Metso

Nordberg HP300 Cone Crusher

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Original instructions

INSTRUCTION MANUAL

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Contents

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1 About this manual

1.1 Purpose and scope

This instruction manual is intended for personnel involved in installation and commissioning, for maintenance personnel and for machine operators. It provides information on the HP300 crushers.

This manual gives rules and recommendations which help ensure that the machine is used safely and effectively.

Read the manual and all recommendations for the unit to ensure that it is operated safely.

Failure to observe the safety recommendations and warnings in the manual and on the machine, and/or using it for a purpose other than those recommended in the manual may result in damage to the machine and/or in injuries.

Keep this manual with the machine or in a location which can be easily accessed at any time.

Ensure that all personnel involved in the use of this machine can periodically consult the manual.

If the instruction manual is lost or damaged, then contact Metso or their agent to obtain a new one.

Always use Metso components and parts to avoid breakdowns and to prevent any risk of injury.

1.2 Safety and warning symbols

In Metso documentation, dangers, warnings, and cautions are used when it is necessary to take special precautions to avoid a potential hazard.

According to the ISO 3864 standards, warnings are divided into three groups according to the hazard severity and the level of risk or harm.

⚠ DANGER

DANGER!

HAZARD TYPE

Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.

⚠ WARNING

WARNING!

HAZARD TYPE

Indicates a hazardous situation which, if not avoided, can result in death or serious injury.

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⚠ CAUTION

CAUTION!

HAZARD TYPE

Indicates a hazardous situation which, if not avoided, can result in moderate injury or property damage.

A danger is used to alert the user to an imminently hazardous situation that could result in death or serious injury.

Warnings concern, for example, information about dangerous voltages or actions that could result in bodily harm or injury.

A caution is used to alert the user to precautions needed to avoid hazard, which, if not avoided, could results in minor or moderate injury, or damage to the product or system.

Cautions concern, for example, damage caused by electrostatic discharge.

The general shape and color of the safety symbols used with danger, warning, and caution is defined in ISO 3864-1.

Table 1: Hazard symbols

Symbol type	Usage
	Warning
	Prohibition
	Mandatory action

1.3 Reading and storing the IOMS manual

Before you use the equipment, carefully read the manual, and make sure that you understand all safety precautions.

After reading the manual, keep it in a convenient place for easy reference for all personnel who use the equipment.

If one or more documents are damaged or lost, order a new copy from Metso.

Contact your nearest Metso Service Center or our head office (see *www.metso.com*).

Please note that the replacement copies may be liable to charge.

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2 Description of equipment

2.1 Product identification

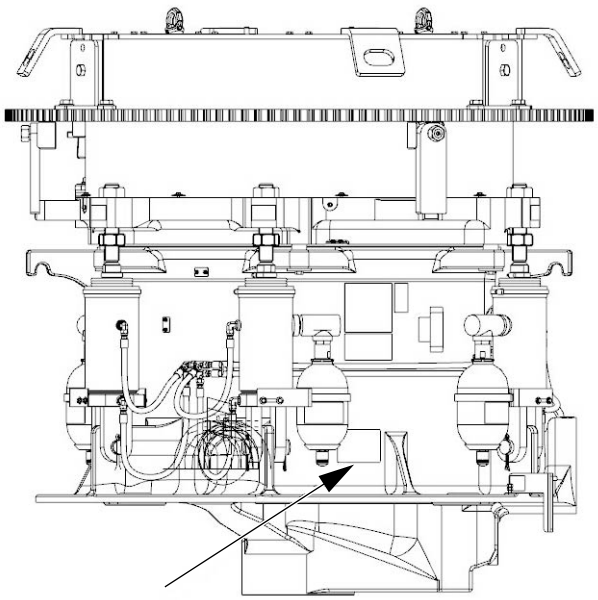

Figure 1. Location of the machine identification plate

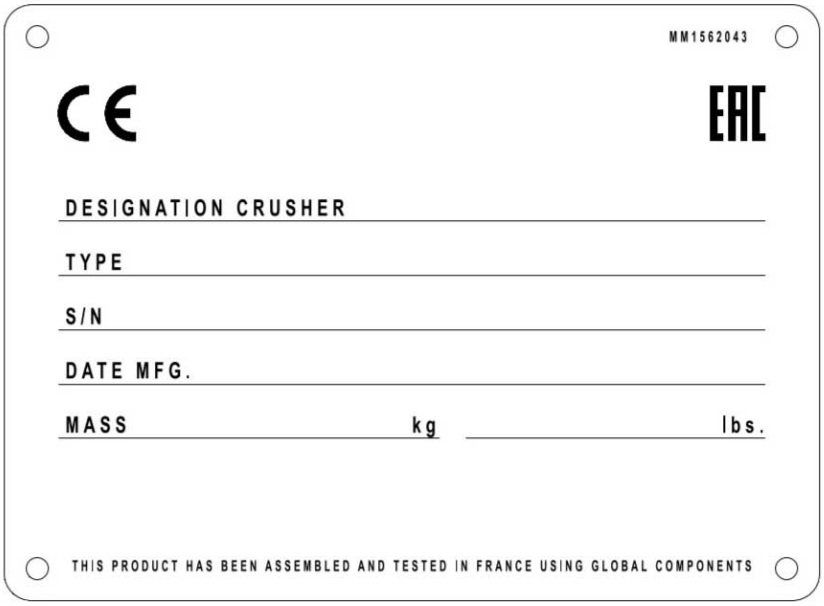

Figure 2. Machine identification plate

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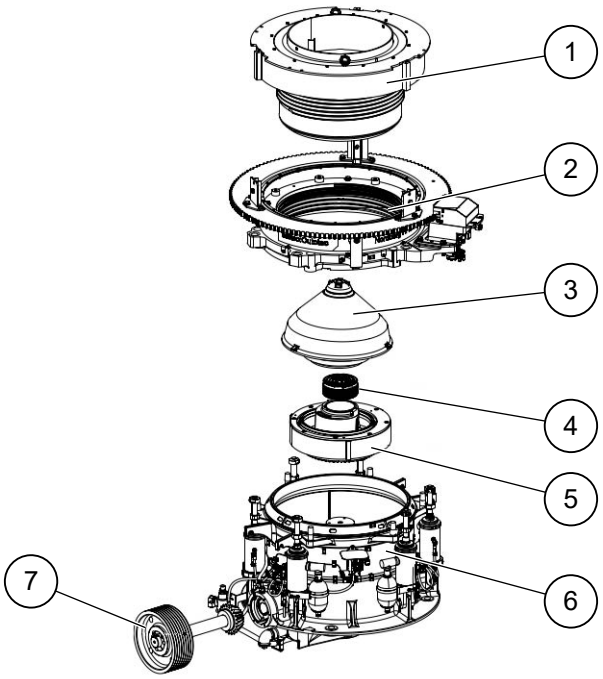
NOTE: Do not remove or modify the machine identification plate

2.2 Intended use

This crusher is only designed to crush rocks.

2.3 Main components



1. Bowl assembly
2. Adjustment ring and adjustment gear assembly
3. Head assembly
4. Socket assembly
5. Eccentric and counterweight assembly
6. Main frame and tramp release assemblies
7. Pulley and countershaft assemblies

Figure 3. Main components

2.4 Technical data

Table 2: Cavity settings and data

		STD EC	STD C	STD M	STD F	SH C	SH M	SH F	SH EF	NF	SC
Max feed size	**mm**	264	233	246	222	184	172	147	131	144	235
	in	10.39	9.17	9.7	8.76	7.26	6.76	5.8	5.16	5.67	9.25

Min setting	**mm**	25	25	17	13	10	6	5	5	13	13
	in	0.98	0.98	0.66	0.51	0.39	0.24	0.2	0.2	0.51	0.51
Max setting	**mm**	64	64	66	77	73	76	77	76	77	77
	in	2.52	2.52	2.6	3.05	2.87	2.98	3.03	2.99	3.03	3.03
Countersh aft speed	**RPM**	850	850	950	950	1050	1050	1050	1050	1050	1050

2.5 Terminology

To avoid any misunderstanding, all the most important terms used throughout this manual are defined below.

- **Capacity (output / yield / throughput):** Crusher output expressed in tons per hour (TPH).
- **Closed-circuit operation:** When regular product size matters; the product is screened at the crusher outlet and oversize particles are redirected to the crusher.
- **Closed side setting (CSS):** The distance between the bottom of the bowl liner and the mantle at the point where they are the closest to each other during gyration. This determines the size of the crushed product.
- **Crushing chamber (or cavity):** The inner area enclosed by the bowl liner and mantle.
- **Discharge opening:** The distance between the bottom of the liner and the mantle in open position during gyration. This enables rapid discharge of the crushed material.
- **Feed (or infeed):** The raw material that is to be crushed.
- **Feed opening (closed side):** The smallest distance between the top of the working wears as measured when they are at the closest to each other during the gyrating cycle.
- **Feed opening (open side):** The largest distance between the top of the working wears as measured when they are at the farthest to each other during the gyrating cycle (diametrically opposed the feed opening closed side).
- **Liners:** The bowl liner and mantle are the working wears in contact with the material. The bowl liner is fixed in the bowl and the mantle on the head.
- **Minimum closed side setting (CSS):** The shortest permissible distance between the bottom of the bowl liner and the mantle when they are closed.
- **Open-circuit operation:** When regular product size does not matter, the product only passes through the crusher once.
- **Parallel zone:** When the bowl liner and the mantle are the closest to each other during gyrating cycle, their lower portions are parallel over a short distance.
- **Product size:** Size of the screened product after crushing.

3 Safety

3.1 Crusher safety instructions

The following chapters of the instruction manual illustrate only basic safety procedures. Additional precautions may be necessary for the safe operation of a crusher. The information contained in this manual is not intended to replace safety codes, insurance requirements, federal, state and local laws, rules and regulations.

Safety of the operator and maintenance personnel is of prime concern.

These paragraphs are presented as a helpful guide to construction equipment personnel and shows some of the daily work problems which they may encounter.

It is the responsibility of the operator to know what specific requirements, precautions and work area hazards exist and to discuss them with his supervisor. A common understanding should be reached by all personnel to assure safe performance in operating the equipment.

The operator is the key to safe job performance and should study these safety tips to be aware of basic safety precautions to help prevent serious injury and damage to property.

3.1.1 Limits of use

The use of this crusher any other purpose other than those described in this document is prohibited.

3.1.2 Personnel qualifications

3.1.2.1 Lock out, tag out and try out procedure

Only competent personnel can perform a lock out, tag out and try out procedure. All isolations must be planned and documented.

A list of all control points specific to that equipment shall be incorporated into the lock out procedure for that equipment. Each Metso site shall maintain a list of equipment requiring LOTOTO.

Inform operations personnel and other people in the area that a lockout procedure is under way.

Turn off the equipment and disconnect from all energy sources. All devices such as switches and valves are located and listed.

Lock out all energy sources by using locks.

Only attach your personal lock under the authorization of the isolating person.

Never alter or tamper with another worker’s personal lock or isolation equipment.

Tag the lock with contact details as a warning not to turn on the equipment.

Release any residual energy (e.g. mechanical, electrical, hydraulic or air pressure).

Test the machinery by available local controls to ensure that power is disconnected. Switches are turned on, then off again.

Perform work according to the method statement/work permit.

Remove your locks and tags when the work is completed and inform co-workers and other operations.

3.1.2.2 Working at heights

Construct, use and maintain fixed platforms and access equipment (such as fixed ladders, stairways and scaffoldings) in accordance with local regulations.

Where there is a risk of falling from a height of one (1) meter or more from a permanent workspace, the workspace must be equipped with handrails.

All holes and openings (including roof windows) shall be covered or isolated by a hard barrier at least 1 meter high.

Never use an unsupported ladder.

Where there is a risk of falling from a height of two (2) meters or more, fall prevention must be used. All equipment for working at heights must be inspected prior to use.

When using a person lift or any other people-lifting device, the use of a safety harness is mandatory. Attachment points must be available.

All personnel working at heights must be competent.

Consider rescue plans if necessary; if that is the case, working alone is not allowed.

3.1.2.3 Lifting

Only trained and authorized personnel are allowed to operate lifting devices and accessories.

Inspections and maintenance of all lifting equipment must be documented.

Follow local procedures for standard lifts.

Written lifting plan is required for complicated lifts.

Coordinate lifting operations with other ongoing activities.

The weight and center of gravity of the lifted equipment must be known. Refer to the transportation drawing.

The maximum lifting capacity of devices or accessories shall not be exceeded.

Loads are never to be lifted over people and the safety distance must always be kept when guiding lifted loads.

Modified or handmade lifting tools are not allowed unless they are engineered (approved by authorized person).

3.1.2.4 Confined spaces

Plan the work and assess the risks. Prepare the tools and equipment, such as sufficient lighting, warning signs, PPE and evacuation plan.

Only competent and authorized personnel can enter a confined space.

There must be a competent rescue person outside the confined space to keep a head count and to rescue in case of emergency.

Isolate the space and lock out, tag out & try out if necessary.

Test the atmosphere for gases and contaminants.

Ensure continuous ventilation.

Mark out the entry to the space and keep evacuation routes clear.

An entry permit mentioning necessary PPE (e.g. supplied air respirator, retrieval harness, communications system, spark-proof lighting, life-line and test devices) is required.

3.1.2.5 Operating tools, equipment and machinery

Tools and equipment are to be risk assessed to ensure that they are suitable for the work task, well maintained and safe to use.

Operators must be trained in usage and provided with authorization according to local regulations. Operating instructions must be available for the operator.

Manufacturer’s specifications and design limitations must be obeyed.

Inspections and maintenance must be documented.

Controls shall exist to ensure that tools and equipment are in good working order before use. Any damaged or broken equipment shall be tagged “out of service” and removed from operation.

Machines must be guarded on all points that expose a person to injury. Guarding must conform with appropriate standards or, in the absence of such standard, designed and constructed to prevent a person from having any part of the body exposed to injury during machine operation.

All machines must have a clearly marked emergency stop button. Deliberately disabling an emergency stop button is considered sabotage.

3.1.2.6 Working with hazardous substances

Hazardous substance is any substance or mixture of substances which, upon release into the atmosphere, water, or soil, or which, in direct contact with the skin, eyes, or mucous membranes, cause health risks to humans or animals through absorption, inhalation, or ingestion. The concept includes safe handling, transportation, and storage of these substances. Any local legal requirements regarding hazardous substances should be regarded as well.

Chemical registers are to be maintained at all locations. Safety Data Sheets shall be required from suppliers before use and made available for all employees in the local language.

Risk assessments are done before using a chemical (for example with regards to storage, labels and signage according to GHS, instructions for handling, usage, and disposal, emergency response, PPE).

Only trained and competent personnel can use hazardous substances.

Hazardous substance storage shall be well ventilated, without risk of spills or leaks and lockable with controlled access. Observe also the following:

- Chemicals and leaks of chemicals that can react with each other must be kept separated
- Flammable or explosive products should be kept separate from other chemicals or ignitable goods

Chemical disposal is controlled according to Safety Data Sheet and local regulations.

Radiation level is monitored for all materials containing metal, such as:

- Incoming material regardless of its origin and formation
- Material used in the products delivered to clients in any formation

All service teams must have their own handheld radiation meter and measure the radiation level of customer sites and equipment prior to any work.

3.1.3 Personal protective equipment

The following PPE shall be used in all Metso production facilities, workshops, warehouses and at customer sites:

- Safety glasses
- Ear protection (for over 85 dB)
- Work wear/high visibility vest
- Protective footwear (unless you are a visitor within marked out areas)

- Safety helmet (at construction sites and in foundries)

If the customer has a higher safety standard than Metso, then the customer standard applies.

Always check the functionality and use-by-date of your equipment before working.

All PPE shall conform to product safety standards (e.g. CE marked, ANSI marked). Never modify any PPE and wear them correctly.

3.1.4 Fire hazards

Do not smoke while refueling or when handling fuel containers. Shut off the engine when refueling and use extra caution if engine is hot. Ground the funnel or spout against the filter neck to avoid static electric spark, when pouring fuel into the tank.

Do not use gasoline or diesel fuel for cleaning parts. Good commercial, non-flammable solvents are preferred. Do not smoke while using cleaning solvents.

Do not let greasy, oily rags accumulate in a poorly ventilated area. Store oily rags and other combustible material in a safe place.

Never use an open flame to check fuel, battery electrolyte or coolant levels or to look for hydraulic leaks anywhere on the equipment. Use a flashlight!

Know where the fire extinguishers are kept, how they operate and for what type of fire they are used. Check fire extinguishers regularly - at least monthly - to be sure they are in the working area.

3.1.5 Noise hazards

DANGER

NOISE HAZARD

Will cause permanent hearing damage.

The noise level near the machine exceeds 85 dB(A). Wear appropriate ear protection.

Crushing equipment is noisy and the auxiliary equipment in and around crushing equipment such as chutes, transfer stations and screens can be even noisier than the crusher itself.

Typical crusher acoustic power level while crushing is between 100 and 130 dB(A).

Ear protective devices may be required if noise levels are higher than those allowed by law.

The operator can see the equipment in operation and still be protected from the noise through the installation of acoustical tile, double windows, air conditioning equipment, or similar.

3.1.6 Dust emission hazards

⚠ DANGER

DUST HAZARD

Can cause death or serious injury.

Machines and their auxiliary equipments can generate dust. Breathing dust will affect the health of people working on or around the crusher. Wear protective mask.

High levels of dust in the air create a hazard of lung disease, depending upon the concentrations of dust, the length of exposure, and the type of material being crushed.

It is the responsibility of the operator to determine the necessity and adequacy of protective devices and warnings, to provide them, and to ensure that they are used and followed.

It is possible to reduce the amount of airborne dust by making alterations to the crushing circuit, such as the addition of a dust collection system, or the use of water spray bars at the feed and/or discharge conveyor. Machines can also be optionally equipped with cowlings that contain dust inside the machine.

For further information, contact Metso.

3.1.7 Safety devices and guards

Proper safety precautions start with the initial installation of the crusher.

Crushers are driven either by V-belts or by direct couplings to motors. The belt drive or coupling must have a protective guard around it.

Crusher sheaves in particular are designed for maximum rim speeds. If these speeds are exceeded, it is possible that the sheave could explode and cause severe injury or even death.

Since the speed of the crusher is important for proper operation, most V-belt drive guards usually have a small opening immediately opposite the center of the crusher drive shaft so that a tachometer can be inserted to occasionally check the speed of the counter-shaft. This opening should be covered with an access door or hatch.

3.1.8 Safety labels and instruction signs

⚠ DANGER

GENERAL HAZARD

Will cause death or serious injury.

Do not use other labels on this machine, expect the ones shown in the manual.

Replace illegible or loose labels immediately.

The figures and table below show the location of safety labels and instruction signs (ISO and ANSI) and explain their meaning.

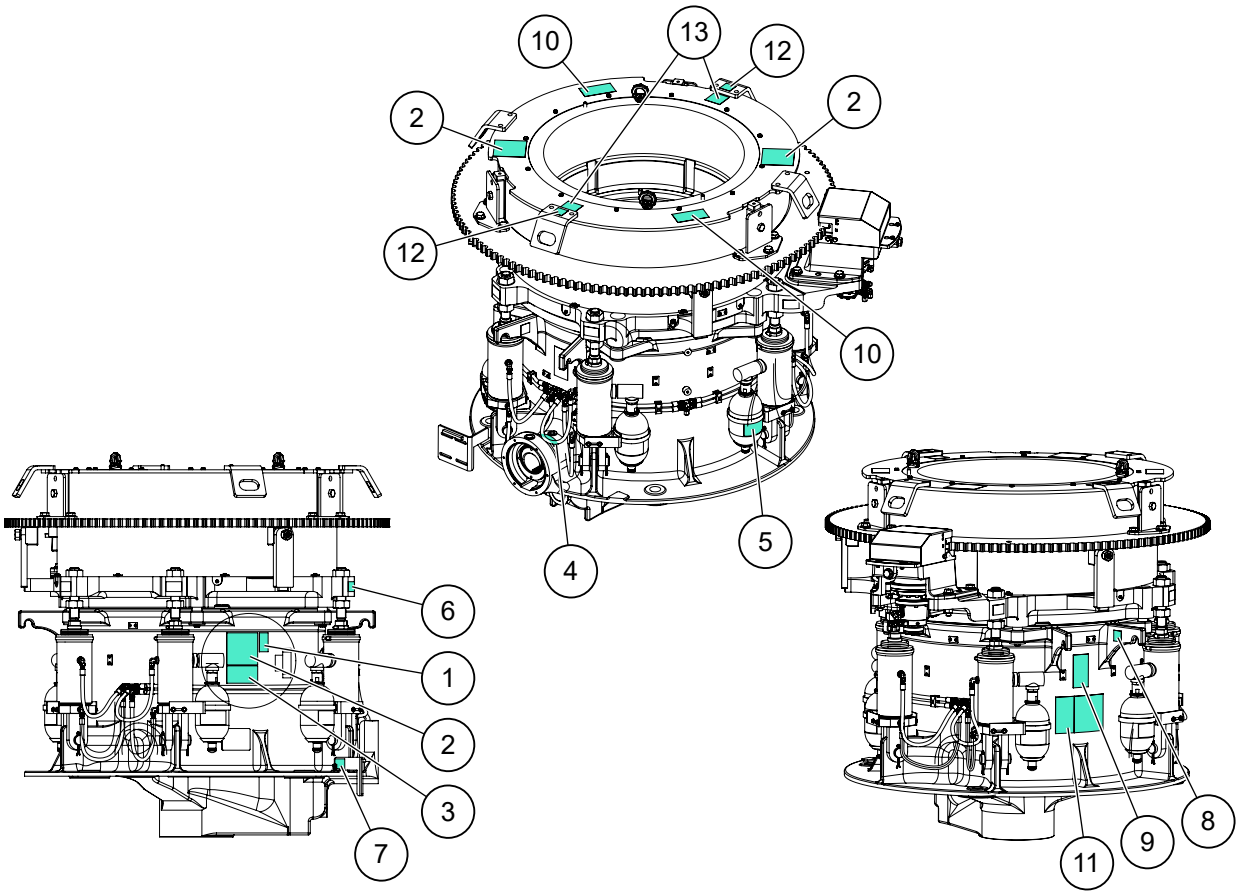


Figure 4. Location of the ISO safety labels

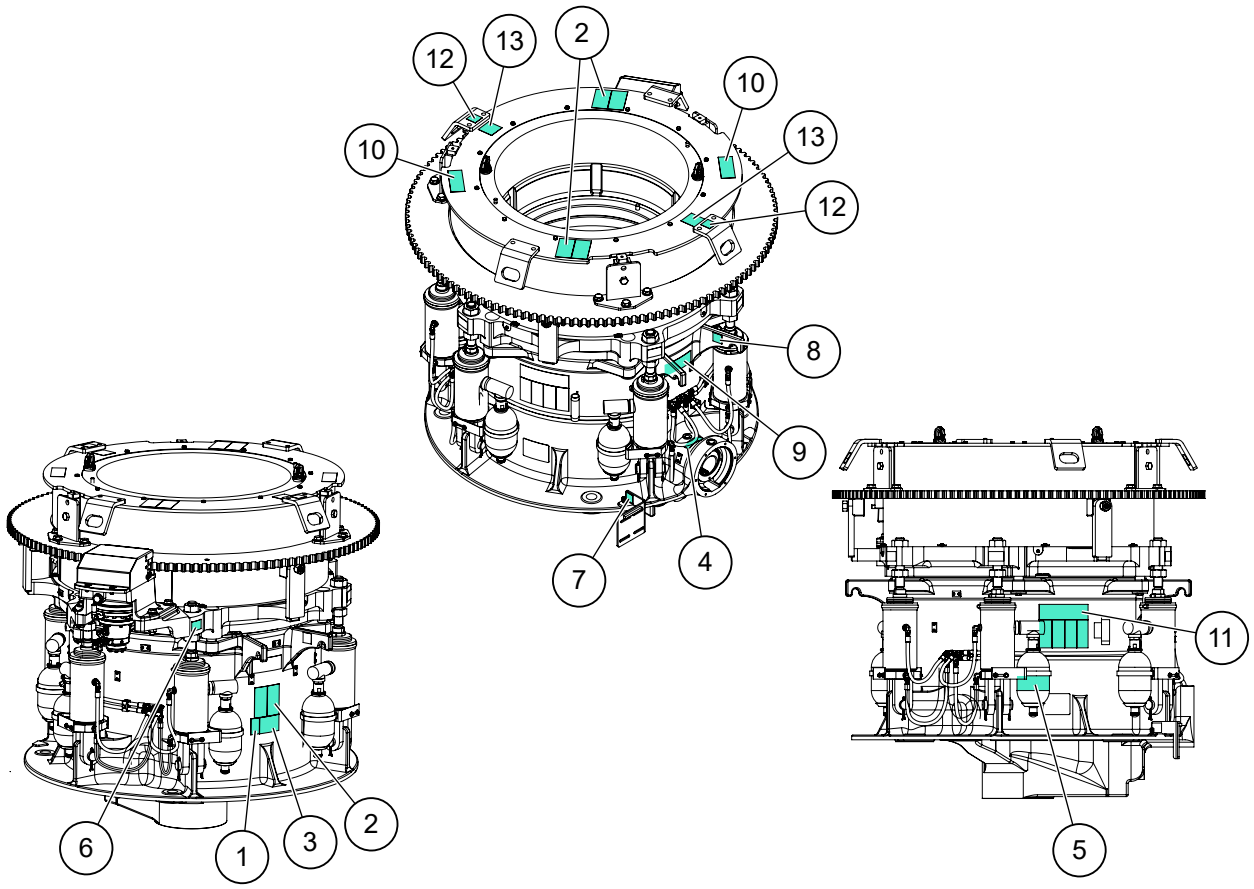


Figure 5. Location of the ANSI safety labels

Table 3: Safety labels

Callout	ANSI	ISO
1		
	WARNING: Servicing while pressurized can cause severe injury. Lock out source and relieve pressure before servicing. Item: MM0230002	**WARNING**: Servicing while pressurized can cause severe injury. Lock out source and relieve pressure before servicing. Item: MM0250241

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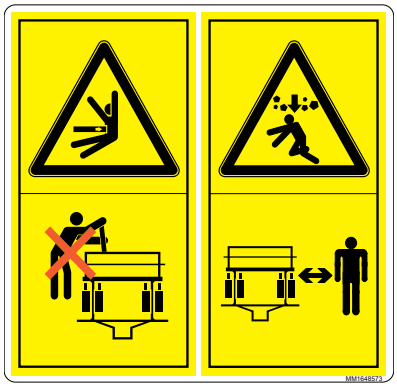
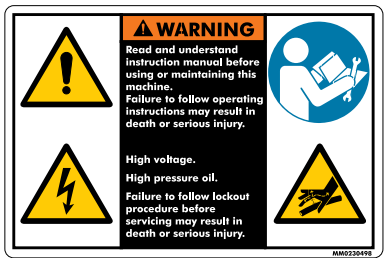
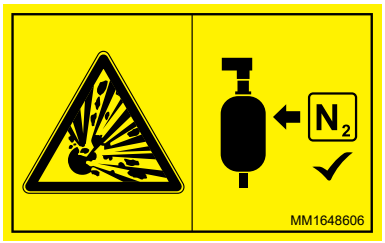
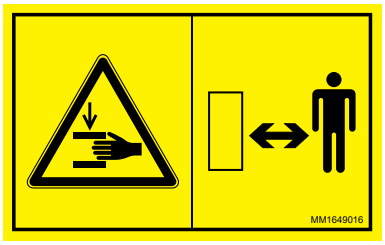
Callout	ANSI	ISO
2		
	DANGER: Moving parts can crush and cut. Do not insert tools in the crusher cavity when the motor is running. **WARNING**: Material can fall out. Do not stand in the vicinity of the crusher when the motor is running. Item: MM0229995	**DANGER**: Moving parts can crush and cut. Do not insert tools in the crusher cavity when the motor is running. **WARNING**: Material can fall out. Do not stand in the vicinity of the crusher when the motor is running. Item: MM1648573
3		
	WARNING: Read and understand instruction manual before using or maintaining this machine. Failure to follow operating instructions may result in death or serious injury. High voltage. High pressure oil. Failure to follow lockout procedure before servicing may result in death or serious injury. Item: MM0230498	**CAUTION**: Lock out the main switch before servicing the machine. Item: MM0367651
4		
	Direction of the rotation of the motor	Direction of the rotation of the motor

Callout	ANSI	ISO
5		
	DANGER: Charge accumulator with nitrogen only. Any other gas or air may cause explosions. Item: MM0447440	Nitrogen only Item: MM1648606
6		
	DANGER: Crush hazard. Stay away during clearing operation. Follow instructions in the instruction manuals to use security shims. Item: MM1648982	**DANGER**: Crush hazard. Stay away during clearing operation. Follow instructions in the instruction manuals to use security shims. Item: MM1649016
7		
	Earthing point Item: MM1648698	Earthing point Item: MM1648698

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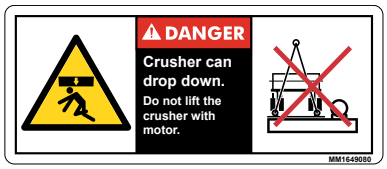
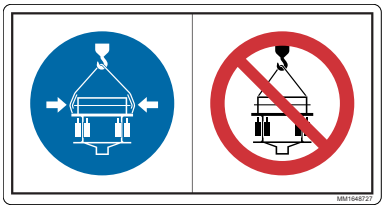
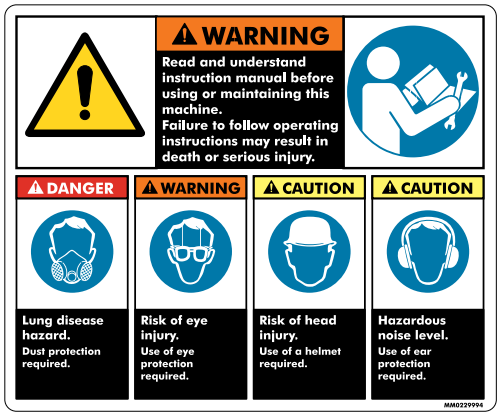
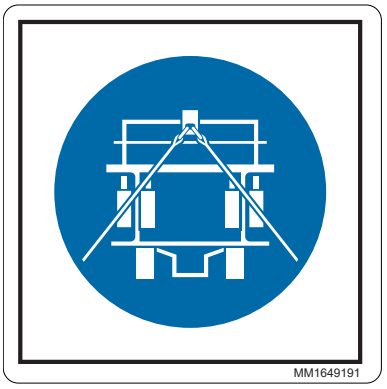
Callout	ANSI	ISO
8		
	Lifting point Item: MM1222784	Lifting point Item: MM1222784
9		
	DANGER: Crusher can drop down. Do not lift the crusher with the motor. Item: MM1649080	**DANGER**: Crusher can drop down. Do not lift the crusher with the motor. Item: MM1649044
10		
	DANGER: You must sling the crusher using the identified lifting points on the main frame Item: MM1648735	**DANGER**: You must sling the crusher using the identified lifting points on the main frame Item: MM1648727

Callout	ANSI	ISO
11		
	WARNING: Read and understand instruction manual before using or maintaining this machine. Failure to follow operating instructions may result in death or serious injury. **DANGER**: Lung disease hazard. Dust protection required. **WARNING**: Risk of eye injury. Use of eye protection required. **CAUTION**: Risk of head injury. Use of a helmet required. **CAUTION**: Hazardous noise level. Use of ear protection required. Item: MM0229994	**WARNING**: Read and understand instruction manual before using or maintaining this machine. Failure to follow operating instructions may result in death or serious injury. **DANGER**: Lung disease hazard. Dust protection required. **WARNING**: Risk of eye injury. Use of eye protection required. **CAUTION**: Risk of head injury. Use of a helmet required. **CAUTION**: Hazardous noise level. Use of ear protection required. Item: MM0250258
12		
	Tie-down point. Use this point to tie down the machine. Item: MM0358522	Tie-down point. Use this point to tie down the machine. Item: MM0358522

Callout	ANSI	ISO
13		
	Fixing cables for transportation Item: MM1649191	Fixing cables for transportation Item: MM1649191

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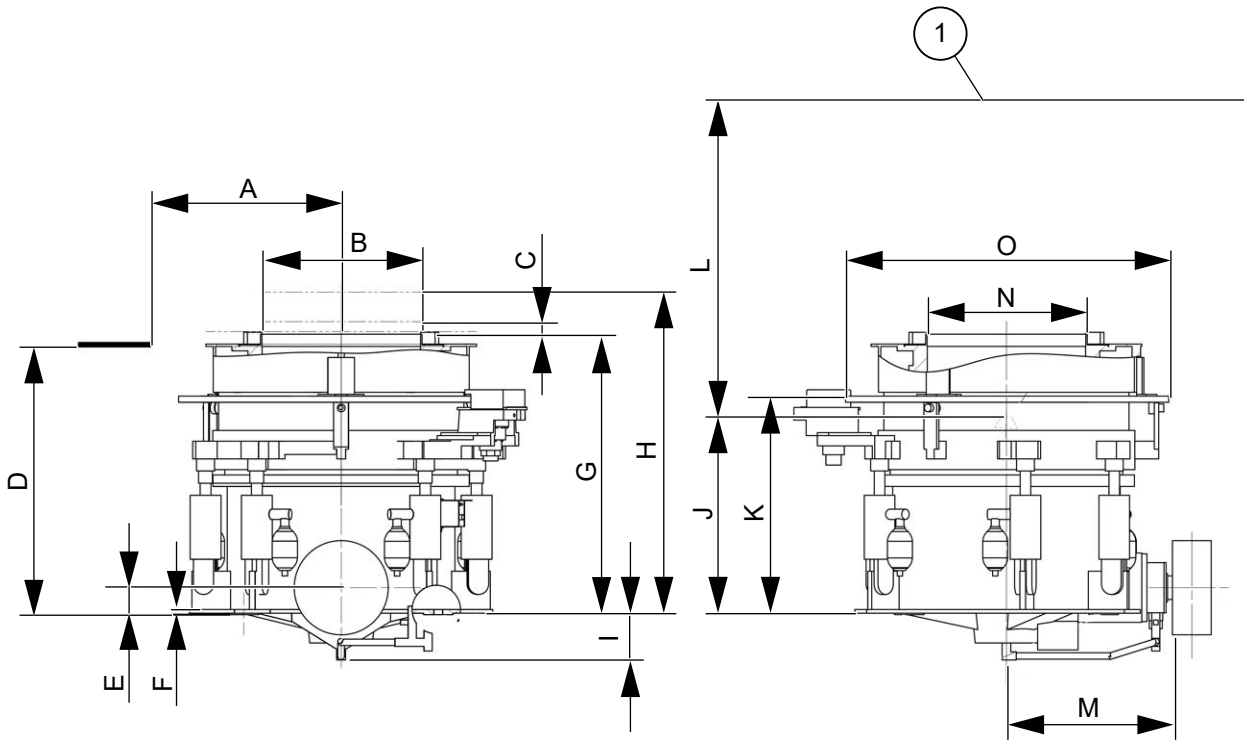
4 Transportation and storage

4.1 Dimensions and weights



1. Maximum drop height for feed materials
A. 1300 mm (51.17")
B. 1077 mm (42.42")
C. 85 mm (3.35")
D. 1820 mm (71.65")
E. 183 mm (7.20")
F. 35 mm (1.38")
G. Max. 2001 mm (78.78") / Min. 1903 mm (74.92")
H. 2188 mm (86.14")
I. 307 mm (12.10")
J. 1345 mm (52.95")
K. 1483 mm (58.39")
L. 1500 mm (59.06")
M. 1128 mm (44.42")
N. Ø Max. 1200 mm (47.24") / Ø Min. 1100 mm (43.31")
O. 2197 mm (86.50")

Figure 6. Main dimensions of the crusher

Table 4: Weights of the crusher and main assemblies

Item	kg	lbs
Crusher	16400	36080
Bowl assembly	3070	6788
Bowl liner	831	1828
Head assembly	2265	5985

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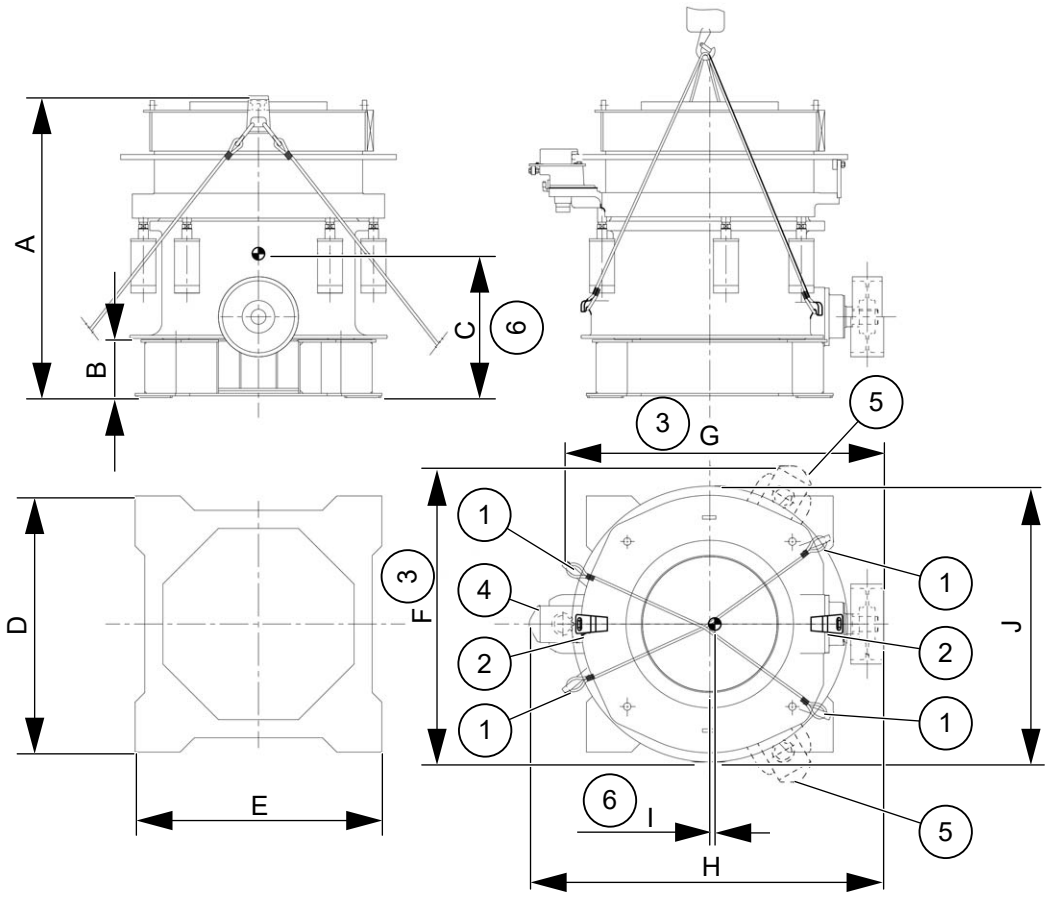
Item	kg	lbs
Eccentric assembly	1154	2544
Counterweight assembly	577	1270
Crusher pulley assembly	206	454
Mantle	904	1993
Feed cone	18	40
Socket	53	117
Cylindrical hopper	237	523
Conical hopper	450	993
Cylindrical feed extension (option)	73	161
Conical feed extension (option)	120	265

4.2 Transportation



A. 2145 mm (95.1")
B. 464 mm (18.3")
C. 1152 mm (45.4")
D. 2050 mm (80.7")
E. 1975 mm (77.8")
F. 2368 mm (93.2")
G. 2572 mm (101.3")
H. 2836 mm (111.7")
I. 40 mm (1.6")
J. 2207 mm (86.9")

1. Lifting point (green painting)
2. Two diametrically opposed tie-down points (yellow painting)
3. Dimension for the positions 5 of motoreducer
Weight maximum: 16.65 ton (18.19 short ton)
4. Bulkiness volume (position 4): 15.1 m3 (19.7 cu.yd)
5. Bulkiness volume (position 5): 14.7 m3 (19.22 cu.yd)
6. Gravity center position : ±40mm (±1 9/16")

Figure 7. Transport without subframe

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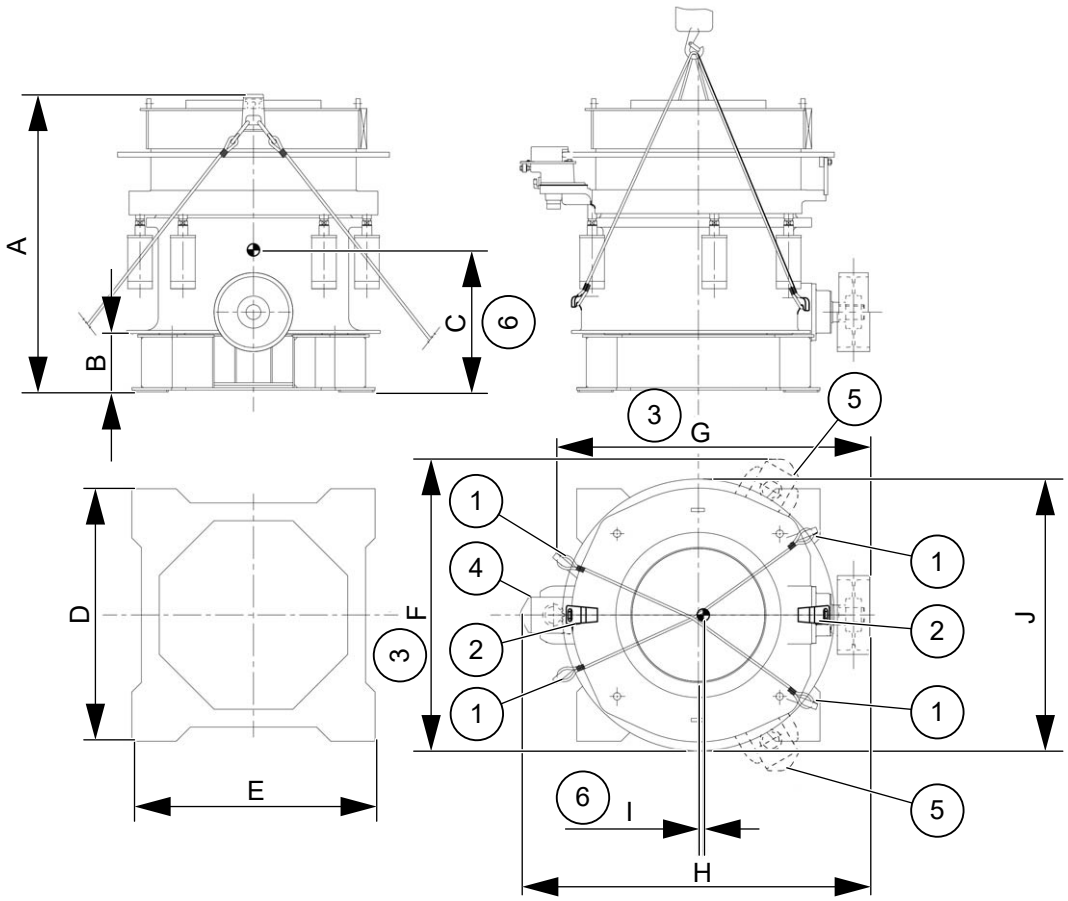

A. 2415 mm (95.1")
B. 464 mm (18.3")
C. 1152 mm (45.4")
D. 2060 mm (80.7")
E. 1975 mm (77.8")
F. 2368 mm (93.2")
G. 2572 mm (101.3")
H. 2836 mm (111.7")
I. 40 mm (1.6")
J. 2207 mm (86.9")

1. Lifting point (green painting)
2. Two diametrically opposed tie-down points (yellow painting)
3. Dimension for the positions 5 of motoreducer
Weight maximum: 16.65 ton (18.19 short ton)
4. Bulkiness volume (position 4): 15.1 m3 (19.7 cu.yd)
5. Bulkiness volume (position 5): 14.7 m3 (19.22 cu.yd)
6. Gravity center position : ±40mm (±1 9/16")

Figure 8. Transport with subframe

4.3 Storage

To protect the crusher from rust corrosion during seasonal shutdown, for foreign shipment or outdoor storage (winter or summer), follow these protective measures:

1. Remove the bowl, head, socket and eccentric assemblies. Disconnect the oil drain line and the oil pressure inlet from the crusher. Ensure that all the piping and holes on the crusher are sealed with pipe plugs.

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2. Use a wide paintbrush to coat all the inside surfaces of the main frame with rust preventive oil. Use a lubricant with a rust prevention agent designed for the protection of internal parts of enclosed assemblies such as combustion engines, compressors, pumps, reduction gears and hydraulic assemblies.
   In most applications, the residual protective film left by such products does not need to be removed when the crusher is refilled with oil and restarted. Usually, 200 litres are sufficient to coat the crusher. Oil viscosity factor should be between 32 to 66 cSt at 38°C.
3. Use the paintbrush to coat the lower thrust bearing, the main shaft and the pinion with rust preventive oil. Disconnect the countershaft oil feed hose from the top of the countershaft to fill the countershaft with oil while rotating it. A light oil leak may occur at the end of the countershaft, this is perfectly normal. Reconnect the oil feed hose to the countershaft.
4. Fill the lubricating hole in the main shaft with oil, then drain.
5. Coat the eccentric, the eccentric bushing, the bevel gear and the upper thrust bearing with rust preventive oil.
6. Coat the head ball, head bushings and all areas of the head next to the seal with a rust preventive agent.
7. Reinstall the eccentric and socket assemblies in the crusher. Coat the socket and socket liner's exposed surfaces with a rust preventive agent. Install the head assembly and the feed cone.
8. Drain the hydraulic unit tank and refill it with a similar rust preventive oil having a viscosity of 32 cSt at 38°C. Make sure the oil used in the hydraulics is compatible with materials used, such as Neoprene rubber, polyurethane, bronze, nickel, chromium-plated, steel and cast iron. Start the hydraulic system in order to fill with rust preventive oil all the hydraulic components (retaining and clamping cylinders and hydraulic motor).
9. Brush or spray a light-bodied petroleum solvent containing a substantial amount of a polar rust preventive additive having strong attraction for metal surfaces all the machined surfaces of assemblies like bowl, adjustment ring, clamping ring and threads. Then cover the threads with a liberal amount of lithium base grease NLGI No. 1 containing a 5-10% of molybdenum disulfide.
   The additive should have excellent ability to wet metal surfaces in the presence of water; as a result, it strongly resists displacement from the surface by water. The solvent should evaporate quickly and leave a thin, transparent, greasy film. The material should be suitable for light and moderate service, for example, protected outdoor storage. It should be applied at plant operating temperature by any convenient means (brushing, rolling, spraying) and the film does not need to be removed when the crusher is placed in operation.
10. Reassemble the bowl assembly in the crusher and cover the top of the crusher with a 2 mm polyethylene sheet to prevent water penetrating and corroding into the crusher. Metso recommends using black rather than transparent film for a longer lifetime protection. The countershaft end including the pulley must also be covered. Steel strapping is the ideal method for holding the polyethylene sheeting in place.
11. Reconnect the oil inlets and drain lines.

A crusher protected according to these instructions and stored outdoors will be protected against rust for 6 to 12 months.

4.3.1 Storage of a dismantled crusher

If the crusher is stored dismantled, all its parts must be even better protected; the procedure described in *Storage* applies to metal surfaces not exposed to the elements (sunshine, rain, snow etc.) The following protective measures are recommended when the crusher is stored with its various assemblies exposed to the elements.

1. Cover the socket liner and the outside of the main shaft with a black polyethylene film. Wrap the fil around the countershaft housing and stretch it across the adjustment ring.

   This protects the inside of the crusher after it has already been prepared as previously described with rust preventive oil. The sheet should be firmly attached.

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2. Spray or paint the machined surfaces of all sub-assemblies, the bowl, head, socket and eccentric with a specially processed asphaltic material that is made fluid by means of a petroleum solvent.

   The material is a medium body, black liquid that can be applied at room temperature by any convenient method. The solvent evaporates and leaves a hard, strong, dry, acid resistant film. This affords long-life protection in extreme conditions, for instance in open air or exposed to corrosive fumes. It is especially suitable for unpainted external surfaces.

   The treated parts will withstand considerable scuffing and moderately rough handling, but they should be protected against severe physical damage, since the hard, dry film is not self-repairing. The film is somewhat like paint and although semi-permanent can be removed even after prolonged aging by various rubbing with solvent soaked rags.

Parts protected according to these instructions and stored outdoors will be protected against rust corrosion for a maximum of 24 months.

4.4 Special tools

Special tools are supplied with the crusher.

These include all the lifting elements required for removing main assemblies from the crusher.

All these tools are painted in the same color as the crusher and shipped in a separate box.

NOTE: An accumulator charging kit is available as an option to control the nitrogen pressure of the accumulator.

Accumulator charging kit ID: MM1813806

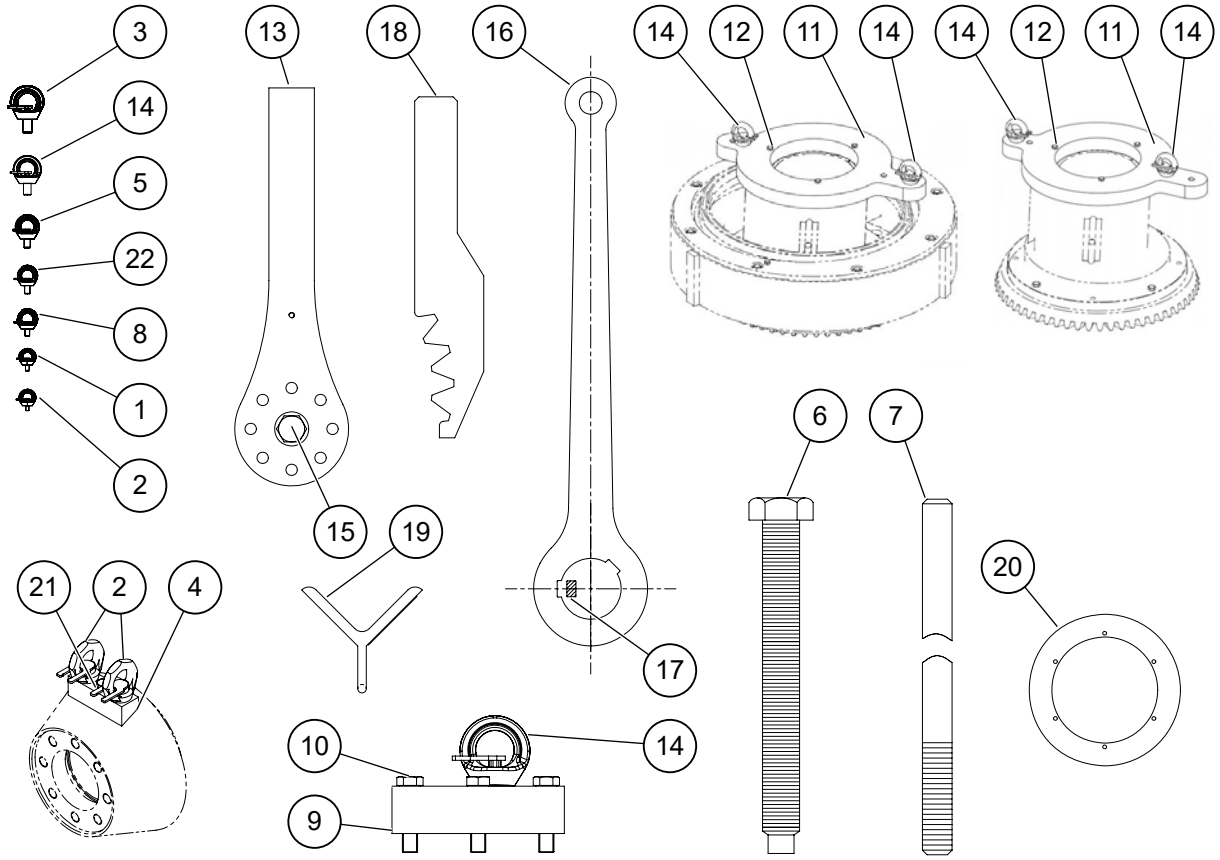

Figure 9. Special tools

Item	Description	Parts to handle
1	Eye bolt M10	Head ball
		Liner socket
		Socket
		Eccentric
		Counterweight liner
2	Eye bolt M8	Eccentric bushing
		Upper head bushing
		Lower head bushing
		Lower thurst bearing
		Upper thrust bearing
3	Eye bolt M24	Adjustment ring

Item	Description	Parts to handle
4	Shim pinion	
5	Eye bolt M16	Main shaft
		Clamping ring
		Eccentric assembly
6	Jack screw	Socket move
7	Threaded rod	
8	Eye bolt M12	Adaptation adjustment ring
		Counterweight
9	Head lifting plate	
11	Eccentric lifting plate	
13	Wrench head nut	
14	Eye bolt M20	Head assembly
		Drive gear
16	Wrench countershaft	
17	Parallel key	
18	Wrench pinion	
19	Safety block	
20	Shim set	
21	Eye bolt M14	Gear

5 Installation

5.1 Safety

Equipment not properly prepared for operation is unsafe equipment.

Run a careful check at the beginning of your shift. If you find something that needs attention, take care of it. Even minor mechanical defects can lead to personal injury and accidents.

Observe the following:

1. DO NOT allow unauthorized personnel to operate the crusher!
2. MAKE SURE all guards and other protective devices are in place, secured and not damaged.
3. CHECK fluid systems. Control the fluid level and check that there are no leaks.
4. CHECK every drain, valve and fitting.
5. LOSS of pressure from low fluid levels may lead to serious hydraulic failures.
6. CRUSHER SEIZURE from lack of oil is a problem that may cause accidents.
7. NEVER adjust pressure relief valves to get higher operating pressures. The manufacturer's recommended pressures give the safest performance with the longest life.
8. NEVER remove safety devices unless otherwise instructed by this manual. Remember to replace them prior starting of the machine.
9. CHECK the crusher thoroughly for visual defects, such as leaks, worn hoses or loose parts.
10. INSPECT your machine according to the operator's manual and your supervisor's instructions.
11. BEFORE STARTING walk completely around your machine. Make sure there is no one next to, under or on the machine. Warn any personnel nearby that you are starting up.

Report any defects to your supervisor.

5.1.1 Before starting

Observe the following before starting:

1. CHECK equipment for warning tags.
2. FOLLOW the recommended starting procedures as outlined.
3. CHECK all gauges and instruments to be sure that everything is operating properly.
4. TEST all controls for proper functioning.
5. LISTEN for and report any unusual noises
6. DO NOT stand on the adjustment gear while the crusher is running.
7. DO NOT lean or place your hands on or against the tramp release cylinders or between the adjustment ring and main frame while the crusher is in operation.
8. DO NOT take a chance with a defective machine. REPORT IT TO YOUR SUPERVISOR.
9. NEVER look into crushing chamber while crusher is operating.

5.1.2 Read and understand

Read and understand the following:

- Instruction manual furnished with the crusher
- Instructions for inspection and maintenance
- Warning labels on the machine
- Warning notes in the instruction manual
- Lubrication guides for periodic servicing

5.1.3 Use quality parts

A replacement part for any item should always be of comparable size, type and quality as the part being discarded.

5.1.4 Report necessary repairs

If your daily check uncovers item that needs attention, repair, replacement or adjustment, report it as soon as possible. The most minor defect could result in more serious trouble if the machine is operated.

Only perform the work you're authorized to do. Do not attempt repairs you do not understand. Only work on equipment you thoroughly understand. A pressure-loaded part, if carelessly released, could injure anyone in its path.

Remember that you are entrusted with the operation and maintenance of a highly valuable piece of equipment.

5.1.5 Drive guards

For information about drive guards, refer to *Safety devices and guards*.

5.2 Unpacking

Upon reception on the truck, carry out a visual inspection of the machine and mainly the following parts:

- Hoses on frame
- Cylinders
- Sheaves
- CMM box
- Wooden box
- Inventory

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Figure 10. Packaging of the crusher during transportation

Before installation and starting the crusher, remove all the protections.

5.2.1 Initial inspection

A full check of the crusher should be carried out when it is delivered to identify any damage sustained in transit and check that all the parts are present. Check also that nothing has been mislaid.

Notify the supplier immediately of any missing or damaged parts so that they can be replaced or repaired without delay.

5.2.2 Information on assembling and dismantling the crusher

Nordberg HP cone crushers are shipped fully assembled or in separate sub-assemblies, depending on the size of the crusher. For road consignments, crushers are generally shipped complete, ready to lay on their base. In certain cases, these crushers are dismantled for sea or road transportation if gauge restrictions apply.

The following sections provide instructions for assembling and dismantling the crusher's components.

Starting with the bowl, the components are presented in the normal dismantling order.

Whether the crusher is shipped assembled or dismantled, it must be assembled according to the instructions in these sections.

Before fitting any part onto the crusher, check that the rust protection of machined surfaces and all dust pollution has been removed, especially from lubricated areas and pipes.

Any machined parts or threads that may have been damaged in transit must be repaired before assembly.

After cleaning the contact surfaces, apply a thin coat of oil.

Strict observance of safety rules is mandatory when lifting equipment, including the appropriate hand signals. You should also ensure that the capacity of all lifting equipment and related parts such as cables and hooks is sufficient to bear the stated weights.

Use tools specific for repairs or maintenance, and read the information provided further on in this chapter.

5.3 Lifting the crusher

To lift the crusher, cross one or several appropriated slings in the frame hooks.

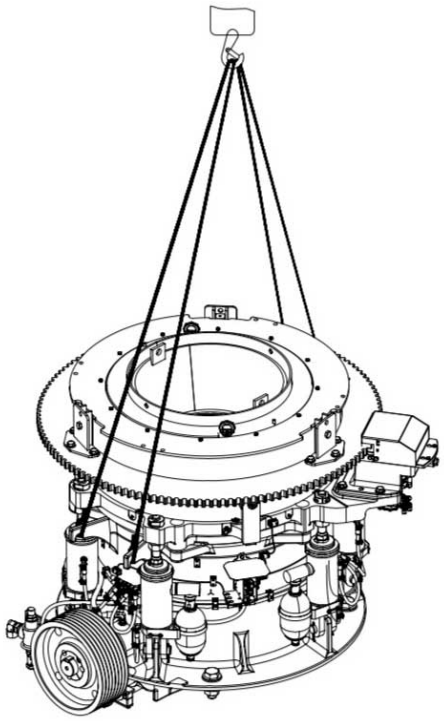

Figure 11. Handling the crusher

5.4 Installing

5.4.1 Structure dimensioning

Concrete blocks or steel constructions must be calculated and sized according to the dimensions and load specified in the installation documents.

The calculations should also consider the results of a preliminary study of the soil’s elasticity at the point of casting or construction.

5.4.2 Installing the crusher

The crusher installation area must have:

- Enough height to dismantle bowl and head assemblies.
- Enough width to dismantle the countershaft assembly.
- Enough room for a hopper feed, chute and other auxiliary equipment, and for removal of crushed material, hopper, conveyors, servicing the crusher, etc.

The frame support must be based on a flat and horizontal surface.

1. Control of the flatness of the structure (1) which will receive the crusher +/- 1 mm.
2. Modular structure: place shimming under feet (2) to adjust A.

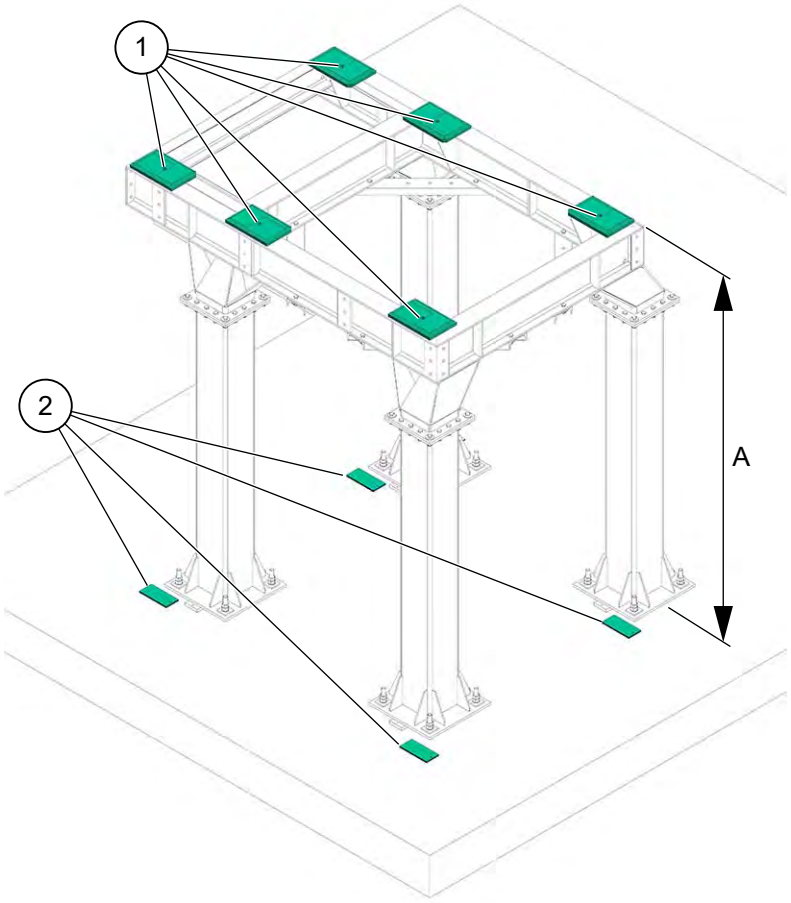

Figure 12. Shimming with modular structure

3. Concrete structure: place shimming under the plates to adjust the level of the crusher +/- 1 mm.

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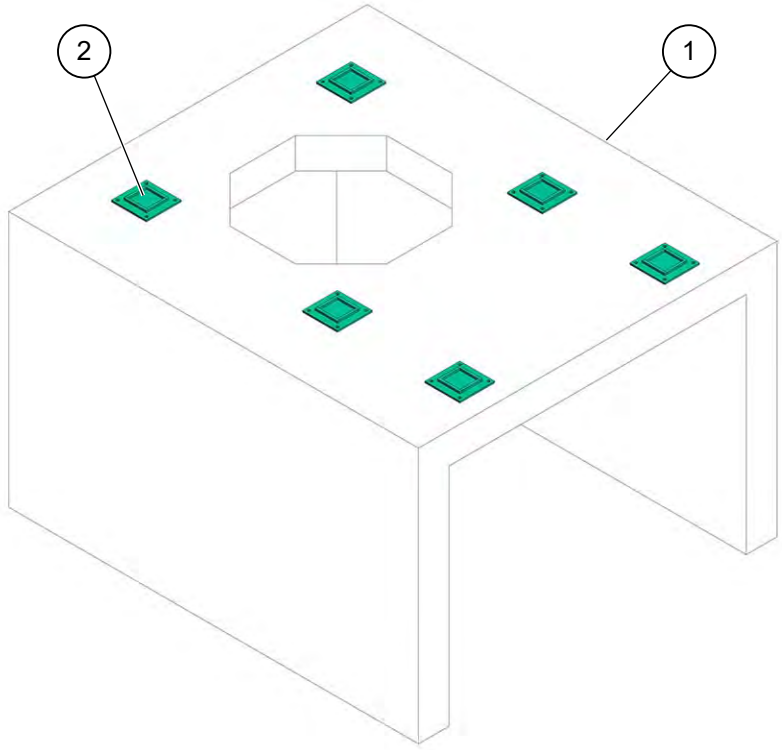

1. Concrete structure
2. Plates

Figure 13. Shimming with concrete structure

4. Assemble the machine sub-frame on the ground (crusher part transmission support part) + slides + rubber dampers.

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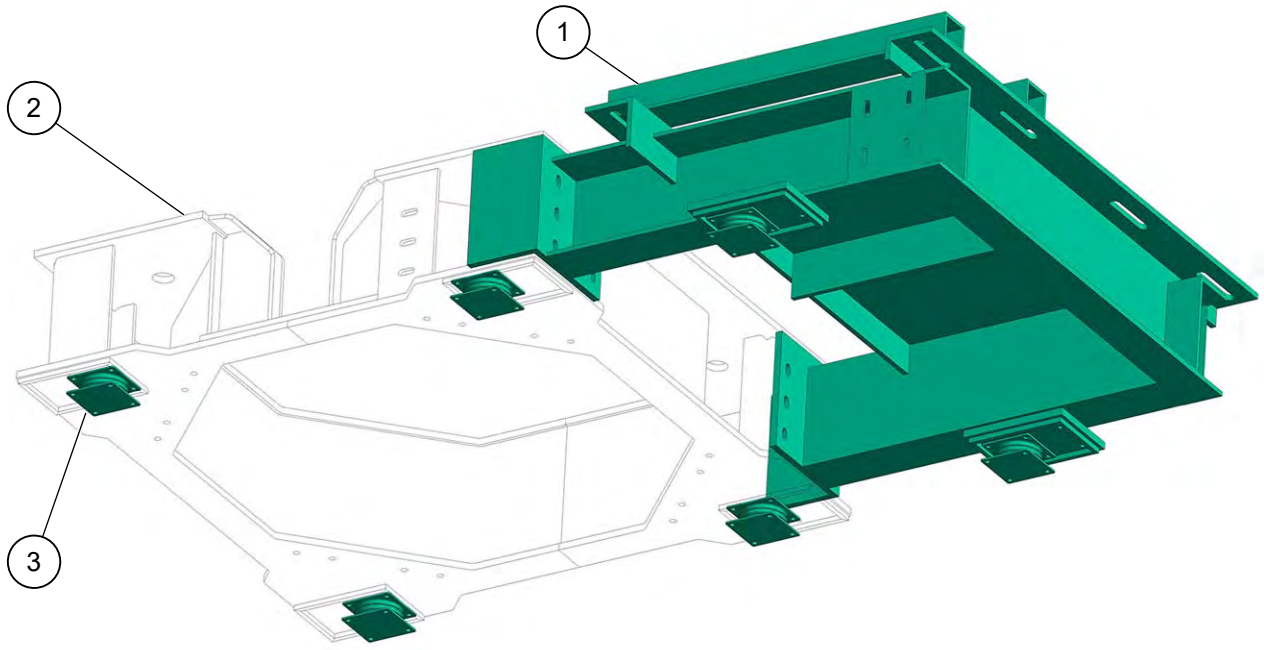

1. Slides
2. Sub-frame
3. Rubber dampers

Figure 14. Sub-frame assembly

5. Assemble the accessories under the crusher. If necessary, assemble the metal sheet or the discharge chute (1) before installing the crusher.

NOTE: Depending on the type of discharge chute, it can be fixed on the metal structure or on the sub-frame.

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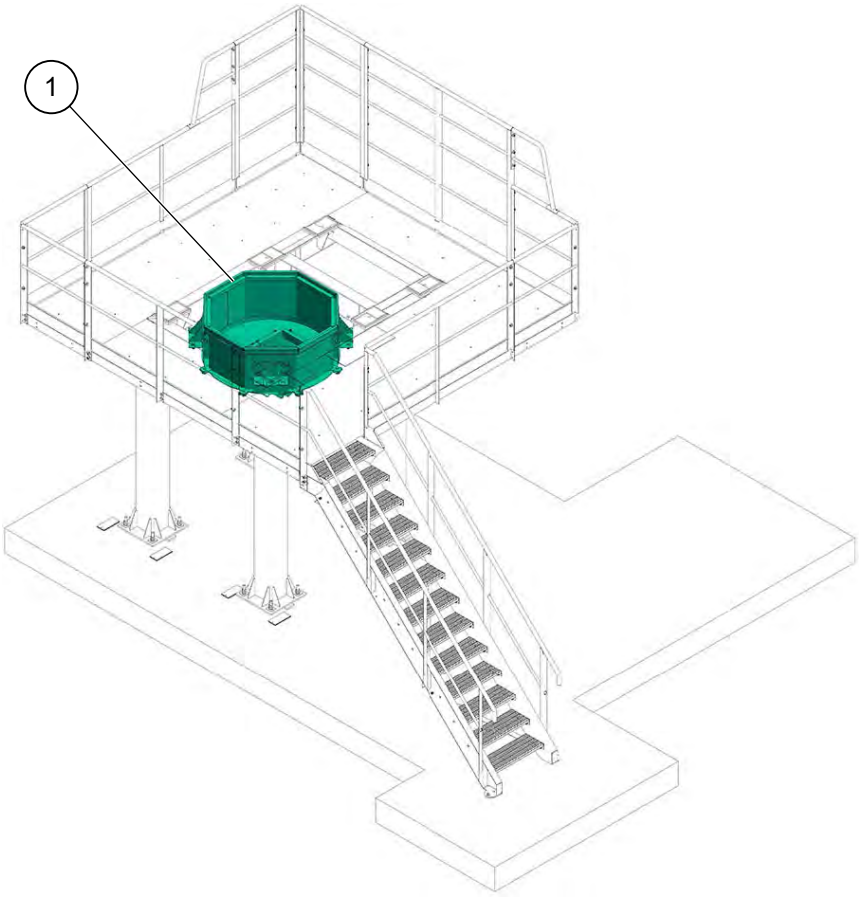

Figure 15. Accessories under the crusher

6. Install the sub-frame (1) of the crusher with studs on the structure (stud levels).

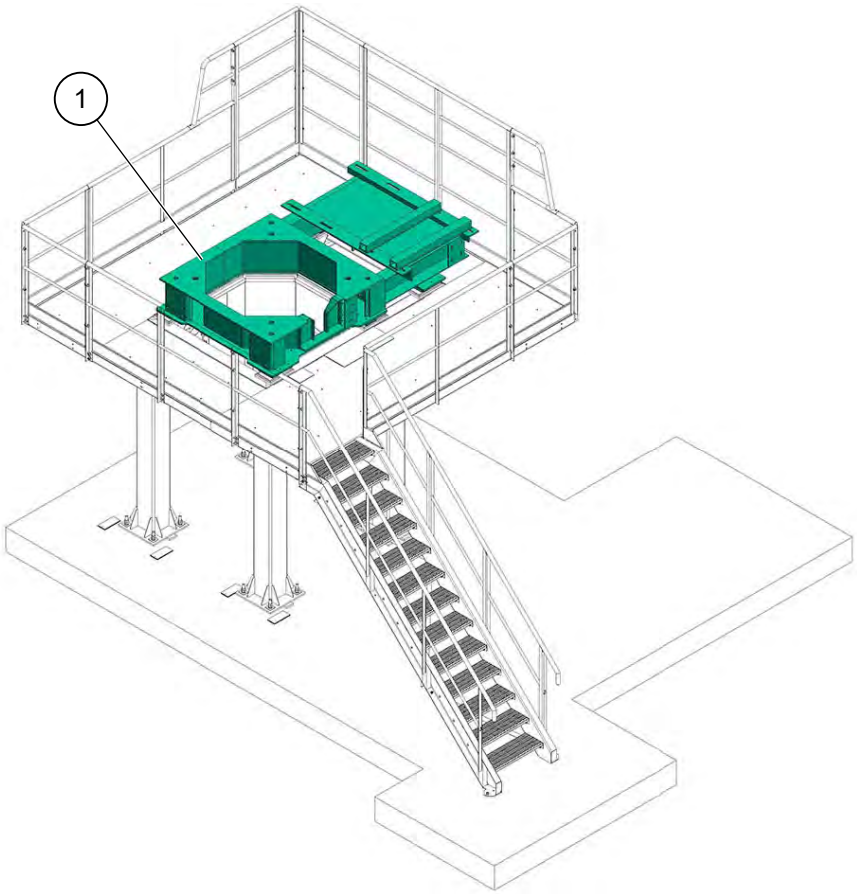

Figure 16. Sub-frame on the structure

7. Check the crusher support points (1) and the level of the motor frame (2) according to the points identified on the picture. If necessary, adjust the crusher supports with the provided shims.

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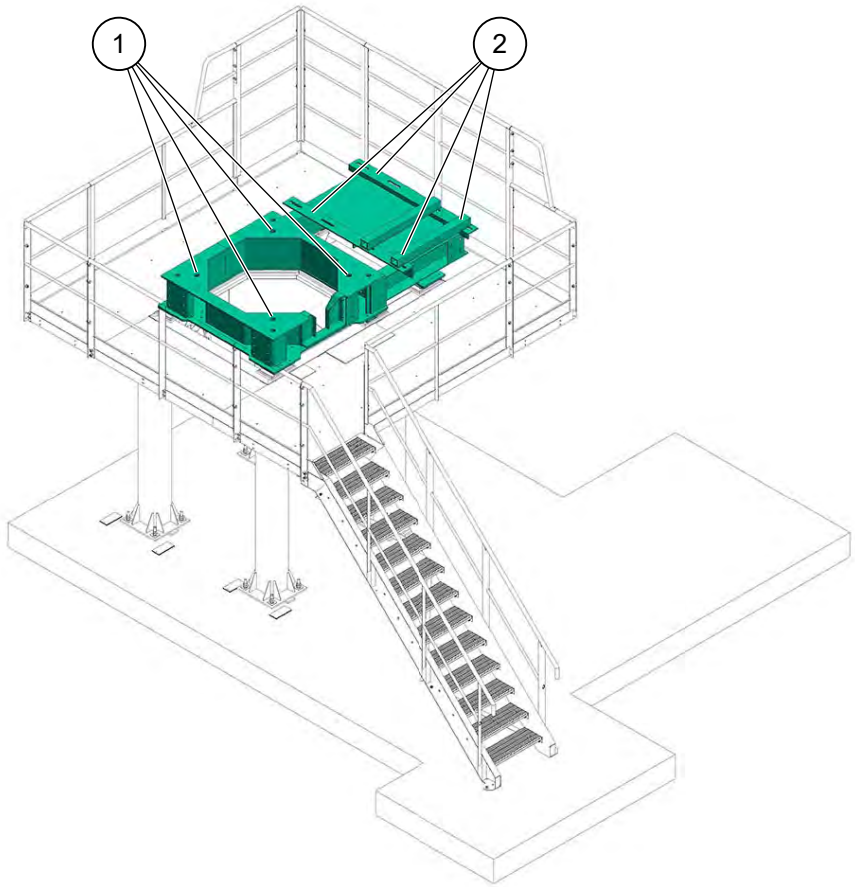

Figure 17. Verification of machine and transmission levels

8. Assemble the crusher (1) on the sub-frame.

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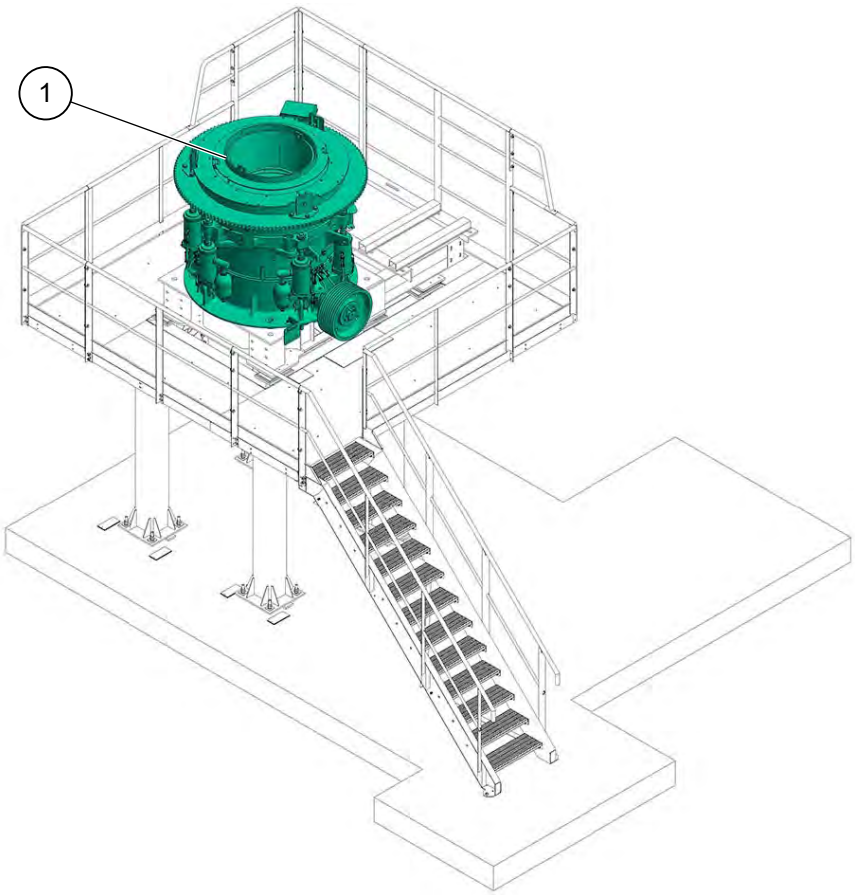


Figure 18. Installation of the crusher

5.4.3 Installing the crusher on concrete

5.4.3.1 Anchoring

When installing on a concrete block, the machine should be anchored to it with several fish-tail or hook anchor bolts. These bolts transmit their tractive force to the concrete bonding by adhesion.

The concrete bonding transmits the force from the bolts to the concrete block. This force should travel from one concrete to the next through their dividing surface.

The anchoring key (where relevant) is only used to maintain the bolt and the part to be bonded until the concrete sets.

Concreting should be completed as soon as possible for slender constructions exposed to wind, in any event before the crusher is brought into service, because a hook anchor bolt is twelve times weaker before the concrete sets.

The anchoring key plays no part in the anchoring strength and a properly set bolt cannot buckle or stretch when the nut is tightened up.

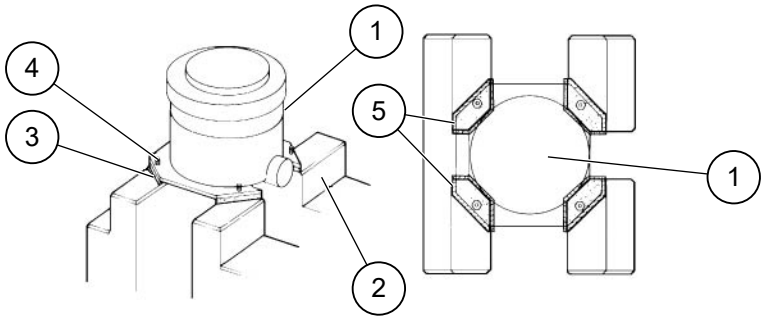
As a general rule, concreting should be done in accordance with good practice and local regulations.

5.4.3.2 Setting up the crusher

Whether the crusher is shipped fully assembled or in separate parts, the frame must be made level on its foundations. Two materials are used to do this: concrete and resin.

Formerly, concrete would be used almost exclusively for embedding purposes. However, resin has tended to be used instead of concrete for some years. In most cases, resin is preferable since it is easy to prepare and use. Epoxy resin stands up well to static and dynamic loads and vibrations and is very resilient. It is available in packs of different quantities.

Each pack includes two products, the resin itself and a hardener, which you mix in just before using it. The kit includes full instructions. No particular equipment, preparation or handling is required to use resin.



1. Crusher
2. Foundations
3. Resin mortar after removing the cast
4. Clamping bolts
5. Form work

Figure 19. Embedding

To install the frame assembly or the complete crusher, see *Figure 19. Embedding* and proceed as follows:

1. Flame-cut 4 holes in a 10 mm metal plate and place it around the bonding holes.
2. Thread one or more suitable slings through the lifting lugs on the lower section of the frame, see *Lifting the crusher*.
3. Lift the frame and coat the footing of the frame with a thin layer of oil to prevent the resin from adhering to the crusher.
4. Place the crusher on the block over the 10 mm washers.

NOTE: When using concrete, place the frame on wooden wedges placed at the four corners of the frame rather than on metal washers. The wood will retract with the concrete.

NOTE: The wedges should raise the frame about 50 to 60 cm above the block's bearing face to have an adequate thickness of bonding concrete.

NOTE: The surface of the block receiving the concrete should be rough and thoroughly cleaned before bonding. This surface should also be thoroughly soaked with water and remain damp to avoid the block rapidly absorbing water from the bounding concrete. However, remove any excess water just before pouring the concrete. Add a rust preventive agent to the bonding concrete.

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5. Set the level of the crusher by sliding the C-shaped washers around the foundation bolts so that there is a gap of between 12 and 20 mm between the frame and the block (optimal thickness for the resin).
6. Build the form work on either side of the frame, which is where the resin will be poured.

   Use battens measuring 25 x 50 mm to build the form work. Place and fasten the form work about 12 mm from the base of the frame outside the crusher in line with the vertical sides inside the crusher. The form work should be coated with three layers of ordinary wax on either side. This prevents the wood from sticking to the resin. All seals should be caulked to prevent leaks when you pour in the resin.
7. Mix and pour the resin as per the instructions.

   In cold weather, heat the resin to 18°/27°C. For better results, store the resin in a warm room before use. To avoid air bubbles forming under the crusher, pour the resin in one place at a time, covering an area of about 600 mm on either side. Then return to the point where the resin stopped previously and pour more in. Continue until the form work is full.

NOTE: Do not fill more than one surface with resin at the same time.

To have the necessary average number of kg for bonding the crusher with a layer of mortar 12 to 20 mm thick, see the table below. The quantities in the table include enough mortar for one adequate bonding layer. If the surface is uneven, increase the quantities by 10%.

Table 5: Requisite quantity of resin for bonding

12 mm mortar	20 mm mortar
45 kg	65 kg

8. When the seating is dry, clamp the crusher firmly to its foundations. The resin usually dries in roughly 6 hours if the seating, crusher and resin are at an ambient temperature of 21°C at the time of casting.

5.4.4 Installing the crusher on a metal structure

If the crusher is mounted on a metal structure, it is simply straightened up and bolted to the structure.

The metal structure should have housings for the six vibration arresters corresponding to the frame and a motor support. The motor base can be mounted to the right or left.

The housings receiving the flexible arresters must be perfectly horizontal and aligned. If not perfectly level, this could lead to serious mechanical damage.

To install the crusher on a metal structure, proceed as follows:

1. Remove all slag and weld spatters from the metal structure up to the base of the frame.
2. Grind down any protruding seams under the frame's base.
3. Thread one or more slings through the lifting lugs on the lower sections of the frame, see *Lifting the crusher*.
4. Flame-cut four washers 305 x 305 mm and 6 mm thick with a hole in the middle, matching the fixing bolt, and place them over it.
5. Raise the frame. Place the frame on the vibration arresters already in place on the metal structure.
6. Level the crusher by sliding U-shaped washers around the foundation bolts on the top of the cross-piece.

The four U-shaped washers may vary in thickness. Use the top of the main shaft to level the crusher in both directions.

7. When the crusher has been set in place, measure the gap between the frame's footing and the metal structure at three different points as shown in the figure below. These surfaces must be wedged to form a support between the frame's footing and the structure.

   The wedges, which may vary in thickness, must be roughly the same width of the frame's footing; 610 mm to 915 mm long, depending on the size of the crusher.

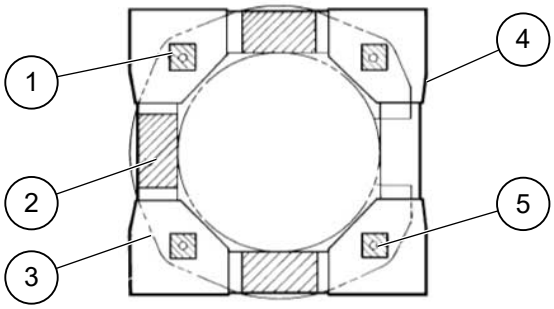

Figure 20. Location of the wedges

1. Spacer plates
2. Wedges
3. Frame footing
4. Structural frame
5. Holes for the retaining screws

8. When the wedges are in place under the frame's footing, spot weld them to the structure to dampen vibrations.
9. Bolt the motor seating onto the metal structure
10. When the crusher is securely bolted to the structure, check whether you can lift the crusher.
11. Check the fastenings periodically: after one week, one month, six months, one year.

5.4.5 Oil return connection

Install the oil return elbow connection (1) before assembling the belt guards. Use sealing paste and tow to seal connections. Oil return pipe length must be adjusted on site.

To connect the crusher to the lubrication unit, refer to the lubrication unit manual.

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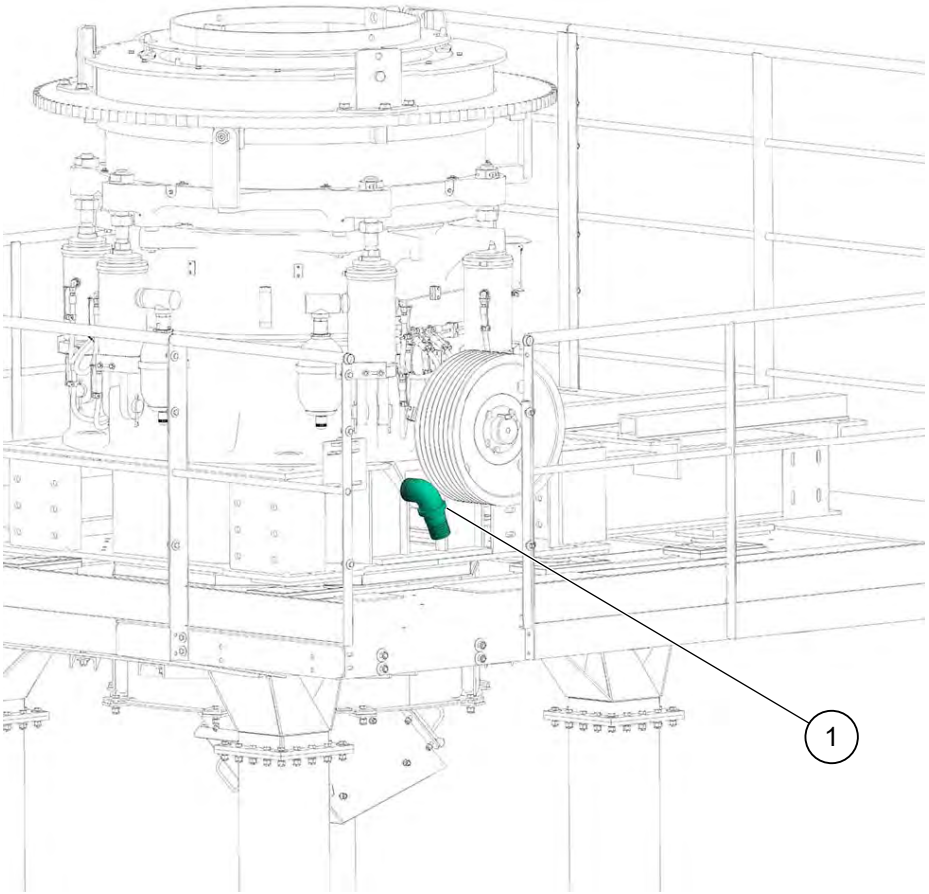

Figure 21. Oil return

5.4.6 Fitting the motor

The crusher’s electric motor may be a squirrel cage rotor motor or a wound-rotor induction motor (continuous run) having a starting torque of around 1.3 times the rated torque.

Admissible voltage change: 10%. Abrasion-resistant insulation and protection of the stator with thermostatic sensors or CPT may be required.

Motor protection may be of the protected type (IP 23) or enclosed (IP 44).

In order to work non-stop at the power rating stated on the layout plan, the motor must have a service factor of 1.15. If the motor's service factor is 1, the rated output as stated on the motor's plate should be 15% more than the rating stated on the layout plan. However, absorbed power should not exceed the power stated on the layout plan.

If a V-type belt drive is used, make sure the motor shaft end and bearings can bear the sheave's off-centre weight and the belts’ off-centre tractive force. The motor must be able to bear these loads over 360°.

The motor shaft end must be able to transmit torque peaks and the simultaneous flexing caused by the belts’ tension and the weight of the sheave. The motor shaft end should be long enough to allow the sheave hub to be mounted and prevent its rim from rubbing against the motor housing.

For V-type belt drives, the motor should be mounted on two runners so that the centre-to-centre distance can be adjusted when mounting and tightening the belts.

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For direct drive motors, check that the dimensions of the motor shaft end allow a coupling socket to be mounted.

The documented power ratings apply to electric motors. If a combustion engine is used, please inform the manufacturer, who will calculate the power requirement matching the electric power rating and speed specifications provided in the layout documents.

5.4.7 Fitting the feed extension

Install the feed extension (1) and dismantle the lifting device by means of a platform or stepladder not supplied.

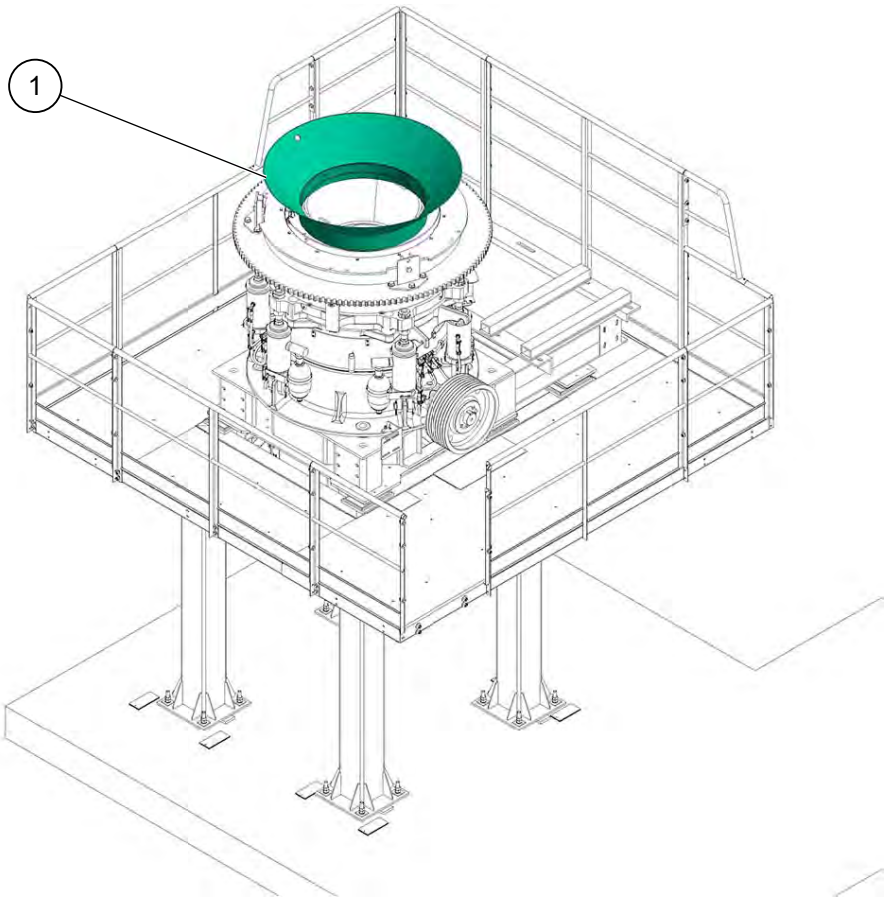

Figure 22. Feed extension

5.4.8 Fitting the oil retention tray

Position the oil retention tray (1) before fixing the lubrication unit. Level it with wedges if necessary.

NOTE: The oil retention trail is available in option.

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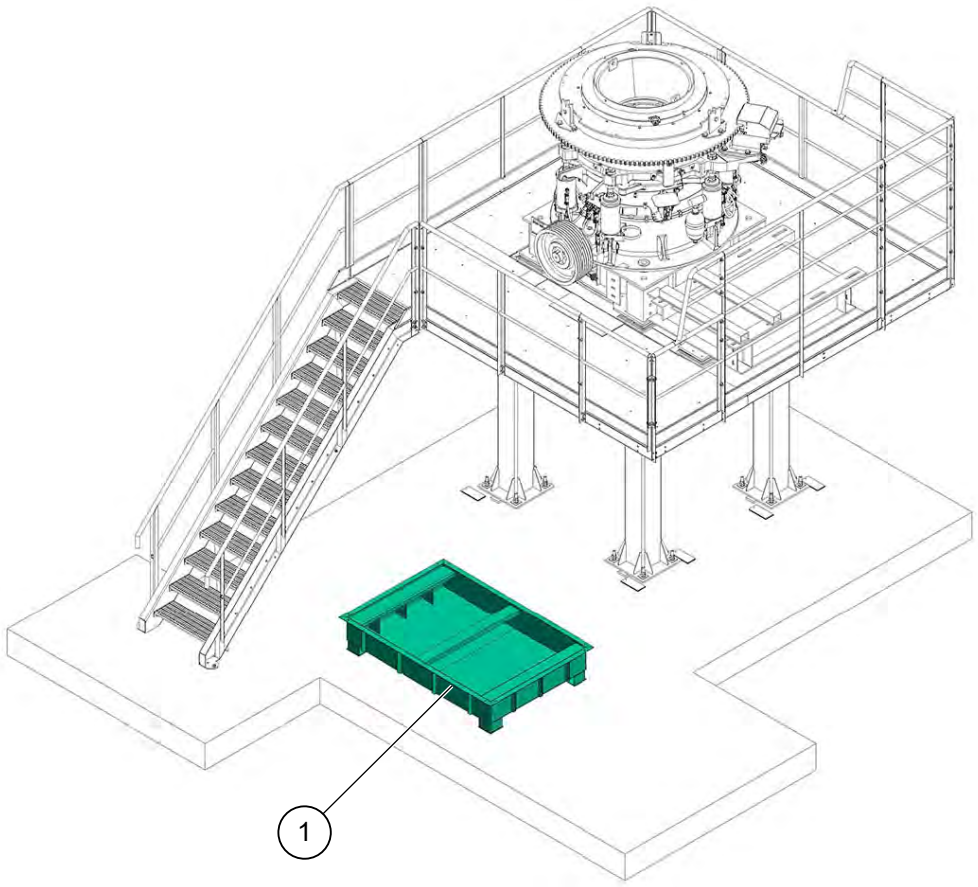

Figure 23. Oil retention tray

5.4.9 Fitting the lubrication unit and the blower

For information on installing the lubrication unit and the blower, refer to the lubrication unit manual. Pay attention to the distance between the lubrication unit (1) and the wall or the lubrication unit (1) and the blower (2), for maintenance purposes.

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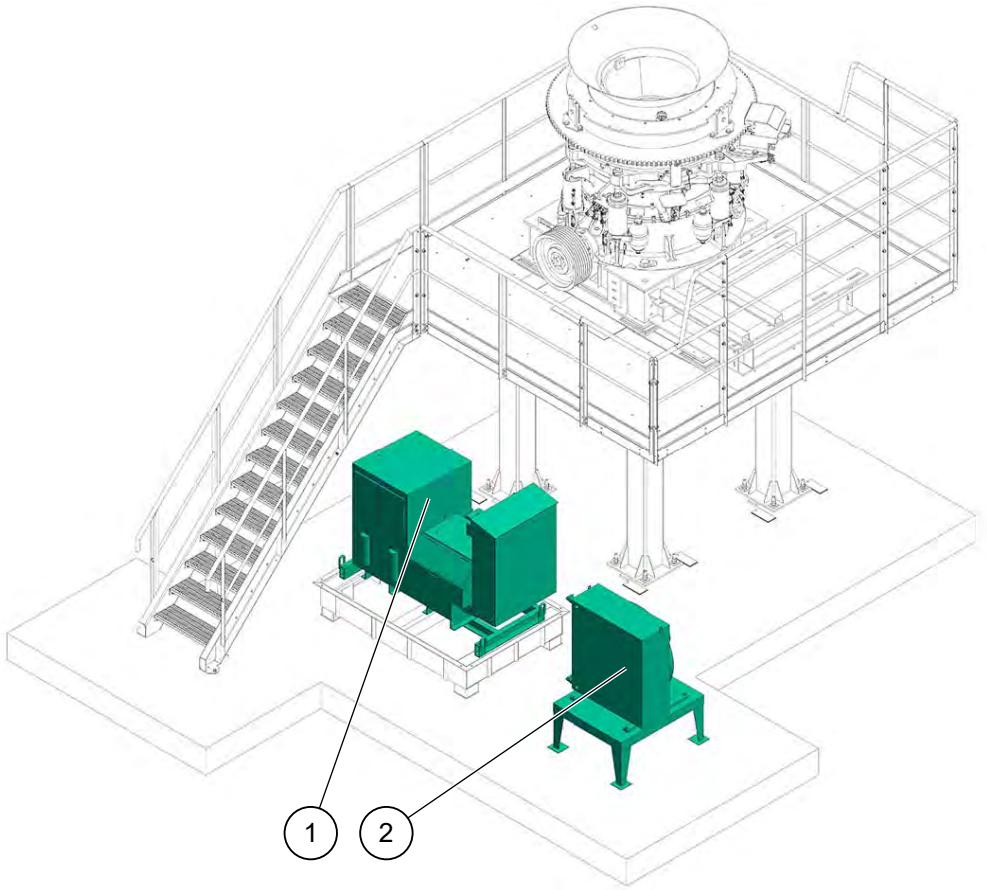
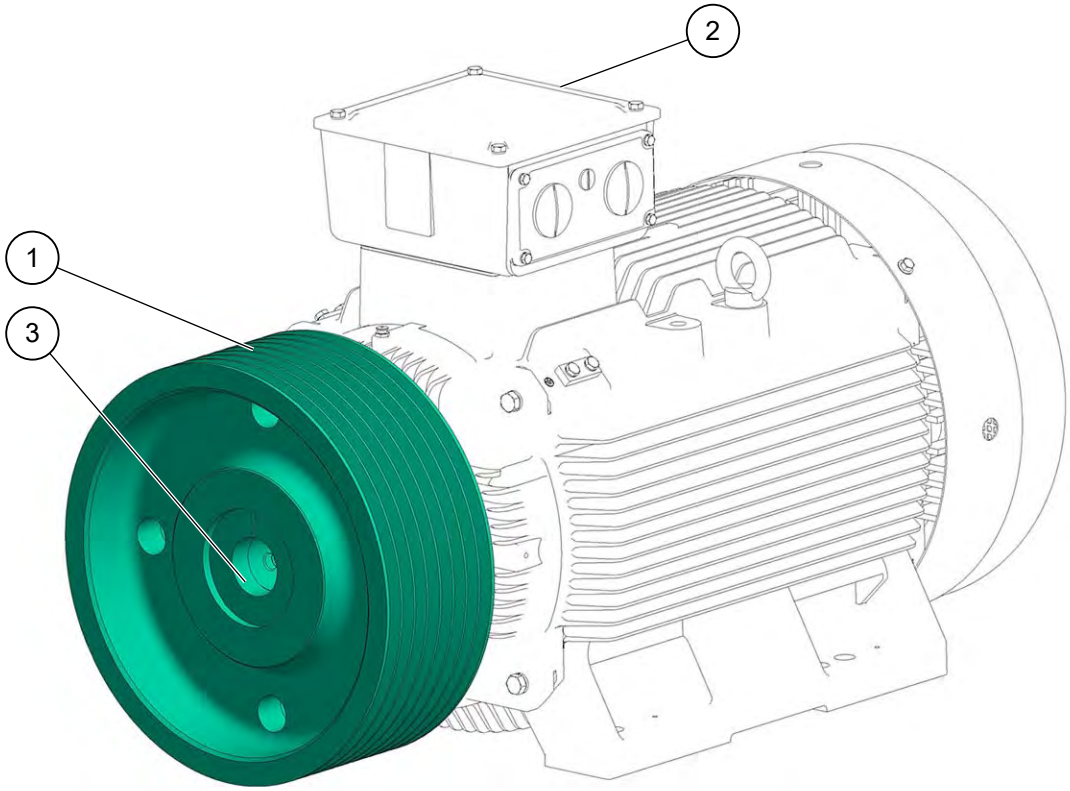


Figure 24. Lubrication unit and blower installation

5.4.10 Fitting the motor sheave

Upon receipt of the crusher, the crusher pulley is already installed.

1. Clean the motor shaft, bushing, screws, pulley tapered bore and key. Remove chips, varnish or paint.
2. If spacers are provided, mount them on the motor shaft.
3. Place the removable hub in the sheave tapered bore, taking care to place the smooth half-holes in front of the threaded half-holes.
4. Lightly grease and tighten the screws but do not fully tighten the screws as the hub is free on the rim.
5. Run a textile sling around the pulley, in the central groove, making a knot. Use a lifting device to slightly tighten the sling.
6. Push the pulley assembly onto the motor shaft to the desired position.
7. Grease the threads and the underside of the heads of the 3 screws, put them in place and then tighten them alternately and gradually until the torque indicated in the hub manual.
8. Install the sheave (1) on the motor (2) on the ground.



1. Sheave
2. Motor
3. Taper lock

Figure 25. Sheave installation on the motor

5.4.11 Fitting the motor

1. Install the motor (1) on the sub-frame. Align the sheaves of the motor and the crusher by using laser or ruler or a stretched rope.

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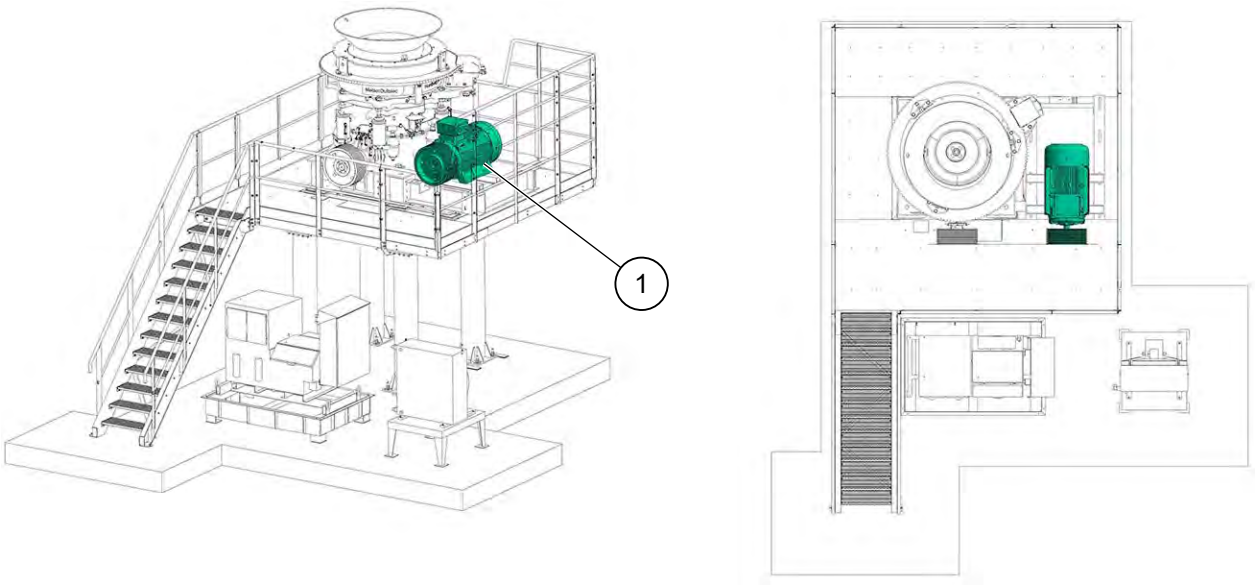

Figure 26. Motor installation on the sub-frame

2. Install the transmission covers, see *Fitting the transmission cover*.

5.4.12 Fitting the transmission cover

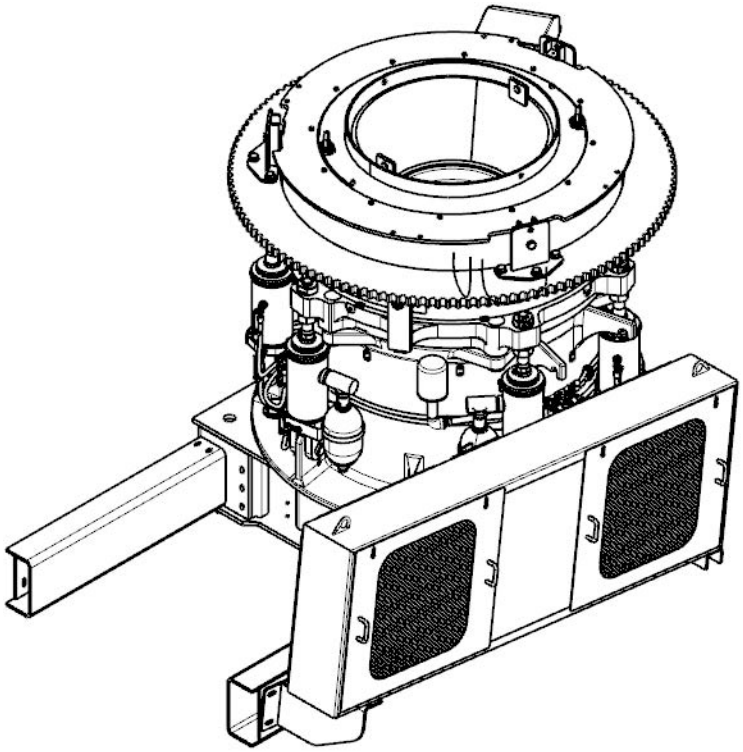

Figure 27. Transmission cover assembly (left side assembly)

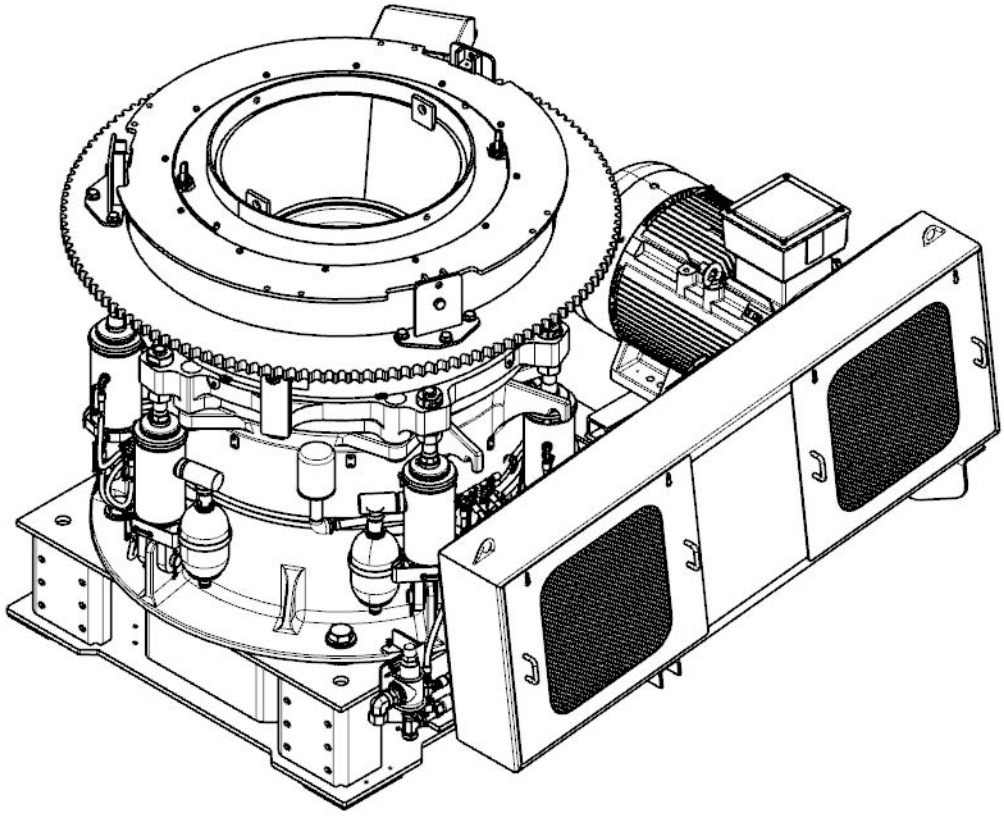

Figure 28. Transmission cover assembly (right side assembly)

The transmission cover is fixed on 3 arms fixed on the sub-frame.

1. Fix the 3 attachment arms on the sub-frame. Do not tighten them hard to allow adjustments.

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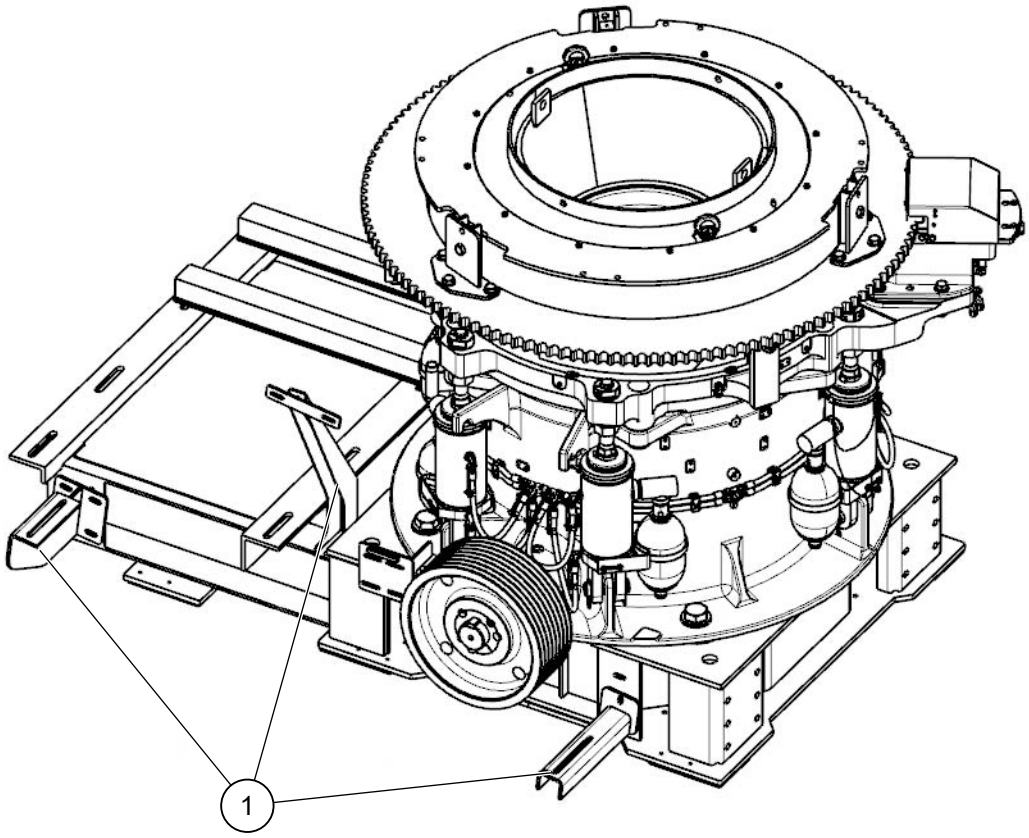
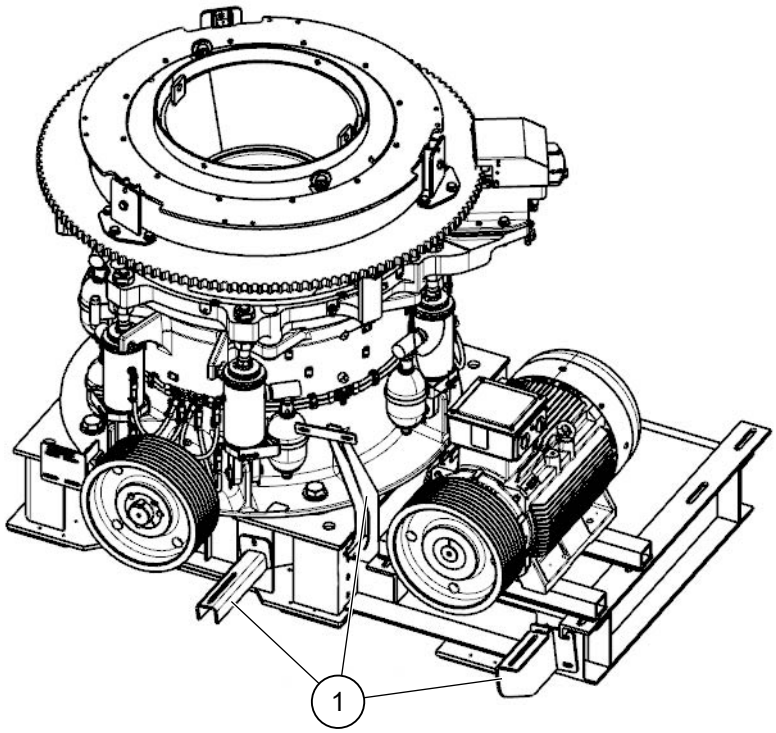


1. Attachment arms

Figure 29. Location of the transmission cover attachment arms (left side assembly)



1. Attachment arms

Figure 30. Location of the transmission cover attachment arms (right side assembly)

2. Use slings in lifting rings (1) to lift the cover assembly.

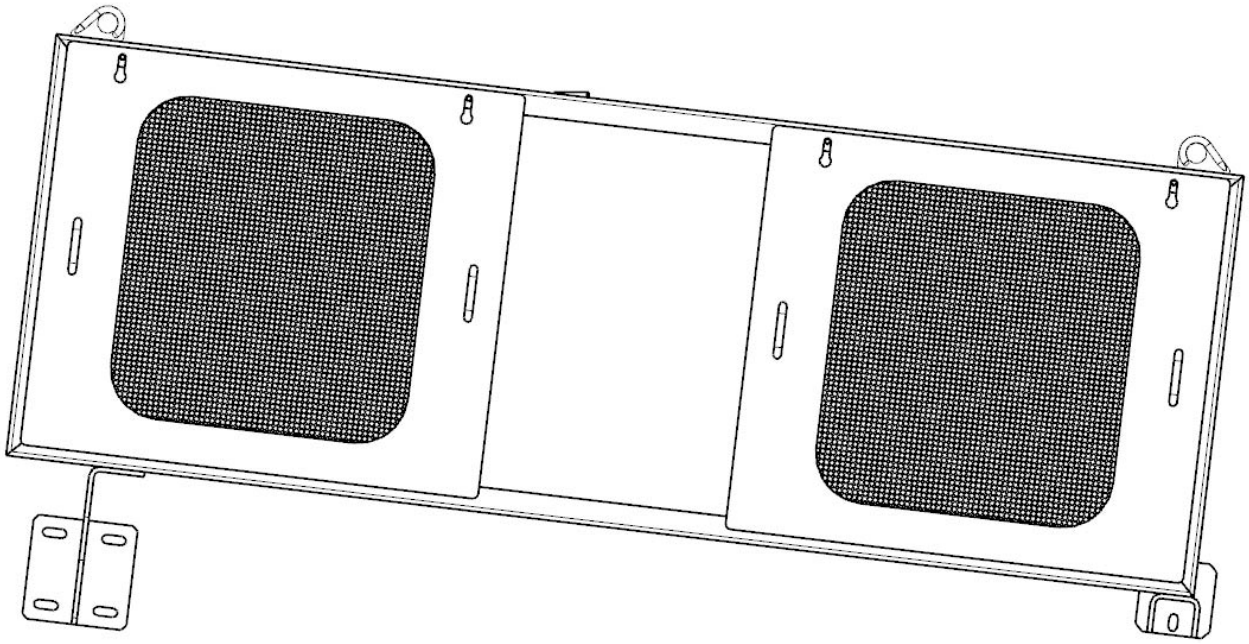


Figure 31. Cover transmission lifting rings (left side assembly)

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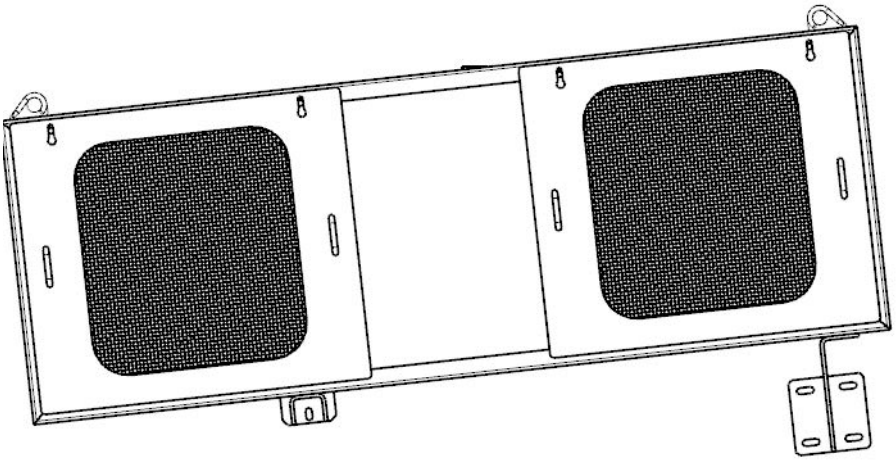

Figure 32. Cover transmission lifting rings (right side assembly)

3. Align the holes to be able to screw the transmission cover with the attachment arms.
4. Fix the transmission cover on the attachment arms and the third one.
5. Lock the screws securing the transmission cover, the attachment arms and the sub-frame together.
6. Install the belts.
7. Cut and adjust the motor and crusher protection flaps.

Figure 33. Protection flaps

5.4.13 Fitting the transmission cover doors

The doors of the transmission covers must be installed before starting the crusher. The doors are held in place by screws on the top.

1. Before installing the doors, loosen the retaining screws as much as possible until they come to a stop with the retaining clip.
2. Place the door on the cover so that the retaining screws pass through the doors.
3. Move the doors down to the stop.
4. Tighten the retaining screws.
5. Check that the doors are clad to the cover throughout the turn.

5.4.14 Fitting the belts

NOTE: Before mounting the belts, check the rotation direction of the motor.

Tension the belts and check the alignment of the sheaves (mount the shoes on the crusher side for tensioning - snail tightening).

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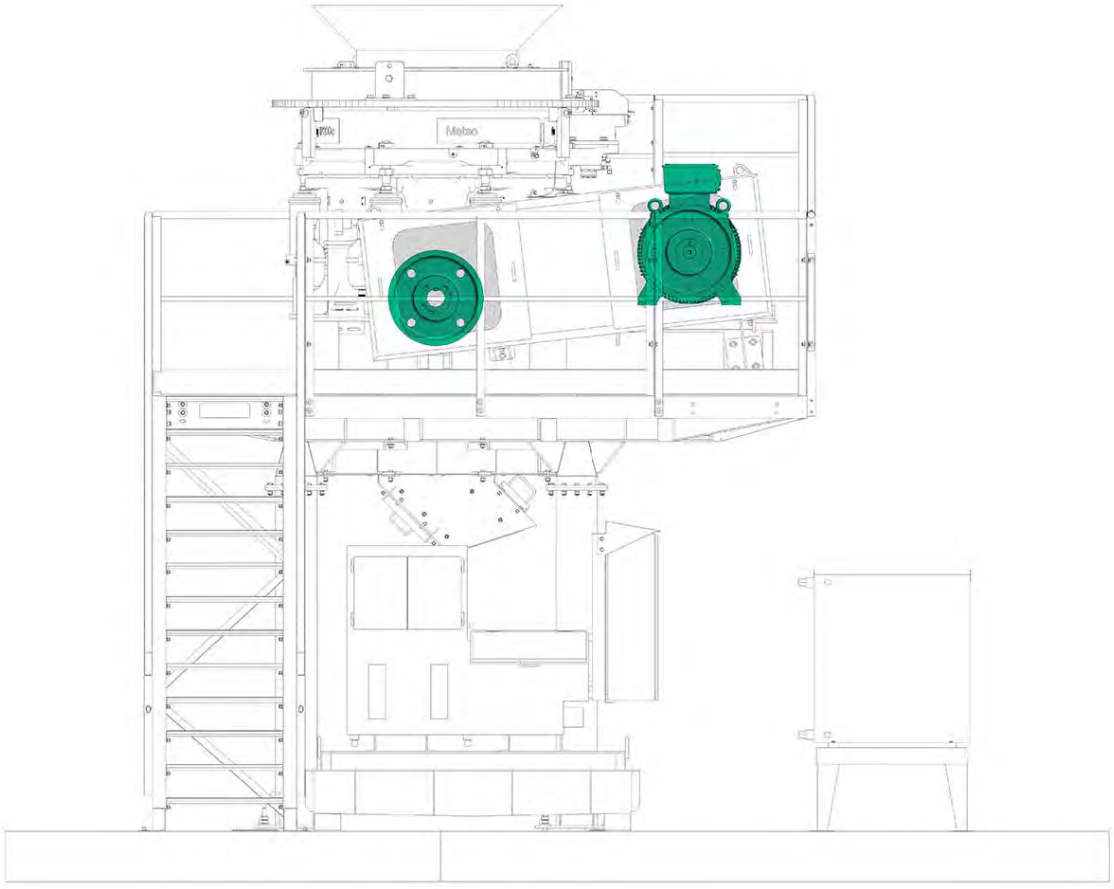
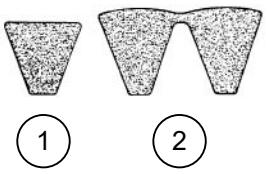


Figure 34. Tension of the belts

V-belt drives are recommended due to their ability to "filter" shocks transmitted from the crusher to the motor and withstand jerks without slowing down the crusher. The drive belts may be 8V or SPC type and be separate or twinned.



1. Single belt
2. Twin belt

Figure 35. Cross-section of belts

Narrow belts have been designed to reduce the space required by the drives, thereby making savings on installation and reducing the load’s overhang at the shaft ends.

Twin belts consist of single belts joined by a band to prevent whiplash and twist. They can be mounted on standard sheaves.

If the motor sheave is directly under the crusher or angled 30° from the vertical, the factory should be informed so that the countershaft ring can be correctly positioned. Power can be supplied by an electric motor, a diesel engine or a hydraulic motor. The crusher can also be directly coupled to the motor.

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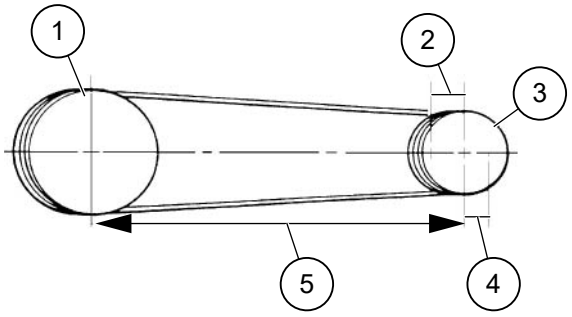
For specific questions regarding the crusher drive, contact Metso.

5.4.14.1 Installing a V-belt drive for the first time



1. Crusher sheave
2. Shorter center distance for V-belt installation
3. Motor sheave
4. Longer center distance for V-belt take-up
5. Center distance

Figure 36. Installing the belts

When installing for the first time or when changing belts, follow these instructions:

1. Remove all traces of oil, grease or rust from sheave grooves.
2. Make sure the sheaves are properly aligned and the shafts are parallel.
3. Make sure that the sheaves are sufficiently close together to allow the belts to pass easily. Never force a belt around the sheaves.

   To determine the minimum tolerances for shortening or lengthening the center-to-center distance between the sheaves, calculate the center-to-center distance for a standard length and slope. Make sure the resulting distance can be shortened by the length indicated in the table below, for easier installation of the belts and to avoid any damage.

   A longer distance than the center-to-center distance should be possible to allow for lengthening and wear. This extra length is given in the last column of the table.

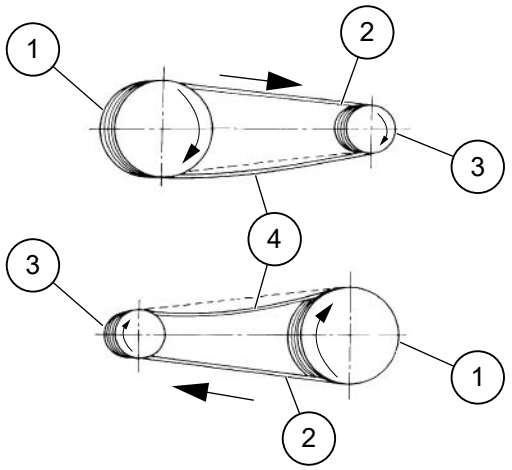
Table 6: Minimum distances mm (inches) for mounting or dismantling the belts

Length of belts mm (inches)	Cross-section of belts			Minimum distance to tauten the belts
	8V	8V twin	SPC	
from 2000 (79) to 2749 (108)	40 (1 1/2)	85 (3 3/8)	35 (1 3/8)	40 (1 1/2)
from 2750 (108) to 3499 (138)	40 (1 1/2)	85 (3 3/8)	35 (1 3/8)	45 (1 3/4)
from 3500 (138) to 4499 (177)	40 (1 1/2)	85 (3 3/8)	35 (1 3/8)	55 (2 1/8)
from 4500 (177) to 5499 (216)	45 (1 3/4)	90 (3 1/2)	35 (1 3/8)	65 (2 1/2)

Length of belts mm (inches)	Cross-section of belts			Minimum distance to tauten the belts
	8V	8V twin	SPC	
from 5500 (216) to 6499 (256)	45 (1 3/4)	90 (3 1/2)	40 (1 1/2)	85 (3 3/8)
from 6500 (256) to 7999 (315)	45 (1 3/4)	90 (3 1/2)	40 (1 1/2)	95 (3 1/2)
from 8000 (315) to 9999 (394)	50	100	45 (1 3/4)	110 (4 3/8)
over 10,000 (394)	50	100	45 (1 3/4)	140 (5 1/2)

4. Fit the belts. Only use new, matching belts from the same source. Never use new and used belts together.
5. Run the belts for a few minutes. Tauten the belts until the slack strand bends slightly during operation.

   The slack strand depends on the position of the motor and the direction of rotation. An example of a taut and slack strand is shown in the figure below .The slack strand side is determined by the position of the motor.



1. Crusher sheave
2. Tight side
3. Motor sheave
4. Slack side (note bow or sag in belts)

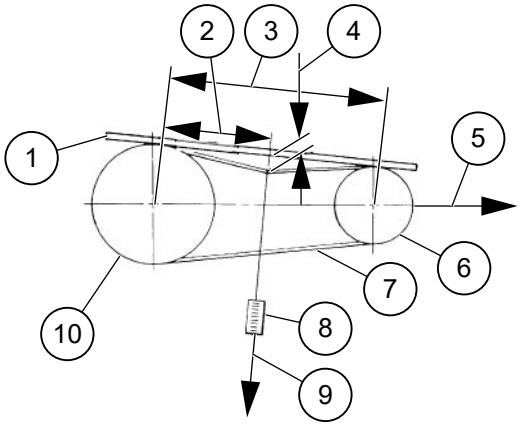
Figure 37. Determining the slack strand

5.4.14.2 Tautening the V-belts

Tautening the drive is the term used to define the method consisting in creating a corner effect between the belt and the sheave's groove. This corner effect lets the belts transmit the motor sheave's force to the crusher sheave.

There are several ways of tautening the belts. Two simplified methods are described in *Tautening the V-belts with the tension-bending method* and *Tautening the V-belts with the relative elongation method*. Either method gives satisfactory results if properly implemented, and both have certain advantages for a particular type of belt.

5.4.14.2.1 Tautening the V-belts with the tension-bending method



1. Ruler
2. 1/2 length
3. Length
4. Sag = Length / 64
5. Traction
6. Motor sheave
7. Belt
8. Balance
9. Force (see *Table 7: Bending forces*)
10. Crusher sheave

Figure 38. Tension method

1. Place a ruler at a tangent to the two sheaves.
2. Measure the length of the tangent (free length of the belts).
3. With the aid of spring scales hanging from the center of one belt, apply a perpendicular force to the belt in such a way that the belt's sag equals 0.016 (1/64) times the length of the tangent.

   The force should be as indicated in the table below.

Table 7: Bending forces

Section	Single belts		Twinned belts*	
	Tension min. (kg)	Tension max. (kg)	Tension min. (kg)	Tension max. (kg)
8V	15.4	22.7	18.1	27.2
SPC	10.4	15.4	11.8	18.1

* Multiply these figures by the number of belts on the ply.

4. After running for 2 to 4 hours, tauten the drive again to the upper limit of bending force.
5. After 24 - 48 hours, check that bending force is within the range given in the table. Excessively slack or taut belts will reduce durability and impair proper functioning of the drive.

NOTE: An adequately taut v-belt drive may appear too slack. The spring scales give a more trustworthy result than visual appearance.

Example

8V belt = SPC belts

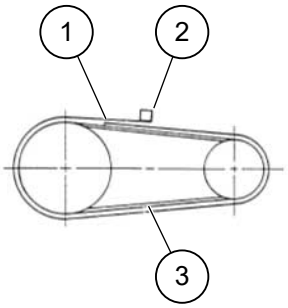
Sag = 1575 mm x 0,016 = 25 mm

Consequently, a new 8V-belt drive with a center-to-center distance of 1575 mm should be tautened in such a way that it sags by 25 mm when a force of 15–22 kg is applied.

5.4.14.2.2 Tautening the V-belts with the relative elongation method

This belt tensioning method has been devised for tensioning twin belts.

1. Tauten until the slack disappears (when stationary).
2. Wind a 10-15 m tape measure around the belts and measure their length to within 1 mm. Make a note of it.



1. Length reading
2. Tape measure
3. Belt

Figure 39. Belt tension using the relative lengthening method

3. Multiply the measured length by the ratio given in the table and add the result to the initial value.

Table 8: Elongation factor

Section*	Ratio	Percentage %
8V	0.009	0.9

* Single or twinned belts

4. Tauten until the belt reaches this new length.
5. Check the tension periodically and tauten using the above method, if necessary. We should point out, however, that the tension-bending method is the easiest.

   Usually, slipping is the first sign of incorrect tension. Slipping causes a loss of power and speed at the crusher sheave and accelerated wear of the sheave grooves. Such conditions are usually accompanied by creaking and overheating of the belts and sheaves. These symptoms are clearly visible, audible and tangible

Example

SPC belt = 8V belt

Initial length= 3048 mm (120")

Elongation ratio (see table) = 0,009 or 0,9%

New length = 3048 mm (120") initial length x 0,009 elongation ratio = 3048 mm (120") + 27 mm (1 1/16") or 3075 mm (121 1/16").

Consequently, a new drive with belts having an overall length of 3048 mm should be tautened until it is 3075 mm long.

5.4.14.3 V-belts - precautions

Observe the following do’s and don’ts regarding the proper use of V-belts:

- Check belt tension frequently during the first few days of operation. New belts are relatively stiff and require greater tension.
- Excessive or insufficient tension also shortens the lifetime of belts and bearings.
  The tension should be uniform. The belts should appear taut when stationary. When in operation, the slack strand should be visible.
- Ventilate the drive if it exceeds 60°C, otherwise it could suffer damage.
  In this respect, the drive housing should have perforated or expanded metal side plates.
- Never let oil or grease come into contact with the belts. Oil makes the rubber swell and impairs its properties.
- Check the drive at regular intervals, in particular the following points:
  - Crusher slows down: check tension.
  - Uneven tension: check each belt.
  - Excessive stretching: make sure it is not overloaded.
  - The belts soften or swell: make sure it is not overloaded.
  - The belts stiffen or crack: check for overheating.

5.4.15 Aligning flexible couplings

For direct control drives, when first mounting or remounting a flexible coupling socket, it is always advisable to align it for greater durability and minimum vibration.

1. Mount the two half-sockets on their shaft ends.
2. Check the gap and angular alignment between the two half-sockets at four points spaced out at regular intervals around the edge. To take this measurement, use thickness gauges, a calliper rule or a comparator mounted on a magnetic base.
   The differences between the measured gaps should not exceed 0.38 mm. If any of the four measurements exceeds the others by more than 0.38 mm, this means that the socket is incorrectly aligned at an angle.
3. Check the alignment by placing a ruler on the lines of the outer diameters of the half-sockets. Take the measurement at four equally spaced intervals. Use thickness gauges or a comparator to check that the non-parallelism does not exceed 0,38 mm.
   The gap, angular alignment and parallelism of the coupling socket are greater for direct control drives.
4. Mount a safety clamp on the countershaft to retain axial clearance.

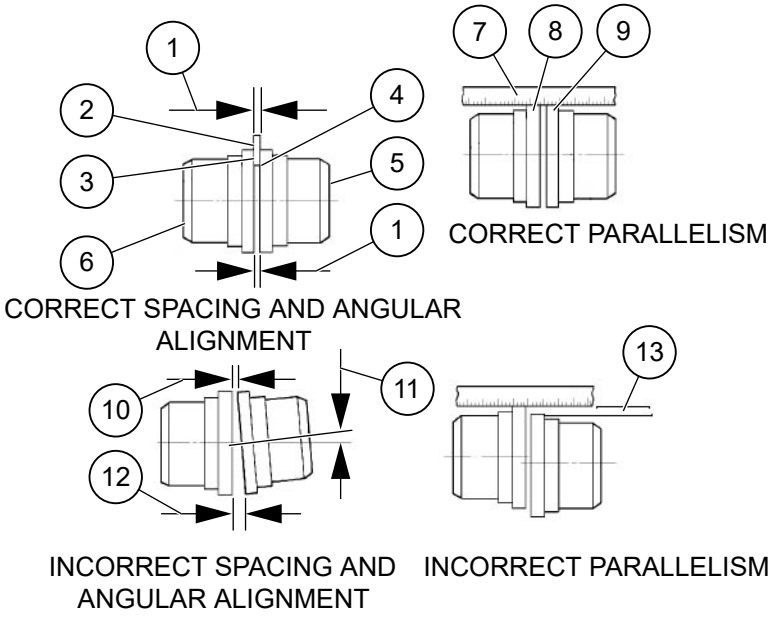


Figure 40. Aligning the coupling

1. Equal gap
2. Use the gauge to check the gap
3. Hold the thickness gauge against the half-sockets here
4. At 4 points spaced out 90°, check parallelism using a thickness gauge
5. Half-coupling at the motor end
6. Half-coupling at the crusher end
7. Ruler
8. Place the ruler on the half-coupling here
9. At 4 points spaced out 90°, check parallelism using a thickness gauge
10. Gap
11. Angular misalignment
12. Maximum variation 0.38 mm
13. Maximum non-parallelism should be 0.38 mm

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5.4.16 Installing the bowl assembly

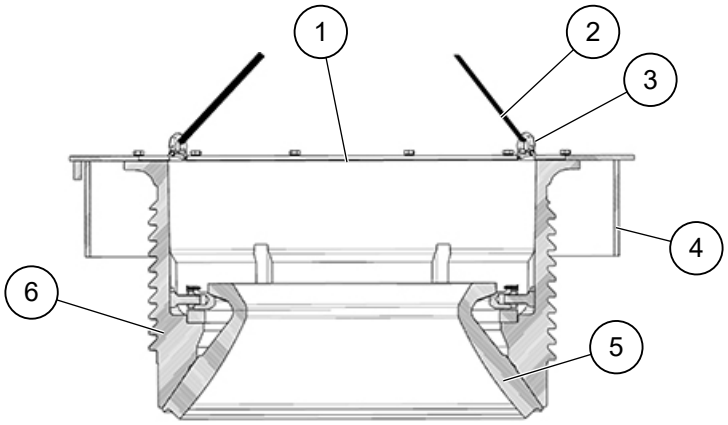

Figure 41. Handling the bowl assembly

1. Feed hopper
2. Sling
3. Lifting ring
4. Adjustment cap
5. Bowl liner
6. Bowl

If the bowl, liner and hopper assemblies have been dismantled from the crusher for transport, they should be cleaned, lubricated and assembled as follows:

1. Dismantle the adjustment cap.
   a) Remove the screws and washers retaining the adjustment cap on the top of the bowl.
   b) Raise the adjustment cap with the aid of the three M12 eye bolts installed on the square bars welded to it.
2. Thoroughly clean the bowl, the adjustment ring and clamping ring threads, removing any dust and possibly the protective varnish.
3. Rub the threaded surfaces of the bowl, adjustment ring and clamping ring with a rag soaked in molybdenum disulphide. This produces a lubricating film on the threaded surfaces, thereby improving bowl rotation.
   This is done in our workshops at the outset.
4. Cover the threads with grease containing 5 to 10% of molybdenum disulphide.

NOTE: When crushing hot material such as clinkers or slag, a high temperature grease mixed with 5-10% (by volume) of molybdenum disulfide powder should be used. This same powder mix with lubricating oil has also been found satisfactory for such applications.

5. Reassemble the adjustment cap and the other parts on the bowl.
6. Raise the assembly with slings secured to the eye bolts screwed in the bowl.
7. Before reassembling the complete assembly, depressurize the clamping cylinders.
8. Rotate the bowl in the clamping ring to engage the threads, then in the adjustment ring.

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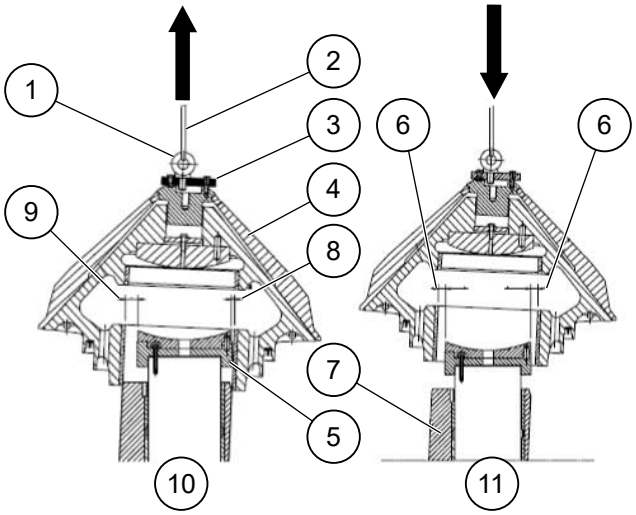
5.4.17 Mounting the head assembly



1. Eye bolt
2. Sling
3. Head lifting washer
4. Head
5. Socket
6. Even gap
7. Thick side of the eccentric
8. Minimum gap
9. Maximum gap

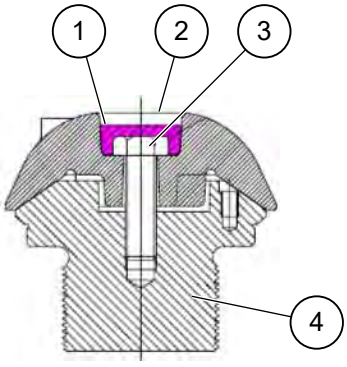
10. Dismantling the head assembly

1. Raise the assembly until the bushing is no longer guided by the eccentric.
2. Center the head in relation to the socket.

11. Mounting the head assembly:

1. Center the head in relation to the socket
2. Move the head so that the highest point of the assembly is aligned with the thick side of the eccentric and continue lowering.

Figure 42. Installing or dismantling the head assembly



1. Silastic
2. Feed cone
3. Head bolt
4. Locking bolt

Figure 43. Feed cone assembly

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If the head, mantle and feed cone assemblies are dismantled for shipping purposes, the various parts must be assembled as follows:

1. If the feed cone has been delivered already fitted on the head, dismantle it before handling the head assembly.
2. Carefully clean the eccentric, the inner walls of the head bushings, the head ball and the socket. Make sure all surfaces are perfectly smooth. If there are any scratches or rough edges, remove them with a fine emery cloth.
3. Check all oil passages.
4. Coat the outer diameter of the eccentric, the head bushings, the head ball, the socket and the thrust bearing generously with lubricating oil. Use the crusher's oil.
5. The tools shipped with the crusher include a round plate with a tapped hole and a large matching handling ring. Fit the lifting ring onto the locking bolt. Align the mounting holes and use the screws provided with the tools to fix the lifting ring onto the locking bolt.
6. With the aid of appropriate lifting device, raise the head assembly and center it over the socket.
   The handling ring is off-center in relation to the lifting ring so that the tilting angle of the assembly matches that of the eccentric's centerline. The highest point of the head assembly must be in line with the thick side of the eccentric.
7. Gently raise the head over the socket.
8. Gently lower the head assembly onto the eccentric shaking the head by hand to ease it into place. The top edge of the eccentric is chamfered to help the head bushing insertion.
9. When the head is resting on its head ball, raise it by 6 mm to 10 mm and maintain it in this position. Then start the oil pump and let it run for 10 to 15 minutes to remove dust and pre-lubricate the bushings.
10. Turn the pump off, lower the head onto the socket and remove the lifting ring.
11. Fix the feed cone onto the locking nut.
12. When the screw is tight, fill the hole with silicon plastic to cover the head of the screw, in order to protect it from crushed materials and to ease later removal.

6 Commissioning and start-up

6.1 Before switching power on

6.1.1 Hydraulic and lubrication oil filling

Refer to the lubrication unit manual.

6.1.2 Oil specifications

For the hydraulics, use a paraffin-rich oil (without naphthalene) having a protective film, strong adhesiveness to metallic surfaces, and stable physical and chemical properties.

Each lubricant should have a high viscosity level, have rapid water separation properties against rust and corrosion, resist emulsion and oxidation and have good wear resistance properties.

Recommended oil is ISO-L-HM32 (ISO 11158 standard). Its viscosity should be:

- 28.8 to 35.2 cSt at 40°C kinematic viscosity
- 4.9 cSt or more at 100°C

In addition, the viscosity index of the oil should be at least 95.

Appropriate lubricants are essential to protecting the parts of your crusher. They are available from most major oil companies. Using the wrong oil can damage the crusher and invalidate its terms of warranty.

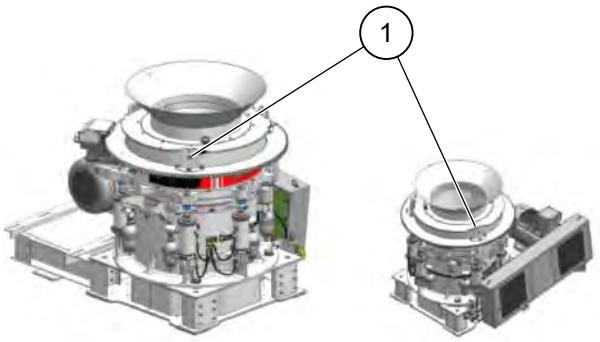
NOTE: Do not use non-flammable hydraulic fluids. Non-flammable hydraulic fluids may not be compatible with the linings, seals, accumulator components, hoses and other parts of the hydraulic system. The useful life of the pump could be shortened and the paint inside the tank could soften and disappear.

NOTE: When filling the crusher's hydraulic circuits, make sure you do not operate the pump without oil. When the hydraulic are full of oil and the holding system is pressurized, keep the oil level at the middle of the oil gauge.

Approximately 100 litres (26 U.S. gallons) are needed to fill the tank of the hydraulic system, holding cylinders, accumulators, locking cylinders and hydraulic hoses.

6.1.3 Unlocking the adjustment gear

Remove the locking screw (painted in yellow) on the adjustment ring before to starting the crusher.



1. Screw to be removed

6.2 Switching power on

6.2.1 Checking the rotation direction of the motor

The rotation direction of the motor must be checked before mounting the belts.

Direction must be clockwise when facing the end of the shaft.

6.2.2 Draining and testing the pressure of the hydraulic system

After making the initial connection, or whenever any circuit has been opened to replace or repair a component, you must drain the circuit to remove the air.

If the crusher is started up for the first time, each circuit must be drained before being pressurized.

NOTE: When draining the hydraulic circuits, check the oil level in the tank frequently and refill if necessary.

6.2.2.1 Starting up the hydraulic unit

Before purging the system or any of the circuits, oil needs to be circulated in all the circuits of the hydraulic unit.

For instructions on starting up the unit for purging or pressure testing purposes, see the hydraulics manual.

NOTE: Do not pressurize the retaining circuit before pre-loading the accumulators with nitrogen. This could damage the bladder and the accumulator would need to be replaced.

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6.2.2.2 Draining the clamping circuit

⚠ WARNING

PRESSURIZED COMPONENT HAZARD

Can cause death or serious injury.

After the engine has been stopped, some pressure can remain in the hydraulic system and in the cooling system of the engine. Let the machine cool down sufficiently before opening pressurized components. Always make sure that the system is pressure-free before doing any checks, maintenance, or repair work.

To bleed and pressure test the clamping circuit, proceed as follows:

1. Start the hydraulic unit. Refer to the hydraulic unit manual.
2. Check that the clamping circuit pressure has been decreased to 0. Refer to the hydraulic unit manual.
3. Follow the clamping circuit hose to the fitting threaded into the tapped hole in the adjustment ring. Loosen the fitting just enough to allow the oil to escape.
4. When the oil is flowing clear without bubbles or evidence of sputtering, tighten the fitting.
5. Increase clamping pressure. Refer to the hydraulic unit manual.

6.2.2.3 Draining the clearing circuit

⚠ DANGER

PRESSURIZED COMPONENT HAZARD

Will cause death or serious injury.

Keep away from the adjustment ring as it is in the upper position. The adjustment ring will quickly go down if the clearing button is released.

The clearing circuit is composed by six cylinders and accumulators, which encircle the outside of the main frame interconnected by hoses.

The clearing side of the cylinders and hose lines are vented of entrapped air at each cylinder as follows:

1. Start the hydraulic unit. Refer to the hydraulic unit manual.
2. Loosen the clearing hose fittings that are connected to the lower end of the tramp release cylinders.
3. Obtain 14 bars (200 PSI) pressure.
4. Loosen the tramp release hose couplings connected to the bottom of the holding cylinder by roughly 1 and a half turns.
5. When the oil flows clear without bubbles or evidence of sputtering at an individual cylinder, tighten the fitting.
6. Continue this procedure until all the fittings are tightened.
7. Pressurize the circuit to lift the adjustment ring to its maximum height until the pressure reaches its maximum of 210 bar (3000PSI).

8. Check the hose and piping connections to be sure there are no oil leaks. Tighten any loose connections.
9. Seat the adjustment ring on the main frame all around the crusher.

6.2.2.4 Draining the tramp release circuit

The tramp release circuit is composed of six cylinders and accumulators, which encircle the outside of the main frame and are interconnected by hoses.

The cylinders and accumulators are vented of entrapped air as follows:

1. Start the power unit. Refer to the hydraulic unit manual.
2. Obtain 14 bars (200 PSI) pressure. Refer to the hydraulic unit manual.
3. At each cylinder, loosen the hose swivel fitting, threaded on the «tee» at the upper end of the cylinders, just enough to allow the air and oil to escape.
4. When all the air has been vented as indicated by the oil flowing clear and free of bubbles or evidence of sputtering, tighten the swivel fitting.
5. Repeat the above procedure at the remaining cylinder and accumulator clusters.
6. Pressurize the system.
7. Check for oil leaks at all hose and piping connections. Tighten any loose connections.
8. Let the power unit connected to the crusher run through two complete cavity release clearing and cavity release pressurizing cycles to work any entrapped air remaining in the system back to the oil reservoir.

6.2.2.5 Draining the braking circuit

NOTE: The brake circuit is interconnected with the loosening and tightening operations.

Bleed the brake circuit as explained below:

1. Follow the brake release circuit hose to the port on the side of the brake which is part of the hydraulic drive assembly mounted on the adjustment ring. Loosen this fitting enough to allow the oil to escape.
2. When the oil is flowing clear without bubbles or evidence of sputtering, tighten the fitting.

6.2.2.6 Pressurizing the tramp release circuit

1. After having made all the connections, purged the circuits and fixed any leaks, pressurize the holding circuit before starting up the crusher. Refer to the lubrication unit manual.

   The tramp release circuit pressure must be maintained at the recommended level in order to provide adequate and safe overload protection to the tramp release cylinders.

   The circuit pressure should be maintained between the minimum and maximum pressures.
2. If circuit pressure is above the recommended limits, refer to *Depressurizing*.
3. If the circuit is to be pressurized after initial installation, after making repairs, or if circuit pressure is low, proceed as follows:
   a) Check the reservoir for adequate oil supply.

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NOTE: Do not pressurize the retaining circuit before pre-loading the accumulators with nitrogen. This could damage the bladder and the accumulator would need to be replaced.

b) Check accumulator pre-charge pressure and charge, if necessary.
c) Pressurize the tramp release circuit. Refer to the hydraulic unit manual.
The crusher must not start up with a pressure too low. The adjustment ring could bump and will be damaged for the main frame seat. To set up the right pressure, see the hydraulic unit manual.

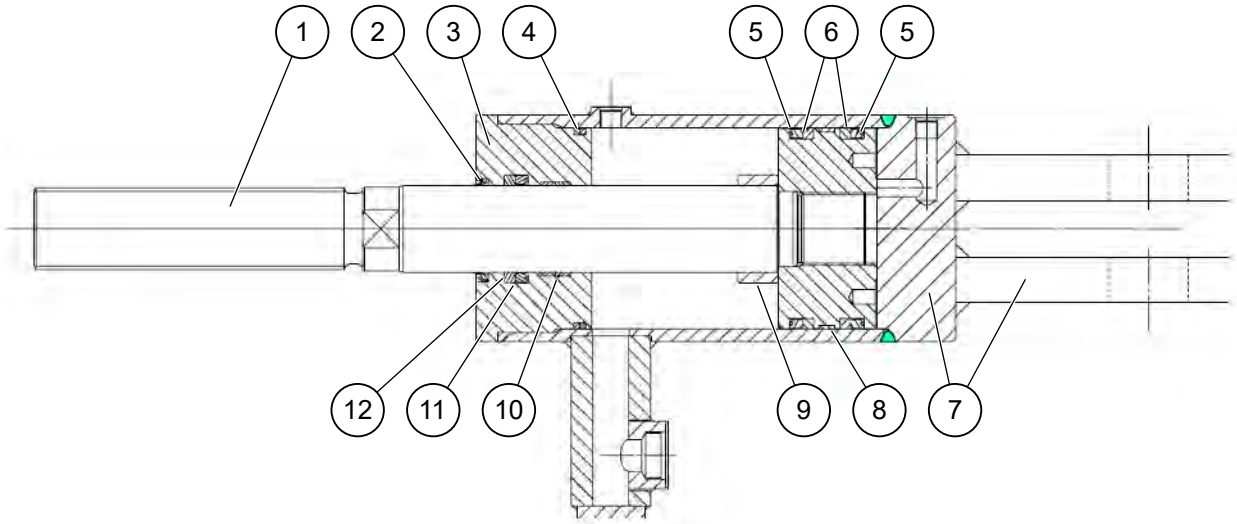
6.2.3 Depressurizing

Any maintenance on any of the devices in the hydraulic system must be preceded by properly depressurizing the circuit that is to be worked on. This is important for the safety of the person (s) working on the machine.

Many of the circuits are normally depressurized during crushing and are only pressurized when an operating function is performed. However, as a general safety precaution, the circuit pressure gauge should be checked before the circuit is worked on to be sure that there is no residual pressure in the circuit.

The cavity release pressurizing circuit, however, remains pressurized by the accumulators even after the pump has been shut off for some period of time. Before working on any of the hydraulic systems, see hydraulics manual.

6.2.4 Rebuilding the tramp or cavity release cylinder



1. Rod assembly
2. Rod wiper
3. Gland
4. O-ring seal
5. Poly-pak seal
6. Back-up ring
7. Cylinder assembly
8. Piston wear ring
9. Stop tube
10. Rod wear ring
11. Poly-pak seal
12. Back-up ring

Figure 44. Tramp or cavity release cylinder

The cylinder parts which need replacement in the course of normal use are the rod wiper or seal guard, the rod seals, piston seals and back-up rings. It is recommended that any O-rings which are removed with other components during disassembly should be replaced.

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Cavity release cylinder leakage is detected by oil seepage from the rod end of the cylinder or by the inability to hold clamping pressure. When a cylinder is found to be leaking, it should be replaced immediately. A leaking cylinder is critical because without full clamping pressure, the seating area of the adjustment ring and frame will be damaged.

When repairing a cavity release cylinder, it is recommended that all the «seals» are replaced at one time rather than gambling on a second oil leak. The entire replacement seals necessary for doing a complete rebuilding job are available in kit form for convenience. Be sure that a sufficient quantity of rod wiper or seal guards, Poly-Pak seals, O-rings and back-up rings are on hand before rebuilding of the cylinders begins.

During the entire rebuilding process it is important that the work is done on a clean surface and in a dust free atmosphere.

To disassemble, inspect, rebuild, and reassemble the tramp release cylinders, proceed as follows:

1. Unscrew the gland from the cylinder tube. Use a «homemade» spanner wrench in the notches in the outside diameter of the gland to turn the gland out of the tube.
2. Carefully pull on the threaded end of the rod to slide the entire piston, rod and gland assembly out of the cylinder.
3. To remove the piston from the rod, unscrew the piston from the rod and pull the rod through the bore of the gland.
4. Remove all the «seals» (rod wiper or seal guards, Poly-Pak seals, O-rings and back-up rings) from the gland and piston. Make a sketch showing exactly how the seals are positioned in the gland and piston so that the replacement seals can be re-installed correctly.
5. Thoroughly clean the rod, piston, gland and cylinder tube. All the surfaces of the entire cylinder and its related parts are to be clean and dust free. Closely examine the inside bore of the cylinder tube for scratches or rust. Any deep scratches or scoring will cause leakage and the cylinder tube must be replaced.
6. Using the sketch you made in step *4*, install the new seals on the gland and piston. Then slide the rod through the gland using a circular motion and re-install the piston on the rod.
7. Lightly oil the surfaces of the rod, piston, gland, seals and bore of the cylinder. Carefully insert the piston, rod and gland assembly into the cylinder tube while rotating the rod and piston back and forth in a circular motion and exerting slight downward pressure.
8. Screw the gland into the rod end of the cylinder tube and tighten securely. The tramp or cavity release cylinder is now ready to be re-assembled on the crusher.

6.2.5 Checking accumulator pre-charge (tramp release circuit)

⚠ WARNING

PRESSURIZED COMPONENT HAZARD

Can cause death or serious injury.

Never inflate accumulators with any other gas than nitrogen. Another gas could cause the circuit to explode.

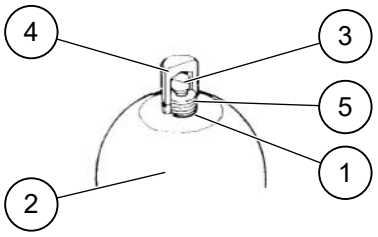
Following extensive use or when the protective device has been dismantled, check the accumulator preload pressure. The accumulators are preloaded with nitrogen and, prior to all monitoring interventions, the pressure in the release circuit must be zero.

To this end, open the corresponding valve in the hydraulic power unit.

When carrying out a check, make sure the accumulators are not in direct sunlight and the outdoor temperature is roughly 20°C.

Proceed as follows to connect the monitoring device and monitor the preload pressure of the accumulators:

1. Ensure that the tramp release circuit and the accumulators are empty. Refer to the hydraulics manual.
2. Remove the valve guard from the bottom of the accumulator and then the valve cap from the gas valve stem. Remove the washer that was under the valve cap.



1. Gas valve stem
2. Accumulator
3. Valve cap
4. Valve guard
5. Washer

Figure 45. Accumulator valve

3. Use the charging and gauging assembly (option) from the crusher tool box.

   The charging assembly is required to connect the gauging assembly to a nitrogen bottle in order to increase the pre-charge in the accumulator to the proper pressure.

   It consists of a 3 meter (10 foot) length of hose attached to a swivel connector on one end and a gland nut (left hand thread), gland and coupling on the other end. The gauging assembly consists of an pressure valve, bleeder valve, and pressure gauge mounted into an lower screw and attached as one unit directly to the gas valve stem on the accumulator. The charging assembly is only used when charging the accumulators; pressure readings can be taken and excess pressure bled off with just the gauging assembly.

   NOTE: The connection to the nitrogen cylinder (optionally supplied) is different depending on the country.

   a) Fully unscrew the knurled button on the inflator/tester and make sure the drain plug is closed.
   b) Screw the inflator/tester onto the accumulator using the knurled button at the lower part the inflator/tester.
   c) Connect the inflator/tester to the nitrogen bottle.
      The relief valve should limit pressure to the maximum value equal to the maximum pressure of the accumulator (this value is cold-stamped on the accumulator).
   d) Screw the knurled button onto the inflator/tester. The pressure value is displayed on the manometer.
   e) If the pressure is higher than 83 bar, unscrew the drain until the required pressure is obtained.
   f) If the pressure is lower than 83 bar, open the nitrogen bottle valve and adjust the pressure to 83 bar.
   g) Close the nitrogen bottle and disconnect it.
   h) Unscrew the knurled button at the upper part of the inflator/tester.
   i) Dismantle the inflator/tester from the accumulator.
4. Monitor the tightness of the valve with soapy water. If the valve leaks, repeat the pressure checking operation. If the leak persists, change the valve.
5. Put back the valve protection plug.
6. Carry out the same operation on the other accumulators.

7. Close the valve in the hydraulic power unit.
8. Pressurize the release circuit.

6.2.6 Oil leakage checking on hydraulic circuit

The additional lubrication and hydraulics manual gives detailed specifications for the type of oil, temperature and temperature regulation and any equipment that is or can be used in the lubrication system.

Please note that the latter is designed for a maximum pressure of 8.6 bars (124.73 PSI).

Refer to the documents showing the pipes, accessories and other equipment supplied with the crusher.

Two key factors should be considered:

1. Piping should be as short and direct as possible, with no high or low points or obstacles
2. The return pipes to the tank should have a downward gradient of at least 10%

Make sure the insides of the pipes are thoroughly clean. Remove any shavings from threaded ends to protect the oil pump and all wear surfaces inside the crusher.

Couplings should be designed to allow all lubrication parts (pump, filter, coolant, etc.) to be dismantled easily. Check that there are no oil leaks at couplings.

Oil suction pipes must be fully sealed, otherwise output and pressure will fall and could damage the crusher. Leaks from suction pipes are particularly dangerous because unlike pressurized pipes they cannot be detected.

6.2.7 Checking the emergency stop loop

Before the starting the crusher you must check the integration of emergency stops in the safety loop.

6.2.8 Checking crusher safety

CHECK warning labels on the equipment.

AFTER the crusher has been started, check all gauges and instruments to be sure that everything is operating properly.

SHUT DOWN immediately if any improper readings are observed.

TEST all controls for proper functioning.

LISTEN for and report any unusual noises.

RECHECK alarms or other warning and safety devices.

DO NOT stand on the adjustment ring while the crusher is running.

DO NOT lean or place your hands on or against the tramp release cylinders or between the adjustment ring and main frame while the crusher is in operation.

DO NOT take a chance with a defective machine. REPORT IT TO YOUR SUPERVISOR.

DO NOT look into crushing chamber while crusher is operating without protection.

6.2.9 Starting the lubrication unit

Refer to the lubrication unit manual.

6.2.10 Initial start-up

Although the crusher has been factory-tested, we recommend first running the crusher idle then at reduced capacity for several hours after the initial start-up or after fitting new rings.

This runs in the crusher and ensures that all the parts are working properly and are well oiled. It is also advisable to check oil temperature more often during this period.

Refer to the lubrication unit manual for more information on oil temperature.

The initial start-up procedure after fitting a new head bushing or eccentric thrust bearing is as follows:

1. Before starting up the crusher, start up the lubrication system.

NOTE: For proper lubrication of the bushings. The temperature of the return oil should be at least 16°C (60°F) before starting up the crusher. If necessary, immersion heaters will heat up the oil.

2. Power up the hydraulic unit.
3. Start up the crusher and let it run idle.
4. Make sure the return oil temperature reaches at least 27°C (80°F).
5. After the crusher has worked unloaded without any anomalies for at least 30 minutes, start steadily feeding the crusher up to 50% of the amperage indicated on the motor's nameplate.
6. After the crusher has worked at 50% load without any anomalies for at least 1.5 hours, feed the crusher for up to 75% of the amperage.
7. After the crusher has worked at 75% load without any anomalies for at least 2 hours, the crusher can now run at full capacity up to 100% of the amperage or the adjustment ring's bounce limit.
8. Take an oil sample after initial start-up and send it to the factory for analysis. Start keeping and updating a crusher event log.

6.3 Feeding the crusher

The product must be correctly distributed all around the crusher cavity, both in terms of level and of grading.

This ensures maximum throughput, better product shape and uniform wear of the bowl liner and mantle.

The first setting determined by the desired size of the end product is not necessarily the best for maximum yield. The best setting depends on the characteristics of the material to be crushed, the motor's absorbed power and the ring's bounce.

We recommend to change settings gradually to find the best compromise between throughput and yield.

6.3.1 Feed arrangement

⚠ CAUTION

PROPERTY DAMAGE HAZARD

Can cause moderate injury or property damage.

It is important to control the drop height of the material. If the drop height is excessive, the materials falling into the crusher can almost entirely pass through the crush cavity on the open side. Since these materials are not crushed, they can cause ring bouncing when they arrive at the bottom of the crush cavity, resulting in damages to the frame support.

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Crusher performance is directly proportional to the feed method. The crusher can only achieve optimal performance if it is fed with an adequate amount of material evenly distributed in the cavity. For best performance, certain precautions should be taken in laying out the feed plant.

The feed plant should be easy to dismantle to facilitate repair work on the crusher itself.

Well-designed feeds should stop the material when it reaches the feed ramp, so that it bounces up and falls vertically into the feed chute. This ensures even distribution over the feed cone.

Well-designed feed assemblies that take the feeder cavity into account ensure even distribution throughout the cavity. Segregation must be avoided at all costs to ensure even wear of the liner and mantle and thus maximum wear life.

For short-head crushers, feed should be adjusted so that the material covers the cone feed plate. The material should spread across the entire crusher cavity.

This feed system ensures high yield or better formed crushed product of a smaller grain size and considerable power savings.

Feed intake assemblies are not supplied with the crusher because their design depends on the layout of each crusher.

NOTE: Wherever possible, install a screen upstream of the crusher to remove fine or sticky material. This prevents packing, which causes excessive ring bounce and time loss. A magnetic separator may also be used to any remove metallic particles that could cause adjustment ring bounce.

The characteristics of the feed system should be such as to maintain the crusher in optimal operating conditions.

An adequate hopper to slow down the excessive fall must be used.

6.3.2 Incorrect feed

The figure below shows an example of an incorrect feed. Here, the material is unevenly distributed and only falling down one side of the feed opening.

Uneven distribution causes the following issues:

- Reduced output
- Irregular grain size of the crushed material
- Excessive adjustment ring bounce
- Excessive power consumption

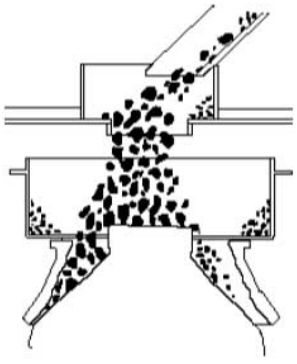

Figure 46. Incorrect feed

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6.3.3 Correct feed

The figure below shows an example of a correct feed. Here the material is evenly distributed.

Even distribution allows for the following:

- Optimal output
- Properly graded material
- Minimum adjustment ring bounce
- Optimal power consumption

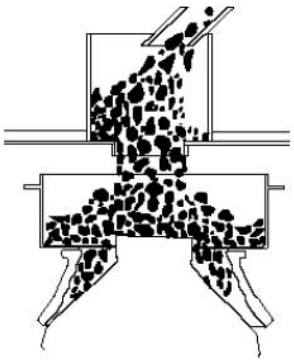

Figure 47. Correct feed

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7 Operation

7.1 Recommended operating conditions

7.1.1 Operator's platform

Since periodic inspection and maintenance must be performed on each crusher, it is important that some type of platform be erected at a level convenient for the maintenance personnel who must inspect and work on the crusher.

A good operator’s platform constructed of a solid floor plate should have hand railings, toe plates and wire mesh or expanded metal between the platform and the top of the hand railing to prevent tools from dropping off the platform and hitting someone working below.

Do not fasten the operator’s platform to the adjustment ring as the entire adjustment ring raises or lifts very quickly when trap iron passes through the crusher.

7.1.2 Ambient temperature

The ambient crusher temperature shall be maintained between -30°C (-22°F) and +50°C (+122°C).

Below this temperature, the resistance of the crusher structure can deteriorate. Over this temperature, it’s difficult to maintain the hydrodynamic conditions in bearings and risk of seizing up the crusher increases.

For an ambient temperature lower than 0°C (32°F), the lubrication circuit must be maintained in temperature even if the crusher does not work (heating mode). The heating mode allows maintaining the oil in a temperature between +20°C* and +25°C* (+68°F* and +77°F *) in the tank, and to make it circulate in the piping when the crusher is stationary.

In every case, if the crusher and the lubrication pump are stopped and the ambient temperature is 0°C* (+32°F *), the circuit must be verified and defrosted before starting the pump and the crusher.

(*) Temperature given for an oil ISO-L-CKC150

The cooler, pressure limiter, pressure controller and hoses can remain frozen even if the heaters are in operation.

For an ambient temperature lower than -15°C (5°F), a hydraulics heating system shall be installed (not supplied with the machine). An oil that is too cold cannot circulate freely. This situation can seriously damage the crusher.

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7.1.3 Backing resins

DANGER

CHEMICAL HAZARD

Will cause death or serious injury.

Do not use molten zinc for sealing crushed parts.

Wear appropriate protective equipment when handling the resin.

Seal liners with epoxy resin when replaced.

When epoxy backings are used, care should be taken when removing the liners with a cutting torch.

The area should be well ventilated because epoxy fumes can cause nausea or possible eye or skin irritation

7.1.4 Instructions for the use of thermal products

DANGER

BURN HAZARD

Will cause death or serious injury.

Follow appropriate safety procedures when handling dry ice, liquid nitrogen or any other refrigerant.
Wear appropriate protective equipment when handling the cooled parts.

7.1.5 Recommendations for proper crusher operation

Crusher operation can be controlled by varying the flow rate of the material fed into the crusher. A higher feed rate results in higher power absorption and a lower feed rate results in lower power absorption.

The crusher's operating power should be as close as possible to its power rating, according to the form of the circuit and the capacity of the control system. Power peaks in excess of 110% of the power rating should be avoided. This can cause the regulating point to lower in order to keep power peaks within safety limits.

On no account should the crusher run with low power for more than a few seconds. Power absorbed during crushing should be kept at 40% more than the power rating. During the start-up and shutdown phases, operation at low power is acceptable, but operation with continuous stop-start of the feed must be avoided at all costs.

If the crusher needs to be without feed for more than 30 minutes, it should be shut down and only restarted when the feed is available.

When the feed rate exceeds the cavity's volume capacity, a static level of feed starts to form above the cavity. A higher feed rate will increase the level of the materials above the crusher cavity, whereas a lower feed rate will reduce the level of the materials above the crusher cavity. With even lower rates, the feed rate will fall below the volumetric capacity of the crushing chamber and the level of materials in the crusher cavity will start to reduce.

For optimal performance, the level of material in the cavity should be about 300 mm (12") above the top of the cone feed plate. This guarantees even distribution of the feed around the crushing chamber and avoids power peaks caused by minor changes in the feed rate. A level sensor can be fitted to monitor the level in the chamber and its signal can be used to adjust the crusher's feeding rate.

The choice of chamber (the shape of the bowl liner and mantle) and the lower end setting create operating conditions with regular absorbed power of between 75% and 100% of nominal power. The crusher setting can be used to optimize the crusher's working power requirement.

Increasing the setting reduces absorbed power for a given level in the chamber while increasing the feed rate necessary to maintain the same level in the chamber. Decreasing the setting increases absorbed power for a given level in the chamber but reduces the feed rate required to maintain the same level in the chamber. A smaller opening also means that the size distribution of the product will be smaller.

A hydraulic motor is used for precise adjustment of the bowl. This adjustment is designed to correct the crusher's feed setting with or without feed. This system can be used to correct the crusher setting and its absorbed power while the crusher is being fed.

Check the feed before making any adjustments. The setting should be corrected to make allowance for liner and mantle wear and to guarantee constant product grading. The setting should not be adjusted more than once an hour.

7.2 Starting and stopping

7.2.1 Checks prior to start up

Table 9: Checks prior to start up

Action	OK	Not OK
Have the wooden chocks between the bowl liner and mantle been removed?		
Crusher adjustment measured at ..... mm ('').		
Drive tension and alignment		
Position of the countershaft bushing's oil groove in relation to the drive		
If the eccentric was delivered dismantled, check the gap between the pinion and the adjustment gear.		
End float of the countershaft		
Crusher's anchorage and fastening bolts		
Does the design of the concrete block or dead-bed under the crusher allow the free flow of crushed material?		

Action	OK	Not OK
Lubrication: 1. Slope of return pipes at least 10% between the crusher and the tank 2. Check the brand and quality of the oil used. Brand: ..... Type : ..... 3. Check the oil level. 4. Pipes are installed according to the plans. 5. Accessories such as filters, fan, unit heater, immersion heater, pressure relief valves, thermostats or temperature sensors, pressure switches and breathers are correctly mounted. 6. Alarm device, pressure switches, level controller and thermostat are correctly connected (see the hydraulics manual). 7. The pressure limiter and related pipes are properly mounted. 8. The pump rotates in the right direction. 9. Hydraulic couplings on the unit are correct. 10. Filter is clean. 11. Breathers in the countershaft housing and breather in tank are correctly fitted. 12. Oil supply and return pipes do not contain foreign bodies. Before connecting, check the condition and cleanliness of the insides of the pipes.		
Adjustment ring lubrication		
Hydraulics: 1. Check the brand and quality of the oil used. Brand: ..... Type : ..... 2. Check the oil level. 3. The retaining system's accumulators are properly filled with nitrogen. 4. All connections between the hydraulic unit and the crusher are correct. 5. Pipes have been blasted and tested for leaks. 6. Make at least one adjustment to ensure that the adjusting system and locking cylinders are working properly.		

Table 10: Checks prior to starting the oil pump

Action	OK	Not OK
Oil temperature is at least 16°C (60°F).		

Table 11: Checks prior to starting the crusher's hydraulics

Action	OK	Not OK
The countershaft rotates in the right direction.		

7.2.2 Preparing for start up

Carrying out inspections as a matter of routine will help to ensure optimal operation of the crusher for many years.

Never rely on your memory when planning regular maintenance, use a maintenance logbook. Regular checks and inspections will avert stoppages and prolong the crusher's lifetime.

Before starting up the crusher, carry out the following operations:

1. Check that the correct lubricating oil is used.
2. Check that the lubrication system is properly fitted as explained in the lubrication manual.
3. Start the oil pump motor.
4. Open the inspection hatch on the tank and check the oil return pipe to make sure the oil is circulating. In normal operation, the oil flowing out of the return pipe should fill half to two-thirds of the pipe.
5. Remove the wooden chocks between the liner and mantle for transportation.
6. Check the gap at the end of the countershaft. The countershaft must be able to move leftwards and rightwards by 1 mm to 1.5 mm.
7. Carry out a final check to ensure there are no tools or mechanical obstacles on the crusher.
8. Check that all joints are properly fitted.
9. Check for any leaks.
10. Check for any other reasons that may prevent the crusher from starting.
11. Rotate the countershaft by hand to check that the mantle does not touch the bowl liner and that there are no other mechanical hitches. If the mantle touches the bowl liner, refer to *Bowl assembly*.
12. Use the checklist in *Checks prior to start up* to ensure all the important points have been checked.
13. After completing the checks, start the crusher. Refer to *Initial start-up*

7.2.3 Starting up the crusher for the first time

Refer to *Initial start-up*.

7.2.4 Daily crusher start-up

It is important to consult the logbook when the crusher has not been in use for a while.

NOTE: Keep track of all operations on the crusher and make sure they are known by the personnel.

1. Before starting up the crusher, start up the lubrication system and make sure the return oil temperature is at least 16°C (60°F). Use ISO CC150 oil all year round.

   NOTE: For proper lubrication of the bushings. The temperature of the return oil should be at least 16°C (60°F) before starting up the crusher. If necessary, immersion heaters will heat up the oil.

   When crushing at extremely low temperatures, the oil may need heating continuously, even when the machine is not in use.

2. Let the lubrication system operate at least 1 minute for the oil to circulate.

   NOTE: Do not let the crusher run for more than 15 seconds if the oil does not appear in the collector unit on the oil tank. This could cause serious damage in the crusher. There should be enough oil flowing through the return pipe to fill at least one third or up to half of the pipe. Lack of oil may be due to several conditions: lack of oil in the lubrication system, a broken oil pump, a priming failure in the pump, a blocked suction pipe or an incorrectly adjusted bypass valve. Refer to the lubrication manual.

3. Power up the hydraulic system. Check all the indicators on the control box to make sure that the hydraulic unit is indeed powered up and the pressure in its circuits is normal. If holding pressure is abnormal, adjust the pressure of the circuit as instructed in the hydraulics manual.
4. Start up the crusher and let it run idle for 5 minutes.
5. Gradually start feeding the crusher until its maximum power requirement is reached (100% of the amperage or the adjustement ring's bounce limit).

7.2.5 Daily crusher shutdown

1. Stop the feed and let the crusher run for 2 to 3 minutes.
2. Shut down the crusher and check how long it takes to stop; this should be at least 30 seconds.
3. After shutting down the crusher, let the oil pump continue operating for 2 minutes.
4. Shut down the hydraulic unit.

7.2.6 Idle running

Table 12: Checks during idle running

Action	OK	Not OK
The crusher must run idle for roughly 1 hour, until the temperature of the return oil reaches 27°C (80°F).		
Crusher rotation speed: _____rpm.		
Seals underneath the crusher have been checked.		
Absorbed current running idle: _____ (A)		
Alarm devices (pressure switches, thermostats or temperature sensors) have been checked and conform.		
The crusher has run at 50% load for 2 hours.		
The crusher has run at 75% load for 4 hours.		
The crusher has run at 100% load for 1 hour.		
The shut-off valve stopped returning oil to the tank at: _____°C.		
Is the material evenly distributed in the cavity?		
The crusher shuts down in _____seconds.		

7.2.7 Starting the air cooler

Check that the air cooler works properly. Refer to the lubrication unit manual.

7.2.8 Starting the blower

Check that the blower works properly. Refer to the lubrication unit manual.

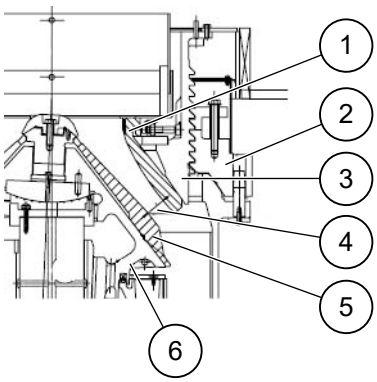
7.3 Normal operation

7.3.1 Crusher adjustments

Crusher adjustments depend on the size of the product to process. In most cases, the bowl should be adjusted so that lower opening between the bowl liner and mantle is a little smaller than the maximum size of the desired end product. The bowl also needs adjusting to make allowance for liner and mantle wear.

NOTE: The initial setting, determined by the size of the desired end product, is not an absolute guarantee of maximum output. This depends both on the characteristics of the material to be crushed and the power of the drive motor. Adjustment ring behavior can also be a factor.

The crusher is adjusted by either lowering or raising the bowl in the adjustment ring. To reduce the setting, lower the bowl by turning it clockwise. To increase the setting, raise the bowl by turning it counter-clockwise.



1. Bowl liner
2. Adjustment ring
3. Bowl
4. Parallel area
5. Mantle
6. Head

Figure 48. Crusher adjustments

Refer to the hydraulics manual for instructions on adjusting the crusher.

After a new adjustment, check visually that the pinion properly engages the adjustment gear on the adjustment cap, otherwise the bowl could become tighter or looser during crushing.

7.3.2 Running conditions

⚠ CAUTION

PROPERTY DAMAGE HAZARD

Can cause moderate injury or property damage.

It is important to control the drop height of the material. If the drop height is excessive, the materials falling into the crusher can almost entirely pass through the crush cavity on the open side. Since these materials are not crushed, they can cause ring bouncing when they arrive at the bottom of the crush cavity, resulting in damages to the frame support.

The product must be correctly distributed all around the crusher cavity, both in terms of level and of grading. For more information, refer to *Feeding the crusher*.

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7.3.3 Intermediate conditions (full to empty / empty to full)

⚠ DANGER

FLYING OBJECT HAZARD

Will cause death or serious injury.

During intermediate conditions, from full to empty or from empty to full, materials can be ejected from the cavity of the crusher. Keep away from the crusher as it is in operation.

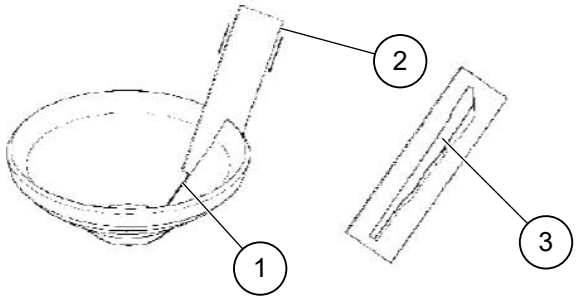
7.4 Settings

7.4.1 Choosing the liner and mantle

After intensive research and studies, Metso has developed a wide range of liners and mantles for a variety of products.

However, working conditions vary so much that one cannot say with certainty what type of liner / mantle is best suited to a particular type of material or process.

If excessive wear of the bowl liner and mantle occurs for any reason whatsoever, we suggest that the bowl liner and mantle be cut and their outline traced on a sheet of paper and sent to Metso in order to determine the exact cause of the wear. Other liners and mantles of different shapes may be recommended.



1. Cut out the mantle or bowl liner
2. Cardboard or thick paper
3. Trace the outline on a sheet of paper inserted in the cutout

Figure 49. Wear check

In order to best advise you on the type of liner/mantle you require, the following details are needed:

1. Dimension of the feed product
2. Type of feed
3. Desired size of the crushed product
4. The circuit of the installation, with the square mesh of the screens and the gradation of the crushers
5. Identification of the bowl liner and mantle
6. Installed capacity

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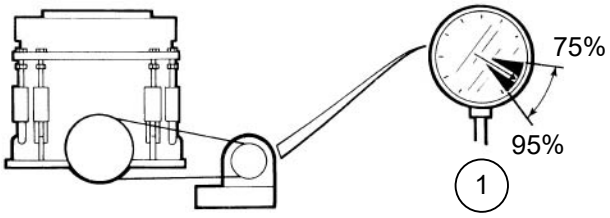
7. Crusher throughput rates

The crusher can be damaged by constantly working with an inadequately sized cavity in the liner and mantle.

7.4.2 Input power

Run the crusher at 75 to 95% of total average power WITHOUT RING BOUNCE.

Advantages: Longer service life for the crusher and higher yield.



1. Input power

Figure 50. Input power

7.4.3 Crusher speed

Speed (or revolutions per minutes) is essential to the proper functioning of the crusher.

The admissible speed range is given in the table below.

Table 13: Countershaft speed

RPM at full capacity
750 - 1150

The recommended dimensions of the pulleys driving the crusher are calculated for operation at full capacity. The countershaft will rotate a little faster when the crusher is running idle. Experience shows that running the crusher with the correct countershaft rotation speed produces a maximum amount of material at a constant grade.

The crusher's countershaft speed determines both the amount of material and the number of impacts a particle sustains in the cavity.

If the crusher cannot run at the right speed (rpm), a higher rotation speed is preferable (no more than 10% over the rated speed). If the countershaft speed is reduced to much lower that the recommended rotation speed, performance will be greatly impaired due to jamming in the crushing chamber, which could block the crusher.

Example:

A countershaft having a recommended speed of 950 rpm can be used at speeds of between 950 and 1045 rpm (950 rpm + 10%) without affecting crushing performance.

A different rotation speed is recommended in certain applications in order to improve the size or shape of the particles without affecting throughput. For such applications, contact Metso to find out the correct speed of the countershaft.

NOTE: A higher speed can alter the material of the drive and drive pulleys.

7.4.4 Feed height and speed regulation

Refer to *Feed arrangement*.

7.4.5 Throughput sensor

Throughput ratings in the sales catalogue are based on tests of numerous plants processing a wide range of materials. For a precise rating of your particular plant, please contact Metso.

Factors to consider for optimal throughput and performance

1. Choice of the crusher cavity (materials to be crushed)
2. Minimal segregation of grain size on intake
3. Feed control
4. Even distribution of the material 360° around the cavit
5. The discharge conveyor belt should be adequately sized
6. Appropriate scalping and screening
7. Automatic feed control
8. Adequate discharge area.

Factors impairing throughput and yield

1. Sticky material in the feed
2. Fines in the feed (over 10% of the material is undersize)
3. Excessively damp product
4. High segregation rate on intake
5. Uneven feed distribution
6. No in-feed control
7. Inadequate motor power rating
8. Inadequate conveyor capacity
9. Insufficient scalping and screening
10. Inadequate discharge area
11. Very hard material that is difficult to crush
12. Inadequate speed.

7.5 Alarms and troubleshooting

7.5.1 Crusher overheating

Cause

Damaged pump or inadequate throughput

Remedy

1. Check the backflow of oil returned by the pump (l/min).

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Cause
Bowl liner and mantle unsuited to the application
Remedy
1. Check if there is too much fine materials in the crusher cavity, entailing excessive input power.

Cause
A special feed generates too much heat in the crusher
Remedy
1. Fit an air cooler to the crusher.

Cause
Insufficient lubrication of the crusher
Remedy
1. Check the pressure relief valve. If the valve is faulty due to wear, it may be bypassing the crusher.
2. Check the quality of the oil used.

Cause
V-type drive belts are too taut
Remedy
1. Adjust belt tension.

Cause
Lubrication too contaminated
Remedy
1. Replace the lubricant as per the specification.

Cause
No end float on the countershaft
Remedy
1. Check that the end float of the countershaft is 0.8 to 1.6 mm. Refer to *Checking end float*.

Cause
Upper thrust washer worn out
Remedy
1. Check if the lubricating grooves are worn, preventing proper lubrication of the surface and causing the temperature to rise.
2. Replace the washer.

Cause
The crusher absorbs to much power
Remedy
1. Check for poor feed conditions, too much fine product or crusher working too hard.
2. Check for tramp iron. Tramp iron causes overloads.

Cause
Crusher adjustments too narrow
Remedy
1. Do not adjust the crusher below its minimum gradation setting.
2. Check bounce on the adjustment ring.

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Cause
The lubrication holes in the shaft are clogged with mud or rubble
Remedy
1. Clean the vertical and horizontal holes in the main shaft with compressed air.

Cause
The unit cooler is clogged up with mud or rubble or blocked on the outside (curtains)
Remedy
1. Clean the unit cooler.

Cause
The lower head bushing is warped
Remedy
1. Check if the crusher is operating with insufficient mechanical force, power under 40%.
2. Check if the crusher remains without feed for too long, or if there are too many fines in the feed.
3. Check for low oil pressure, high temperature, or too low oil viscosity.
4. Check if the oil is contaminated due to the presence of foreign particles upstream of the filter, or if the filter is obstructed.

Cause
Eccentric bushing surface is warped
Remedy
1. Check for lubricating failure due to too high a temperature of the oil or too low oil viscosity.
2. Check if there is an excessive quantity of fines in the feed or if the crusher gradation is set too fine. Check for large amount of impurities in the feed.
3. Check if the oil film is sufficient.
4. Check for damage on the surface of the main shaft.
5. Check if there is a gap between the main shaft and the eccentric bushing.
6. Check for incorrect adjustment between the shaft and the frame with a thickness gauge.

7.5.2 Unlocked socket

Cause
Socket screws broken
Remedy
1. Replace the screws using the correct thread torque. Tighten the screws after cooling the assembly. See *Bowl thread and adjustment ring wear*.

Cause
Gap between the socket and the shaft due to wear
Remedy
1. Check the gap between the shaft and the socket. If necessary, recondition the socket by hard-surfacing and machining, to achieve maximum screw adjustment.
2. If the shaft is damaged, mount a socket with a smaller bore.

7.5.3 The crusher uses too much oil

Cause
The T and/or U seals are worn or damaged
Remedy
1. Replace the seals.

Cause
Faulty pressure relief valve
Remedy
1. Check if the relief valve is incorrectly set or the spring remains in the closed position.
2. Replace the relief valve.
3. Check for too much oil flow in the crusher.

Cause
Oil is too cold
Remedy
1. Fit an immersion heater to heat the oil to 27°C.

Cause
The oil in the crusher is too viscous
Remedy
1. Use the right oil.

Cause
The crusher is not properly ventilated
Remedy
1. Clean the breathers at the countershaft housing or on the cover.

Cause
Oil return blocked with mud or rubble
Remedy
1. Inspect the oil return and clean if necessary.

Cause
Oil return unsuitable
Remedy
1. Check the oil return gradient (minimum 25 mm for 300 mm) or if the diameter of the oil return tube is too small.
2. Replace the return tube with a suitable one.

7.5.4 Production is reduced

Cause
Too fine a feed causes irregular wear on the bowl liner and mantle that when corrected reduces grip
Remedy
1. Replace the bowl liner and mantle or adjust the bowl for a bigger opening.

Cause
Too low or high an operating speed
Remedy
1. Check countershaft speed.

Cause
Too much debris in the feed (wood, roots, etc.)
Remedy
1. Remove the debris.

Cause
Materials are too large at the feed, preventing correct feed
Remedy
1. Reduce the dimensions of the materials at the feed.

Cause
Too much sticky material in the feed, blocking the bowl liner and mantle inlet
Remedy
1. Remove sticky products.

Cause
Incorrect feed distribution
Remedy
1. Correct feed distribution.

Cause
The mantle or the bowl liner is "cupping" at the bottom in the parallel zone
Remedy
1. Replace the bowl liner and mantle. Contact Metso.

Cause
The bowl liner and mantle in the parallel zone area have worn too quickly
Remedy
1. Replace the bowl liner and mantle, use another type of profile. Contact Metso.

7.5.5 The crusher is blocked

Cause
V-type drive belts are too slack
Remedy
1. Tauten the V-type belts.

Cause
Electric problems on the motor
Remedy
1. Check the crusher's off-load power rating and power absorbed by only the motor (without the belts). If both readings are similar, have the motor tested by an electrician.

Cause
Clogging under the crusher
Remedy
1. Check the passage of materials in the sheet metal work under the crusher.
2. Fit a rotation checker on the discharge conveyor and have it driven by the crusher feed.

Cause
Countershaft speed too slow
Remedy
1. Check countershaft speed (rpm).

Cause
Oil pressure too low
Remedy
1. Check to have a correct pressure.

Cause
Feed opening problem

Since crushing only occurs at the bottom of the chamber, motor power take-off.

Remedy
1. Check to have a correct pressure.

Cause
The bowl liner and mantle look like a "duckbill"
Remedy
1. Cut the "duckbill".
2. Replace the bowl liner and mantle.

Cause
The bowl liner and mantle wear out quickly in the parallel zone
Remedy
1. Replace the bowl liner and mantle with suitable profiles. Contact Metso.

7.5.6 Oil leak

Cause
The T and/or U seals are worn or damaged
Remedy
1. Replace the seals.

Cause
The O-ring or lip seals of the counterhshaft housing are damaged or worn
Remedy
1. Replace the joints.
2. Thoroughly clean the pinion side interlocking, lag with silicone.

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7.5.7 Countershaft jammed or broken

Cause
Belts too tight
Remedy
1. Check the tension of the belts and the alignment of the sheaves.

Cause
No lubrication or not enough oil on the countershaft bushings
Remedy
1. Check the connection between the main oil pipe and the oil inlet in the countershaft box.
2. Remove any valve or other device restricting the countershaft oil supply pipe.

Cause
The lubrication grooves in the bushing are incorrectly positioned
Remedy
1. Check that the belt drive is not pulling the countershaft against the lubrication groove.

Cause
No end float on the countershaft
Remedy
1. Check that the end float of the countershaft is 0.8 to 1.6 mm.

Cause
Countershaft bent

Generally this is caused by to excessive vibrations at the end of the countershaft.

Remedy
1. Replace the countershaft.

Cause
The oil grooves in the outer countershaft bushing are clogged up with mud or debris
Remedy
1. Clean the oil grooves.

Cause
Adjustment gear or pinion teeth broken
Remedy
1. Replace the adjustment gear or pinion.

Cause
Incorrect gap between teeth or at the bottom of the teeth between the adjustment gear and the pinion
Remedy
1. Adjust the gap between and at the bottom of the teeth.

7.5.8 Water is mixed with oil

Cause
Accumulation of water coming through the counterweight cover
Remedy
1. Drill holes and weld return tubes.

Cause
Breather blocked on the oil tank
Remedy
1. Replace the breather.

7.5.9 Bowl blocked

Cause
Accumulation of dust or rust in the thread of the bowl adjustment ring

This can be due to:

- Too hot a feed
- Insufficient lubrication of the threading
- The adjustment cap cover is worn or the dust prevention collar is damaged
- No weather protection
- The crusher has run too long for the given settings
- Bowl or adjustment ring threads damaged
- The threads are broken.

Try any of the following solutions:

Remedy
1. Put penetrating oil in the threads.
2. Relieve the pressure in the holding and locking cylinders and let the products pass through the crusher.
3. Feed small pieces of wood through the crusher.
4. Throw small pieces of soft steel into the crusher.
5. Heat the adjustment ring and cool down the bowl. DO NOT REMOVE THE FRAME'S ADJUSTMENT RING.

7.5.10 The bowl mantle or liner are detached

Cause
The thread torque of the nut's locking bolt is not correct, nor is the gap between the head of the screw and the locking nut
Remedy
1. Apply the correct thread torque.

Cause
Wrong position of the locking nut on the spacer ring
Remedy
1. Change the locking nut.

Cause
The locking nut knocks against the top of the head
Remedy
1. Check if the gap between the bottom of the locking nut and the top of the head is insufficient. The gap should be about 10 mm.

Cause
Liner, mantle or head seating surfaces damaged
Remedy
1. Remake the seating surfaces.

Cause
Insufficient gap for the seal between the mantle and the head
Remedy
1. Check that the gap is between 6 mm and 10 mm.

Cause
Cylindricality defect
Remedy
1. Check that the cylindricality does not exceed 3 mm.

Cause
Mantle is not secured to the head
Remedy
1. Check the bottom of the mantle with a gauge. The gap between the mantle and the head should not exceed 0.1 mm.

Cause
Mantle not centered on the head
Remedy
1. Dismantle the mantle and reinstall correctly.

Cause
The crusher rotates too long without feed
Remedy
1. Ensure that the maximum time without feed does not exceed 30 minutes.

Cause
Mantle is too thin
Remedy
1. Check that wear does not exceed 2/3 of the mantle. See *Determining liner and mantle wear*.

Cause
The old backing resin was not completely removed before the new mantle was installed
Remedy
1. Remove all the old backing resin.

Cause
The tightening lugs of the bowl liner touch the outer diameter of the liner or the screws have worked loose
Remedy
1. Wedge the lug or tighten the screw.

Cause
Bowl liner is too thin
Remedy
1. Check that wear does not exceed 2/3 of the bowl liner. See *Determining liner and mantle wear*.

Cause
Too much tramp iron passes through the crusher

Too much tramp iron will loosen the bowl liner.

Remedy
1. Check the amount of tramp iron in the feed.

Cause
The seating surface on the bowl liner or bowl is damaged
Remedy
1. Remake the seating surfaces to the original dimensions.

7.5.11 Oil leak at the end of the countershaft housing (sheave side)

Cause
The crusher is not at atmospheric pressure
Remedy
1. Clean the breather of the countershaft housing.

Cause
Not enough oil returns from the countershaft housing or oil deflector, especially when the oil is cold.
Remedy
1. Clean the oil inlet hole in the countershaft housing.

Cause
Defective lip seals
Remedy
1. Replace the lip seals.

Cause
The crusher is not level
Remedy
1. Level the crusher.

7.5.12 Excessive vibrations

Cause
Counterweight or counterweight liner worn
Remedy
1. Remake the counterweight. Contact Metso.
2. Replace the counterweight liner.

Cause
Gap at the bottom of the teeth is incorrectly adjusted
Remedy
1. Reassemble the eccentric and wedge it.

Cause
Bent countershaft
Remedy
1. Replace the countershaft.

Cause
The crusher's sheave turns with difficulty
Remedy
1. Remove the accumulated dust on the spokes of the sheave.

Cause
If the crusher is mounted as a mobile unit, the ground should be correctly prepared
Remedy
1. Check the seating.

Cause
Unsuitable foundations
Remedy
1. Check the foundations.

Cause
Bowl liner loose or worn
Remedy
1. Dismantle the bowl liner and replace or change it.

Cause
Countershaft speed too high (rpm)
Remedy
1. Use the correct speed. Refer to the table about countershaft speeds.

Cause
Counterweight liner missing
Remedy
1. Replace the liner. Contact Metso.

7.5.13 Wear on the head seating surface and bowl

Cause
The crusher runs with the bowl liner and mantle loose
Remedy
1. Make sure the bowl liner and mantle are properly mounted and that the locking nut is tight enough.

Cause
The crusher runs with damaged or worn bowl liner and mantle
Remedy
1. Check the bowl liner and mantle for wear or damage. Excessive wear on the bowl liner and mantle accelerates wear on the bowl and head seating surfaces.

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Cause
Mantle and bowl liner broken
Remedy
1. Check if the mantle and bowl liner are broken. Running with broken bowl liner and mantle accelerates wear on the bowl and head seating surfaces.

Cause
Intermittent feed while the new bowl liner and mantle are being run in
Remedy
1. Avoid intermittent feed when new bowl liner and mantle are mounted. For crushers without freewheeling clutch, starting the feed loosens torque when the feed slows down the head rotation.

7.5.14 Dust enters the lubrication system

Cause
No breather on the crusher
Remedy
1. Fit a breather on the top of the countershaft housing.

Cause
The breathers on the crusher or the oil tank do not work properly
Remedy
1. Clean the breathers on the countershaft and the oil tank.
2. Check the breathers by placing a sheet of paper placed on the breather pipe. The paper should be sucked slightly inwards.

Cause
The crusher sheave sends dust towards the breather
Remedy
1. Position the breather further away from the sheave.

Cause
Dust penetrated the crusher when parts were being dismantled
Remedy
1. Cover the socket and the eccentric with a plastic sheet.

Cause
The oil return between the crusher and the tank is too vertical

Dust may have been sucked towards the socket.

Remedy
1. Add another breather on the oil return pipe. Contact Metso.

Cause
No seal between the oil tank and its cover
Remedy
1. Fit a seal or apply silicone.

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Cause
The hose between the fan and the countershaft housing is damaged or disconnected
Remedy
1. Check the hose and the couplings.

Cause
The breather hose or couplings are damaged or disconnected
Remedy
1. Check the hose and the couplings.

7.5.15 Wear on the adjustment gear and pinion teeth

Cause
The oil is dirty
Remedy
1. Replace the oil and clean the tank.

Cause
Tooth wear too low
Remedy
1. Check for defective eccentric thrust washers.
2. Adjust the eccentric assembly with spacer rings.

Cause
Tooth wear too high
Remedy
1. Lower the eccentric assembly by removing spacer rings.

Cause
Crusher overworking

Generally revealed by adjustment ring bounce.

Remedy
1. Reduce the amount of feed.

Cause
Too much gap on the countershaft
Remedy
1. Check that the end float of the countershaft is 0.8 to 1.6 mm.

7.5.16 Noise on the drive gear and pinion

Cause
Incorrect gap between the teeth and at the bottom of the teeth
Remedy
1. Adjust the gap.

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Cause
The crusher runs with a new adjustment gear and an old pinion, or vice versa
Remedy
1. Contact Metso.

7.5.17 The adjustment ring is tilted

Cause
Contact surfaces between frame and adjustment ring are damaged due to ring bounce.
Remedy
1. Check if feed is incorrectly distributed in the crusher cavity.
2. Turn the ring 180°.
3. Check the pressure in the holding cylinders. If the pressure is too low, increase it.

Cause
Too frequent overload or unsuitable bowl liner and mantle profiles, causing the adjustment ring to bounce
Remedy
1. Check if there is too much fine product in the feed. Refer to *Choosing the liner and mantle*.
2. Increase the feed in the crusher.
3. Increase the gap between bowl liner and mantle.
4. Check if materials have clogged, water the feed.

7.5.18 Bowl bounce

Cause
Wear on the adjustment ring and bowl threads
Remedy
1. Re-machine the surface of the threads at 45° to achieve a uniform slope, provided that the threads are not irreparably damaged.

Cause
Lack of pressure in the locking cylinders
Remedy
1. Restore normal pressure in the locking cylinders.

Cause
Crusher adjustments too narrow
Remedy
1. Increase the gap until the bowl no longer jumps.

Cause
Bowl liner and mantle too thick

Not enough threads are engaged.

Remedy
1. Mount thinner bowl liner and mantle.

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Cause
Gap adjustment too wide

Not enough threads are engaged.

Remedy
1. Reduce the gap.

Cause
Hydraulic hoses and locking cylinders are not correctly connected
Remedy
1. Check that the hose between the cabinet and the locking cylinders is taut when the hydraulic unit is running.

7.5.19 Light signal indicating low pressure in the tightening circuit

Cause
Possible leak on the unit or tightening circuit
Remedy
1. If the signal comes on more than once in the space of 10 minutes, look for leaks on the unit and the tightening circuit.

7.5.20 Light signal indicating low pressure in the tramp release circuit

Cause
Possible leak on the unit or tramp release circuit
Remedy
1. If the signal comes on more than once in the space of 3 hours, look for leak on the unit and the tramp release circuit.

7.5.21 Locking bolts on the feed cone are broken

Cause
Too much feed in the crushing chamber
Remedy
1. Reduce the amount of feed.

Cause
Feed contains large pieces of product
Remedy
1. Reduce the size of the input products or increase the admission opening by changing the bowl liner and mantle.

Cause
The contact surfaces between the feed cone and the locking bolt are worn
Remedy
1. Hard-surface and re-machine the locking bolt.
2. Replace the feed cone.

Cause
The feed cone bolts are loose
Remedy
1. Tighten the bolts to their thread torque.

Cause
Drop too high
Remedy
1. Reduce the drop between the feed box or belt and the feed cone.

7.5.22 Bounce on the adjustment ring

Cause
Overload or incorrect profile of the bowl liner and mantle
Remedy
1. Check if there is an excessive quantity of fines in the feed.
2. Check if there is too much feed.
3. Check if the opening is too narrow.
4. Check for sticky materials in the feed.

Cause
Operation with too little cylinder pressure
Remedy
1. Check if the cylinder seal is defect.
2. If the unit does not repressurize the cylinders automatically, check for a faulty pressure switch.
3. Check for a leak in the cylinder circuit valve inside the unit.
4. Check for a leak in the cylinder pressure relief valve or valve left open.
5. Check for a leak or defect on the hose or coupling.

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8 Maintenance

8.1 Specific tools

Refer to *Special tools* for a list of specific tools for maintenance.

8.2 Planned maintenance

8.2.1 Daily inspection and maintenance

Table 14: Daily inspection and maintenance

	Items	List	Normal conditions
1	Check the oil level in the tank.		Oil level in the gauge
2	Check the temperature at the inlet and exit of the crusher.		**Inlet:** 38°C - 54°C **Return temperature:** +0° to 5°C without cooling tower +0° to 8°C with cooling tower
3	Check pressure at the countershaft housing.		1.4 - 2.8 bar (20 - 40 PSI)
4	Check input power or current requirement.		
5	Check setting at cavity outlet.		
6	Check release pressure.		See the hydraulics manual
7	Check locking pressure.		165 - 193 bar (2400 - 2800 PSI)
8	Check feed, distribution and level.		
9	Check the crusher's discharge area and accumulation on the arms.		
10	Check the counterweight liner.		
11	Check the time countershaft takes to stop.		30 - 60 seconds
12	Check connections and clamps.		
13	Check for unusual sounds, signs of wear or excessive strain.		
14	Liner and mantle wear out, check their condition at regular intervals.		

	Items	List	Normal conditions
15	Check the adjustment ring for bounce.		Correct operation when loaded, no bounce
16	Check return oil flow in the tank and the pump outlet filter.		

8.2.2 Weekly inspection and maintenance

Table 15: Weekly inspection and maintenance

	Items	List	Normal conditions
1	Clean/replace the countershaft housing breathers and those of the tank.		
2	Check the oil circuits (for leaks).		
3	Check the liner, mantle and cone feed plate for wear.		
4	Lubricate the adjustment ring threads with the bowl released. Then lock the bowl and lubricate the threads again.		
5	Check the return filter in the tank.		
6	Check that there is no bouncing.		Correct operation when loaded, no bounce
7	Check the tension and condition of the belts.		
8	Make sure there are no oil leaks.		
9	Check the sheave (break, and tightness on shaft).		
10	Check that the feed cone screws are tight.		
11	Check the alarm indicators on the electrical cabinet are in good condition.		
12	Check the guards of the arms, counterweight, head and the state of wear of the frame seating surface plating.		
13	Check the oil level in the tank.		
14	Check the oil inlet and outlet oil temperatures.		
15	Check the oil pressure at the countershaft.		
16	Check the crusher's adjustment and wear of the bowl liner and mantle.		

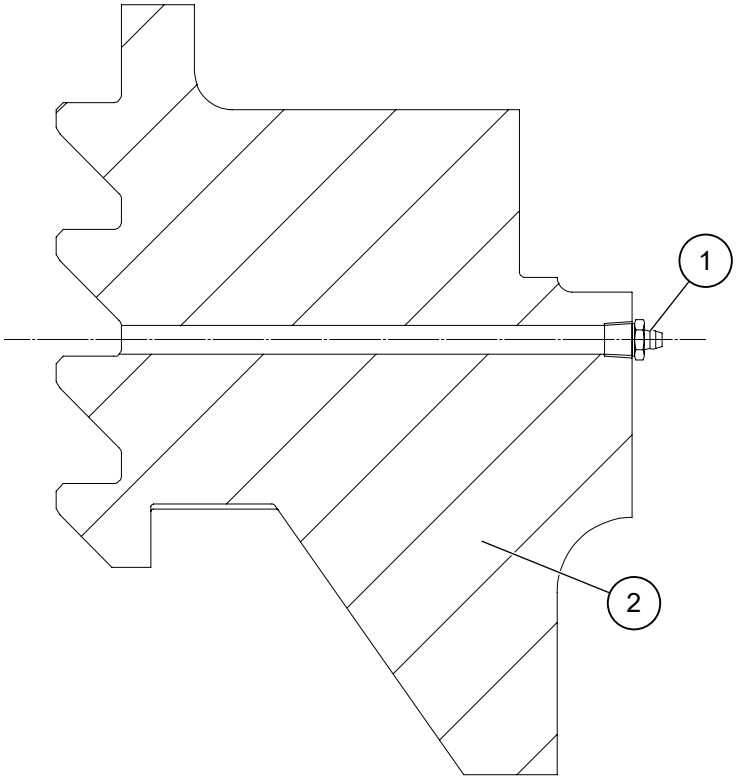
	Items	List	Normal conditions
17	Check the power or electric current requirement for the crusher.		
18	Check that no suspicious noise is emitted, nor any unusual vibrations.		

8.2.3 Lubricating the threading

It is very important to lubricate the threads of the bowl and adjustment ring on a regular basis to ensure the bowl continues to move freely in the adjustment ring.

Grease fittings around the side of the adjustment ring lubricate the threads, the bowl remaining engaged in the adjustment ring. The grease is forced into these fittings when the bowl is in crushing position and released.

Use a lithium-based grease, NLGI 1 or an equivalent type, preferable mixed with 5-10% of molybdenum bisulphite powder (by volume). For crushing hot products, such as slag and clinker, a high-temperature grease, preferably mixed with 5 to 10% of molybdenum bisulphite powder, is recommended.



1. Grease fitting
2. Adjustment ring

Figure 51. Grease fitting

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8.2.4 Monthly inspection and maintenance (200 h)

Table 16: Monthly inspection and maintenance

	Items	List	Normal conditions
1	Check the pre-load of the accumulators and top up with nitrogen if necessary.		See the hydraulics manual.
2	Check the pinion on the adjustment mechanism engages the driver ring on the adjustment cap.		
3	Test all alarms, warning lights and lubricating and hydraulic devices (pressure switch, temperature, thermostats).		
4	Unlock the bowl and rotate it in one direction then in the other.		
5	Check the lubricating oil. Change if necessary.		
6	Analyse the lubricating oil if in doubt.		See the oil contamination table.
7	Check the countershaft's axial clearance.		
8	Check the guards of the arms, counterweight, head and the state of wear of the frame seating surface.		

8.2.5 Annual inspection and maintenance (2000 h)

Table 17: Annual inspection and maintenance

	Items	List	Normal conditions
1	Dismantle the crusher completely to check the wear of all rings (head, eccentric, bearing and the surfaces of the pinion and adjustment gear).		
2	Inspect the frame, head and bowl (check for any fatigues or cracks).		
3	Check the state of couplings, supports, pipes.		
4	Check the state of wear of the head ball.		
5	Check the state of wear of the pinion and adjustment gear.		
6	Change the gear motor oil.		

8.2.6 Inspection and maintenance during bowl liner and mantle change

Table 18: Inspection and maintenance during bowl liner and mantle change

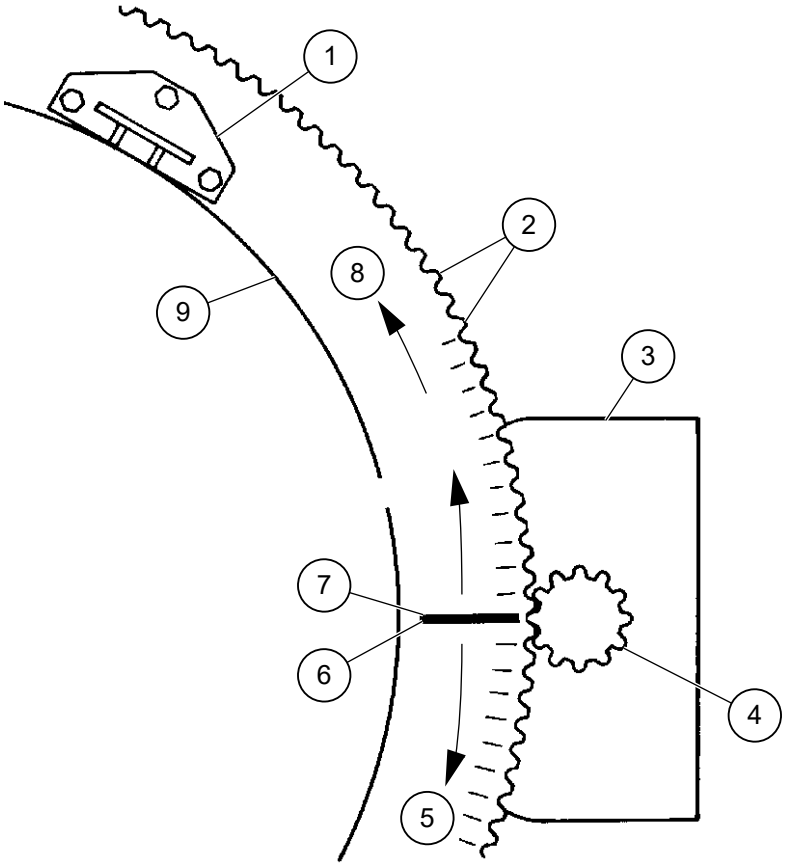
	Items	List	Normal conditions
1	Inspect the bowl liner and mantle, the bowl's seating surface and the head. Grind down any defects on the seating surfaces (if necessary).		
2	Inspect the head bushing, head ball, bearing, eccentric ring and seals.		
3	Check the locking nut and the feed cone (for wear). Replace if necessary.		
4	Check the guards of the frame's arms, countershaft and frame seating surface		
5	Inspect the threads of the bowl, adjustment and clamping ring.		
6	Inspect the hydraulics hoses (for leaks).		
7	Check the bowl liner's wedge locks and screws.		
8	Check the tightness of the counterweight bolts on the eccentric.		
9	Check the counterweight liner.		

8.2.7 Determining liner and mantle wear

Use the following information to determine when the liners (liner and mantle) are worn out and need replacing. Accurate records can be kept to record the degree of liner wear without stopping the crusher.

Record the wear of the first set of liners as follows:

1. When crusher adjustments are complete, make a mark on the adjustment gear, where it comes into contact with a pinion tooth. This will mark the first setting.
   Turning the adjustment gear by one tooth causes a very small vertical displacement of the bowl.
2. Keep a record of the exact number of teeth used during the life cycle of the first set of liners. Starting from the first position, note down each position until the bowl liner and mantle are completely worn.



1. Guide
2. Teeth of adjustment gear
3. Hydraulic setting assembly
4. Pinion teeth
5. Screw adjustment
6. Mark showing the initial position
7. Keep a record of the exact number of teeth used during the life cycle of the first set of liners
8. Unscrew adjustment
9. Adjustment cap

Figure 52. Position of the teeth and pinion and of the adjustment gear

NOTE: Because no two crushing operations are identical, and because of the wide range of liners and mantles available, it is not possible to predict in advance how many teeth a particular liner and mantle set will last before wearing out.

NOTE: In normal conditions, a liner generally wears out when its weight diminishes by 50%. This can vary according to application. Do not tighten the bowl until contact is made between the adjustment cap and the adjustment ring.

3. When the bowl liner and mantle wear out, but before removing the bowl from the adjustment ring, count by how many teeth the adjustment gear turned, and paint a horizontal line on the dust shell just above the adjustment cap.

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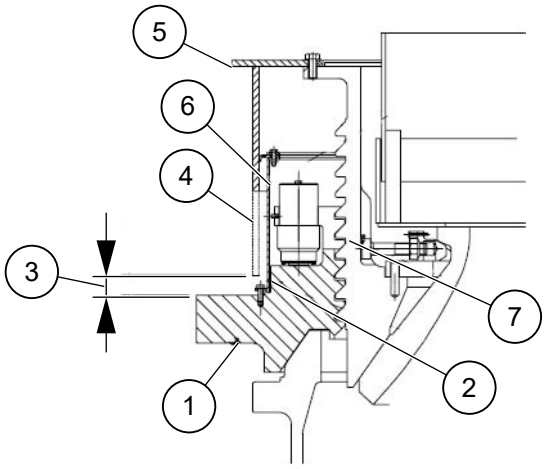

1. Adjustment ring
2. Mark on the dust shell giving the position of the adjustment cap when the liners are worn.
3. Distance "A", see table below.
4. Position of the adjustment cap with new bowl liner and mantle
5. Adjustment cap
6. Dust shell
7. Bowl

Figure 53. Checking wear of the bowl liner and mantle

4. Fit a new bowl liner and mantle, and taking account of the number of teeth the adjustment gear turned. The degree of liner and mantle wear can be determined by comparison with the number of teeth needed before the initial liner and mantle set wore out. The mark painted on the dust shell will also indicate when wear limit is approaching.
5. Follow this procedure several times to establish an average, because two liners do not wear out in exactly the same way.

   To facilitate the operator's task, the number of teeth available for each bowl rotation, as well as the change in vertical height and the adjustment per tooth are given in the table below.

   When the bowl liner and mantle are worn, see the minimum APPROXIMATE height between the top of the adjustment ring and the bottom of the adjustment cap.

   Because the setting varies depending on what the crusher is breaking up, the distance between the top of the adjustment ring and the bottom of the adjustment cap also varies. Refer to the table and apply the formula for determining distance A.

NOTE: The state of wear of the first set of liners should be monitored very closely.

When the first set of liners has worn out and is removed, cut out a section roughly 100 mm wide from each of them. Take these profiles into account when setting or correcting dimension «A» for the next set of liners. The bowl liner sections can be sent to Metso for profile analysis.

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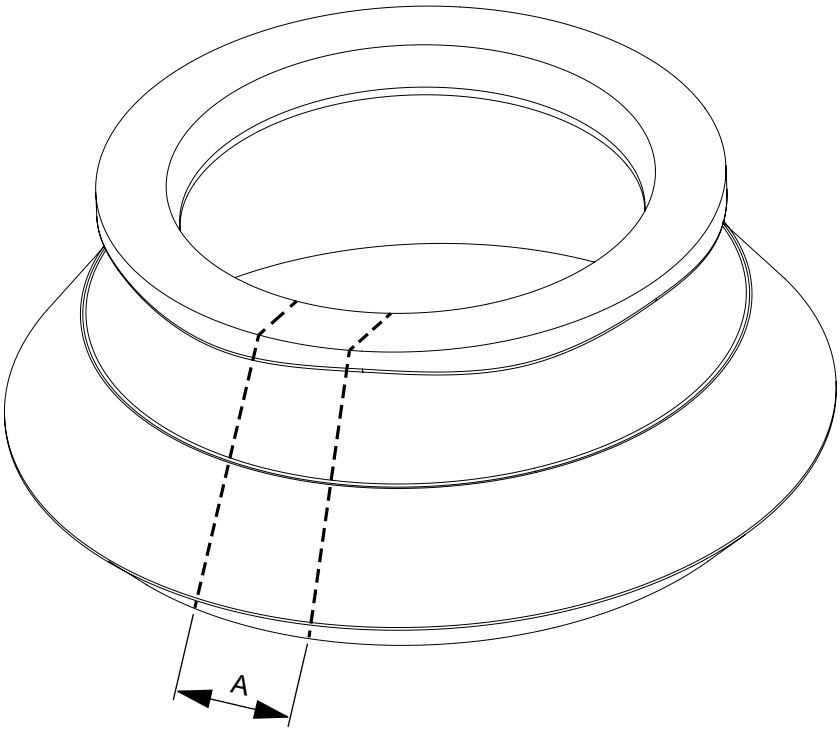


A. 100 mm

Figure 54. Cutting the bowl liner

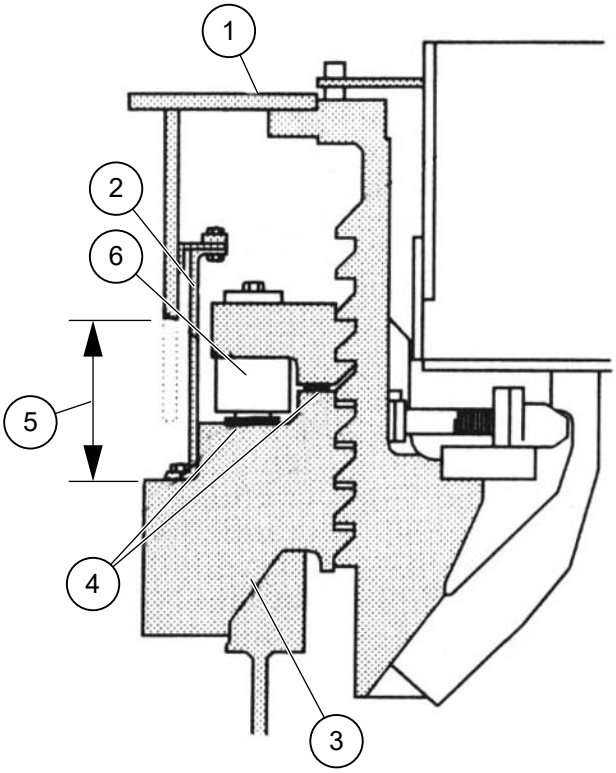
Table 19: Number of driver ring teeth and bowl travel information

Crusher	Number of driver ring teeth available in one complete revolution of bowl	Vertical travel of bowl per driver ring tooth	Change in crusher setting per driver ring tooth	1/4 turn of driver ring changes crusher setting	A Approximate minimum dimension when the liners are worn out
HP300	156	0.33 mm (0.013")	0.23 mm (0.009")	8.73 mm (11/32")	A = 37 + (1.59 x CSS)

8.2.8 Bowl thread and adjustment ring wear

Whenever liners are changed, check the wear of the bowl thread and the adjustment ring. To determine the degree of wear, check the difference between the vertical position of the bowl when locked and unlocked.

Measure the distance between the top of the adjustment ring and the bottom of the adjustment cap. See dimension A in the figure below.



1. Adjustment cap
2. Dust shell
3. Adjustment ring
4. Wedges
5. Dimension A
6. Clamping cylinder

Figure 55. Adjusting the ring with the head

For a new crusher, the gap between the threads is 3.57 mm. Any bigger gap is a sign of thread wear. If the size of the gap reaches 8 mm, thread wear equals 4.5 mm, which is the authorized maximum.

When the bowl's vertical displacement attains 8 mm, indicating 4.5 mm of wear, the clamping cylinders and the clamping ring must be reconditioned.

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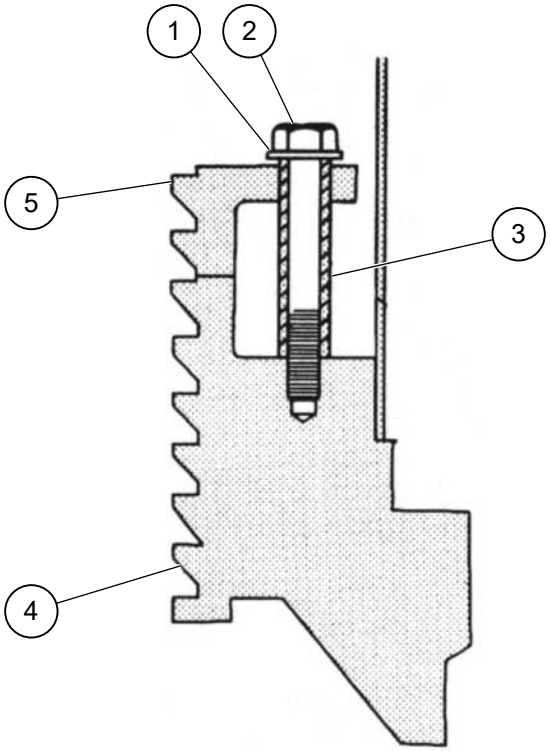

1. Flat washer
2. Locking screw
3. Spacer tube
4. Adjustment ring
5. Clamping ring

Figure 56. Spacer tube

If the vertical displacement between the threads after locking and unlocking reaches 8 mm, the threads of the bowl or adjustment ring or both must be reconditioned.

8.2.9 Dismantling and installing the bowl

To dismantle the bowl assembly when replacing the bowl liner and mantle or to gain access to other parts, proceed as follows:

1. Unlock the bowl. Refer to the hydraulics manual.
2. Turn the bowl in the adjustment ring counterclockwise or clockwise, using the hydraulic system or a crane or a cable as explained in *Rotating the bowl using a hydraulic system*.

8.2.10 Overhauls and repairs

Possibilities are offered to reconstruct cone crushers or recondition parts that have been used intensively or are worn after long periods of operation. It may be advisable and advantageous to return the crusher to the factory for this purpose.

A thorough overhaul done in time is cheaper than the replacement of certain worn parts.

We fully dismantle the crushers and examine all the parts to assess their value and remaining service life, and replace worn parts with new ones.

Contact Metso before re-tooling parts like the head, bowl, adjustment ring or frame.

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8.2.11 Regular inspections

The best way to keep a crusher in good working order after it has been installed and brought into service to carry out regular inspections. Metso recommends inspecting the crusher at regular intervals and maintenance work be carried out in good time.

The required inspections and intervals at which they should be carried out are listed in *Planned maintenance* They are only given as a rough guide; only you can determine whether they need carrying out more or less often. The type of material being processed, the climate and operating conditions are key factors in determining inspection intervals.

Keep the crusher clean and painted. A clean machine is easier to service and depreciates more slowly than a neglected one.

Inspection intervals vary according to conditions of use and applications.

8.3 Maintenance procedures

8.3.1 General information for servicing the crusher

The following precautions must be observed for all maintenance work and servicing of the crusher:

1. If parts with machined surfaces or bearing surfaces are removed, they should be oiled or covered with a protective film if put in storage for any length of time.
2. Handle machined parts with great care because their tolerance ranges are small.
3. When dismantling parts with machined surfaces, place them on wooden blocks to make sure they do not touch the ground.
4. Bronze parts must be handled with special care. Any shock to this soft material could damage such parts.
5. Clean and oil all machined parts thoroughly before mounting them on the crusher. Apply a coat of oil to load-bearing surfaces before replacing them.
6. When assembling two parts that need to be tightened using a press, cover the contact surfaces with a thin layer of oil. This will act as a lubricant and prevent rust forming.
7. The head bushings and eccentric thrust bushings must be stored vertically. Otherwise they could become distorted into an elliptical shape. This could lead to difficulties when installing future parts on the crusher.
8. All threaded parts should be rubbed with a cloth soaked in molybdenum disulphide powder then coated with grease or oil. If that powder is not available, simply greasing them may suffice.
9. Incorrect heating procedures can damage certain parts; please observe the following instructions:
    a. Whenever possible, it is better to mount hot parts by immersing them in an oil bath or an oven.
    b. Never exceed the required temperature, as this could damage the parts.
    c. Do not use a blowtorch to mount hot parts because the heat would not be evenly distributed.
    d. Propane or acetylene equipment should be used to raise the temperature in special cases.
    e. If a blowtorch is used to assemble the gear, avoid the flame coming into direct contact with the parts being treated. Let the heat escape first.
    f. When dismantling parts, heat them quickly and evenly. Dismantle them quickly.
10. Observe the following when fastening screws:
    - Screws used without thread brake: All screws and holes must be cleaned, the screws fitted with grease and tightened to their rated thread torque.
    - Screws used with thread brake: All screws and holes must be cleaned and degreased before fitting the thread brake onto the screws. In addition, if a part has been heated for mounting purposes, the screws must be fitted without thread brake. When the part's temperature has fallen to ambient

temperature, remove the screws, apply the thread brake then tighten them to their rated thread torque.

8.3.2 Removal of crushed material

The crushed material removal system is not supplied with the crusher, because the suitable solution depends on operating conditions, which vary according to layout.

The system in question, be it a hopper or dead-bed, should match the instructions in the installation plan. It should include a manhole to allow easy access for cleaning or inspection purposes.

Wherever possible, a dead-bed is preferable to a hopper because it absorbs most of the kinetic energy before the material reaches the conveyor. If a chute is used, it should be angled at more than 45° or an even steeper gradient for very sticky material.

As indicated on the layout plan, there should be enough clearance for material removal between the crusher and the hopper on the one hand and the hopper and take-up conveyor on the other. This gap should allow the crushed material to flow freely.

8.3.3 General maintenance tasks

A certain amount of work must be done in the immediate area of the crusher during the normal course of operations on a day-to-day basis.

- DO NOT perform maintenance on moving machinery. This includes such items as adding lubricating oil or greasing parts of the crusher while it is in operation.
- DO NOT put hands or feet on the tramp release cylinders which protect the crusher from tramp iron overloads while the crusher is in operation.
- DO check the manufacturer’s recommendations for periodic maintenance procedures. These maintenance procedures are designed to not only avoid damage to the equipment but also avoid harm to the operator as well.
- DO avoid spillage around the crusher. Crushers seem to attract odd size pieces of rock, gravel, etc. Plant operators should make it a habit to keep the area immediately adjacent to the crusher free from this type of spillage which could cause unsuspecting personnel to trip and fall.
- NEVER LOOK into the crushing cavity while the crusher is in operation.
- WHEN USING A CRANE to raise or lower a load keep all personnel clear of the area.
- NEVER walk, stand, crawl or lay under any load hanging from a crane.

8.3.4 Bowl assembly

This chapter describes the bowl, bowl liner and hopper assemblies.

The bowl is screwed inside the adjustment ring, adjustments are made by rotating the bowl anticlockwise or clockwise, according to the desired setting. Bowl adjustment determines the gap between the bowl liner and mantle.

The adjustment cap is fixed to the top of the bowl and rubs against the joint of the dust shell fixed to the adjustment ring. This protects the bowl and the clamping ring.

A set of clamping cylinders is located at the top of the adjustment ring and all round it. These cylinders push the clamping ring and raise the bowl to the crushing position.

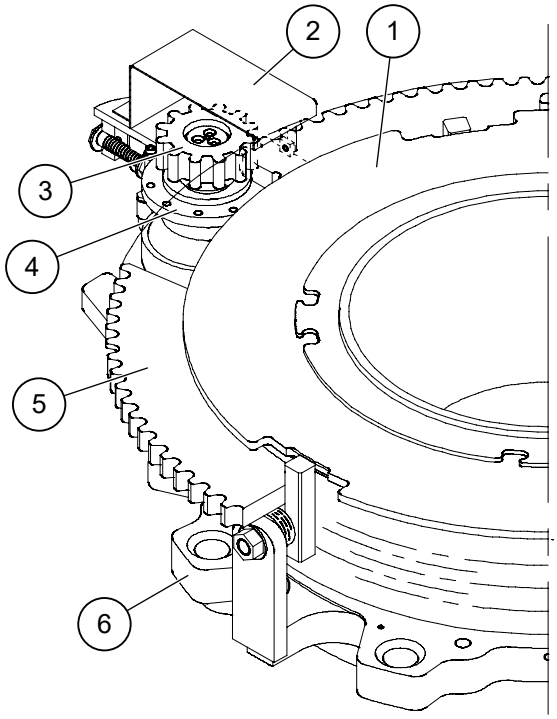
The bowl turns with the adjustment cap with the aid of a hydraulic motor mounted on the adjustment ring.

The hopper is placed on two pins on the upper edge of the bowl. The inside of the hopper directly feeds the crusher cavity. The shape of the bottom of the hopper has been designed so that the materials build up there, thereby forming a dead-bed that protects the hopper against the flow of feed material.

Under the hopper and on the bowl are several wedges and their screws. The wedges hold the liner firmly on the bowl.

8.3.4.1 Dismantling the bowl

1. Release the bowl by releasing the pressure in the locking cylinders.
2. Turn the bowl counterclockwise outside the adjustment ring using the hydraulic adjusting system.



1. Adjustment cap
2. Guard
3. Pinion
4. Hydraulic motor assembly
5. Adjustment gear
6. Adjustment ring

Figure 57. Hydraulic adjusting assembly

3. Raise the bowl with slings secured to the bowl eyebolts and lay it on a wooden block.

8.3.4.2 Backing

The HP300 is now delivered with a bowl liner without backing. At the customer's request, it is still possible to have these bowl liners with backing.

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8.3.4.3 Dismantling the bowl liner

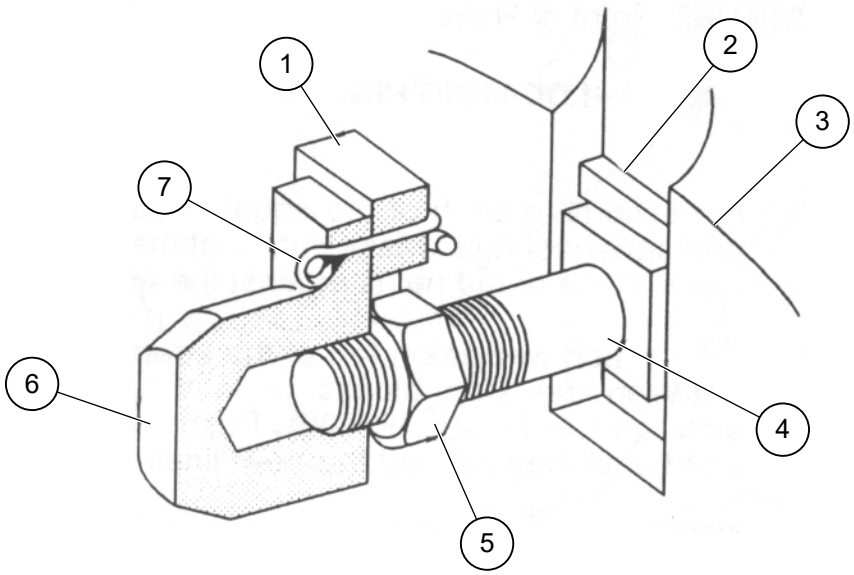
⚠ DANGER

TOXIC GAS HAZARD

Can cause death or serious injury.

Make sure the area is well ventilated or personnel use respiratory protection when handling chemical products to avoid inhaling toxic fumes.

1. Dismantle the adjustment cap.
2. Make sure the bowl assembly rests on the bowl liner, not on the bowl. Insert wedges under the bowl liner if necessary.
3. Clean the threads of the adjustment ring, clamping ring and bowl, removing all traces of dust and grease.
4. Dismantle the hopper from the bowl to have access to the lugs that retain the bowl liner on the bowl. The lugs are located on the bowl's adapter ring, which is fixed with pins.
5. Remove the pins retaining the nut locks.
6. Remove the nut locks.
7. Use a spanner to loosen the ball nut that presses against the rear side of the locking wedge.
8. The wedges will be caught between the edge of the liner and the adapter ring. Place a chisel against the shoulder of the wedge and strike it with a hammer to release it.



1. Nut lock
2. Stop
3. Position of the bolt in the notch of the bowl
4. Square head bolt
5. Ball nut
6. Lug
7. Pin

Figure 58. Wedge assembly

9. Use a special wrench to loosen the ball nuts by 20 mm. These nuts retain the wedges against the bowl liner.
10. The wedges are wedged between the edge of the liner and the adapter ring. Place a chisel against the shoulder of the wedge and strike it with a hammer to release it.

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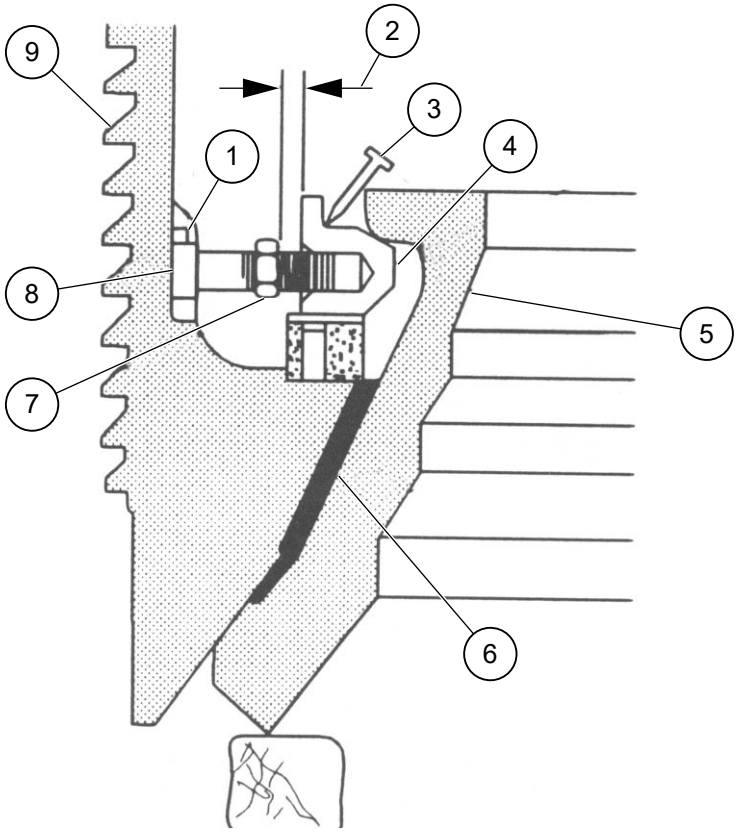

1. Stop
2. Loosen the nut by 20 mm
3. Chisel
4. Lug
5. Bowl liner
6. Backing resin
7. Ball nut
8. Square head bolt
9. Bowl

Figure 59. Dismantling the wedge

11. Repeat this procedure for all the wedges.

12. Raise the bowl above the liner. If resin blocks the liner in the bowl, hit the liner vertically to break up the resin.

13. Break up any remaining resin on the bowl. Usually the resin hardly adhere at all to the liner.

14. Check the bowl seating. Grind down any scratches.
The bowl seating should be clean so that the bowl liner fits properly and does not bounce.

8.3.4.4 Installing the bowl liner

DANGER

PERSONAL INJURY HAZARD

Can cause death or serious injury.

Follow safety instructions on the resin boxes. Contact with the skin or inhaling of fumed chemical can cause personal injuries. Wear suitable personal protective equipment.

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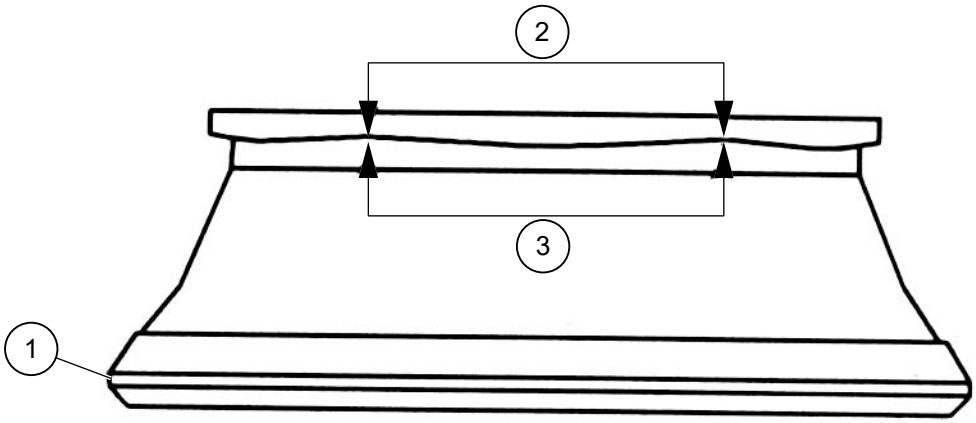
1. Place the liner on wooden wedges. Make sure the wedges allow the bowl to completely cover the liner.
2. When backing resin is used, lightly coat the lower surface of the bowl with oil to prevent the resin sticking to it.
3. Mark the position of the top of the liner undulation with chalk.



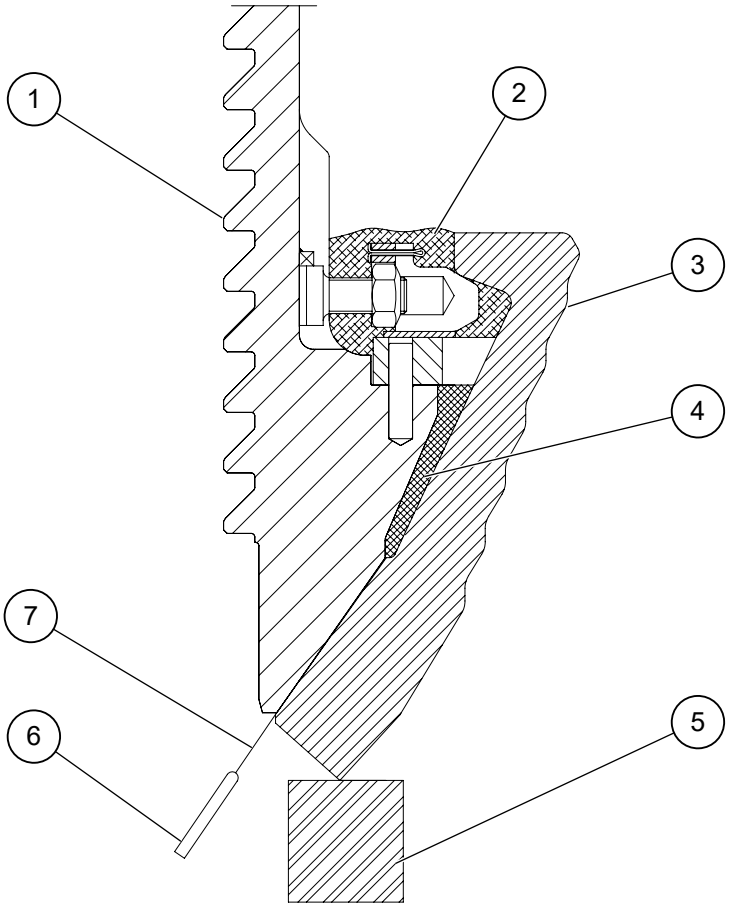
1. Bowl liner
2. Mark the top of the undulation
3. Top of undulation

Figure 60. Position of the top of the undulation

4. With the bowl's adapter ring fixed, lower the bowl and the adjustment cap into position on the liner. To ensure it locks into place, position the bowl so that the lugs are aligned with the tops of the bowl liner undulations.
5. To be sure that the bowl liner is centered on the bowl, measure the distance between the outer diameter of the bowl liner and the inner diameter of the bowl at four different points 90° apart. An incorrectly positioned bowl liner will damage its seating.
6. Pre-assemble each square head bolt, ball nut and wedge. Make sure that the spherical surface of the nut is placed against the wedge.
7. Place each wedge on the top of the bowl's adapter ring. Push them until they come into contact with the liner.

NOTE: Make sure that the middle of the tapered part of each wedge is clean.

8. Check each contact point between wedges, lugs and the bowl liner. Remove or add wedges underneath, if necessary, to achieve a correct point of contact. The wedges can be welded.
9. Place square head bolts and barrel nuts behind the wedges making the that the bolt heads are under the square stops welded to the bowl.
10. Tighten each nut alternately and in opposition until each lug fits neatly against the liner’s helix.
11. Use a gauge to check that the liner sits correctly all around the bowl seating surface. The gap should not exceed 0.25 mm. Block up any gaps due to wear with clay, etc. to prevent the backing resin from escaping.



1. Bowl
2. Foam seal
3. Bowl liner
4. Backing resin
5. Wedging
6. Set of wedges
7. Max acceptable gap 0.25 mm (0.01")

Figure 61. Checking the gap

NOTE: If the nose of the wedge once in place touches the vertical wall of the liner, place a wedge under the locking wedge so that there is contact between its sloping side and the undulated surface of the liner. When all wedges are in place and tightly fixed, there should still be a small gap between the nose of the wedge and the outer vertical part of the liner.

12. Pour in the resin, filling the cavity behind the bowl liner.
For the approximate quantity of resin, see the table below.

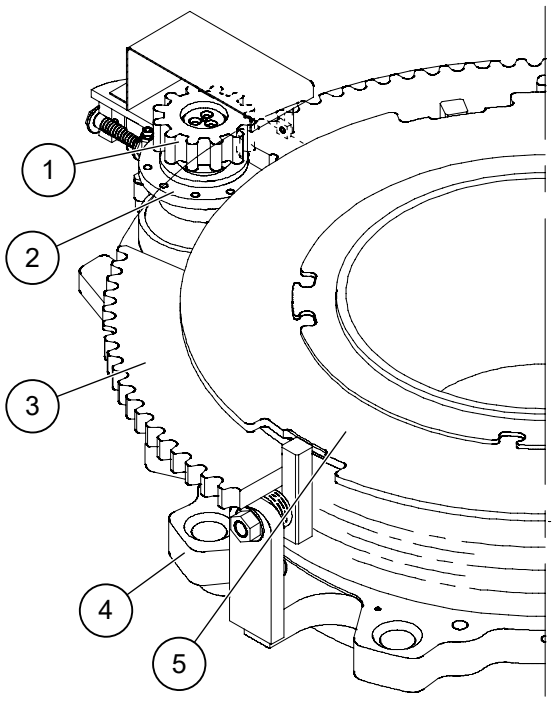
Table 20: Required quantity of backing resin

Type	HP300 Standard	HP300 Short head
Required quantity of resin for the bowl liner Average weight (kg)	35	35

Type	HP300 Standard	HP300 Short head
The backing resin comes in kits of 10 kg and 5 kg after mixing.		

13. Check again that all the wedges and ball nuts are tight when the resin has solidified.
14. Place the nut locks on the outer parts of the barrel nut.
15. Insert the pins through the wedge and the nut lock. Spread the two half-ends of the pins so that they remain in place.
16. Weld a block measuring 12 mm x 12 mm x 40 mm (1/2" x 1/2" x 1 1/2") just above the square head of the locking screw. The block will prevent the screw head from turning during crushing.
17. Cover the wedge assembly with foam joints to prevent ingress of dust and thereby facilitate subsequent dismantling of the liner.
18. Reinstall the hopper by positioning it on the pins fitted to the bowl.
19. Lubricate the threads of the bowl, clamping ring and adjustment ring. It is very important that the bowl rotates freely in the adjustment ring.
20. Reassemble the rest of the parts.

8.3.4.5 Rotating the bowl using a hydraulic system



1. Pinion
2. Hydraulic motor assembly
3. Adjustment gear
4. Adjustment ring
5. Adjustment cap

Figure 62. Bowl rotation - Hydraulic method

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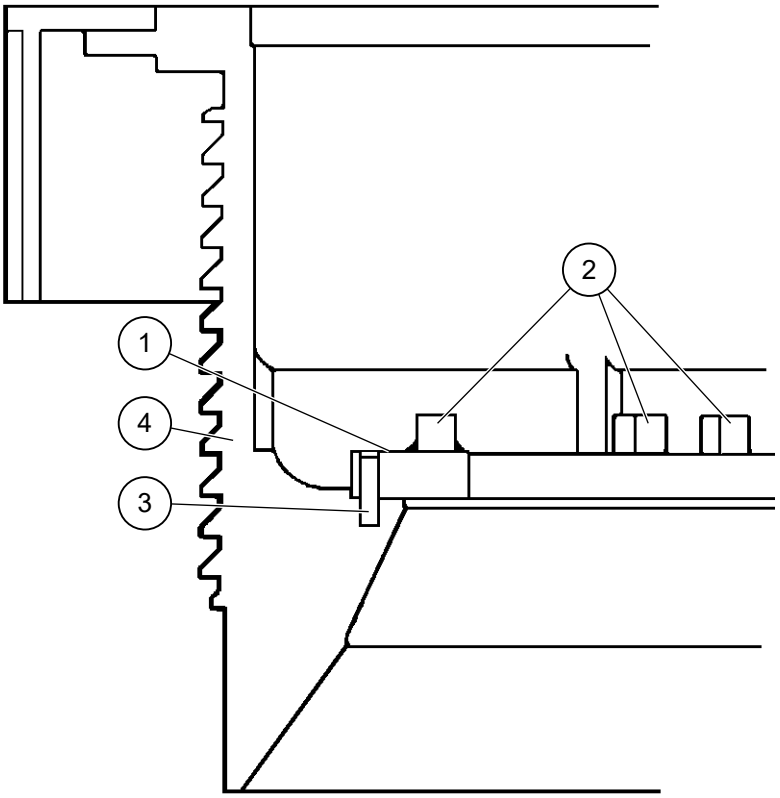
To dismantle the bowl assembly when replacing the bowl liner and mantle or to gain access to other parts, proceed as follows:

1. Unlock the bowl. Refer to the lubrication unit manual.
2. Turn the bowl in the adjustment ring anticlockwise or clockwise, using the hydraulic system.

8.3.4.6 Replacing the bowl's adapter ring

To change equipment for a different production job, it may be necessary to change the adapter ring.

1. To dismantle the adapter ring, lift it away. The adapter ring is simply centered in the bowl thanks to pins.
2. Install the new ring, positioning it with the pins. The new adapter ring already has the wedge locking blocks.



1. Bowl adapter ring
2. Wedge locking bolts
3. Pin
4. Bowl

Figure 63. Bowl adapter ring

8.3.4.7 Reconditioning the bowl seating (liner)

After a long period of use, the bowl seating must re-machined or reconditioned. Contact Metso.

8.3.5 Head assembly

This chapter describes the head, mantle and feed cone assemblies, the head and mantle, as well as the bowl and bowl liner form the crusher cavity.

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On the top of the mantle, there is the spacer ring. These two parts are firmly held on the head by a locking bolt screwed inside the head. A feed cone is fixed onto the locking bolt. This cone rotates with the head, evenly spreading the material in the cavity.

Inside the head a bore is machined to receive the head ball.

Two bores receive an upper head bushing, and one lower head bushing, the first fixed with keys, the second with screws slightly recessed.

The lower head bushing is mounted with gap on the eccentric making contact between the bushing and the eccentric the head is rotated.

When the machine is running idle, the upper head bushing comes into contact with the socket liner to maintain contact between the head ball and the socket liner.

Holes in the main shaft guide the oil towards the upper and lower head bushings and into the socket liner.

A U-shaped seal machined over the counterweight matches the T-shaped seal mounted in a groove under the head, to prevent oil leaks and protect the drive gear, pinion and bushing surfaces from dust.

A skirt acting as an oil deflector prevents leaks through the labyrinth seal.

8.3.5.1 Dismantling the head

⚠ CAUTION

PROPERTY DAMAGE HAZARD

Can cause moderate injury or property damage

Make sure the head removal is performed carefully and according to the instructions, as the head can sway and hit other component and thus damage the head bushing and other components.

To remove the head for inspection or part replacement purposes, proceed as follows:

1. Loosen the central bolt.
2. Remove the feed cone.
3. Screw the handling ring into the head's lifting plate (supplied with the tools).
4. Position the lifting plate on the locking bolt with the aid of the holes on the head, in such a way that the handling ring is at the highest point of the head. Use appropriate bolts supplied with the tools.
5. With the aid of appropriate lifting gear, raise the head assembly until the bushing is no longer guided by the eccentric, then center the head assembly in relation to the socket end and raise vertically.
6. Place the head assembly on suitable wooden blocks.

8.3.5.2 Backing

The HP300 is now delivered with a mantle without backing. At the customer's request, it is still possible to have the mantle with backing.

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8.3.5.3 Removing the mantle

⚠ WARNING

FALLING OBJECT HAZARD

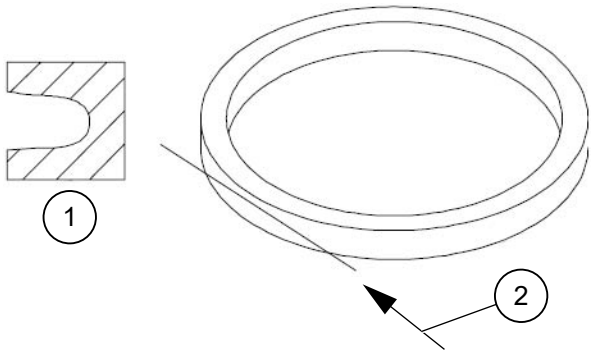
Can cause death or serious injury.

Lifting the frame liner with the welded lugs is highly dangerous. Make sure that all persons in the area have been warned and that there is no one near the suspended load at any stage.

To dismantle a worn mantle, proceed as instructed below:

1. Dismantle the lifting plate.
2. Grind the two weld seams between the locking bolt and the spacer ring and the mantle.
3. Because the mantle tends to stretch during crushing, it is not possible the locking bolt. Oxygen-cut the spacer between the mantle and the locking bolt to eliminate the tension on the screw.

   To oxygen-cut the spacer ring, some precautions should be taken to avoid damaging the head. The blowtorch should be aimed at a tangential angle to the spacer ring and it is preferable to burn a groove all the way round before actually cutting it off.



1. (Section) Circular groove
2. Direction of the blowtorch flame

Figure 64. Cutting a groove in the spacer ring

4. Fix the locking wrench (supplied with the tools) with the screw into the matching holes on the locking bolt.
5. Hit the wrench with a sledgehammer to turn the locking bolt clockwise and release it.
6. Lift the wrench with slings attached to the handle.
7. Lower the wrench into the imprint of the locking bolt and fit the L30 washer and M30 screw supplied with the tools to lock the wrench onto the bolt.
8. Hit the wrench with a sledgehammer to release the locking bolt by turning it clockwise.

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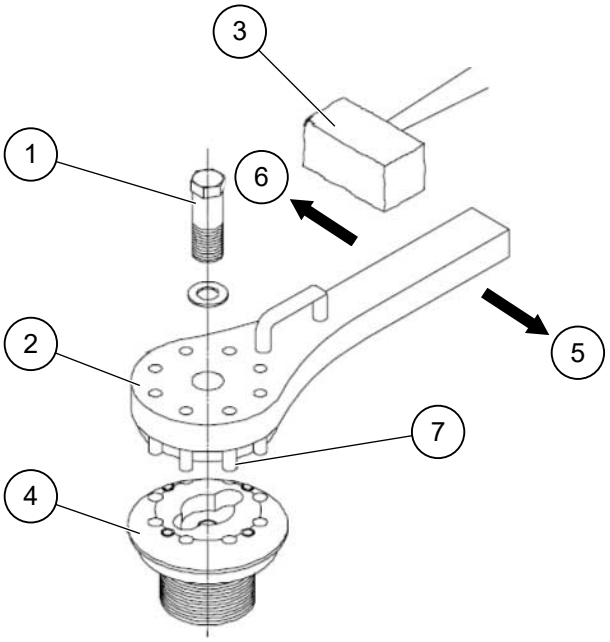


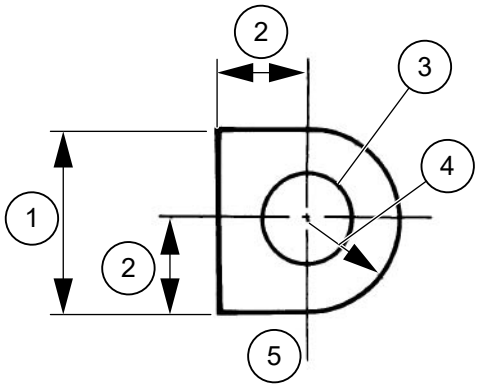
1. Wrench fastening screw
2. Locking wrench
3. Sledgehammer
4. Locking bolt
5. Loosen
6. Tighten
7. Pins

Figure 65. Dismantling the locking bolt

9. Dismantle the locking wrench with its screws. Raise the locking wrench with a sling and suitable shackle inserted in the lifting eye bolt.
10. Screw the M30 handling ring (supplied with the tools) onto the locking bolt.
11. Unscrew the locking bolt by hand.
12. Lift the locking bolt with a sling and a suitable shackle placed into the lifting ring.
13. Remove the spacer ring.
14. Since April 2011, each crusher comes with a mantle lifting tool. This accessory is included in the toolbox and designed to handle only new and worn Metso mantles for Nordberg HP cone crushers. Please refer to the Lifting Tool instruction manual for instructions on setting up, using and maintaining the lifting accessory.

NOTE: If the production date of your crusher is earlier than April 2011, please contact Metso to procure this accessory and find out the technical alterations to be made to the crusher.

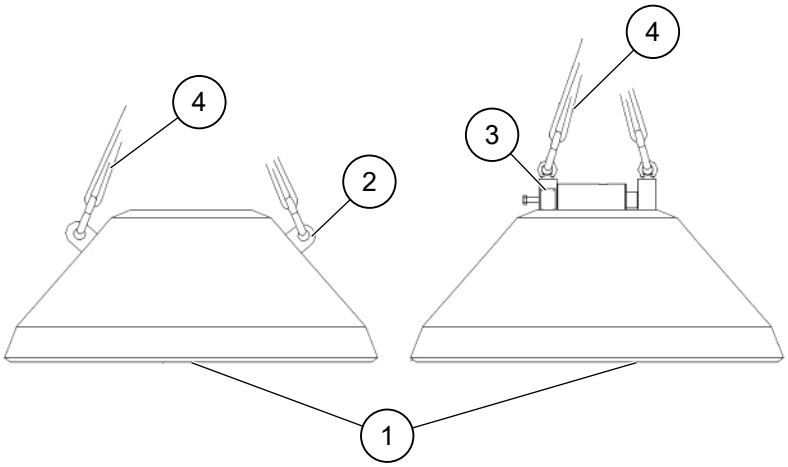
15. Make the lifting lugs according to the dimensions in *Figure 66. Lifting lug*.
    a) Use electrodes compliant with standard EN 1600 E19 12 3 LR12, AWS 5.4 E 316 L-16 or full wire compliant with standard EN ISO 13343 G 18 8 Mn, AWS A 5-9 ER 307 Si (workshop).
    b) DO NOT preheat the mantle.
    c) Clean the eye bolt welding surfaces thoroughly.
    d) Make a 6 mm weld seam on either side of the eye bolt.
    e) Make sure that the welding is impeccable.



1. 100 mm
2. 50 mm
3. Diameter of hole: 50 mm
4. R: 50 mm
5. Thickness of the plate: 10 mm

Figure 66. Lifting lug

16. Raise the mantle with slings, placing a suitable shackle in the lifting tool.



1. Mantle
2. Lifting with welded lugs
3. Lifting with the lifting accessory
4. Slings

Figure 67. Handling the mantle

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8.3.5.4 Installing the mantle

DANGER

TOXIC GAS HAZARD

Can cause death or serious injury.

Make sure the area is well ventilated or personnel use respiratory protection when handling chemical products to avoid inhaling toxic fumes.

WARNING

FALLING OBJECT HAZARD

Can cause death or serious injury.

Lifting the frame liner with the welded lugs is highly dangerous. Make sure that all persons in the area have been warned and that there is no one near the suspended load at any stage.

DANGER

PERSONAL INJURY HAZARD

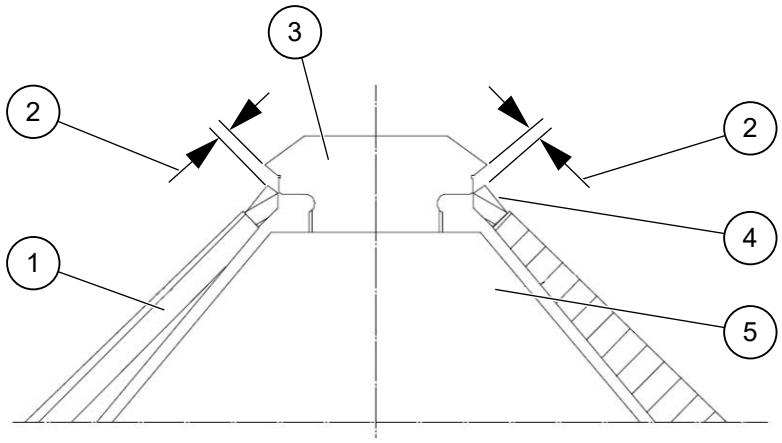
Can cause death or serious injury.

Follow safety instructions on the resin boxes. Contact with the skin or inhaling of fumed chemical can cause personal injuries. Wear suitable personal protective equipment.

To install a mantle, proceed as instructed below:

1. Inspect the mantle and the head before reassembling.
   a) Remove any remaining backing resin on the head.
   b) Remove any rough edges, traces or blisters of paint from the bowl seating.
   c) Clean the seating of the liner on the head, this surface should be free of any defects.
   d) Check the head’s threads and the locking bolt. Remove any remaining burrs or rough edges and clean the threads thoroughly.
   e) Check the seating of the spacer ring on the locking bolt, which should be free of burrs and rough edges.
   f) If the locking bolt is not replaced, check that the screw rests properly on the spacer ring. If it does not, the screw threads or head could be damaged and the mantle would no longer be firmly attached to the head, and the retaining locking bolt screw must be replaced.
   g) Lightly coat the bowl seating with oil, to prevent corrosion.
   h) Check that the mantle has holes for pouring the resin. If not, cut out two 25 x 40 mm notches diametrically opposed in the top of the mantle for pouring the resin.
2. Lift the mantle with a sling and suitable shackle inserted in the lifting accessory's lugs, the welded lifting rings or with slings attached directly to the molded hooks on the mantle.
3. Install the mantle. Make sure that the mantle is properly fitted to the head. If the mantle were to bounce, extensive damage could be caused to the head at the level of the seating surface.

a) Before lowering the mantle onto the head, coat the bottom of the mantle seating with grease over a length of 25 mm.
b) Lower the mantle over the head.
c) Grease the head and the locking bolt threads with lithium grease containing 5 to 10% of molybdenum disulphide or contact Metso before using anti-seize paste.
d) Screw the locking bolt by hand counterclockwise without the spacer ring.
e) Loosen the screw and fit the spacer ring onto the liner.
f) Bring the locking bolt close to the spacer ring.
g) Position the mantle so that the gap between the spacer ring and the locking bolt is equal all around the edge. If the gap is uneven, the mantle can be adjusted by hitting it at the top or raising its bottom. Do not rely on the tightness of the bolt to align the mantle correctly.



1. Mantle
2. Equal distance
3. Locking bolt
4. Spacer ring
5. Head

Figure 68. Correct position of the mantle

4. Fit the locking key (supplied with the tools) with the pins into the matching holes on the locking bolt.
5. Fit washer L30 and screw M30 supplied with the tools to lock the wrench onto the bolt.
6. Bring the locking bolt into contact by hand with the spacer ring by turning it counterclockwise with the aid of the locking wrench mounted on the locking bolt.
7. Make a vertical mark on the mantle, the spacer ring and the locking bolt, then strike the locking wrench with a sledgehammer to achieve the displacement stated in the table below.

Table 21: Displacement value before heating the mantle

Crusher	Displacement value
HP300	85 mm

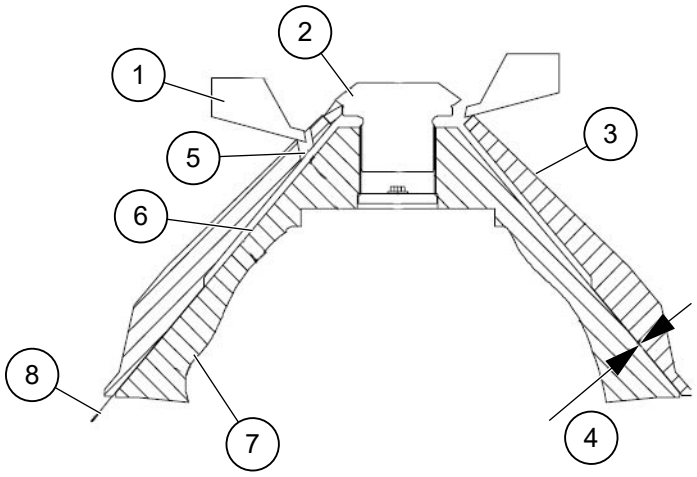
8. Use a gauge to check that the mantle seating is in contact with the head set liner. The gap should not exceed 0.25 mm (0.010'). If the gap is wider due to wear, lift the mantle, cover the bottom of the head with clay or another material then refit the mantle to prevent any leaking of the sealant.
9. Make a vertical mark on the mantle, the spacer ring and the locking bolt.
10. Heat the lower part of the mantle with a flame at roughly 55°C above ambient temperature.

11. With a sledgehammer, strike the wrench to lock the locking bolt by making it turn counterclockwise, to obtain a displacement of 20 to 30 mm.
12. Make the following welds:
    a) Apply 2-3 mm weld seams diametrically opposite over a length of 50 mm (2 inches) between the mantle and the spacer ring.
       Use electrodes compliant with standard EN 1600 E19 12 3 LR12, AWS 5.4 E 316 L-16 or full wire compliant with standard EN ISO 13343 G 18 8 Mn, AWS A 5-9 ER 307 Si (workshop).
    b) Apply 2-3 mm weld seams diametrically opposite over a length of 50 mm (2 inches) between the spacer ring and the locking bolt.

       Use rods compliant with standard ISO (2560), E515 B 120 29 (H), NF (EN 499) E 423 B 32 H 5, WAS (A 5.1) E 7018 or cored wire compliant with standard WAS A518. E70C-6MH4, EN 758: T 42 3 M M2 H5

    The weld seams between the mantle and the spacer ring and those between the spacer ring and the locking bolt should be in a quincunx and spaced 45° apart.

NOTE: The weld should not interfere with the feed cone support on the mantle's locking bolt.



1. Pouring channel
2. Locking bolt
3. Mantle
4. Maximum admissible gap 0,25 mm (0,01")
5. Filling hole
6. Clean this surface with oil
7. Head
8. Set of wedges

Figure 69. Installing the mantle

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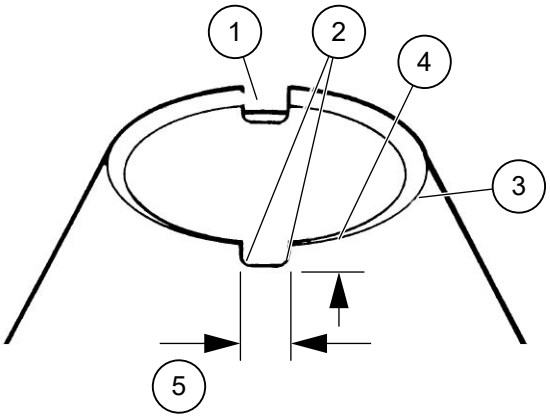

1. If there are no filling holes, cut out notches
2. Min r: 10 mm
3. Top of the mantle
5. 25 mm
6. 40 mm

Figure 70. Installing the mantle

13. Cut the lifting lugs or molded hooks on the mantle.

14. When the mantle has cooled down, fill the cavity with backing resin up to the top of the head.

a) Use the filling holes molded in the mantle or oxygen-cut two holes measuring 25 x 40 mm, diametrically opposed, at the top of the mantle, to pour the backing resin. Make a pouring channel in sheet metal or cardboard to pour the resin. To speed up the operation, it can be poured at several places at the same time.

b) If 25 x 40 mm notches are used to pour the resin, block them afterwards with a 3 mm (1/8") metal sheet welded to the mantel. This prevents dust penetrating the threads of the locking bolt and the head.

The backing resin is a hard-wearing, non- metallic and resilient material. It is available in various quantities. Each packet contains a large box of resin and a small box of hardener for mixing.

No special handling, preparation or equipment is necessary to use it. The resin can be prepared at the place of use, without any prior training required for the personnel. Follow the instructions on the packaging.

When the resin has been mixed, it must be used without delay. If the prepared quantity is not enough, the operation can be repeated and liquid resin poured on the resin that has already solidified. The resin cannot be reused.

Unopened boxes of resin can be kept for 12 months from the date of production.

NOTE: If the resin is too cold, it will harden slowly and be too viscous to fill the space between the two walls that are too close together. If it is too hot, the mixture can harden in the box before it is poured. To avoid this, immerse the boxes in water before opening them to bring them to a temperature between 16°C and 32°C.

NOTE: Do not use resin when the temperature of the crusher feed exceeds 80°C.

Table below gives the approximate quantity of backing resin required.

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Table 22: Required quantity of backing resin

Type	HP300 Standard	HP300 Short head
Requisite quantity of resin for the mantle Average weight (kg)	25	25
The backing resin comes in kits of 10 kg and 5 kg after mixing.		

8.3.5.5 Replacing the head ball

⚠ WARNING

CORROSIVE HAZARD

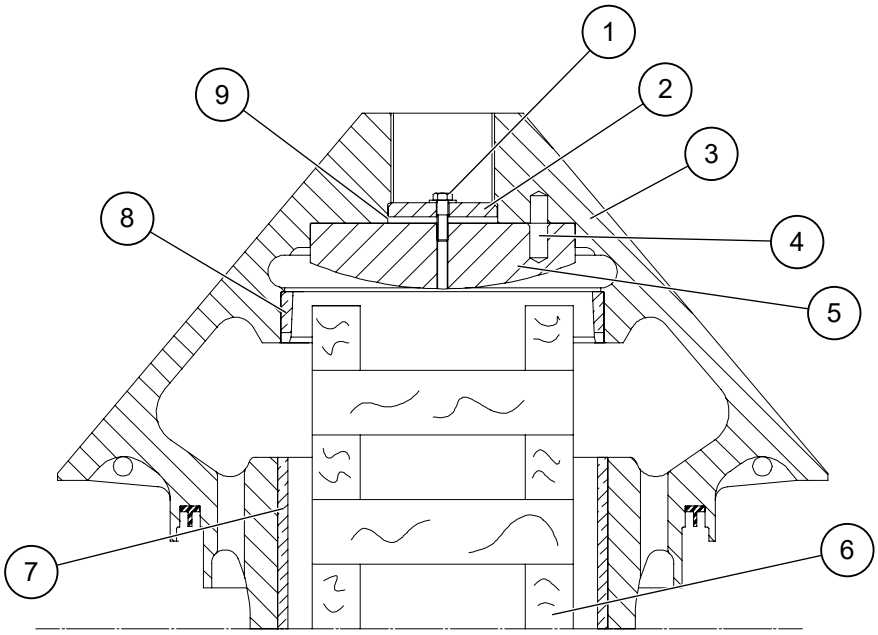
Can cause death or serious injury.

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.

The head ball rests on the socket liner. Ball wear is therefore usually minimal.

However, if the ball is worn so much that its spherical surface is uneven, due a lack of oil or contaminated oil, it must be replaced.

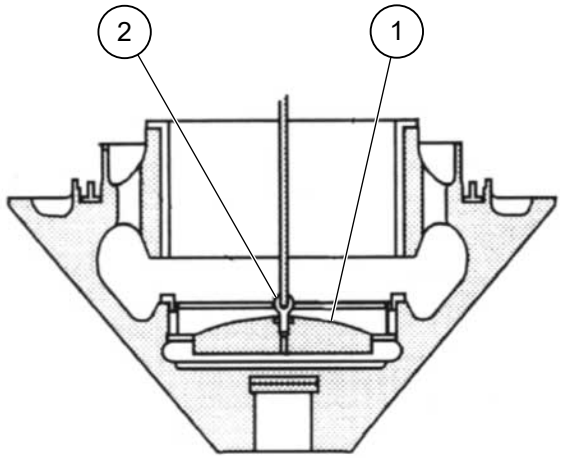
1. Remove the bolt fixing the head ball to the head. If the bolt was fitted with Loctite, it must be heated by flame to a temperature of approximately 205°C.
2. Remove the head ball. The ball is partially recessed in the head.
   a) Place a wooden wedge under the head in such a way that there is only a short distance between the ball and the wedge, to allow the ball to lower correctly.
   b) Place a 50 x 50 mm rafter between the welded washer and the bore of the head, and strike until the head ball is released.
3. When the worn head ball has been dismantled, upturn the head and clean the head bore receiving the ball.
4. To reduce the diameter of the new head ball, place it in a refrigerated bath for 4 to 6 hours. This will require approximately 23 kg of carbon dioxide snow.
5. Measure the outer diameter of the ball and the inside of the head bore to determine whether the ball can be mounted.



1. Capscrew and spring washer
2. Head strap
3. Head
4. Pins
5. Head ball
6. Wooden timbers
7. Lower head bushing
8. Upper head bushing
9. Weld 6 mm

Figure 71. Replacing the head ball

6. Secure the head ball use a lifting ring placed in the central hole of the ball, and lower it into its housing.
7. Ensure that its bearing surface comes into contact with the head by checking four points with the aid of a gauge.
8. Ensure that the pin hole in the head ball is aligned with the pin in the head.



1. Head ball
2. Lifting ring

Figure 72. Assembling the head ball

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9. Fit the screw into the washer welded in the head bore, then screw it into the ball.
10. Heat the ball to ambient temperature then remove the screw and clean all the threads and the hole with a solvent.
11. Apply Loctite 277 to the threads of the screw, and refit it with its washer.

8.3.5.6 Replacing the lower head bushing

DANGER

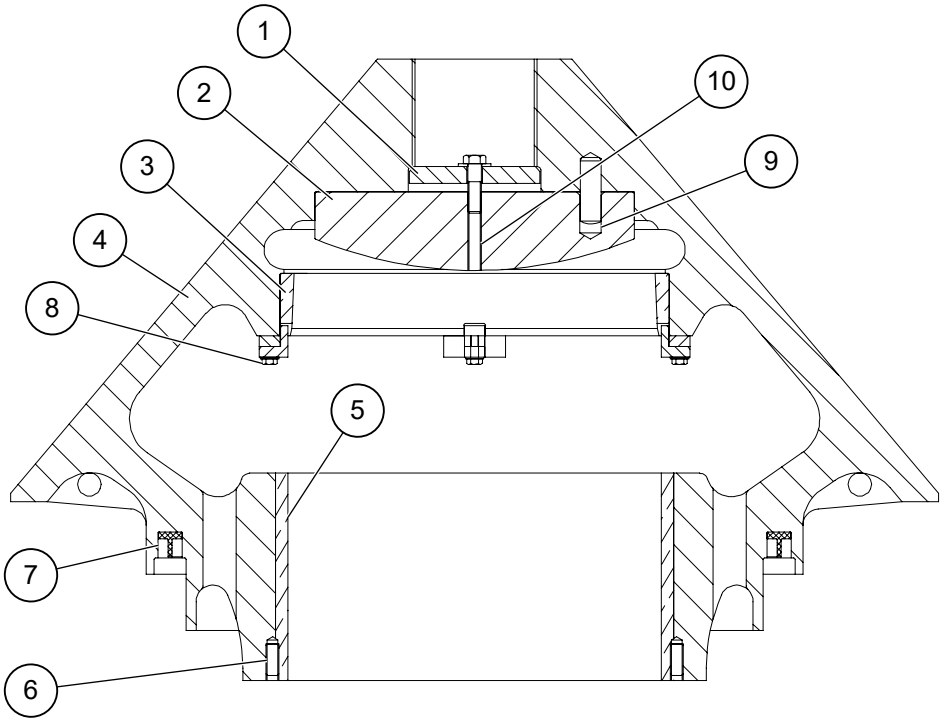
PERSONAL INJURY HAZARD

Can cause death or serious injury.

Protective equipment must be worn. In particular, protect your head with a shock-resistant mask throughout the operation.

The lower head bushing mounted tightly in the head is kept in place by headless screws.

1. Upturn the head.
2. Use a saw with a suitable blade to cut the bronze ring in two places. Adjust the saw so that it follows and is guided by the head bushing bore hole.



1. Washer
2. Head ball
3. Upper head bushing
4. Head
5. Lower head bushing
6. Screw slightly recessed
7. T-joint
8. Retainer lock and its support
9. Pins
10. Screws and locking washers

Figure 73. Installing the upper and lower head bushings

3. Measure the distance between the blade and the head's bore hole. Deduct a few tenths of millimeters from the resulting distance to be sure the saw does not damage the head.
4. Adjust the saw to the sawing depth determined in the previous step.
5. Saw a test cut to ensure the sawing depth is correct. Make any necessary adjustments.
6. Saw the head bushing along the cone distance. Repeat at the diametrically opposed point. The bushing should be practically free after the second cut.

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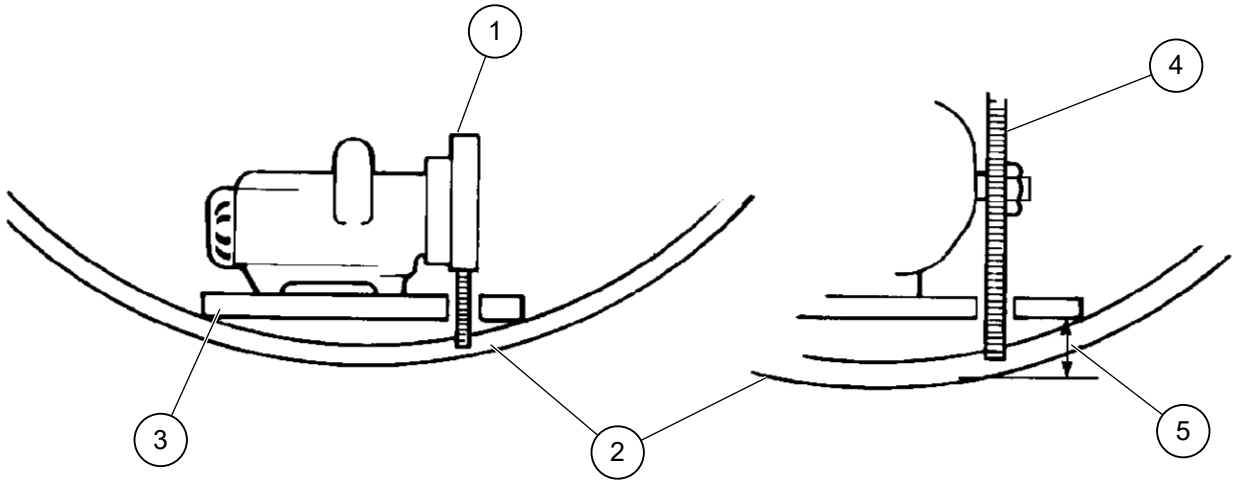

1. Circular saw
2. Head bushing
3. Saw base
4. Use suitable metal cutting blade
5. Blade depth

Figure 74. Removing the bushing by sawing

8.3.5.7 Replacing the head bushing (alternative method)

To replace the upper head bushing, the lower head bushing needs to be dismantled. To recover and reuse the lower head bushing, proceed as follows:

1. Upturn the head.
2. Remove the screws retaining the bushing on the head.
3. Make a centering plate. See image below.

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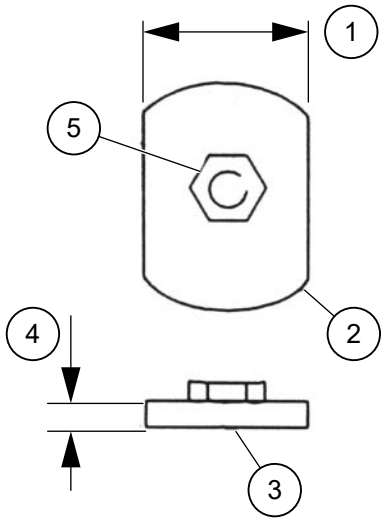
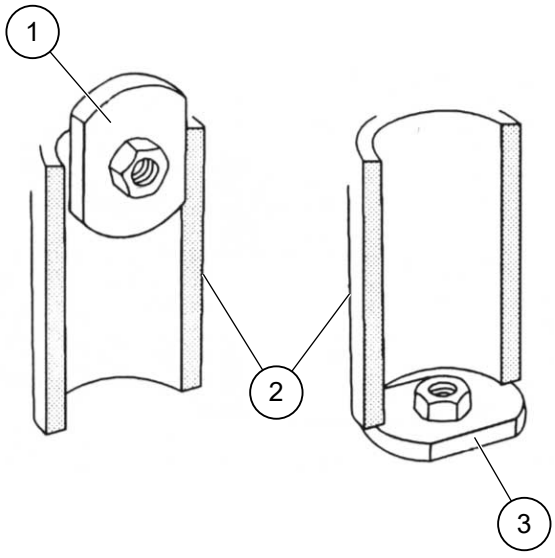


1. Dimension on lower flat metal strips inside the bushing
2. The diameter of the plate should be 3 mm less than the outer diameter of the bushing
3. Centring plate
4. 25 mm
5. Weld a 24 or 27 mm nut

Figure 75. Centering plate

4. Slide the plate vertically through the bushing until it is behind the bushing. Turn the centering plate 90°.



1. Slide the centring plate through the bushing and turn through 90°
2. Bushing
3. Centering plate

Figure 76. Centering plate

5. Holding the plate in position, screw a threaded rod 24 or 27 mm in diameter into the welded nut in the center of the plate. The threaded rod should be longer than the height of the bushing.

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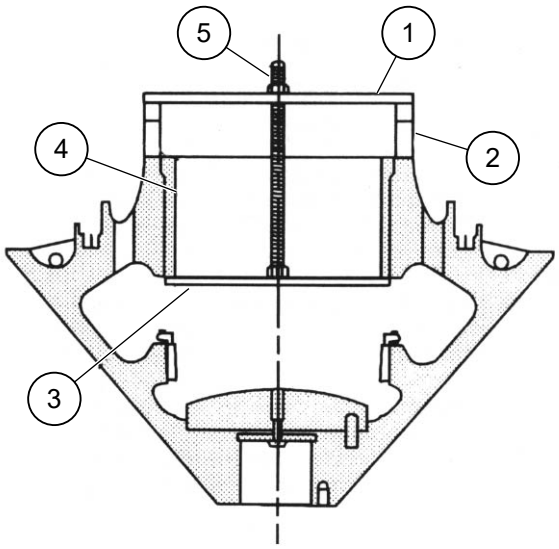
6. Place a bar measuring 25 mm x 75 mm over the threaded rod and tighten firmly with a nut.
7. Place runners between the bar and head drum.



1. Bar - Same length or longer than the inner diameter of the head
2. Runners
3. Centering plate
4. Lower head bushing
5. Threaded rod

Figure 77. Dismantling the lower head bushing

8. Fill the bushing's bore with carbon dioxide snow to make it narrower. Cooling time is roughly 2 hours.
9. Use the threaded rod as a cylinder. Tighten the nut until the bushing comes out. Cylinders can also be used.
10. Unscrew the nut and place additional runners under the bar. Then tighten the nut until the bushing comes out.

8.3.5.8 Checking the bore of the head and the two bushings

1. Before fitting the new head bushing, check that the head’s bore hole is clean and smooth, free of scrapes etc.
2. Check that the bore has not been deformed after being heated. Measure the bore from the bottom upwards.

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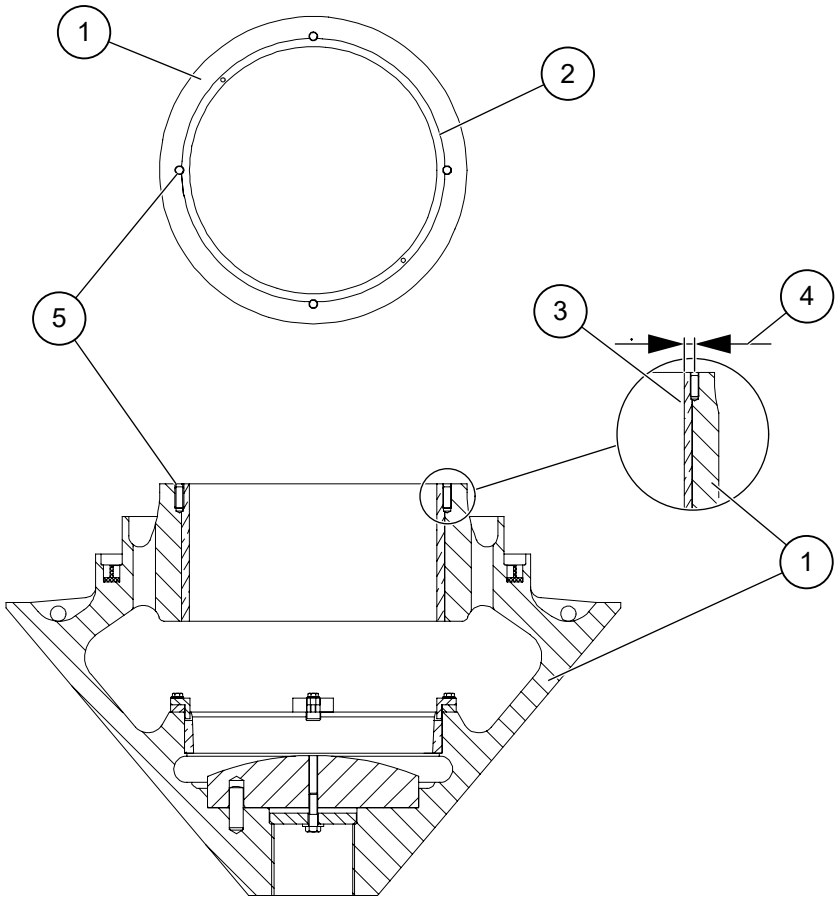
8.3.5.9 Installing the head bushing

⚠ WARNING

CORROSIVE HAZARD

Can cause death or serious injury.

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.



1. Head
2. Lower head bushing
3. Inner diameter of the head bushing
4. Distance A (see table in step 7)
5. Screw slightly recessed

Figure 78. Head assembly

1. Clean the bore of the head and outer circumference of the bushing.
2. Fill the new head bushing with carbon dioxide snow to make it narrower. Use a piece of wood measuring 100 x 100 mm to leave a large enough gap around it in the head bushing for the requisite quantity of carbon dioxide snow. Wrap the outside of the head bushing with several layers of fiber glass to prevent frost forming, which could impede reassembly of the bushing into the head, this also helps cooling the bushing right down.

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90 kg of carbon dioxide snow are required to reduce the outer diameter of the head bushing. The cooling process takes about two hours. Do not use this method for the head's bore hole, it would shrink.

3. Measure the outer diameter of the bushing and the inside of the head bore to determine whether the bushing has shrunken enough to fit inside the head bore.
4. Fit two lifting rings (supplied with the tools) into the bushing's handling holes.
5. Raise the bushing and center it over the bore hole. Lower it rapidly into the head.
6. Push the bushing until the lower surfaces of the cylindrical bushing and the head are aligned.
7. After fitting the bushing, drill and tap the head and bushing to fix the slightly recessed screws.

Table 23: Information on slightly recessed screw

Crusher	Number of screws	Dimension A	Dimension of the slightly recessed screws
HP300	4	18.5 mm	M16x40

8. Clean the holes and screws with solvent then insert the screws with Loctite 277. Check that the screws do not protrude beyond the head.
9. Lock the screws with a CHS-type wrench.
10. Install the bushing head. When reassembling the feed cone, cover the heads of the screws retaining the cone with silastic.
11. After fitting a new lower head bushing, refer to *Initial start-up*

8.3.5.10 Dismantling the upper head bushing

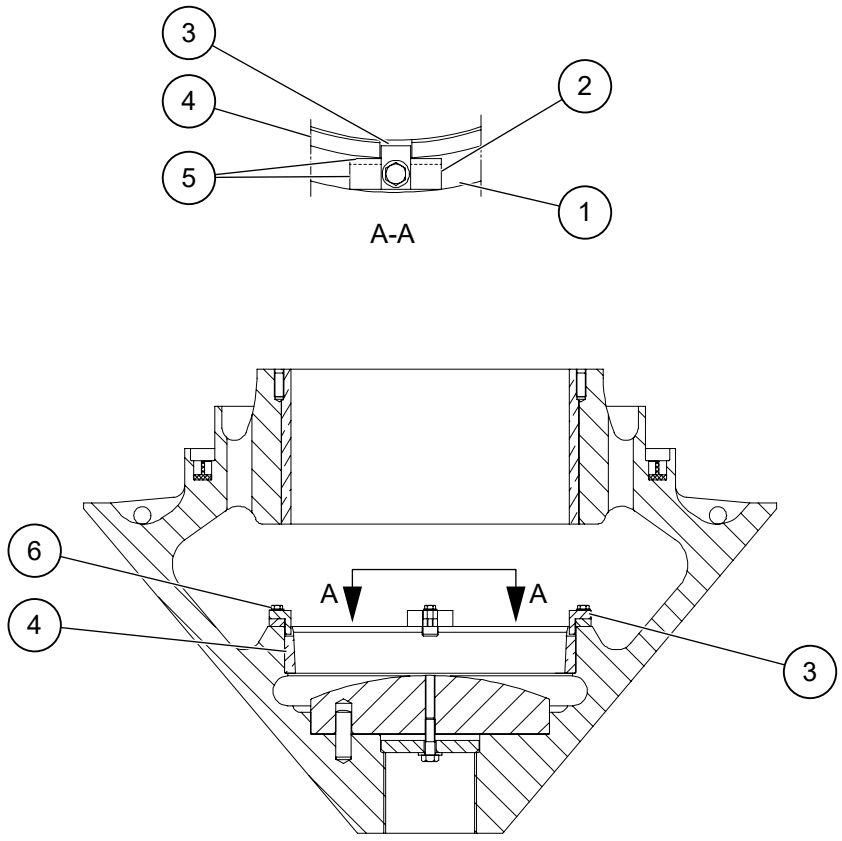
The upper head bushing is mounted slightly tightened in the head and retained by retainer locks.

The lower head bushing must be dismantled before dismantling the upper head bushing.

1. Remove the 4 rail stops by loosening the screws. If these screws were fitted with Loctite, they must be heated to around 205°C.
2. Remove the head bushing by sawing. This is done in the same manner as with the lower head bushing, refer to *Replacing the lower head bushing*.
3. Check that the head's bore is clean.
4. Check the dimensions of the head's bore.

8.3.5.11 Mounting the upper head bushing

1. Clean the bore of the head and outer circumference of the bushing.
2. Cool the bushing with carbon dioxide snow for at least two hours.
3. Install the handling rings and bring the bushing into position over the bore hole.
4. Quickly lower the bushing until it fits into the bottom of the bore hole, aligning the grooves of the bushing's retainer lock with those of the rail stop supports.
5. Put the rail stops in place using locking plates and screws. Fit the screws with Loctite 277, after cleaning the holes and screws with solvent.
6. After tightening the retainer locks, pull the stop plates over the fastenings, remount the lower head bushing as instructed in this section.
7. After installing the new head bushings, refer to *Initial start-up*.



1. Head
2. Rail stop support
3. Retainer lock
4. Upper head bushing
5. Rail stop support welded on both sides
6. Screw and washer

Figure 79. Fitting the upper head bushing

8.3.5.12 Checking the feed cone and the feed cone bolt

⚠ CAUTION

PROPERTY DAMAGE HAZARD

Can cause moderate injury or property damage.

If the feed cone falls into the cavity, it can cause serious damage. Regularly check that the feed cone's locking bolt is tight. In case of doubt, change the bolt.

1. Check the feed cone and its central bolt for wear.
2. Replace if necessary.

8.3.5.13 Fitting the feed cone

1. Lower the cone on the screw.
2. Insert the screw HM30 and tighten it.
   The cone has a male part that fits into the female part of the screw, to prevent the cone from rotating.

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8.3.5.14 Replacing the seals

DANGER

TOXIC GAS HAZARD

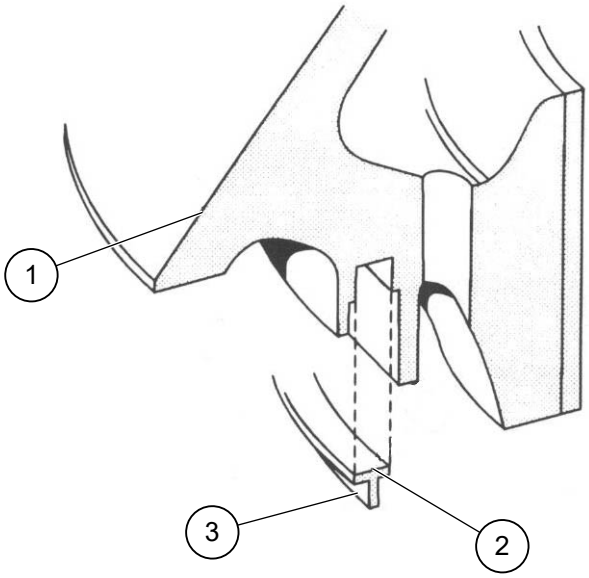
Can cause death or serious injury.

Make sure the area is well ventilated or personnel use respiratory protection when handling chemical products to avoid inhaling toxic fumes.

The T-shaped polyurethane seal glued into the machined groove under the head is not subject to wear. Should it be damaged for any reason whatsoever, it should be replaced straight away.

This seal protects the pinion and adjustment gear assembly and bushings from airborne dust, which causes rapid wear, contaminates the oil and clogs up the oil filter.

1. Remove the worn seal and scrape off any remaining debris in the seal groove.
2. Clean the groove thoroughly with a quick-drying oil-free cleaner.
3. The diameter of the spare seals is the same or slightly larger than required. Insert the new seal into the groove without glue and mark out the required length. The seal must be able to be mounted in its groove without forcing
4. Remove the seal and make a clean cut at the desired length.
5. Apply the adhesive to the bottom of the head's throat. Use just enough adhesive to ensure the bond.
6. Put the seal in place in its groove as soon as the adhesive is applied. Press the seal in such a way that of is firmly fixed to the contact surface. The bonding is complete after about 3 minutes.



1. Head
2. Thoroughly clean the surface of the joint before applying the activator and the adhesive to the bottom of the head's throat.
3. T-joint

Figure 80. Replacing the joint

8.3.6 Socket assembly

This paragraph covers the socket assembly.

The socket with the socket liner supports the head assembly and transmits the crushing force to the main frame. The socket is held rigidly to the main shaft by an interference fit and a series of capscrews installed around the perimeter of the socket.

The socket liner which is dowelled to the top of the socket provides the bearing surface for the head ball bolted to the underside of the head.

The grooved surface of the socket liner is thoroughly lubricated by oil under pressure pumped through interconnecting oil passages between the main shaft and socket.

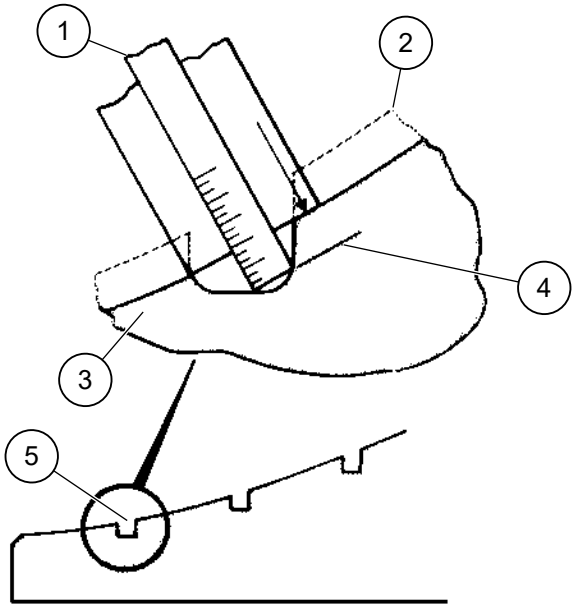
8.3.6.1 Replacing the socket liner

Oil grooves in the spherical surface of the socket liner are to be used to determine when the liner requires replacing.

Measure the socket liner as shown in the figure below.

When the bearing surface of the socket liner has worn to where the oil groove depth is reduced to 2.5 mm (0.098 inches) the liner should be replaced.

If socket liner to socket fit becomes slightly loose, it does not matter because dowels will prevent socket liner from turning.



1. Depth gauge
2. Original contour of socket liner
3. Worn socket liner
4. Minimum grove depth 2.5 mm (0.098")
5. Oil groove

Figure 81. Measuring the depth of the oil grooves

Replace socket liner as follows :

1. Install three jackscrews (from tool box) in the tapped holes in the socket liner.
2. Tighten the jackscrews alternately in small amounts. If necessary, heat the upper portion of the socket to assist in the removal of liner.
3. Remove the jackscrews and install ring bolts in outside diameter of socket liner.
4. Attach a suitable lifting device and remove worn socket liner.
5. Heat the upper portion of the socket to 45°C (80°F). This will increase the socket bore enough to allow the socket liner to drop right in.
6. Align clearance holes in bottom of socket liner over the locating dowels in the socket and lower into socket bore.

NOTE: Make sure that the liner is fully seated on the socket.

8.3.6.2 Removing the socket

The socket can be removed to allow for the removal of the eccentric or replacement of other parts.

1. Remove the three capscrews that attach the socket to the main shaft.
2. Install the three jackscrews (from tool box) in the tapped holes in the socket.

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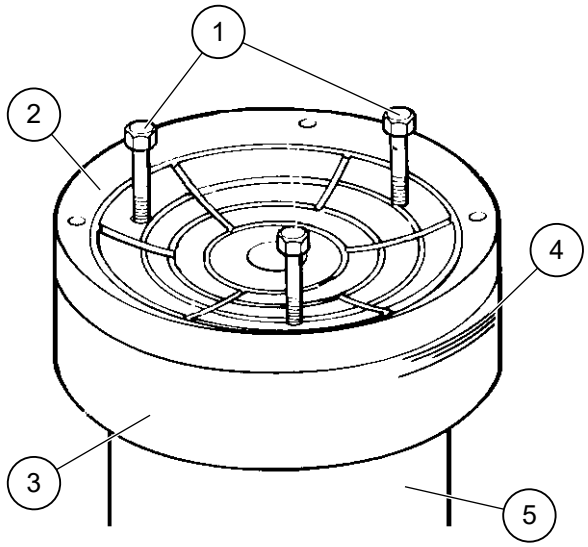


1. Jackscrews
2. Socket liner
3. Socket
4. Heat upper portion of socket, if necessary
5. Main shaft

Figure 82. Removing the socket

3. Heat the lower portion of the socket on the outside diameter while alternately tightening the jackscrews in small increments. When the socket is heated above ambient temperature, as specified in the table below, the socket will have expanded sufficiently to be free of its interference fit on the shaft.

Table 24: Socket heating temperature

Above ambient temperature	
Centigrade (°C)	Fahrenheit (°F)
70	125

4. Remove jackscrews.
5. Install ring bolts in the top of the socket.
6. Attach suitable lifting device and remove socket.

NOTE: If there is no interference fit between the main shaft and the socket, replace the socket.

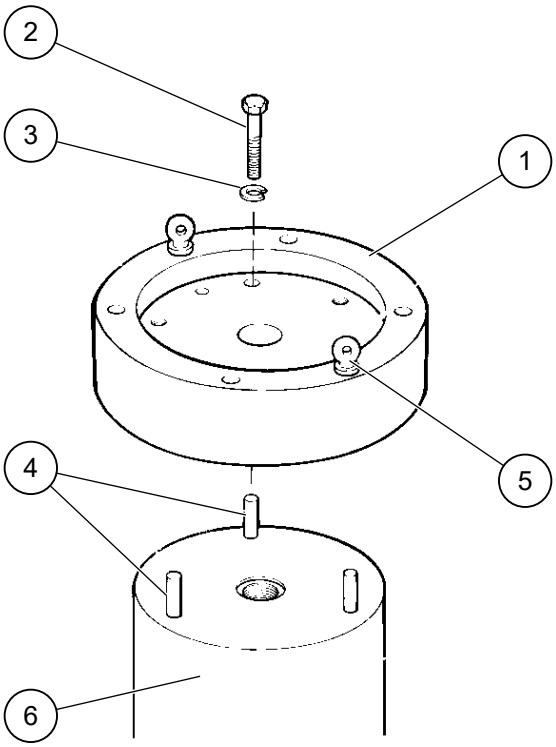
8.3.6.3 Assembling the socket and socket liner

⚠ WARNING

PERSONAL INJURY HAZARD

Can cause death or serious injury.

Wear adequate personal safety equipment, such as gloves, when handling hot components.



1. Socket
2. Capscrew
3. Lockwasher
4. Alignment studs
5. Ring bolt
6. Main shaft

Figure 83. Installing the socket

If the socket and socket liner were removed in order to allow for the removal of the eccentric for shipping purposes, assemble them as follows:

1. Install the eccentric assembly. Refer to *Mounting the eccentric assembly*.
2. Take the three alignment studs from the tool box and thread them into the tapped holes in the top of the main shaft.
3. Install two ring bolts into the socket and connect them to a lifting device of suitable capacity.

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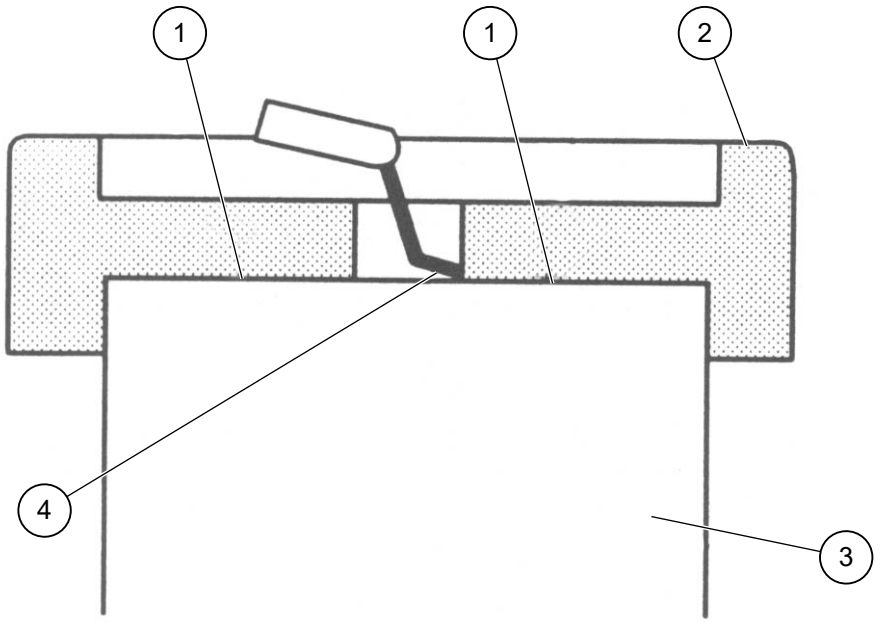
4. Heat the socket above ambient temperature, as specified in the table below and install on the main shaft as quickly as possible.

Table 25: Socket heating temperature

Above ambient temperature	
Centigrade (°C)	Fahrenheit (°F)
70	125

5. Lower the socket over the alignment studs and onto the shaft. Make sure that the socket is tightly seated against the top of the main shaft.
6. Check with a feeler gauge through the access holes in the side of the socket to make sure the socket is seated flat on the main shaft (no clearance).



1. Tight
2. Socket
3. Main shaft
4. Checking gauge

Figure 84. Checking socket contact

7. Remove the alignment studs and install capscrews with lockwashers through the socket into the tapped holes in the main shaft.
8. Tighten the capscrews little by little alternately until they are tight as specified in the table below.

Table 26: Socket capscrew torque requirements

Socket capscrew		
Size and length	Tightening torque (Nm)	Tightening torque (ft lb)
M16 x 90 mm	260	192

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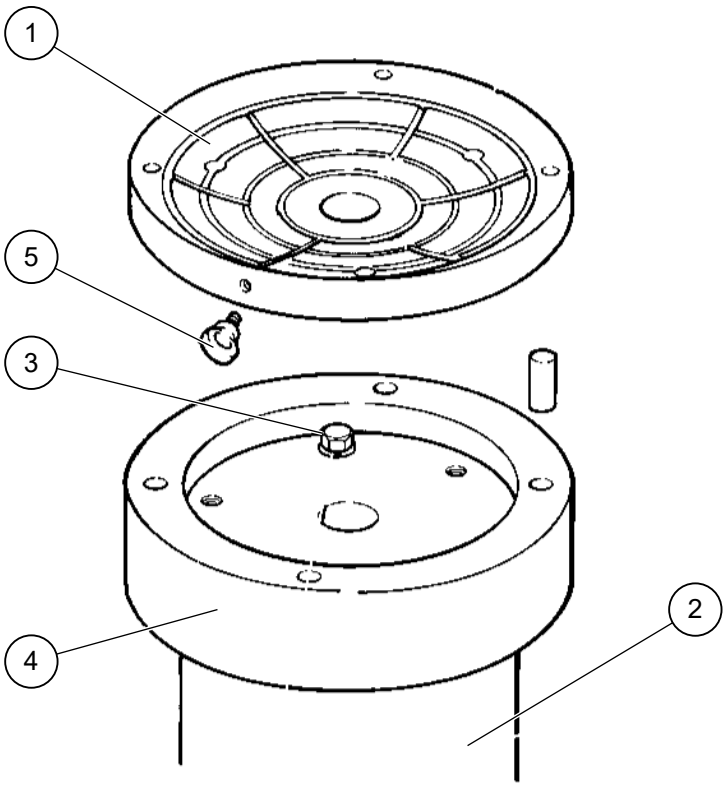
9. Recheck the torque of the capscrews after the assembly has cooled.
10. Reheat the socket to 45°C (80°C)
11. Fit the new socket liner
    - Pre-heating: Pre-heat the socket liner to 45°C (80°C).
    - Cooling: Cool the socket liner to 45°C (80°C)
12. Install ring bolts into the tapped holes on the outside diameter of the socket liner.



1. Socket liner
2. Main shaft
3. Capscrew and lock washer
4. Socket
5. Ring bolt

Figure 85. Installing the socket liner

13. Attach socket liner ring bolts to a suitable lifting device.
14. Position socket liner so that the clearance holes in the bottom of the liner go over the locating dowels in the socket.
15. Lower liner onto socket.

8.3.7 Eccentric assembly

This paragraph describes the eccentric assembly including the eccentric, eccentric bushing, gear and counterweight.

The eccentric has an offset bore. The eccentric allows the head to follow an eccentric path during each cycle of rotation.

An eccentric bushing locked into the eccentric bore provides the bearing surface for the main shaft.

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A large bevel gear bolted to the bottom of the eccentric is driven by the pinion on the countershaft. The eccentric in turn rotates around the stationary main shaft.

The entire assembly is supported by a series of thrust bearings. The bronze upper thrust bearing is bolted to the bottom of the eccentric and the steel stationary lower thrust bearing is bolted to the main frame. This series of thrust bearings reduces the frictional wear of the eccentric assembly. Backlash and root clearance between gear and pinion teeth are maintained in this assembly by the addition or subtraction of shims inserted beneath the lower thrust bearing.

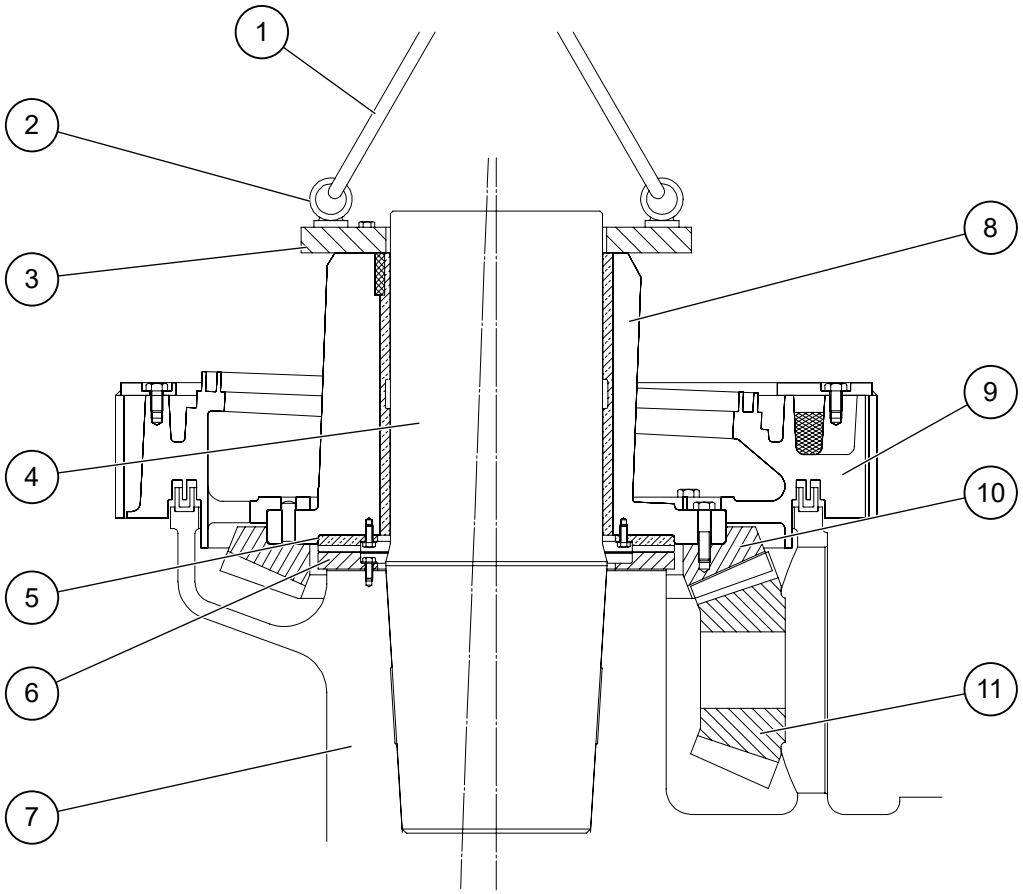
The counterweight installed on the eccentric has a light and heavy side and is positioned so as to reduce the unbalanced forces created by the crushing motion. Counterweight segments bolted to the counterweight fine tune the balance, as required for various weight mantles. The counterweight liner and cover welded to the counterweight protect the counterweight from falling discharging material.

This counterweight forms an oil and dust seal between the rotating head and the fixed main frame, with a system of baffles with U and T joints.

8.3.7.1 Removing the eccentric assembly

To remove the eccentric assembly from the crusher for servicing or replacement of parts, proceed as follows:

1. Fasten the lifting ring (from the tool box) to the top of the eccentric using the tapped holes in the eccentric.
2. Install two ring bolts into the lifting ring and connect to a suitable lifting device.



1. Slings
2. Ring bolts
3. Lifting ring
4. Main shaft
5. Upper thrust bearing
6. Lower thrust bearing
7. Main frame
8. Eccentric
9. Counterweight
10. Gear
11. Pinion

Figure 86. Lifting the eccentric assembly

3. Carefully lift the eccentric straight up off the main shaft.
4. Carefully lift the assembly clear of the crusher and lower it onto suitable cribbing.

8.3.7.2 Replacing the counterweight liner

The crushers have a liner around the counterweight to prevent any wear to it caused by friction of the materials.

Check the wear of the liner and the build-up of materials on the counterweight, as they could impair the counterweight. If the liner is very damaged, it must be replaced before the counterweight itself sustains damage.

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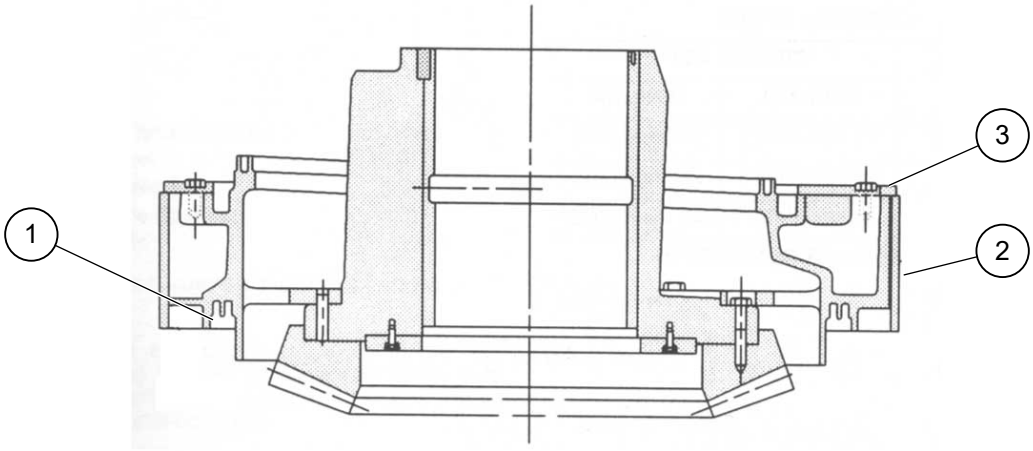


1. Shield ring
2. Seal
3. Counterweight liner

Figure 87. Counterweight liner

Material discharge in the frame must be checked every day to ensure there are no materials above all in the ballast. Material build-up is often caused by branches or roots that get caught on or between the arms of the frame. This can lead to rapid wear of the counterweight.

The useful life of the liner can be extended with a hard metal facing on the outer surface. The U and T joints at the top and bottom of the counterweight are not subject to contact or wear. These joints protect the bevel gear and thrust washers from ingress of dust.

The liner is crewed to the counterweight.

To replace the counterweight liner:

1. Slide the liner over the counterweight and fix it.
2. Caulk all around the bottom between the counterweight and the inner diameter of the liner. Do not caulk two zones 130 mm (5") long at 180° directly under the drain holes.

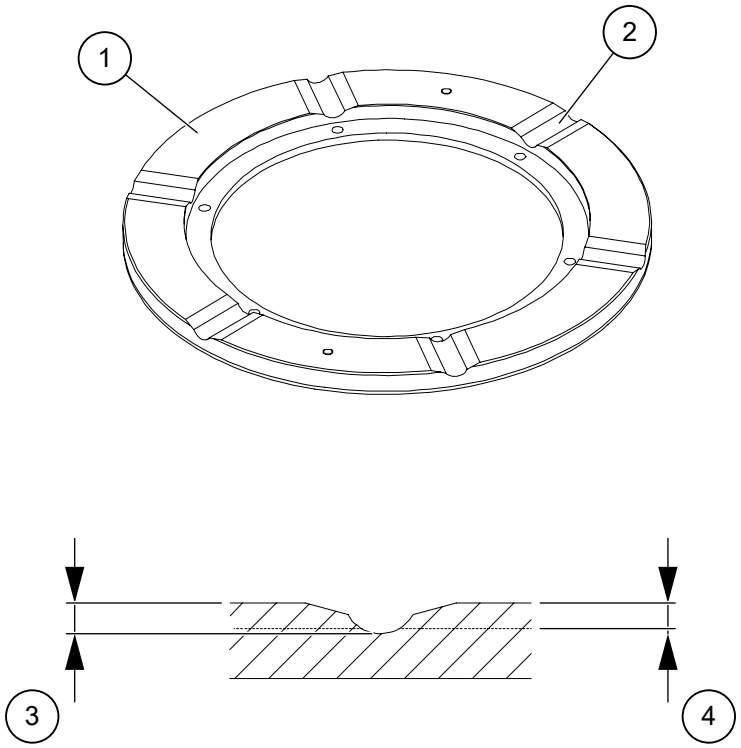
8.3.7.3 Wear of the upper thrust bearing

Anytime the eccentric is out of the crusher, the upper thrust bearing should be inspected for nicks, gouges or wear.

Wear at the thrust bearing causes two operating problems:

1. Wear allows the eccentric assembly to lower, causing the gear teeth to mesh farther into the mating teeth of the pinion. This condition is corrected by adding shims under the lower thrust bearing.
2. Wear reduces the shape and size of the oil grooves in the thrust bearing contact surface. If the groove depth is less than the minimum width or minimum depth shown in the table below, the thrust bearing should be replaced. In an emergency, the taper or depth can be machined to deepen the groove.

NOTE: The absolute wear limit for the upper thrust bearing is when the contact surface of the bearing reaches the level of the capscrew heads.



1. Upper thrust bearing
2. Oil grooves
3. Original groove depth
4. Minimum groove depth

Figure 88. Upper thrust bearing wear limit

Table 27: Groove depth

Groove depth when new	Minimum groove depth
10 mm (25/64")	8.7 mm (11/32")

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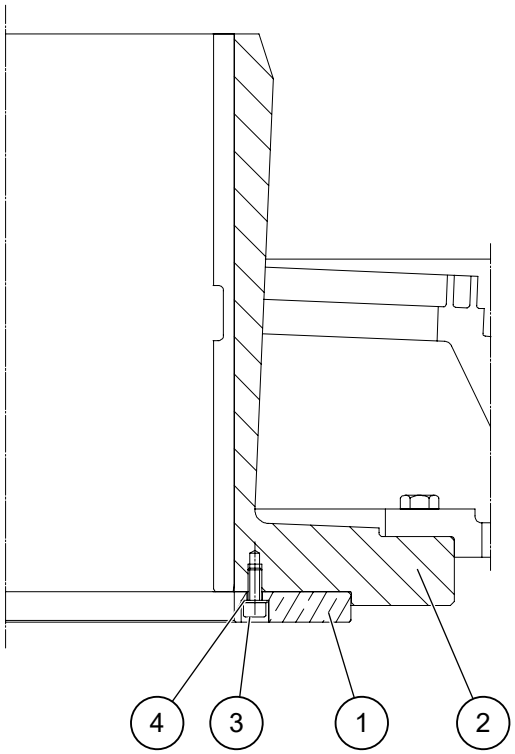
8.3.7.4 Replacing the upper thrust bearing



1. Upper thrust bearing
2. Eccentric
3. Socket head capscrew
4. Spring washer

Figure 89. Upper thrust bearing

To replace a damaged or worn upper thrust bearing, proceed as follows:

1. To gain access to the thrust bearing, remove the bowl, head, socket and eccentric assemblies. Refer to *Dismantling the bowl*, *Dismantling the head*, *Removing the socket* and *Removing the eccentric assembly*.
2. Turn eccentric assembly upside down so that thrust bearing is facing up.
3. Remove the socket head capscrews and spring washers that hold the thrust bearing to the eccentric.
4. Thread a ring bolt into each of the two tapped holes in the thrust bearing.
5. Attach a suitable lifting device to the ring bolts and carefully lift the thrust bearing off the eccentric. It is a loose fit between thrust bearing and eccentric.
6. Check the replacement thrust bearing to be sure there are no burrs or upset edges that would prevent the bearing from lying flat against the eccentric with full surface contact.
7. Remove the ring bolts from the old bearing and install them in the new bearing.
8. Lower the thrust bearing in place making sure that all holes are properly aligned with the holes in the eccentric. Make sure bearing is properly seated.
9. Place a new spring washer over each hole in the thrust bearing.
10. Insert capscrews through the spring washers. Tighten each capscrew alternately in a crisscross pattern to the torque specified in the table below.

Table 28: Thread torque for fixing the upper thrust bearing

Retaining screws for the upper thrust bearing	Tightening torque (Nm)
M10x25	90

8.3.7.5 Wear of the eccentric bushing

Whenever the eccentric is removed, the eccentric bushing should be checked for looseness and excessive wear.

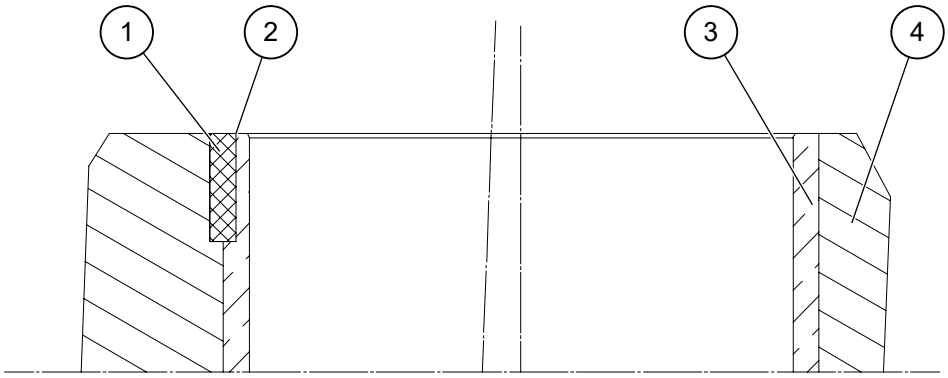
NOTE: A bushing with normal use tends to wear more at the heaviest side of the eccentric. This is no cause for concern since it is a normal and expected condition. A bushing that is worn excessively thin or cracked will require replacement.

8.3.7.6 Removing the eccentric bushing

Bushing locks are found at the top of the bushing and consist of mating tapered pockets, in both the bushing and eccentric, which are filled with locking compound to prevent the bushing from turning.

To replace the bushing, proceed as follows:

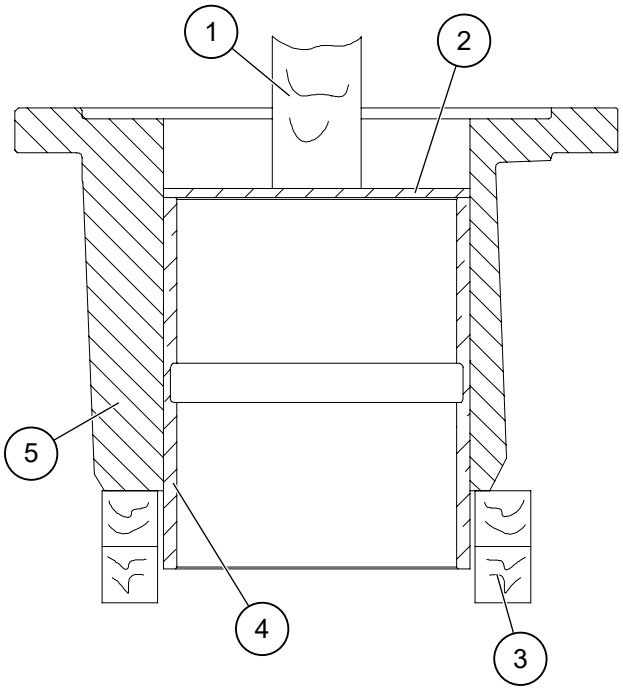
1. Drill a series of holes in the locking material in each cored pocket.



1. Drilled holes in the locking material
2. Cored pockets
3. Eccentric bushing
4. Eccentric

Figure 90. Removing bushing locks

2. Chisel through the adjoining walls of the drilled holes and clean out the material so that there is no interlocking material that would prevent removal.
3. Turn the eccentric upside down onto wooden blocking so that the bushing can drop free of the eccentric.



1. Wooden timber
2. Steel plate
3. Wooden blocking
4. Eccentric bushing
5. Eccentric

Figure 91. Removing the eccentric bushing

4. Cut a circular 25 mm (1") thick steel plate, slightly smaller than the outer diameter of the bushing.
5. Smooth and tape the outside diameter of the plate so there will be no rough edges to score the eccentric bore.
6. Place the plate against the bottom of the bushing making sure it is centered and not touching the eccentric bore.
7. Use a 100 mm x 100 mm (4"x4") wood timber to ram against the plate until the bushing is completely out of the eccentric.
8. If the bushing cannot be forced out of the eccentric by ramming, the bushing can be removed by cutting through the bushing wall in at least two locations using a heavy duty, industrial grade circular saw.

8.3.7.7 Inspecting the eccentric bore

Before installing a new eccentric bushing, inspect the eccentric bore:

- Check the eccentric bore for scoring or rough spots. Smooth these out.
- Check that the bore has not worn oversize or shrunken undersize due to the presence of heat. Measure the eccentric bore from bottom to top. Contact Metso for the correct bore dimension. Measure the entire length of the bore, checking about every 150 mm (6").
- Check for out-of roundness by swinging the micrometer 90° to the first measurement and measure this diameter. With a bore that has shrunk unevenly, the high spots can be ground off to the correct diameter. If the bore has pulled in to the extent where hand grinding is no longer practical, the entire eccentric bore must be machined out to the original diameter. If the bore has worn out-of-round, it should be remachined concentric. Contact Metso when a bore has either been worn or must be machined oversize to correct an out-of-round condition.

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8.3.7.8 Inspecting the main shaft

When an eccentric bushing needs to be replaced, in particular if it has been jammed on the main shaft, inspect the main shaft:

- Remove all traces of lead and bronze from the shaft with very fine emery cloth. Make sure to move only in a horizontal and peripheral direction.

NOTE: Make sure not to leave any remnants of lead and bronze on the shaft.

- Contact Metso to determine whether the condition of the shaft warrants its replacement.

8.3.7.8.1 Removing a jammed eccentric bushing

If the eccentric bushing has jammed against the main shaft, remove it with a saw.

1. Use a very hard-wearing circular saw fitted with an appropriate metal blade (the eccentric bushing is made of bronze and lead). Set blade depth to between 20 mm (0.75") and 25 mm (1") maximum.
2. There is a longitudinal groove on the inner diameter aligned with the large oil hole. Cut the side of the bushing at the location of the longitudinal groove. Be careful not to scratch the main shaft with the saw's blade because this could impair the performance of the new eccentric bushing.
3. With a lever, pry open the bushing at the point of cutting by placing a bar into the cut and levering outwards.

8.3.7.9 Installing the eccentric bushing

⚠ WARNING

CORROSIVE HAZARD

Can cause death or serious injury.

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.

Eccentric bushings are machined to provide a metal-to-metal or a few tenths of a millimeter (thousandths) loose fit in the bore.

Should a bushing have such a metal-to-metal fit or be out of round because of improper storage or shipment, the following procedure using dry ice is recommended.

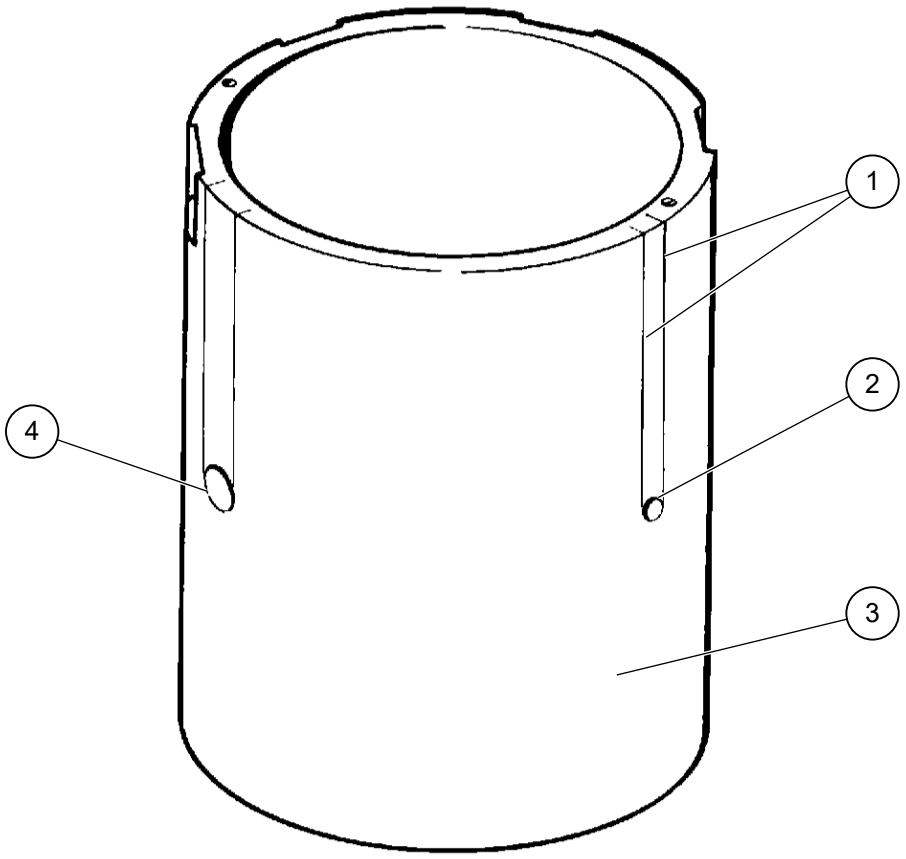
NOTE: Do not use this method of installation to overcome an eccentric bore that has closed-in.

To install a replacement eccentric bushing using dry ice proceed as follows:

1. Make sure that the locking compound is cleaned out of the cored pockets at the top of the eccentric and that the bore is clean and free of any surface roughness.
2. Prepare the bushing by thoroughly cleaning all surfaces and removing any surface irregularities.
3. Pack the bore of the replacement bushing with dry ice to shrink the bushing. Approximately 90 kg (200 lbs.) of dry ice is necessary to adequately pack the inside of the bushing, provided that some sort of filler

is used in the center of the bushing. As an example, a 100 mm x 100 mm (4" x 4") wooden timber leaves sufficient area around it to allow for an adequate amount of dry ice to shrink the bushing.

4. Wrap the outside of the bushing with several layers of fiberglass insulation to prevent the external build up of frost which would hinder the installation of the bushing in the eccentric. Wrapping also helps to achieve a more thorough cooling. Cooling time should be approximately 2 hours.
5. Measure the outside diameter of the bushing and the bore of the eccentric to determine when the bushing has cooled sufficiently.
6. Install two ring bolts (from the tool box) into the top of the eccentric bushing.
7. Paint or scribe a line down the outside of the bushing along both sides of the oil holes (both the large and small diameter holes) in the bushing. Then paint or scribe a line along both sides of the oil holes in the eccentric and over the top face of the eccentric. These lines are to be used to assure proper alignment of the oil holes in the bushing and the eccentric.



1. Paint or scribe lines along side of the oil holes
2. Small hole
3. Eccentric bushing
4. Large hole

Figure 92. Aligning eccentric bushing

8. Using ring bolts and washers (from tool box), lift the bushing into position. Center it in the top of the eccentric bore.

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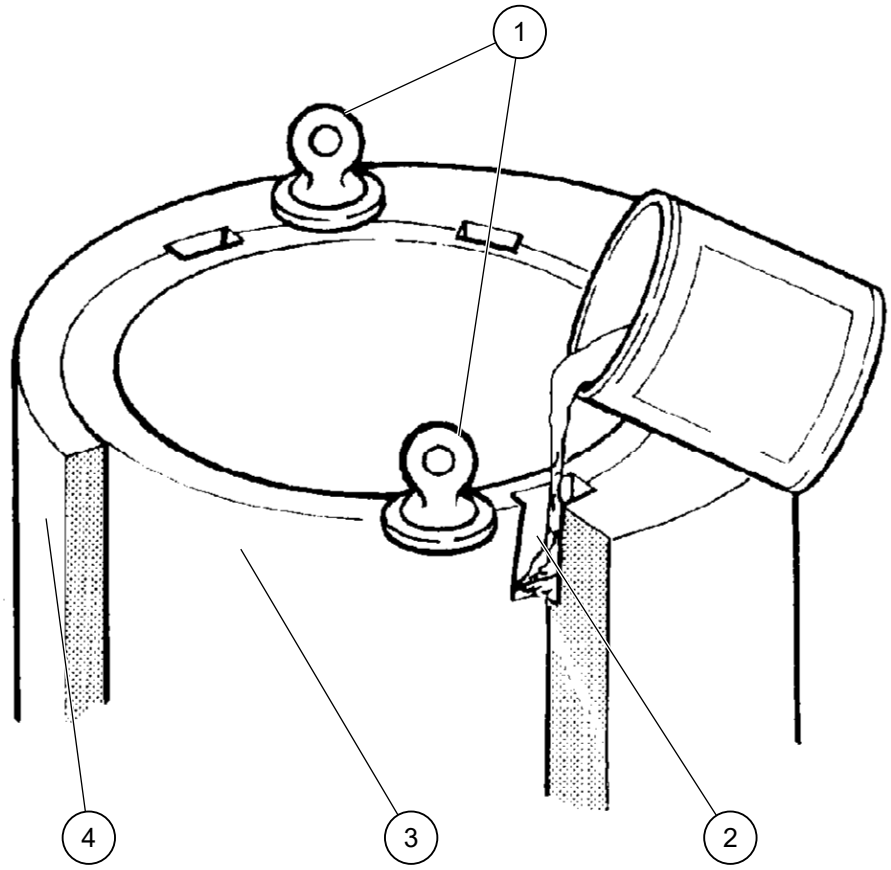

1. Ring bolts washers will hold bushing flush top of eccentric until bushing is locked into the eccentric
2. Bushing locks
3. Eccentric bushing
4. Eccentric

Figure 93. Locating eccentric bushing in eccentric

9. Quickly lower the cooled bushing, into the bore of the eccentric while aligning the pockets and the oil holes. When the bushing is properly installed in the eccentric, the bushing should be flush with the top of the eccentric.

NOTE: The lubricant passage holes in the side of the bushing must be absolutely aligned with the mating holes through the wall of the eccentric. The pockets at the top of the outside circumference of the bushing should align with the mating pockets in the eccentric. The pockets may be slightly misaligned, but the lubrication passage hole locations are critical.

10. Mix Nordberg Locking Compound according to the directions included in each kit and pour in the pockets at the top of the eccentric and bushing, filling each pocket to the top. The eccentric, bushing and locking compound should be at room temperature, 16°C (60°F) to 32°C (90°F), prior to pouring.
11. After the locking material has fully hardened, grind off flush any excess material.
12. After a new eccentric bushing has been installed, refer to *Initial start-up*.

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8.3.7.10 Pouring bushing lock

Should a bushing become free to rotate within the eccentric by wearing through the bushing lock, it is then necessary to repour these locks.

NOTE: Before repouring any lock, check that the bushing is properly installed.

1. Drill, chip and clean out the locking material from the pockets. See *Figure 90. Removing bushing locks*.
2. Pour in an additional quantity of backing material. Take care that the oil holes in the bushing and eccentric are in alignment. See *Figure 92. Aligning eccentric bushing*.

8.3.7.11 Adjusting gear backlash for wear

When thrust bearing and tooth wear reaches a point where the proper backlash can no longer be maintained, the backlash must be adjusted. This is accomplished by adding or removing the correct combination of shims which will give the proper backlash. See *Checking or adjusting the backlash and root clearance*

Adding shims raises the entire assembly, thereby moving the gear and pinion farther apart, while removing shims lowers the assembly to bring the gear and pinion closer together. Make sure that the thrust bearings and shims are reassembled correctly.

NOTE: Bottoming of gear teeth should be avoided at all times. Clearance must be provided at the bottom of the teeth, regardless of tooth wear. Therefore, when teeth become worn to the extent that the minimum root clearance cannot be maintained with the proper backlash, then backlash figures must be disregarded.

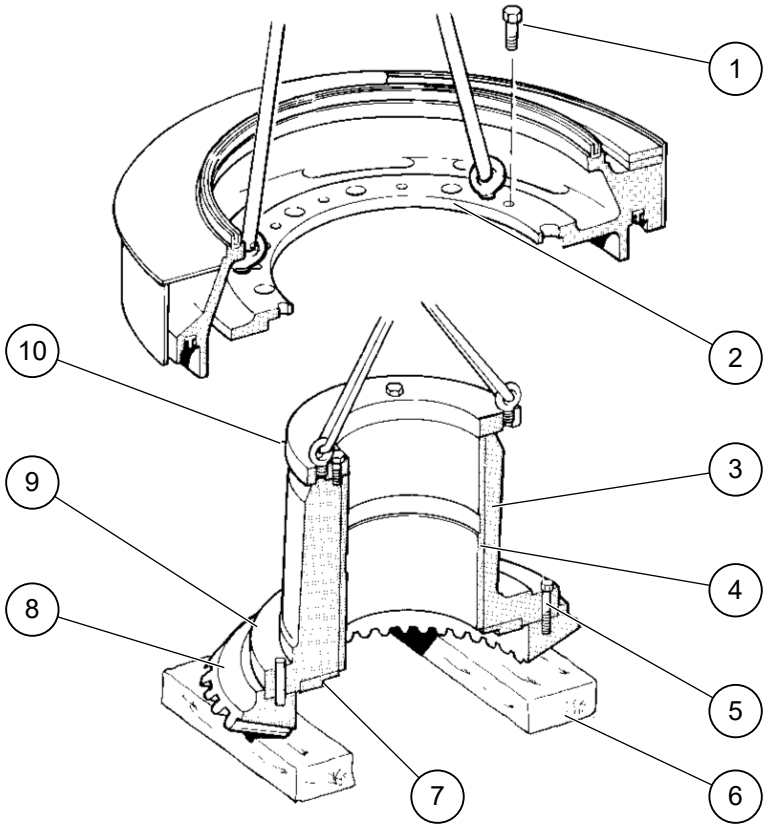
8.3.7.12 Replacing gear

The bevel gear which is mounted at the bottom of the eccentric should be inspected whenever the eccentric is removed for servicing other related parts or if broken or excessively worn teeth are suspected.

Pitting or galling on the face of the teeth are a good indication of excessive wear. This can originate from an incorrect quantity of shims being placed under the lower thrust bearing or by overloading the crusher or by using excessively dirty oil.

If the gear is worn, it has to be replaced by a new one.

8.3.7.13 Removing the counterweight and gear



1. Counterweight to eccentric capscrews
2. Counterweight
3. Eccentric
4. Eccentric bushing
5. Eccentric to gear capscrews
6. Wooder timber
7. Upper thrust bearing
8. Gear
9. Alignment dowel
10. Lifting ring

Figure 94. Lifting the counterweight and eccentric

After the eccentric assembly has been removed from the crusher using the lifting procedure, it can be disassembled for replacement of worn or damaged parts as follows:

1. Place the entire eccentric assembly on wooden timbers.
2. Remove the counterweight capscrews bolting the counterweight to the eccentric flange. Since these capscrews were installed with Loctite, the capscrews must be heated with a torch to approximately 205°C (400°F) before they can be unscrewed.
3. Install four ring bolts (from tool box) into the inner flange in the counterweight.
4. Lift the counterweight straight up to clear the single dowel that locates the counterweight correctly on the eccentric.
5. Remove the capscrews that are inserted through the eccentric flange and threaded into the tapped holes in the top of the gear. Since these capscrews were installed with Loctite, the capscrews must be heated with a torch to approximately 205°C (400°F) before they can be unscrewed.
6. Install two ring bolts into the lifting ring (both are to be found in the tool box) and bolt the lifting ring to the top of the eccentric.

7. Lift the entire assembly about 40 mm (1-1/2") above the cribbing.
8. Heat the gear evenly with a torch until the gear diameter expands and the gear falls clear of the eccentric.
9. Place the eccentric onto its side with the machined surfaces resting on hardwood blocking.
10. Remove the upper thrust bearing socket head capscrews and spring washers. Then remove the thrust bearing.
11. Replace the counterweight liner.
    a) Remove the screws fastening the liner to the counterweight and the two screws blanking off the handling holes.
    b) Fasten two eye bolts in the handling holes and remove the liner with a suitable lifting device.
    c) Put back a new liner and fasten it using the screws provided, which are mounted with a hard thread locker.
    d) Remove the eye bolts and replace the two screws blanking off the handling holes.

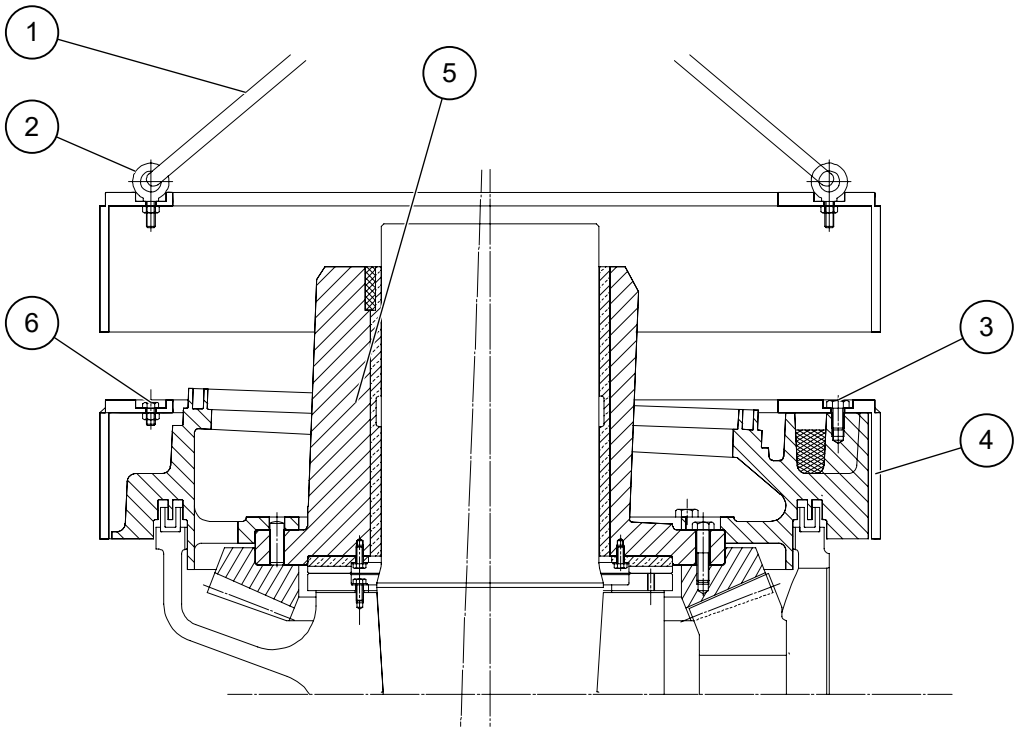


Figure 95. Removing the counterweight liner

1. Sling
2. Eye bolt
3. Liner fixing screw
4. Counterweight liner
5. Eccentric assembly
6. Screws blanking off the handling holes

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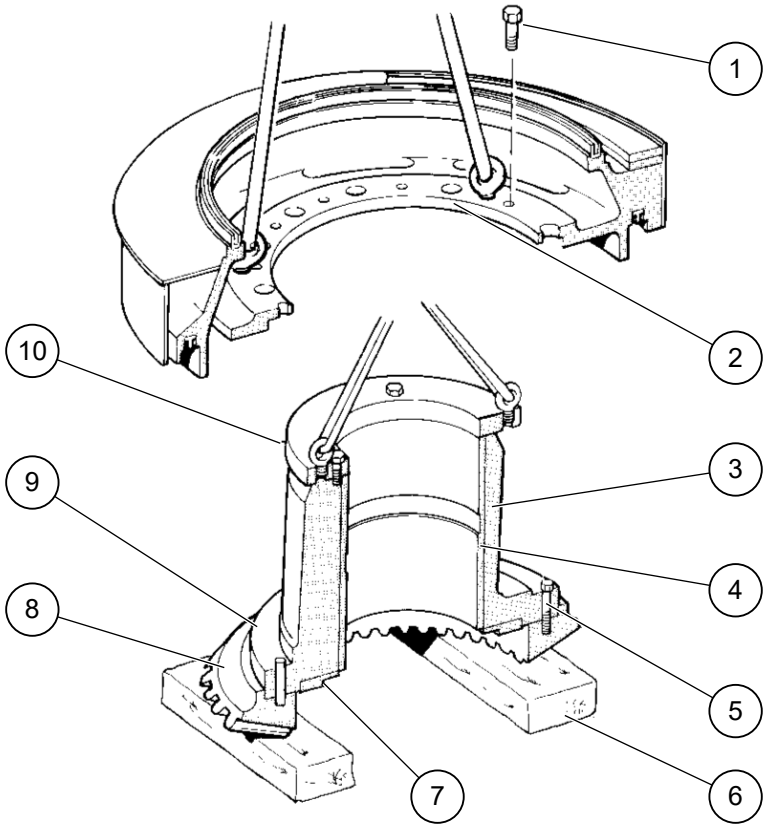
8.3.7.14 Assembling the counterweight and gear



1. Counterweight to eccentric capscrews
2. Counterweight
3. Eccentric
4. Eccentric bushing
5. Eccentric to gear capscrews
6. Wooder timber
7. Upper thrust bearing
8. Gear
9. Alignment dowel
10. Lifting ring

Figure 96. Lifting the counterweight and eccentric

1. Turn the eccentric upside down and place on suitable blocking.
2. Position the upper thrust bearing in the bottom of the eccentric making sure all holes are properly aligned.
3. Install and tighten the socket head capscrews with new spring washers.
4. Place the gear on suitable cribbing with teeth downward.
5. Turn the eccentric right side up. Insert two ring bolts into the lifting ring and attach the lifting ring to the top of the eccentric.
6. With a suitable lifting device, lift the eccentric over the gear. Make sure that the eccentric is centered and perpendicular to the gear.
7. Uniformly heat the gear with a torch to approximately 45°C (80°F) above ambient temperature.

NOTE: It is important that the gear is heated evenly throughout and the heat is not concentrated in one area creating a hot spot which could destroy the heat treatment of the gear. A chemical marking device, which melts at a predetermined temperature should be used to insure uniform and safe heating.

8. Measure the outside diameter of the eccentric and the bore of the gear as it is being heated to be sure the bore is slightly larger than the eccentric.
9. Quickly lower the eccentric into the gear counterbore, aligning matching holes. The holes are equally spaced so no special alignment is necessary. Make sure the eccentric is tightly seated against the gear.
10. Clean both the shorter and longer length capscrew threads and the tapped holes in the gear with an oil free solvent, such as alcohol or acetone.
11. Apply Loctite 271 to the threaded surfaces.
12. Insert the shorter length eccentric to gear capscrews through the clearance holes in the eccentric flange and into the tapped holes in the gear. Tighten the capscrews alternately in a crisscross pattern to the torque specified in the table below.

Table 29: Gear capscrew torque requirements

Eccentric to gear capscrew	Tightening torque	Above ambient temperature	
		Centigrade (C°)	Fahrenheit (F°)
M16x70	260	45	80

13. If the gear was replaced, install the eccentric in the crusher without the counterweight assembly in order to provide access to check gear and pinion backlash and root clearance.
14. Install four ring bolts (from the box) into the inner flange into the counterweight.
15. Carefully lower the counterweight over the eccentric, onto the eccentric flange. Keep the dowel hole in the counterweight aligned with the dowel in the eccentric.
16. Insert the longer length counterweight to gear capscrews through the clearance holes in the eccentric and into the tapped holes in the gear. Alternately tighten these longer capscrews in a criss-cross pattern to the torque specified in the table below.

Table 30: Gear capscrew torque requirements

Counterweight to eccentric capscrews	Tightening torque	Above ambient temperature	
		Centigrade (C°)	Fahrenheit (F°)
M16x70	260	45	80

17. Before installing the eccentric assembly in the crusher, rotate the countershaft and check the pinion teeth for wear or damage.
18. Install the eccentric assembly.

NOTE: Check the thread torque of the capscrews retaining the eccentric and the counterweight to the bevel gear each time the liner is changed and when the head is dismantled.

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8.3.7.15 Mounting the eccentric assembly

1. Thoroughly clean the outside and top surface of the main shaft, the gear and the surfaces of the main frame and the bore of the eccentric bushing. Remove any nicks, scratches and burrs.
2. Clean the top surface of the lower thrust bearing fastened to the main frame and the bottom surface of the upper thrust bearing bolted to the underside of the eccentric.
3. Make sure the socket head capscrews and spring washers holding the upper and lower thrust bearings are tight.
4. Fasten the lifting ring (from the tool box) to the top of the eccentric using the tapped holes in the top of the eccentric.
5. Install two ring bolts (from the tool box) into the lifting ring.
6. Apply a light coat of oil to the main shaft, eccentric bushing and both thrust bearings.
7. Connect a suitable lifting device to the ring bolts and carefully lower the eccentric assembly over the main shaft. The beveled edge of the eccentric bushing will help center the assembly.
8. Lower the assembly until the upper thrust bearing is resting on the lower thrust bearing. It may be necessary to rotate the eccentric slightly to fully mesh the gear into the pinion. Make sure the eccentric is fully seated on the lower thrust bearing.
9. Make sure that the gear and pinion have properly meshed and are in their correct relationship to each other.
10. Check the backlash and root clearance and adjust, if necessary. See *Checking or adjusting the backlash and root clearance*.
11. After satisfactory tooth backlash and root clearance has been established, remove the eccentric lifting plate.

8.3.7.16 Checking or adjusting the backlash and root clearance

1. Remove the counterweight from the eccentric.
2. Pull the countershaft toward the drive end until the pinion is tight against the inner countershaft bushing.

NOTE: V-belts must be loose before proceeding with the measurements.

3. Turn the countershaft slightly, until a gear tooth is in a vertical position.

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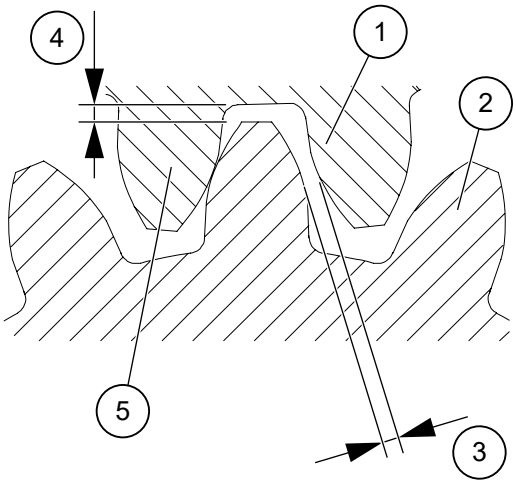


1. Gear
2. Pinion
3. Backlash
4. Root clearance
5. Gear tooth must be vertical to take an accurate measurement

Figure 97. Checking backlash and root clearance

4. Remove all clearance between the eccentric bushing and the main shaft by pushing or prying the heavy side of the eccentric assembly toward the main shaft so that the teeth on the gear are in their proper relationship to the pinion. Hold the gear in this position while taking the measurements. Use only enough force as is required to slide the eccentric assembly toward the main shaft. Using excessive pressure could «tip» the eccentric assembly and give incorrect readings.
5. To check the backlash, rotate the countershaft until the pinion tooth just «touches» the gear tooth. Measure and note the clearance on the opposite side of the tooth with a feeler gauge at the location, see *Figure 97. Checking backlash and root clearance* Then measure and note the root clearance.
6. If the backlash and root clearance is found to be less than that which is specified in the table below, remove the eccentric assembly and add metal shims of the proper thickness under the lower thrust bearing. Adding shims will raise the eccentric assembly and move the gear away from the pinion, thereby increasing the backlash and root clearance. If the measurements are more than specified, remove metal shims of the proper thickness.

Table 31: Backlash and root clearances (measurements to be taken at outer end of teeth only)

Backlash		Root clearance	
mm	inches	mm	inches
0.508 - 1.016	0.020 - 0.040	2.388	0.094

Table 32: Thickness of the wedges

mm	inches
3.0	0.1181
1.7	0.0669

mm	inches
0.4	0.0157

NOTE: Shims placed beneath the lower thrust bearing when the crusher left the factory are of the required thickness to provide proper backlash and root clearance. These shims, while placed in the crusher initially for backlash adjustment are primarily used for wear compensation.

8.3.8 Countershaft box, countershaft and sheave assemblies

This paragraph describes the countershaft housing, countershaft and sheave assemblies.

Power is transmitted to the crusher's countershaft motor by a V-belt transmission or a coupling sleeve. At one end of the countershaft, a pinion is mounted. The rotation of the pinion is transmitted to the eccentric by the bevel gear.

The countershaft is supported by two bronze bushings. These two bushings are prevented from rotating by pins inserted in the countershaft housing. The bushings have a flange at their end that receives the axial load both from the pinion and the oil deflector.

The oil deflector is inserted tight on the countershaft control side. The deflector's role is to centrifuge on the cover the oil coming from the lubrication of the housing's bushings.

The countershaft housing returns the oil to the tank. This countershaft housing is solidly fixed with large screws.

The oil seal is formed between the frame and the countershaft housing by an O-ring seal or a lip seal.

A shield protects the part of the countershaft housing exposed to wear caused by the falling crushed materials.

8.3.8.1 Countershaft rotation

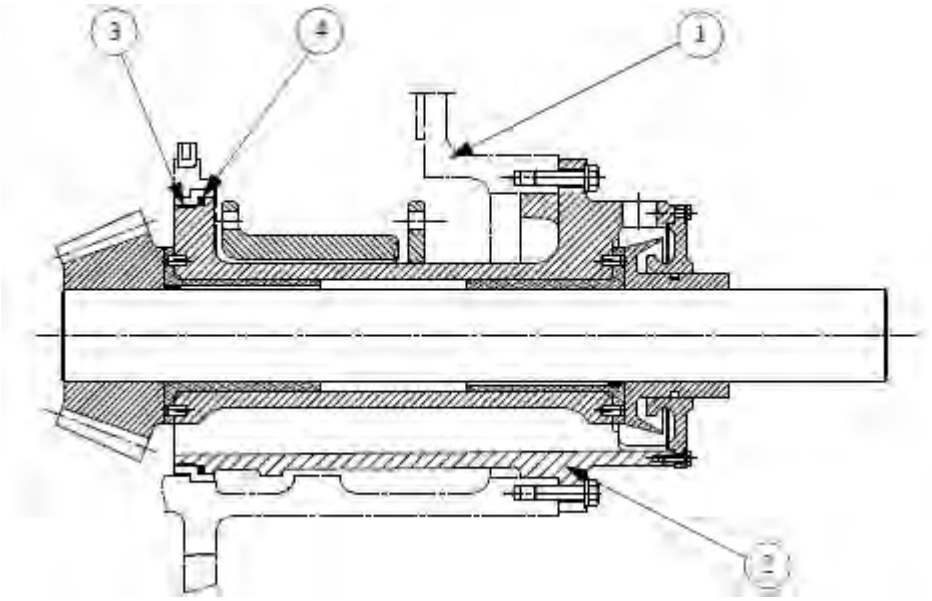
All Nordberg HP crushers are designed in such a way that their countershaft rotates clockwise, as viewed when facing the countershaft. The direction of rotation is important because the locking nut keeps the mantle tight against the head, and correct rotation ensures its self-clamping capacity.

NOTE: Check the rotation direction of the motor before mounting the belts. Direction should be clockwise when facing the end of the shaft.

8.3.8.2 Assembling the countershaft housing

If the countershaft housing was dismantled for shipment, it must be reassembled as follows:

1. Lubricate and correctly position the O-ring seal in the appropriate groove on the flange on the pinion side of the countershaft housing. This forms a seal between the drum of the main frame and the countershaft housing.



1. Frame
2. Countershaft housing
3. Bearing seal
4. O-ring seal

Figure 98. Countershaft housing seal

2. Fit a bearing seal in the groove of the countershaft housing, on the pinion side. This seal suppresses any vibrations between the countershaft housing and the frame.
   This seal is split, so fit the seal into the groove of the countershaft housing, on the pinion side, and glue the two ends together. There should be no gap between the two ends of the seal. If there is no glue, maintain the bearing seal with the aid of metal wire twisted at the ends. Cover the seal with grease. If metal wire is used, remove it when the seal is in place in the bore of the frame.
3. Fill the bore of the frame at the locations of the O-ring seals with a strip of silicone seal.
4. Slide a long tube at the sheave side end of the countershaft to balance the weight of the other end.
   If there is not enough space to use a tube for counterbalancing purposes, push the countershaft housing into the bore of the frame as far as possible. Reset the interior flange of the housing (pinion side) temporarily on the frame's guide lobe. Raise the countershaft housing with a sling threaded inside the crushing then continue fitting the housing in as far as possible.

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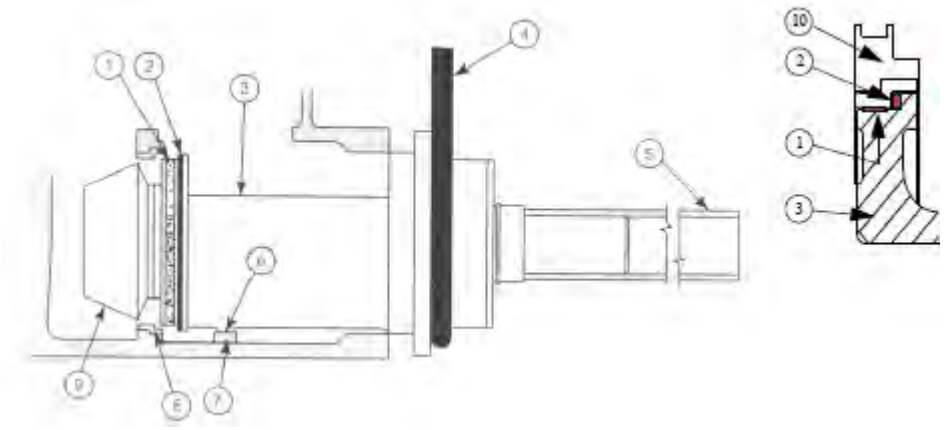
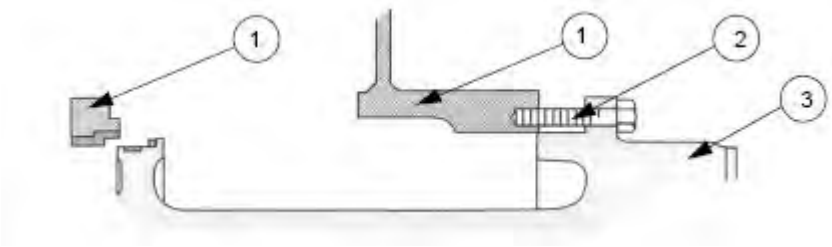


1. Bearing seal
2. O-ring seal
3. Countershaft housing
4. Sling
5. Tube
6. Centring lobe on housing
7. Guide lobe on housing
8. Frame bore
9. Pinion
10. Frame

5. With the aid of hoisting gear (overhead traveling crane or other gear), place the guide lobe of the countershaft housing on the guide lobe of the frame.
6. Screw the three tension bolts into the outer housing flange matching the three holes at 120° angles on the frame.



1. Frame
2. Tension bolt
3. Countershaft housing

7. Because the countershaft housing is mounted tight in the frame, gradually tighten each of the three bolts in turn to keep the housing aligned, until contact is made between the housing's flanges and the frame.
8. Remove the bolts and fit shim washers under the screw heads and repeat the previous operation. Tighten each of the bolts again alternately until they reach the bottom of the threaded holes.

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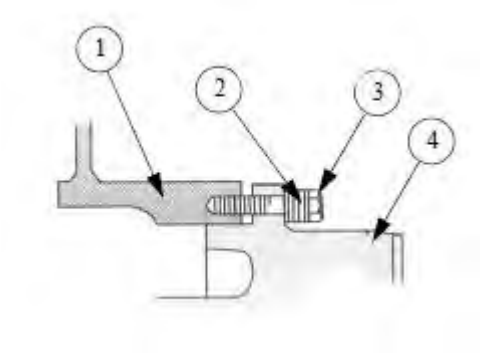
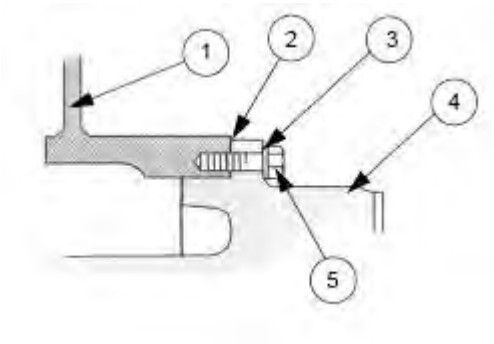


1. Frame
2. Shim washers
3. Tension bolts
4. Countershaft housing

9. Replace the tension bolts with normal bolts that will fix the countershaft housing.



1. Frame
2. Contact
3. Washer
4. Countershaft housing
5. Final bolts

10. Continue pushing the countershaft housing in by successive turns on the bolts until the flanges of the frame and the countershaft housing come into contact.
11. Place the shield onto the countershaft housing, engaging the notches on the shield with the bosses of the housing.

8.3.8.3 Mounting countershaft bushings

⚠ WARNING

CORROSIVE HAZARD

Can cause death or serious injury.

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.

When the countershaft and its housing have been fully examined, the new bushings can be mounted. If the bushing-frame assembly is slippery, mount the bushings, making sure that the oil grooves are in the correct position.

If the bushings are mounted slightly tight, cool them down to mount them. Proceed as follows:

1. Remove the locating pins from the housing flange.

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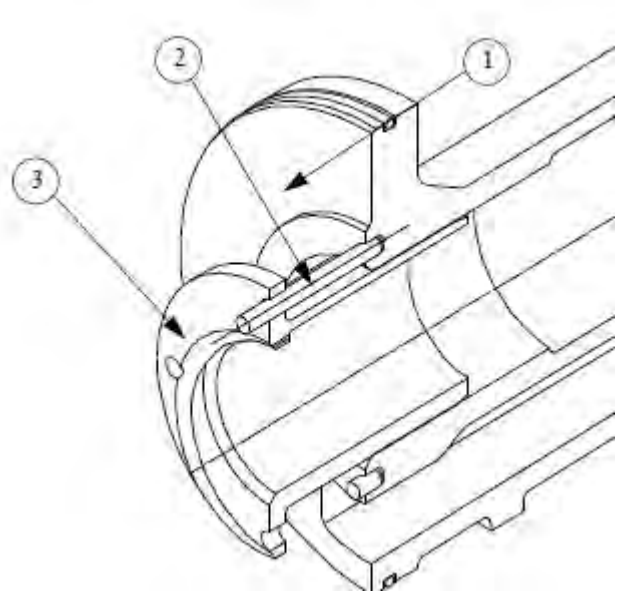
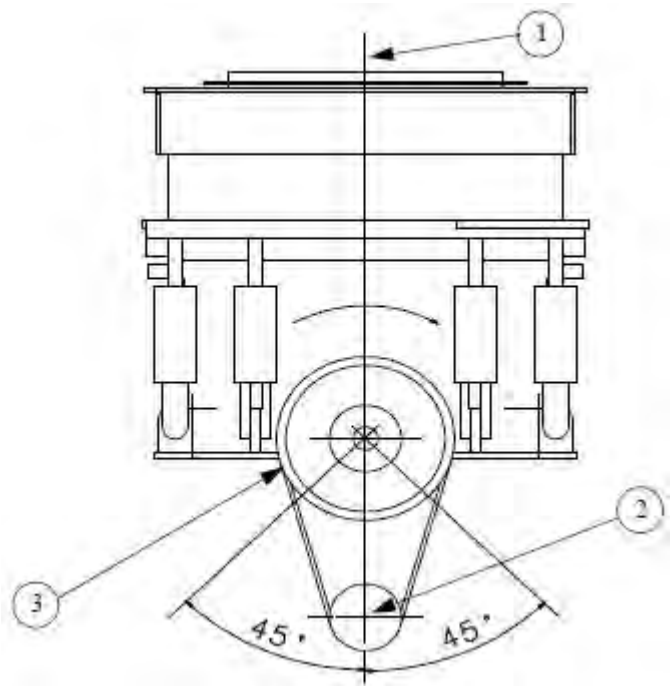
2. Replace the pins with rods of the same diameter and slightly longer than the bushings. These rods will serve as a guide.



1. Countershaft housing
2. Guide rod
3. Countershaft housing

3. The inner and outer bushings are identical. However the position of their oil groove may differ. Determine this position as follows:
   a) The longitudinal oil groove of the countershaft bushing on the pinion side should be situated at 12h.
   b) The longitudinal oil groove of the countershaft bushing on the sheave side should be situated at 6h. See *Figure 100. Position of the countershaft bushing lubrication grooves*. However, this position must be changed it the motor is situated above the crusher in a region 45° either side of the vertical axis (see *Figure 99. Vertical control - motor under crusher*). The bushing must then be turned so that the longitudinal groove is situated on the upper part. This position lets the transmission exert its tractive force outside the groove and therefore does not impede the oil supply.



1. With crusher vertical
2. Drive sheave
3. Crusher sheave

Figure 99. Vertical control - motor under crusher

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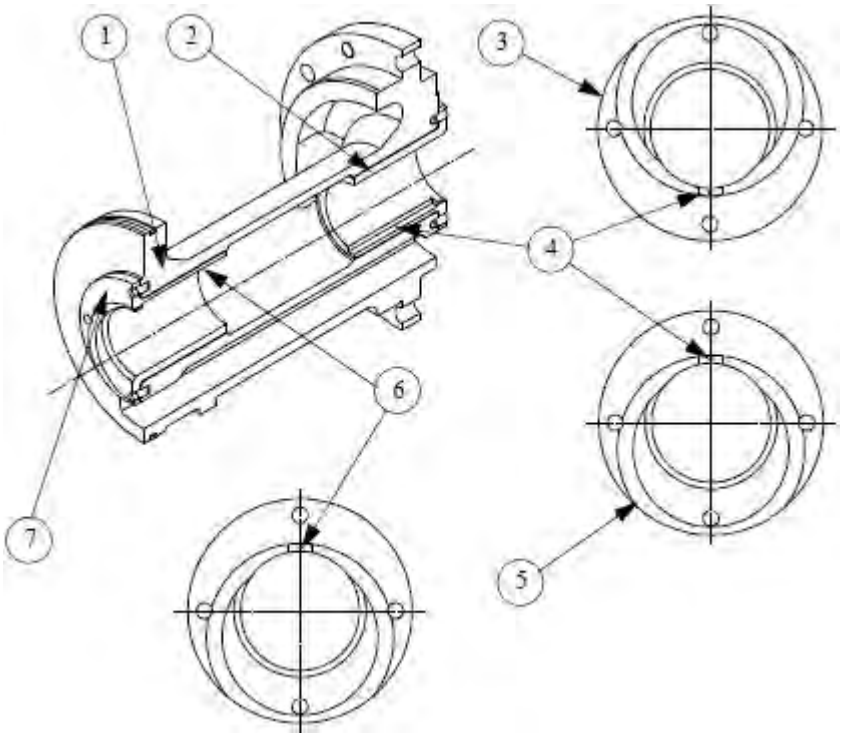

1. Countershaft housing
2. Outer countershaft housing
3. Oil groove positioned at 6h for horizontal or vertical transmission, with the motor over the crusher sheave.
4. Oil groove
4. Oil groove positioned at 12h for vertical transmission, with the motor under the crusher sheave.
5. Oil groove positioned at 12h
7. Inner countershaft bushing

Figure 100. Position of the countershaft bushing lubrication grooves

4. Line the bores of the new bushings with carbon dioxide snow for 2 to 3 hours to facilitate assembly. Measure the outer diameter of the bushing and the housing bore to determine when the bushing has cooled down enough. Approximately 22 kg of carbon dioxide snow are needed to replace both bushings.

NOTE: Cover the outside of the cooled bushing to prevent formation of condensation, which could impede assembly of the bushing in the housing. This also helps to achieve more uniform cooling.

NOTE: If the temperature of the countershaft housing exceeds 24°C, you can use ice instead of carbon dioxide snow.

5. Quickly slide the bushing into the housing using the guide rods.
6. Clean the threads of the headless screws and the tapping of the hole in the frame with a solvent. The apply Loctite 277 to the threaded surfaces and fit the headless screws. Screw in until the screw comes into contact with the bushing. Do not tighten excessively: too much pressure may deform the bushing's bore.
7. If the assembly was not completed soon enough and the bushing works loose during assembly, or if you have no means of cooling, you can insert the bushings by hitting them if you protect them with a piece of wood. The guide rods particularly are useful in that case.

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NOTE: Exert moderate pressure to prevent the bushing jamming.

8. Remove the guide rods and replace them with the two pins you previously removed.

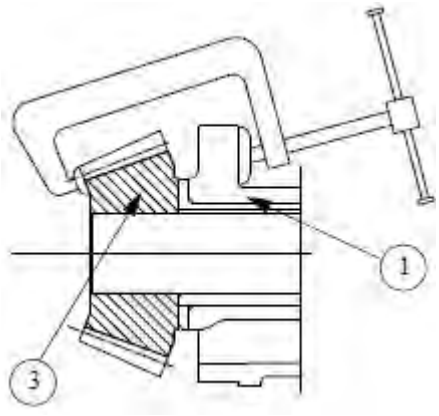
8.3.8.4 Mounting the countershaft housing

Whether the countershaft is dismantled for inspection purposes or to replace parts, it is advisable to replace the seals: O-ring seal or lip seal between the housing and the frame, flat or silicone seal between the housing cover and the countershaft housing or frame, compression ring between the oil ring and housing cover.

These seals can lose their quality over time. They are not expensive and it is better to replace them than to run the risk of dismantling in order to fix an oil leak.

To mount the countershaft assembly housing, proceed as follows:

1. Mount the countershaft assembly in the countershaft housing.
2. To hold the countershaft in place, use a C-clamp. You can also place the pinion against a wall or on solid wooden wedges



1. Countershaft housing
3. Pinion

3. Heat the oil ring to roughly 27°C above ambient temperature and mount it as quickly as possible on the countershaft.
4. If difficulties arise, push the oil ring with a rafter. The ring is correctly mounted when the end float matches the values specified in *Table 36: End float value*, check with a gauge.
5. When the oil ring has cooled down, remove the gauge and fit the compression ring.
6. The oil ring is equipped with a ring seal to form a seal between the oil ring and its housing. Check that this ring can turn freely in the groove machined in the ring. Remove all burrs or dirt that may have gathered on the ring. Replace it if necessary.
7. Check the ring bore before mounting the ring on the countershaft housing. The bore should be smooth.
8. Apply silicone sealant to the face of the countershaft housing before fixing its housing cover onto it. Fit the cover by matching up the bolt holes.
9. Gradually and alternately tighten the retaining screws.

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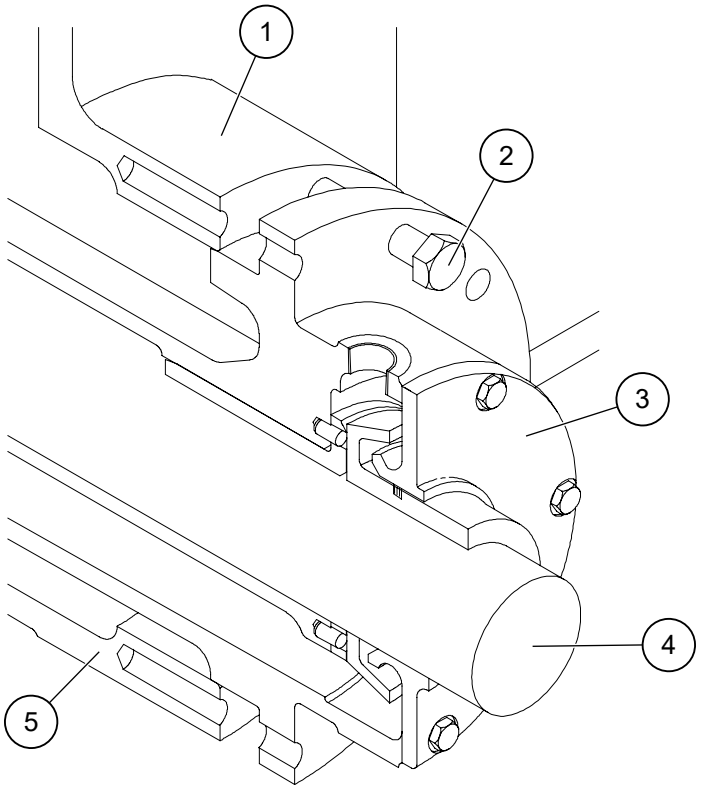
8.3.8.5 Dismantling the countershaft box

⚠ WARNING

PERSONAL INJURY HAZARD

Can cause death or serious injury.

Wear adequate personal safety equipment, such as gloves, when handling hot components.



1. Main frame
2. Jack screws
3. Flinger housing or flinger cover
4. Countershaft
5. Countershaft box

Figure 101. Removing the countershaft box

Disassemble the countershaft box and countershaft assembly for replacement of bushings, pinion or other worn parts, as follows:

1. Remove all oil piping that would interfere with the removal of the box. Plug and cap all open ports.
2. Remove the crusher sheave. This is done primarily to prevent damaging or breaking the sheave during box removal.
3. Remove the capscrews holding the countershaft box to the main frame.

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4. Install the special jacking screws, that are furnished with the machine, into the three equally spaced tapped holes in the outer flange of the box. Alternately tighten each jackscrew a small amount to prevent binding in the frame.

NOTE: If it is occasionally difficult to remove the countershaft box as explained above, you can heat the main frame to about 55°C (100°F) above ambient temperature.

5. Continue tightening the jackscrews until the box is free of the frame.
6. Slide a long section of pipe over the sheave end of the countershaft to counterbalance the assembly and remove the assembly by using an overhead crane or other suitable lifting device.
7. Remove the flinger housing or flinger cover.
8. Heat the oil flinger to approximately 27°C (50°F) above ambient temperature.
9. Place a pry bar between the flinger and the countershaft box and exert moderate pressure. Once the flinger starts to move, grasp each side of the flinger and pull the flinger straight off the shaft.
10. Pull the countershaft assembly out of the countershaft box.

8.3.8.6 Replacing the pinion

Whenever the countershaft box is out for inspection or replacement of parts, it is advisable to inspect the pinion for wear or broken teeth.

Pitting or galling on the face of the teeth are good indications of excessive wear. This can be due to improper tooth contact resulting from an incorrect quantity of shims being placed under the lower thrust bearing, by overloading the crusher or using excessively dirty oil.

A worn pinion is more susceptible to tooth breakage. Also, running on a worn pinion could lead to structural damage in other parts due to vibration. Excessively worn pinions should be replaced.

To get maximum benefit from new parts, it is recommended that gear and pinion be replaced at the same time. If a new pinion is run with a worn gear, the root clearance must be checked.

To replace the pinion, proceed as follows:

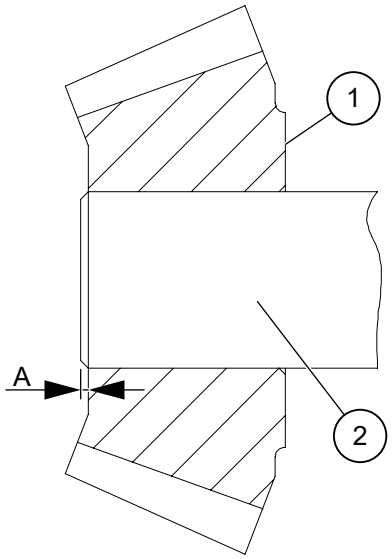
1. Remove the countershaft assembly from the countershaft box and place the countershaft on suitable wooden blocking.
2. Heat the pinion with a torch to approximately 100°C (180°F) above ambient temperature.
3. Repeatedly bump the pinion with a heavy wooden ram while continuously moving the flame around the outside of the pinion. Once the pinion starts to move, grasp each side of the pinion and pull the pinion straight off the shaft.
4. Heat the replacement pinion in an oil bath or with a torch to the required temperature, see the table below.

Table 33: Required heating temperature for the replacement pinion

Above ambient temperature	
Centigrade (C°)	Fahrenheit (F°)
100	180

5. When the pinion has been heated to the correct temperature, quickly place the pinion on the end of the shaft and push the pinion on the shaft so that the end of the shaft protrudes from the pinion the distance specified in the table below.

NOTE: If the pinion cools and becomes hung up on the shaft, reheat the pinion with a torch while bumping the pinion with a wooden ram. Remember to continuously keep the flame moving around the outside of the pinion to avoid any high heat concentration in one spot.



1. Pinion
2. Countershaft

A. Position of the pinion

Figure 102. Position of the pinion

Table 34: Position of the pinion

mm	inch
4	5/32

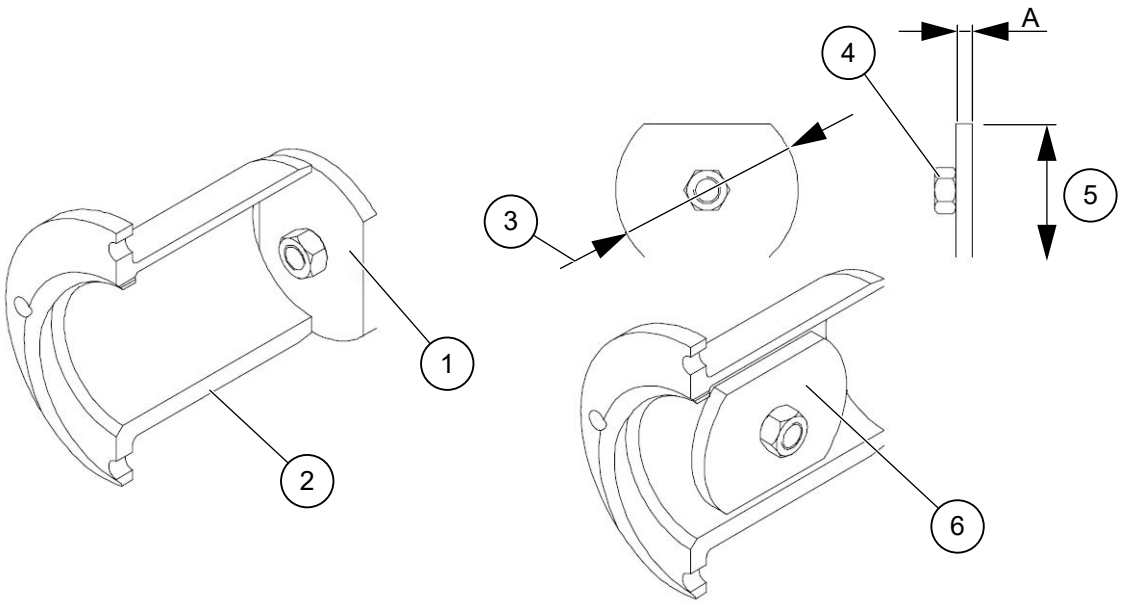
8.3.8.7 Removing the countershaft bushing

On occasions when a bushing becomes worn and replacement is necessary, the bushing will be loose in the box. In instances such as this, the bushing is simply slid from the box without difficulty.

Due to extreme limits of manufacturing tolerances, the countershaft bushings may have had a slight interference fit within the countershaft box. If such is the case, removal will be more difficult.

To replace the countershaft bushings that have such a press fit or those that have seized in the box because of a build up of heat due to inadequate lubrication or from overloading the crusher, proceed as follows:

1. Remove the countershaft box from the main frame and the countershaft from the countershaft box.
2. Construct a steel centering plate as shown in the figure below.



1. Centering plate
2. Countershaft bushing
3. Diameter of plate to be larger than inside bushing
4. M24 nut welded onto the plate
5. Flats are to be smaller than inside diameter of bushing
6. Slide centering plate through bushing and turn 90° to bear against end of bushing

Figure 103. Centering plate

3. Slide the narrow portion of the plate through the bushing until the plate is behind the bushing as shown. Turn the centering plate 90° so that the outer edge of the plate will bear against the bushing.
4. While holding the plate in position, thread a M24 rod into the nut which is welded to the center of the plate. The rod must be a few longer than the bushing and threaded on both ends.
5. Place a 25 mm x 75 mm x 305 mm (1";x 3" x 12") steel bar over the other end of the rod and hold firmly in place with a hex nut.
6. Insert a long timber or pipe through the opposite end of the countershaft box and ram against the centering plate.

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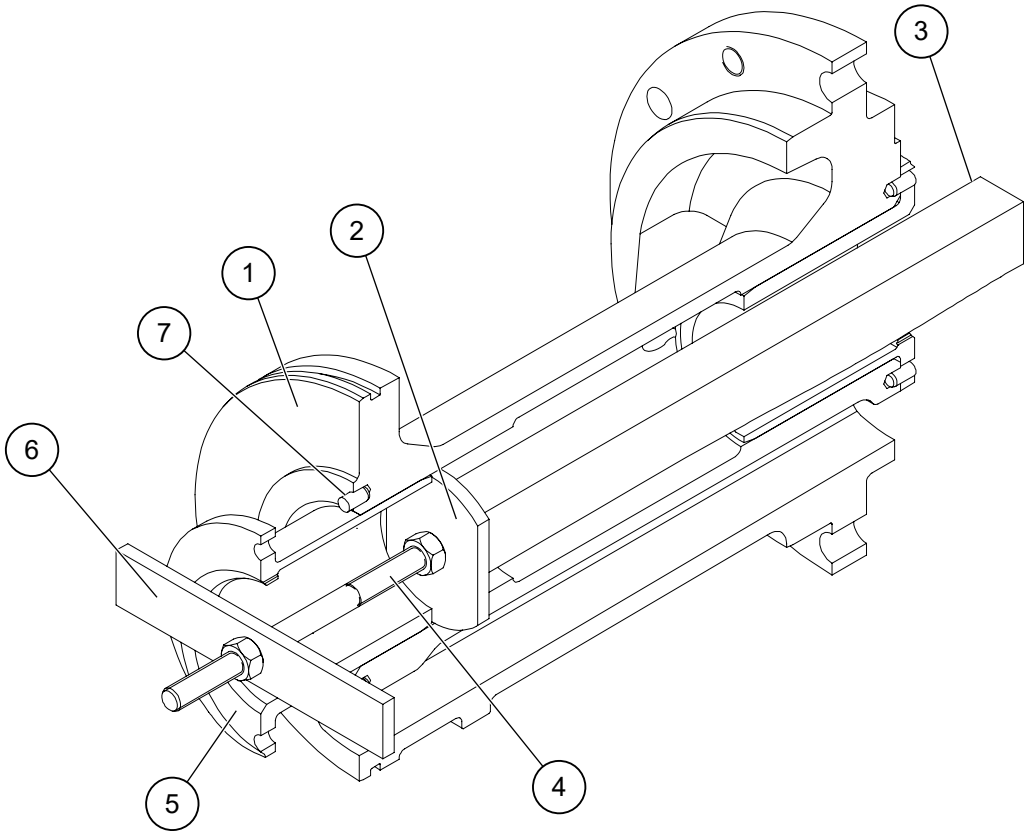

1. Countershaft box
2. Centering plate
3. Timber
4. Threaded rod
5. Countershaft bushing
6. Flat bar
7. Dowel

Figure 104. Removing the countershaft bushing by ramming

7. If bushing remains tight within the countershaft box, remove the bushing using the jacking procedure.
   a) Using the same centering device as previously described and in the same manner, except for a much longer rod and steel bar, place wooden blocking between the steel bar and the countershaft box flange.
   b) Using the threaded rod as a jackscrew, tighten the hex nut until the flange of the bushing is pulled against the steel bar.
   c) Unscrew the nut and place additional blocking under the bar and tighten the hex nut until the bushing is again pulled against the bar.
   d) If necessary, repeat the previous step until the bushing is free.

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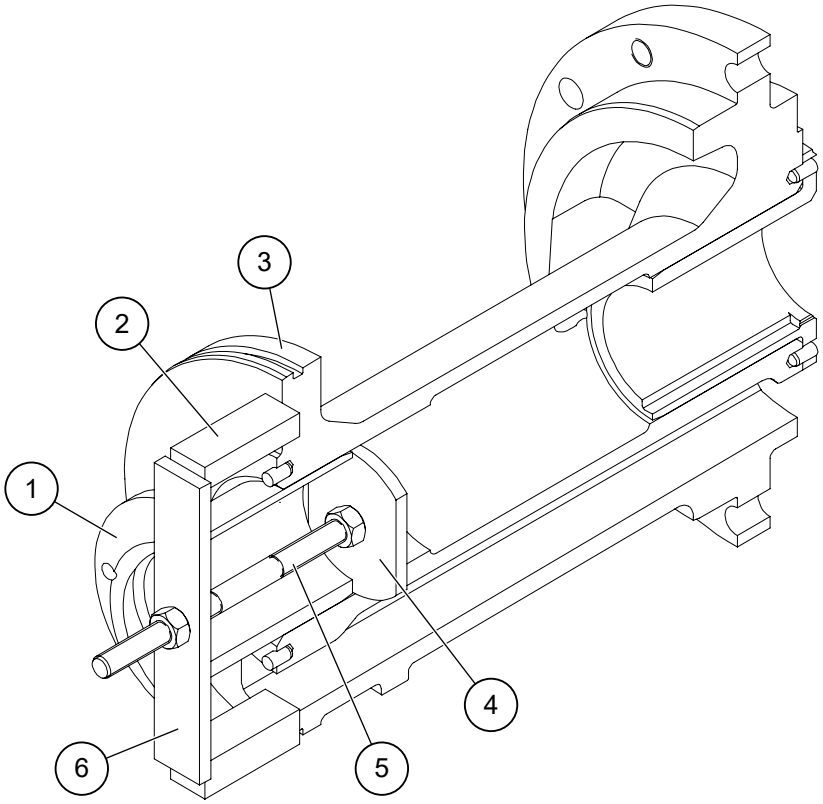

1. Countershaft bushing
2. Blocking
3. Countershaft box
4. Centering plate
5.Threaded rod
6. Flat bar

Figure 105. Removing a countershaft bushing by jacking

8.3.8.8 Examining prior to mounting a countershaft bushing

When mounting new bushings it is advisable to check the housing/bushing adjustment.

The housing bore and the outer diameter of the bushing must be checked to ascertain this adjustment. If it is too tight, the bore of the housing must be altered to bring it within tolerance. Excessive tightness can cause the inner diameter of the bushing to contract, and therefore reduce the gap between it and the countershaft.

If the diameter of the countershaft housing bore is smaller than it should be, contraction can therefore be put down to overheating.

8.3.8.9 Oil leakage from the drive end of the countershaft box

Should oil begin to leak out of the flinger cover area at the drive end of the countershaft box, it may be that the packing ring on both sides of the flinger cover have become damaged or worn and requires replacing.

Check for a dirt build-up in the long cored hole in the countershaft box, just below the countershaft. Such a build-up of dirt would restrict oil flow from the flinger.

It is also possible that the cause of the oil leakage is the inability of the oil to drain away fast enough from the crusher especially when the oil is cold. Minimum pitch is 25 mm (1") for every 305 mm (12") of drain pipe used.

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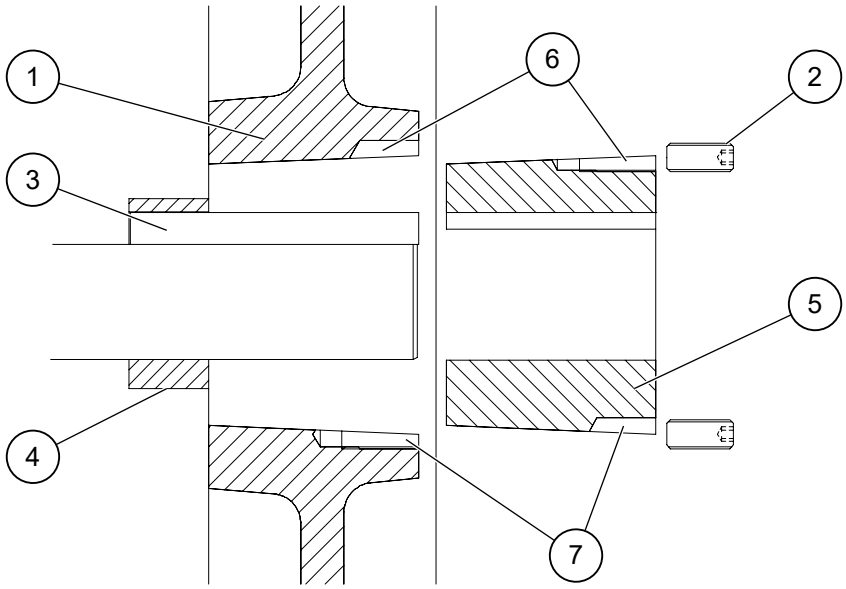
Also check the inside of the main drain line hose or piping for any obstructions, such as dirt build-up or a collapsed hose that may restrict oil flow.

Any of these items just described could cause the oil to back up and leak out of the flinger housing area.

8.3.8.10 Installing the crusher sheave



1. Sheave
2. Screw
3. Key
4. Sleeve
5. Bushing
6. For removal
7. For assembly

Figure 106. Sheave assembly

To install a crusher sheave with a removable bushing, proceed as follows:

1. Refer to the oil piping drawing and install all oil piping.
2. Remove the removable pulley hub by removing the tightening and loosening screws.
3. Clean the shaft, the key, the surfaces and outer cone of the hub together with the conical bore of the pulley on which it is to be assembled. Remove chips and varnish and paint marks.
4. Pull the countershaft to the outside of the crusher so that the pinion is bearing on the countershaft box bushing. Check the axial clearance of the countershaft.
5. Place the sleeve and the removable hub in the conical pulley bore, ensuring the smooth half holes are placed opposite the tapped half holes.
6. Oil the thread and the rounded end of the screws (or underneath the head for screws with head).
7. Place the screws in the tap holes on the pulley without tightening them. The hub is free on the rim.
8. Slide the assembly onto the shaft until the required position is reached. Do not forget the key (keyed pulley version).
9. Evenly tighten the screws in turn. Screws should be tightened until they are locked at the required torque.

NOTE: Apply clamping torque on the hub fastening screws for the keyed and non-keyed versions.

Table 35: Thread torque

Sheave	Torque (Nm)
560-8 SPC	360
630- 6/8V	360

10. If there are any oxidizing risks, fill up the other holes with grease.

8.3.8.11 Removing the crusher sheave

See *Figure 106. Sheave assembly*.

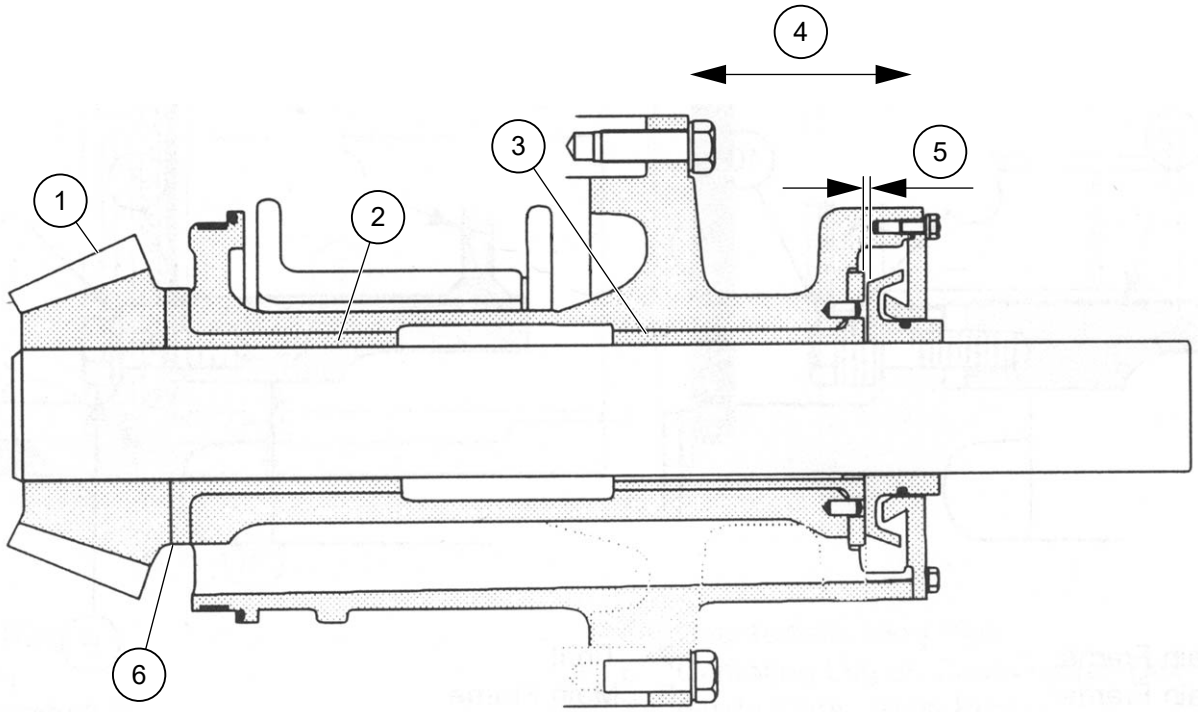
To dismantle the crusher sheave, proceed as follows:

1. Remove the hub fastening screws.
2. Insert the screws into the hub tap holes.

NOTE: If it is difficult to separate the pulley from its removable hub, strike it gently with a hammer while maintaining pressure on the thrust screws.

8.3.8.12 Checking end float

If the crusher was shipped completely assembled, the end float was set correctly at the factory. However, as it is important for the proper operation of the crusher, recheck the end float.



1. Pinion
2. Inner countershaft bushing
3. Outer countershaft bushing
4. End float
5. See table below for value
6. Tight

Figure 107. End float

Table 36: End float value

Crusher	
HP300	0.8 mm (0.031") - 1.6 mm (0.062")

8.3.8.13 Replacing the countershaft liner

1. Remove the bowl assembly.
2. Remove the head assembly.
3. Withdraw the worn shield and replace it with a new liner.
4. Refit the head assembly.
5. Refit the bowl assembly.

8.3.9 Main frame, adjustment ring and tramp release assemblies

This section covers the main frame, adjustment ring, and tramp release assemblies.

The main frame, which is securely bolted to a foundation, transmits the crushing force to the foundation and provides a rigid support for the remaining crusher components. A main frame liner welded or bolted to the inside of the frame as well as arm guards are replaceable and protect the inside of the frame from wear.

There is a replaceable guard attached to the outside diameter of counterweight to protect the eccentric counterweight from excessive wear during operation.

An adjustment ring, which seats on a conical machined surface at the top of the main frame, is threaded on its inside diameter to provide the means of adjusting the bowl assembly.

A clamping ring which is supported above the adjustment ring by a set of clamping cylinders, is threaded on its inside diameter and is used to provide the means of locking the bowl assembly in the crushing position in the adjustment ring.

A dust shell attached to the top of the adjustment ring shields the clamping cylinders and bowl threads from dust and dirt.

Hydraulic cylinders, connected to the underside of the main frame and bolted to the adjustment ring, hold the adjustment ring firmly to the main frame against normal crushing forces. Excessive forces created by improper operation or by passing noncrushable material will cause the adjustment ring to lift which in turn will pull the cylinder rods within the hydraulic cylinders upward.

Oil will be displaced from the upper cylinder chamber into the accumulators further compressing the nitrogen gas within the accumulators. Once the overload or tramp iron has passed through the crusher and crushing forces normalize, the compressed nitrogen will return the oil to the cylinder, the cylinder rods will retract, and the adjustment ring will again seat itself on the main frame.

Main frame pins projecting from the top of the frame or from the under side of the adjustment ring, depending on crusher size, prevent the adjustment ring from rotating and serve as a guide to return the ring to its original position when the adjustment ring lifts or tilts.

A thrust bearing bolted to the main frame around the base of the main shaft supports the rotating eccentric. Shims inserted under the thrust bearing determine gear and pinion backlash and root clearances.

The countershaft is supported by two bronze bushings.

A U seal glued into a groove around the gear well area of the main frame with the rotating T seal behind the counterweight.

The main shaft, rigidly mounted in the center hub of the main frame around which the eccentric rotates, also serves as a support for the socket.

8.3.9.1 Difficulty turning the bowl

Difficulties may be encountered turning the bowl, due to the poor condition of the bowl or adjustment ring threads or both.

Often this occurs when first assembling the bowl assembly in the adjustment ring, when using a single cable on the adjustment cap to rotate the bowl. When turning the bowl this way, one generally uses a cable with anchor to a tractor or loader.

If a single cable is used to turn the bowl in the adjustment ring, the bowl tends to tilt in the threads of the adjustment ring. This swaying creates a point of contact between the outer diameter of the bowl's threads and the flat surface of the adjustment ring's threads in the direction of traction, above all if it is not horizontal.

When the bowl is pushed to the center of the apparatus, this causes swaying, which chips the threads. This damage is usually confined to the first thread of the bowl and the adjustment ring and appears on the flat surfaces of the threads. The resulting chips can damage the rest of the bowl's threads when turning in the adjustment ring. The same effects can occur when dismantling the bowl.

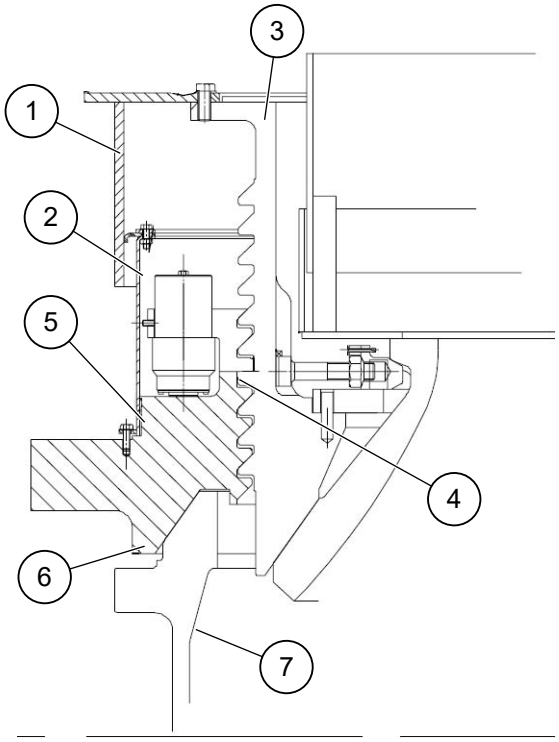
If stripping occurs on the thread, the methods below can minimize the damage when the bowl is being assembled or dismantled:

- Turn the bowl using a crane or another lifting system to maintain the adjustment ring in the floating position. With the bowl in the floating position, two people can tighten or loosen the bowl to the desired setting. After each quarter turn, lower or raise the bowl so that it remains free in the adjustment ring. Rotate the bowl by at least two complete revolutions using this method.

- Use a double cable and pull, to turn the bowl in one direction or the other.
- Use the bowl's hydraulic adjustment system to complete at least two complete bowl revolutions. After two complete revolutions, a single cable can be used to continue tightening or loosening it. Pull the bowl slowly (approximately one bowl revolution per minute); considerable force may be exerted to overcome the friction inside the adjustment ring.

One or more of the following conditions can make it difficult for the bowl to rotate in the adjustment ring:

1. Crushing hot materials; using an unsuitable lubricant for the threads.
2. The threads of the bowl and the adjustment ring have not been regularly lubricated.
3. Wear or incorrect fitting of the dust seal, see *Figure 108. Dust shell and seal*.
4. Crusher used with the same setting for too long a period.
5. Crusher exposed to bad weather, rain in particular, without adequate protection.



1. Adjustment cap
2. Seal
3. Bowl
4. Clamping ring
5. Dust shell
6. Adjustment ring
7. Frame

Figure 108. Dust shell and seal

The following suggestions will eliminate any possibility of the bowl getting blocked in the adjustment ring:

1. Periodically, release the bowl from its crushing position and make it turn by moving it backwards and forwards.
2. Add grease in the grease fittings located all around the adjustment ring when bowl is engaged in it. Draw up a lubrication maintenance program. Use a grease as recommend in *Lubricating the threading*.
3. On installation or when the bowl is removed, clean the threading and cover it with lubricant.
4. Check the seals of the dust shell occasionally for wear or damage.

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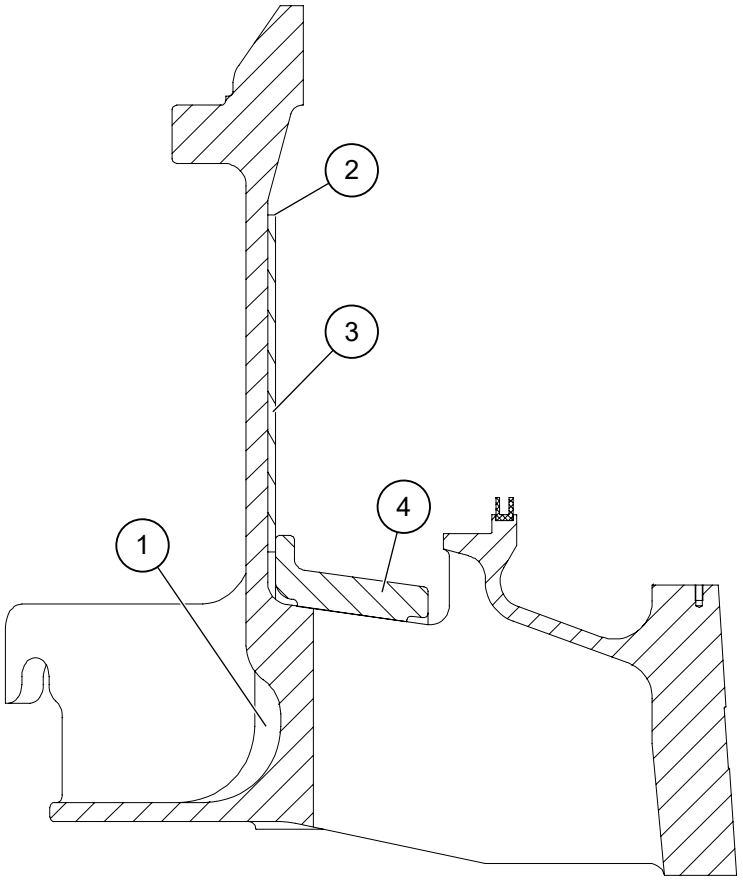
8.3.9.1.1 Releasing a bowl blocked in the adjustment ring

When the bowl is blocked in the adjustment ring and cannot turn by the usual means, proceed as follows:

1. While the crusher is running, feed a certain amount of material into the crusher when the bowl is in the released position.
2. Pour penetrating oil or antifreeze all around the circumference of the bowl's threading and pour the same solution into the grease fittings through the adjustment ring.
   The penetrating oil or antifreeze will release any build-up of dust that may have infiltrated through the thread gap and will also remove any rust that may have formed.
3. Try and unscrew the bowl by applying as much force as possible.
4. If this procedure does not produce satisfactory results immediately, leave the crusher as is for a few hours, periodically applying penetrating oil or antifreeze around the threads, then repeat the previous steps.

8.3.9.2 Main frame liner and arm guards



1. Main frame
2. Weld
3. Main frame liner
4. Arm guard

Figure 109. Main frame liner and arm guards

When the crusher is «down» for a liner change, inspect the main frame liner and arm guards for wear.

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With the head removed from the crusher, lower the arm guards from the top onto the main frame arms. An arm guard could be slipped in place from beneath the crusher while the head is in place but with considerable difficulty.

A replacement main frame liner is usually shipped in sections, making the installation of the liner a somewhat easier task. Should a liner be received in one piece, the ends of the liner must be overlapped until the liner is smaller in diameter than the adjustment ring threads.

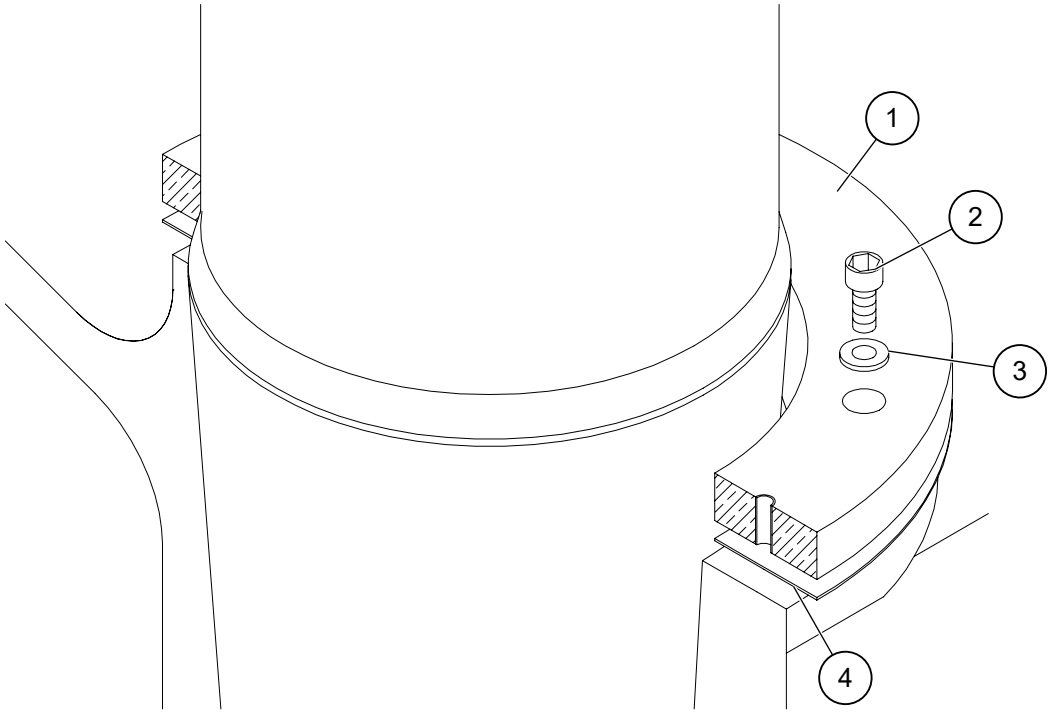
The height of the liner is to be welded inside the frame is readily noticeable by the remaining weld from the old liner. Weld liner at the top only.

8.3.9.3 Main shaft replacement

The need to replace a main shaft should be extremely rare.

Due to the importance of obtaining the proper fit between the main shaft and the main frame hub, removal and installation of the main shaft should be performed only by a Metso representative who has the proper training and equipment.

8.3.9.4 Replacing the lower thrust bearing and shims



1. Lower thrust bearing
2. Capscrew
3. Spring washer
4. Thrust bearing shim

Figure 110. Lower thrust bearing replacement

To replace a damaged or worn lower thrust bearing or to add shims to restore proper gear and pinion backlash and/or root clearance, proceed as follows:

1. To gain access to the thrust bearing, remove the bowl, head, socket and eccentric assemblies. Refer to *Dismantling the bowl*, *Dismantling the head*, *Removing the socket* and *Removing the eccentric assembly*.
2. Remove the socket head capscrews and spring washers that hold the thrust bearing to the main frame.

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3. Thread a ring bolt into each of the two tapped holes in the thrust bearing.
4. Attach a suitable lifting device to the ring bolts and carefully lift the thrust bearing over the main shaft.
5. Check the replacement thrust bearing and the thrust bearing shims that are to be added to be sure there are no burrs or upset edges that would prevent the bearing or shims from lying flat against the main frame with full surface contact.
6. Refer to *Checking or adjusting the backlash and root clearance* to determine the correct amount of shims to be installed. Any additional shims to be added are placed on the top of the existing shim stack.
7. If a new thrust bearing is to be installed, remove the ring bolts from the old bearing and install them in the new bearing.
8. Lower the thrust bearing in place making sure that all holes are properly aligned with the holes in the main frame hub. Make sure bearing is properly seated on the shims.
9. Place a new spring washer over each hole in the thrust bearing. Insert capscrews through the spring washers, lower thrust bearing and shims into the tapped holes in the frame. Then alternately tighten each capscrew a small amount until they are tight.

8.3.9.5 Replacing the seal

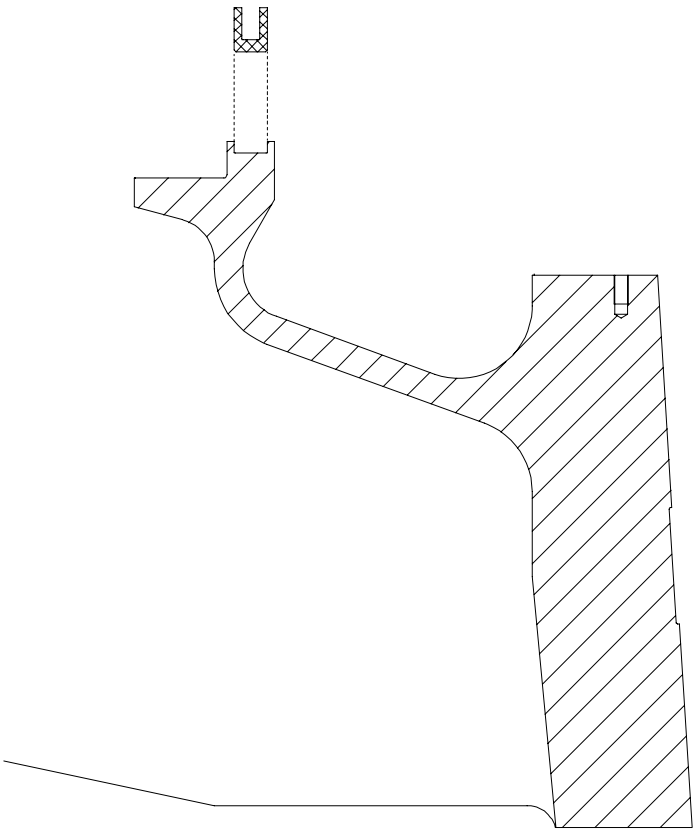

Figure 111. Seal replacement

The U-shaped seal installed around the gear well portion of the main frame is normally not subjected to contact or wear. However, if the seal is damaged in any way, it is important that it is replaced. The seal prevents oil leakage and protects the precision machined surfaces of the gear, pinion, and bearings from harmful dust infiltration.

Replace the seal as follows:

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1. Remove the damaged seal and completely clean out any adhesive that remains in the seal groove. Use a sharpened chisel or a stiff putty knife to cut through the seal and to scrape the old adhesive out of the groove.
2. Thoroughly clean the groove with an oil free solvent and allow to dry. Use alcohol or acetone.
3. After removing the replacement «molded to size» seal from its shipping carton, thoroughly clean the bottom of the seal using coarse sand paper to remove the surface «shine» before cementing the seal in place.
   These seals were coated with a mold release agent which allows the seal to be removed from their mold during manufacture. In order for the seal to adhere properly to the adhesive used to hold the seal in the groove in the main frame, this release agent must be completely removed.

NOTE: If the mold release agent is not completely removed, the seal could come loose during operation.

4. Apply activator in a very thin film to bottom of seal. If an excessive amount of activator is applied, a partially cured bond may result.
5. Sparingly apply adhesive to bottom of seal groove in the main frame. Apply only enough adhesive to ensure minimal squeeze out.
6. Position the seal into the groove as soon as possible after adhesive application. Maintain enough force on the bottom of the seal so that there is pressure contact between the seal and the bottom of the groove. A handling bond is attained in approximately three minutes.

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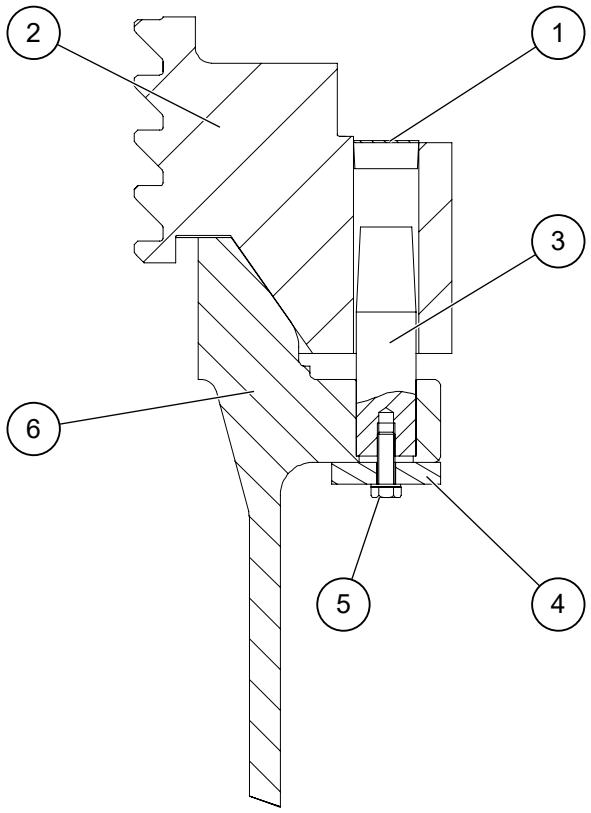
8.3.9.6 Replacing the main frame pins



1. Pin cover
2. Adjustment ring
3. Main frame pin
4. Pin retainer
5. Capscrew and lockwasher
6. Main frame

Figure 112. Main frame pin replacement

The main frame pins prevent the adjustment ring from rotating in respect to the main frame and also guide the adjustment ring back to its original position when the ring lifts due to tramp iron or packed material in the crushing cavity.

Repeated adjustment ring lift is not normal and can usually be corrected by proper feed distribution and correct crusher settings. Incorrect operation with excessive ring movement will result in wear of main frame pins and elongation of the holes in the adjustment ring or in the main frame pin bushings.

The wear can be observed by viewing the underside of the adjustment ring in the main frame pin area. Due to the rotation of the head in relationship to the bowl, the adjustment ring will want to turn in the direction of machine rotation. Since this force will be acting on the adjustment ring in one direction only, the main frame pins and the pin holes in the adjustment ring or pin bushings will have a tendency to wear on one side only.

Replace worn pins as follows:

1. Depressurize the tramp release cylinders. Make sure the pressure gauge in the cavity release pressurize circuit reaches zero (0) pressure.
2. With a crane or other suitable lifting equipment, slightly lift the adjustment ring off the main frame. Then turn the ring to center the main frame pins in the holes in the adjustment ring or pin bushings
3. Remove the capscrew, lockwasher and pin retainer from the underside of each main frame pin to be replaced.

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4. Force the worn pin out through the top of the main frame using a hydraulic lack centered under the pin. Heating of the frame boss may be required. Removal of the tramp release cylinders and accumulators may be required during this procedure.
5. Heat the pin boss on the frame to ease installation.
6. Drive the new pin down into the main frame by sledging. The pins must be seated against the bottom of the counterbored hole in the frame.
7. Fasten the main frame pin to the frame with pin retainer, lockwasher and capscrew.
8. Repressurize the tramp release cylinders.
9. After the new main frame pins have been installed, cover the holes in the adjustment ring with new adhesive backed rubber pin covers.

8.3.9.7 Replacing the main frame pin bushing

⚠ DANGER

PERSONAL INJURY HAZARD

Will cause death or serious injury.

Do not remove the pin bushings without first inserting the safety blocks. Although the compressive force from the tramp release cylinders has been eliminated, there still remains the remote possibility of a hydraulic failure that would allow the heavy weighted adjustment ring bowl assembly to fall.

⚠ WARNING

CORROSIVE HAZARD

Can cause death or serious injury.

Wear well-insulated gloves when handling the carbon dioxide snow. This substance can cause serious burns.

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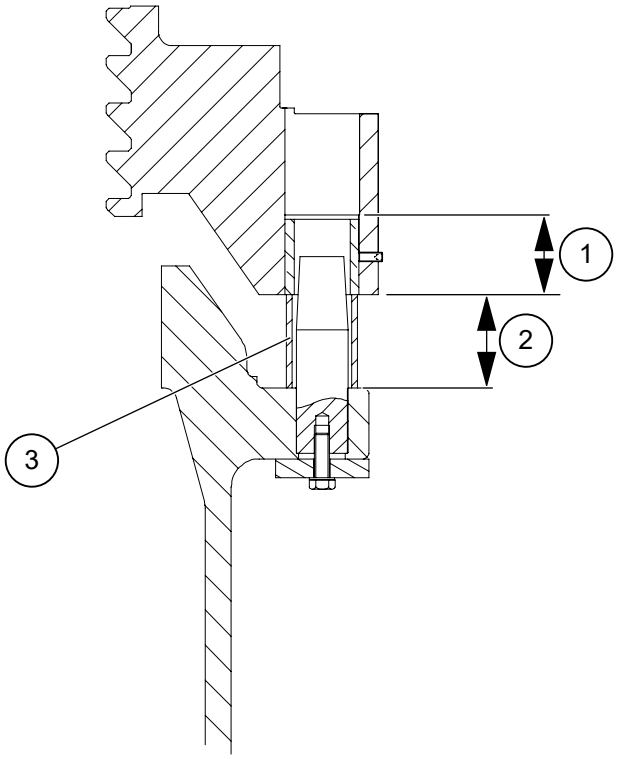

1. Fit area
2. Measure this distance
3. Split tubing (tubing in half)

Figure 113. Main frame pin bushing removal

1. Raise the adjustment ring until the tramp release cylinders are fully extended.
2. When the ring has been fully raised, place the three safety blocks that were furnished with the crusher at three equally spaced main frame pin locations between the main frame and the raised adjustment ring. Then lower the ring to rest on top of the safety blocks.

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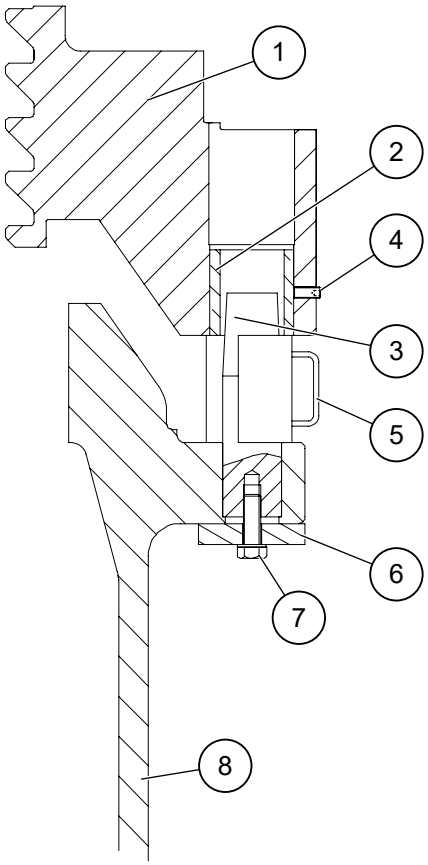

1. Adjustment ring
2. Main frame pin bushing
3. Main frame pin
4. Socket set screw
5. Safety block
6. Pin retainer
7. Capscrew and lockwasher
8. Main frame

Figure 114. Safety blocking

3. Back off all six socket setscrews in the side of the adjustment ring that hold the main frame pin bushings in the ring and remove the rubber pin covers.
4. Measure the distance from the bottom of the pin bushings to the top of the main frame pin boss. Cut three pieces of 76 mm x 6 mm wall tubing (3" x 1/4") to measured length.
5. Cut each tube in half, lengthwise as shown in *Figure 113. Main frame pin bushing removal*.
6. Place one set of tubing halves around each main frame pin as shown in *Figure 113. Main frame pin bushing removal*.
7. Wrap electrical tape or duct tape around the tubing halves to hold them together.
8. Raise the adjustment ring off the safety blocks, then remove the safety blocks.
9. Pressurize the tramp release cylinders to bring the ring down onto the three sets of split tubing. Keep pressurizing the release cylinders until the split tubing forces the pin bushings up and out of the fit area in the bosses on the adjustment ring. The bushing can now be lifted up and out by hand.
10. When the adjustment ring reaches its seating surface on the main frame, raise the ring back up to its full height and place the safety blocks at those locations where the pin bushings have just been forced out of the adjustment ring. This will permit the other three bushings to be removed.

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11. Remove the remaining three bushings by repeating steps *6* - *9*.
12. Once again, raise the adjustment ring to its full height and re-insert three equally spaced safety blocks.
13. Before installing the replacement pin bushings in the adjustment ring, pack them in dry ice for approximately 2 hours.
14. Just before installing the pin bushings, heat the adjustment ring boss with a torch for approximately 10 minutes. Then quickly slide the «frozen» bushing down into the boss until it is flush with the bottom of the adjustment ring.
15. While holding the bushing against the bottom of the adjustment ring, tighten the setscrew in the side of the ring to hold the bushing in place.
16. Raise the adjustment ring to its full height off the safety blocks and move the blocks to the three locations where the pin bushings have just been installed. Lower the ring onto the safety blocks.
17. Install the remaining three «frozen» pin bushings as described in steps *14* and *15*.
18. After installing new frame pins, cover the holes in the adjustment ring with new foam plugs.
19. Raise the adjustment ring slightly and remove the safety blocks.
20. Lower the ring onto the main frame and fully pressurize the tramp release cylinders to their normal operating pressure.

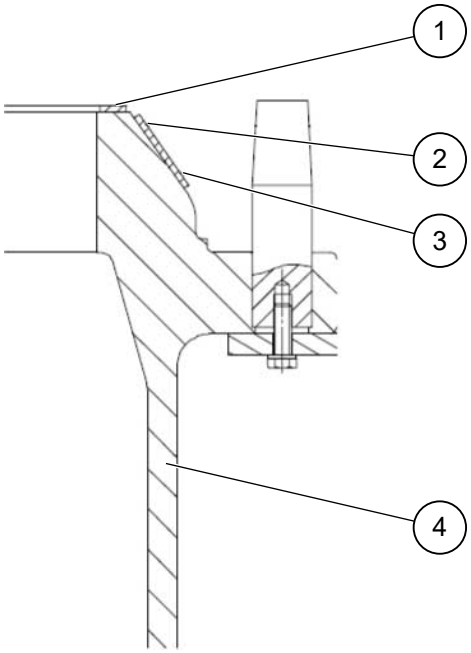
8.3.9.8 Inspecting the main frame seat for wear

Once the tramp release cylinder assemblies have been removed from the crusher, the adjustment ring can be lifted from the main frame to inspect the main frame seat for wear.

Due to irregularity in feed to a crusher and the slight rubbing action between the adjustment ring and main frame seat, there is a certain amount of wear. Should there be an excessive amount of adjustment ring movement, this wear could be increased.

As standard on all cone crushers, a bronze liner is welded on the frame. The use of a bronze alloy which forms the seating surface for the adjustment ring of these machines, provides a replaceable wearing surface. The bronze alloy being of a softer metal than either the frame or the ring does the wearing.

In conjunction with the bronze main frame seat liners, a steel fulcrum bar has been added. The fulcrum bar is very important as they permit the adjustment ring to tilt and recenter properly when the ring raises due to a piece of tramp iron passing through the crushing cavity.



1. Fulcrum bar
2. Seat liner
3. Seating surface
4. Main frame

Figure 115. Main frame seating surfaces

To determine exactly how much wear is taking place on the seat liners, proceed as follows:

1. Starting at the first main frame pin location to the left of the countershaft box, paint or stamp on the outside of the adjustment ring or main frame pin boss, in a clockwise direction, the numbers 1, 2, 3, 4, 5 and 6 or 1, 2, 3 and 4 depending on the number of main frame pins.
2. Measure the distance between the adjustment ring boss and the pin boss on the main frame. Record these dimensions.

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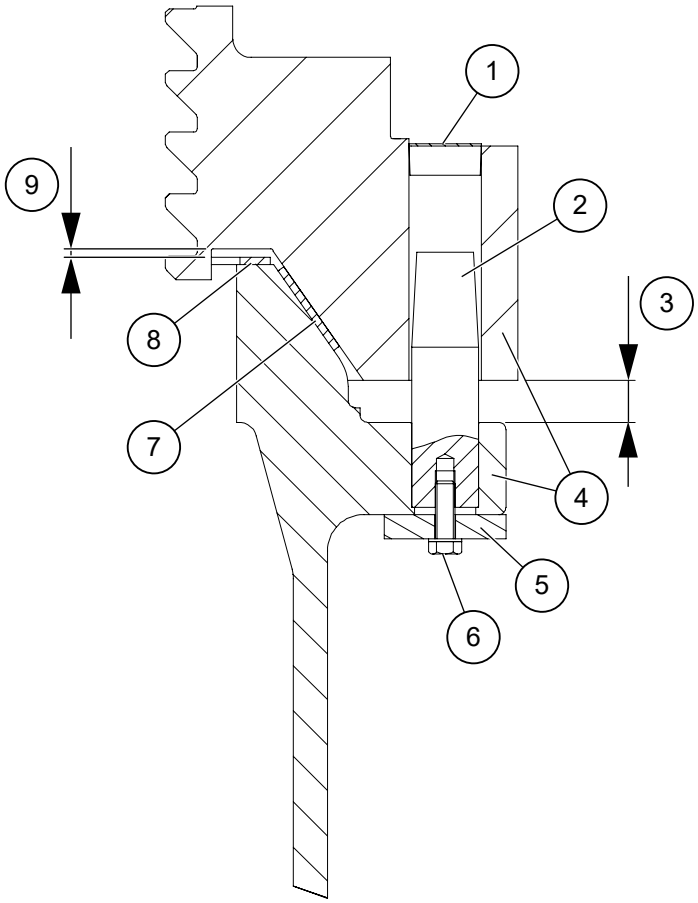

1. Pin cover
2. Main frame pin
3. Measure and record wear dimension here
4. Paint or stamp the numbers 1,2,3 etc. here
5. Pin retainer
6. Capscrew and lockwasher
7. Seat liner
8. Fulcrum bar
9. Gap

Figure 116. Marking pin bosses to determine seating surface wear

3. At periodic intervals, remeasure these points and compare them to the original dimensions. Comparing the two sets of dimensions will show at a glance how much wear has taken place and if the wear is even all the way around the crusher.
   Due to casting and machining variations this is the only accurate method in which wear can be determined
4. When any one of the check dimensions measures less than the initial recorded dimensions by the amount shown in the table below, replace the seat liner and fulcrum bar (if so equipped). This much vertical wear means that only 1.5 mm (1/16") of material is left on the seat liner.

Table 37: Seat liner wear

Original recorded measurement	Periodic dimensional check measurement	Difference
35 mm (1 3/8")	27 mm (1 1/16")	8 mm (5/16")

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The 8 mm (5/16") difference between the two measurements indicates the seating surface has worn and, according to the table, the seat liner and fulcrum bar (if so equipped) need replacing.

When taking the periodic checks and it is found that after subtracting the original recorded measurement from the periodic check, that the difference varies 6 mm (1/4") or more from one check point to the other, the seat liner has worn on one side causing the adjustment ring to seat tilted on the main frame.

This tilting is caused by the crushing cavity being fed heavily in one area instead of the feed being evenly distributed all around. The uneven feed distribution will make the adjustment ring work on the frame seat where the majority of the crushing is being done and cause the seat liner to wear excessively in that area. If the difference from one checkpoint to the other varies 6 mm (1/4") to 10 mm (3/8"), then the main frame seat liner and fulcrum bar (if so equipped) need to be replaced.

To correct this problem, the crusher feeding arrangement should be adjusted so the feed being introduced into the crusher is evenly distributed all around the cavity as described in *Feed arrangement*.

Whenever replacing the worn bronze main frame seat liner, the steel fulcrum bar must be replaced at the same time. Installation and welding procedures are shown on the drawings furnished with each set of seat liners. The drawing is entitled field welding of main frame seat liner and fulcrum bar.

The method just described can also be used for determining how much wear is taking place between the adjustment ring and main frame if the crusher is not equipped with seat liners.

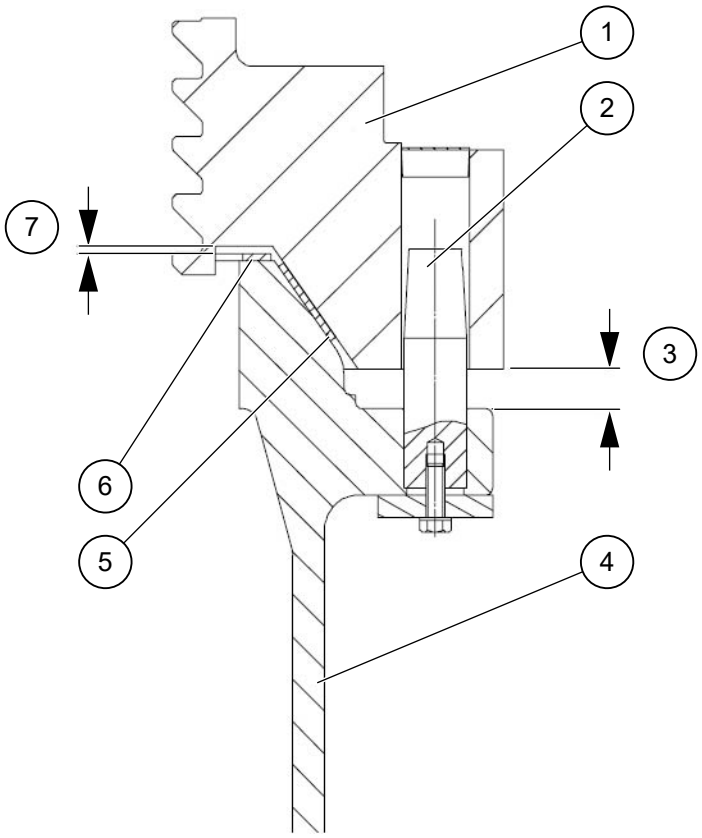
NOTE: Before a liner can be mounted on an old crusher, the frame and the adjustment ring must be reconditioned as new.

8.3.9.9 Inspecting the adjustment ring for wear

There is gap between the fulcrum bar and the lower face of the adjustment ring; this gap must be maintained when replacing the liner.

After a long period of activity, remember to change the bar if there is no more gap between the lower face of the adjustment ring and the fulcrum bar.

NOTE: It is important that a gap is maintained between the lower part of the ring and the fulcrum bar. If the adjustment ring remains supported on the fulcrum bar, it could suffer serious damage.



1. Adjustment ring
2. Frame pin
3. Measure this distance
4. Frame
5. Bronze liner
6. Fulcrum bar
7. Gap of 1 to 4 mm after fitting the liners

Figure 117. Wear liners

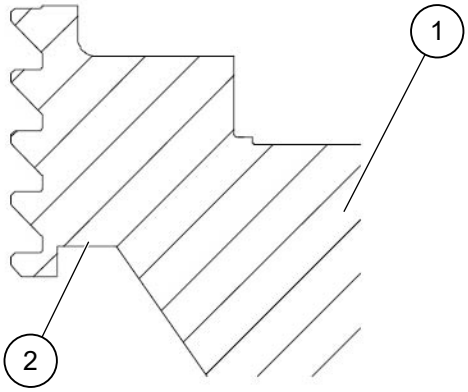
To determine if the gap between the top of the fulcrum bar and the bottom of the adjustment ring is correct, proceed as follows:

1. Place balls of clay or mastic on the top of the fulcrum bar or on the frame.
2. Lower the adjustment ring onto the frame.
   When the adjustment ring rests on the seating surface, the clay or mastic will be compressed, showing the exact amount of gap between the adjustment ring and the fulcrum bar.
3. Raise the adjustment ring.
4. Measure the thickness of the compressed clay or mastic.
   a) If the thickness of the compressed clay or mastic is less than 1 mm (0.04"), the lower surface of the adjustment ring must be hard-surfaced and machined to obtain the minimum gap.
   b) If the thickness of the compressed clay or mastic is greater than 4 mm (5/32"), the lower surface of the adjustment ring must be hard-surfaced and machined to obtain the maximum gap.

Table 38: Example

1.0 mm (1/32")	Minimum admissible gap between the fulcrum bar and the lower face of the adjustment ring.

0.2 mm (0.008")	Thickness of the clay or mastic.
0.8 mm (1.32")	The machining dimension of the lower part of the adjustment ring, to obtain the minimum gap.



1. Adjustment ring
2. Lower surface of the ring

Figure 118. Adjustment ring seating surface

5. Compare the measurements in the various measurement points. If there is a difference of 6 mm (1/4") or more between the various measured points, this means that the adjustment ring has been knocked on one side. To remedy this problem, the adjustment ring's seating surface must be hard-surfaced and re-machined. Contact Metso for the seating surface reconditioning procedure (welding and re-machining). Review also the crusher's feed and its distribution in the crusher cavity.
   If the adjustment ring is knocked on one side, the adjustment ring tilts on the frame. Fitting a bronze liner and fulcrum bar will not resolve the problem. The adjustment ring tilts due to uneven distribution of the materials in the crusher cavity. Uneven distribution causes the adjustment ring to work mainly on this face, which causes excessive wear to this surface.

8.3.9.10 Installing the bronze liners and fulcrum bars

1. Depressurize the protective cylinders as described in the paragraph on depressurizing in the hydraulics manual.
2. Unscrew the ball nut over the adjustment ring from the protective cylinders' piston rod. Since this nut was fitted with Loctite, it must be heated to roughly 205°C (400°F) before it can be removed.
3. Fix all the protective cylinders to the outer diameter of the main frame.
4. With a crane or other suitable hoisting equipment, lift the adjustment ring assembly, including the lock ring and the locking cylinders to take them out of the main frame.
5. Remove the old liners.
6. Weld the bronze sectors.
   a) Preheat the inside of the frame to around 50°C (122°F).
   b) Place the bronze liners in position and spot weld them to the frame.
   c) Preheat the inside of the frame again to a temperature of between 80°C (176°F) and 100°C (212°F) then finish welding the bronze liners.

      Preheating is necessary for proper penetration and resistance of the welding material.

7. Weld the protective liner on top of the main frame in individual segments.

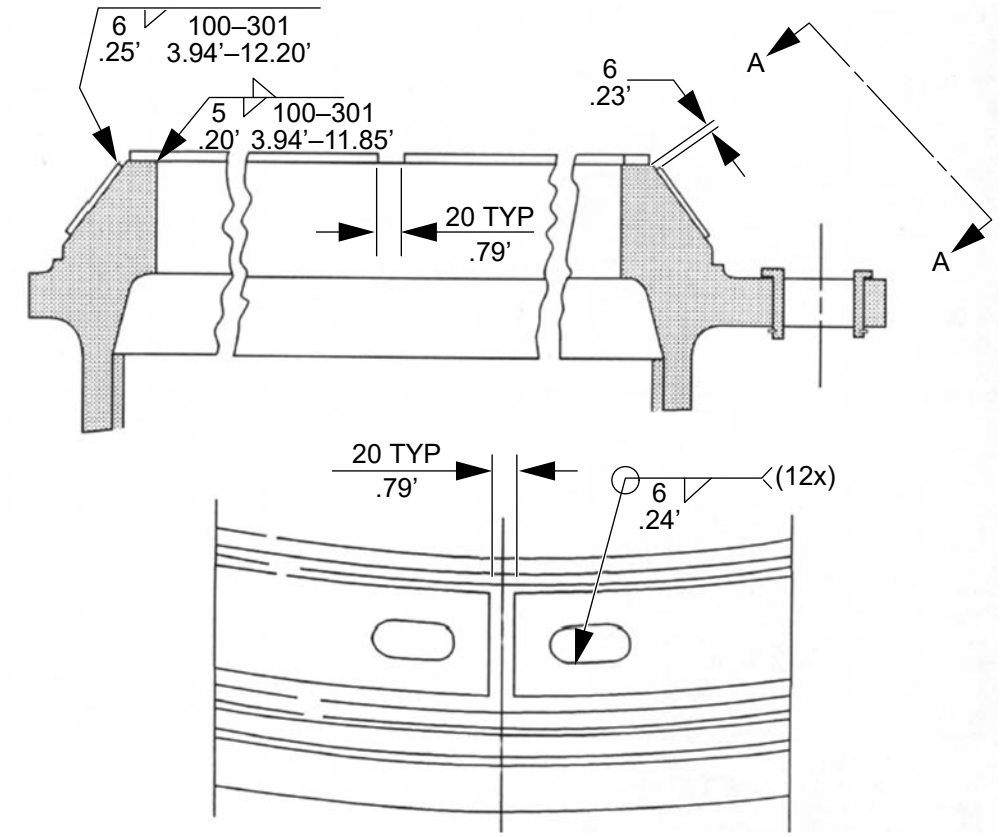


Figure 119. Welds

8. Check the gap between the support bar and the underneath of the adjustment ring. See *Inspecting the adjustment ring for wear*.
9. Install the adjustment ring assembly on the main frame. The adjustment rings must be coated with grease, lithium NLG1 No.1 with 5-10% of molybdenum disulphide powder.
10. Refit the cylinders' domed nuts.

8.3.9.11 Removing the tramp release cylinder

⚠ WARNING

PRESSURIZED COMPONENT HAZARD

Can cause death or serious injury.

After the engine has been stopped, some pressure can remain in the hydraulic system and in the cooling system of the engine. Let the machine cool down sufficiently before opening pressurized components. Always make sure that the system is pressure-free before doing any checks, maintenance, or repair work.

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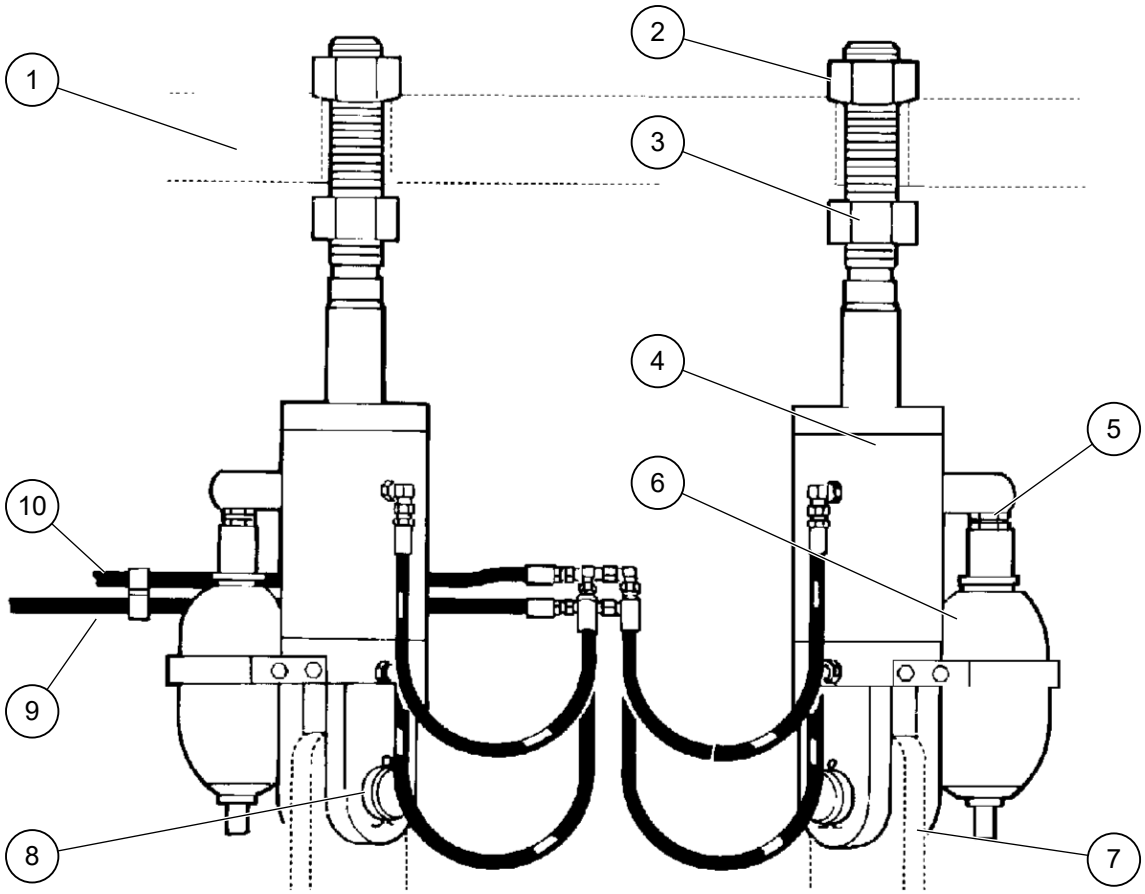

1. Adjustment ring
2. Spherical nut
3. Hex nut
4. Tramp release cylinder
5. Union
6. Accumulator
7. Main frame rib
8. Clevis pin
9. Clearing circuit
10. Cavity release pressurizing circuit

Figure 120. Tramp release assembly

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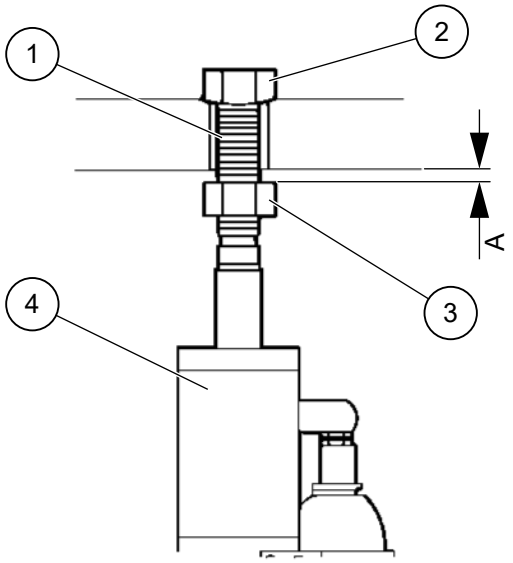


1. Piston rod
2. Special spherical nut
3. Regular hex nut
4. Tramp release cylinder

Figure 121. Cylinder rod end connection

A leaking cylinder is a condition which requires immediate attention.

A leaking cylinder either externally around the piston rod or past the gland seals or internally past the piston and into the opposite side of the cylinder will result in excessive adjustment ring movement. External leakage will be visible by oil seepage around the piston rod area at the top of the cylinder or at the junction between the cylinder and the gland.

Either condition, external or internal leakage, will show itself at the cavity release system pressure gauge. If the system loses pressure and requires repeated re-pressurizing, an oil leak should be suspected.

To remove a leaking cylinder for replacement or repair, proceed as follows:

1. Shut the power off to the power unit motor and lock out the motor. This will vent the pressurized oil at the accumulator side of the cylinders back to tank.
2. Make sure the pressure gauge in the cavity release pressurize circuit reaches zero (0) pressure.
3. Disconnect the cavity release pressurizing circuit hose fitting at the top of the tramp release cylinder and the clearing circuit hose fitting at the bottom of the cylinder. Cap or plug all fittings, hoses, etc.
4. Attach a sling around the cylinder to be replaced and connect to a suitable lifting device.
5. Unscrew the spherical nut that is on top of the adjustment ring from the piston rod. Since this nut was installed with Loctite, the nut must be heated to approximately 205°C (400°F) before the nut can be unscrewed.
6. Remove the cotter pins from both ends of the clevis pin at the base end of the cylinder.
7. The clevis pins have a slight loose fit within the clevis. Drive the pins free by striking with a sledge from the most convenient side. Do not strike the pin directly which could mushroom the end of the pin and make removal impossible. Place a steel or brass round bar squarely against the face of the pin and then hit against the bar until the pin is driven free.
8. Lift the cylinder and accumulator clear of the crusher while sliding the piston rod down through the hole in the adjustment ring. Be careful not to damage any of the hoses or fittings.

9. Loosen the accumulator clamp segment capscrews enough to allow the accumulator to move freely in the clamp bracket.
10. Remove the accumulator by unscrewing the pipe union and sliding the accumulator downwards and out of the clamp bracket. See *Replacing the accumulator*.
11. Reassemble the circuit. See the hydraulics manual for instructions.

8.3.9.12 Installing the tramp release cylinder

Refer to the figures in *Removing the tramp release cylinder*.

Install a new or repaired cylinder as follows:

1. Reassemble the accumulator to the side of the cylinder.
2. Push the piston rod down to bottom the piston in the cylinder.
3. Thread a regular hex nut onto the piston rod and turn the hex nut down to the bottom of the threads on the rod.
4. Connect a lifting device to the cylinder so that it will hang vertically with the piston rod end upward.
5. Lift the cylinder while sliding the rod up through the hole in the adjustment ring and position the base end of the cylinder so that the clevis mounting lugs straddle the main frame rib.
6. Inspect the clevis pin and remove any burrs or nicks which protect above the machined diameter.
7. Align the clevis mounting lugs with the hole in the main frame.
8. Coat the pin with oil then drive the pin through the mounting lugs and main frame by tapping lightly with a hammer against a steel or brass round rod.
9. Install cotter pins at each end of the clevis pin.
10. Clean the top 100 mm (4") of the threaded portion of the piston rod with an oil free solvent (alcohol or acetone). Then, using a CLEAN brush, apply Loctite 242 to the threads of the piston rods.
11. Turn the special spherical nut on the piston rod several turns and pull the rod out of the cylinder the distance shown in the table. Install the spherical nut with the spherical surface toward the top of the adjustment ring.

Table 39: Rod pull-out distance

Adjustment (mm)	Adjustment (inches)
23	1

12. Clean the piston rod threads below the adjustment ring using an oil free solvent. Apply Loctite 242 to the cleaned threads from the bottom of the adjustment ring to the top of the previously installed lower hex nut.
13. Turn the hex nut up the rod until there is a clearance of 20 mm (3/4") between top of hex nut and underside of adjustment ring.
14. Connect all hydraulic and accumulator hoses.
15. After the cylinder is installed and all connections completed, bleed the system to remove any entrapped air. Then pressurize the system and check for leaks. See the hydraulics manual for instructions on bleeding, charging and checking the system.
16. With the tramp release circuit pressurized, check the distance between the top of the lower hex nut and the underside of adjustment ring as outlined in step *13*. If the distance is not correct, depressurize the

circuit and readjust the lower hex nut to obtain the correct setting. Recheck the distance with the circuit pressurized and readjust if necessary.

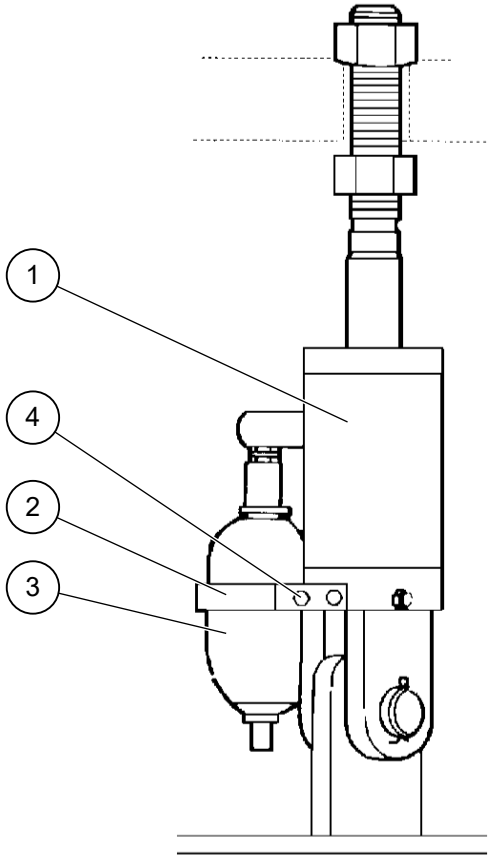
8.3.9.13 Replacing the accumulator

⚠ WARNING

PRESSURIZED COMPONENT HAZARD

Can cause death or serious injury.

After the engine has been stopped, some pressure can remain in the hydraulic system and in the cooling system of the engine. Let the machine cool down sufficiently before opening pressurized components. Always make sure that the system is pressure-free before doing any checks, maintenance, or repair work.



1. Tramp release cylinder
2. Accumulator clamp segment
3. Accumulator
4. Accumulator clamp bracket bolted to tramp release cylinder

Figure 122. Accumulator replacement

A faulty accumulator, either the nitrogen gas escaping to atmosphere or a leak in the internal bladder, is a serious condition that requires immediate attention. In either instance, the accumulator will completely fill with oil.

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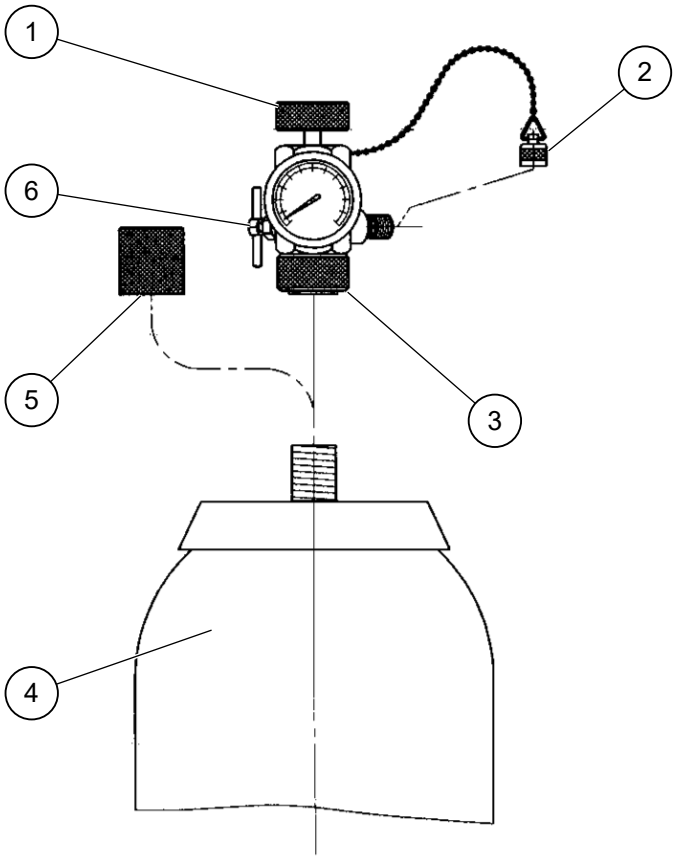
Since the gas or pre-charge has escaped or leaked from the bladder, the tramp release arrangement will not function properly. Oil which is normally displaced from the tramp release cylinders into the accumulators when uncrushable material or overloads are encountered, cannot compress the nitrogen gas within the accumulator bladders, thereby creating excessive forces within the crushers components.

The accumulator pre-charge pressure should be checked every 200 hours (1 month). If the accumulator gas pressure is not at its normal pre-charge level or is unable to sustain the recommended level of normal operating pressure, the accumulator should be removed and replaced.

Replace a faulty accumulator as follows:

1. Shut the power off to the power unit motor and lockout the motor. This will vent the pressurized oil at the accumulator side of the cylinders back to tank.
2. Make sure the pressure gauge in the cavity release pressurize circuit reaches zero (0) pressure.
3. Depressurize the accumulator bladder.
   a) Remove the valve protection plug at the top of the accumulator.
   b) Take the inflator / tester and ensure the coupling screwed at its base is compatible with the accumulator valve.
   c) Fully unscrew the knurled button on the inflator / tester and make sure the drain plug is closed.
   d) Screw the inflator / tester onto the accumulator using the knurled button at the lower part of the inflator / tester.
   e) Screw the knurled button onto the inflator / tester.
   f) Put back the valve protection plug and open the bleed screw, until emptying nitrogen (pressure gauge reads «0»).
   g) Remove the inflator / tester.



1. Pressure valve
2. Connection guard
3. Lower screw
4. Accumulator
5. Valve guard
6. Bleeder valve

Figure 123. Depressurizing the accumulator bladder

4. Remove the hex nuts, lockwashers and capscrews from the clamp segment around the accumulator body and remove the clamp segment from the accumulator bracket.
5. Attach a sling around the accumulator and to a suitable lifting device.
6. Position a large pipe or adjustable wrench around the union at the top of the accumulator and turn the accumulator clockwise until it is free to be removed.
7. Liberally coat the threads on the pipe union and the inside threads of the replacement or rebuilt accumulator with a suitable pipe thread compound. Screw the union into the accumulator.
8. Carefully position the replacement accumulator and union next to the tramp release cylinder and turn the accumulator union into the cylinder threaded connection being careful that the accumulator is going on straight and is not cross threaded. Tighten firmly.
9. Install the clamp segment and attaching hardware.
10. Pre-charge the replacement accumulator. The accumulator can be damaged if oil pressure is applied before correctly pre-charging with nitrogen.
11. After the accumulator is installed and all connections completed, bleed the system to remove any entrapped air.

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12. Pressurize the system and check for leaks. See the hydraulic manual for instructions on purging and testing pressure in the hydraulic circuit.

8.3.9.14 Removing the clamping ring

To remove the clamping ring for inspection or replacement of parts, proceed as follows:

1. Remove the bowl.

NOTE: For safety reasons and to avoid any damage to the machine, the locking pressure should be kept at 0 bars when the bowl assembly is not engaged in the clamping and adjustment rings (while the bowl is unscrewed and until it is reassembled).

2. Remove the hex head capscrews and jam nuts that go through the clamping ring into the top of the adjustment ring.

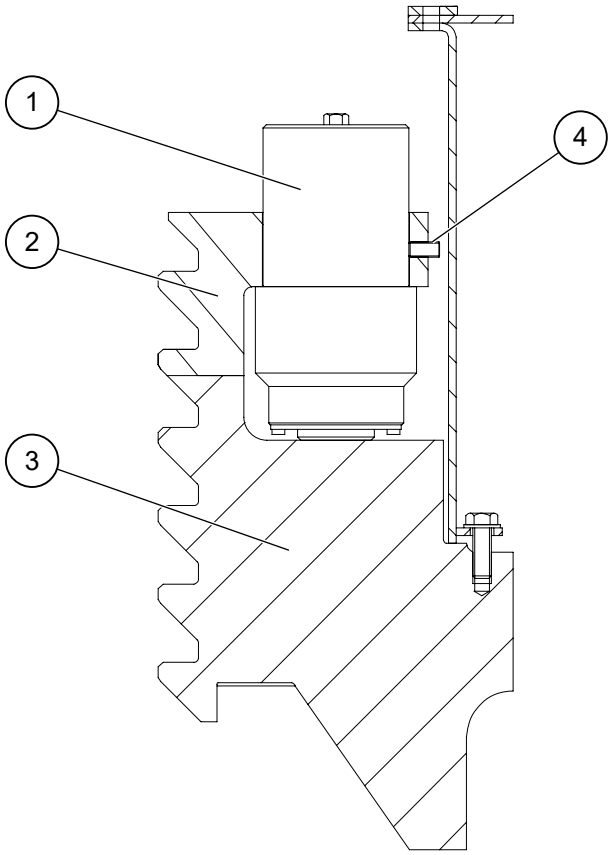
   These capscrews are used to prevent accidental lifting of the clamping ring when removing the bowl and to prevent damage to the clamping cylinders if they are pressurized when the bowl assembly is not in place.

3. Make sure the clamping circuit is depressurized, then disconnect the hose that is connected between the first clamping cylinder and the elbow fitting in the top surface of the adjustment ring.
4. Insert ring bolts into the top of the clamping ring and lift the ring and clamping cylinders off the adjustment ring using a suitable lifting device.
5. Any or all of the clamping cylinders can now be removed from the clamping ring for repair or replacement. Disconnect the hoses on both sides of the cylinders, remove the socket setscrews that hold the cylinders in the ring and slide the cylinders out of the clamping ring.

8.3.9.15 Installing the clamping ring

Install the clamping ring on the adjustment ring as follows:

1. Thoroughly clean the threads on the clamping ring and also the threads on the bowl and adjustment ring.
2. Clean the holes in the clamping ring for the clamping cylinders and ground any burrs smooth.
3. Slide the clamping cylinders into the holes in the clamping ring as shown in the figure below. The cylinders must be positioned so that the tapped ports in the sides of the cylinders will permit the installation of the interconnecting hydraulic hoses. Then lock the clamping cylinders in the clamping ring with the socket setscrews and install the hoses.



1. Clamping cylinder
2. Clamping ring
3. Adjustment ring
4. Socket setscrew

Figure 124. Clamping ring installation

4. Thread ring bolts into the tapped holes in the top of the clamping ring. Rig slings between the ring bolts and a suitable lifting device, then lift the clamping ring over the adjustment ring.
5. Turn the clamping ring until the alignment hole through the clamping ring aligns with the corresponding match-mark hole in the adjustment ring. See the table below for match-mark location and alignment hole diameter.

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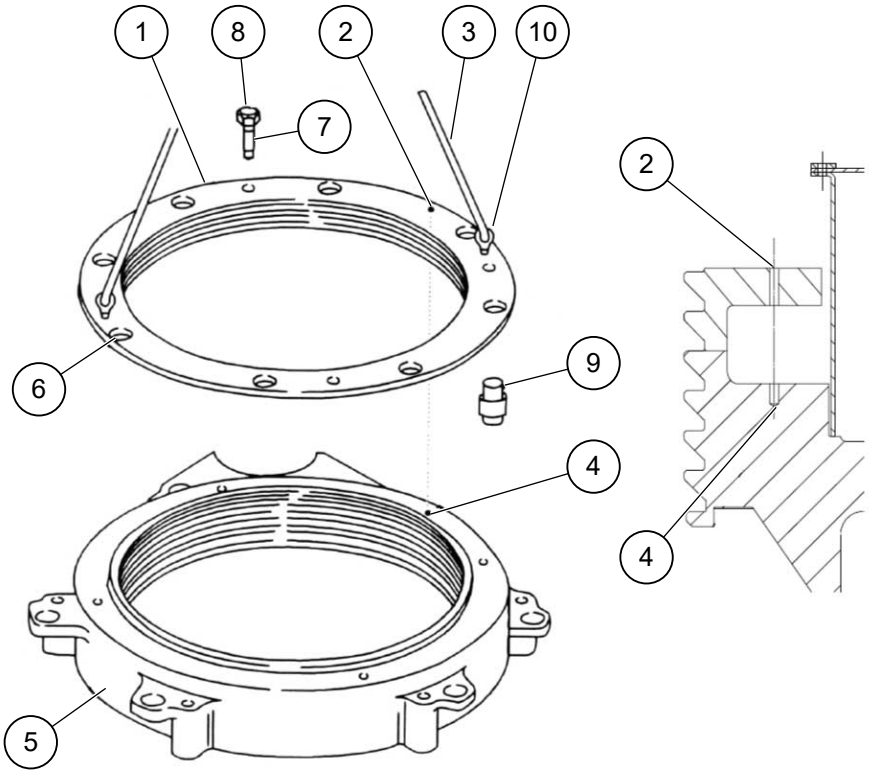


1. Clamping ring
2. Match-mark hole in clamping ring
3. Lifting cables
4. Match-mark hole in adjustment ring
5. Adjustment ring
6. Clamping cylinder holes
7. Tube spacer
8. Capscrew
9. Clamping cylinder
10. Lifting ring

Figure 125. Aligning match-mark holes

Table 40: Match-mark location and alignment hole diameter

Adjustment ring match-mark hole location	Alignment hole diameter
15° to the right of the countershaft box	12 mm (1/2")

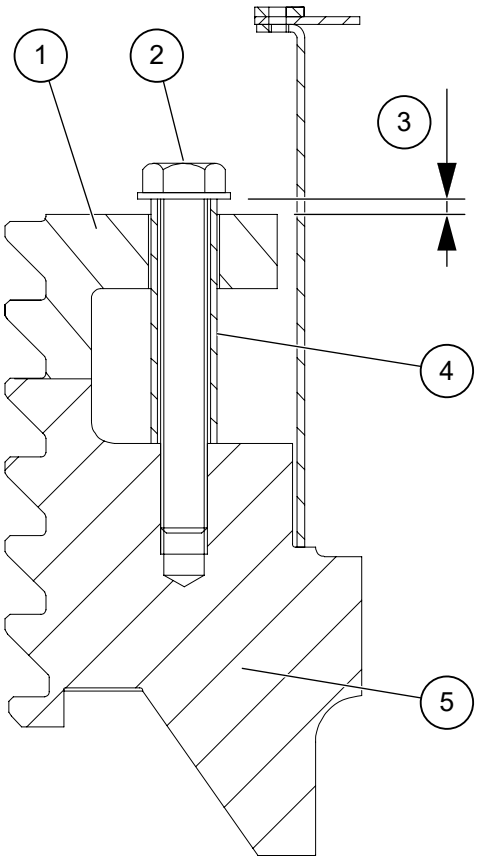
NOTE: If the match-mark holes are not in alignment with each other, the threads on the clamping ring will be out of phase with the adjustment ring threads making it difficult and sometimes impossible to turn the bowl into the adjustment ring. The proper location of the clamping ring on the adjustment ring is extremely important.

6. Slowly lower the clamping ring onto the adjustment ring. Make sure the clamping cylinders are depressurized.
7. Install the holding capscrews.
   a) Insert the hex head capscrews through the holes in the clamping ring and thread jam nuts onto the capscrews before threading them into the adjustment ring.
   b) Screw each capscrew into the adjustment ring until the head of each capscrew is 10 mm (3/8") above the clamping ring.

c) Tighten the jam nuts tightly against the adjustment ring.

The clearance between the heads of the capscrews and the top of the clamping ring is needed to permit the clamping ring to move vertically when the clamping cylinders are pressurized.

The capscrew is tightened down on top of the spacer to give the proper clearance between the heads of the capscrews and the top of the clamping ring.



1. Clamping ring
2. Capscrew
3. 10 mm (3/8’’) when depressurized
4. Tube spacer
5. Adjustment ring

Figure 126. Installing holding capscrew

8. Connect the loose hose from the number one clamping cylinder to the elbow in the top surface of the adjustment ring. This hose connects all of the cylinders through a hole in the adjustment ring to the hydraulic power unit.

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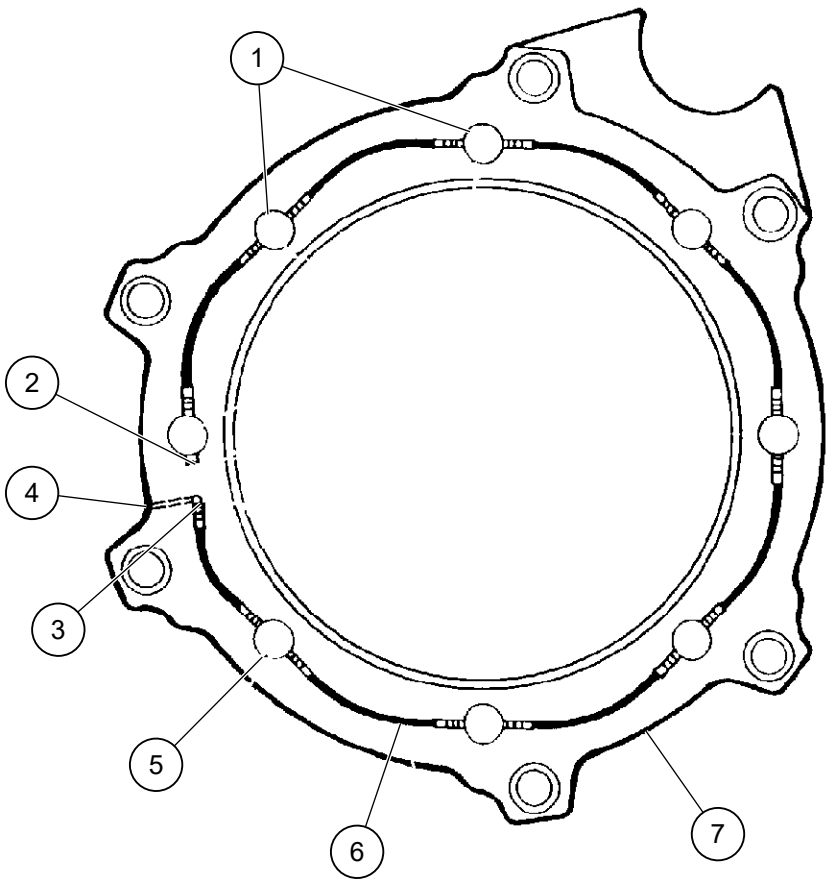

1. Clamping cylinders
2. Cap
3. 90° elbow
4. Hole in adjustment ring for connecting clamping cylinders to power unit
5. N°1 cylinder
6. Hose
7. Adjustment ring

Figure 127. Clamping cylinders hose connections

9. After assembly of cylinders and hose connections but before installing the bowl into the machine, pressurize the system to a maximum of 172 bars (2,500 PSI). Hold for 10 minutes to check the clamping cylinders and hose fittings for leaks.
10. Rub down the thread surfaces of the clamping ring, bowl and adjustment ring with a cloth impregnated with molybdenum disulfide powder.

    This procedure bonds a lubricating film to the metal allowing the bowl to rotate more freely. An initial coat of molybdenum disulfide was applied to these threads at the factory.

    NOTE: When crushing hot material such as clinkers or slag, a high temperature grease mixed with 5-10% (by volume) of molybdenum disulfide powder should be used. This same powder mix with lubricating oil has also been found satisfactory for such applications.

11. Liberally coat the threads with a mixture of grease and 5-10% (by volume) of molybdenum disulfide powder.
12. Depressurize the clamping cylinders.
13. Install the bowl in the crusher.

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8.3.10 Lubrication and hydraulics

All Nordberg HP cone crushers are equipped with hydraulic tramp or cavity release and clearing.

Hydraulic cylinders connected to the underside of the main frame and bolted to the adjustment ring, hold the adjustment ring firmly to the main frame against normal crushing forces. Excessive forces created by improper operation or by passing non-crushable material (tramp iron) will cause the adjustment ring to lift which in turn will pull the cylinder rods within the hydraulic cylinders upward.

Oil will be displaced from the upper cylinder chamber into the accumulators further compressing the nitrogen gas within the accumulators. Once the overload or tramp iron has passed through the crusher and crushing forces normalize, the compressed nitrogen will return the oil to the cylinders, the cylinder rods will retract, and the adjustment ring will again seat itself on the main frame.

To clear the crusher, the lower cylinder chambers are pressurized, forcing the cylinder rods upward, lifting the adjustment ring off the main frame.

In addition to hydraulic cavity release and clearing, the crushers are also equipped with hydraulic bowl clamping and adjusting.

A clamping ring which is supported above the adjustment ring by a set of clamping cylinders located between the clamping ring and the adjustment ring, holds the bowl in the crushing position in the adjustment ring when the cylinders are pressurized.

When the pressure in the clamping cylinders is reduced and the hydraulic motor mounted on the adjustment ring is activated, the pinion on the motor engages the driver ring attached to the adjustment cap, which then turns the bowl assembly, closing or opening the crusher setting automatically.

All Nordberg HP cone crushers are equipped with a hydraulic power unit that controls all the hydraulic functions of the crusher.

8.3.10.1 Hydraulic unit operation

The power unit must be ON at all times when the crusher is operating to maintain bowl clamping pressure and pressure in the tramp or cavity release cylinders holding the adjustment ring to the main frame.

Refer to the hydraulic unit manual for using the crusher's setting and clearing functions and dismantling and installing the bowl.

8.3.10.2 Oil specifications

For the hydraulics, use a paraffin-rich oil (without naphthalene) having a protective film, strong adhesiveness to metallic surfaces, and stable physical and chemical properties.

Each lubricant should have a high viscosity level, have rapid water separation properties against rust and corrosion, resist emulsion and oxidation and have good wear resistance properties.

Recommended oil is ISO-L-HM32 (ISO 11158 standard). Its viscosity should be:

- 28.8 to 35.2 cSt at 40°C kinematic viscosity
- 4.9 cSt or more at 100°C

In addition, the viscosity index of the oil should be at least 95.

Appropriate lubricants are essential to protecting the parts of your crusher. They are available from most major oil companies. Using the wrong oil can damage the crusher and invalidate its terms of warranty.

NOTE: Do not use non-flammable hydraulic fluids. Non-flammable hydraulic fluids may not be compatible with the linings, seals, accumulator components, hoses and other parts of the hydraulic system. The useful life of the pump could be shortened and the paint inside the tank could soften and disappear.

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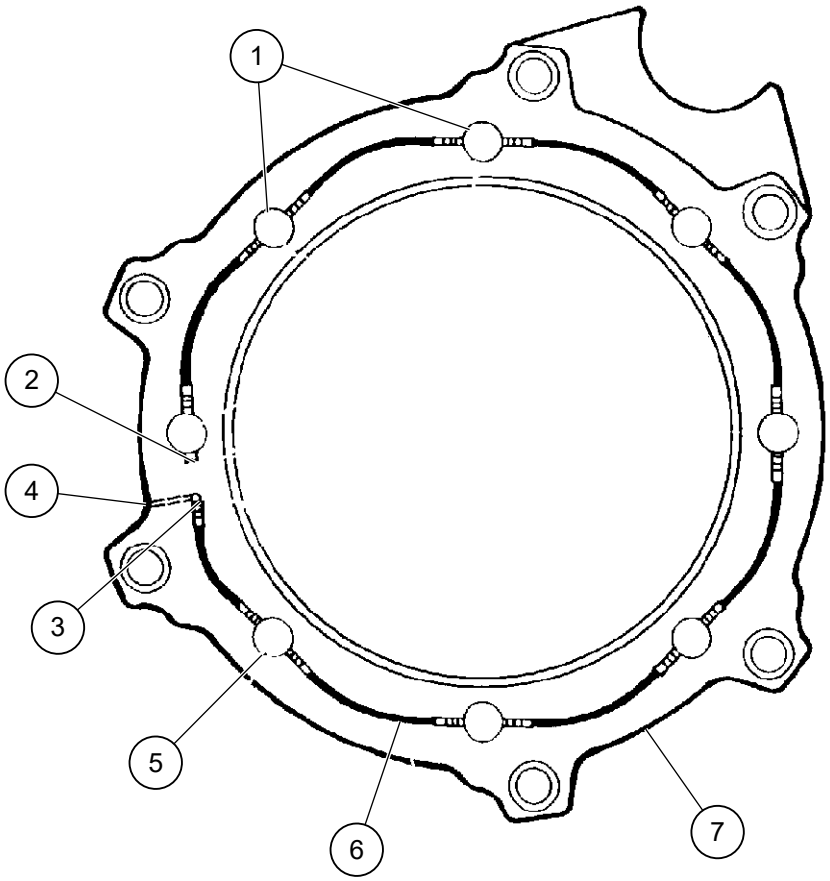
NOTE: When filling the crusher's hydraulic circuits, make sure you do not operate the pump without oil. When the hydraulic are full of oil and the holding system is pressurized, keep the oil level at the middle of the oil gauge.

Approximately 100 litres (26 U.S. gallons) are needed to fill the tank of the hydraulic system, holding cylinders, accumulators, locking cylinders and hydraulic hoses.

8.3.10.3 Clamping cylinder assembly

To install the clamping cylinders refer to *Main frame, adjustment ring and tramp release assemblies*.



1. Clamping cylinders
2. Cap
3. 90° elbow
4. Hole in adjustment ring for connecting clamping cylinders to hydraulic unit
5. N°1 cylinder
6. Hose
7. Adjustment ring

Figure 128. Clamping cylinders hose connections

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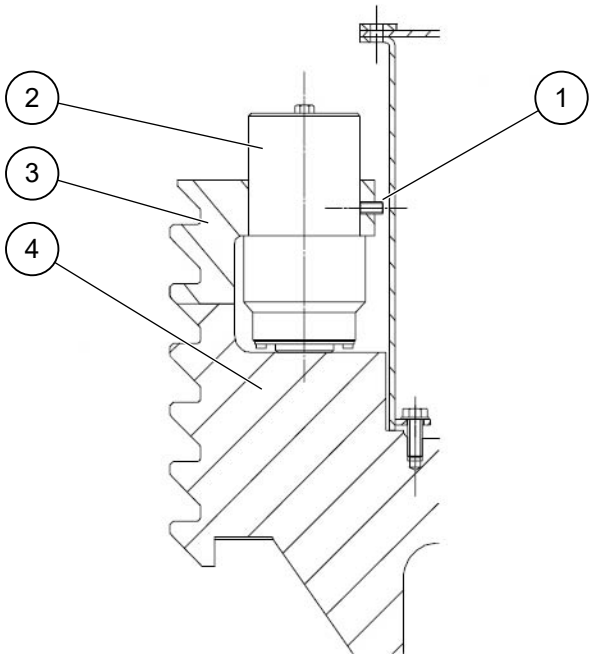

1. Socket setscrew
2. Clamping cylinder
3. Clamping ring
4. Adjustment ring

Figure 129. Clamping cylinder installation

8.3.10.4 Assembling the hydraulic adjustment mechanism

In most instances the hydraulic adjustment mechanism (bowl turning arrangement) will be shipped installed on the crusher adjustment ring. However, in some rare cases, shipping restrictions or space limitations may require that the unit be shipped disassembled.

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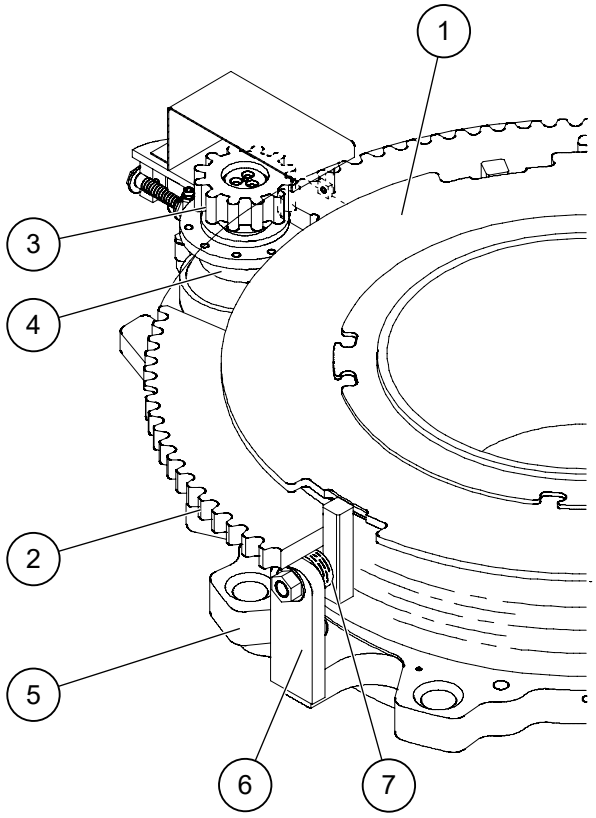

1. Adjustment cap
2. Driver ring
3. Pinion
4. Hydraulic motor drive assembly
5. Adjustment ring
6. Roller support
7. Roller

Figure 130. Hydraulic adjustment mechanism

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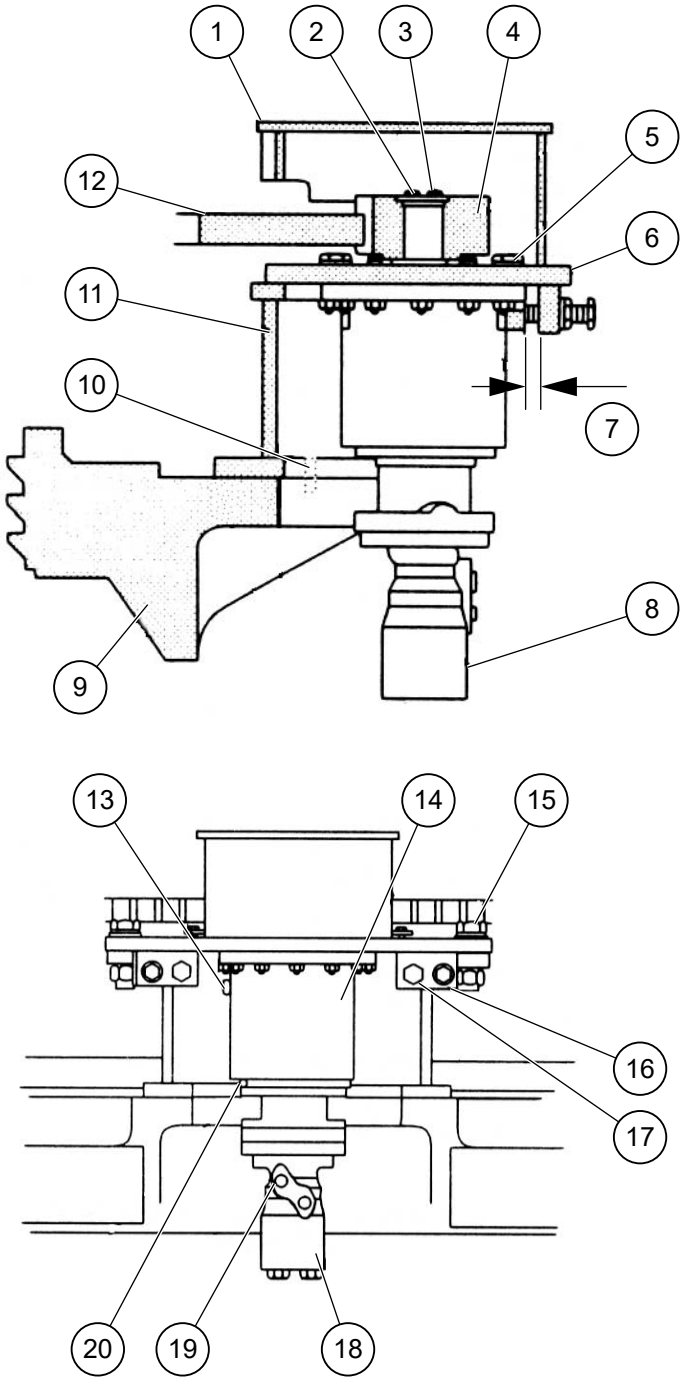

1. Guard plate
2. Screws and washers
3. Pinion cover
4. Pinion
5. Screws, washers and nuts
6. Bearing plate
7. Play
8. Gear motor
9. Adjustment ring
10. Pins
11. Mounting bracket
12. Adjustment gear
13. Plug
14. Reduction gear
15. Screws, washers and nuts
16. Locking screw
17. Screws, washers and nuts
18. Hydraulic motor
19. Brake
20. Plug

Figure 131. Assembling the hydraulic adjustment mechanism on the adjustment ring

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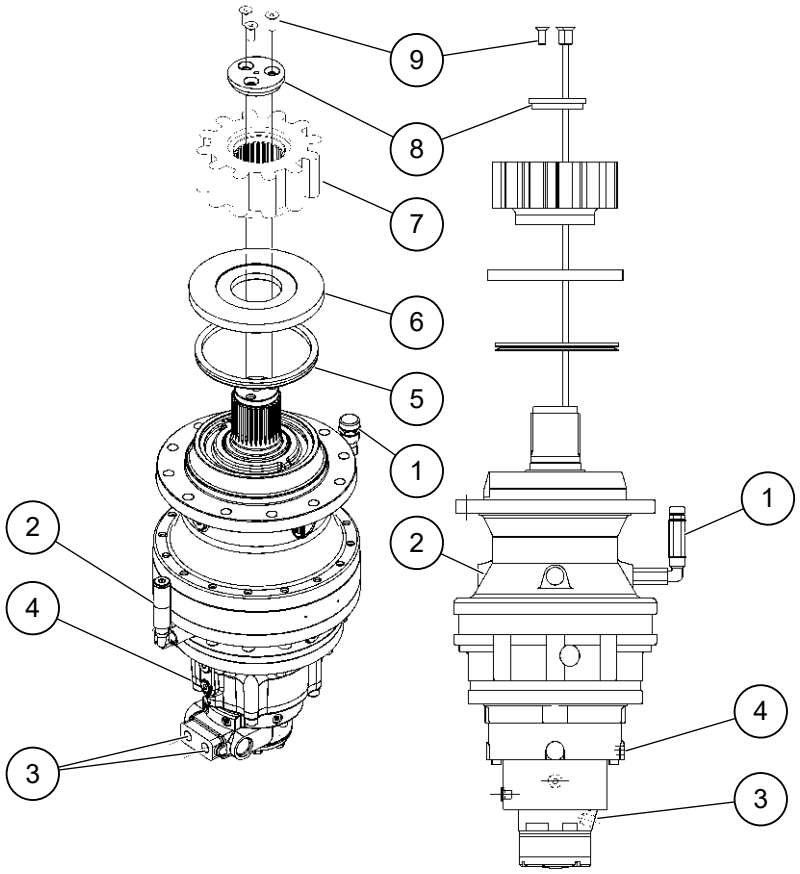
If the assembly is dismantled, proceed as follows:

1. Position the mounting adapter over the two location pins on the adjustment ring in the area shown in *Figure 131. Assembling the hydraulic adjustment mechanism on the adjustment ring*.
2. Weld the mounting adapter to the adjustment ring as shown on the adjustment mechanism and adjustment ring assembly drawings. Make sure the mounting adapter is level and square on the adjustment ring before welding!
3. Install the gear motor. The position of the gear motor is important: the gear motor's lubrication taps must be in line with the hole of the plate and the feed connections towards the exterior to assemble the hoses on the hydraulic motor.
   a) Install the gear motor under the bearing plate (see *Figure 131. Assembling the hydraulic adjustment mechanism on the adjustment ring*). Place the mounting weldment on top of the mounting adapter. Install the clamp bolts, flat washers, lockwashers and hex nuts at this time but do not tighten them.
   b) If the pre-assembly of the gear motor on the bearing plate does not allow you to mount it above the motor mounting bracket, first mount the bearing plate alone on the top of the motor mounting bracket. Fit the holding screws and flat washers but do not tighten them. Then install the gear motor under the bearing plate as shown in *Figure 131. Assembling the hydraulic adjustment mechanism on the adjustment ring*.



1. Breather tap
2. Levelling tap
3. Tightening/loosening connection
4. Brake connection
5. Seal
6. Bushing
7. Pinion
8. Tightening washer
9. Bolt

Figure 132. Taps and connections on the gear motor

4. Mount the pinion on the shaft of the gear motor and fix the washer with the screw.
5. Assemble the roller on its support, this is welded to the outer diameter of the adjustment ring.

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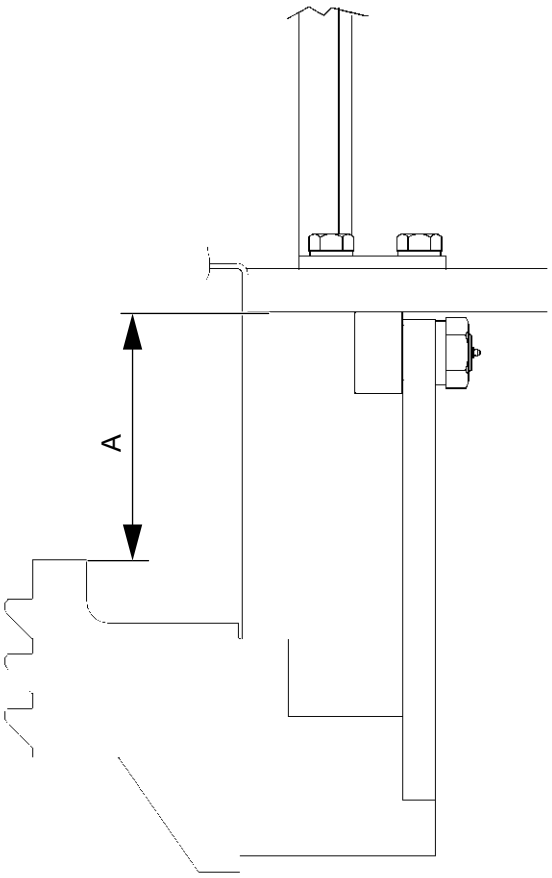


Position of the top of the roller at the top of the adjustment ring (A): 152 mm (6")

Figure 133. Position of the cam

6. Place the bevel gear in such a way that it rests on the top of the roller.
7. Fix the slides on the top of the bevel gear as shown in *Figure 131. Assembling the hydraulic adjustment mechanism on the adjustment ring*, using the screws and washers.
8. Center the bevel gear on the adjustment cap.
9. Use the adjustment screw on the bearing plate to position the pinion so that the teeth of the gear are three-quarters engaged in the teeth of the pinion. Then tighten the screws, washers and nuts.
10. Connect the unit's hydraulic hoses to the hydraulic adjustments system on the crusher. See *Connecting the hydraulic hoses to the crusher*.
11. The gear motor is filled with oil when it leaves the factory. Check the oil level before start-up and every 1000 hours of crusher operation. To do so, proceed as follows:
    a) With the gear motor in a vertical position, remove the levelling tap plug in the middle of the gear motor. The oil level should be visible in the levelling tap.
    b) If necessary, fill oil as specified in the table below. Filling takes place via the breather tap on the upper part of the gear motor.

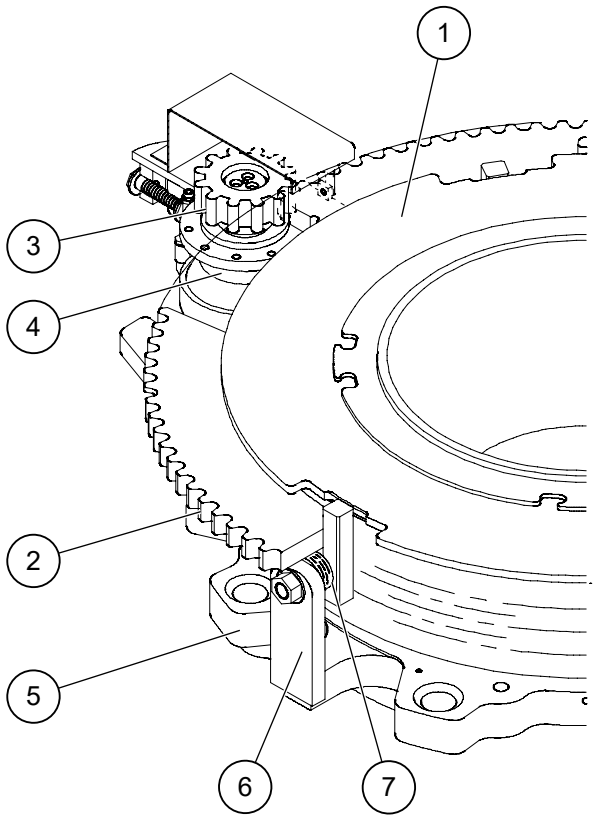
Table 41: Oil specification for the hydraulic adjusting system

	Type of oil

Reduction gear	ISO-L-CKC-150 (as per standard ISO 12925-1)

12. Turn the hydraulic adjustments system 360° to ascertain that the teeth of the pinion and the adjustment ring engage properly. Adjust play with the bearing plate adjusting screw. When the control is positioned correctly, tighten the locking bolt.
13. Fit the protective hood on the bearing plate to prevent materials jamming the teeth of the gear and pinion.

8.3.10.5 Assembly with a welded gear motor bracket



1. Adjustment cap
2. Adjustment ring
3. Pinion
4. Hydraulic drive assembly
5. Adjustment ring
6. Roller support
7. Roller

Figure 134. Hydraulic adjustment mechanism

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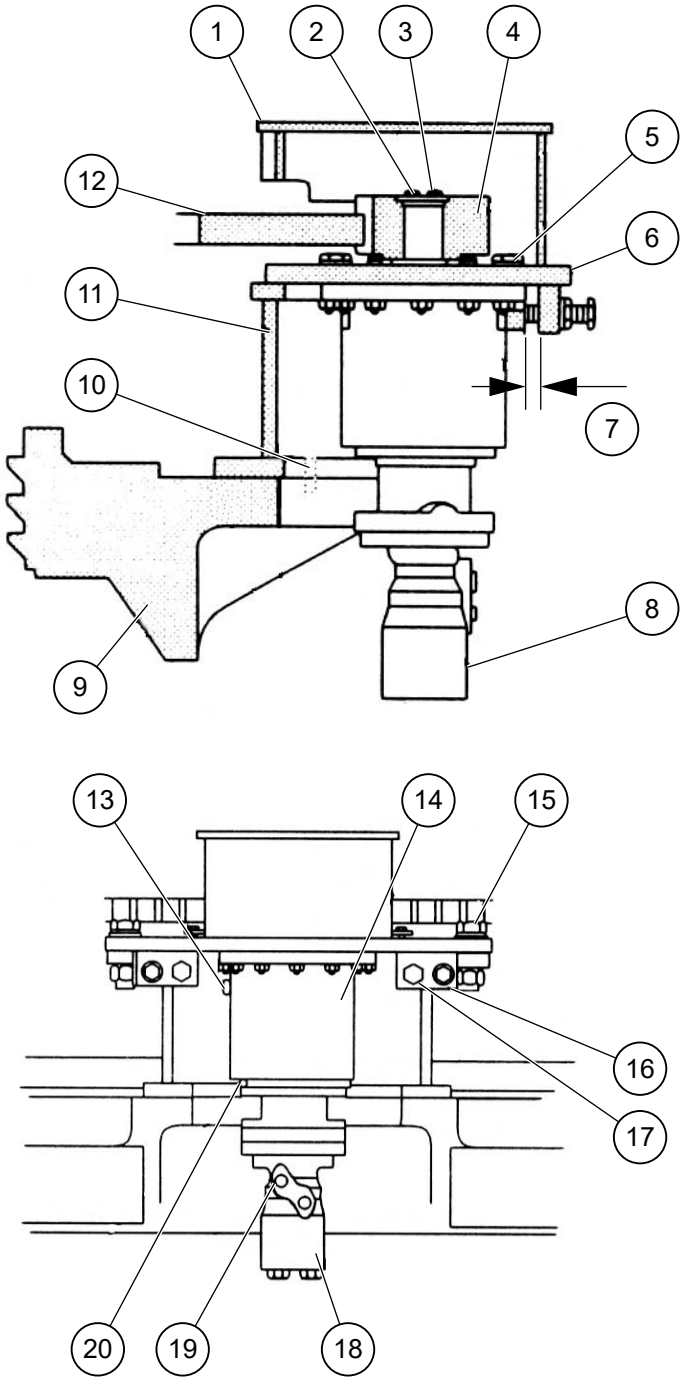

1. Guard plate
2. Screws and washers
3. Pinion cover
4. Pinion
5. Screws, washers and nuts
6. Bearing plate
7. Play
8. Gear motor
9. Adjustment ring
10. Pins
11. Mounting bracket
12. Adjustment ring
13. Plug
14. Reduction gear
15. Screws, washers and nuts
16. Locking screw
17. Screws, washers and nuts
18. Hydraulic motor
19. Brake
20. Plug

Figure 135. Assembling the hydraulic adjustment mechanism on the adjustment ring

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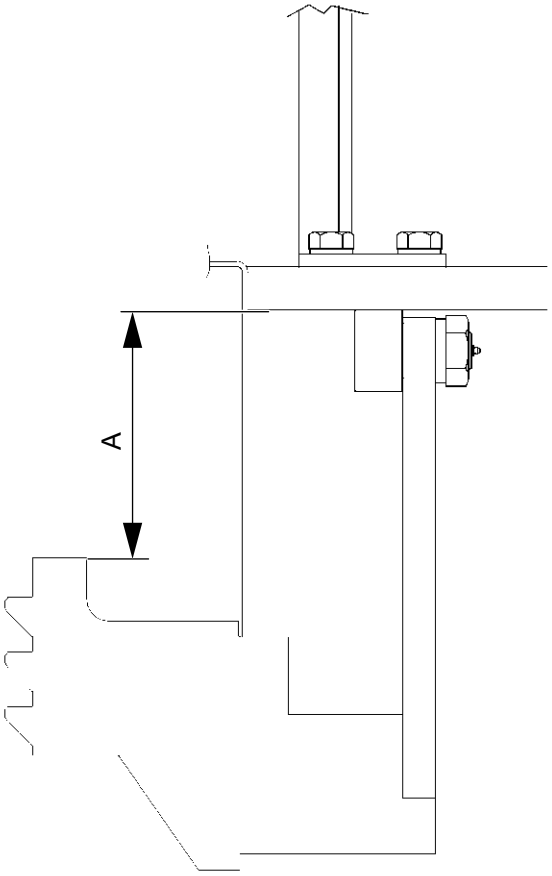
1. Position the bracket over the pins on the adjustment ring as shown in *Figure 134. Hydraulic adjustment mechanism*.
2. Weld the mounting bracket to the adjustment ring. Make sure the motor mounting bracket is level and straight on the adjustment ring before welding.
3. Install the gear motor. The position of the gear motor is important: the gear motor's lubrication taps must be in line with the hole of the plate and the feed connections towards the exterior to assemble the hoses on the hydraulic motor.
   a) Install the gear motor under the bearing plate (see *Figure 135. Assembling the hydraulic adjustment mechanism on the adjustment ring*). Place the mounting weldment on top of the mounting adapter. Install the clamp bolts, flat washers, lockwashers and hex nuts at this time but do not tighten them.
   b) If the pre-assembly of the gear motor on the bearing plate does not allow you to mount it above the motor mounting bracket, first mount the bearing plate alone on the top of the motor mounting bracket. Fit the holding screws and flat washers but do not tighten them. Then install the gear motor under the bearing plate.
4. Mount the pinion on the shaft of the gear motor. Fix the washer with the screw.
5. Assemble the roller on its support then fit; this is welded to the outer diameter of the adjustment ring, see *Figure 134. Hydraulic adjustment mechanism*. See figure below for the correct position.



Position of the top of the roller at the top of the adjustment ring (A): 152 mm (6")

Figure 136. Position of the cam

6. Fix the slides on the top of the adjustment ring as specified in *Figure 135. Assembling the hydraulic adjustment mechanism on the adjustment ring*, using the screws and washers.

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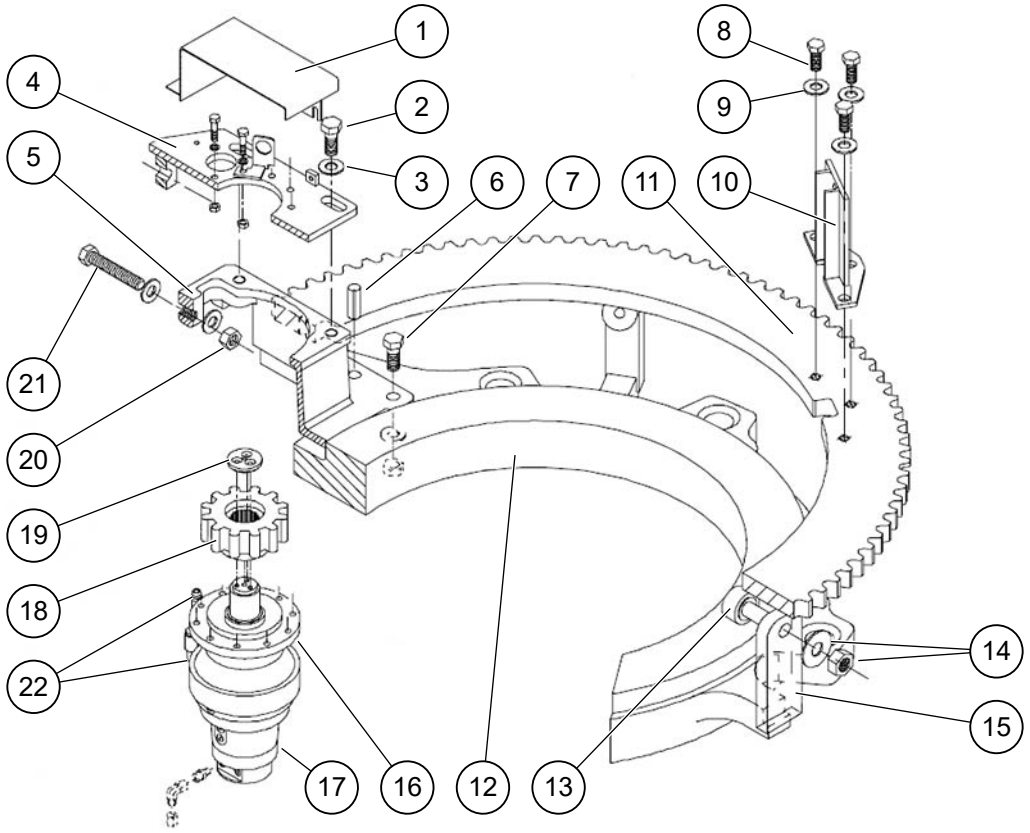
7. Centre the adjustment ring on the adjustment cap. See *Figure 134. Hydraulic adjustment mechanism*.
8. Use the adjusting screw on the bearing plate to position the pinion so that the teeth of the gear are three-quarters engaged in the teeth of the pinion. Then tighten the screws, washers and nuts.
9. Connect the hydraulic hoses of the unit to the hydraulic adjustments system. Refer to the lubrication/ hydraulics manual.
10. The gear motor is filled with oil when it leaves the factory. Check the oil level before start-up and every 1000 hours of crusher operation. To do so, proceed as follows:
    a) With the gear motor in a vertical position, remove the levelling tap plug in the middle of the gear motor. The oil level should be visible in the levelling tap.
    b) If necessary, fill as specified in the table below. Filling takes place via the breather tap (see *Figure 132. Taps and connections on the gear motor*) on the upper plate of the gear motor

    Table 42: Oil specification for the hydraulic adjusting system

	Type of oil
Reduction gear	ISO-L-CKC-150 (as per standard ISO 12925-1)

11. Turn the hydraulic adjustments system 360° to ascertain that the teeth of the pinion and the adjustment ring engage properly. Adjust play with the bearing plate adjusting screw. When the plate is positioned correctly, tighten the locking bolt.
12. Fit the protective hood on the bearing plate to prevent materials jamming between the teeth of the gear and pinion.

8.3.10.6 Assembly with a bolted gear motor bracket



1. Guard plate
2. Locking bolt
3. Washer
4. Bearing plate
5. Motor mounting bracket
6. Pins
7. Screw + washer + nut for fixing the motor mounting bracket
8. Bolt
9. Washer
10. Slide
11. Adjustment gear
12. Adjustment ring
13. Roller
14. Self-locking nut and washer
15. Roller support
16. Reduction gear
17. Hydraulic motor
18. Pinion
19. 3 screws and washers for fixing the pinion
20. Locking nut
21. Locking screw
22. Lubrication tap

Figure 137. Assembling the hydraulic adjustment mechanism on the adjustment ring

1. Position the bracket over the pins on the adjustment ring. Fix the motor mounting bracket on the adjustment ring with the screws.
2. Install the gear motor. The position of the gear motor is important: the gear motor's lubrication taps must be in line with the hole of the plate and the feed connections towards the exterior to assemble the hoses on the hydraulic motor.
   a) Install the gear motor under the bearing plate. Place the mounting weldment on top of the mounting adapter. Install the clamp bolts, flat washers, lockwashers and hex nuts at this time but do not tighten them.

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b) If the pre-assembly of the gear motor on the bearing plate does not allow you to mount it above the motor mounting bracket, first mount the bearing plate alone on the top of the motor mounting bracket. Fit the holding screws and flat washers but do not tighten them. Then install the gear motor under the bearing plate.

3. Mount the pinion on the gear motor shaft. Fix the washer with the screw.
4. Assemble the roller on its support then set and weld it on the outer diameter of the adjustment ring. See *Figure 133. Position of the cam* for the correct position.
5. Place the adjustment gear in such a way that it rests on the top of the roller.
6. Fix the slides on the top of the adjustment gear, using the screws and washers.
7. Center the adjustment gear on the adjustment cap.
8. Use the adjusting screw on the bearing plate to position the pinion so that the teeth of the gear are three-quarters engaged in the teeth of the pinion. Then tighten the locking bolts.
9. Connect the hydraulic hoses of the unit to the hydraulic adjustments system. See *Connecting the hydraulic hoses to the crusher*.
10. The gear motor is filled with oil when it leaves the factory. Check the oil level before start-up and every 1000 hours of crusher operation. To do so, proceed as follows:
    a) With the gear motor in a vertical position, remove the levelling tap plug in the middle of the gear motor. The oil level should be visible in the levelling tap.
    b) If necessary, fill with oil as specified in the table below. Filling takes place via the breather tap or the levelling tap, see *Figure 132. Taps and connections on the gear motor*.

    Table 43: Oil specification for the hydraulic adjusting system

	Type of oil
Reduction gear	ISO-L-CKC-150 (as per standard ISO 12925-1)
Brake	ISO-L-CKC-150 (as per standard ISO 12925-1)

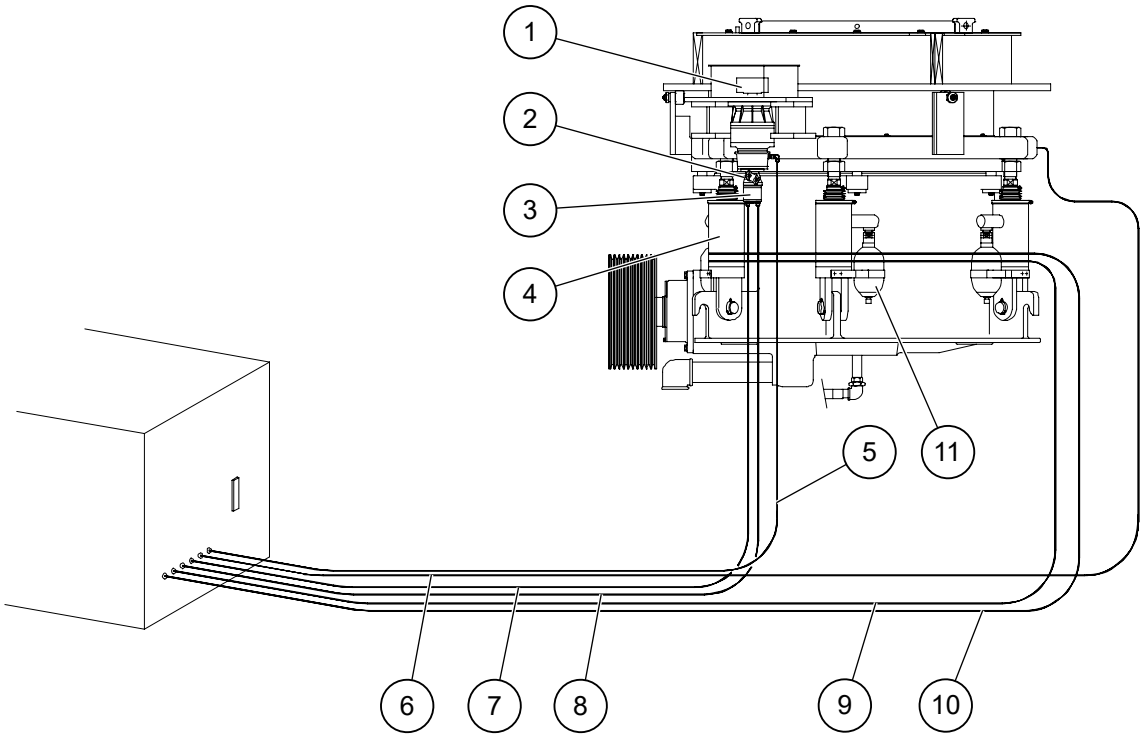
11. Turn the hydraulic adjustments system 360° to ascertain that the teeth of the pinion and the adjustment gear engage properly. If necessary, adjust play by loosening the locking bolt, then turn the adjusting screw of the bearing plate. When the plate is positioned correctly, tighten the locking bolt.

8.3.10.7 Hydraulic adjustments assembly

Hydraulic motor maintenance should seldom be necessary.

Given the complexity of the internal components, only the supplier of the equipment is fully equipped to dismantle and replace parts and reassemble the assembly.

8.3.10.8 Connecting the hydraulic hoses to the crusher



1. Hydraulic drive assembly
2. Brake
3. Hydraulic motor
4. Tramp release cylinder
5. Brake release hose
6. Clamping cylinder circuit hose
7. Open setting circuit
8. Close setting circuit
9. Cavity release clearing circuit hose
10. Cavity release pressurizing circuit hose
11. Accumulator
12. Adjustment ring

Figure 138. Hydraulic hose connections

Once the power unit is in position and the hydraulic adjustment mechanism has been installed on the crusher, connected the hoses to the hydraulic motor, clamping cylinders and cavity release cylinders, then the connecting to crusher as follows:

The six hoses from the power unit to the crusher are all the same. All ports and hose connections are clearly marked at the factory to aid in connecting the hoses to the power unit, Crusher and hydraulic motor.

Numbers 1, 2, 3, 4, 5 and 6 are stamped at the various locations.

NOTE: It is important to keep dirt out of all hoses and fittings during the entire piping procedure

1. Connect the close setting hose to the fitting in the left hand port in the hydraulic motor.
2. Connect the close setting hose to the fitting in the right hand port in the hydraulic motor.
3. Connect the brake release hose from its fitting at the power unit to the fitting in the port of the brake which is just above the hydraulic motor.

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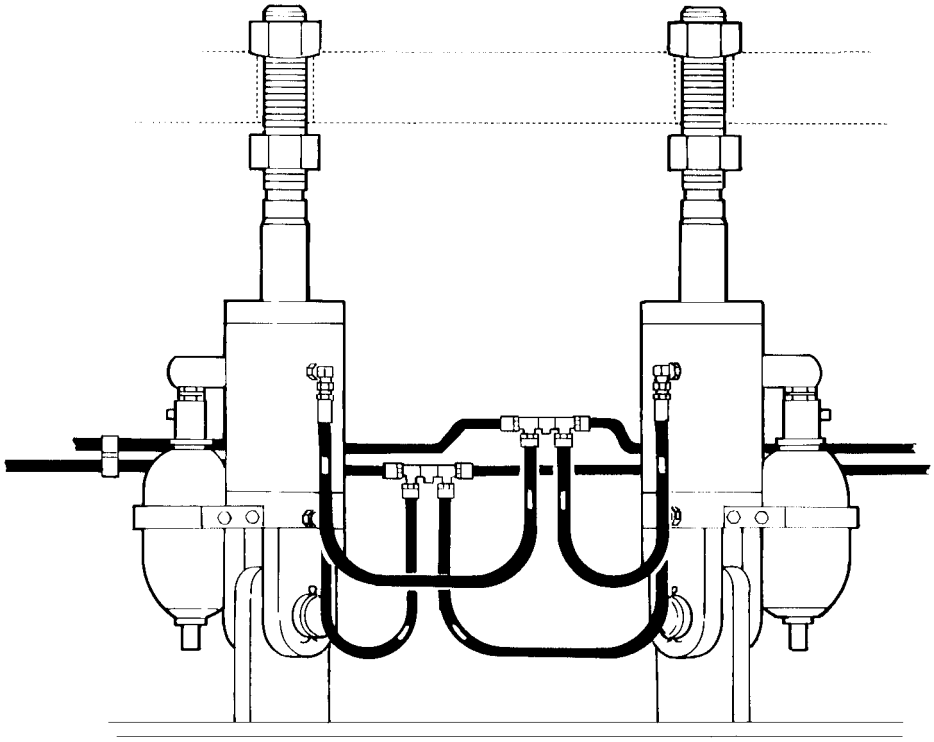
4. CHECK THE POSITION OF THE HYDRAULIC LINES TO THE HYDRAULIC MOTOR AND BRAKE SO THEY WILL NOT INTERFERE WITH ANY MOVING PARTS.
5. Connect the CLAMPING CYLINDER hose to the tapped hole in the side of the adjustment ring.
6. Connect the CLEARING CIRCUIT hose to the «T» connection in the CLEARING CIRCUIT hose on the Crusher that connects to the lower or CAP END of the release cylinders, see figure below.



1. Tramp or cavity release cylinders
2. «T» connection
3. Cavity release pressurizing circuit
4. Cavity release clearing circuit
5. Accumulator

Figure 139. Tramp or cavity release cylinder connections

7. Connect the PRESSURIZING CIRCUIT hose to the «T» connection in the PRESSURIZING CIRCUIT hose on the Crusher that connects to the upper or ROD END of the release cylinders, see *Figure 139. Tramp or cavity release cylinder connections*.

8.3.10.9 Checking accumulator pre-charge (tramp release circuit)

⚠ WARNING

PRESSURIZED COMPONENT HAZARD

Can cause death or serious injury.

Never inflate accumulators with any other gas than nitrogen. Another gas could cause the circuit to explode.

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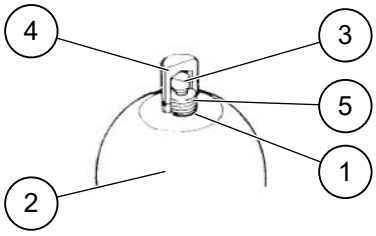
Following extensive use or when the protective device has been dismantled, check the accumulator preload pressure. The accumulators are preloaded with nitrogen and, prior to all monitoring interventions, the pressure in the release circuit must be zero.

To this end, open the corresponding valve in the hydraulic power unit.

When carrying out a check, make sure the accumulators are not in direct sunlight and the outdoor temperature is roughly 20°C.

Proceed as follows to connect the monitoring device and monitor the preload pressure of the accumulators:

1. Ensure that the tramp release circuit and the accumulators are empty. Refer to the hydraulics manual.
2. Remove the valve guard from the bottom of the accumulator and then the valve cap from the gas valve stem. Remove the washer that was under the valve cap.



1. Gas valve stem
2. Accumulator
3. Valve cap
4. Valve guard
5. Washer

Figure 140. Accumulator valve

3. Use the charging and gauging assembly (option) from the crusher tool box.

   The charging assembly is required to connect the gauging assembly to a nitrogen bottle in order to increase the pre-charge in the accumulator to the proper pressure.

   It consists of a 3 meter (10 foot) length of hose attached to a swivel connector on one end and a gland nut (left hand thread), gland and coupling on the other end. The gauging assembly consists of an pressure valve, bleeder valve, and pressure gauge mounted into an lower screw and attached as one unit directly to the gas valve stem on the accumulator. The charging assembly is only used when charging the accumulators; pressure readings can be taken and excess pressure bled off with just the gauging assembly.

   NOTE: The connection to the nitrogen cylinder (optionally supplied) is different depending on the country.

   a) Fully unscrew the knurled button on the inflator/tester and make sure the drain plug is closed.
   b) Screw the inflator/tester onto the accumulator using the knurled button at the lower part the inflator/tester.
   c) Connect the inflator/tester to the nitrogen bottle.
      The relief valve should limit pressure to the maximum value equal to the maximum pressure of the accumulator (this value is cold-stamped on the accumulator).
   d) Screw the knurled button onto the inflator/tester. The pressure value is displayed on the manometer.
   e) If the pressure is higher than 83 bar, unscrew the drain until the required pressure is obtained.
   f) If the pressure is lower than 83 bar, open the nitrogen bottle valve and adjust the pressure to 83 bar.
   g) Close the nitrogen bottle and disconnect it.
   h) Unscrew the knurled button at the upper part of the inflator/tester.

i) Dismantle the inflator/tester from the accumulator.

4. Monitor the tightness of the valve with soapy water. If the valve leaks, repeat the pressure checking operation. If the leak persists, change the valve.
5. Put back the valve protection plug.
6. Carry out the same operation on the other accumulators.
7. Close the valve in the hydraulic power unit.
8. Pressurize the release circuit.

8.3.10.10 Draining and testing the pressure of the hydraulic system

After making the initial connection, or whenever any circuit has been opened to replace or repair a component, you must drain the circuit to remove the air.

If the crusher is started up for the first time, each circuit must be drained before being pressurized.

NOTE: When draining the hydraulic circuits, check the oil level in the tank frequently and refill if necessary.

8.3.10.10.1 Starting up the hydraulic unit

Before purging the system or any of the circuits, oil needs to be circulated in all the circuits of the hydraulic unit.

For instructions on starting up the unit for purging or pressure testing purposes, see the hydraulics manual.

NOTE: Do not pressurize the retaining circuit before pre-loading the accumulators with nitrogen. This could damage the bladder and the accumulator would need to be replaced.

8.3.10.10.2 Draining the clamping circuit

⚠ WARNING

PRESSURIZED COMPONENT HAZARD

Can cause death or serious injury.

After the engine has been stopped, some pressure can remain in the hydraulic system and in the cooling system of the engine. Let the machine cool down sufficiently before opening pressurized components. Always make sure that the system is pressure-free before doing any checks, maintenance, or repair work.

To bleed and pressure test the clamping circuit, proceed as follows:

1. Start the hydraulic unit. Refer to the hydraulic unit manual.
2. Check that the clamping circuit pressure has been decreased to 0. Refer to the hydraulic unit manual.
3. Follow the clamping circuit hose to the fitting threaded into the tapped hole in the adjustment ring. Loosen the fitting just enough to allow the oil to escape.
4. When the oil is flowing clear without bubbles or evidence of sputtering, tighten the fitting.
5. Increase clamping pressure. Refer to the hydraulic unit manual.

8.3.10.10.3 Draining the clearing circuit

⚠ DANGER

PRESSURIZED COMPONENT HAZARD

Will cause death or serious injury.

Keep away from the adjustment ring as it is in the upper position. The adjustment ring will quickly go down if the clearing button is released.

The clearing circuit is composed by six cylinders and accumulators, which encircle the outside of the main frame interconnected by hoses.

The clearing side of the cylinders and hose lines are vented of entrapped air at each cylinder as follows:

1. Start the hydraulic unit. Refer to the hydraulic unit manual.
2. Loosen the clearing hose fittings that are connected to the lower end of the tramp release cylinders.
3. Obtain 14 bars (200 PSI) pressure.
4. Loosen the tramp release hose couplings connected to the bottom of the holding cylinder by roughly 1 and a half turns.
5. When the oil flows clear without bubbles or evidence of sputtering at an individual cylinder, tighten the fitting.
6. Continue this procedure until all the fittings are tightened.
7. Pressurize the circuit to lift the adjustment ring to its maximum height until the pressure reaches its maximum of 210 bar (3000PSI).
8. Check the hose and piping connections to be sure there are no oil leaks. Tighten any loose connections.
9. Seat the adjustment ring on the main frame all around the crusher.

8.3.10.10.4 Draining the tramp release circuit

The tramp release circuit is composed of six cylinders and accumulators, which encircle the outside of the main frame and are interconnected by hoses.

The cylinders and accumulators are vented of entrapped air as follows:

1. Start the power unit. Refer to the hydraulic unit manual.
2. Obtain 14 bars (200 PSI) pressure. Refer to the hydraulic unit manual.
3. At each cylinder, loosen the hose swivel fitting, threaded on the «tee» at the upper end of the cylinders, just enough to allow the air and oil to escape.
4. When all the air has been vented as indicated by the oil flowing clear and free of bubbles or evidence of sputtering, tighten the swivel fitting.
5. Repeat the above procedure at the remaining cylinder and accumulator clusters.
6. Pressurize the system.
7. Check for oil leaks at all hose and piping connections. Tighten any loose connections.

8. Let the power unit connected to the crusher run through two complete cavity release clearing and cavity release pressurizing cycles to work any entrapped air remaining in the system back to the oil reservoir.

8.3.10.10.5 Draining the braking circuit

NOTE: The brake circuit is interconnected with the loosening and tightening operations.

Bleed the brake circuit as explained below:

1. Follow the brake release circuit hose to the port on the side of the brake which is part of the hydraulic drive assembly mounted on the adjustment ring. Loosen this fitting enough to allow the oil to escape.
2. When the oil is flowing clear without bubbles or evidence of sputtering, tighten the fitting.

8.3.10.11 Pressurizing the tramp release circuit

1. After having made all the connections, purged the circuits and fixed any leaks, pressurize the holding circuit before starting up the crusher. Refer to the lubrication unit manual.

   The tramp release circuit pressure must be maintained at the recommended level in order to provide adequate and safe overload protection to the tramp release cylinders.

   The circuit pressure should be maintained between the minimum and maximum pressures.
2. If circuit pressure is above the recommended limits, refer to *Depressurizing*.
3. If the circuit is to be pressurized after initial installation, after making repairs, or if circuit pressure is low, proceed as follows:
   a) Check the reservoir for adequate oil supply.

   NOTE: Do not pressurize the retaining circuit before pre-loading the accumulators with nitrogen. This could damage the bladder and the accumulator would need to be replaced.

   b) Check accumulator pre-charge pressure and charge, if necessary.
   c) Pressurize the tramp release circuit. Refer to the hydraulic unit manual.
   The crusher must not start up with a pressure too low. The adjustment ring could bump and will be damaged for the main frame seat. To set up the right pressure, see the hydraulic unit manual.

8.3.10.12 Maintenance of the lubrication and hydraulic system

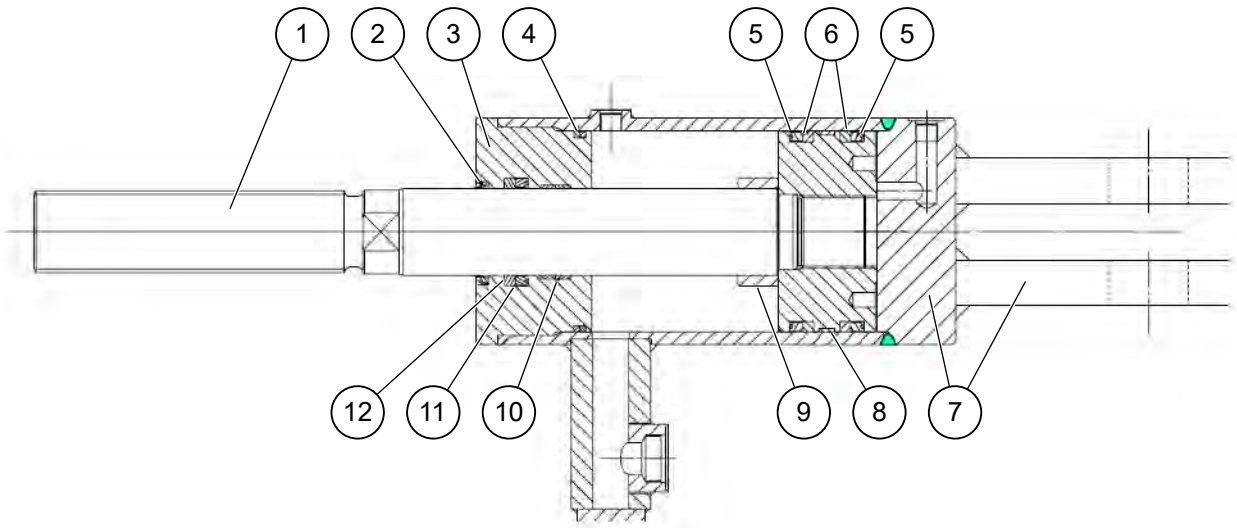
8.3.10.12.1 Depressurizing

Any maintenance on any of the devices in the hydraulic system must be preceded by properly depressurizing the circuit that is to be worked on. This is important for the safety of the person (s) working on the machine.

Many of the circuits are normally depressurized during crushing and are only pressurized when an operating function is performed. However, as a general safety precaution, the circuit pressure gauge should be checked before the circuit is worked on to be sure that there is no residual pressure in the circuit.

The cavity release pressurizing circuit, however, remains pressurized by the accumulators even after the pump has been shut off for some period of time. Before working on any of the hydraulic systems, see hydraulics manual.

8.3.10.12.2 Rebuilding the tramp or cavity release cylinder



1. Rod assembly
2. Rod wiper
3. Gland
4. O-ring seal
5. Poly-pak seal
6. Back-up ring
7. Cylinder assembly
8. Piston wear ring
9. Stop tube
10. Rod wear ring
11. Poly-pak seal
12. Back-up ring

Figure 141. Tramp or cavity release cylinder

The cylinder parts which need replacement in the course of normal use are the rod wiper or seal guard, the rod seals, piston seals and back-up rings. It is recommended that any O-rings which are removed with other components during disassembly should be replaced.

Cavity release cylinder leakage is detected by oil seepage from the rod end of the cylinder or by the inability to hold clamping pressure. When a cylinder is found to be leaking, it should be replaced immediately. A leaking cylinder is critical because without full clamping pressure, the seating area of the adjustment ring and frame will be damaged.

When repairing a cavity release cylinder, it is recommended that all the «seals» are replaced at one time rather than gambling on a second oil leak. The entire replacement seals necessary for doing a complete rebuilding job are available in kit form for convenience. Be sure that a sufficient quantity of rod wiper or seal guards, Poly-Pak seals, O-rings and back-up rings are on hand before rebuilding of the cylinders begins.

During the entire rebuilding process it is important that the work is done on a clean surface and in a dust free atmosphere.

To disassemble, inspect, rebuild, and reassemble the tramp release cylinders, proceed as follows:

1. Unscrew the gland from the cylinder tube. Use a «homemade» spanner wrench in the notches in the outside diameter of the gland to turn the gland out of the tube.
2. Carefully pull on the threaded end of the rod to slide the entire piston, rod and gland assembly out of the cylinder.
3. To remove the piston from the rod, unscrew the piston from the rod and pull the rod through the bore of the gland.

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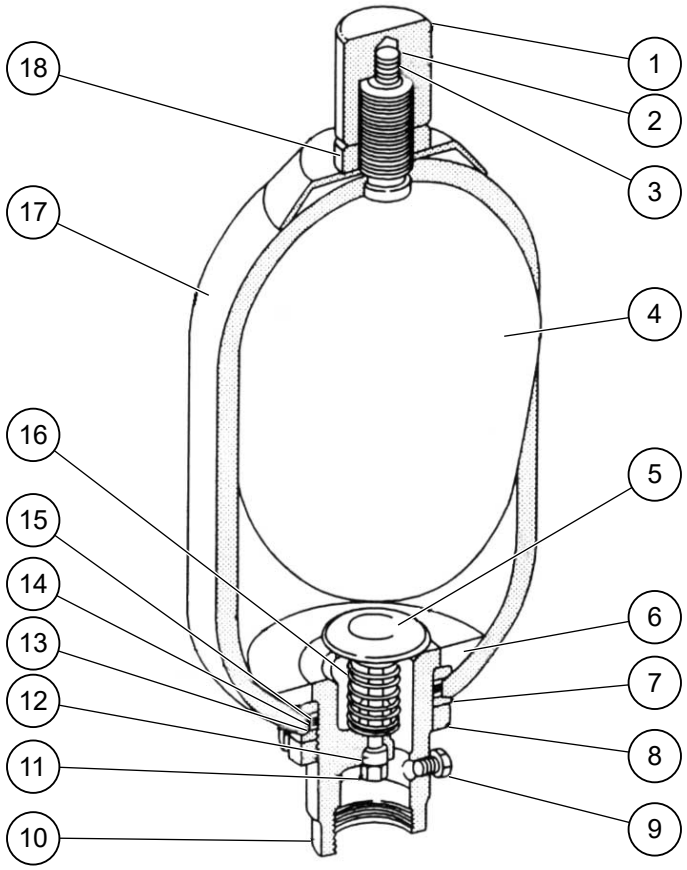
4. Remove all the «seals» (rod wiper or seal guards, Poly-Pak seals, O-rings and back-up rings) from the gland and piston. Make a sketch showing exactly how the seals are positioned in the gland and piston so that the replacement seals can be re-installed correctly.
5. Thoroughly clean the rod, piston, gland and cylinder tube. All the surfaces of the entire cylinder and its related parts are to be clean and dust free. Closely examine the inside bore of the cylinder tube for scratches or rust. Any deep scratches or scoring will cause leakage and the cylinder tube must be replaced.
6. Using the sketch you made in step *4*, install the new seals on the gland and piston. Then slide the rod through the gland using a circular motion and re-install the piston on the rod.
7. Lightly oil the surfaces of the rod, piston, gland, seals and bore of the cylinder. Carefully insert the piston, rod and gland assembly into the cylinder tube while rotating the rod and piston back and forth in a circular motion and exerting slight downward pressure.
8. Screw the gland into the rod end of the cylinder tube and tighten securely. The tramp or cavity release cylinder is now ready to be re-assembled on the crusher.

8.3.10.12.3 Accumulator repair

If it ever becomes necessary to disassemble the accumulator for replacement of the bladder or inspection of parts, contact Metso for instructions on the proper procedures for reassembling the accumulator.



1. Valve guard
2. Gas valve stem
3. Seal
4. Bladder and gas valve assembly
5. Poppet
6. Anti-extrusion ring
7. Spacer
8. Locknut
9. Bleed screw
10. Machined plug
11. Stop nut
12. Piston
13. Back-up ring
14. O-ring seal
15. Washer
16. Spring
17. Accumulator
18. Gas valve nut

Figure 142. Accumulator assembly

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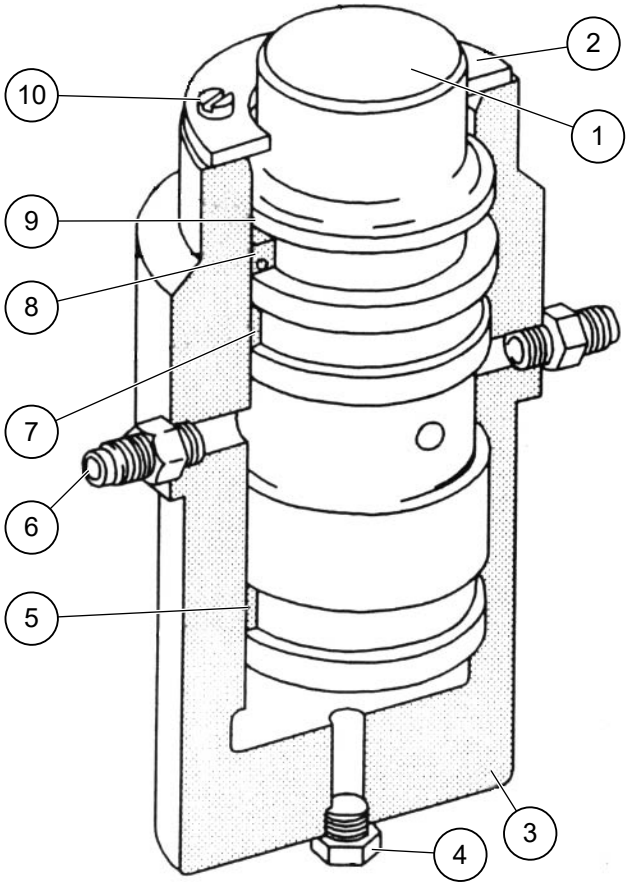
8.3.10.12.4 Rebuilding the clamping cylinder



1. Piston
2. Thrust washer
3. Cylinder
4. Plug
5. Wearing ring
6. Coupling
7. Wearing ring
8. Piston seal
10. Machined screw

Figure 143. Clamping cylinder

Clamping cylinder leakage is detected by oil seepage under the dust shell or by the inability to hold clamping pressure. When a cylinder is found to be leaking, it should be replaced immediately. A leaking clamping cylinder is critical because without full clamping pressure, the threads in the adjustment ring and bowl will be damaged.

When repairing a cylinder, it is recommended that all the seals are replaced at one time rather than gambling on a second oil leak. The entire replacement seals necessary for doing a complete rebuilding job are available in kit form for convenience.

Be sure that a sufficient quantity of wear rings, Poly-Pak seals and modular back-up rings are on hand before rebuilding of the clamping cylinders begins. During the entire rebuilding process it is important that the work is done on a clean surface and in a dust free atmosphere.

To disassemble, inspect, rebuild, and reassemble the clamping cylinders, proceed as follows:

1. Disconnect the hose fittings where they are attached to the faulty cylinder.

2. Back out the socket setscrew that holds the clamping cylinder in the clamping ring. The cylinder is now free to be removed.
3. Remove the piston retainer and O-ring plug at opposite ends of the cylinder.
4. Remove the piston by placing a wooden dowel through the hole in the bottom of the cylinder, against the piston and gently tapping with a hammer, push the piston upward out of the cylinder.
5. Remove the Poly-Pak seal, modular back-up ring and both wear rings from the piston.
6. Thoroughly clean the piston and cylinder. All the surfaces of the cylinder and piston are to be clean and dust free. Closely examine the inside bore for scratches or rust. Any deep scratches or scoring will cause cylinder leakage and the cylinder must be replaced.
7. From each end, slide a new wear ring over the piston and into its respective groove. Carefully slide a new Poly-Pak seal with lips facing downward along with a modular back-up ring over the piston and into its groove near the top.
8. Lubricate the surfaces of the piston, seals and the cylinder with light hydraulic oil. Carefully insert the piston into the cylinder while rotating the piston back and forth in a circular motion and exerting slight downward pressure.
9. After the piston is fully seated in the cylinder bore, install the piston retainer and O-ring plug.
10. Install clamping cylinder.

8.3.11 Instrumentation assembly

8.3.11.1 Adjusting the pressure switch (B5)

The pressure switch is factory-set by Metso. If for any reason it needs to be reset, contact Metso.

During the configuration, the device always works. It continues to execute its functions of supervision with the previous parameters until the new configuration is validated.

Every configuration is made in three stages.

1. Select the parameter. Press on the **Mode/Enter** button until the needed parameter is shown.
2. Adjust the value of the parameter. Press and hold the **Set** button. The current value of the setting flashes during 5 seconds. After 5 seconds, the adjusted value is modified, either single step by pressing several times on the push-button, or by holding the button.
3. Validate the value of the parameter. Press briefly on the **Mode/Enter** button. The parameter is again indicated. The new adjusted value is memorized.

Once the setting was ended, the device starts to work after 15 seconds. Watch out, if during the setting of a parameter no button is pressed during 15 seconds, the device starts to work without the value of the parameter is changed.

To visualize the parametrized values, press on **Mode/Enter** until the parameter is shown, then press briefly on **Set**. The value will be shown during 15 seconds. After additional 15 seconds, the device starts to work in standard way.

The device can be electrically locked to avoid a false and not deliberate setting. The device is delivered not locked. To lock or unlock it, press on **Mode/Enter**+ **Set** for 10 seconds.

8.3.11.1.1 Configuring the display

The display has to be in bar unit during the configuration. At the end of the configuration, it will be possible to change the unit display in PSI if needed.

1. Select the **Uni** mode, adjust the value to **bar** and validate.

2. Select the **diS** mode, adjust the value on **rd2** and validate.

8.3.11.1.2 Configuring the n°1 output

1. Select the mode **OU1**, adjust the value to **Hno** and validate.
2. Select the mode **SP1**, adjust the value to 1,1 and validate.
3. Select the mode **rP1**, adjust the value to 0,8 and validate.

8.3.11.1.3 Configuring the n°2 output

1. Select the mode **OU2**, adjust the value to **I** and validate.

8.3.11.1.4 Changing the display unit

Once the configuration ready, it is possible to have the display in PSI unit rather than bar unit.

1. Select the **Uni** mode, adjust the value to **PSI** and validate.

8.3.11.1.5 Parameters that must not be changed

By default, the following parameters must not be changed:

1. Mode **dS1**, value 0
2. Mode **dr1**, value 0
3. Mode **dAP**, value 60

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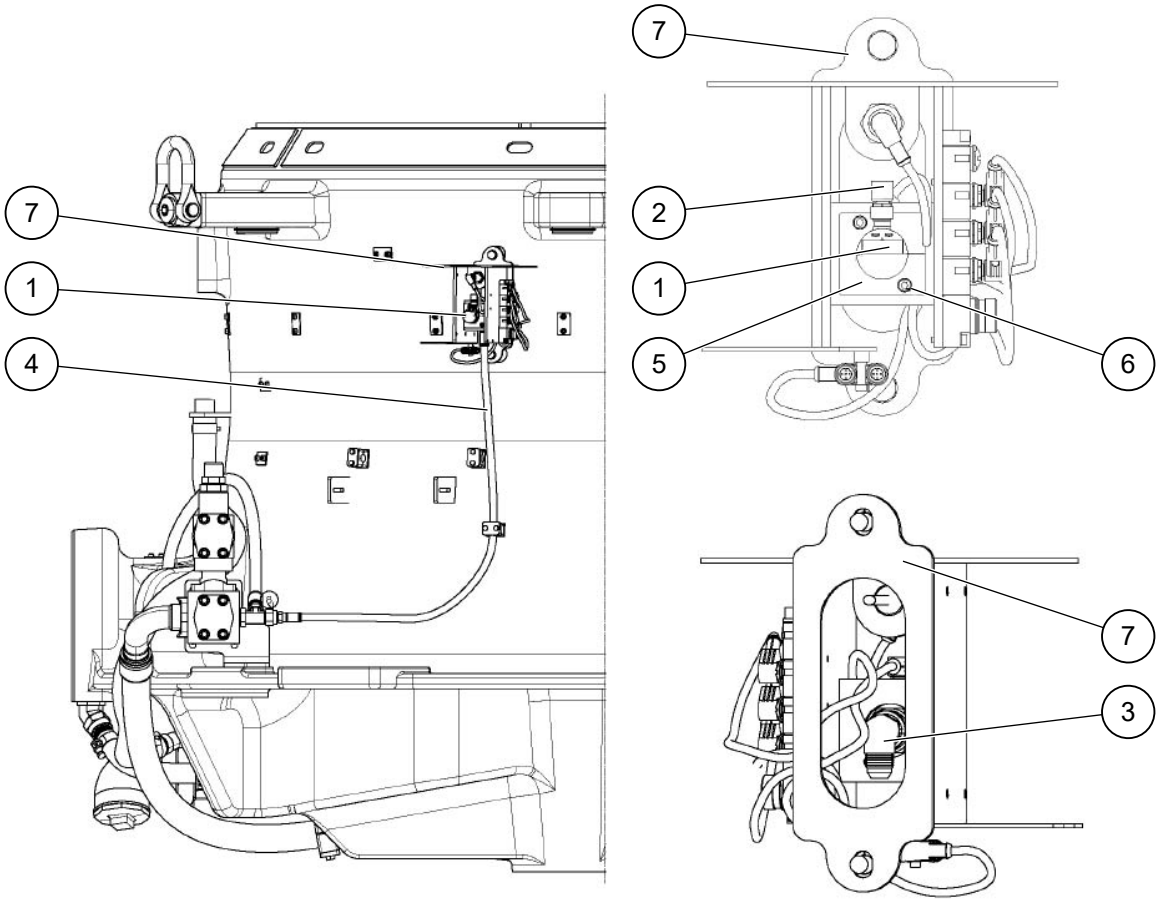
8.3.11.2 Removing the pressure switch



1. Pressure switch
2. Connector
3. Coupling
4. Hydraulic flexible hose
5. Collar
6. Screw on the collar
7. Support

Figure 144. Removing the pressure switch

1. Unscrew the screw on the top of the connector of the pressure switch and uncouple the connector of the sensor.
2. Unscrew the hydraulic flexible hose of the pressure switch. Leave the coupling mounted on the pressure switch.
3. Unscrew the two screws maintaining the collar of the sensor on the support, then remove the pressure switch from the support.
4. Remove the collar and unscrew the coupling of the sensor.

8.3.11.3 Fitting the pressure switch

When fitting a new pressure switch, it is necessary to configure the pressure switch. See *Adjusting the pressure switch (B5)*.

1. Assemble the collar on the pressure switch and the coupling by taking care in its orientation. The connector of the pressure switch has to be in the opposite side to the hydraulic coupling.

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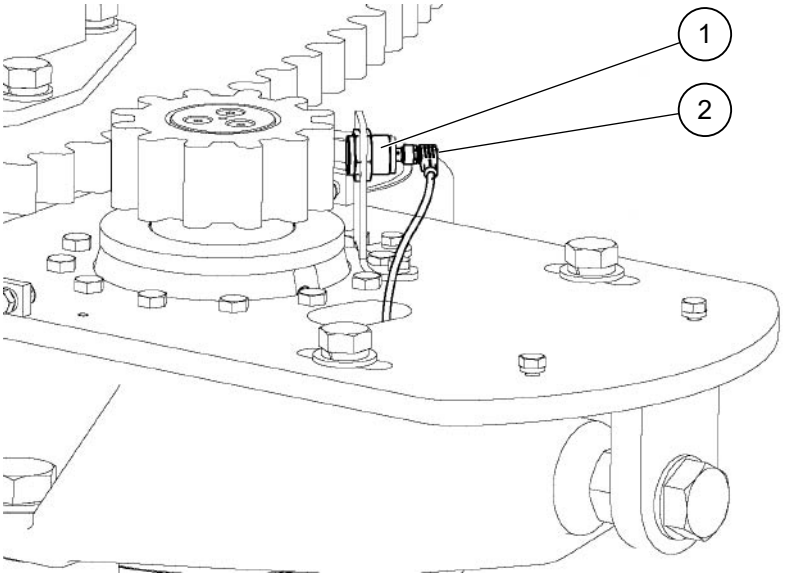
2. Fix the collar to the support by using both screws.
3. Screw the hydraulic flexible hose on the coupling.
4. Screw the connector of the electric cable on the sensor.

8.3.11.4 Removing the induction proximity sensor



1. Induction proximity sensor
2. Connector

Figure 145. Induction proximity sensor

1. If the crusher is equipped with a feed platform, remove the reduction gear drive hood.
2. Remove the reduction gear drive hood, fitted on the adjustment ring, by unscrewing the 4 HM 10 x 20 screws.
3. Unscrew the screw of the connector and dismantled the connector from the sensor.
4. Remove the induction sensor from the support by unscrewing one nut on sensor.

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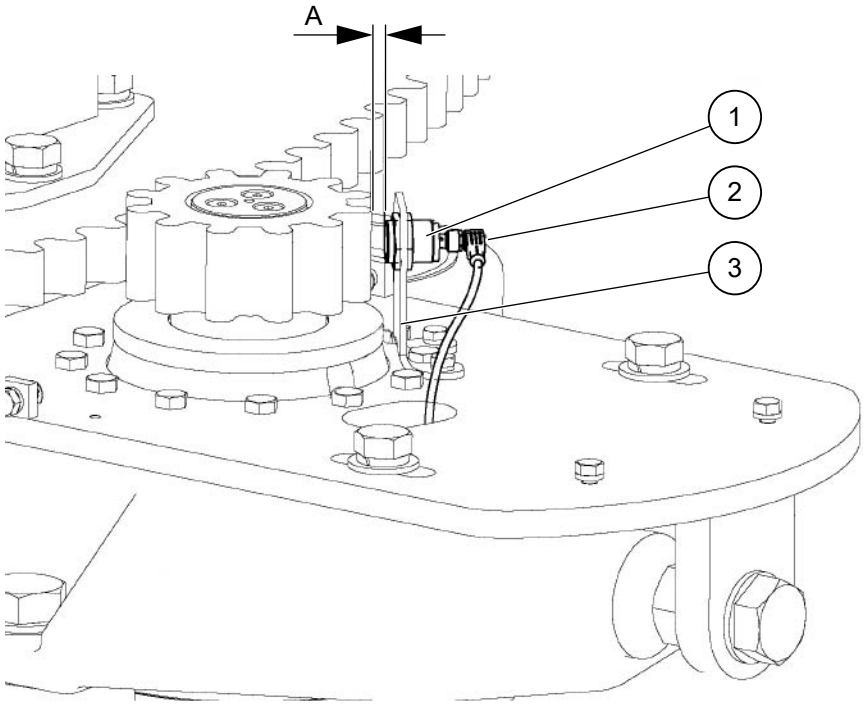
8.3.11.5 Fitting the induction proximity sensors



1. Induction proximity sensor
2. Connector
3. Support
A. 4 - 5 mm

Figure 146. Positioning the induction sensors

1. Fit the induction sensor on their support by screwing one nut and locknut on sensor. The sensor must be placed 4 mm to 5 mm from the teeth of the pinion.
2. Screw the connector of the wire on the sensor.
3. Fit the reduction gear drive hood, by screwing in the 4 HM 10 x 20 screws.
4. If the crusher is equipped with a feed platform, fit the reduction gear drive hood.

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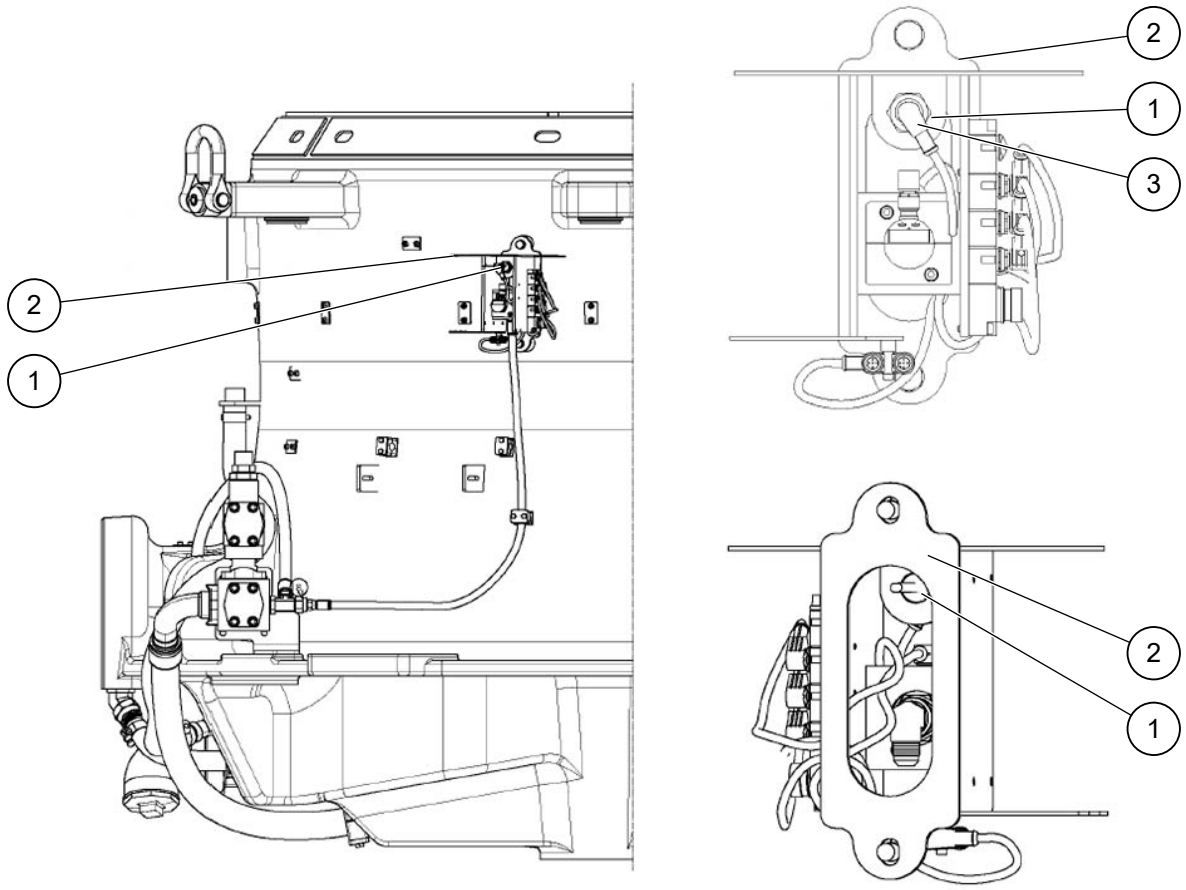
8.3.11.6 Removing the temperature sensor



1. Temperature sensor
2. Support
3. Connector

Figure 147. Ambient temperature sensor

1. Unscrew the connector and disconnect it from the temperature sensor.
2. Using a wrench, unscrew the temperature sensor from the support.

8.3.11.7 Fitting the temperature sensor

1. With a wrench, screw the temperature sensor into the support.
2. Screw the connector onto the temperature sensor.

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8.3.11.8 Removing the pulley rotation detector

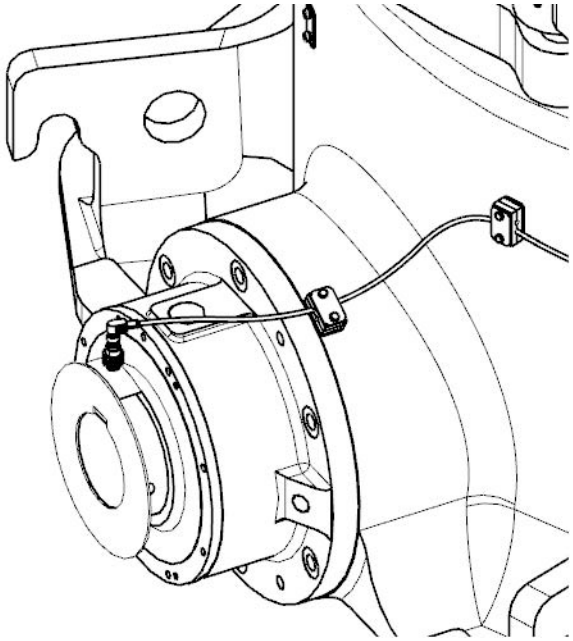


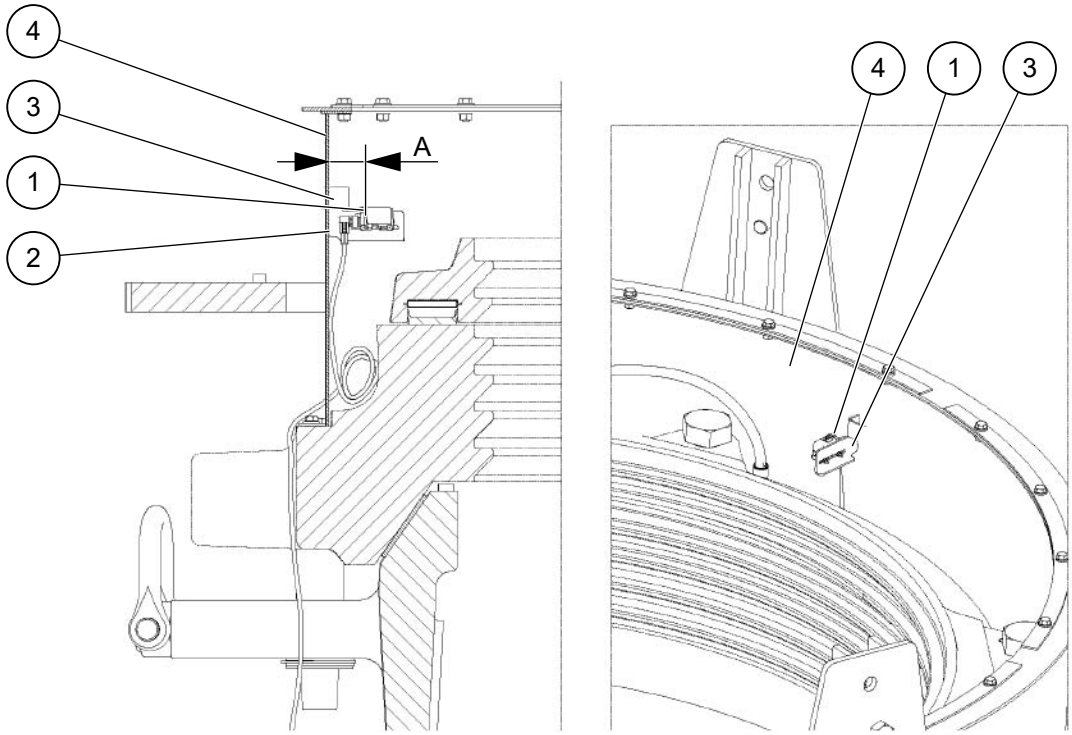
Figure 148. Pulley rotation detector

1. Unscrew the connector and disconnect it from the rotation detector.
2. Using a wrench, unscrew the upper nut of the detector to withdraw it from the support.

8.3.11.9 Fitting the pulley rotation detector

1. Introduce the detector into the support.
2. Using a wrench, screw the upper nut of the detector onto the support. The sensor must be placed between 4 mm and 6 mm to the countershaft ring.
3. Screw the connector onto the rotation detector, connect the 3 wires.

8.3.11.10 Removing the bowl position sensor (B12)



1. Bowl position sensor
2. Connector
3. Support
4. Protection plate
5. Sensor retaining screw

A. 48 mm

Figure 149. Bowl position sensor

1. Remove the bowl assembly.
2. Unscrew the connector and remove it from the position sensor.
3. Unscrew the 2 HM4 x 30 screws and remove the position sensor.

8.3.11.11 Fitting the bowl position sensor (B12)

1. Position the sensor on the support and fix it with the 2 HM4 x 30 screws. A dimension of about 48 mm must be respected between the protection plate and the outside fastening screw, to position the detection beam of the sensor correctly .
2. Screw the connector on the position sensor.
3. Fit the bowl assembly.

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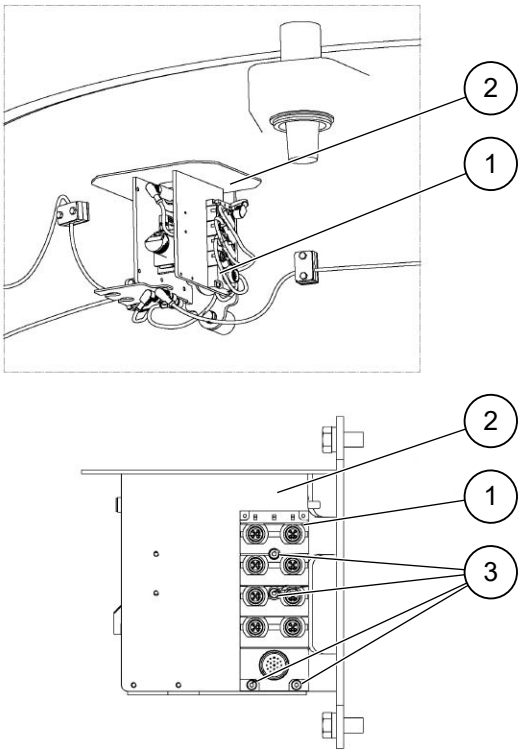
8.3.11.12 Removing the distribution box (XCR1)



1. Distribution box
2. Support
3. Fastening screw

Figure 150. Distribution box

1. Unscrew the connectors and remove them from the distribution box.
2. Unscrew the four HM4 x 20 screws fixing the distribution box on the support.

8.3.11.13 Fitting the distribution box (XCR1)

1. Position the distribution box on the support and fix it with the four HM4 x 20 screws.
2. Screw the connectors on the distribution box.
3. Check the position of the connectors. Refer to *Connections of the sensors on the distribution box (XCR1)*.

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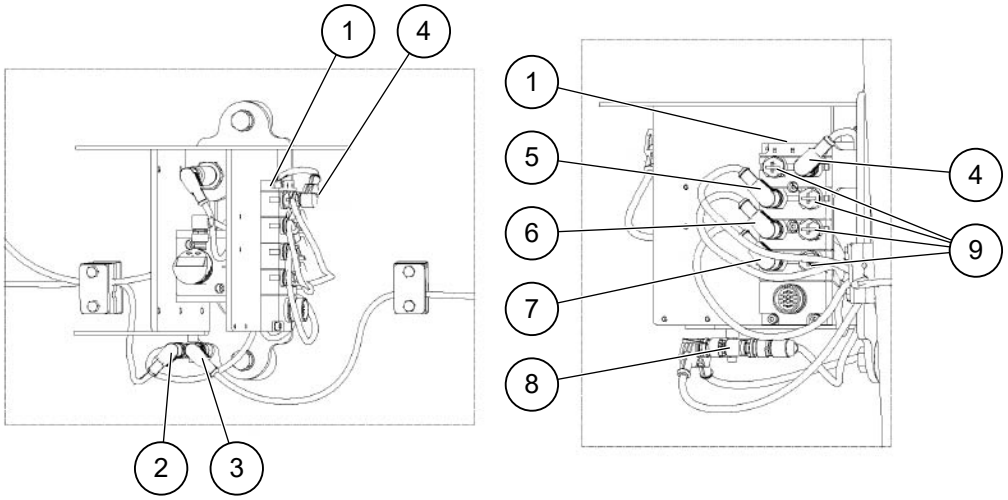
8.3.11.14 Connections of the sensors on the distribution box (XCR1)



1. Distribution box (XCR1)
2. Connection of the speed sensor of the pulley (B9) on the T-union (position 1)
3. Connection of the teeth sensor (B13) on the T-union (position 2)
4. Connection of the bowl position sensor (B12) on the distribution box (XCR1)
5. Connection of the ambient temperature sensor (B11) on the distribution box (XCR1)
6. Connection of the pressure switch (B5) on the distribution box (XCR1)
7. Connection of the T-union on the distribution box (XCR1)
8. T-union
9. Cap

Figure 151. Connection of the sensors

The speed sensor of the pulley (B9) is connected to the T-union (position 1) over a 2 m length electrical wire.

The teeth sensor (B13) is connected to the T-union (position 2) over a 3,5 m length electrical wire.

The T-union is connected to the distribution box (XCR1) over a 0,6 m length electrical wire.

The bowl position sensor (B12) is connected to the distribution box (XCR1) over a 2 m length electrical wire.

The ambient temperature sensor (B11) is connected to the distribution box (XCR1) over a 0,6 m length electrical wire.

The pressure switch (B5) is connected to the distribution box (XCR1) over a 0,6 m length electrical wire.

Caps are used to protect the non-used connections.

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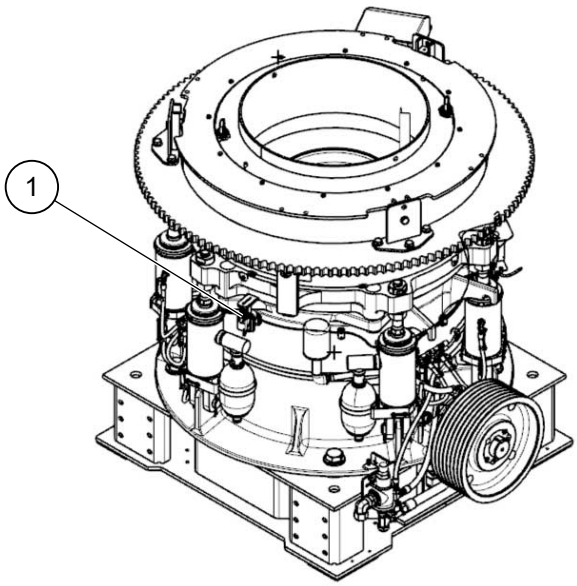
8.3.11.15 Ring bouncing sensor



1. Ring bouncing sensor

Figure 152. Position of the ring bouncing sensor

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9 Decommissioning and disposal

9.1 Decommissioning plan

⚠ WARNING

PERSONAL INJURY HAZARD

Can cause death or serious injury.

Before starting any decommissioning activities, read all safety instructions. Failure to comply with the instructions could result in death or serious injury.

⚠ WARNING

PERSONAL INJURY HAZARD

Can cause death or serious injury.

Read the material safety data sheets. Failure to comply with the instructions and procedures for handling hazardous substances could result in death or serious injury, or danger to the environment.

At the end of the product life, it is the responsibility of the person supervising the decommissioning and disposal to create a decommissioning plan and to carry out a risk assessment with careful consideration of health and safety, environmental aspects, and local legislation.

Liaise with local authorities to make sure that all statutory and local authority requirements and regulations are followed in disposal and decontamination activities.

If the decommissioning risk assessment reveals a risk of emissions to the groundwater, work together with the local authorities to carefully plan the risk management activities.

When creating the decommissioning plan, consider the following :

- Establish communication with plant personnel to ensure surrounding plant areas are prepared for the decommissioning activity.
- Undertake removal of hazardous substance by cleaning the equipment and ensuring it is empty, with particular consideration where there may be piping dead-legs where material may be trapped.
- Dispose of hazardous substances in accordance with the material safety data sheets and all statutory and local authority requirements.
- Decontaminate equipment that may be contaminated by absorption of hazardous substances and chemical change.
- Make sure all statutory and local authority requirements and regulations are followed.
- Mechanically isolate the equipment from its surroundings by physical disconnection or fitting of blanks.
- Electrically isolate the equipment from power sources by physical disconnection.

9.1.1 Draining the lubricating and hydraulic circuits

⚠ WARNING

PRESSURIZED COMPONENT HAZARD

Can cause death or serious injury.

After the engine has been stopped, some pressure can remain in the hydraulic system and in the cooling system of the engine. Let the machine cool down sufficiently before opening pressurized components. Always make sure that the system is pressure-free before doing any checks, maintenance, or repair work.

⚠ WARNING

PERSONAL INJURY HAZARD

Can cause death or serious injury.

In addition to these instructions, read the safety data sheets for the oils prior to using the oils.

1. Check that the pressure of the circuits are at 0.
2. Drain the circuits. For more information on how to drain the circuits, refer to *Draining and testing the pressure of the hydraulic system*.
3. Process the oils in accordance with the instructions given on the safety data sheets.

9.1.2 Draining the motoreducer

⚠ WARNING

PRESSURIZED COMPONENT HAZARD

Can cause death or serious injury.

After the engine has been stopped, some pressure can remain in the hydraulic system and in the cooling system of the engine. Let the machine cool down sufficiently before opening pressurized components. Always make sure that the system is pressure-free before doing any checks, maintenance, or repair work.

⚠ WARNING

PERSONAL INJURY HAZARD

Can cause death or serious injury.

In addition to these instructions, read the safety data sheets for the oils prior to using the oils.

1. Check that the pressure of the circuits are at 0.
2. Drain the motreducer.
3. Process the oils in accordance with the instructions given on the safety data sheets.

9.1.3 Draining oil and grease from the crusher and removal of hoses

⚠ WARNING

PRESSURIZED COMPONENT HAZARD

Can cause death or serious injury.

After the engine has been stopped, some pressure can remain in the hydraulic system and in the cooling system of the engine. Let the machine cool down sufficiently before opening pressurized components. Always make sure that the system is pressure-free before doing any checks, maintenance, or repair work.

⚠ CAUTION

ENVIRONMENTAL HAZARD

Can cause moderate injury or property damage.

Dispose of components to be recycled in a waste collection center.

Check the pressure gauges before starting to dismantle the crusher. If there is pressure left in the oil circuits, depressurize them. Before dismantling the crusher, drain oils and grease..

The oils are hazardous waste. Dispose them according to local legislation. Make sure no oil or grease enter the ground when draining the crusher. Use leakproof containers. Wear the appropriate personal protective equipment, such as eye protection and protection gloves when handling oil and grease. Used oils may contain harmful impurities that have accumulated during use and skin contact should be avoided. Consult with the Material Safety Data Sheet (MSDS) for adequate protective equipment.

In the crusher, there is grease

- in the countershaft box and
- inside the crusher around the lower end of the main shaft.

The oil in the countershaft box can be removed by using a drain plug.

Part of the oil inside the crusher around the lower end of the main shaft can be removed by using lubricating oil remove hose. Rest of the oil must be removed by using e.g. a pump after the upper frame assembly and the main shaft have been removed.

Remove the hoses.

9.1.4 Dismantling the crusher and the subframe

NOTE: Some parts of the crusher may be glued together. Also polyurethane can be used for sealing the gaps between the liner and frame of the crusher. Be cautious if welding or torch cutting glued or polyurethane containing parts. Welding or torch cutting these parts can generate hazardous gases.

1. Before dismantling the crusher, make sure that there are no stones let in the crusher cavity.
2. Dismantle the upper and intermediate frame assembly. For dismantling the assembly, see *Maintenance*.

   After removing the upper and intermediate frame assembly, the main shaft and lower frame assembly are left on their places.

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NOTE: Depending on the crusher model, the upper frame assembly can be dismantled in two pieces. After removing the upper frame assembly, the main shaft and lower frame assembly are left on their places.

3. Remove the concave from the crusher frame assembly, see *Maintenance*.
4. Dismantle the mantle and main shaft together. The mantle head and the mantle are attached to the main shaft. For dismantling the mantle, see *Maintenance*.

NOTE: A thrust plate made of bronze is attached to the lower end of the main shaft. This thrust plate must be removed from the main shaft.

NOTE: The main shaft and the head can be disposed as whole.

5. After removing the mantle and the main shaft, remove the slip ring. There are thrust bearings made of bronze under the slip ring. Remove the thrust bearings.
6. Remove eccentric bushing with the special tool.

NOTE: The eccentric bushing is made of bronze and thus contains lead.

7. Remove the frame bushing. Before removing the frame bushing, the eccentric shaft, hub and gear must be first removed. Use hoisting machinery and lifting points on each component to remove these safely.

NOTE: The frame bushing contains lead.

8. Remove the thrust bearing plates, see *Maintenance*.

NOTE: The thrust plates at the lower end of the main shaft and in the adjusting cylinder are made of bronze.

9. Dismantle the countershaft assembly. For lifting the countershaft assembly, use lifting hoist. Drain the oil from the countershaft assembly. There are bearings at both ends of the countershaft assembly. In order to remove the bearings, the pinion and the v-belt pulley must first be removed.
10. Dismantle the lower frame assembly. Remove the lower frame arm protections and lower frame protection plates. In older machines, these are manganese components. In new machines, these are steel components.
11. For recycling of the crusher motor unit, refer to the motor documentation.

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9.2 Recycling

⚠ CAUTION

ENVIRONMENTAL HAZARD

Can cause moderate injury or property damage.

Dispose of components to be recycled in a waste collection center.

9.2.1 Dismantling parts containing lead

There are bronze parts in the crusher. There is approximately 10-20% lead in the bronze parts.

Lead is a substance of very high concern (SVHC) and thus the bronze parts are hazardous waste.

Refer to *Substances of very high concern* for more information about the parts containing lead.

Dispose the parts containing lead according to local legislation.

9.2.2 Substances of very high concern

Companies who supply articles or products containing substances of very high concern (SVHC) on the REACH Regulation Candidate List in a concentration greater than 0.1% weight by weight (w/w) within the EU market are obliged to submit information on such articles to European Chemical Agency (ECHA).

The information is to be submitted to the database for Substances of Concern In articles as such or in complex objects (Products) (SCIP) under the Waste Framework Directive (WFD).

This information for the Nordberg HP crusher has been submitted to the SCIP database.

9.2.3 Dismantling the manganese parts

⚠ DANGER

TOXIC GAS HAZARD

Will cause death or serious injury.

There are components made of manganese steel. Welding or flame cutting these components generates gas that will cause death or serious injury. Only weld or flame cut the manganese steel components outdoors or in well-ventilated premises equipped with local exhaust ventilation. Also wear respiratory protection.

There are painted parts and parts containing manganese and zinc in the crusher.

The manganese and zinc parts do not require fire work, but when burning the torch ring open between the locking welds when dismantling the mantle, the fire work is done close to the manganese parts.

When welding manganese, zinc and painted parts, hazardous gas can generate.

Sort the manganese parts as metal waste.

9.2.4 Recycling the rubber parts

There are rubber seals and other parts made of rubber in the crusher.

Remove the rubber and plastic seals from dismantled crusher parts and recycle them according to local legislation. The rubber seals may contain carcinogenic compounds and hazardous gases may generate if torch cutting the seals.

Pay attention to the dust seal of the crusher because of its size. The dust seal is made of plastic.

If the crusher has a discharge chute, there is also rubber in its flanges.

There may be a rubber lining in the feed hopper. e.g. if the crusher is delivered with Lokotrack.

Rubber is combustible waste.

9.2.5 Recycling the electric components

The electric cabinet is electrical waste and thus hazardous waste.

Discard the electric cabinet like all electrical components to waste electrical and electronic equipment (WEEE) or to hazardous waste.

Follow the local legislation.

10 Services and spare parts

10.1 Introduction to Metso services

Metso services are designed to optimize the customers' plants and processes. Depending on the technology concerned, these services cover everything from spare parts support and delivery, site and equipment maintenance and plant audits to optimization and upgrades, project management, and training.

If you have any questions regarding our equipment/products or services, contact your nearest Metso location or our head office (*www.metso.com*). For more information, see *www.metso.com/contact/*.

10.2 Spare parts and consumables

Metso offers you:

- Original equipment manufacturer components, including warranty
- Spare and wear part deliveries
- Stock planning consultation

Metso recommends using genuine spare parts and accessories in order to ensure optimal equipment performance and safety.Metso assumes no liability for defects or damages resulting from the use of non-genuine spare parts and accessories. Your Metso representative can help you with your spare part enquiries.

NOTE: Any damage that occurs by using other than original or Metso approved spare parts or accessories rules out all liability and warranty on suppliers' behalf.

The customer personnel that replace parts for the equipment should be certified and authorized maintenance technicians and/or electricians. Please contact Metso for more information about available maintenance and technical trainings for your product.

10.2.1 Ordering spare and wear parts

Metso can assist you with the provision of site-specific spares information and the supply of genuine parts.

When ordering spare parts or making enquiries, provide the following information to Metso:

- Equipment type and serial number in which the part is used
- Metso part number
- Description of the part
- Quantity required
- Your contact information

Specifying this data ensures that you receive the correct information or the required spare parts.

10.2.2 Recommended parts and wears lists

Equipment-specific spare part recommendation helps you to budget and store the right number of spare parts to secure an uninterrupted production.

NOTE: Request a spare parts recommendation from your Metso representative.

10.2.3 List of minimum recommended spare parts

Here is a list of critical spares one should always have to hand to guarantee minimal downtime or when faced with problems:

1. Bowl liner
2. Bowl liner bolts
3. Mantle
4. Ring spacer
5. Cone feed plate + screws

Obviously this is only a minimum list of spares; if the factory has several crushers, this list should be adjusted accordingly.

Contact Metso for a list of spares specific to your facility.

Before checking spares into the storeroom, check that the protective film applied prior to shipment is still intact.

Before replacing a bearing or other important part, or when the crusher starts for the first time, refer to *Commissioning and start-up*.

10.3 Technical services

Metso has a comprehensive technical service portfolio covering all phases from installation and start-up to planned proactive maintenance and decommissioning.

10.3.1 Advisory services

Advisory services prioritize the most cost-efficient ways to improve safety, reliability, availability, and productivity based on in-depth information from inspections, studies, audits, assessments, and advisory services conducted by Metso technology, process, and service experts.

10.3.2 Maintenance services

Metso offers a portfolio of maintenance services to ensure that the customer's assets perform at their optimum level and that maintenance activities are carried out at the right time.

- Maintenance inspection

  Regular maintenance inspection by certified Metso field service technicians can give you precise information on the equipment's condition and recommendation for upcoming maintenance planning.
- Maintenance advisory

  Metso technical advisors provide your maintenance crew with deeper knowledge about the equipment and maintenance tasks.
- Preventive maintenance

  Metso field service technicians are trained to safely perform the maintenance activities in accordance to the maintenance schedule and agreed share of responsibilities.

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10.3.3 Life Cycle Services

Metso helps you plan, program, execute and set up your maintenance and operations as quickly as possible after installation and commissioning. Metso can provide scheduled maintenance inspections, wears and spares replacement, scheduling, supervision and field service to make your shutdowns safe and efficient. Digital process optimization is also available.

10.3.4 Expert services

Metso Operations Support Center provides remote troubleshooting, assessment, and monitoring services. Remote condition monitoring is also offered. Metso Metrics provides on line details of equipment performance and service requirements.

10.3.5 Spare and wear part audit and recommendations

Metso offers high-quality spares that ensure the safety and functionality of your equipment. Metso's customized spare and wear parts solutions help you improve equipment reliability and availability and support you in optimizing plant performance and total cost of ownership. Metso Owned Inventory (MOI) can reduce your on site inventory costs while maintaining high quality wear and spare part availability.

10.3.6 Training services

Metso offers training to enhance the effectiveness of the process and the safety of maintenance operations. Classroom, on site, online and even virtual training sessions are available.

10.3.7 Modernizations

During the equipment life cycle the needs might change, the equipment performance might decrease or there might be some further development of the technology in question. Metso modernization solutions offer services to either refurbish the equipment back to the original performance level or to upgrade it to meet new targets.

The following Metso modernization solutions are available:

- Modernization assessments
  - When facing ever increasing production demands, Metso can support customer decision-making to find the optimal modernization solution
- Refurbishments
  - Bring under-performing equipment back to original performance level and reliability either by repairing or replacing parts
- Upgrading equipment either by improving an existing function or adding a new one. These services include:
  - Process upgrades, equipment upgrades, plant upgrades
  - New product versions
  - Upgrade installation and start-up services
  - Accessories and extended options

You can order modernization services for your equipment through *my.metso.com* or by contacting your local Metso dealer.

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