{64}$953 24.21
$\frac{31}{64}$484 12.30	$\frac{31}{32}$969 24.61
$\frac{1}{2}$500 12.70	$\frac{63}{64}$984 25.00
		1	1.000 25.40

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2

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