Balls, Caps, and Pins

Section 03-05

Komatsu has made every effort to make this manual as accurate as possible based on the information available at the time of publication and printing. Continuous improvement and advancement of product design may cause changes to machines, which may not have been included in this publication. Komatsu reserves the right to make changes and improvements at any time. To ensure the most current information, please contact your service center.

Table of Contents

List of Figures

List of Tables

Customer Responsibilities and Warranty Advisories

The P&H wheel loader series wheel loaders are warranted in accordance with the warranty policy provided with the machine. The recommended operating and maintenance procedures set forth shall be followed to ensure warranty coverage is not jeopardized. Failure to comply with recommended operating and maintenance procedures may void machine warranty.

Any questions or problems relating to warranty policy or administration should be directed to Komatsu Service Center. Include the model and serial number, in-service date of the machine, and hour meter reading. **We especially draw your attention to the following safety advisors.**

Safety

This publication contains special instructions that pertain to safety, operation, maintenance, and repair of the machine. Listed below are the signal words and symbols that precede these instructions and their meanings:

⚠ DANGER

- **The danger label indicates a hazardous situation which, if not avoided, will result in death or serious injury.**

⚠ WARNING

- **The warning label indicates a hazardous situation which, if not avoided, could result in death or serious injury.**

⚠ CAUTION

- **The caution label, used with the safety alert symbol indicates a hazardous situation which, if not avoided, could result in minor or moderate injury (includes the safety alert symbol ⚠).**

CAUTION

- **The caution label (without safety alert symbol) is used to address practices not related to personal injury – only equipment damage.**

NOTICE

The NOTICE graphic is to indicate areas of importance to the reader that are not related to personal injury or machine damage.

Safety, Warnings, and Cautions, 03-05

The following warnings and cautions apply to maintenance and inspections of the ball joints on the various models of the P&H wheel loader. **These warnings and cautions will not be reiterated in the following text.** Before any inspections or repairs are performed to the structural components on the machine it is critically important to read and comply with the following warnings and cautions as well as ensuring the safety of all personnel working in the area before, during and after the work being performed.

⚠ WARNING

CRUSH HAZARD

- **Crush hazard exists if the machine is not positioned straight or turned to either side and the frame lock is not installed prior to any testing. Always steer the machine straight and install the frame lock before performing any testing. Be sure all personnel are secure and in safe positions prior to performing any testing. Place signs to alert other personnel to keep a safe distance from the machine. Failure to place the frame lock in the locked position and to alert personnel to keep a safe distance could cause a crush hazard resulting in serious injury or death.**
- **Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.**
- **Crush hazards exist in machine pivot area and area between the tires. Do not enter these areas unless it is verified that the operator has control over the steering and that personnel locking the frame lock have good communication with the operator. Entering the pivot area and area between the tires while the machine is moving or pivoting (articulating) could cause crush hazards resulting in serious injury or death.**
- **Crush hazard exists if endplay readings are taken on the rear axle of an operating machine. These readings should be taken using either jacks or a crane of appropriate capacity (LOADER JACKING INSTRUCTIONS, located in Section 3 in this manual). Taking endplay readings of a rear axle on an operating machine can cause a crush hazard resulting in serious injury or death.**
- **Crush hazard exists if cranes or jacks of suitable capacity are not used to lift the major components of the machine for removal and installation of the ball joints. Always select cranes and jacks of sufficient capacity to hold the weight of the machine or component being lifted or placed on a jack. Failure to select cranes or jacks of sufficient capacity to support the weight of the machine or component can cause crush hazards resulting in serious injury or death.**
- **Crush hazard exists if standing under or placing hands or feet under any component of the machine that is hoisted. Crush hazards exist when a load is suspended. Suspended loads can fall. Never work under suspended loads. Working under suspended loads could cause a crushing hazard which might result in serious injury or death.**
- **Crush hazard exists if proper welding procedures are not used when replacing or repairing ball and cap components. Do not weld the spherical part of the ball or the neck area. The ball base assemblies are special heat-treated steel. Any welding to the ball or neck will cause damage to the steel and detrimentally affect the strength of the ball. Replacement of a ball base entails very specific welding procedures to prevent any damage to the spherical part of the ball and neck. Follow the ball base replacement procedures provided in FIELD WELDING PROCEDURES, located in Section 03-02 of the Service Manual. Failure to follow proper welding procedures can cause crush hazards resulting in serious injury or death.**

- **Crush hazard exists when lifting the rear axle off the ground. Caution should be exercised when using jacks to lift the machine. If both wheels of the oscillating axle are off the ground at the same time, the axle may swivel vertically. This is a potentially hazardous situation. Both sides of the axle should be blocked to prevent swiveling. Failure to block both sides of the rear axle can cause a crush hazard resulting in serious injury or death.**
- **Crush hazard exists if indications exist on a hoist or lift arm ball. The machine must be taken out of service and the ball replaced. Operating equipment with cracks (indications) in hoist or lift arm balls could lead to ball failure, which could cause crush hazards from unexpected motion resulting in serious injury or death.**
- **Crush hazard exists when attempting to remove or install the ball cap. Ball caps are heavy and removing a cap requires equipment with sufficient capacity rating to support the weight of the cap. Always read and understand all WARNINGS AND CAUTIONS provided before attempting to remove or replace a ball cap. Failure to use equipment with adequate lifting capacity and to follow WARNINGS AND CAUTIONS could cause a crush hazard resulting in serious injury or death.**
- **Crush hazards exist if all personnel are not cleared from the bucket and lift arm area before using the hydraulic hoist and bucket hydraulic pressure bleed down valves to relieve pressure from the hoist and bucket circuit. Clear all personnel from the area around the bucket and lift arms before operating hydraulic hoist and bucket hydraulic pressure bleed down valves. Using the hydraulic bleed down valves could result in some movement of the lift arms and bucket which could cause a crush hazard resulting serious injury or death.**
- **Crush hazard exists if working on a machine that is elevated with jacks. Do not work under machine without using jacks with positive locking devices. Failure to use jacks with positive locking devices while working on an elevated machine can cause a crush hazard resulting in serious injury or death.**
- **Crush hazard exists if failing to support the frame and axle properly. Always support the axle and frame with external support structures such as jacks or stands when removing the axle. Failure to properly support the axle and frame could cause a crush hazard or cause the axle to fall resulting in serious injury or death.**
- **Crush hazard exists if the alignment is done with the lift arms on the machine. A thorough risk assessment should be done to ensure that the job can be done safely. The lift arms must be securely supported so they cannot move. The ball cap must be properly lifted and supported. The personnel assembling and inspecting the cap and socket must use appropriate fall prevention equipment. All local mine site regulations must be obeyed. Failure to perform a risk assessment before beginning the procedure can cause crush hazard resulting in serious injury or death.**

CRUSH, SHOCK, OR OTHER HAZARDS

- **Crush, shock, or other hazards exist if stored energy is not removed or isolated prior to working on the machine. Stored energy (hydraulic, electrical, pneumatic, mechanical, etc.) may be present if not isolated or released prior to working on the machine. Do not work on the machine without removing this stored energy (suspended loads, electrical power, air pressure, etc.). Risk of crushing, shock, or other physical injury exists if stored energy is not removed or isolated prior to working on the machine which could result in serious injury or death.**

STRUCK-BY HAZARDS

- **Struck-by hazards exist when around hydraulic fluid, air, fuel, or grease that is under pressure. Hoses under pressure can blow out or come loose from connections, causing a struck-by hazard with deadly force. DO NOT tighten or loosen hydraulic, air, fuel, or grease lines without first relieving the pressure. DO NOT make adjustments to any fluid pressures while the machine is running. Shut down the machine, make the adjustment, then restart the machine to check the adjustment. Wear safety goggles for eye protection and wear all other locally required personal protective equipment (PPE) when working around possibly pressurized liquids or air. Failure to use proper PPE or to shut down the machine before making adjustments can cause a struck-by hazard resulting in serious injury or death.**

BURN HAZARDS

- **Burn hazards exist when around hot hydraulic fluid that is under pressure. Hoses under pressure can blow out or come loose from connections, causing a burn hazard from leaks or spraying. DO NOT tighten or loosen hydraulic fluid hoses without first relieving the pressure. DO NOT make adjustments to any fluid pressures or flow while the machine is running. Shut down the machine, make the adjustment, then restart the machine to check the adjustment. Wear safety goggles for eye protection and wear all other locally required personal protective equipment (PPE) when working around possibly hot pressurized liquids. Failure to use proper PPE or to shut down the machine before making adjustments can cause a burn hazard resulting in serious injury or death.**

SKIN INJECTION HAZARD

- **Skin injection hazard exists when around diesel fuel, air, hydraulic fluid, or grease that is under pressure. Fluids under pressure can penetrate the skin and cause serious personal injury, blindness, or death. If any fluid is injected into the skin, it must be removed as soon as possible by a doctor familiar with treating this type of injury. Fluid or air leaks under pressure may not be visible. When searching for leaks, NEVER use your hand; use a piece of metal. Wear work gloves and keep your hand well away from the possible source of leakage. DO NOT tighten or loosen fuel, hydraulic, air, or grease lines without first relieving the pressure. Wear safety goggles for eye protection and wear all other locally required personal protective equipment (PPE) when working around possibly pressurized liquids or air. Failure to use proper PPE can cause a skin injection hazard resulting in serious injury or death.**

⚠ CAUTION

STRUCK BY AND CRUSH HAZARDS

- **Struck by or crush hazards exist if proper lifting equipment and techniques are not used. Ball caps are heavy and lifting equipment of sufficient capacity and proper lifting procedures should be used to ensure a safe lift. Approximate weights for the various types of ball caps are provided in Table "BALL CAP WEIGHT CHART" in this document. Failure to select sufficient capacity equipment and use proper lifting techniques when working with balls and caps can cause a crush hazard resulting in serious injury.**

CHEMICAL HAZARD AND INHALATION HAZARD

- **Chemical hazard and inhalation hazard exists if the appropriate Personal Protective Equipment (PPE) is not used when using solvents or other chemicals. Eye contact with some solvents can cause blindness. When working with chemicals, avoid contact with them and ensure proper ventilation is adequate. Breathing fumes from some solvents can cause asphyxiation. Ensure all required PPE is used. Follow all local rules and regulations when working with chemicals. Failure to use proper PPE and to avoid chemical contact could cause a chemical hazard and inhalation hazard resulting in serious injury.**
- **Chemical hazard and inhalation hazard exists if the appropriate Personal Protective Equipment (PPE) is not used when working with solvents or other chemicals such as liquid nitrogen or dry ice. Ensure all required PPE is used. Nitrogen and dry ice are extremely cold. Do not touch liquid nitrogen or dry ice. Do not breathe liquid nitrogen or dry ice as it evaporates. Liquid nitrogen and dry ice can damage lungs and burn skin. Eye contact with liquid nitrogen or solvents can cause blindness. Skin contact with liquid nitrogen or dry ice can cause freeze burns. When working with liquid nitrogen or dry ice ensure proper ventilation is adequate. Follow all local rules and regulations when working with chemicals. Failure to use proper PPE and to avoid chemical contact could cause a chemical hazard, inhalation hazard, and freeze burns resulting in serious injury.**

Ball Cap Weight (*Approximate)

Machine	Lift Arm		Hoist Cylinder		Middle Pivot		Rear Axle Pivot	
	Lbs.	Kgs.	Lbs.	Kgs.	Lbs.	Kgs.	Lbs.	Kgs.
L-1350	275	125	225	103	325	148	225	103
L-1850	625	284	250	114	325	148	225	103
L-2350	625	284	400	182	325	148	225	103

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Scope of This Publication, 03-05

Balls, Caps, and Pins is provided to assist operators and maintenance technicians in the maintenance, inspection, troubleshooting, and replacement of the ballcap and pin joint assemblies on the machine.

It contains information about maintaining and servicing pivot balls and caps at the lift arms, hoist cylinders, middle pivot and rear axle pivot. Pins and bushings are also used in various connections such as lift arm to bucket, level link to bucket, level link to bellcrank, bucket cylinder (both ends), hoist cylinder to lift arms, and bellcrank pivot

Figures “Hoist cylinder”, “Rear axle – front ball cap shown – rear cap is the same”, “Articulated joint – lower ball cap shown – upper cap is the same” and “Lift arm ball cap” (below) show some typical ball joints. Specific illustrations for various machine applications are included within this section.

Figure 1. Hoist cylinder

Figure 2. Rear axle - front ball cap shown - rear cap is the same

Figure 3. Articulated joint - lower ball cap shown- upper cap is the same

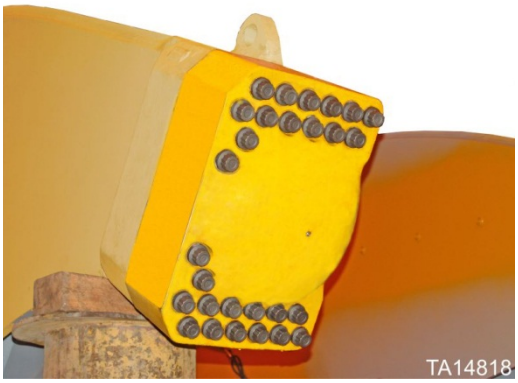

Figure 4. Lift arm ball cap

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Theory of Operation

The ball joint assembly employs the use of two (halves) semi-spherical nickel-aluminum-bronze ball liner bushings. The ball liners are mounted within the ball socket and ball cap, and have low friction, high output load carrying capacity as required by these applications. The spherical ball bearing surface absorbs loads from all directions. The ball design allows for constant loading of the ball liner bushing under varying load conditions.

Alignment of the cap and socket is important because misalignment may contribute to excessive heat. A certain amount of manufacturing tolerance is required, so that the threaded holes in the socket and the drilled holes in the cap will align properly. This tolerance means that the cap has some up, down and/or side to side movement prior to tightening the bolts. This tolerance is typically in the ± .030” range. If the cap is positioned improperly it can cause the joint clearances to be reduced and may cause excessive heating.

The joint has long life if properly lubricated by the auto lube system. However, it is very important that each ball socket be properly maintained and adjusted. Shims allow the joint clearance to be adjusted on a periodic basis with normal wear of the liners.

While the ball joint assemblies are different sizes on the various models of P&H wheel loaders, the basic principles for assembly and maintenance are the same. Sizes and locations of the ball joint assemblies found on the various models of are located on table “Ball base socket-cap specifications”.

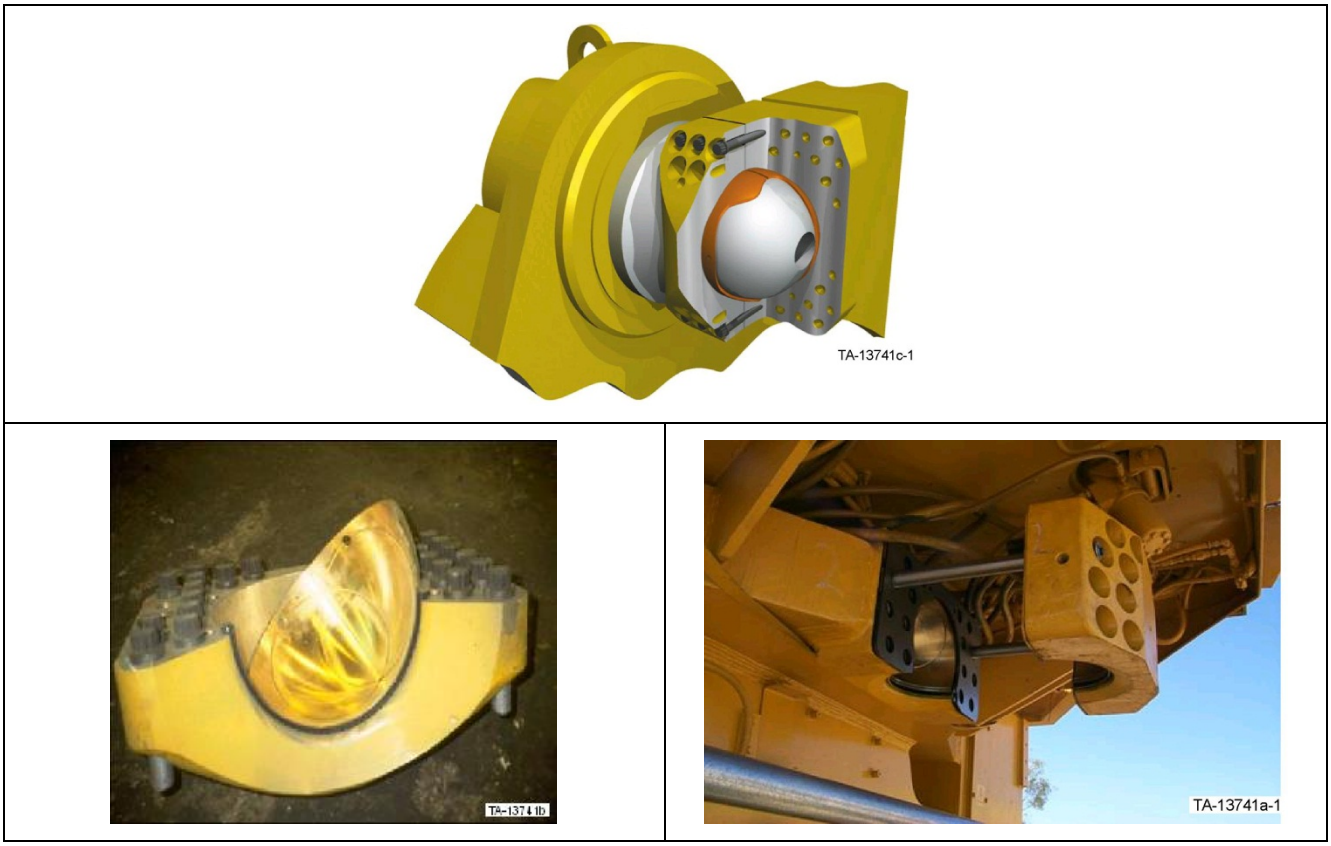

Figure 5. Typical hinge and attachment joints

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Component Descriptions

Ball Base/Cap Specifications and Location

Ball Size and Location

Machine	Lift Arm	Hoist Cylinder	Middle Pivot	Rear Axle Pivot
L-1350	12	12	9	9
L-1850	14	12	12	9
L-2350	14	14	12	9

Ball Base Specifications

Nominal Diameter	7.5"	9”	12”	14”
Machined ball diameter	7.500" ± .003”	8.997” ± .003”	12.000” ± .003”	14.000” ± .003”
Machined neck diameter	6.250" ± .010”	7.500” ±.005”	10.000" ± .005”	11.750" ± .003”
Ball Socket Specifications				
Machined diameter	8.003" ± .002”	9.503” ± .002”	12.503” ± .002”	14.503” ± .002”

Ball Base/Socket/Cap Assembly Specifications

New Liner (or new ball/socket) Setup					
	7.5"	9”	12”	14” Lift arm	14” Hoist
Suggested shim pack with new liners (adjust as needed to get correct endplay)	1 ea. 3/16" spacer plate 4 ea. .030" shim 1 ea. .018" shim 4 ea. .007" shim	1 ea. 3/16” spacer plate 4 ea. .030” shim 2 ea. .018” shim 2 ea. .007” shim	1 ea. 3/16” spacer plate 4 ea. .030” shim 2 ea. .018” shim 2 ea. .007” shim	1 ea. 1/4” spacer plate 2 ea. .030“ shim 2 ea. .018” shim	1 ea. 3/16” spacer plate 2 ea. .030“ shim 2 ea. .018” shim
New setup endplay reading	0.011-0.015"	0.014-0.018”	0.018-0.024”	0.021-0.028”	0.021-0.028”

PM Checks and Setup				14” Lift arm	14” Hoist
Min. reading at PM	0.008"	0.009”	0.012”	0.014” Lift arm	0.014” Lift arm
Max. reading at PM check (if higher, then shims must be removed.)	0.023"	0.027”	0.036”	0.042”	0.042”
Reading range after PM shim removal.	.015” ± .002	.018” ± .002	.024” ± .003	.028” ± .003	.028” ± .003
Minimum shim pack before replacing liners	3/16" spacer plate	3/16” spacer plate	3/16” spacer plate	1/4” spacer plate	3/16” spacer plate

If the ball or socket is out of round (TIR) by more than this amount, rapid wear of the brass liners may be noted. This of course depends on the severity of the application. Ball wear is typically an indication of either a lubrication problem or running the ball socket assembly at high endplay limits.

Special shimming procedures are required when shimming a ball cap assembly when the ball is worn. This will only be temporary, as rapid liner wear will be common until the ball is replaced.

Table 1. Ball base-socket-cap specifications

Ball Cap Weight (*Approximate)

Machine	Lift Arm		Hoist Cylinder		Middle Pivot		Rear Axle Pivot	
	Lbs.	Kgs.	Lbs.	Kgs.	Lbs.	Kgs.	Lbs.	Kgs.
L-1350	275	125	225	103	325	148	225	103
L-1850	625	284	250	114	325	148	225	103
L-2350	625	284	400	182	325	148	225	103

NOTICE

These weights are only approximate and provided as a guide for determining proper lifting procedures and equipment. In all cases, adequate equipment should be used to provide a good safety margin.

Table 2. Ball cap weight chart

General Information

Clearance Recommendations

If the spherical ball joint clearance is properly set, and the joint heats beyond acceptable limits, the root causes of heating may be related to items such as bronze liner thickness, distorted sockets and misaligned ball caps.

If the root causes have been corrected and the heating is within specification, the ball clearances should be set as follows for maximum ball and liner life.

In general the clearances are calculated as:

Minimum clearance	1X ball diameter (in .001”)
Target set up clearance	2X ball diameter (in .001”)
Maximum clearance	3X ball diameter (in .001”)

For example: 9” ball = .009” min, .018” target set up and .027” max.

Recommended Snap Clearance	**Ball Joint Diameter**			
	7.5”	9”	12”	14”
Minimum	.008”	.009”	.012”	.014”
Setup Target	.015” ± .002	.018” ± .002	.024” ± .003	.028” ± .003
Maximum	.023”	.027”	.036”	.042”

Lubrication Requirements

The ball joint assemblies are lubricated by the Automatic Lubrication System. The ball joint assembly requires the use of the proper type of 3% minimum 5% maximum molybdenum grease for maximum life. The operation and maintenance of the Automatic Lubrication system and grease specifications are located in AUTOMATIC LUBRICATION SYSTEM OPERATION AND SERVICE, located in Section 04 of the Service Manual.

NOTICE

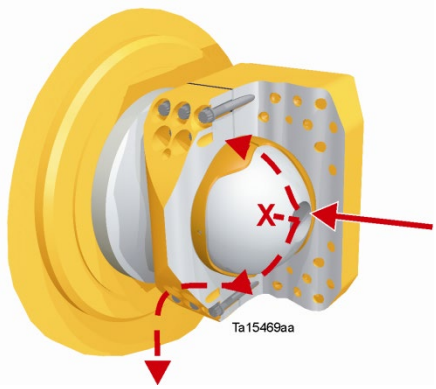
It is essential that the Auto Lubrication System timer be set with an interval time no greater than 15 minutes. Each individual grease injector for the ball socket assemblies should be set to maximum flow. Refer to Section 04-02 “GREASE SYSTEM” in the Service Manual and in the vendor literature in that section.

It may be necessary, in certain extreme applications, to lower the time interval or replace the standard Lincoln SL-1 type injector with a larger type to provide adequate lubricant to the various ball socket assemblies on the machine.

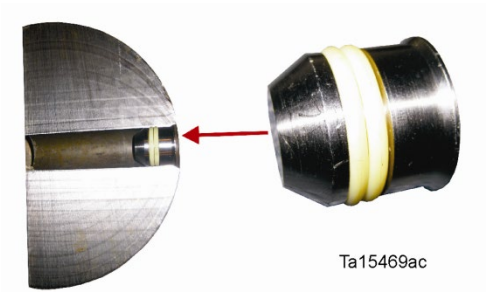
Ball Lubrication Methods

The balls used in the spherical ball joints are constructed with a hole through the middle. A grease plug must be installed in the hole for proper greasing of the hoist cylinder or lift arm balls. Some spherical ball joints are greased through the ball while other joints are greased through the cap.

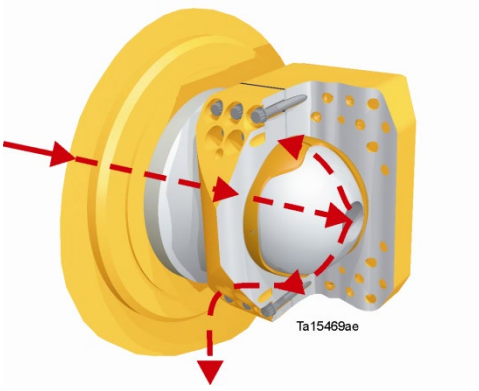
If a spherical ball joint for the lift arms or hoist cylinders does not appear to be getting sufficient grease then the location and function of the plugs must be verified. The plugs and hoses must be properly connected to injectors to assure that the grease is going through the bronze liners properly – and not into the ball mount tube.

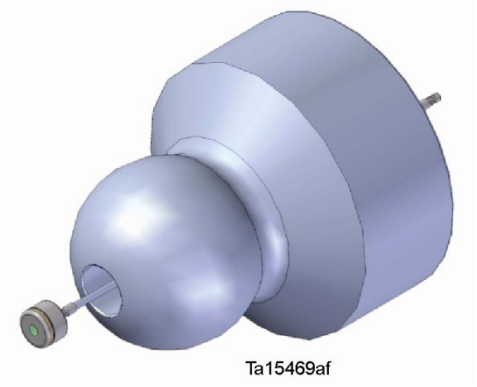


Spherical ball joint greased through cap – hole in ball is plugged



Spherical ball joint greased through cap – hole is plugged (refer to SIL 413)





Spherical ball joint greased through ball – hole is plugged and grease hose connects to the plug plate

Figure 6. Ball lubrication methods

Operator Daily and Weekly Maintenance Inspections and Services

It is essential that the following inspections and service be performed by the operator to ensure the ball joints are properly maintained:

It is the responsibility of each operator to check daily for fresh grease at each ball joint assembly (a “wet” look), as an indication that the Auto Lubrication System is functioning properly. Should a joint be dry, then maintenance personnel should be advised and the problem repaired before operation resumes.

It is the responsibility of each operator to monitor the ball joints for endplay on a daily basis. The operator should note any loose ball socket assemblies that are detected during normal operation, and advise maintenance personnel so that additional detailed checks can be performed.

It is the responsibility of the operator, on a daily basis, to check the ball caps for broken or missing capscrews. **Under no circumstances should the machine be allowed to operate with a broken or missing capscrew.**

It is the responsibility of the operator to inspect the auto lubrication grease reservoir, on a weekly basis, to ensure the reservoir has an adequate supply of lubricant. Before the machine is used in material handling operations, the reservoir must be filled with an adequate amount of grease. Filling procedures for the automatic lubrication system are located in “HYDRAULIC & GREASE SYSTEMS”, in Section 04-02 of the Service Manual.

Torque Inspection of Ball Cap Capscrews

It is essential that the proper torque be maintained on the ball cap capscrews. Trained and experienced personnel should conduct the torque inspections. Torque specifications for the ball joint assemblies in the various models of P&H wheel loaders are located on tables and illustrations in this publication.

New Machines or Replacement Capscrews

New machines or replacement capscrews should be torqued to the proper lubed value and each capscrew should be checked for torque value as follows:

1. Verify torque after first 2, 6, 14 and 100 hours of operation and every 500 hours thereafter.

2. If no loose capscrews are found during the 2-hour and 6-hour verifications, then it is acceptable to perform spot checks on subsequent verifications.

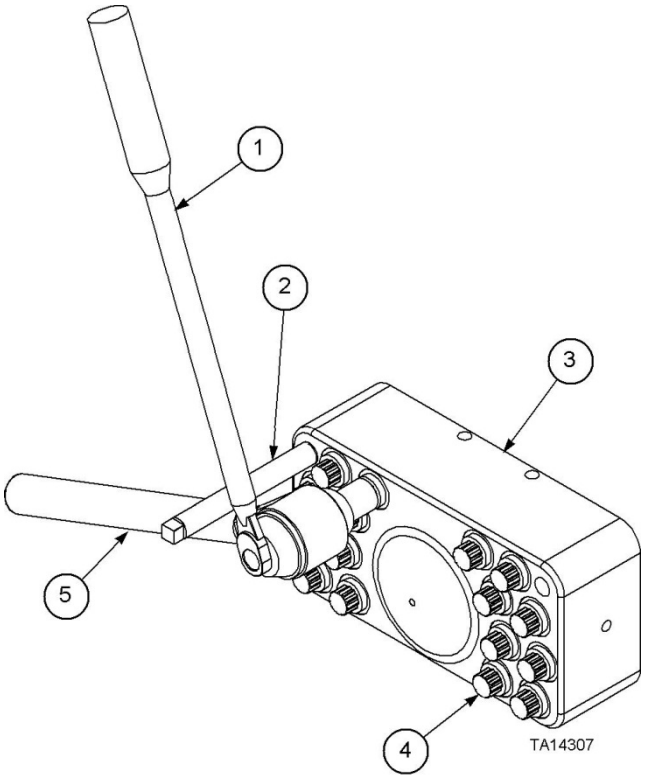
3. If any loose capscrews are found during the 6-hour or 14-hour check, torque the loose capscrews and continue to verify the torque at 4-hour intervals. If, after four verifications of torque, the capscrews continue to come loose, disassemble the ball cap and examine the components for cause.

Use of the Reaction Stud for Ball Cap Capscrew Installation and Removal

Some ball caps have two tapped holes for installation of the reaction stud. The stud must be installed to the full depth of the threads for safe use. Proper tightening of the Ball Cap Capscrews requires the use of a reaction stud with the torque multiplier which is installed in a tapped hole in the ball cap (refer to figure “Reaction stud for ball cap capscrew installation and removal”).

NOTICE

The following illustration shows the reaction stud used with a mechanical torque multiplier and click-type torque wrench. The stud can also be used with hydraulic torque wrenches.



1) Click-type torque wrench

2) Reaction stud-P/N 425-4570

3) Ball cap

4) Capscrew-P/N 423-3222

5) Torque multiplier

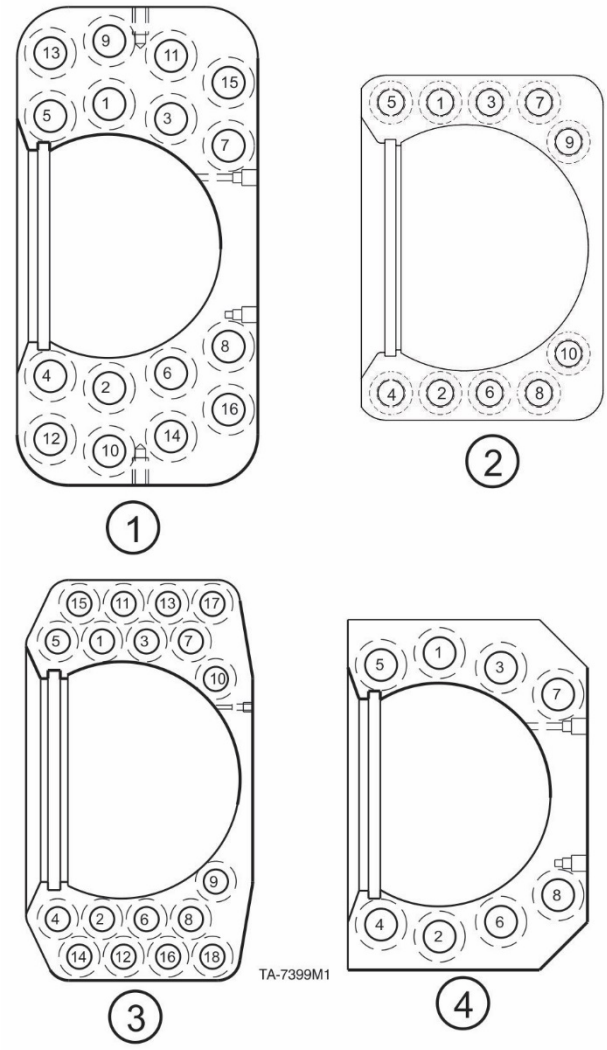
Figure 7. Reaction stud for ball cap capscrew installation and removal

Capscrew Identification and Torque Values

The type of capscrew and proper torque value for each ball cap location is provided on table “Capscrew identification and torque chart”, in this document. All capscrews are to be lubricated with 30W motor oil on the threads and under the heads.

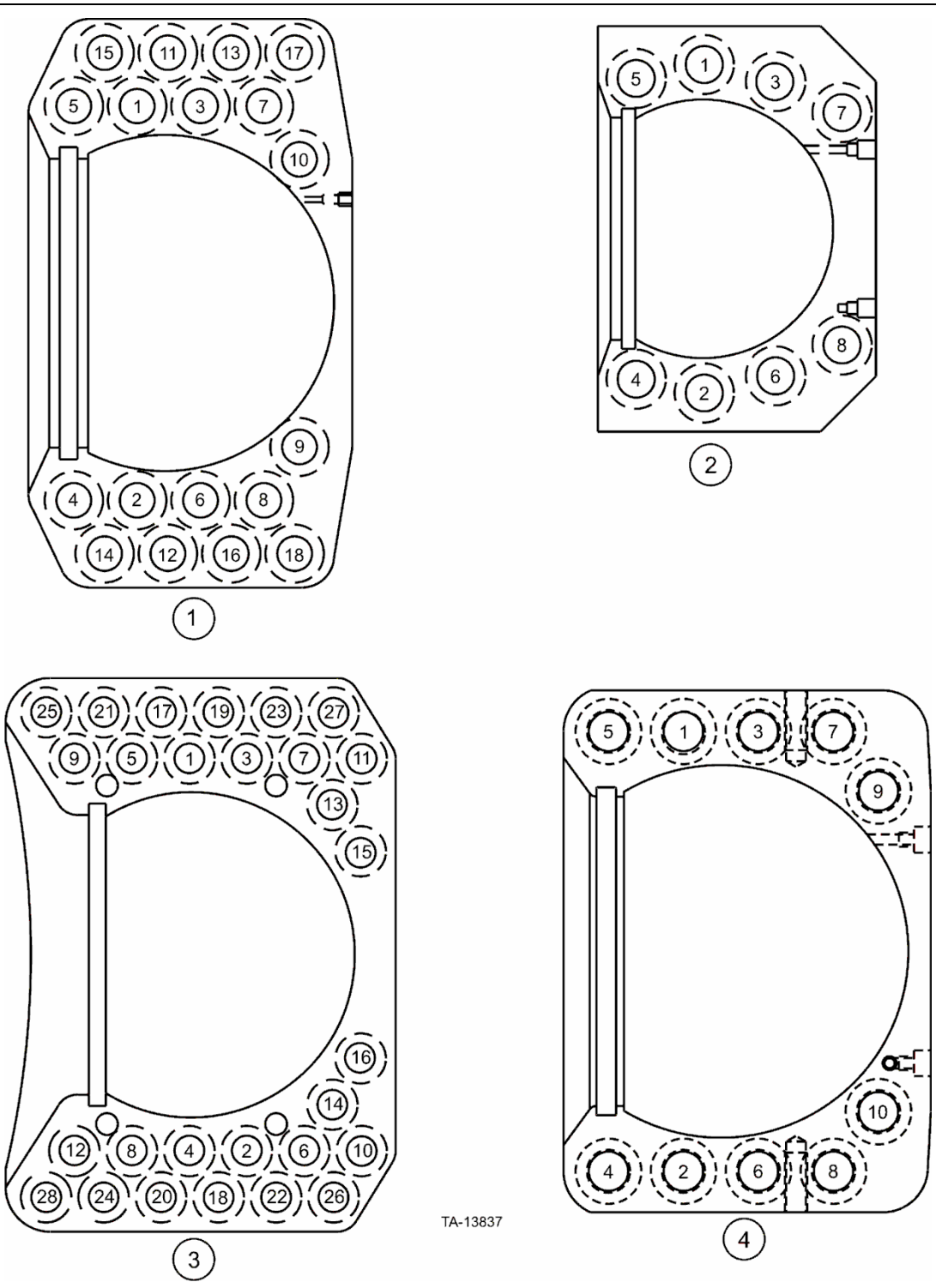
NOTICE

A Ball cap maintenance inspection log form is provided within this section. Make copies of this log as needed to document your ball cap preventive maintenance program. Keep copies of the log in the machine’s permanent file.



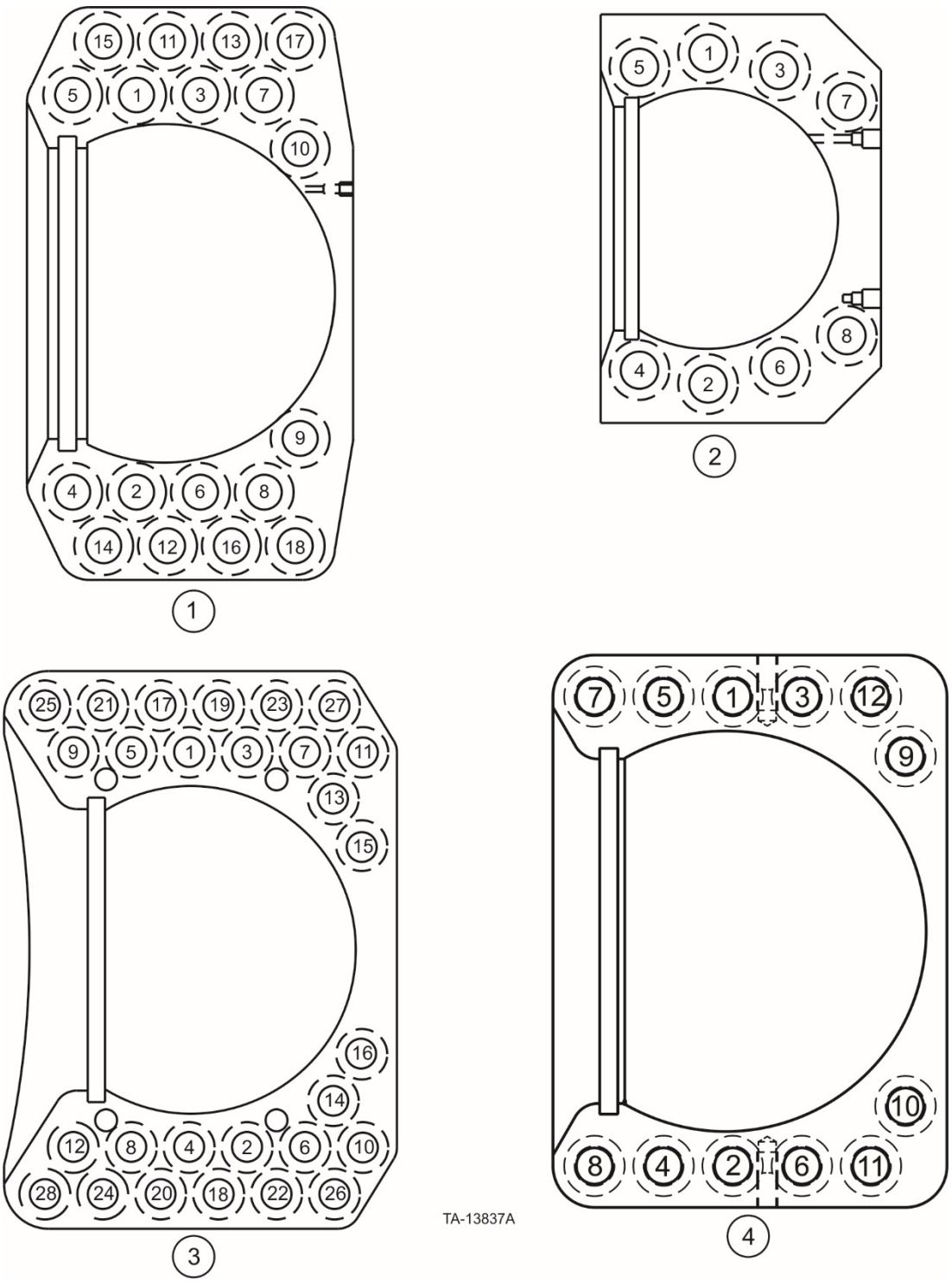
1) Middle pivot	**3)** Lift arm
2) Hoist cylinder	**4)** Oscillating axle

Figure 8. L-1350 ball cap torque patterns – maintenance inspections



1) Middle pivot	**3)** Lift arm
2) Oscillating axle	**4)** Hoist cylinder

Figure 9. L-1850 ball cap torque patterns – maintenance inspections



1) Middle pivot	**3)** Lift arm
2) Oscillating axle	**4)** Hoist cylinder

Figure 10. L-2350 ball cap torque patterns – maintenance inspections

Ball cap maintenance inspection log

Machine Model:				Serial No:			
Ball Cap Location		500-Hour Torque Inspection Hour meter Reading _____		500-Hour Visual Inspection Hour meter Reading _____		2,000-Hour Dial Indicator "Snap" Reading Inspection Hour meter Reading _____	
		Torque Verified		Movement Detected		Movement Detected	
		YES	Problem Bolt Position NO	YES*	NO	YES (enter data)	NO
Lift arm	RHS						
	LHS						
Hoist cyl.	RHS						
	LHS						
Middle pivot	Upper						
	Lower						
Rear axle	Front						
	Rear						
Inspection Test Conducted		By:		By:		By:	
		Date:		Date:		Date:	

Any General Comments By Inspector:

* If any Movement is Detected, Conduct a Dial Indicator Inspection.

** Refer to Bolt Patterns Provided in this Section.

NOTICE

1. **Enter Data in The Respective Column Above – Show the Hours At Top Of Column.**
2. **There Should Be One of These Data Pages for Each Inspection Event.**
3. **Dial Indicator Inspection Must Be Conducted If Any Movement Is Noticed.**
4. **Retain Data Sheets in Machine's Permanent File.**

Table 3. Ball cap maintenance inspection log

Checking Ball Cap Endplay

Visual Inspection of Ball Cap Endplay

A qualified technician should check each ball joint assembly visually at 500-hour intervals. If ANY movement is seen, then the joint should be checked closely with a dial indicator to determine its actual clearance. Refer to “Dial Indicator Inspection of Ball Cap Endplay” below) for instructions on performing these inspections.

Dial Indicator Inspection of Ball Cap Endplay

Each of the ball joint assemblies should be checked in detail by a qualified technician as part of a regular preventive maintenance program, as outlined in the PREVENTIVE MAINTENANCE SCHEDULES, located in Section 02-02 of the Service Manual. Specifications and allowable movement at PM inspection, for the various types and sizes of ball joint assemblies found on the various models of machines, are located on table “Ball base-socket-cap specification” in the following information. It is recommended that the checks be made at the following intervals:

- Initial 100 hours
- Initial 250 hours
- Initial 500 hours
- Initial 1000 hours
- Initial 2000 hours
- Each 2000 hours thereafter

These check intervals would also apply to the installation of new ball, new socket, or new liners.

NOTICE

These hour intervals are only recommendations based on typical usage. The personnel performing the checks may have to adjust these hours downward depending on the severity of the application in which the machine is working.

If the endplay measurements change dramatically from one check to the next, or are found to be out of the wear limits on a particular joint, the checks may have to be performed more often until the joint stabilizes.

Visual and dial indicator inspections of the ball joint assemblies require operational tests of the machine. These tests should only be performed by qualified and experienced personnel. It is critically important that no personnel be in close proximity to the machine during these tests as serious injury or loss of life is possible. A signal person should advise the operator during these inspections.

⚠ WARNING

Crush hazard exists if the machine is not positioned straight or turned to either side and the frame lock is not installed prior to any testing. Always steer the machine straight and install the frame lock before performing any testing. Be sure all personnel are secure and in safe positions prior to performing any testing. Place signs to alert other personnel to keep a safe distance from the machine. Failure to place the frame lock in the locked position and to alert personnel to keep a safe distance could cause a crush hazard resulting in serious injury or death.

Safety Preparations

⚠ WARNING

Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.

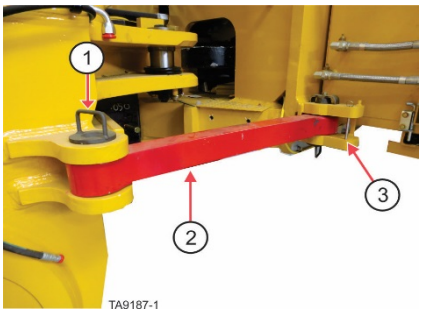
a. Ensure the bucket is empty and clear of debris.

b. Set bucket flat and level on the ground.

c. Move the frame lock to the locked position so that the frame cannot be steered.

⚠ WARNING

Crush hazards exist in machine pivot area and area between the tires. Do not enter these areas unless it is verified that the operator has control over the steering and that personnel locking the frame lock have good communication with the operator. Entering the pivot area and area between the tires while the machine is moving or pivoting (articulating) could cause crush hazards resulting in serious injury or death.



1) Retaining pin for locked position, **2)** Frame lock - shown in locked position,

3) Retaining pin bracket for un-locked position

Figure 11. Frame lock in locked position

d. Set the parking brakes.

e. Shut off the engine.

Checking Lift Arm Ball Cap Endplay

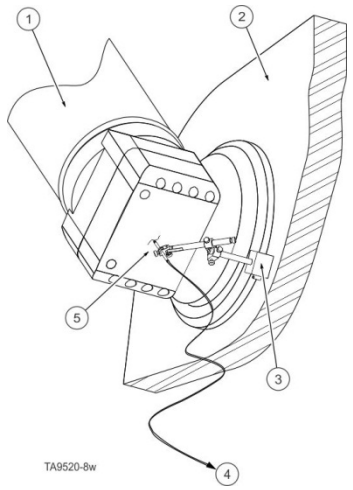
This test needs to be performed on flat level ground so the lift arms cannot move up and down during the test.

a. Set the bottom plane of the bucket flat on the ground.

b. Mount the magnetic base of a dial indicator on the frame structure next to the lift arm ball cap so the indicator contacts the ball cap as near to center as possible. The centerline of the dial indicator should be aligned with the centerline of the ball cap. It may be necessary to scrape off some paint on the frame in order to have the magnetic base securely mounted.

NOTICE

Refer to figure "Typical indicator setup for measuring endplay in ball and cap assembly" (below) for an example of dial indicator setup. Ball joint shown in the illustration is a hoist cylinder; however, dial indicator installation is the same for other ball joints.



1) Hoist cylinder **2)** Frame **3)** Magnetic base securely attached to frame **4)** To the remote meter outside the vehicle **5)** Dial indicator probe in contact with cap

Figure 12. Typical indicator setup for measuring endplay in ball and cap assembly

c. Move the machine backwards three to four feet and apply the brakes. Zero the dial indicator.

d. Release the brakes and slowly move the machine forward three to four feet (with the bucket still on the ground).

e. As the machine begins to move forward, the dial indicator needle should "snap" from the zero setting to some value.

Ball Cap Location	Machine	Capscrew	LeT P/N	Torque Value	
				Ft.-Lb.	N•M
Lift Arms*	L-1350	1-1/4”-7 x 6” UNRC	423-3222	1900	2584
	L-1850/L-2350	1-1/4”-7 x 10” UNRC	424-1671		
Hoist Cylinders* Middle Pivot Rear Axle	L-1350 L-1850/L-2350	1-1/4”-7 X 6” (Ball caps with countersunk holes)	423-3222	1744	2365
		1-1/4”-7 X 8-1/2” (Ball caps with non-countersunk holes)	424-3968		

CAUTION

Use only capscrews available under Komatsu P/N shown for these applications. Inspect the thread count, size of bolt and type of bolt removed from the original application before installing new bolts. Always make sure the bolt thread count, size and type matches the old or new application before installing bolts.

Table 4. Capscrew identification and torque chart

NOTICE

All capscrews to be lubricated on the threads and under the heads with 30W motor oil.

Use properly calibrated hydraulic torque wrench or torque multiplier.

Inspect the bolt thoroughly to determine the exact type of bolt (especially size and thread count). Check the “CAPSCREW TORQUE CHART”, of this manual, to determine the proper amount of torque to be applied to the bolt. Read all NOTES or KEY ITEM callouts on the “TORQUE CHART” before determining the torque amount.

Use Parts Manual to determine what bolt PN is used.

NOTICE

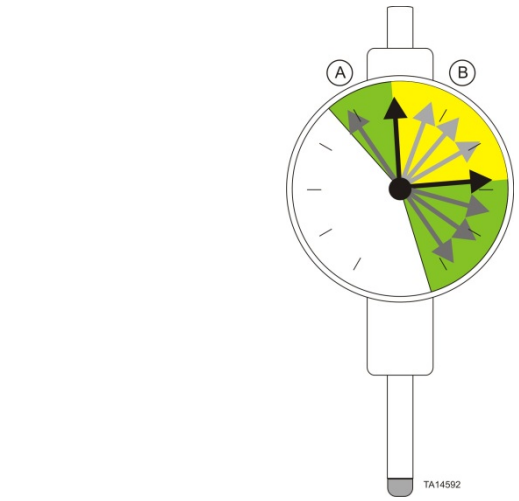
The “snap” value is the endplay reading for the lift arm ball cap. Take care to read only the “snap” reading. Failure to do this can lead to very tight ball socket assemblies, heat, and rapid wear.

f. Repeat the test moving backwards.

g. Repeat the test several times until you are able to obtain consistent numbers.

h. Check both left and right sides.

i. Compare this reading to those in table “Ball base-socket-cap specifications”, below. If readings are above the maximum reading (or below the minimum new setup reading) the shim pack will have to be adjusted. Adjust the shim pack to bring the endplay into the “New Setup Range”. Refer to figure “Snap value (deflection and clearance)”, below.



(A) Green area – needle moves slowly in proportion to how much machine is moved, steered, hoisted. etc. This is **DEFLECTION**	**(B)** Yellow area – Needle snaps quickly between low and high when the machine is moved, steered, hoisted, etc. This is the **CLEARANCE**.

Figure 13. Snap value (deflection and clearance)

Checking Hoist Cylinder Ball Cap Endplay (loaders only)

⚠ WARNING

Crush hazard exists if the machine is not positioned straight or turned to either side and the frame lock is not installed prior to any testing. Always steer the machine straight and install the frame lock before performing any testing. Be sure all personnel are secure and in safe positions prior to performing any testing. Place signs to alert other personnel to keep a safe distance from the machine. Failure to place the frame lock in the locked position and to alert personnel to keep a safe distance could cause a crush hazard resulting in serious injury or death.

a. Set the bottom plane of the bucket flat on the ground.

b. Mount the magnetic base of a dial indicator on the frame structure next to the hoist cylinder ball cap so the indicator contacts the ball cap as near to center as possible. The centerline of the dial indicator should be aligned with the centerline of the ball cap. In this case, the dial indicator will typically be nearly horizontal. It may be necessary to scrape off some paint on the frame in order to have the magnetic base securely mounted.

c. Slowly power down the machine with the hoist until the weight comes off of the tires. **(It is not necessary to lift the front end of the machine).** Zero the dial indicator.

d. Slowly hoist the lift arms.

e. As the arms begin to move up, the dial indicator needle should “snap” from the zero setting to some value.

NOTICE

The “snap” value is the endplay reading for the lift arm ball cap. Take care to read only the “snap” reading. Failure to do this can lead to very tight ball socket assemblies, heat, and rapid wear.

f. Repeat the test while holding the joystick in the “Power Down” position.

g. Repeat the test several times as you hoist up and down until you are able to obtain consistent numbers.

h. Repeat the test on both left and right hoist cylinder ball caps.

i. Compare this reading to those in table “Ball base-socket-cap specifications”. If above the maximum reading for (or minimum new setup reading) the shim pack will have to be adjusted. Adjust the shim pack to bring the endplay into the “New Setup Range”. Refer to figure “Snap value (deflection and clearance”.

Checking Middle Pivot Endplay

⚠ WARNING

Crush hazard exists if the machine is not positioned straight or turned to either side and the frame lock is not installed prior to any testing. Always steer the machine straight and install the frame lock before performing any testing. Be sure all personnel are secure and in safe positions prior to performing any testing. Place signs to alert other personnel to keep a safe distance from the machine. Failure to place the frame lock in the locked position and to alert personnel to keep a safe distance could cause a crush hazard resulting in serious injury or death.

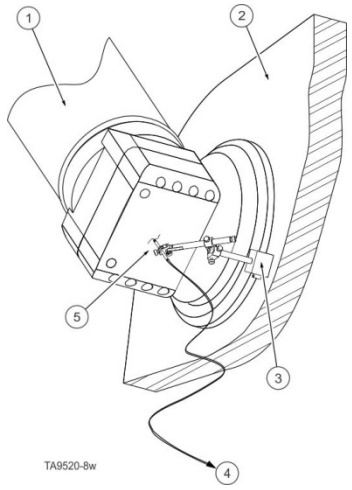
a. Set the bottom plane of the bucket flat on the ground.

b. Mount the magnetic base of a remote readout dial indicator on the front frame structure next to the middle pivot ball cap so the indicator transducer or remote gauge head contacts the ball cap as near to center as possible. The centerline of the indicator transducer or remote gauge head needs to be aligned with the centerline of the ball cap. In this situation, it will be horizontal. It may be necessary to scrape off some paint in order to have the magnetic base securely mounted.

c. The remote indicating unit or gauge amplifier should be placed outside the pivot area where it can be seen from a safe position.

NOTICE

Remote readout electronic dial indicators are available from many manufacturers such as Starrett, Brown and Sharp, Federal, Mitutoyo and others.



1) Hoist cylinder **2)** Frame **3)** Magnetic base securely attached to frame **4)** To the remote meter outside the vehicle **5)** Dial indicator probe in contact with cap

Figure 14. Typical indicator setup for measuring endplay in ball and cap assembly

d. Slowly power down with the hoist until the weight comes off of the tires (it is not necessary to lift the front end of the machine). Zero the dial indicator.

e. Slowly hoist the lift arms.

f. As the arms begin to move up, the dial indicator needle should “snap” from the zero setting to some value. After that, the needle will typically continue to move slowly in the same direction.

NOTICE

The “snap” value is the endplay reading for the middle pivot ball cap. Take care to read the “snap” reading. All other needle movement is due to deflection and cap movement. Failure to do this can lead to very tight ball socket assemblies, heat, and rapid wear.

g. Repeat the test powering down.

h. Repeat the test several times as you hoist up and down unit you are able to obtain consistent numbers.

i. Repeat the test for top and bottom pivot ball caps.

j. Compare the reading obtained to those in table “Ball base-socket-cap specifications”, below. If above the maximum reading (or below the minimum new setup reading), the shim pack will have to be adjusted. Adjust the shim pack to bring the endplay into the “New setup range”. Refer to table “Snap value (deflection and clearance)”, above).

Checking Rear Oscillating Axle Endplay

WARNING

Crush hazard exists if endplay readings are taken on the rear axle of an operating machine. These readings should be taken using either jacks or a crane of appropriate capacity (LOADER JACKING INSTRUCTIONS, located in Section 3 in this manual). Taking endplay readings of a rear axle on an operating machine can cause a crush hazard resulting in serious injury or death.

WARNING

Crush hazard exists if the machine is not positioned straight or turned to either side and the frame lock is not installed prior to any testing. Always steer the machine straight and install the frame lock before performing any testing. Be sure all personnel are secure and in safe positions prior to performing any testing. Place signs to alert other personnel to keep a safe distance from the machine. Failure to place the frame lock in the locked position and to alert personnel to keep a safe distance could cause a crush hazard resulting in serious injury or death.

a. Set the bottom plane of the bucket flat on the ground.

b. Mount the magnetic base of a dial indicator on the axle structure next to the pivot ball cap so the indicator contacts the ball cap as near to center as possible. The centerline of the dial indicator needs to be aligned with the centerline of the ball cap. In this case, it should be vertical. It may be necessary to scrape off some paint in order to have the magnetic base securely mounted.

c. Slowly raise the frame with the jack until the ball caps hold the weight of the axle.

NOTICE

Do not lift the machine high enough to allow the axle to oscillate or false readings will be obtained.

d. Lower the frame slowly and smoothly until the frame rests on the axle. As the frame begins to lower, the dial indicator needle should “snap” from the zero setting to some value.

NOTICE

The “snap” value is the endplay reading for the rear oscillating axle ball cap. Take care to only read the “snap” reading. Failure to do this can lead to very tight ball socket assemblies, heat and rapid wear.

Do not do this test while powering up with a jack. Typically a jack will hoist in a jerky manner and cause the needle of the dial indicator to simulate a “snap” reading. Even though it is actually showing deflection.

e. Repeat the test several times as you hoist up and down until you are able to obtain consistent numbers.

f. Compare this reading to those in table “Ball base-socket-cap specifications”, below. If above the maximum reading (or below, the minimum new setup reading), the shim pack will have to be adjusted. Adjust the shim pack to bring the endplay into the “New setup range”. Refer to figure “Snap value (deflection and clearance)”, above.

NOTICE

Follow the numbered sequence in incremental tightening until all bolts achieve desired torque.

Do not tighten any one bolt before others are drawn down incrementally.

For proper torque amount, refer to table “Capscrew Identification and Torque Chart”, located in section 01-05 of the service manual.

Overview of Ball Joint Troubleshooting Adjustment and Replacement

This section of the manual provides technicians with instructions for the troubleshooting, adjustment and replacement of the ball joint assemblies on the various models of P&H wheel loader. The need for adjustment or repair is indicated by inspections.

Safety, Warnings and Cautions

The following warnings and cautions apply to the disassembly of the ball joints on the various models of P&H wheel loader. **These warnings and cautions will not be reiterated in the following text.**

⚠ WARNING

Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.

⚠ WARNING

Crush hazard exists if cranes or jacks of suitable capacity are not used to lift the major components of the machine for removal and installation of the ball joints. Always select cranes and jacks of sufficient capacity to hold the weight of the machine or component being lifted or placed on a jack. Failure to select cranes or jacks of sufficient capacity to support the weight of the machine or component can cause crush hazards resulting in serious injury or death.

⚠ WARNING

Crush hazard exists if standing under or placing hands or feet under any component of the machine that is hoisted. Crush hazards exist when a load is suspended. Suspended loads can fall. Never work under suspended loads. Working under suspended loads could cause a crushing hazard which might result in serious injury or death.

⚠ WARNING

Crush hazard exists if proper welding procedures are not used when replacing or repairing ball and cap components. Do not weld the spherical part of the ball or the neck area. The ball base assemblies are special heat-treated steel. Any welding to the ball or neck will cause damage to the steel and detrimentally affect the strength of the ball. Replacement of a ball base entails very specific welding procedures to prevent any damage to the spherical part of the ball and neck. Follow the ball base replacement procedures provided in FIELD WELDING PROCEDURES, located in Section 03-02 of the Service Manual. Failure to follow proper welding procedures can cause crush hazards resulting in serious injury or death.

⚠ WARNING

Crush hazard exists when lifting the rear axle off the ground. Caution should be exercised when using jacks to lift the machine. If both wheels of the oscillating axle are off the ground at the same time, the axle may swivel vertically. This is a potentially hazardous situation. Both sides of the axle should be blocked to prevent swiveling. Failure to block both sides of the rear axle can cause a crush hazard resulting in serious injury or death.

⚠ CAUTION

Struck by or crush hazards exist if proper lifting equipment and techniques are not used. Ball caps are heavy and lifting equipment of sufficient capacity and proper lifting procedures should be used to ensure a safe lift. Approximate weights for the various types of ball caps are provided in Table “BALL CAP WEIGHT CHART” in this document. Failure to select sufficient capacity equipment and use proper lifting techniques when working with balls and caps can cause a crush hazard resulting in serious injury.

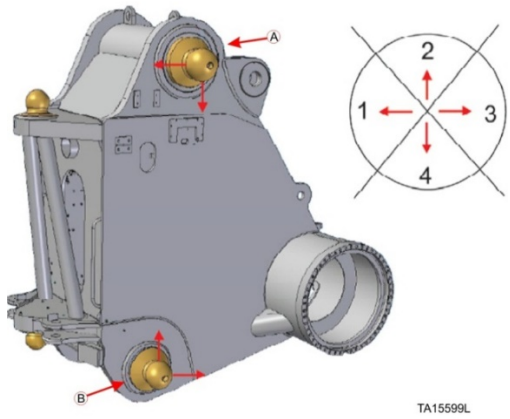
CAUTION

Under no circumstances should anything be welded to a ball cap to assist in handling the cap or to assist in torquing the capscrews. The ball cap is specially heat-treated steel. Any welding will cause damage to the steel and the ball cap can potentially fail. A tapped and threaded hole is provided for use of a lifting eye.

Inspection Guidelines for Hoist and Lift Arm Balls

Hoist Ball Inspections

Inspection area is the upper part of the ball (area 2 and 3 in Figure “Inspection Area Mapping”). This will require cap removal and the hoist cylinder to be moved away from the ball to be inspected. Refer to the text “Hoist Cylinder Ball Cap Removal and Installation” for disassembly and reassembly process. Carefully follow re-commissioning procedures including lubrication and bolt torqueing.

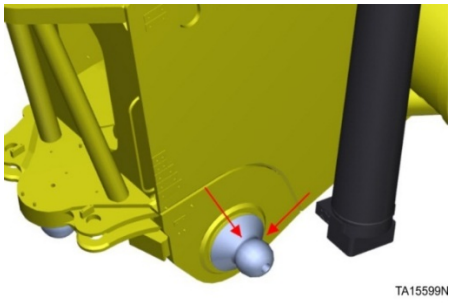


(a) Lift Arm Ball	**(b)** Hoist Ball
Area 1 – Rear of ball **Area 4 – Bottom of ball**	**Area 2 –Top of ball** **Area 3 – Front of ball**

Figure 15. Inspection Area Mapping

NOTICE

Before attempting to remove or install the ball cap, read and follow instructions in text “Hoist Cylinder Ball Cap Removal and Installation” and refer to warnings and cautions at the beginning of the section. Failure to follow warnings and cautions could result in serious injury, loss of life, or machine damage.

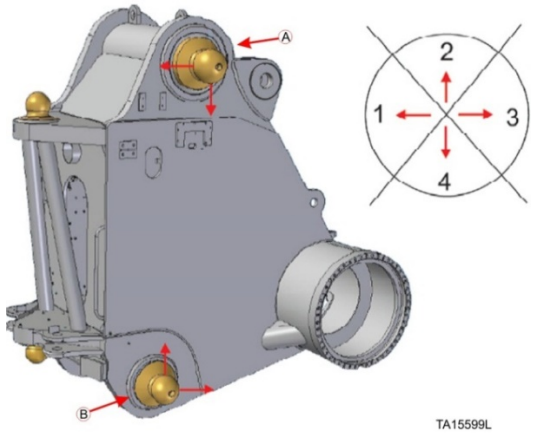


Hoist cylinder cap removed and cylinder secured to inspect front and top of ball

Figure 16. Hoist Ball Inspection

Lift Arm Ball Inspections

Inspection area is the lower part of the ball (area 1 and 4 in Figure “Inspection Area Mapping”). This will require the lift arm cap to be moved away from the ball to be inspected. Refer to the text “Lift Arm Ball Cap Removal and Installation” for disassembly and reassembly process. Since the inspection area is exposed with just the cap removed, the lift arm can stay in place. Carefully follow re-commissioning procedures including lubrication and bolt torqueing.

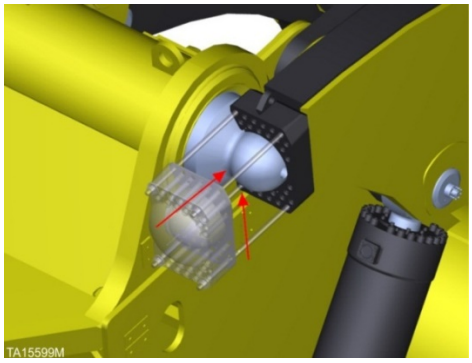


(a) Lift Arm Ball	**(b)** Hoist Ball
Area 1 – Rear of ball **Area 4 – Bottom of ball**	**Area 2 –Top of ball** **Area 3 – Front of ball**

Inspection Area Mapping

NOTICE

Before attempting to remove or install the ball cap, read and follow instructions in text “Lift Arm Ball Cap Removal and Installation” and refer to warnings and cautions at the beginning of the section. Failure to follow warnings and cautions could result in serious injury, loss of life, or machine damage.



Lift arm cap backed off with lift arms left in place to inspect rear and bottom of ball

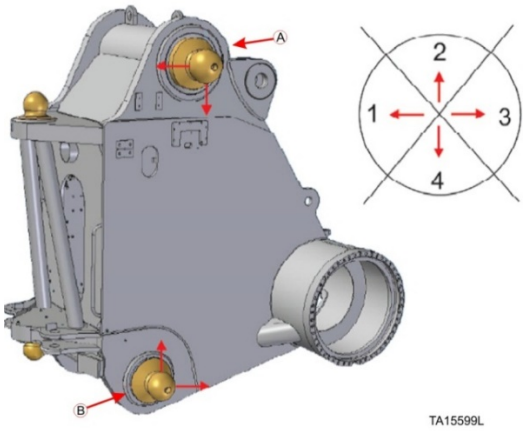
Figure 17. Lift Arm Ball Inspection

Inspection Methods

⚠ CAUTION

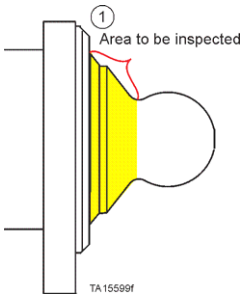
Chemical hazard and inhalation hazard exists if the appropriate Personal Protective Equipment (PPE) is not used when using solvents or other chemicals. Eye contact with some solvents can cause blindness. When working with chemicals, avoid contact with them and ensure proper ventilation is adequate. Breathing fumes from some solvents can cause asphyxiation. Ensure all required PPE is used. Follow all local rules and regulations when working with chemicals. Failure to use proper PPE and to avoid chemical contact could cause a chemical hazard and inhalation hazard resulting in serious injury.

The balls must be inspected for cracking using Mag Particle (MT) or Dye Penetrant (PT) which is temperature limited and must be done immediately by an ASNT (American Society of Non-Destructive Testing) level 1, or higher, PT or MT inspector. Where ASNT is not the governing body authority, the inspector shall be certified to the appropriate local governing body.



a) Lift Arm Ball	**b)** Hoist Ball
Area 1 – Rear of ball **Area 4 – Bottom of ball**	**Area 2 –Top of ball** **Area 3 – Front of ball**

Inspection Area Mapping



1) Area to be inspected

Inspect ball surface between neck and weld using Mag particle or dye penetrant method

Figure 18. Ball Inspection Surface

Indications

If indications are found on the ball, lightly polish the indication. The indication may disappear upon light polishing, indicating surface marking. It is not recommended to attempt to blend polish any indications. The ball must be replaced if any indications are found beyond surface marking.

⚠ WARNING

Crush hazard exists if indications (such as cracks) exist on a hoist or lift arm ball. The machine must be taken out of service and the ball replaced. Operating equipment with cracks (indications) in hoist or lift arm balls could lead to ball failure, which could cause crush hazards from unexpected motion resulting in serious injury or death.

General Disassembly and Assembly Instructions for Ball Joints

Disassembly

a. Upon disassembly, all parts should be thoroughly cleaned with industrial solvent.

b. Inspect the ball base, socket and cap for damage.

c. Check the ball base, socket and cap for wear. Specifications for these components are provided in table “Ball base-socket-cap specifications” (below).

d. If the ball, socket or cap has worn beyond the limits shown in table “Ball base-socket-cap specifications” (below) if replacement is necessary.

e. A “Ball joint troubleshooting” chart is provided within this section to help identify deficiencies in maintenance or operation that may be causing the difficulties. Refer to this chart following disassembly for corrective action that should be taken to prevent a reoccurrence of the problems.

Assembly

a. Before assembly, inspect the ball base, ball cap, socket, ball liner and spacer to make sure they are free of debris or damage that might impair accurate assembly.

b. Check the hole through the center of the ball to see that the plug is securely in place. If the plug is not in place or leaking, grease might be escaping through the center of the ball rather than lubricating the liners. This plug prevents grease transfer through the ball. The hole is placed through the ball assembly to aid in heat-treating during the manufacturing process. These plugs are only used on balls that are greased through the caps. Ball assemblies that are greased through the ball do not have a plug.

c. Liners currently manufactured by Komatsu have two round grease grooves in the inner diameter of the liner. These grooves aid in better distribution of the grease to all parts of the ball and liner. These are beneficial in applications such as the hoist cylinder and rear axle that do not incur much angular movement. The large angular movement of the lift arm and middle pivot tends to “pump” grease around the ball.

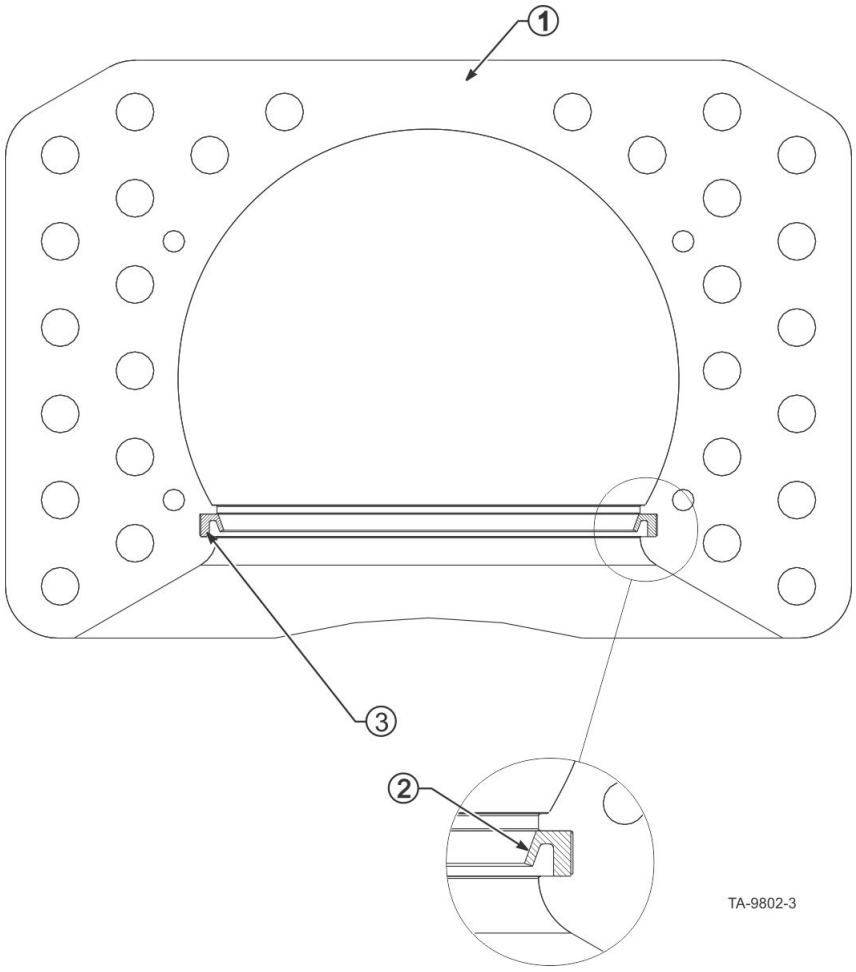
d. Prior to assembly, lightly coat the spherical surface of the ball cap and socket with multi-purpose grease. This provides the necessary pre-lubrication and will facilitate assembly by helping the ball liner to adhere to the cap and socket.

e. The typical auto lube grease may be too thin to hold the ball liner to the cap and socket. It may be necessary to use a standard EP2 general-purpose grease which is more tacky.

f. Use care when placing the bronze ball liner half (bushing) into the socket. Check to see that the grease holes align with the grease holes in the socket. At the same time check to see that the grease holes in the spacer plate and shims also line up with the holes in the socket. **Failure to check this can cause rapid failure due to lack of lubrication.**

g. The check for the grease holes is only necessary on the ball cap positions that have grease lines to the cap and socket. If grease comes through the center of the ball, the small holes are not necessary, although they may be there for parts commonality.

h. Use caution when installing the grease seal. The grease seal is manufactured in two half-moon pieces. Place one half of the seal into the groove in the socket and the other half into the groove in the cap. **It is essential to align the seal in the manner shown in figure "Ball cap liner and seal installation" (below) so that the seal will allow grease to escape and prevent contaminates from entering the joint.**



1) Ball cap. **2)** Lip, **3)** Seal

NOTE: When installing the seal ensure that the lip is pointing down as shown

Figure 19. Ball cap liner and seal installation

Ball Joint Troubleshooting Chart

Item	Symptom Found	Likely Reason	Solution
1	Brass deposits on the ball.	Ball has been running without grease.	Check auto lube system for proper pump and timer operation.
			Check injector for proper operation.
			Check grease hoses.
			Check the plug in the ball on ball sockets that are lubed through the cap.
2	Discolored ball.	Shimmed too tight.	Check clearance.
			Check for worn ball. Shim per special procedures.
			Check auto lube system as noted in Item 1.
3	Rapid wear on ball.	Shimmed too tight.	a. Check clearance.
			b. Check for worn ball. Shim per special procedures.
		Running without grease.	Check auto lube system as noted in Item 1.
		Ball is worn and TIR too great.	Replace ball base assembly.
4	Scratch marks on ball.	Grit and contamination on the liner.	Typically caused by careless assembly. Be sure all components are properly cleaned during assembly. Flush out all hoses and old grease to ensure no contaminants are present.
			Check to be sure the seal is not damaged and is installed properly.
5	Red/brown colored grease or stain.	Typically due to poor grease transfer. Fresh grease is not getting into the area.	Check to see that proper type of auto lube grease is being used.
			Check that all grease transfer holes in the ball cap, spacer, shims and socket are open and properly placed.
			Add grease transfer grooves to the inner

			diameter.
6	Metal scraping on the ball.	Spacer and shims contacting the ball due to worn liners.	Replace brass liners.
Continued on next page			

Table 5. Ball joint troubleshooting(sheet 1 of 2)

Item	Symptom Found	Likely Reason	Solution
7	Damage to the neck of the ball.	Cap and socket contacting the neck of the ball due to worn out liners.	Replace brass liner. Replace ball if damaged (FIELD WELDING PROCEDURES, located in the MECHANICAL section (Section 03-02) of this manual).
8	Wear is not centered on the ball.	Balls and sockets not aligned properly.	Proper alignment tolerance is from neutral, to the balls being slightly wider than the sockets.
		Possibly due to damage from accident or abuse.	Align the components.
	Wear is on the neck side of the ball.	Balls closer together than the sockets. Check the alignment to see if something has bent, if ball installed improperly, etc.	Proper alignment tolerance is from neutral (centerline of ball and socket exactly the same) to the balls being slightly wider than the sockets.
	Wear is from the center to outer part of the ball.	Normal	Check for reasons for wear.
9	Scorched paint on ball cap (running hot).	Out of grease.	Check lube system per Item 1.
		Incorrect type of grease.	Check grease specifications to be sure it meets the specifications on illustration "LUBRICATION AND FLUID SPECIFICATIONS," located in the HYDRAULICS section (Section 04-01) in this manual.
		Endplay tolerances too tight.	Adjust ball cap tolerances.
		Ball cap and socket are misaligned with respect to each other.	Replace components that are incorrect.

Table 5. Ball joint troubleshooting Ball joint troubleshooting (sheet 2 of 2)

Lift Arm Ball Cap Removal and Installation Procedures

The lift arm is attached to the frame by use of two ball socket assemblies on the top of the front frame.

Before disassembly of the ball caps is attempted, the following procedure must be performed.

⚠ WARNING

Crush hazard exists when attempting to remove or install the ball cap. Ball caps are heavy and removing a cap requires equipment with sufficient capacity rating to support the weight of the cap. Always read and understand all WARNINGS AND CAUTIONS provided before attempting to remove or replace a ball cap. Failure to use equipment with adequate lifting capacity and to follow WARNINGS AND CAUTIONS could cause a crush hazard resulting in serious injury or death.

Safety Preparations

Component Weights

NOTICE

Component weights are approximate. Always allow a safety margin when selecting lifting equipment.

Loader	Lift Arm	Hoist Cylinder	Middle Pivot	Rear Axle Pivot
L-1350	275 lbs. (125 kgs.)	202 lbs. (92 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)
L-1850	610 lbs. (277 kgs.)	250 lbs. (114 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)
L-2350	610 lbs. (277 kgs.)	390 lbs. (177 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)

NOTICE

These weights are only approximate and provided as a guide for determining proper lifting procedures and equipment. In all cases, adequate equipment should be used to provide a good safety margin.

Ball cap weight chart

⚠ WARNING

Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.

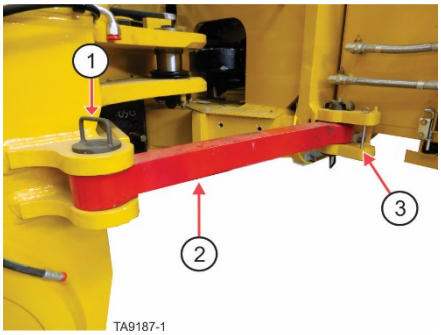
a. Stop the wheel loader on flat level ground.

b. Move the frame lock to the locked position so that the frame cannot be steered.

c. Place wheel chocks in front and behind each wheel.

⚠ WARNING

Crush hazards exist in machine pivot area and area between the tires. Do not enter these areas unless it is verified that the operator has control over the steering and that personnel locking the frame lock have good communication with the operator. Entering the pivot area and area between the tires while the machine is moving or pivoting (articulating) could cause crush hazards resulting in serious injury or death.



1) Retaining pin for locked position, **2)** Frame lock - shown in locked position,

3) Retaining pin bracket for un-locked position

Frame lock in locked position

d. Set bucket flat and level on the ground.

e. Set the parking brakes.

f. Shut off the engine.

⚠ WARNING

Crush, shock, or other hazards exist if stored energy is not removed or isolated prior to working on the machine. Stored energy (hydraulic, electrical, pneumatic, mechanical, etc.) may be present if not isolated or released prior to working on the machine. Do not work on the machine without removing this stored energy (suspended loads, electrical power, air pressure, etc.). Risk of crushing, shock, or other physical injury exists if stored energy is not removed or isolated prior to working on the machine which could result in serious injury or death.

g. Turn the battery and engine isolation switches to the off position and install locks on the battery isolation switch.

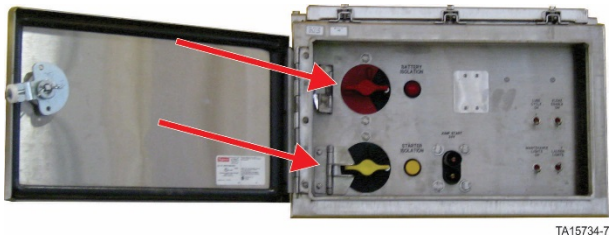


Figure 20. Battery isolation switch in OFF position with locks in place

h. Release the air from the hydraulic reservoir by using the hydraulic reservoir air valve (ball valve) on top of the reservoir. The supply line from main air system will be blocked and reservoir air will vent out the hose that runs down the outside of the hydraulic reservoir.

- Turn the handle to the up position as shown

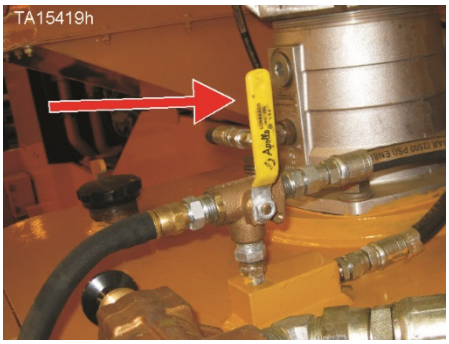


Figure 21. Hydraulic reservoir air valve handle UP

i. Release the air from the various air storage reservoirs by opening all of the air bleed valves.

Three valves on right side of rear frame under hydraulic reservoir
One valve on right side of front frame near hoist cylinder ball cap

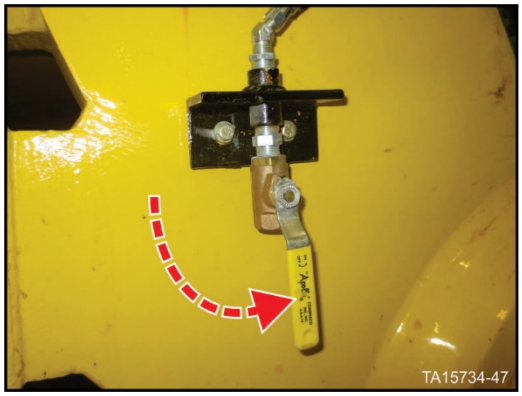


Figure 22. Open air reservoir bleed valves

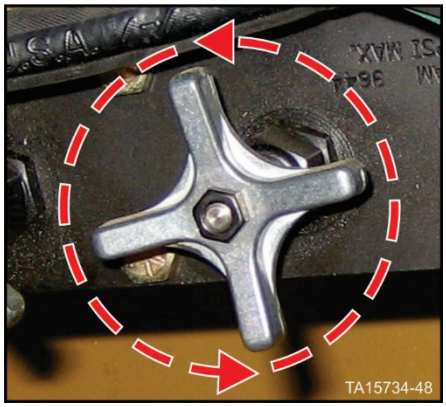
⚠ WARNING

Crush hazards exist if all personnel are not cleared from the bucket and lift arm area before using the hydraulic hoist and bucket hydraulic pressure bleed down valves to relieve pressure from the hoist and bucket circuit. Clear all personnel from the area around the bucket and lift arms before operating hydraulic hoist and bucket hydraulic pressure bleed down valves. Using the hydraulic bleed down valves could result in some movement of the lift arms and bucket which could cause a crush hazard resulting serious injury or death.

j. Use the hydraulic pressure bleed down valves located in the front frame underneath the Husco valves to bleed any stored pressure in the hoist and bucket cylinders.

k. Turn each valve slowly counterclockwise as shown below and allow the pressure to bleed down.

- Open the valve completely and leave it open during this procedure.



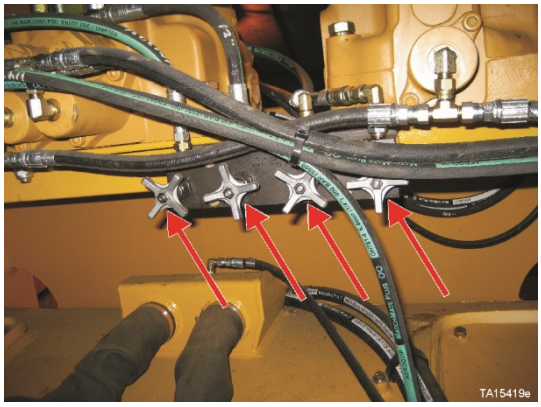


Figure 23. Pressure bleed down valves

l. Following all local environmental rules and regulations, drain the hydraulic reservoir and any residual fluid in the hydraulic lines.

Lift Arm Ball Cap Removal

a. Attach a suitable lifting device to the ball cap.

b. Use a crane to support the lift arms.

c. Disconnect the radial transducer prior to removing the right hand lift arm ball cap. Note the way that it is connected, as it is possible to rotate the coupling.

d. Remove two of the capscrews in the ball cap and install 1-1/4” of the appropriate thread studs of long enough length to slide the ball cap away from the ball approximately 2 feet (refer to figure “Typical installation of ball cap stud supports for ball cap removal – installation”, below).

e. Remove the remaining capscrews in the ball in a crisscross pattern (reverse torque pattern). Remove only one capscrew at a time.

f. Slide the ball cap onto the studs approximately two feet from the lift arm.

g. If liners need to be replaced, start the machine using site location start-up procedures. Steer the machine in the direction of the ball cap to be removed. (Example: if right hand ball cap is to be removed, steer right). The machine does not need to be steered very far for the liner to loosen.

h. Replace the ball cap liner using the “General Disassembly and Assembly Instructions for Ball Joints” below.

i. After the liner has been replaced, steer to the left to re-align ball socket to ball cap. Reinstall ball cap using the “General Disassembly and Assembly Instructions for Ball Joints”.

Lift Arm Ball Cap Installation

After the “General Disassembly and Assembly Instructions for Ball Joints” have been performed, the following details apply to the lift arm ball socket assemblies (refer to figure “Typical lift arm ball cap assembly (all models”, below).

a. Place the spacer plate on the flat clamping face of the ball socket with cutouts toward the liner (relief), and hold in place with two short 1-1/4” diameter bolts of correct thread type. In place of these, the regular capscrew and spacer sleeve may be used. The idea being to hold the spacer plate tight against the socket during installation of the lift arms. This will prevent the brass liner from rotating when if first contacts the ball.

NOTICE

L-1850 and L-2350 machines have 1/2” threaded holes to aid in positioning the spacer plate, shims and ball cap. The spacer plate and shims are attached to the socket by means of four each 1/2” diameter bolts. Corresponding holes in the ball cap will clear the bolt heads.

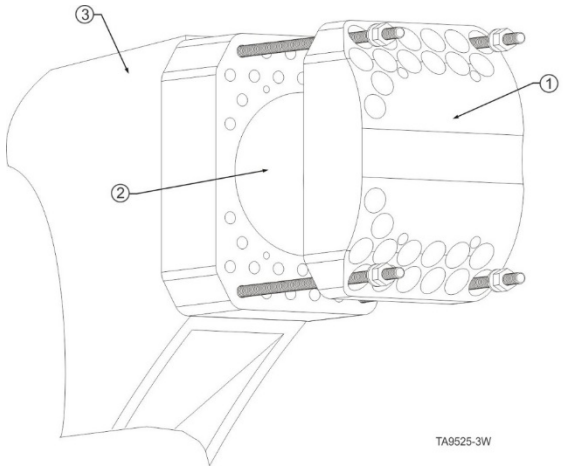
NOTICE

The suggested shim pack to use for installation of new brass liners is shown in table “Ball base-socket-cap specifications”. If old liners are being used, then the shim pack may need to be adjusted accordingly.

b. Use two 1-1/4” extension studs (Grade 8 all-thread) with appropriate threads to attach the ball cap to the ball socket. The extensions should be long enough to allow the ball cap to clear the ball base. If extensions are not used, then a second crane will be needed to handle the ball cap (refer to figure “Typical installation of ball cap stud supports for ball cap removal - installation”, below).

c. Raise the lift arm to mount the socket over the ball base. If the lift arms are not installed on the machine, then a crane is required. The face of the ball sockets on the lift arms should be nearly vertical when the lift arm is placed against the ball bases. This will make it easier to install the ball cap. If the hoist cylinders were used to move lift arms away, then they can be used to pull the lift arms back to the ball.

d. Start the machine and run engine at low idle. Very slowly move the hoist lever to the POWER DOWN position. This will pull the lift arms back against the balls.

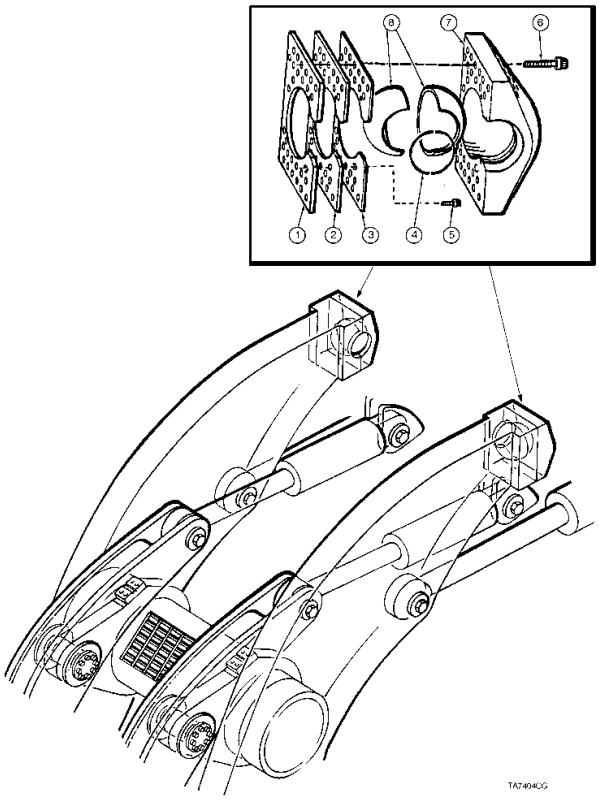


1) Ball cap, **2)** Ball socket, **3)** Lift arm

NOTICE

Lift arm ball cap shown uses two 1-1/4” –7 UNC X 24” GRADE 8 All-Thread studs installed top of ball cap.

Figure 24. Typical installation of ball cap stud supports for ball cap removal - installation



1.	Spacer	**5.**	Capscrew
2.	Shim	**6.**	Capscrew
3.	Shim	**7.**	Ball cap
4.	Lip seal	**8.**	Ball liner

Figure 25. Typical lift arm ball cap assembly (all models typical)

e. Once the lift arms are positioned correctly and are securely against the balls, the small bolts holding the spacer plate tight against the socket may be removed.

f. Push the ball cap up against the socket.

g. Install the capscrews. Start all of the capscrews by hand to ensure good thread engagement. All capscrews should have been hand started prior to any of them being tightened or torqued. It may be necessary to move the ball cap, spacer and shims a little in order to get all the capscrews to start properly. Failure to hand start each capscrew can cause the threads to strip out. Torque per the applicable specifications for your machine on various machine model figures “BALL CAP TORQUE PATTERNS” (L-1350, L-1850 and L-2350) as applicable. Repeat the sequence until the torque remains constant.

h. The torquing should be done with a hydraulic torque wrench or torque multiplier. Refer to table Capscrew identification and torque chart (within this section) for proper torque amount.

i. Once the ball socket assembly is fully assembled, a grease gun should be used to fill the ball socket with grease. The grease should be pumped into the ball cap at the appropriate auto lube injector using a grease gun with equivalent grease. Doing this will ensure that the hose is full of grease and that the ball socket assembly is fully lubed prior to movement.

j. Reconnect the position indicator and check that it is connected properly.

k. After the ball cap has been fully torqued, check it for proper clearance. Use the methods described in “Dial Indicator Inspection of Ball Cap Endplay”, located above.

Hoist Cylinder Ball Cap Removal and Installation Procedure

⚠ WARNING

Crush hazard exists when attempting to remove or install the ball cap. Ball caps are heavy and removing a cap requires equipment with sufficient capacity rating to support the weight of the cap. Always read and understand all WARNINGS AND CAUTIONS provided before attempting to remove or replace a ball cap. Failure to use equipment with adequate lifting capacity and to follow WARNINGS AND CAUTIONS could cause a crush hazard resulting in serious injury or death.

Safety

Component Weights

NOTICE

Component weights are approximate. Always allow a safety margin when selecting lifting equipment.

Loader	Lift Arm	Hoist Cylinder	Middle Pivot	Rear Axle Pivot
L-1350	275 lbs. (125 kgs.)	202 lbs. (92 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)
L-1850	610 lbs. (277 kgs.)	250 lbs. (114 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)
L-2350	610 lbs. (277 kgs.)	390 lbs. (177 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)

NOTICE

These weights are only approximate and provided as a guide for determining proper lifting procedures and equipment. In all cases, adequate equipment should be used to provide a good safety margin.

Ball cap weight chart

Each hoist cylinder is attached to a ball base located on the lower part of the front frame. The socket is an integral part of the hoist cylinder assembly.

Before removal of hoist cylinder ball caps is attempted, the following procedures must be performed.

⚠ WARNING

Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.

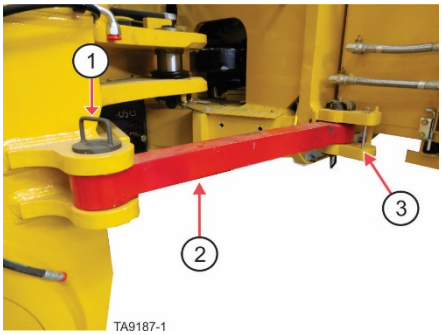
a. Stop the wheel loader on flat level ground.

b. Place wheel chocks in front and behind each wheel.

c. Move the frame lock to the locked position so that the frame cannot be steered.

⚠ WARNING

Crush hazards exist in machine pivot area and area between the tires. Do not enter these areas unless it is verified that the operator has control over the steering and that personnel locking the frame lock have good communication with the operator. Entering the pivot area and area between the tires while the machine is moving or pivoting (articulating) could cause crush hazards resulting in serious injury or death.



1) Retaining pin for locked position, **2)** Frame lock - shown in locked position,

3) Retaining pin bracket for un-locked position

Frame Lock in locked position

d. Set bucket flat and level on the ground.

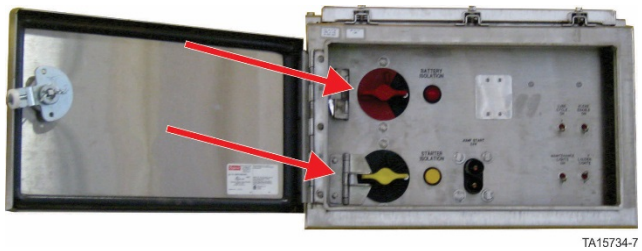
e. Set the parking brakes.

f. Shut off the engine.

⚠ WARNING

Crush, shock, or other hazards exist if stored energy is not removed or isolated prior to working on the machine. Stored energy (hydraulic, electrical, pneumatic, mechanical, etc.) may be present if not isolated or released prior to working on the machine. Do not work on the machine without removing this stored energy (suspended loads, electrical power, air pressure, etc.). Risk of crushing, shock, or other physical injury exists if stored energy is not removed or isolated prior to working on the machine which could result in serious injury or death.

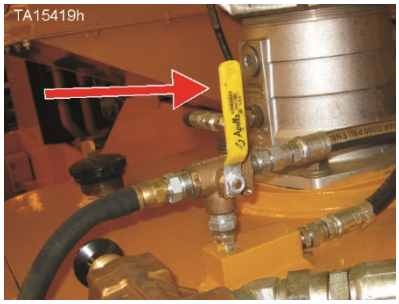
g. Turn the battery and engine isolation switches to the off position and install locks on the battery isolation switch.



Battery isolation switch in OFF position with locks in place

h. Release the air from the hydraulic reservoir by using the hydraulic reservoir air valve (ball valve) on top of the reservoir. The supply line from main air system will be blocked and reservoir air will vent out the hose that runs down the outside of the hydraulic reservoir.

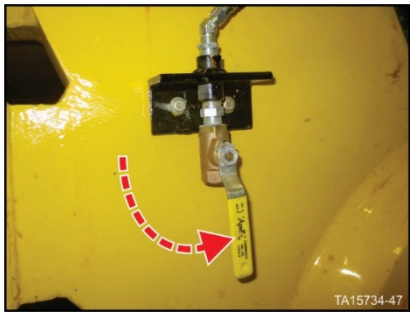
- Turn the handle to the up position as shown

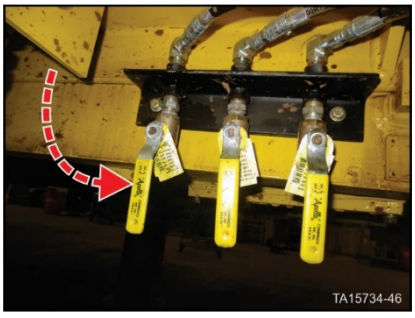


Hydraulic reservoir air valve handle UP

i. Release the air from the various air storage reservoirs by opening all of the air bleed valves.

Three valves on right side of rear frame under hydraulic reservoir
One valve on right side of front frame near hoist cylinder ball cap





Open air reservoir bleed valves

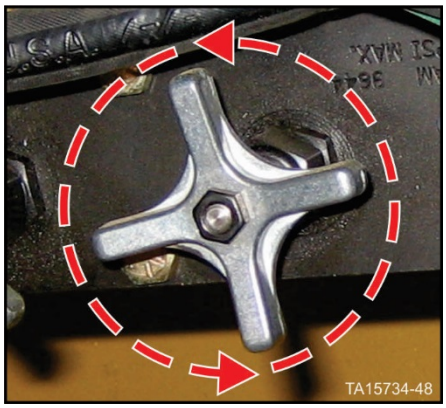
⚠ WARNING

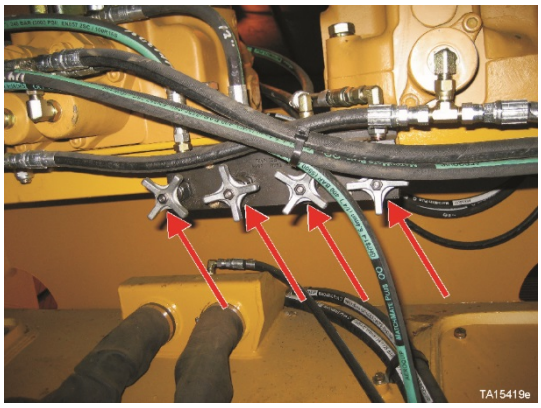
Crush hazards exist if all personnel are not cleared from the bucket and lift arm area before using the hydraulic hoist and bucket hydraulic pressure bleed down valves to relieve pressure from the hoist and bucket circuit. Clear all personnel from the area around the bucket and lift arms before operating hydraulic hoist and bucket hydraulic pressure bleed down valves. Using the hydraulic bleed down valves could result in some movement of the lift arms and bucket which could cause a crush hazard resulting serious injury or death.

j. Use the hydraulic pressure bleed down valves located in the front frame underneath the Husco valves to bleed any stored pressure in the hoist and bucket cylinders.

k. Turn each valve slowly counterclockwise as shown below and allow the pressure to bleed down.

l. Open the valve completely and leave it open during this procedure.





Pressure bleed down valves

m. Following all local environmental rules and regulations, drain the hydraulic reservoir and any residual fluid in the hydraulic lines.

Hoist Cylinder Ball Cap Removal Procedure

a. Attach a suitable lifting device to the ball cap.

b. Remove the rest of the capscrews in the ball cap in a crisscross pattern (reverse torque pattern). Remove only one capscrew at a time.

c. Attach a suitable lifting device to the base area of the cylinder. If liners need to be replaced, start the machine using site location start up procedures.

d. To relieve pressure on the hoist cylinder ball cap, lift up on the base of the hoist cylinder slightly. Slowly move the joystick into the POWER DOWN position. When the cylinder retracts enough to allow the liner to be removed and replaced, stop the cylinder movement by returning the joystick to center position. It may be necessary to lift the cylinder with the overhead crane at this time to help lift the cylinder off the ball. Refer to “General Disassembly and Assembly Instructions for Ball Joints”, above, for liner replacement.

e. To re-align the ball socket, move hoist joystick slowly. This will allow the cylinder to move back down and be firmly seated on the ball.

Hoist Cylinder Ball Cap Installation

a. After the GENERAL DISASSEMBLY AND ASSEMBLY INSTRUCTIONS have been performed, the following details apply to the hoist cylinder ball socket assemblies (refer to figure “Hoist cylinder ball cap installation”, below).

b. Fasten the spacer plate to the ball socket. Install two short 1-1/4”-7 UNC diameter bolts (or two long capscrews with tube spacers) to hold the spacer plate onto the socket. This will keep the liner in the proper position and prevent it from rotating as the hoist cylinder is lowered onto the ball.

c. Lower the cylinder ball base onto the ball.

d. Remove the bolts holding the spacer plates to the sockets.

e. Position the spacer plate and shim pack on the flat clamping face of the ball cap and hold in place by installing two capscrews through the ball cap.

NOTICE

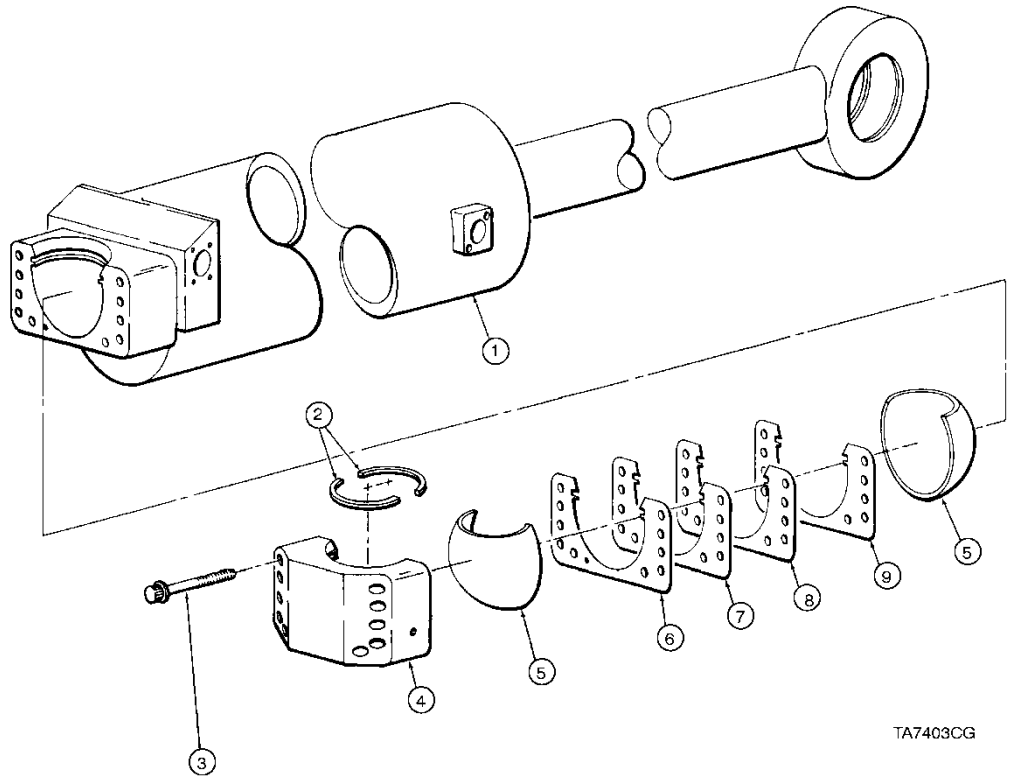
The suggested shim pack to use for installation of new brass liners is shown in table “Ball base-socket-cap specifications”. If old liners are being used, then the shim pack may need to be adjusted accordingly.

f. Hoist the ball cap to the ball base on the cylinder and install the capscrews.

g. Start all of the capscrews by hand to ensure good thread contact. All capscrews should have been hand started prior to any of them being tightened or torqued. It may be necessary to move the ball cap, spacer and shims a little in order to get all the capscrews to start properly. Failure to hand start each capscrews can cause the threads to strip out. Torque per the applicable specifications for your machine on various machine model figures “BALL CAP TORQUE PATTERNS” (L-1350, L-1850 and L-2350 as applicable) located in this section. Repeat the sequence until the torque remains constant. The torquing should be done with a hydraulic torque wrench or torque multiplier.

h. Once the ball socket assembly is fully assembled, a grease gun should be used to fill the ball socket with grease. The grease should be pumped into the ball cap at the appropriate auto lube injector using a grease gun with equivalent grease. Doing this will ensure that the hose is full of grease and that the ball socket assembly is fully lubed prior to movement. Fresh grease should be seen at the ball (refer to figure “Hoist cylinder ball cap installation”, below).

i. After the ball socket has been fully torqued, it needs to be checked for proper clearance. Use the methods described in Dial Indicator Inspection of Ball Cap Endplay, located in this section.



1.	Hoist cylinder	**6.**	Shim
2.	Seal	**7.**	Shim
3.	Capscrew	**8.**	Shim
4.	Ball cap	**9.**	Spacer
5.	Ball liner		

Figure 26. Hoist cylinder ball cap installation (typical)

Articulation Pivot Ball Cap Removal and Installation Procedures

⚠ WARNING

Crush hazard exists when attempting to remove or install the ball cap. Ball caps are heavy and removing a cap requires equipment with sufficient capacity rating to support the weight of the cap. Always read and understand all WARNINGS AND CAUTIONS provided before attempting to remove or replace a ball cap. Failure to use equipment with adequate lifting capacity and to follow WARNINGS AND CAUTIONS could cause a crush hazard resulting in serious injury or death.

Safety

Component Weights

NOTICE

Component weights are approximate. Always allow a safety margin when selecting lifting equipment.

Loader	Lift Arm	Hoist Cylinder	Middle Pivot	Rear Axle Pivot
L-1350	275 lbs. (125 kgs.)	202 lbs. (92 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)
L-1850	610 lbs. (277 kgs.)	250 lbs. (114 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)
L-2350	610 lbs. (277 kgs.)	390 lbs. (177 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)

NOTICE

These weights are only approximate and provided as a guide for determining proper lifting procedures and equipment. In all cases, adequate equipment should be used to provide a good safety margin.

Ball cap weight chart

The front and rear parts of the frame are connected in the middle by use of an upper and lower ball socket assembly. The balls are welded to the front frame and the sockets are welded to the rear frame (refer to figure “Middle pivot ball cap installation” below).

⚠ WARNING

Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine’s starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine’s SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.

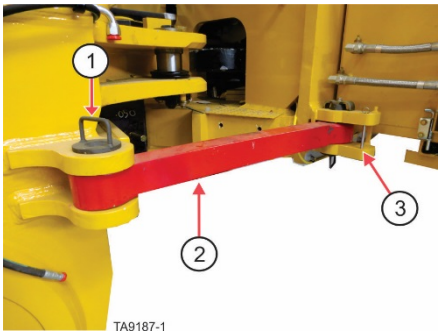
a. Stop the wheel loader on flat level ground. The ground must be stable and firm enough to support the weight of the machine in the areas where the jacks or stands are to be placed.

b. Place wheel chocks in front and behind each wheel.

c. Move the frame lock to the locked position so that the frame cannot be steered.

⚠ WARNING

Crush hazards exist in machine pivot area and area between the tires. Do not enter these areas unless it is verified that the operator has control over the steering and that personnel locking the frame lock have good communication with the operator. Entering the pivot area and area between the tires while the machine is moving or pivoting (articulating) could cause crush hazards resulting in serious injury or death.



1) Retaining pin for locked position, **2)** Frame lock - shown in locked position,

3) Retaining pin bracket for un-locked position

Frame lock in locked position

d. Set bucket flat and level on the ground.

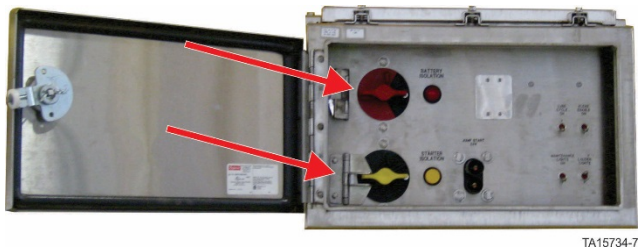
e. Set the parking brakes.

f. Shut off the engine.

⚠ WARNING

Crush, shock, or other hazards exist if stored energy is not removed or isolated prior to working on the machine. Stored energy (hydraulic, electrical, pneumatic, mechanical, etc.) may be present if not isolated or released prior to working on the machine. Do not work on the machine without removing this stored energy (suspended loads, electrical power, air pressure, etc.). Risk of crushing, shock, or other physical injury exists if stored energy is not removed or isolated prior to working on the machine which could result in serious injury or death.

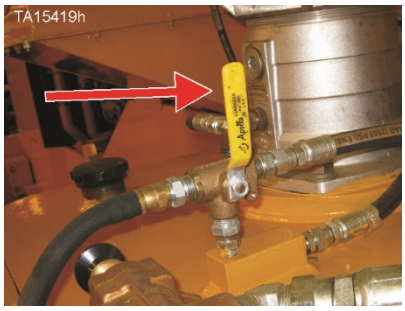
g. Turn the battery and engine isolation switches to the off position and install locks on the battery isolation switch.



Battery isolation switch in OFF position with locks in place

h. Release the air from the hydraulic reservoir by using the hydraulic reservoir air valve (ball valve) on top of the reservoir. The supply line from main air system will be blocked and reservoir air will vent out the hose that runs down the outside of the hydraulic reservoir.

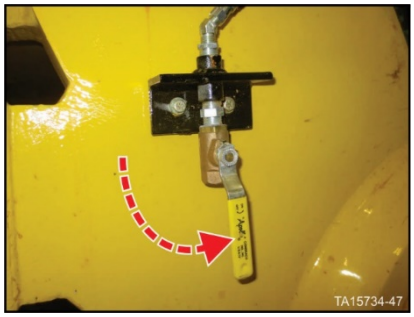
- Turn the handle to the up position as shown

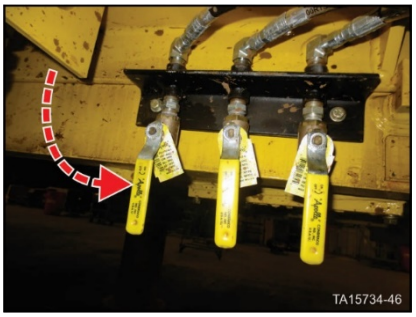


Hydraulic reservoir air valve handle UP

i. Release the air from the various air storage reservoirs by opening all of the air bleed valves.

Three valves on right side of rear frame under hydraulic reservoir
One valve on right side of front frame near hoist cylinder ball cap





Open air reservoir bleed valves

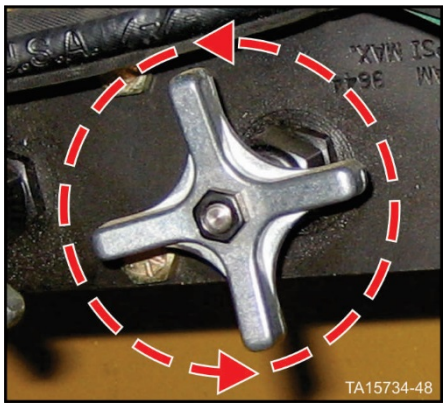
⚠ WARNING

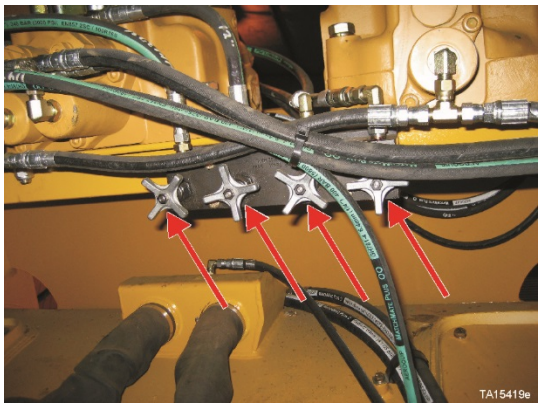
Crush hazards exist if all personnel are not cleared from the bucket and lift arm area before using the hydraulic hoist and bucket hydraulic pressure bleed down valves to relieve pressure from the hoist and bucket circuit. Clear all personnel from the area around the bucket and lift arms before operating hydraulic hoist and bucket hydraulic pressure bleed down valves. Using the hydraulic bleed down valves could result in some movement of the lift arms and bucket which could cause a crush hazard resulting serious injury or death.

j. Use the hydraulic pressure bleed down valves located in the front frame underneath the Husco valves to bleed any stored pressure in the hoist and bucket cylinders.

k. Turn each valve slowly counterclockwise as shown below and allow the pressure to bleed down.

l. Open the valve completely and leave it open during this procedure.





Pressure bleed down valves

m. Following all local environmental rules and regulations, drain the hydraulic reservoir and any residual fluid in the hydraulic lines.

CAUTION

The pilot relief pressures should be checked prior to the following middle pivot procedures. Pilot relief valves must be functioning and set to the proper pressures before attempting the following procedures. Refer to PILOT RELIEF VALVE, located in the HYDRAULICS section (Section 04-01) in this manual, for specifications.

Articulation Pivot Ball Cap Removal

Bottom Pivot Ball

a. Remove the hydraulic multi-port distribution manifold mount bolts in the front frame. This will prevent the pivot crossover hoses from stretching.

b. Neutralize all bucket cylinder pressures by using the “Manual Bleed Valve Assembly”.

⚠ WARNING

Crush hazard exists if working on a machine that is elevated with jacks. Do not work under machine without using jacks with positive locking devices. Failure to use jacks with positive locking devices while working on an elevated machine can cause a crush hazard resulting in serious injury or death.

c. Place two 100-ton capacity jacks under the pivot area. Place one under the thick steel slab on the rear frame. Both should be placed so that they are near the centerline of the machine. The front one needs to be placed so that it allows enough clearance to remove the ball cap. Pump up the jacks until they just touch the frame and apply slight pressure (refer to figure “Articulation pivot ball cap removal and installation (typical jack placement”, below).

d. Remove the bottom cap.

e. Slowly lower the jacks. The bottom pivot ball should slowly move out of the ball socket.

f. If the ball does not move out of the socket, then it may be necessary to help the separation. This is done by returning the joystick to the center. Start the engine (keep in low idle) and very slowly move the joystick to apply POWER DOWN hydraulic power. This should cause the ball to separate from the socket.

g. When enough room is achieved to access the ball liners, stop the movement. Make sure pressure is maintained on the jacks.

h. Remove the liners for inspection. Refer to table “Ball base socket-cap specifications” to determine if liners need replacing.

i. Check ball diameter per table “Ball base-socket-cap specifications”. Check for damage or signs of wear.

j. For reassembly, place the ball liner into the socket. Replace the seal if necessary. Install seal in proper direction (refer to illustration “Ball cap liner and seal installation”). Fasten the spacer plate to the ball socket. Install two short 1-1/4-7” UNC diameter bolts (or two long capscrews with tube spacers) to hold the spacer plate onto the socket. This will keep the liner in the proper position and prevent it from rotating as the socket is put onto the balls.

k. Jack up the jacks until the ball is firmly in the sockets.

l. Reassemble the shims, spacer, seal, liner and ball cap. Add or remove shims as determined in earlier checks.

NOTICE

The suggested shim pack to use for illustration of new brass liners is shown in illustration Table “Ball base-socket-cap specifications”. If old liners are being used, then the shim pack may need to be adjusted accordingly.

m. Hoist the ball cap into position and start capscrews by hand. All capscrews should have been hand started prior to any of them being tightened or torqued. It may be necessary to move the ball cap, spacer and shims a little in order to get all the capscrews to start properly.

n. Torque the capscrews per the applicable pattern and amount for your machine as shown in figure “BALL CAP TORQUE PATTERNS” (L-1350, L-1850 and L-2350 as applicable) previously provided in this document.

o. Remove the jacks.

p. Install the front frame hydraulic multi-port distribution manifold bolts back into place and tighten to proper torque.

q. Once the ball socket assembly is fully assembled, a grease gun should be use to fill the ball socket with grease. The grease should be pumped into the ball cap at the appropriate auto lube injector using a grease gun with equivalent grease. Doing this will ensure that the hose is full of grease and that the ball socket assembly is fully lubed prior to movement. Fresh grease should be seen at the ball.

r. After the ball cap has been fully torqued, it is necessary to perform a dial indicator inspection of the ball joint endplay (Dial Indicator Inspection of Ball Cap Endplay, located above).

Top Pivot Ball

a. Remove the front frame hydraulic multi-port distribution manifold bolts.

b. Place a 100-ton jack under the bottom pivot area (front part of the rear frame near pivot). Apply light pressure on the frame.

c. Neutralize all bucket cylinder pressures by using the “Manual Bleed Valve Assembly” Refer to MANUAL BLEED VALVE ASSEMBLY, located in the HYDRAULICS section (Section 04-01) of this manual.

d. Remove the ball cap.

e. Slowly raise the jack. This should cause the top ball to come out of the socket.

f. Inspect the ball and liners. Replace any damaged or worn items.

g. For reassembly, place the ball liner into the socket. Replace the seal if necessary. Install seal in proper direction (refer to figure “Ball cap liner and seal installation” above). Fasten the spacer plate to the ball socket. Install two short 1-1/4-7” UNC diameter bolts (or two long capscrews with tube spacers) to hold the spacer plate onto the socket. This will keep the liner in the proper position and prevent it from rotating as the socket is put onto the balls.

h. Lower the jack and allow the ball to firmly contact the socket liner.

i. Reassemble the shims, spacer, seal, liner and ball cap. Add or remove shim as determined in earlier checks.

j. Hoist the ball cap into position and start capscrews by hand. All capscrews should have been hand started prior to any of them being tightened or torqued. It may be necessary to move the ball cap, spacer and shims a little in order to get all the capscrews to start properly.

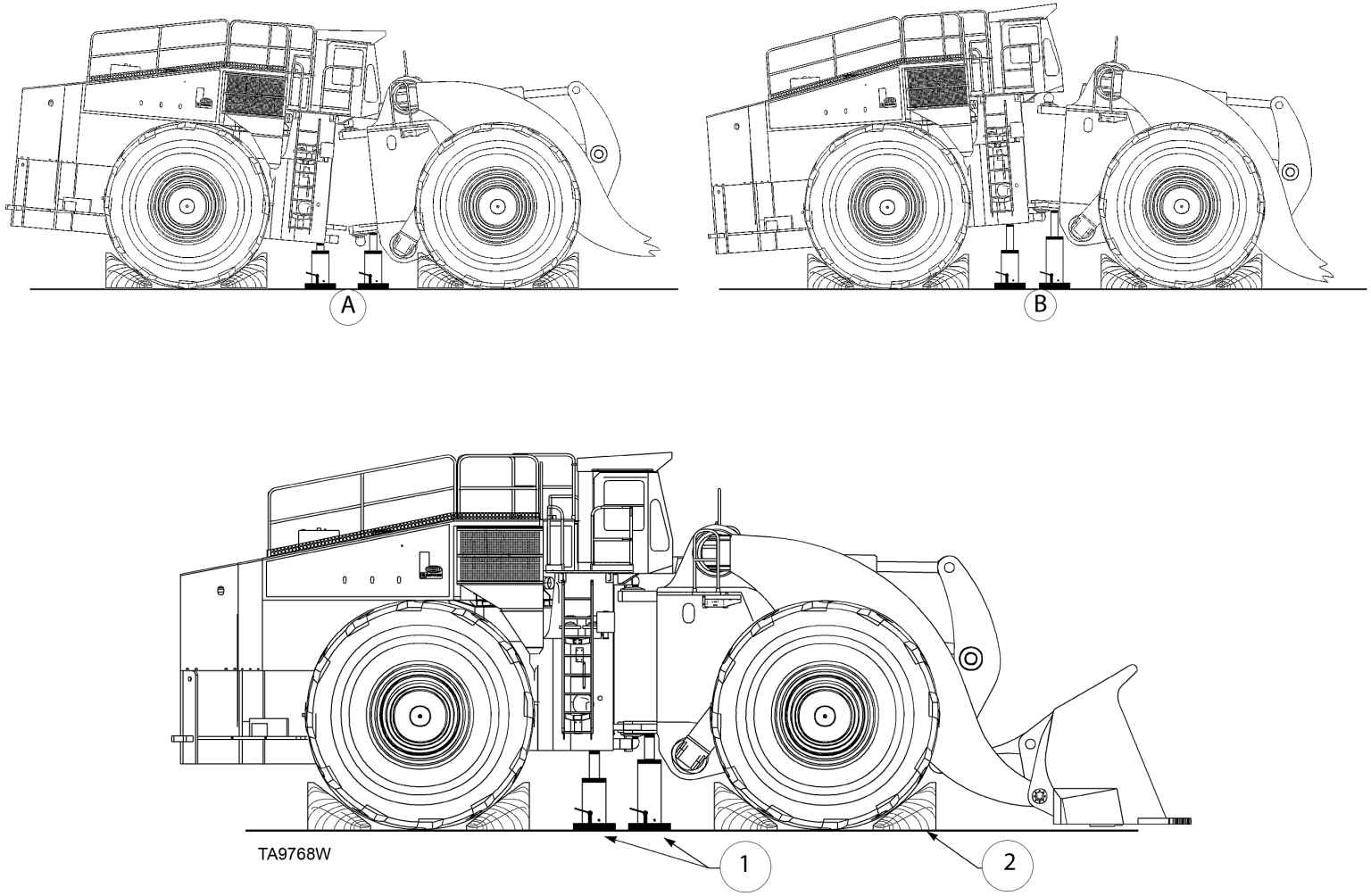
k. Torque the capscrews per the applicable pattern and amount for your machine.

l. Remove the jack.

m. Install the front frame hydraulic multi-port distribution manifold bolts back in place and tighten to proper torque.

n. Once the ball socket assembly is fully assembled, a grease gun should be used to fill the ball socket with grease. The grease should be pumped into the ball cap at the appropriate auto lube injector using a grease gun with equivalent grease. Doing this will ensure that the hose is full of grease and that the ball socket assembly is fully lubed prior to movement. Fresh grease should be seen at the ball.

o. After the ball cap has been fully torqued, it is necessary to perform a dial indicator inspection of the ball joint endplay (Dial Indicator Inspection of Ball Cap Endplay, located above).



A) Bottom pivot (maintain top pivot in place and leave bolted), **B)** Top pivot (maintain bottom pivot in place and leave bolted)

1) 100 TON hydraulic cylinders, **2)** wheel chocks at all wheels

NOTE: Make sure ground below cylinders will support machine load

Figure 27. Articulation pivot ball cap removal and installation (typical jack placement)

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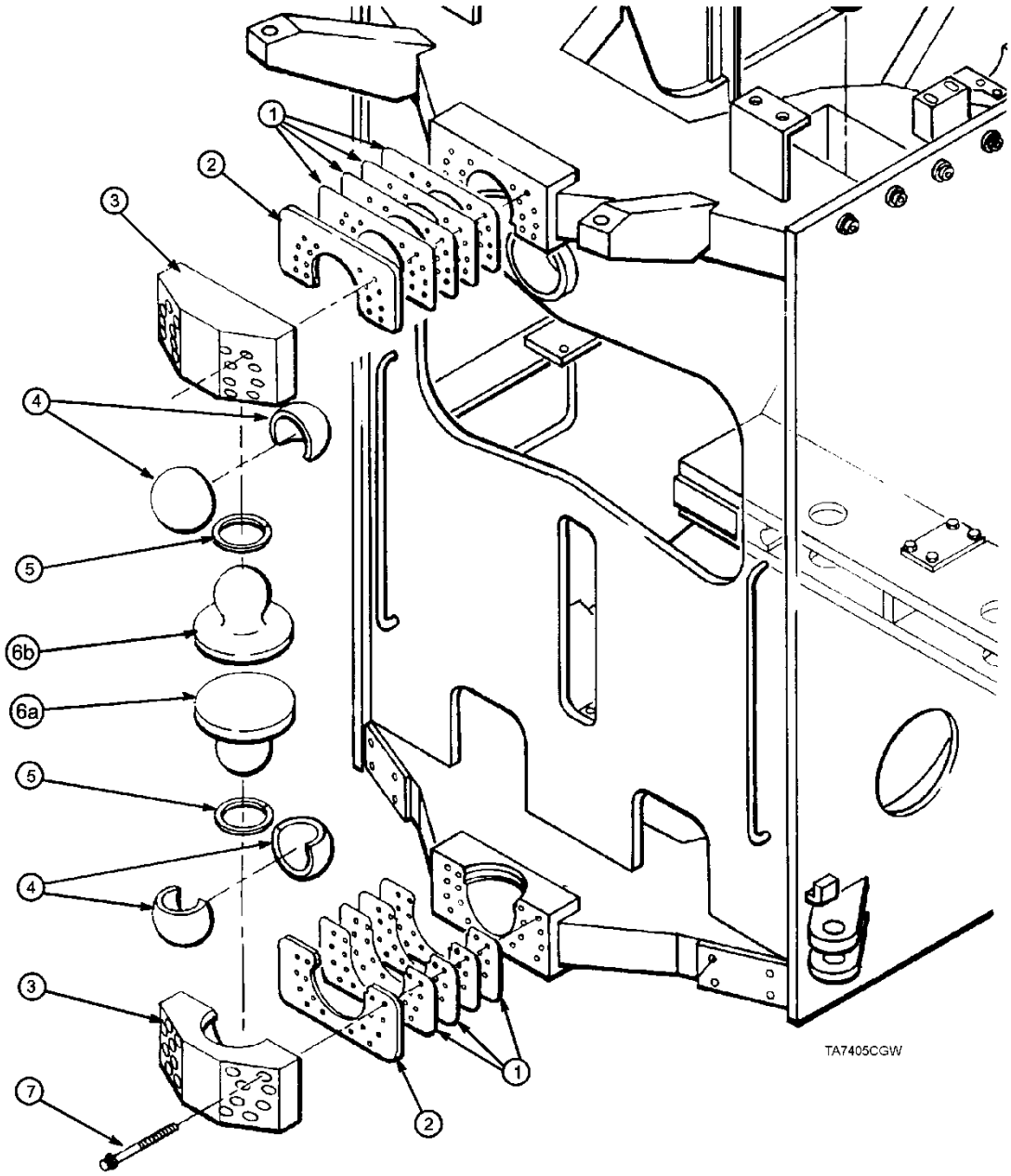

1.	Shim	**5.**	Lip seal
2.	Spacer	**6A.**	Bottom ball base/ball
3.	Ball cap	**6B.**	Top ball base/ball
4.	Ball liner	**7.**	Capscrew

Figure 28. Middle pivot ball cap installation (typical)

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Rear Axle (Oscillating) Ball Cap Removal and Installation

⚠ WARNING

Crush hazard exists when attempting to remove or install the ball cap. Ball caps are heavy and removing a cap requires equipment with sufficient capacity rating to support the weight of the cap. Always read and understand all WARNINGS AND CAUTIONS provided before attempting to remove or replace a ball cap. Failure to use equipment with adequate lifting capacity and to follow WARNINGS AND CAUTIONS could cause a crush hazard resulting in serious injury or death.

⚠ WARNING

Crush hazard exists if failing to support the frame and axle properly. Always support the axle and frame with external support structures such as jacks or stands when removing the axle. Failure to properly support the axle and frame could cause a crush hazard or cause the axle to fall resulting in serious injury or death.

Safety

Component Weights

NOTICE

Component weights are approximate. Always allow a safety margin when selecting lifting equipment.

Loader	Lift Arm	Hoist Cylinder	Middle Pivot	Rear Axle Pivot
L-1350	275 lbs. (125 kgs.)	202 lbs. (92 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)
L-1850	610 lbs. (277 kgs.)	250 lbs. (114 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)
L-2350	610 lbs. (277 kgs.)	390 lbs. (177 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)

NOTICE

These weights are only approximate and provided as a guide for determining proper lifting procedures and equipment. In all cases, adequate equipment should be used to provide a good safety margin.

Ball cap weight chart

The oscillating axle is connected to the rear frame by the use of two ball socket assemblies. The front and rear ball base assemblies are welded to the axle structure. The sockets are welded to the rear frame structure. The following procedure should be used to remove and or replace the rear axle ball caps.

⚠ WARNING

Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.

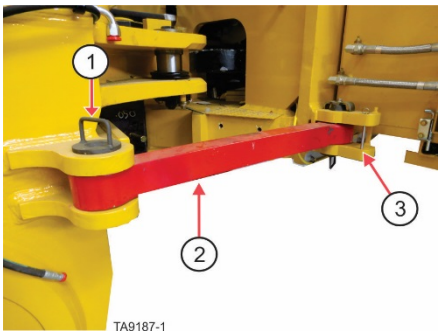
a. Stop the wheel loader on flat level ground.

b. Place wheel chocks in front and behind each wheel.

c. Move the frame lock to the locked position so that the frame cannot be steered.

⚠ WARNING

Crush hazards exist in machine pivot area and area between the tires. Do not enter these areas unless it is verified that the operator has control over the steering and that personnel locking the frame lock have good communication with the operator. Entering the pivot area and area between the tires while the machine is moving or pivoting (articulating) could cause crush hazards resulting in serious injury or death.



1) Retaining pin for locked position, **2)** Frame lock - shown in locked position,

3) Retaining pin bracket for un-locked position

Frame lock in locked position

d. Set bucket flat and level on the ground.

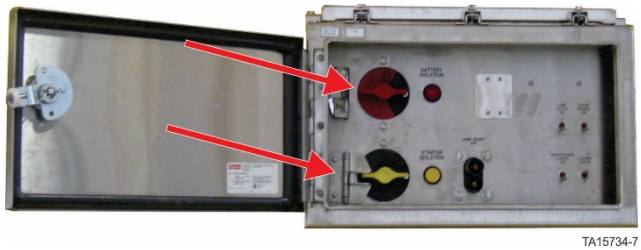
e. Set the parking brakes.

f. Shut off the engine.

⚠ WARNING

Crush, shock, or other hazards exist if stored energy is not removed or isolated prior to working on the machine. Stored energy (hydraulic, electrical, pneumatic, mechanical, etc.) may be present if not isolated or released prior to working on the machine. Do not work on the machine without removing this stored energy (suspended loads, electrical power, air pressure, etc.). Risk of crushing, shock, or other physical injury exists if stored energy is not removed or isolated prior to working on the machine which could result in serious injury or death.

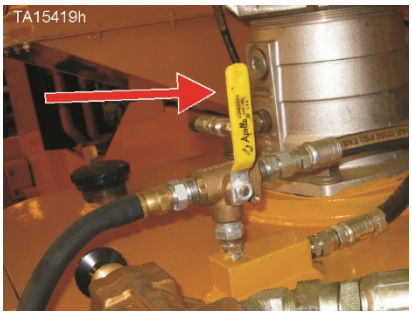
g. Turn the battery and engine isolation switches to the off position and install locks on the battery isolation switch.



Battery isolation switch in OFF position with locks in place

h. Release the air from the hydraulic reservoir by using the hydraulic reservoir air valve (ball valve) on top of the reservoir. The supply line from main air system will be blocked and reservoir air will vent out the hose that runs down the outside of the hydraulic reservoir.

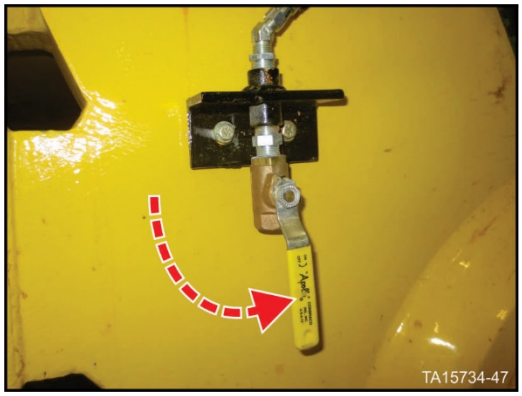
- Turn the handle to the up position as shown

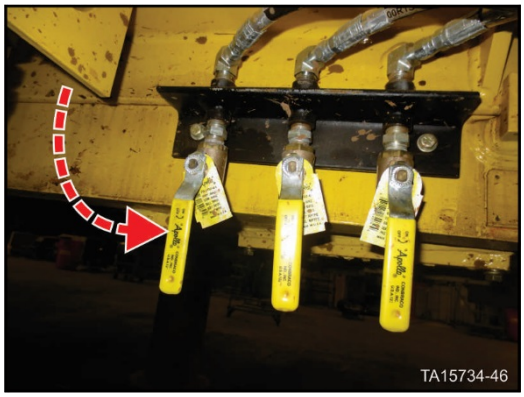


Hydraulic reservoir air valve handle UP

i. Release the air from the various air storage reservoirs by opening all of the air bleed valves.

Three valves on right side of rear frame under hydraulic reservoir
One valve on right side of front frame near hoist cylinder ball cap





Open air reservoir bleed valves

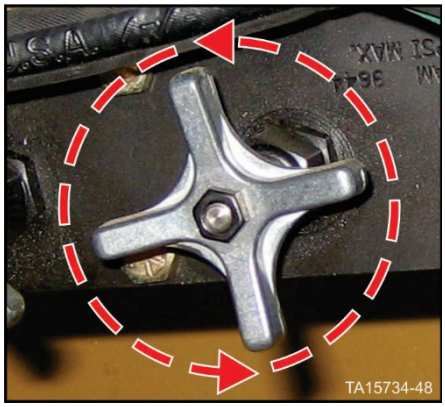
⚠ WARNING

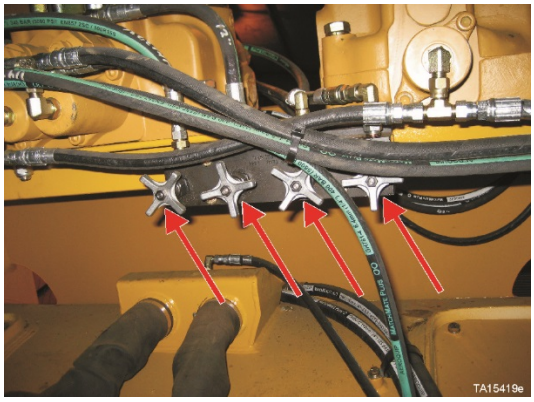
Crush hazards exist if all personnel are not cleared from the bucket and lift arm area before using the hydraulic hoist and bucket hydraulic pressure bleed down valves to relieve pressure from the hoist and bucket circuit. Clear all personnel from the area around the bucket and lift arms before operating hydraulic hoist and bucket hydraulic pressure bleed down valves. Using the hydraulic bleed down valves could result in some movement of the lift arms and bucket which could cause a crush hazard resulting serious injury or death.

j. Use the hydraulic pressure bleed down valves located in the front frame underneath the Husco valves to bleed any stored pressure in the hoist and bucket cylinders.

k. Turn each valve slowly counterclockwise as shown below and allow the pressure to bleed down.

l. Open the valve completely and leave it open during this procedure.





Pressure bleed down valves

m. Following all local environmental rules and regulations, drain the hydraulic reservoir and any residual fluid in the hydraulic lines.

Rear Axle Ball Cap Removal

a. Attach a suitable lifting device to the ball cap.

b. The weight of the rear frame must be on the rear axle prior to removing the ball caps. This can be done in two basic ways:

c. The tires are on the ground and the weight of the machine is sitting on axle and tires. If there is a jack under the machine, it must not be carrying any weight.

d. The tires and drivers are off the ground and the rear axle is supported by stands. The stands must be carrying the weight of the rear frame.

e. Remove the capscrews. The ball cap will come down as the capscrews are removed.

Rear Axle Ball Cap Installation

Once the GENERAL DISASSEMBLY AND ASSEMBLY INSTRUCTIONS have been completed, the following details apply to the rear axle ball socket assembly.

NOTICE

If the rear wheels are off of the axle, it is easier to hoist the axle up to the frame using floor jacks. If the rear wheels are on the axle, it is easier to chock the wheels and lower the frame onto the axle using floor jacks.

a. Fasten the spacer plate to the ball socket. Install two short 1-1/4”-7 UNC diameter bolts (or two long capscrews with tube spacers) to hold the spacer plate on the socket. This will prevent it from rotating as the socket is put onto the balls.

b. Hoist the oscillating axle (or lower the frame) gradually onto the axle ball sockets. Do not gall or otherwise damage the ball liner bushings. Make sure the balls are firmly in the sockets with the liners in the proper location.

c. Remove the bolts holding the spacer plate to the socket.

d. Place the spacer plate and shim pack on the flat clamping face of the ball cap and hold in place with two capscrews.

NOTICE

The suggested shim pack to use for illustration of new brass liners is shown in table “Ball base socket cap specifications”. If old liners are being used, then the shim pack may need to be adjusted accordingly.

e. Hoist the ball cap to the ball base and install the capscrews.

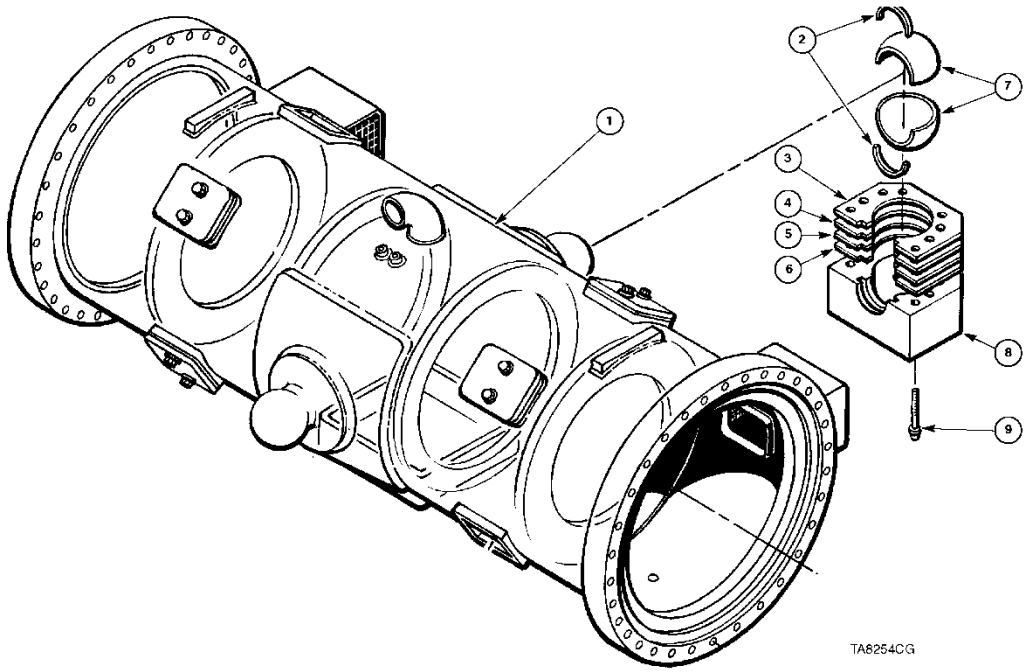
f. Start all of the capscrews by hand to ensure good thread contact. All capscrews should have been hand started prior to any of them being tightened or torqued. It may be necessary to move the ball cap, spacer and shims a little in order to get all the capscrews to start properly. Failure to hand start each capscrews can cause the threads to strip out. Torque per the applicable specifications for various machine model figures “BALL CAP TORQUE PATTERNS” (L-1350, L-1850 and L-2350 as applicable). Repeat the sequence until the torque remains constant.

g. The torquing should be done with a hydraulic torque wrench or torque multiplier.

h. Once the ball socket assembly is fully assembled, a grease gun should be use to fill the ball socket with grease. The grease should be pumped into the ball cap at the appropriate auto lube injector using a

grease gun with equivalent grease. Doing this will ensure that the hose is full of grease and that the ball socket assembly is fully lubed prior to movement. Fresh grease should be seen at the ball.

i. After the ball socket has been fully torqued, it needs to be checked for proper clearance. Use the methods described in Dial Indicator Inspection of Ball Cap Endplay, located above.



NOTICE

Not shown here is the other half of base sockets, which is welded to the rear frame structure.

1.	Axle structure	**6.**	Shim
2.	Lip seal	**7.**	Ball liner
3.	Spacer	**8.**	Ball cap
4.	Shim	**9.**	Capscrew
5.	Shim		

Figure 29. Oscillating axle ball cap installation (typical)

Spherical Bearing and Pin Installation Procedures

Safety

Component Weights

NOTICE

Component weights are approximate. Always allow a safety margin when selecting lifting equipment.

Loader	Lift Arm	Hoist Cylinder	Middle Pivot	Rear Axle Pivot
L-1350	275 lbs. (125 kgs.)	202 lbs. (92 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)
L-1850	610 lbs. (277 kgs.)	250 lbs. (114 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)
L-2350	610 lbs. (277 kgs.)	390 lbs. (177 kgs.)	309 lbs. (141 kgs.)	202 lbs. (92 kgs.)

NOTICE

These weights are only approximate and provided as a guide for determining proper lifting procedures and equipment. In all cases, adequate equipment should be used to provide a good safety margin.

Ball cap weight chart

⚠ WARNING

Crush hazards exist if the machine is started or moved while work processes are being performed on the machine. Place bucket flat and level on the ground. Place frame lock in the locked position and lock out the machine's starting capability before performing any work process. Follow all applicable lockout procedures and local rules and regulations for performing work processes. ANYONE performing inspections or service procedures to the machine should be familiar with ALL instructions and procedures contained in the machine's SERVICE MANUAL. Crush hazard could occur if the machine is started or moves while any type of work process is being conducted on the machine, resulting in serious injury or death.

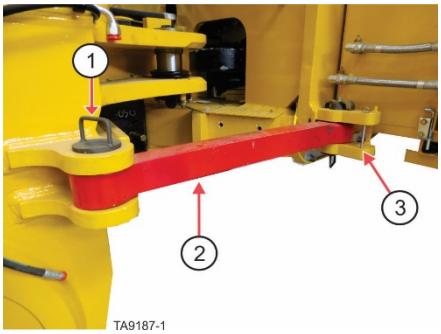
a. Stop the wheel loader on flat level ground.

b. Place wheel chocks in front and behind each wheel.

c. Move the frame lock to the locked position so that the frame cannot be steered.

⚠ WARNING

Crush hazards exist in machine pivot area and area between the tires. Do not enter these areas unless it is verified that the operator has control over the steering and that personnel locking the frame lock have good communication with the operator. Entering the pivot area and area between the tires while the machine is moving or pivoting (articulating) could cause crush hazards resulting in serious injury or death.



1) Retaining pin for locked position, **2)** Frame lock - shown in locked position,

3) Retaining pin bracket for un-locked position

Frame lock in locked position

d. Set bucket flat and level on the ground.

e. Block the lift arms and bellcrank to prevent movement during installation or removal of pins or bushings.

⚠ WARNING

Crush hazards exist when installing or removing pins or bushings. Always block the lift arms and bellcranks to prevent movement during an installation or removal process. Failure to properly block the lift arms before a removal or installation process can cause crush hazards resulting in serious injury or death.

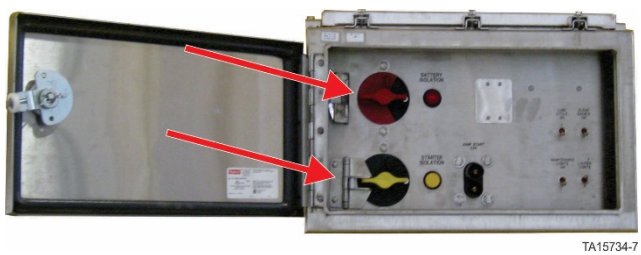
f. Set the parking brakes.

g. Shut off the engine.

⚠ WARNING

Crush, shock, or other hazards exist if stored energy is not removed or isolated prior to working on the machine. Stored energy (hydraulic, electrical, pneumatic, mechanical, etc.) may be present if not isolated or released prior to working on the machine. Do not work on the machine without removing this stored energy (suspended loads, electrical power, air pressure, etc.). Risk of crushing, shock, or other physical injury exists if stored energy is not removed or isolated prior to working on the machine which could result in serious injury or death.

h. Turn the battery and engine isolation switches to the off position and install locks on the battery isolation switch.



Battery isolation switch in OFF position with locks in place

Bucket Cylinder and Bellcrank to Level Link (All Machines)

A. Spherical Bearing Installation

NOTICE

Clean all components with a suitable mineral oil based solvent.

1. Install a retainer ring into a groove in the bore of new level link structure.
2. Align the spherical bearing with bore of level link structure from side opposite the retainer ring. Ensure that the split line of spherical bearing's outer ring is positioned 90º to the centerline of level link assembly. Apply a light coat of 30W oil to the OD of the spherical bearing.
3. Using a sleeve with O.D. slightly smaller than the level link structure bore I.D., placed against the outer race of the spherical bearing. Press the spherical bearing into bore of level link assembly.

CAUTION

Do *NOT* hammer on spherical bearing as damage to the spherical bearing outer ring may occur.

CAUTION

Liquid Nitrogen should not be used since it will result in metallurgical change in the bearing material and potentially permanent size change. The bearing should not be chilled below -110º F (-78.8º C) for installation.

The recommended methods for chilling are either an industrial freezer or packing in dry ice (-109.3F [-78.5º C]).

Typically, -40º F (-40º C) should allow for a drop in or light press for install.

4. Press the spherical bearing snugly against the retainer ring. Check that both halves of the outer race of the spherical bearing are snug against the retainer ring.

NOTICE

Typical press fits for common press fits are listed below.

P/N	Vendor P/N	Bore[1]	Common Usage	Press Fit Range
R4231131	B75771-10	10.496 ±.001	Level Link, Hoist Cylinder	10,000 to 33,000 lbs
R6964139	B96-9L-12	8.7466 ±.0009	Bucket Cylinder	6,000-21,000 lbs
R4241000	B136-9LSSQ-10	12.7454 ±.0011	Hoist Cylinder	14,000-43,000 lbs
R6944893	B64-LSS	6.2484 ±.0005	Steer Cylinder	400-8,000 lbs
[1] Assumes a COF of .15 for the contacting surface.				
[1]Assuming the bore dimensions are correct in the structure.				

5. Check that inner race of the spherical bearing rotates freely within the outer race. If the inner race of spherical bearing does not rotate freely, the spherical bearing may be require to be pressed out and the bore of level link structure verified for correct internal dimensions.
6. Install another retainer ring in the vacant groove in the bore of level link structure to secure the

spherical bearing in place.
7. Pack the bearing with approved grease (3% moly min). The inner race will need to be rotated and the bearing grease grooves filled. Lightly coat the ID of the inner race with grease.

B. Spherical Joint Assembly

NOTICE

Clean all components with a suitable mineral oil based solvent.

1. Apply grease to both sides of the spherical bearing outer face and position the O-rings in position on both sides of spherical bearing. The grease will aid to holding the O-rings in place while installing the level link structure. The O-rings may catch on the bell cranks. If this occurs, use a suitable tool to force the O-ring back into position.
2. Apply a light amount of grease (3% moly min) to the hardened pin surface being careful not to get grease on the taper portion of the pin.
3. Align the inner race bore of the spherical bearing as close as possible with the bore of the bellcrank structure.
4. Insert the pin into the bore of the spherical bearing. The pin should be a slip fit. DO NOT use a hammer for installation. Once the pin is installed, carefully clean all grease off of the taper ends of the pin. The bores on the bell crank should also be clean.
5. Lightly coat the tapered ID and the OD of the sawcut bushing with 30W oil.
6. Install the sawcut bushing at each end of the pin and into the bore of the structure. The cut in the sawcut bushings should be installed at 90° degrees to the thrust of the joint and 180° degrees apposed.
7. Position the capture washers at each end of pin.
8. Lubricate the bolt head and threads with 30W oil. Insert the bolt through the washers.

NOTICE

The bolt has to be installed from the inside of the lift arms with bolt threads pointed outward, toward the tires.

9. Install the hardened washer and nylon insert locknut.
10. Center the capture washers in reference to the bell crank bosses and torque the nylon insert locknut to the torque listed in the torque chart.

NOTICE

Once, bolt torque is achieved, remove the torquing device and strike the area around the lift arm bosses to help seat the tapers. Re-torque the bolt and repeat the striking procedure until no further advancement is recorded.

11. The bolt torque needs to be checked immediately after the first 15 minutes of operation, then rechecked at 2, 4, 8, and 16 hour intervals or until no further nut advancement is recorded.

C. Pin Removal

1. Unload the pin joint by placing bucket on the ground and neutralizing the hydraulic pressure by using the manual hydraulic bleed valve assembly.
2. Remove the bolt, nut, and the two capture washers.
3. Loosen the sawcut bushing by using a drift or heavy bar (made from soft metal such as brass) to strike the end of the pin.
4. If the bushings have seized in the bore, install the bushing removal tool by bolting to the sawcut bushing. Tighten the four bolts evenly. If the bushing does not come out when bolts are tight, strike the center of bushing removal tool with hammer.
5. With the bushings removed, push the pin from the bore of the spherical bearing.

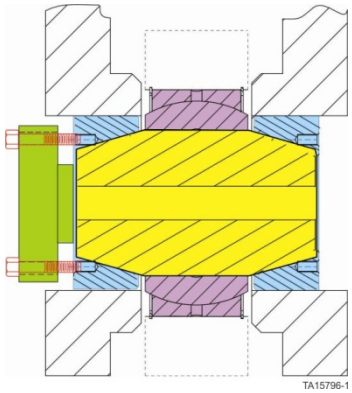


Figure 30. Sawcut bushing removal

Bell Crank Pivot Pin (All Machines)

⚠ CAUTION

Chemical hazard and inhalation hazard exists if the appropriate Personal Protective Equipment (PPE) is not used when working with solvents or other chemicals such as liquid nitrogen or dry ice. Ensure all required PPE is used. Nitrogen and dry ice are extremely cold. Do not touch liquid nitrogen or dry ice. Do not breathe liquid nitrogen or dry ice as it evaporates. Liquid nitrogen and dry ice can damage lungs and burn skin. Eye contact with liquid nitrogen or solvents can cause blindness. Skin contact with liquid nitrogen or dry ice can cause freeze burns. When working with liquid nitrogen or dry ice ensure proper ventilation is adequate. Follow all local rules and regulations when working with chemicals. Failure to use proper PPE and to avoid chemical contact could cause a chemical hazard, inhalation hazard, and freeze burns resulting in serious injury.

A. Sleeve to Arm Installation

1. The sleeve is a press fit into the lift arm bore and must be checked for proper fit. Check sleeve O.D. and bore I.D. to assure a press fit with 0.007” (0.178 mm) minimum and 0.009” (0.229 mm) maximum tight fit.

CAUTION

Verify that the grease hole in the lift arm will line up with grease groove in the sleeve O.D. Failure to do so can result in a quickly failed assembly.

2. The sleeve must be submerged in liquid nitrogen (N_2) or surrounded by N_2 pellets or snow to shrink the sleeve so that it will slide into the lift arm bore.

3. It is recommended that a tool be made to support the sleeve when handling and installing it. A typical tool is made of two discs held in the sleeve with an all-thread rod. The disc is stepped to fit down into the sleeve and has 3 holes drilled in it, one in the center for the all-thread rod and two additional openings to allow the coolant to enter the cavity.
4. When the sleeve has cooled, quickly locate it in the bore to the lift arm. Position the sleeve centrally in the lift arm bore, having an equal amount of the sleeve protruding from each side.

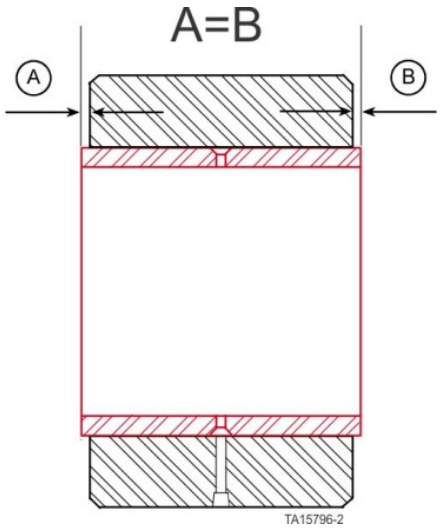


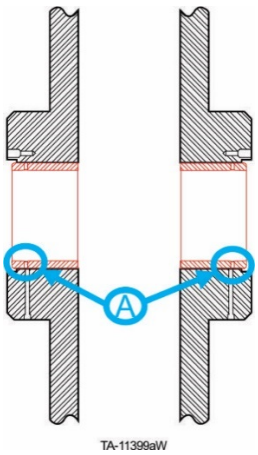
Figure 31. Bell crank sleeve position

CAUTION

Align the grease hole in the lift arm with the grease groove in the sleeve. Adjust the position of the sleeve to ensure grease hole alignment. Failure to do so can result in a rapidly failed assembly.

B. Bushing to Bellcrank Installation

1. The bushing to bellcrank is a press fit from 0.002” (0.051 mm) loose to 0.002” (0.051 mm) tight and can be pressed without cooling.
2. Install the bushings with the grease groove to the outside.



A) Verify grease grove location (grease groove to the outside)

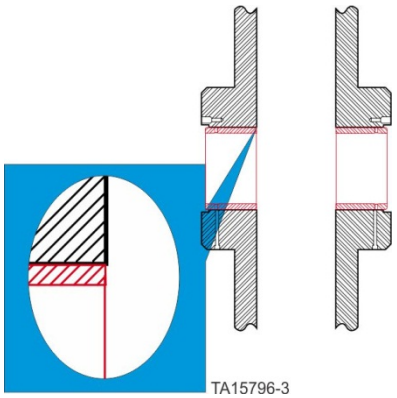
Figure 32. Bell crank pivot brass bushings

3. Coat the outside of the bushing and the bore of the bellcrank with Loctite RC635 immediately before installation.

NOTICE

The Loctite RC635 will remain fluid for approximately 30 minutes. <u>The following steps must be completed within this time.</u>

4. Press both bushings into the bell crank so they are flush with inside surface of the bell crank.



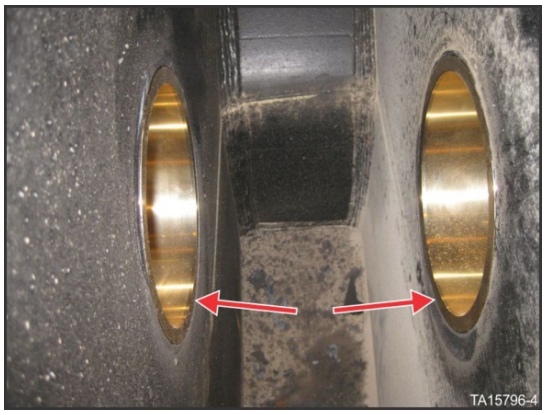
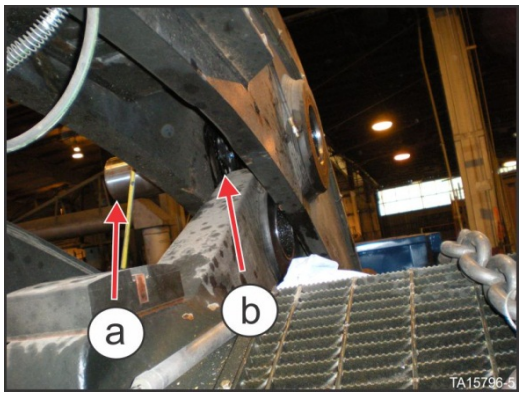


Figure 33. Bell crank pivot brass bushings

5. Install the pivot pin on one side of the bell crank. Ensure that the pin does not pass all the way through the first brass bushing.



a) Pin installed but not pushed through point B.

b) Bushing flush with inside of the bell crank bore

Figure 34. Pin installation

6. Position the bell crank over the torque tube ear. Align the bell crank bore to the torque tube ear bore.

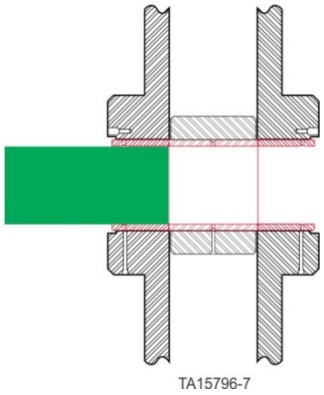


Figure 35. Bell crank pivot pin alignment

7. Install the bell crank pivot pin.
8. Install the capture plates
9. Using a pry bar, check the side to side movements of the bell crank on the torque tube ear.

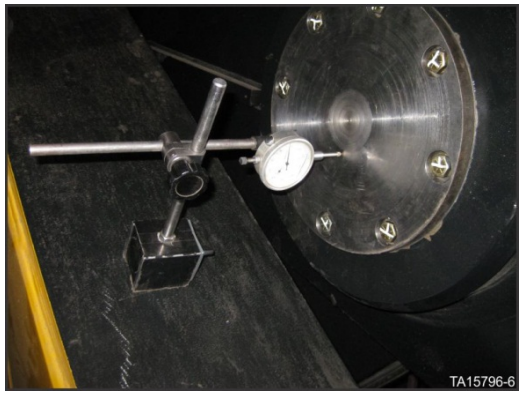


Figure 36. Dial indicator setup for checking side to side movement

10. Divide the reading obtained above by 2 and add .015” thousandths. This is the amount of shims that will be added under both capture plates.
11. Install the shims.
12. Verify the side to side movement. The reading should be .010 to .030” inch.

Bucket to Lift Arms (All Machines)

A. Bushing and Seal Installation In Lift Arm

1. The bronze bushing to lift arm bore is a press fit from .002” to .004” tight. They can be pressed in without cooling. The beveled end of the bushing goes toward the center with the bushing spacer between the two bushings. The bushings should be pressed in flush with the outside edge of the bore. The center bushing spacer should be loose in the bore between the bushings.
2. Place the Thrust bushing into the bore with the lip going to the outside (both sides).
3. Coat the seal metal cup with Loctite RC635. Position the seal so that the seal lip goes to the inside. Press the seal into the bore.

B. Bucket Pivot Assembly and Shimming

1. Nest O-rings on groove provided on lift arm bosses.
2. Position bucket to lift arm so that lift arm centerline and bucket boss centerline are in alignment.
3. Slide both pins into position. Grease the pins with the appropriate grease (min 3% moly) before installation.
4. Using the pins as a reference in the bucket bores; improve alignment of the bucket to lift arm bores if needed.
5. Install sleeve into the bucket bosses. Use capture plate and two ¾” UNC all-thread rods about 6” inches long with two ¾” UNC nuts to press sleeves into place.
6. Back nuts off on capture plate and screw three bolts in the puller plate mounted to the sleeve. Use the capture plate to press sleeves in until they bottom against thrust washer in the lift arm bore (this must be done on all four sleeves).
7. Look at the gaps between the lift arm boss and bucket ears. Determine what side has the smaller gap and start shimming from that side.
8. Start on the side with the smaller gap and install shims to completely fill the shimming space. The last shim should extend past the face of the bolt ring.
9. Install the capture plate and tighten the bolts.

NOTICE

L2350 High Lift ONLY

The capture plate cut-out area must be positioned facing away from the bucket. It will be oriented approximately 90 degrees from the bottom surface of the bucket.

CAUTION

Failure to correctly orient the cutout area of the capture plate will result in extensive damage to the machine components.

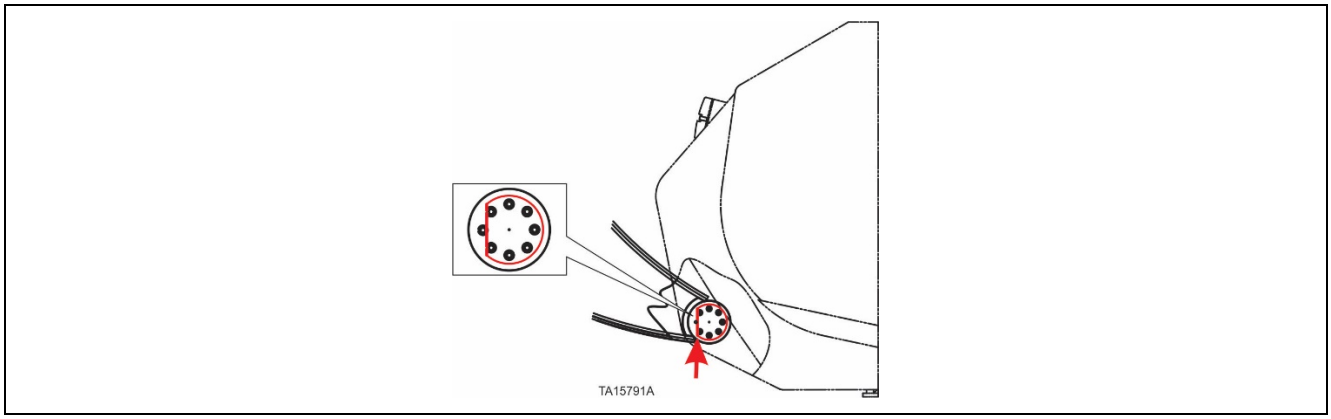


Figure 37. L2350 high lift capture plate cutout orientation

10. On the other end of the pin, install shims just one short of filling the shim space.
11. Install the capture plate and tighten the bolts.
12. Repeat Steps #7 through #11 for the other arm.
13. Roll the O-ring off the lift arm bosses and into the grooves between the bosses.
14. Purge the grease system until grease comes through the capture plates.

C. Bucket Removal

1. Remove the capture plate. Screw three bolts into the sleeve puller plate and jack sleeves out. If the pin moves rather than the sleeve, put the capture plate on the other side to keep pin from coming out while jacking the sleeves out.
2. With both sleeves removed, the pin should come out by hand.
3. Repeat Steps #1 through #2 for the other side.

Level Link to Bucket (L-1350/L-1850 and L-2350)

A. Spherical Bearing Installation

NOTICE

Clean all components with a suitable mineral oil based solvent.

1. Install a retainer ring into a groove in the bore of new level link structure.
2. Align the spherical bearing with bore of level link structure from side opposite the retainer ring. Ensure that the split line of spherical bearing's outer ring is positioned 90º to the centerline of level link assembly. Apply a light coat of 30W oil to the OD of the spherical bearing.
3. Using a sleeve with O.D. slightly smaller than the level link structure bore I.D., placed against the outer race of the spherical bearing. Press the spherical bearing into bore of level link assembly.

CAUTION

Do *NOT* hammer on spherical bearing as damage to the spherical bearing outer ring may occur.

CAUTION

Liquid Nitrogen should not be used since it will result in metallurgical change in the bearing material and potentially permanent size change. The bearing should not be chilled below -110º F (-80º C) for installation.

The recommended methods for chilling are either an industrial freezer or packing in dry ice.

Typically, -40º F (-40º C) should allow for a drop in or light press for install.

4. Press the spherical bearing snugly against the retainer ring. Check that both halves of the outer race of the spherical bearing are snug against the retainer ring.

NOTICE

Typical press fits for common press fits are listed below.

P/N	Vendor P/N	Bore[1]	Common Usage	Press Fit Range
R4231131	B75771-10	10.496 ±.001	Level Link, Hoist Cylinder	10,000 to 33,000 lbs
R6964139	B96-9L-12	8.7466 ±.0009	Bucket Cylinder	6,000-21,000 lbs
R4241000	B136-9LSSQ-10	12.7454 ±.0011	Hoist Cylinder	14,000-43,000 lbs
R6944893	B64-LSS	6.2484 ±.0005	Steer Cylinder	400-8,000 lbs
[1] Assumes a COF of .15 for the contacting surface.				
[1]Assuming the bore dimensions are correct in the structure.				

5. Check that inner race of the spherical bearing rotates freely within the outer race. If the inner race of spherical bearing does not rotate freely, the spherical bearing may be require to be pressed out and the bore of level link structure verified for correct internal dimensions.

6. Install another retainer ring in the vacant groove in the bore of level link structure to secure the spherical bearing in place.
7. Pack the bearing with approved grease (3% moly min). The inner race will need to be rotated and the bearing grease grooves filled. Lightly coat the ID of the inner race with grease.

B. Joint Assembly

NOTICE

Clean all components with a suitable mineral oil based solvent.

1. Apply grease to both sides of the spherical bearing outer face and position the O-rings in position on both sides of spherical bearing. The grease will aid to holding the O-rings in place while installing the level link structure. The O-rings may catch on the bucket hinge bosses. If this occurs, use a suitable tool to force the O-ring back into position.
2. Center the self-aligning bushing in reference to the bucket hinge boss bore.
3. Apply grease to the hardened surface of the straight pin. Install the pin.
4. Install the sawcut bushing at each end of the pin and into the bore of the structure. The cut in the sawcut bushings should be installed at 90° degrees to the thrust of the joint and 180° degrees apposed.
5. Position the capture washers at each end of pin.
6. Use the centering alignment tool to measure the depth of pin relative to bucket hinge ears.
    a. The alignment pin should be inserted through the small hole in the hardened washer on the outside bucket hinge ear. Measure the distance between the measurement pin leg and the bucket hinge ear. Record this measurement.
    b. Next, insert the alignment pin through the small hole in the hardened washer on the inside bucket hinge ear. Measure the distance between the measurement pin leg and in the bucket hinge ear. Record this measurement.
    c. The pin is properly centered when the measurement taken in step “a” is one inch larger than the measurement taken in step “b”. If the step “a” measurement is not one inch larger than step “b”, move the pin in the bucket pivot until the correct reading is obtained.
7. Lubricate the bolt head and threads with 30W oil. Insert the bolt through the washers.

NOTICE

The bolt has to be installed from the inside of the lift arms with bolt threads next to the lift arms.

8. Install the hardened washer and nylon insert locknut.

NOTICE

Once, bolt torque is achieved, remove the torquing device and strike the area around the bucket bosses to help seat the tapers. Re-torque the bolt and repeat the striking procedure until no further advancement is recorded.

9. The bolt torque needs to be checked immediately after the first 15 minutes of operation, then rechecked at 2, 4, 8, and 16 hour intervals or until no further nut advancement is recorded.

C. Pin Removal

1. Unload the pin joint by placing bucket on the ground and neutralizing the hydraulic pressure by using the manual hydraulic bleed valve assembly.
2. Remove the bolt, nut, and the two capture washers.
3. Loosen the sawcut bushing by using a drift or heavy bar (made from soft metal such as brass) to strike the end of the pin.
4. If the bushings have seized in the bore, install the bushing removal tool by bolting to the sawcut bushing. Tighten the four bolts evenly. If the bushing does not come out when bolts are tight, strike the center of bushing removal tool with hammer.
5. With the bushings removed, push the pin from the bore of the spherical bearing.

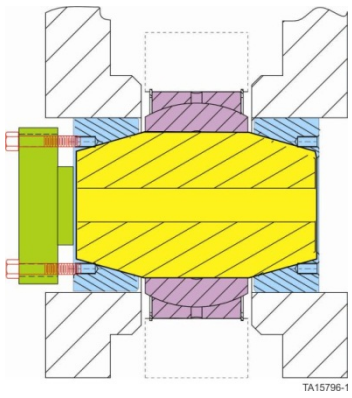


Figure 38. Sawcut bushing removal

Hoist Rod to Lift Arm Structure (L-1350)

A. Spherical Bearing Installation into hoist rod eye structure.

NOTICE

Clean all components with a suitable mineral oil based solvent.

1. Install a retainer ring into a groove in the bore of new hoist rod eye structure.
2. Align the spherical bearing with bore of hoist rod eye structure from side opposite the retainer ring. Ensure that the split line of spherical bearing's outer ring is positioned 90º to the centerline of hoist rod eye assembly. Apply a light coat of 30W oil to the OD of the spherical bearing.
3. Using a sleeve with O.D. slightly smaller than the hoist rod eye structure bore I.D., placed against the outer race of the spherical bearing. Press the spherical bearing into bore of hoist rod eye assembly.

CAUTION

Do *NOT* hammer on spherical bearing as damage to the spherical bearing outer ring may occur.

CAUTION

Liquid Nitrogen should not be used since it will result in metallurgical change in the bearing material and potentially permanent size change. The bearing should not be chilled below -110º F (-80º C) for installation.

The recommended methods for chilling are either an industrial freezer or packing in dry ice.

Typically, -40º F (-40º C) should allow for a drop in or light press for install.

4. Press the spherical bearing snugly against the retainer ring. Check that both halves of the outer race of the spherical bearing are snug against the retainer ring.

NOTICE

Typical press fits for common press fits are listed below.

P/N	Vendor P/N	Bore[1]	Common Usage	Press Fit Range
R4231131	B75771-10	10.496 ±.001	Level Link, Hoist Cylinder	10,000 to 33,000 lbs
R6964139	B96-9L-12	8.7466 ±.0009	Bucket Cylinder	6,000-21,000 lbs
R4241000	B136-9LSSQ-10	12.7454 ±.0011	Hoist Cylinder	14,000-43,000 lbs
R6944893	B64-LSS	6.2484 ±.0005	Steer Cylinder	400-8,000 lbs
[1] Assumes a COF of .15 for the contacting surface.				
[1]Assuming the bore dimensions are correct in the structure.				

5. Check that inner race of the spherical bearing rotates freely within the outer race. If the inner race of spherical bearing does not rotate freely, the spherical bearing may be require to be pressed out and the bore of hoist rod eye structure verified for correct internal dimensions.
6. Install another retainer ring in the vacant groove in the bore of hoist rod eye structure to secure the spherical bearing in place.
7. Pack the bearing with approved grease (3% moly min). The inner race will need to be rotated and the bearing grease grooves filled. Lightly coat the ID of the inner race with grease.

B. Spherical Joint Assembly

NOTICE

Clean all components with a suitable mineral oil based solvent.

1. Apply grease to both sides of the spherical bearing outer face and position the O-rings in position on both sides of spherical bearing. The grease will aid to holding the O-rings in place while installing the hoist rod eye structure. The O-rings may catch on the bell cranks. If this occurs, use a suitable tool to force the O-ring back into position.
2. Apply a light amount of grease (3% moly min) to the hardened pin surface being careful not to get grease on the taper portion of the pin.
3. Align the inner race bore of the spherical bearing as close as possible with the bore of the bellcrank structure.
4. Insert the pin into the bore of the spherical bearing. The pin should be a slip fit. DO NOT use a hammer for installation. Once the pin is installed, carefully clean all grease off of the taper ends of the pin. The bores on the lift arms should also be clean.
5. Lightly coat the tapered ID and the OD of the sawcut bushing with 30W oil.
6. Install the sawcut bushing at each end of the pin and into the bore of the bellcrank structure. The **cut** in the sawcut bushings should be installed at 90° degrees to the thrust of the joint and 180° degrees apposed.
7. Position the capture washers at each end of pin.
8. Lubricate the bolt head and threads with 30W oil. Insert the bolt through the washers.

NOTICE

The bolt has to be installed from the inside of the lift arms with bolt threads next to the tires.

9. Center the capture washers in reference to the lift arm bosses and torque the nylon insert locknut to the torque listed in the torque chart.

NOTICE

Once, bolt torque is achieved, remove the torquing device and strike the area around the bucket bosses to help seat the tapers. Re-torque the bolt and repeat the striking procedure until no further advancement is recorded.

10. The bolt torque needs to be checked immediately after the first 15 minutes of operation, then rechecked at 2, 4, 8, and 16 hour intervals or until no further nut advancement is recorded.

C. Pin Removal

1. Unload the pin joint by placing bucket on the ground and neutralizing the hydraulic pressure by using the manual hydraulic bleed valve assembly.
2. Remove the bolt, nut, and the two capture washers.
3. Loosen the sawcut bushing by using a drift or heavy bar (made from soft metal such as brass) to strike the end of the pin.
4. If the bushings have seized in the bore, install the bushing removal tool by bolting to the sawcut bushing. Tighten the four bolts evenly. If the bushing does not come out when bolts are tight, strike the center of bushing removal tool with hammer.
5. With the bushings removed, push the pin from the bore of the spherical bearing.

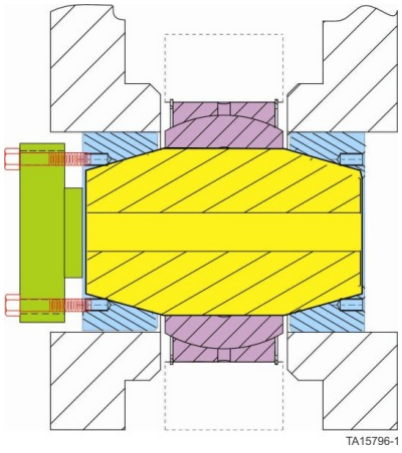


Figure 39. Sawcut bushing removal

Hoist Rod to Lift Arm Structure (L-1850 and L-2350)

A. Spherical Bearing Installation

NOTICE

Clean all components with a suitable mineral oil based solvent.

1. Install a retainer ring into a groove in the bore of new hoist rod eye structure.
2. Align the spherical bearing with bore of hoist rod eye structure from side opposite the retainer ring. Ensure that the split line of spherical bearing's outer ring is positioned 90º to the centerline hoist rod eye assembly. Apply a light coat of 30W oil to the OD of the spherical bearing.
3. Using a sleeve with O.D. slightly smaller than the hoist rod eye structure bore I.D., placed against the outer race of the spherical bearing. Press the spherical bearing into bore of hoist rod eye assembly.

CAUTION

Do *NOT* hammer on spherical bearing as damage to the spherical bearing outer ring may occur.

CAUTION

Liquid Nitrogen should not be used since it will result in metallurgical change in the bearing material and potentially permanent size change. The bearing should not be chilled below -110º F (-80º C) for installation.

The recommended methods for chilling are either an industrial freezer or packing in dry ice.

Typically, -40º F (-40º C) should allow for a drop in or light press for install.

4. Press the spherical bearing snugly against the retainer ring. Check that both halves of the outer race of the spherical bearing are snug against the retainer ring.

NOTICE

Typical press fits for common press fits are listed below.

P/N	Vendor P/N	Bore[1]	Common Usage	Press Fit Range
R4231131	B75771-10	10.496 ±.001	Level Link, Hoist Cylinder	10,000 to 33,000 lbs
R6964139	B96-9L-12	8.7466 ±.0009	Bucket Cylinder	6,000-21,000 lbs
R4241000	B136-9LSSQ-10	12.7454 ±.0011	Hoist Cylinder	14,000-43,000 lbs
R6944893	B64-LSS	6.2484 ±.0005	Steer Cylinder	400-8,000 lbs
[1] Assumes a COF of .15 for the contacting surface.				
[1]Assuming the bore dimensions are correct in the structure.				

5. Check that inner race of the spherical bearing rotates freely within the outer race. If the inner race of spherical bearing does not rotate freely, the spherical bearing may be require to be pressed out and the bore of hoist rod eye structure verified for correct internal dimensions.

6. Install another retainer ring in the vacant groove in the bore of hoist rod eye structure to secure the spherical bearing in place.
7. Pack the bearing with approved grease (3% moly min). The inner race will need to be rotated and the bearing grease grooves filled. Lightly coat the ID of the inner race with grease.

B. Spherical Joint Assembly

NOTICE

Clean all components with a suitable mineral oil based solvent.

1. Apply grease to both sides of the spherical bearing outer face and position the O-rings in position on both sides of spherical bearing. The grease will aid to holding the O-rings in place while installing the hoist rod eye structure. The O-rings may catch on the bell cranks. If this occurs, use a suitable tool to force the O-ring back into position.
2. Apply a light amount of grease (3% moly min) to the hardened pin surface being careful not to get grease on the taper portion of the pin.
3. Align the inner race bore of the spherical bearing as close as possible with the bore of the bellcrank structure.
4. Insert the pin into the bore of the spherical bearing. The pin should be a slip fit. DO NOT use a hammer for installation. Once the pin is installed, carefully clean all grease off of the taper ends of the pin. The bores on the lift arms should also be clean.
5. Lightly coat the tapered ID and the OD of the sawcut bushing with 30W oil.
6. Install the sawcut bushing at each end of the pin and into the bore of the structure. The cut in the sawcut bushings should be installed at 90° degrees to the thrust of the joint and 180° degrees apposed.
7. Position the capture washers at each end of pin.
8. Lubricate the bolt head and threads with 30W oil. Insert the bolt through the washers.

NOTICE

The bolt has to be installed from the inside of the lift arms with bolt threads next to the tires.

9. Install the hardened washer and super nut.
10. Center the capture washers in reference to the lift arm bosses and torque the super nut to 66 ft-lbs.

NOTICE

Tensioners with 4 or 6 jackbolts – use a star pattern for all steps.

Step 1:
Spin the tensioner onto the main thread until it seats against the washer. You may want to back off the tensioner 1/16” to 1/8” gap before tightening.
Step 2:
Tighten (4) jackbolts at 90º apart (at the 12:00, 6:00, 9:00, and 3:00 o’clock position) on all studs with a partial torque (30 – 70%). This serves to seat the flange. If using an air impact wrench, use a reduced setting or lightly pulse the trigger at the full setting.
Step 3:
At 100% target torque, tighten the same (4) jackbolts on all studs.
Step 4:
At 100% target torque, tighten all jackbolts in a circular pattern. Do this for all studs (1 round only).
Step 5:
Repeat “STEP 4” until all jackbolts are stabilized (less than 10º rotation). This usually requires 2 – 4 additional passes. If using air tools, switch to a torque wrench when socket rotation is small. Use the torque wrench to stabilize at the target torque.

Figure 40. Torque nut and torque sequence (typical)

NOTICE

Once, the super nut torque is achieved, remove the torquing device and strike the area around the lift arm bosses to help seat the tapers. Re-torque the bolt and repeat the striking procedure until no further advancement is recorded.

11. The super nut torque needs to be checked immediately after the first 15 minutes of operation, then rechecked at 2, 4, 8, and 16 hour intervals or until no further nut advancement is recorded.

C. Pin Removal

1. Unload the pin joint by placing bucket on the ground and neutralizing the hydraulic pressure by using the manual hydraulic bleed valve assembly.
2. Remove the bolt, nut, and the two capture washers.
3. Loosen the sawcut bushing by using a drift or heavy bar (made from soft metal such as brass) to strike the end of the pin.
4. If the bushings have seized in the bore, install the bushing removal tool by bolting to the sawcut bushing. Tighten the four bolts evenly. If the bushing does not come out when bolts are tight, strike the center of bushing removal tool with hammer.
5. With the bushings removed, push the pin from the bore of the spherical bearing.

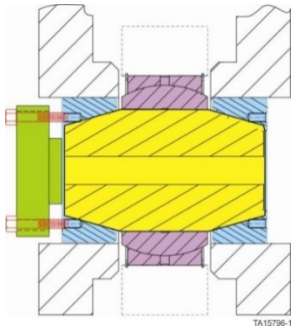
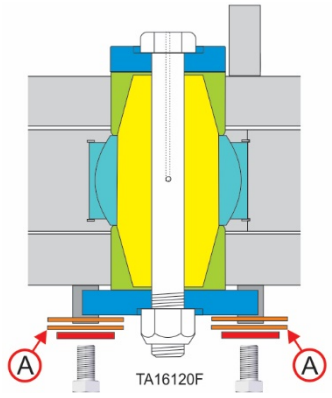


Figure 41. Sawcut bushing removal

Steering Pin Installation

Line item numbers and letters/numbers in parenthesis in text reference figure “Steering pin installation for L1350-L1850-L2350”.

1. Retaining bolt holds the pin and bearing assembly together.
   - The retaining bolt has a grease passage through the head and into the shaft and has a horizontal passage that must be positioned 90 degrees from the action of the cylinder.
   - The bolt has a special torque value (850 ft-lb) (1152 N•m), lubed with 30W oil.
     - Reference torque and lubricant type on “Capscrew and Bolt-Nut Torque Specifications” found in section “General Information”.
     - Do not lube with another type of lubricant as this might change the value of the torque.
   - Grease line is installed into grease passage (B) in head of bolt.
2. A special countersunk washer retains the sawcut bushing.
   - It must not be substituted.
3. Sawcut bushings hold the pin in position.
   - Cut in top sawcut bushing (A1) is positioned 180 degrees from cut in bottom sawcut bushing and 90 degrees from action of cylinder.
   - Cut in bottom sawcut bushing (A2) is positioned 180 degrees from cut in top sawcut bushing and 90 degrees from action of cylinder.
4. O-rings seal the grease from escaping the assembly around the bearing ends.
5. Retaining rings secure the bearing in place.
6. Bushings hold the O-rings in position.
7. O-rings prevent the grease from exiting around the bolt.
8. A pin allows the joint to pivot and takes the load from the steer cylinder.
9. A bearing allows the assembly joint to pivot.
10. A capture plate secures the bottom of the assembly joint.
11. Washers space the assembly.
    - Adjust the position of the bottom sawcut and cylinder with the quantity of washers.
    - They act as shims to set the position.
    - They have a large hole and fit over the bolt block on the frame.



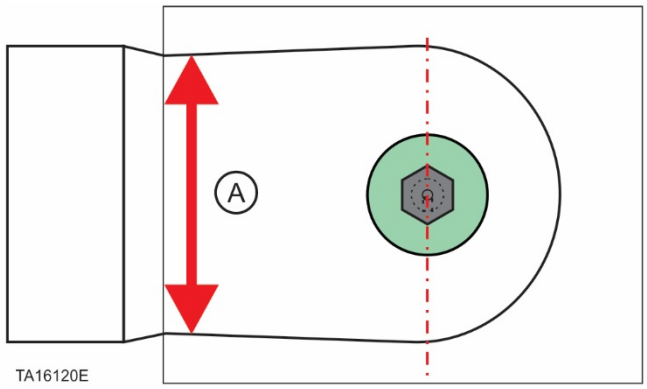
A. Washers act as shims

Figure 42. Washers act as shims to position sawcut and cylinder rod

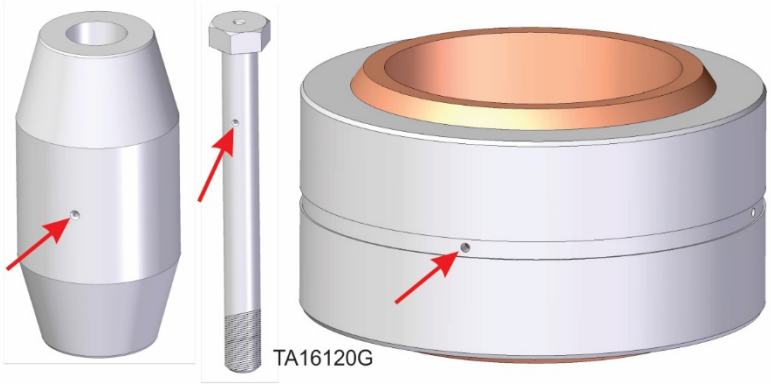
12. Washers secure the spacer washers.
    - They fit tight against the bolt block.
13. Lock washers lock the capture plate securing capscrews.
14. Capscrews secure the capture plate.
15. A main nut secures the bolt in position.

CAUTION

Grease passages in bolt (B1), pin (C), and bearing (D) should all be aligned 90 degrees from action of cylinder. Failure to align all passages can result in equipment damage, including bending the pin.



A. Bolt, pin, and bearing grease hole orientation



Grease passages in bolt, pin, and bearing

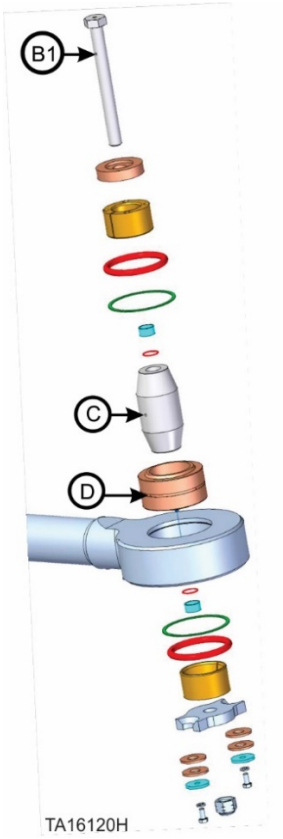
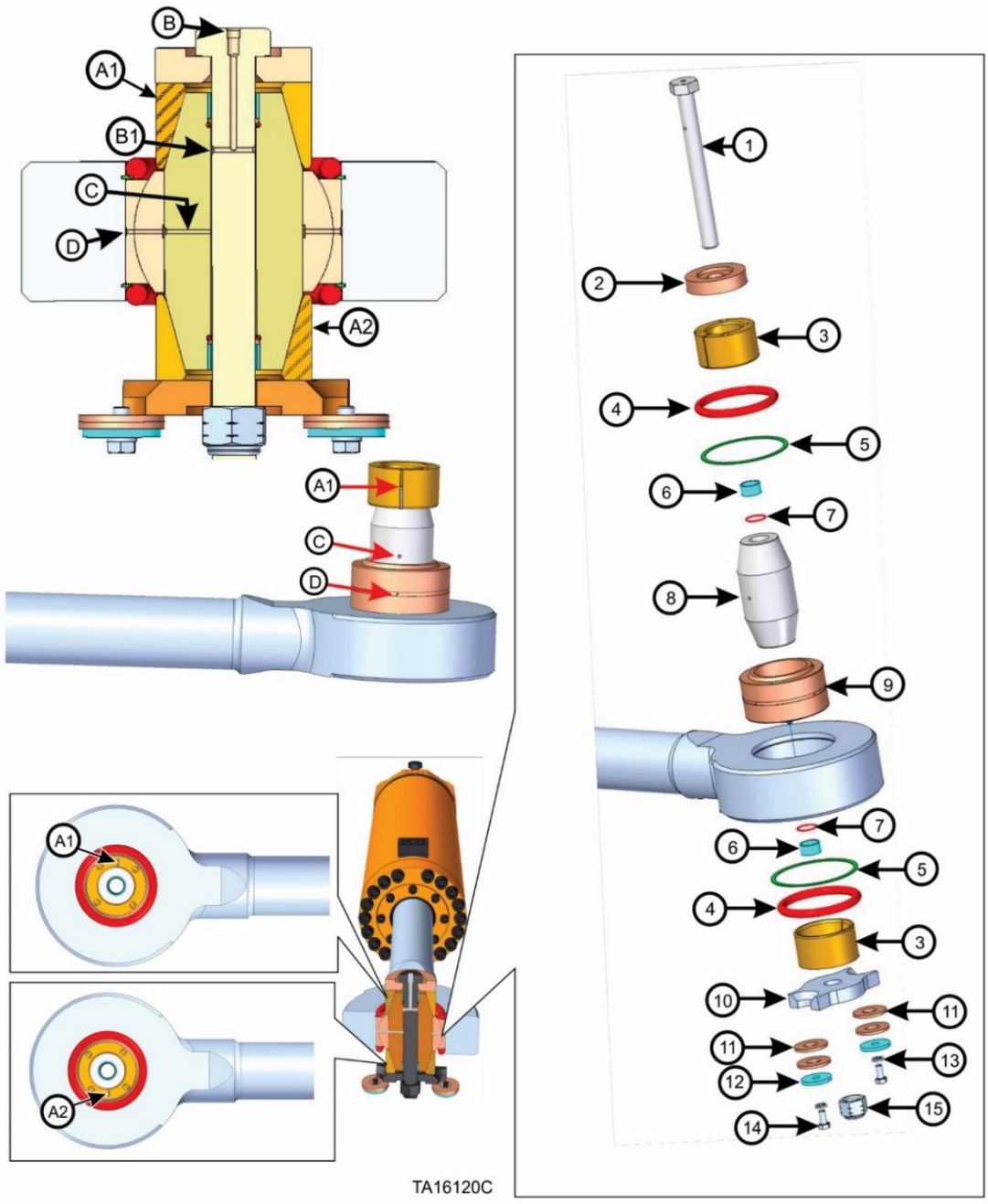


Figure 43. Grease passages

NOTICE

The bearing has grease passages in four (4) locations, 90 degrees apart. Any of the passages can be used to align 90 degrees from the action of the cylinder.



1. Bolt	**12**. Washer (1 each bolt)
2. Special countersunk washer.	**13**. Lock washer (1 each bolt)
3. Saw cut bushing	**14**. Bolt (2)
4. O-ring	**15**. Retaining nut
5. Retainer ring	**A1**. Cut in top sawcut bushing
6. Sleeve	**A2**. Cut in bottom sawcut bushing
7. O-ring	**B**. Grease passage in bolt.
8. Pin	**B1**. Horizontal grease passage in bolt.
9. Self-aligning bearing	**C**. Grease passage in pin.
10. Capture plate	**D**. Grease passage in self-aligning bearing.
11. Washer (2 each bolt)	

Figure 44. Steering pin installation for L-1350-L1850-L2350

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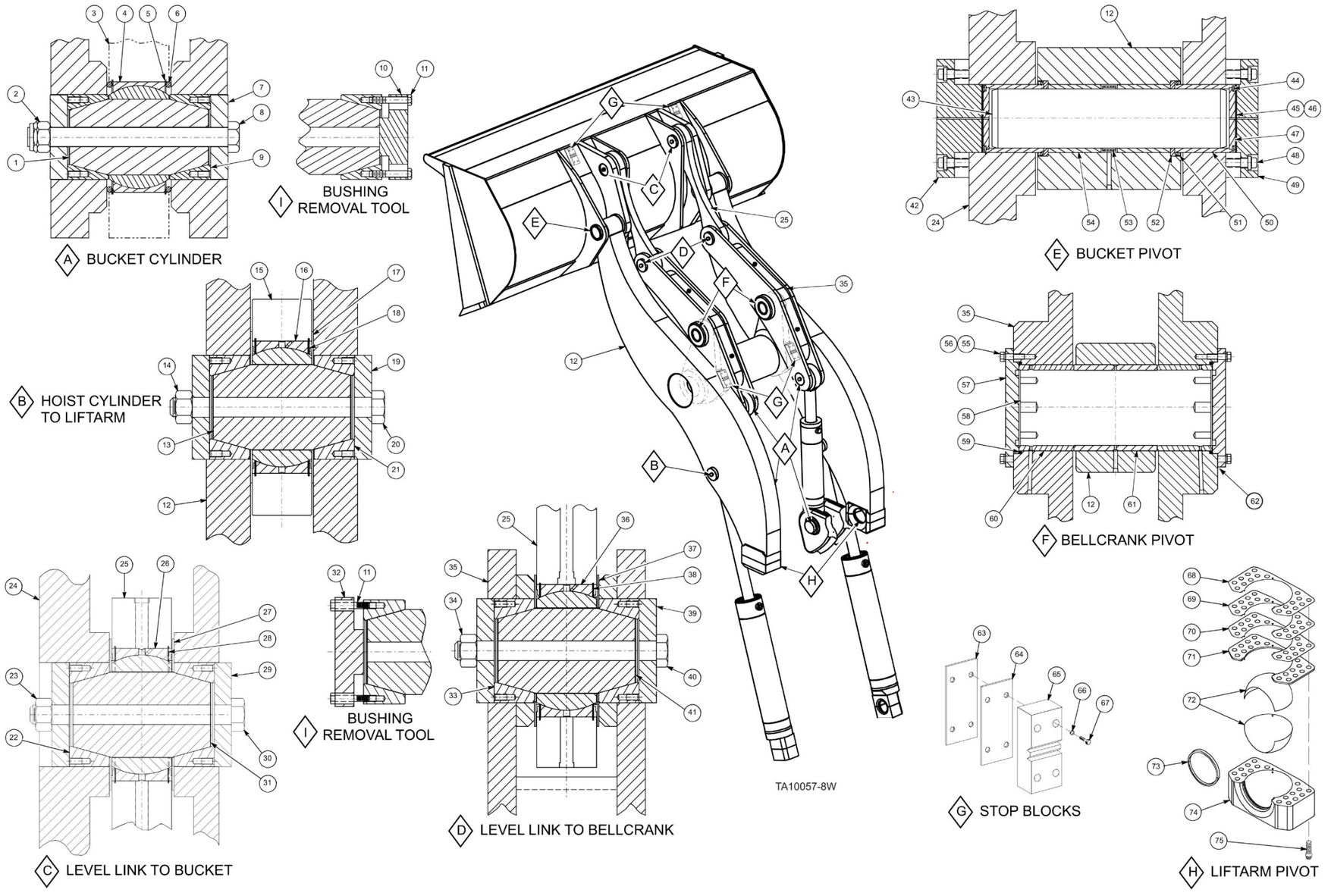

A) Bucket Cylinder, **B)** Hoist Cylinder to Lift arm, **C)** Level Link to Bucket, **D)** Level Link to Bellcrank, **E)** Bucket Pivot, **F)** Bellcrank Pivot, **G)**Stop Blocks, **H)** Lift arm Pivot, **I)** Bushing Removal Tool

1. Pin
2. Locknut
3. Bucket cylinder assembly
4. Bushing
5. Ring
6. Not used
7. Flatwasher
8. Bolt
9. Bushing
10. Tool
11. Bolt
12. Lift arm structure - high lift
13. Pin
14. Locknut
15. Hoist cylinder
16. Bushing
17. Not used
18. Ring
19. Flatwasher
20. Bolt
21. Bushing
22. Bushing
23. Locknut
24. Bucket structure
25. Level link assembly
26. Bushing
27. Not used
28. Ring
29. Flatwasher
30. Bolt
31. Pin
32. Tool
33. Bushing
34. Locknut
35. Bellcrank structure
36. Bushing
37. Not used
38. Ring
39. Flatwasher
40. Bolt
41. Pin
42. Cap
43. Pin
44. Ring
45. Shim
46. Shim
47. Cap
48. Capscrew
49. Cap
50. Sleeve
51. Seal
52. Bushing
53. Spacer
54. Bushing
55. Bolt
56. Lockwasher
57. Plate
58. Pin
59. O-ring
60. Bushing
61. Sleeve
62. Shim
63. Spacer
64. Spacer
65. Stop block
66. Lockwasher
67. Bolt
68. Shim
69. Shim
70. Shim
71. Spacer
72. Liner
73. Seal
74. Cap
75. Capscrew

Figure 45. L1350 lift arm and linkage group — pin and bushing installation

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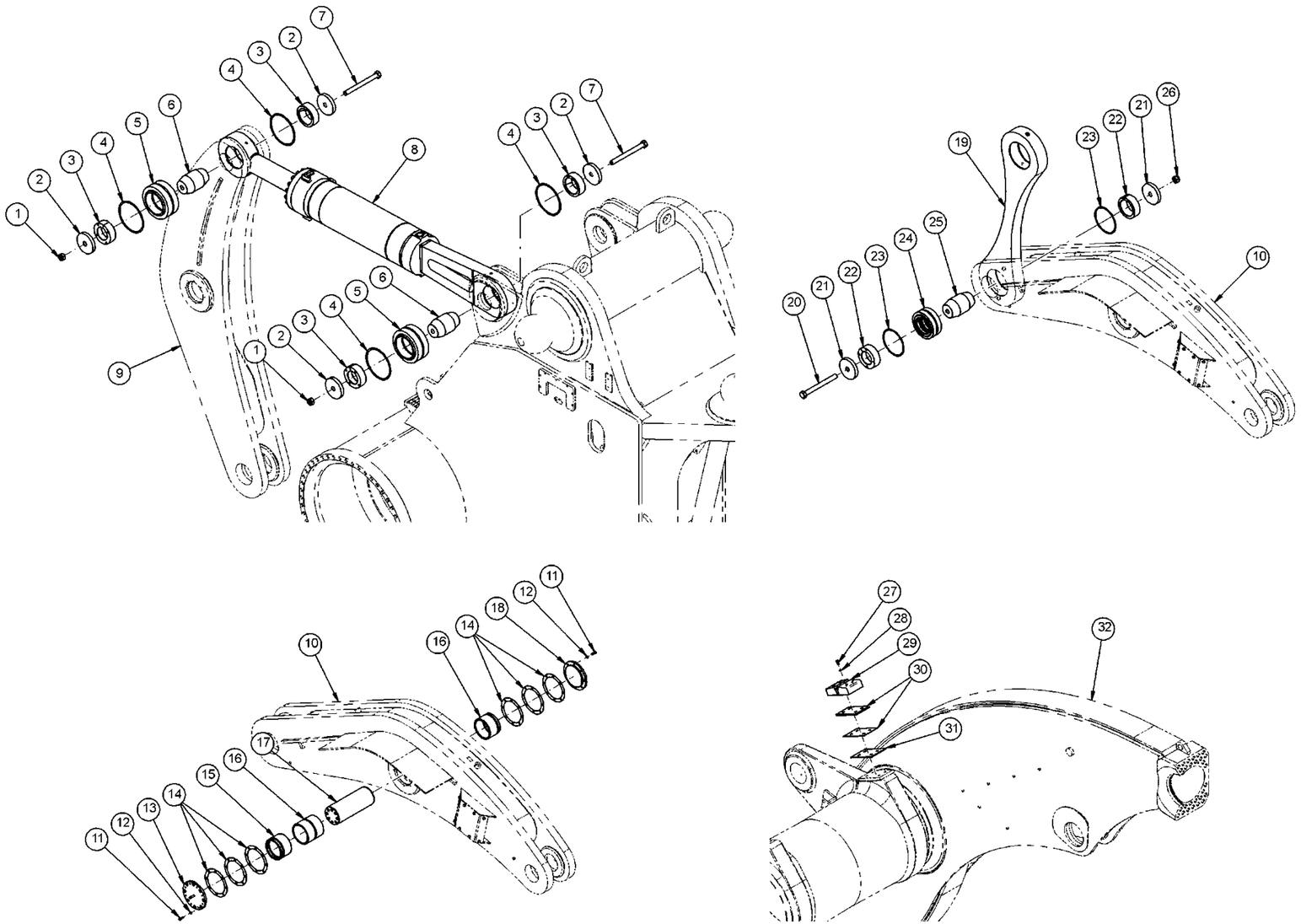

1 Locknut
2 Flatwasher
3 Bushing, Sawcut
4 Ring, Retaining - Internal
5 Bushing. Self-Aligning
6 Pin
7 Bolt
8 Cylinder. Bucket
9 Bellcrank Structure L.H.
10 Bellcrank Structure .R.H.
11 Bolt
12 Lockwasher
13 Cover Plate. Level Indicator
14 Shim. Round - .020
15 Bushing. Cylindrical
16 Sleeve
17 Pin
18 Plate. Cover - Pin
19 Level Link Assembly
20 Bolt
21 Flatwasher
22 Bushing. Sawcut
23 Ring. Retaining - Internal
24 Bushing. Self-Aligning
25 Pin
26 Locknut
27 Bolt
28 Lockwasher
29 Stop Block
30 Spacer
31 Spacer
32 Lift Arm Structure

Figure 46. L-1850/2350 lift arm and linkage group — pin and bushing installation (1 of 2)

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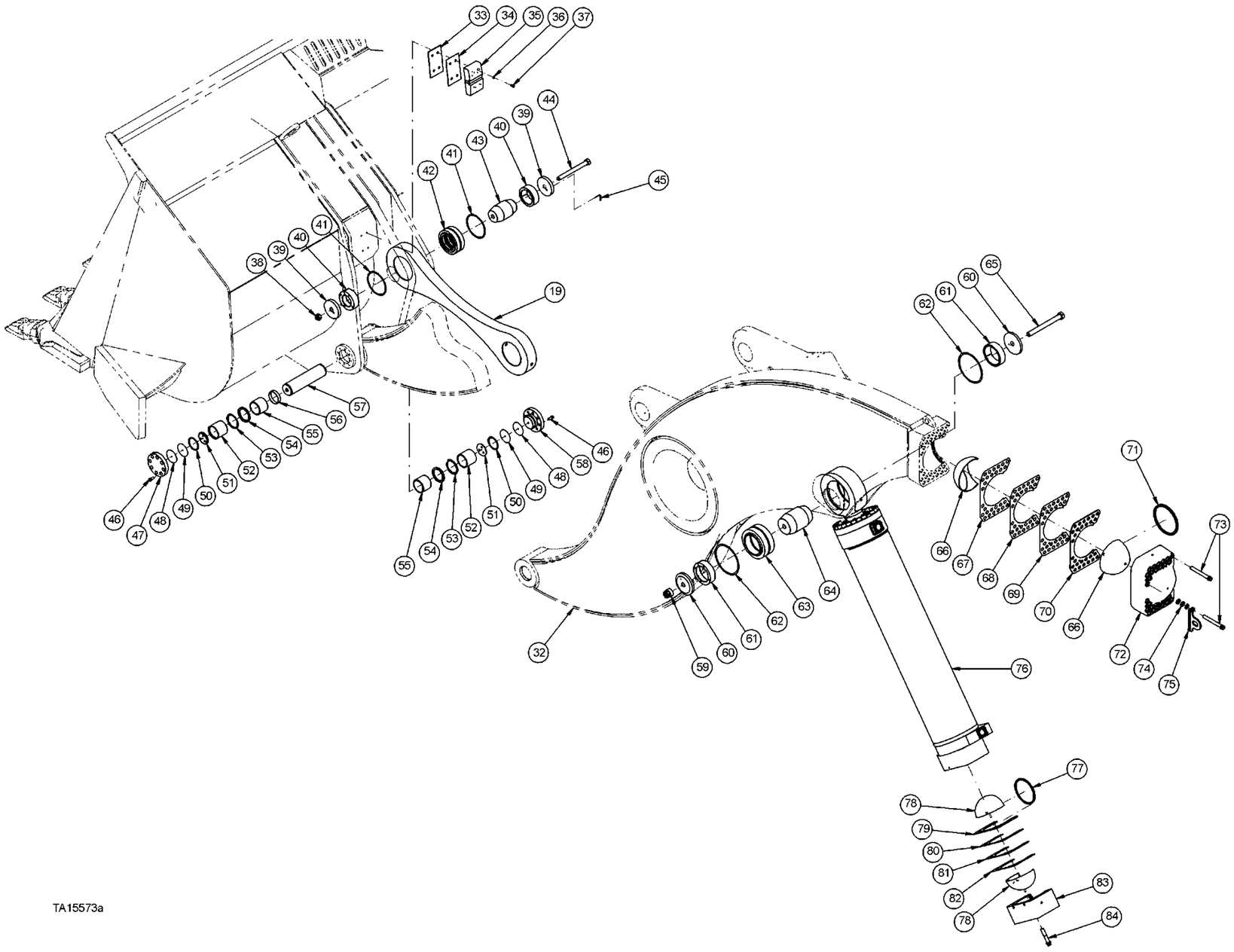

19 Level Link Assembly
32 Lift Arm Structure
33 Spacer
34 Spacer
35 Stop Block
36 Lockwasher
37 Bolt
38 Locknut
39 Flatwasher
40 Bushin G.Sawcut
41 Ring.Retaining - Internal
42 Bushing.Self-Aligning
43 Pin
44 Bolt
45 Tool.Measurement - Pin Depth
46 Capscrew
47 Cap.Pin Retainer - Short
48 Shim
49 Shim
50 Ring.Retaining - Internal
51 Cap.Pin Puller
52 Sleeve
53 Seal.Grease
54 Bushing.Thrust
55 Bushing
56 Spacer.Bushing
57 Pin.Bucket Pivot
58 Cap.Pin Retainer - Long
59 Nut.Torque
60 Washer.Hoist Pivot - with hole for pin measurment
61 Bushing.Sawcut
62 Ring.Retaining - Internal
63 Bushing.Self-Aligning
64 Pin
65 Bolt
66 Liner.Ball - Half
67 Shim,
68 Shim,
69 Shim,
70 Spacer
71 Seal.Ball
72 Cap.Ball - Lift Arm
73 Capscrew
74 Flatwasher
75 Plate.Torque
76 Hoist Cylinder
77 Seal, Ball
78 Liner, Ball - Half
79 Shim
80 Shim
81 Shim
82 Shim
83 Cap, Ball
84 Capscrew

Figure 47. L-1850/2350 lift arm and linkage group — pin and bushing installation (2 of 2)

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Temperature Limits

1) The spherical ball joints are highly loaded in some severe applications.
2) They are designed for intermittent high loading.
3) It is normal for the highly loaded spherical ball bearing joints to warm up under hard usage.
4) The limiting factor for joint temperature is the temperature capacity of the grease.
5) The working temperature of a properly aligned spherical ball joint with the correct brass liners will vary depending on the severity of the application, the grease being used, the amount of grease, the cycle time of the auto lube system, etc.
6) Average temperatures up to 125°F (52°C) above ambient temperature are typical and acceptable for most greases. (Temperature measured on the outside surface of the cap and socket)
    - For example – in an ambient temperature of 86°F (30°C) – a ball cap temperature up to 211°F (82°C) is acceptable with intermittent temperature spikes.
7) Temperature spikes up to 170°F (77°C) above ambient temperature are acceptable.
    - For example – in an ambient temperature of 86°F (30°C) – a short term ball cap temperature up to 256°F (107°C) is acceptable.

The ball cap temperature can be measured with a non-contact infrared thermomenter or a contact probe.

Figure 48. Measuring ball cap temperature

NOTICE

The average temperature limit of 125°F (52°C) and short term temperature limit of 170°F (77°C) above ambient are very conservative and are based on use of a low temperature grease of minimum specification. Higher quality auto lube greases used in most locations permit a much higher temperature limit prior to concern. The specifications for the grease used should be examined to determine the temperature limits for your application.

If the ball cap alignment is correct and temperature continually rises above these limits then the joints should have the following parameters checked:

- Bronze liner thickness
- Clearance
- Grease quality and quantity
- Socket flatness

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Ball Liner

Bronze Liner Thickness

The bronze liner is designed to be the wear component in the spherical joint. The bronze liner sits between the ball and socket/cap. One liner is secured to the socket and a second liner is secured to the cap.

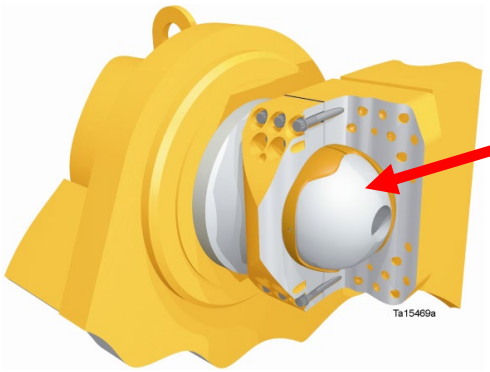


Figure 49. Bronze liner

On current production machines, a quality control process ensures that the brass liners meet Komatsu specifications.

NOTICE

Any liner that has either the Supplier Identification mark or the Factory Identification mark, or both, has been through the enhanced quality control process. IF no identification marks can be found on the liner, then a thorough review of the following liner thickness and chamfer checks should be performed.

The supplier and factory identification marks are shown in the following pictures. The supplier marks are typically on one of the edges. The factory marks are typically on the outside of the sphere.

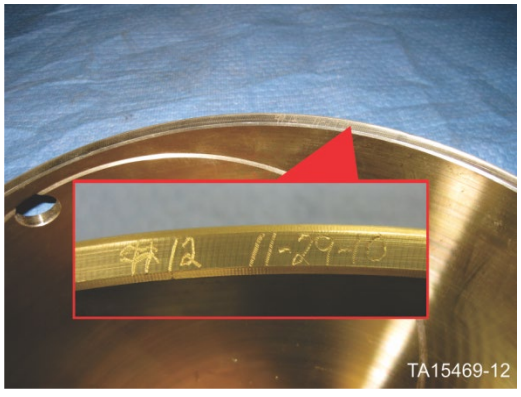
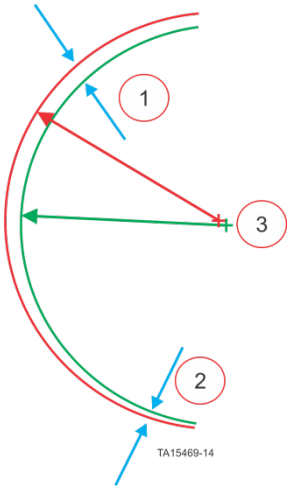


Figure 50. Supplier identification marking

Figure 51. Factory identification marking

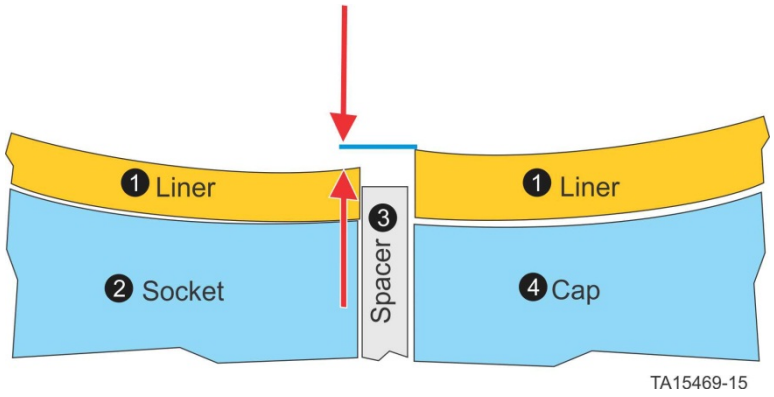
If the liner is too thick – the clearance in the joint will be reduced and excessive heat may be a result. Variation in the liner thickness is an indicator that the true center positions of the outer and inner spheres are not aligned.



1. Maximum thickness, **2.** Minimum thickness, **3.** Offset centers

Figure 52. Cause of liner thickness differences (sphere centers are not the same location)

When the liners in the socket and cap are assembled into a spherical joint - a major thickness difference will cause a step that creates a high load area on one liner. This condition can lead to high temperatures and if left uncorrected, can cause failures of the spacer plate and shim pack. This condition is shown exaggerated in the following drawing.



1) Liner
2) Socket
3) Spacer
4) Cap

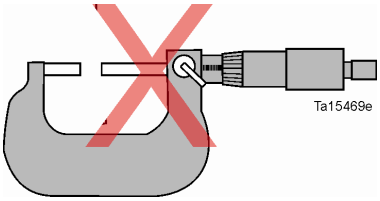
Figure 53. Bronze liner step caused by differing thickness

Typical bronze liner thickness specifications are listed in the following table.

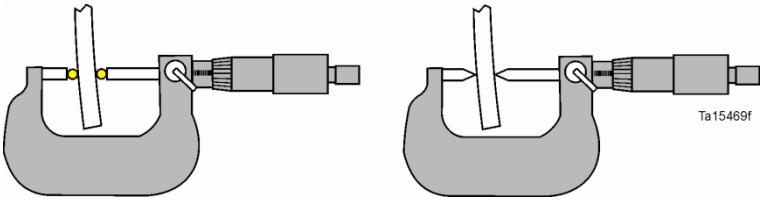
Bronze Liner Nominal Diameter	Bronze Liner Thickness Tolerance
7.5”	.239” - .249”
9”	.239” - .249”
12”	.237” - .247”
14”	.236” - .246”

NOTICE

The bronze liner thickess cannot be checked directly with a standard micrometer or caliper due to the curved spherical surface.



DO NOT measure thickness with a standard micrometer



Measure liner thickness over balls or with a point micrometer

Figure 54. Measuring liner thickness

The bronze liner thickness can be checked with a micrometer over balls or with a point micrometer. Check multiple locations near the edge and as far in as the micrometer frame will allow. If the thicknesses measured are outside of the tolerance chart, then the liner should not be used.

Figure 55. Measure liner thickness with a point micrometer

Bronze Liner Edge Chamfer

A maximum 1/16” (1.5 mm) X 45° chamfer is called out for the edge of the bronze liner. Komatsu has found that the corners on some 14” liners were chamfered using a grinder or sander and the size of the chamfer are much larger than specified.

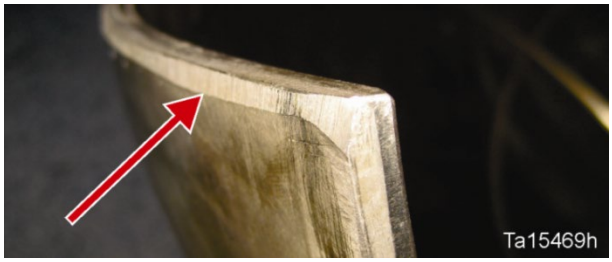
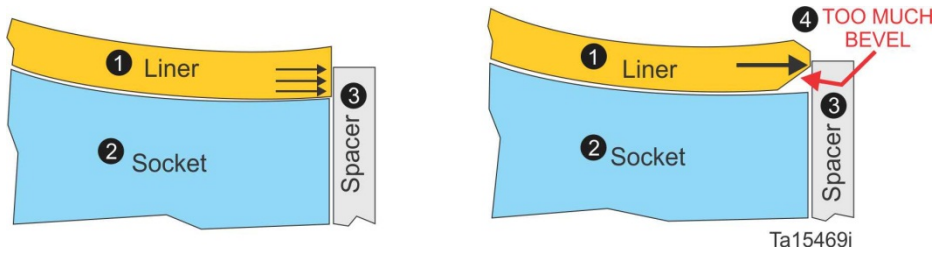


Figure 56. Bronze liner chamfer (bevel)

If the chamfer is too large in certain areas of the bronze liner, the liner can rotate and wedge underneath the spacer, break the spacer and shims and cause damage to the seal retainer in the socket and cap.



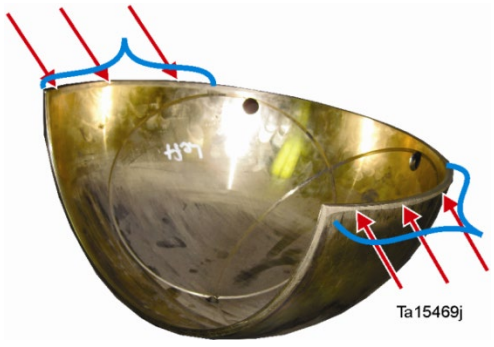
1) Liner
2) Socket
3) Spacer
4) Too much level

Bronze liner chamfer(bevel)

Figure 57. Too much bronze liner bevel

Any 14” bronze liners that are found to have excess machining in the critical areas shown in the following figure should not be used.

The critical areas are the edges shown in the following figure:



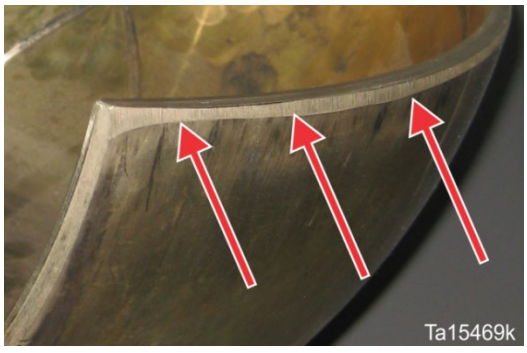


Figure 58. Bronze liner critical area for oversize chamfer

The critical areas shown are:

- On the outside edge of the sphere (not the inside edge)
- On the edge of the sphere against the spacer (not the neck)
- On the edge that is closest to the neck opening (not the neck opening)

Socket Flatness

There has been some variance with the welding processes used to install the socket into the lift arm. Komatsu has found that the socket can warp during the installation welding process. In most cases the socket will warp open. In the following picture the colors represent the type of distortion that typically occurs. The light blue represents minimal distortion and the red represents where the maximum distortion typically occurs. There is more distortion on the neck side of the socket because it is open.

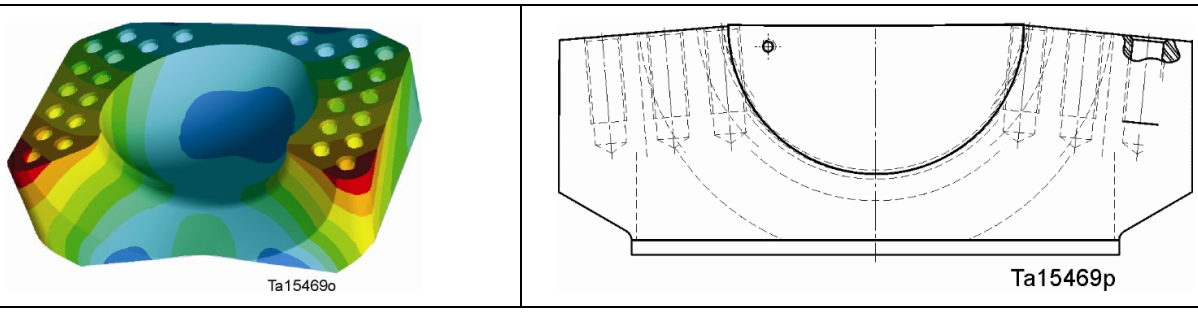


Figure 59. Socket distortion after welding

The joint design and bronze liner can tolerate the sphere opening up. However the flat mating surface needs to be flat with in .010” or distortion of the cap can occur.

When the cap is installed onto a warped socket – the cap and the socket will both move and tighten up the sphere when the capscrews are tightened. This will make the sphere in the cap undersize causing interference and heat.

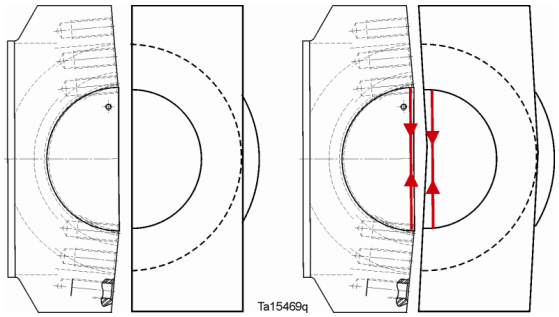
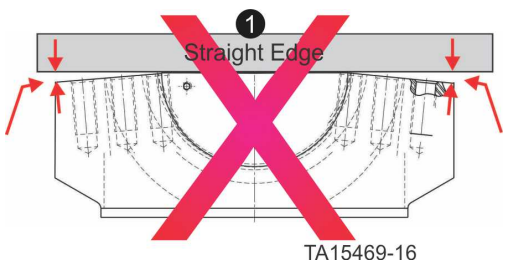


Figure 60. Both cap and socket tighten up when cap placed on a warped socket

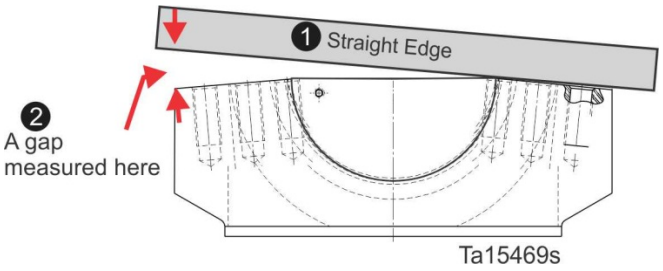
Because the distortion is in multiple directions - it is difficult to check for .010” distortion directly without the use of a milling machine/dial indicator or coordinate measuring machine.



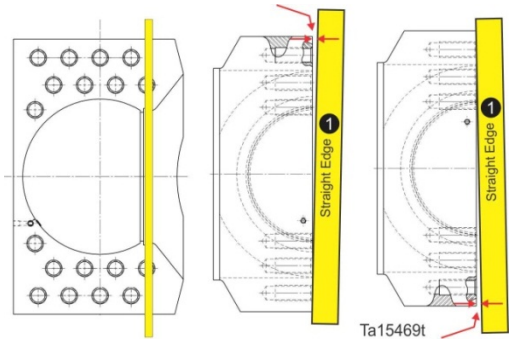
1) Straight Edge

Figure 61. Difficult to measure accurately (do not check this way)

We have found that this distortion can be amplified into something that is easily measurable with the use of a straight edge and feeler gauges.



1) Straight Edge, **2)** A gap measured here



1) Straight Edge

Measure across the neck opening and measure the gap on both directions to determine

Figure 62. Amplified measurement

The straight edge is placed on one side of the flat surface and the gap on the opposite side is measured with feeler gauges. This is done in the area of the socket near the neck as shown. The gap is checked on both sides.

Typically the amount measured in this manner is approximately 3 times the actual. .025” measured in this manner equivalent to .008 to 010” out of tolerance on the flat face.

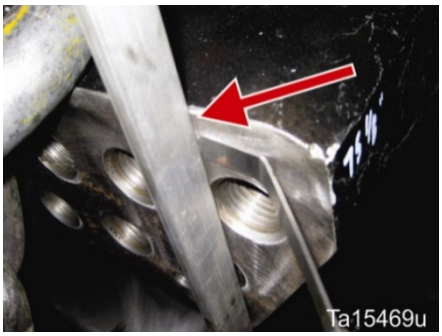


Figure 63. Feeler gauges under straight edge

When excessive distortion (>.025”) is found with this test during fabrication of new lift arms – it is first verified with milling machine and dial indicator inspection and then milled flat.

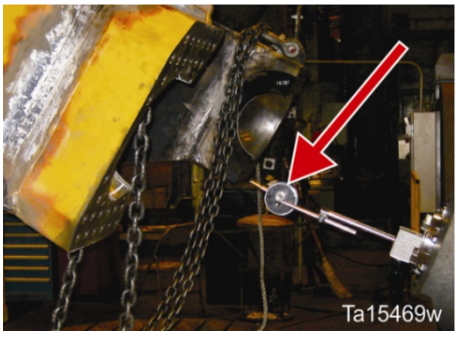


Figure 64. Machining face of socket

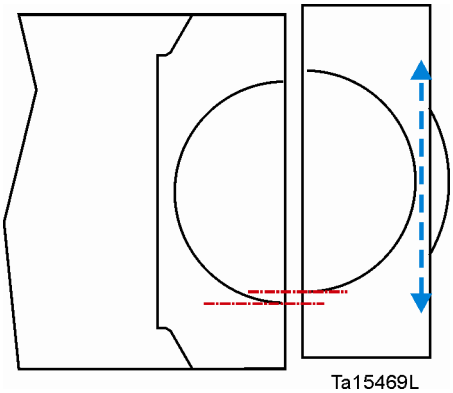
Field repair of excessively distorted sockets requires inspecting, set up and machining of the face in a similar manner.

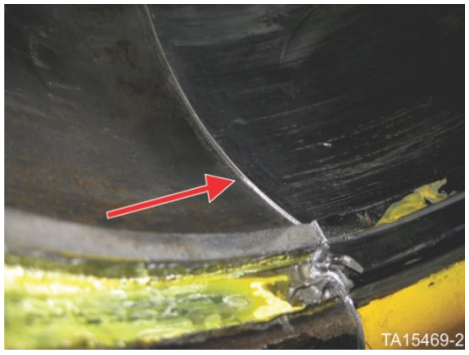
Ball Cap to Socket Alignment

When Installing a ball cap, self-centering does not happen in most cases because the ball joint clearances are loose. Current production machines have the caps and sockets matched visually and marked. If a cap is replaced on an earlier production machine, it should be matched to the existing socket. The socket and cap should be checked prior to installation to determine if the match marks exist.

During installation onto the machine, the match marks should be lined up prior to tightening the capscrews.

The following procedures provide instructions for the proper matching of the cap to the socket.





Typically the cap has up to ± .030” vertical and horizontal movement

(Which produces sphere misalignment)

Figure 65. Ball cap to socket alignment

NOTICE

Previously, it was recommended that the cap be aligned based on dial indicator measurements. Research and testing have found that the spheres are not perfectly centered with the bolt holes because of normal dimensional tolerances. The dial indicator method is not reliable and SHOULD NOT BE USED.

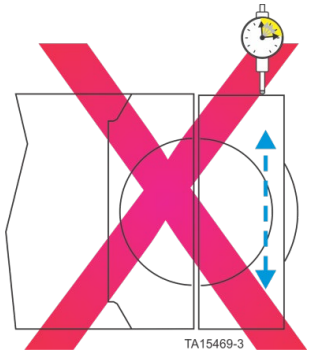


Figure 66. Do not use the dial indicator method

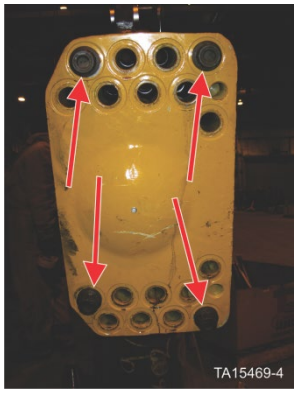
Ball Cap Alignment Procedure

1. Position the lift arms in a position so that the ball cap and ball socket can be checked.
   - This is typically done with the lift arms removed from the machine.
   - If this is done with lift arms on the machine – the arms must be pulled back far enough from the balls so that the cap can be installed on the socket

⚠ WARNING

Crush hazard exists if the alignment is done with the lift arms on the machine. A thorough risk assessment should be done to ensure that the job can be done safely. The lift arms must be securely supported so they cannot move. The ball cap must be properly lifted and supported. The personnel assembling and inspecting the cap and socket must use appropriate fall prevention equipment. All local mine site regulations must be obeyed. Failure to perform a risk assessment before beginning the procedure can cause crush hazard resulting in serious injury or death.

2. Remove the shims, spacer plate, and brass liners from the socket and cap.
3. Thoroughly clean all mating surfaces.
4. Remove one half of the lip seal from either the socket or the cap.
5. Place the ball cap into position on the ball socket.
6. Secure the cap to the socket by installing 4 bolts into the four corners of the cap.
   - The bolt torque should only hold the cap from moving on the socket.



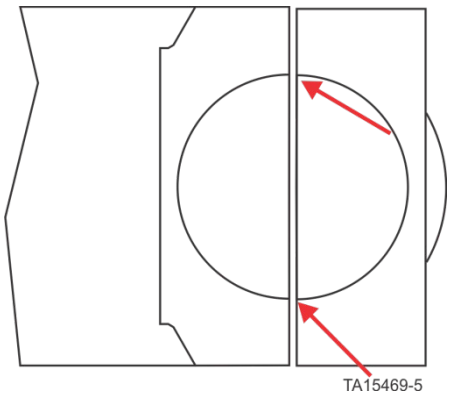
Four corner bolts

Figure 67. Ball cap alignment bolts

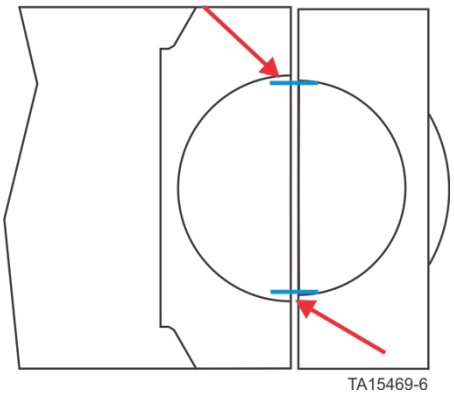
7. Visually inspect the sphere area and note any misalignment of the cap to the socket.
8. Tap the cap into an optimal position that best aligns the sphere of the cap to the sphere of the socket.
   - Use a dead blow hammer.

NOTICE

It is important that the sphere be checked both vertically and horizontally. Typically there will be a slight difference in size between the machined sphere in the socket and cap. If the socket and cap spheres are not the same diameter, the cap should be positioned with an equal step amount in the top, bottom, and side positions.



Optimal cap sphere to socket sphere



Best alignment when the sphere diameters are not equal. Drawing exaggerated to show condition

Figure 68. Cap aligned vertically with the socket

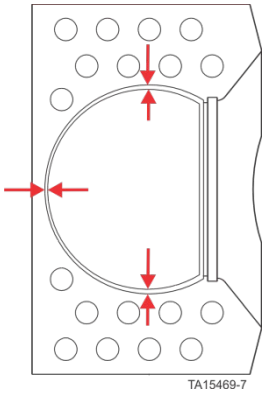
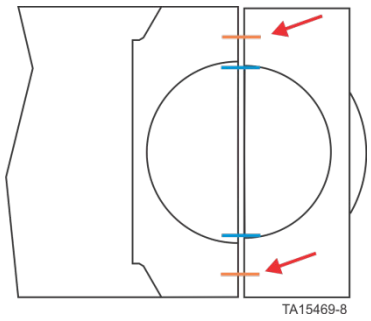


Figure 69. Exaggerated horizontal alignment (arrows showing misalignment between socket and cap)

9. Tighten the four corner bolts with a ¾” air impact gun (approximately 600 to 900 ft lbs).
   - The bolt torque only has to be sufficient to hold the cap from moving relative to the socket when the marks are made with a chisel in the next step.
10. Recheck the alignment between the two spheres.
    - Loosen and re-adjust if the cap moved during the tightening of the bolts.

11. Make two locating marks on top of the cap and the socket.
    - Use a chisel.
12. Make two additional marks on the side of the cap and socket.



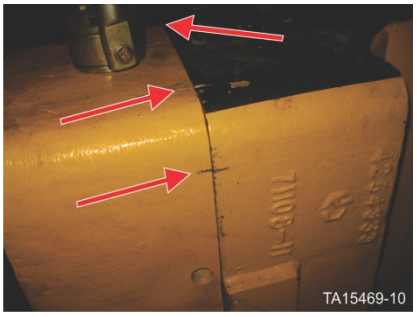


Figure 70. Align the cap sphere visually with the socket sphere and match mark with a chisel

13. Mark the caps left or right to indicate the cap location on the lift arms.
    - Use a letter stamp.

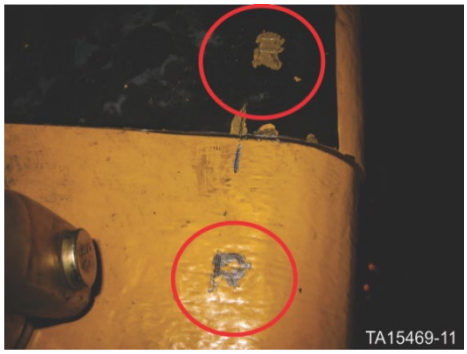


Figure 71. Letter stamp

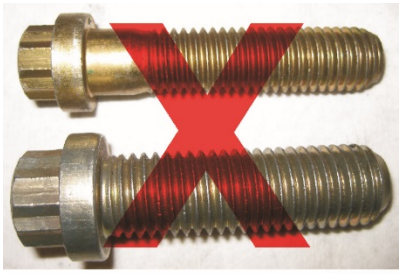
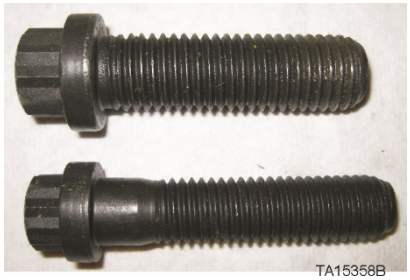
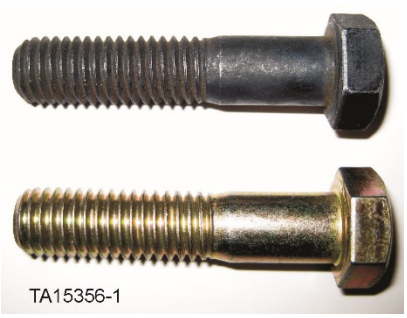
14. Remove the four retainer bolts and reassemble the sockets with the capture plate, shims, and bronze liner on both left and right sides.
15. Re-install the one half of the lip seal that was previously removed.
    - Use a weather strip adhesive (P/N 151-0303).
16. Install the lift arms onto the front frame.
17. Install the ball caps onto the sockets aligning the chisel marks on the cap and socket as close as possible.
18. Torque the ball cap screws.

Capscrew and Bolt-Nut Torque Specifications

There are some exceptions to the torques provided on the following pages. Reduced torques are specified in the planetary drive rebuild manual, for the capscrews holding the planetary drive covers, due to a copper sealing washer under the head of the capscrew.

The torque specifications on this chart apply only to Grade 8 bolts, black or gold colored, and 12PT black-colored alloy steel capscrews. 12PT capscrews with gold-colored zinc chromate plating are excluded from these specifications and the zinc chromate 12PT capscrews should not be used on loaders or dozers. (except for planetary drive covers)

These torque values are for normal routine operations. If doing component rebuilds or any other abnormal machine component assembly/disassembly, please contact the factory for these values for specific instances.

 TA15358A	 TA15358B	 TA15356-1
Does not apply X	12PT Alloy Capscrew ✓	Grade 8 Bolt ✓

NOTICE

Please note the additional tables for exceptions to the torque values for items such as Lift Arm Ballcaps, Super Nuts and steering pin bolts with drilled grease passages.

Please direct any questions to Komatsu Product Support.

Capscrew and Bolt-Nut Torque Specifications Chart

Standard SAE G8 and Alloy Steel and Hex Socket Capscrews

Size	Thread	GRADE 8 Fasteners		Alloy Steel 12PT. and Hex Socket Capscrews	
		USA Units lb-ft	Metric Units N-m	USA Units lb-ft	Metric Units N-m
		**Lubed	**Lubed	**Lubed	**Lubed
1/4 (0.25)	20 UNC	9	13	12	16
	28 UNF	10	14	14	19
5/16 (0.3125)	18 UNC	18	25	24	33
	24 UNF	20	27	27	37
3/8 (0.375)	16 UNC	33	45	45	61
	24 UNF	37	50	50	68
7/16 (0.4375) (* See Note below)	14 UNC	52	71	70	95
	20 UNF	58	79	79	107
1/2 (0.5) (* See Note below)	13 UNC	80	109	108	146
	20 UNF	90	122	122	165
5/8 (0.625)	11 UNC	159	216	203	275
	18 UNF	180	244	230	312
3/4 (0.75)	10 UNC	282	383	361	490
	16 UNF	315	427	403	546
1 (1.0) (*** See Note below)	8 UNC	682	925	872	1182
	14 UNS	764	1,036	977	1325
1-1/8 (1.125)	7 UNC	966	1310	1235	1674
	12 UNF	1083	1468	1385	1878
1-1/4 (1.25) (**** See Note below)	7 UNC	1,363	1,848	1744	2365
	12 UNF	1,509	2,046	1930	2617
1-1/2 (1.5)	6 UNC	2,371	3,215	3033	4113
	12 UNF	2,668	3,618	3413	4628

* **See Special Torque Specifications for ROPS super nut.**

** **See page 4 for specifications for "LUBED" – engine oil on threads and shoulder.**

*** **See Special Torque Specifications for 950/1150 steering pins.**

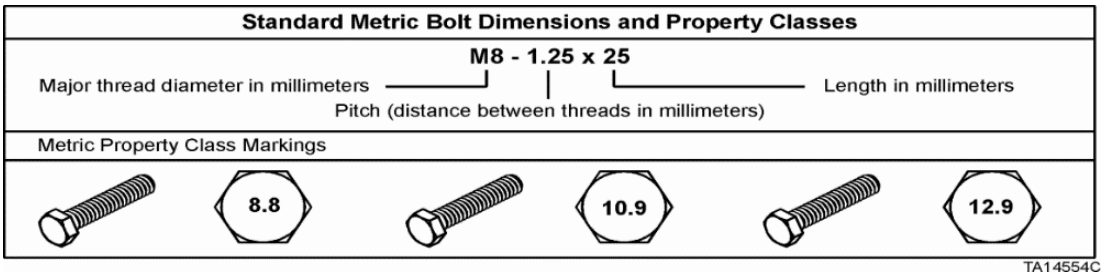
*** **This bolt is UNS (with 14 threads per inch), it is NOT UNF. It is a unique thread count bolt.**

**** **See Special Torque Specifications for loader lift arms and 1350/1850/2350 steering pins.**

Capscrew and Bolt-Nut Torque Specifications

Standard Metric Bolts and Grades (SAE J1701M)

Size (mm)	Pitch (mm)	Property Class 8.8		Property Class 10.9		Property Class 12.9	
		USA Units lb-ft	Metric Units N-m	USA Units lb-ft	Metric Units N-m	USA Units lb-ft	Metric Units N-m
		** Lubed	** Lubed	** Lubed	** Lubed	** Lubed	** Lubed
6	1.00	6	8	8	11	10	13
7	1.00	10	13	14	19	16	22
8	1.25	14	19	20	27	24	32
10	1.50	28	38	40	54	47	63
12	1.75	49	66	70	94	81	110
14	2.00	77	105	111	150	130	176
16	2.00	121	164	173	235	202	274
18	2.50	167	226	239	324	279	378
20	2.50	244	331	337	458	394	535
24	3.00	422	572	584	791	682	925



Capscrew and Bolt-Nut Torque Specifications

Special Torque Specifications

Alloy Steel 12PT. Capscrew for Wheel Loader Lift Arm Ballcaps

Size	Type	Thread	USA Units lb-ft	Metric Units N-m	Application
			**Lubed	**Lubed	
1-1/4 (1.250)	12PT. capscrew F-C on head	7 UNC	1900	2577	LHD, L-950, L-1150, L-1350, L-1850, and L-2350 (Lift arm ball caps only)
1-1/4 (1.250)	12PT. capscrew B-7 on head	12 UNF	1320	1790	L-1000-L-1100 (Lift arm ball caps only)

Steering Pins (Hex Head Bolt)

Size	Type	Thread	USA Units lb-ft	Metric Lubed N-m	Application
			** Lubed	** Lubed	
1 (1.0)	Bolt (drilled center)	8UNC	425	576	LHD, L-950, D-950, L-1150 (Steering Pins)
1-1/4 (1.250)	Bolt (drilled center)	7UNC	850	1152	L-1350, L-1850, L-2350 (Steering Pins)

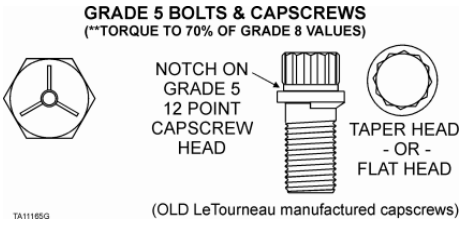
Aluminum 12pt. Capscrews used for Motor Pinion Balancing

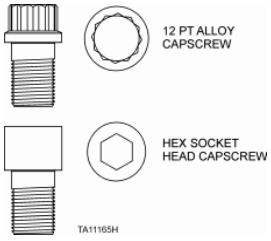
Size	Type	Thread	USA Units (lb-ft)		Metric Units (N-m)	
			Dry	**Lubed	Dry	**Lubed
¾ (0.75)	Aluminum	16 UNF	114	86	155	117
¾ (0.75)	Aluminum 2024-T4	16 UNF	150	113	203	153
15/16 (.9375)	Aluminum 6061 T6	12 NF	217	163	294	221
15/16 (.9375)	Aluminum 2024-T4	12 NF (2 START)	285	214	387	290

2-Thread (2-Start) Steel 12PT. Capscrews

Size	Type	Thread	USA Units lb-ft	Metric Units N-m
			** Lubed	** Lubed
3/8 (.3750)	12PT.	24 NF	25	34
9/16 (.5625)	12PT.	18 NF	87	119
15/16 (.9375)	12PT.	14 NF	428	584
1-5/16 (1.325)	12PT.	12 NF	1216	1660

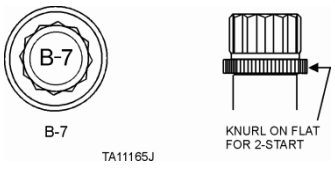
Bolt and Capscrew Markings on Head





Typical Markings on Alloy Capscrew Heads

Typical B-7, 2-Start



** See “Key Items” for specifications for “LUBED” – engine oil on threads and shoulder.

Capscrew and Bolt-Nut Torque Specifications

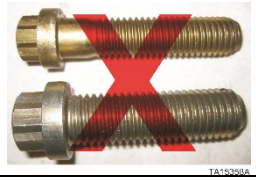
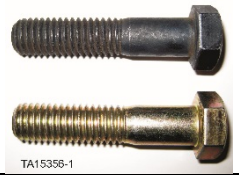
Key Items

- "LUBED" is defined as having the threads and under the head lubricated with engine oil. Engine oil is defined as SAE 30 or 40 weight oil, including multi viscosity grades 5W-30 through 15W-40. No other lubricant (such as anti-seize, MolyKote, copper coat, grease, etc.) is permitted unless specifically called out in a Komatsu procedure.

****LUBED = Lubricated with engine oil on threads and under head**
(SAE 30 or 40 weight oil, including multi viscosity grades 5W-30 through 15W-40)

NOTE: No other lubricant (such as anti-seize, never seize, MolyKote, copper coat, grease, etc.) is permitted unless specifically called out in a Komatsu procedure.

- All capscrews and bolts should be started by hand until a minimum of three (3) threads are engaged prior to any air impact equipment being used.
- If a procedure in a Rebuild Manual, Repair and Overhaul or Operating and Service Manual calls for the use of Loctite® threadlocker on the threads, the torque specification for "lubed" should be used. The threads on both the fastener and mating part should be thoroughly cleaned with a proper solvent prior to use of Loctite®. The Loctite® thread sealant should only be used on the threads - not the head.
- Certain applications in components such as drivers or lift arm ball caps may specify a FERRY brand of capscrew. Use only FERRY brand capscrews in these applications.
- Komatsu, recommends that any old 12PT. Komatsu-fabricated (fabrication was stopped many years ago) capscrew (refer to illustration under BOLT AND CAPSCREW MARKINGS ON HEAD) be replaced at the time of repair with alloy capscrews. If new capscrews are not available, then the Komatsu-fabricated capscrews should only be torqued to Grade 5 specifications (70% of Grade 8 value - lubed).
- The torque specifications on the charts on page 2 only apply to Grade 8 bolts, metric bolts and 12PT. black-colored alloy steel capscrews. Capscrews with gold-colored zinc chromate plating are excluded from these specifications and these capscrews should not be used on loaders or dozers except for driver covers.

		
Does not apply X	**12PT Alloy Capscrew ✓**	**Grade 8 Bolt ✓**

- CLEANING: It is mandatory to remove all paint, rust and debris from all mating surfaces, surfaces under the head of the bolt or capscrew and threads prior to installation and torquing of all bolts and capscrews.

	
Arrow indicates location to be cleaned	**Cleaning paint and rust prior to torquing**

Capscrew and Bolt-Nut Torque Specifications

Super Nut Specifications

Bolt size	Jack bolt size	Jack bolt thread	USA Units lb-ft	Metric Units N-m	Application
			*****Lubed	*****Lubed	
1 ¾" - 5	7/16 (0.4375)	20 UNF	68	92	Hoist Cylinder Rod Pin
2 ¼" – 4.25	½ (0.50)	20 UNF	114	155	ROPS Pin
2 ¾" - 8	**NOTICE** **Refer to Authorized Cylinder Rebuild Center**				Steering Cylinder Piston
*****NOTE:** Supernut jackbolts require P/N 427-3753 Lube JL-G from Superbolt (do not use any substitute)					

Capscrew and Bolt-Nut Torque Specifications

Helpful Tips for Supernuts®

Prior to Tightening:

1) Check threads of main stud: If possible, verify that the tensioners spin on prior to the installation date. If a tensioner is tight or will not thread on, try using lapping compound on the main thread and work the tensioner in a back and forth motion making small advances when the thread loosens up. If necessary, chase the studs with a die.

2) Use of spacers: Tensioners should be positioned at the ends of the studs to minimize exposed threads and facilitate easy access to the jackbolts. A spacer (or stacked washers) can be used beneath the special hardened washer to accomplish this. A spacer will also "step over" a damaged area on a stud where years of bolting have deformed the first few threads.

3) Back the tensioner off before tightening to provide 1/16" (1.59mm) to 1/8" (3.175 mm) gap: The additional jackbolt extension provides easy access for oiling the jackbolt tips prior to removal. This is especially beneficial for oiling when the tensioners are inverted. Note: There may be insufficient jackbolt stroke to allow this step when tensioning exceptionally long bolts or tie rods, or when closing a gap between flanges.

4) For spinning the tensioner on and off the stud: Custom "sockets" which grip the tensioner are available. Also, two deep well sockets inserted over two jackbolt hex's at 180º apart can serve as "handles" for spinning the tensioners on and off the studs.

For Tightening:

5) To improve efficiency when using impacts: Don't wait for the socket to stall completely on a specific jackbolt before advancing to the next jackbolt. It is faster, overall, to move quickly between jackbolts.

6) Overshooting the target torque: You may want to use 110 - 120% of the target torque for Step 3, Step 4, and for 1-2 rounds of Step 5. This may eliminate a tightening round. Be careful not to stabilize all of the jackbolts at this torque however. For long bolts or tie rods, you may want to experiment using even higher torque values. Call Superbolt before using more than 120% target torque.

7) For gasketed joints: During gasket compression, the load is transferred to the jackbolts (i.e. stud) being tightened. Don't be concerned if some jackbolts (or tensioners) become loose during the procedure. Continue following the procedure. Don't spin down tensioners that become loose during gasket compression.

Helpful Tips For Removal

8) 1/4 turn or less!: Removing the jackbolts more than a 1/4 turn will increase the removal torque of the remaining jackbolts and you may get stuck. If this happens, you will have to retighten and start again.

9) Stuck jackbolt **removal:** If a jackbolt will not turn, remove, relube, and retighten a neighboring jackbolt and then try to turn it.

Air Impact Tool Selection (90 PSI (620 kPa) Air Pressure)

NOTICE

The jackbolt torque actually achieved by an air impact wrench is usually only 30 - 50% of its rated output. For minimum hand work, use an air impact with an output of 110% - 120% target torque. For maximum power, use the largest air line fitting.

Up to 70 lbs-ft (311 N•m): For 15-35 lbs-ft (67-155 N•m) use a right angle ratchet or light duty 3/8" impact. For 35-70 lbs-ft (155-311 N•m) use a heavy duty 3/8" impact.

70-100 lbs-ft (311-445 N•m): Use a light duty 1/2" impact at a reduced pressure or setting. (Be careful not to over tighten! Calibrate the impact before starting.)

100-170 lbs-ft (445-756 N•m): For 100-130 lbs-ft (445-578 N•m) use a light duty 1/2" impact. For 130–170 lbs-ft (578-756 N•m) use a heavy duty 1/2" impact.

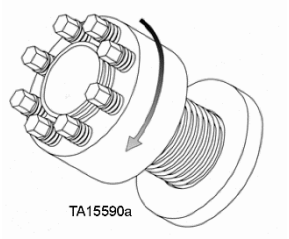
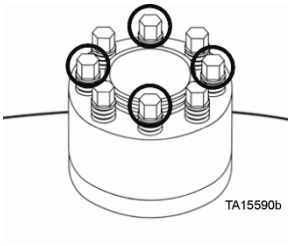
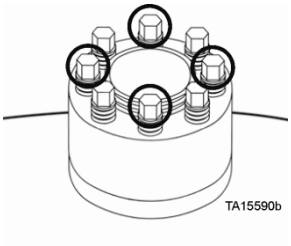
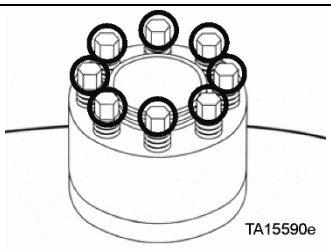
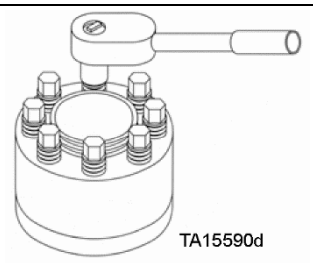
170-200 lbs-ft (756-890 N•m): Use a light duty 3/4" impact on low setting. Some heavy duty 1/2" impacts will also reach this range.

Over 200 lbs-ft (890 N•m): For 200-300 lbs-ft (890-1334 N•m), use a light to medium duty 3/4" impact. Over 300 lbs-ft (1334 N•m), use a heavy duty 3/4" impact.

Calibrating an air impact wrench: Tighten one jackbolt until the socket rotation stops and check the jackbolt with a torque wrench. The torque required to move the jackbolt further is the output of the impact as measured on Superbolt® tensioners.

Capscrew and Bolt-Nut Torque Specifications

Installation Procedure for Supernuts

	**Step 1:** Spin the tensioner onto the main thread until it seats against the washer. You may want to back off the tensioner slightly as mentioned in Helpful Tip #3.
	**Step 2:** Tighten (4) jackbolts at 90º apart (12:00, 6:00, 9:00, and 3:00) on all studs with a partial torque (30-70%). This serves to seat the flange. If using an air impact, use a reduced setting or lightly pulse and trigger at the full setting.
	**Step 3:** At 100% target torque, tighten the same (4) jackbolts on all studs.
	**Step 4:** At 100% target torque, tighten all jackbolts in a circular pattern. Do this for all studs (1 round only). See Helpful Tip #7 about using up to 120% torque.
	**Step 5:** Repeat ‘STEP 4’ until all jackbolts are stabilized (less than 10º rotation). This usually requires 2-4 additional passes. If using air tools, switch to a torque wrench when socket rotation is small. Use the torque wrench to stabilize at the target torque.

NOTICE

Product with 4 or 6 jackbolts – use a star pattern for all steps.

Capscrew and Bolt-Nut Torque Specifications

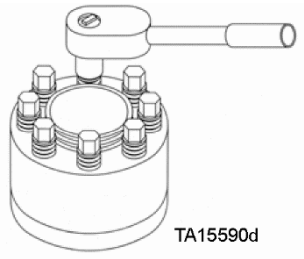
Removal Procedure for Supernuts

CAUTION

Jackbolts must be unloaded gradually. If some jackbolts are fully unloaded prematurely, the remaining jackbolts will carry the entire load and may be hard to turn. With extreme abuse, a jackbolt tip can deform, making removal difficult.

Service Under 250ºF (121ºC)

Preparation: Spray jackbolts with penetrating oil or hydraulic oil prior to start (especially if product is in corrosive environment)



Step 1: Loosen each jackbolt 1/8 turn following a circular pattern around the tensioner (1 round only). As you move around and get back to the first jackbolt, it will be tight again. Do this for all studs on the joint prior to the next step.

Step 2: Repeat a 2nd round as above for all studs, now loosening each jackbolt ¼ turn in a circular pattern.

Step 3. Continue loosening ¼ turn for 3rd and successive rounds until all jackbolts are loose.

NOTICE

Usually after the 3rd or 4th rounds, an impact can be used to completely extract the jackbolts, one by one. For long bolts or tie roads, additional rounds may be required before removing the jackbolts with an impact tool.

Step 4 Remove, clean and relubricate the jackbolts prior to next use with correct Superbolt lubricant (JL-G) Komatsu P/N 427-3753 (do not use any substitute).

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