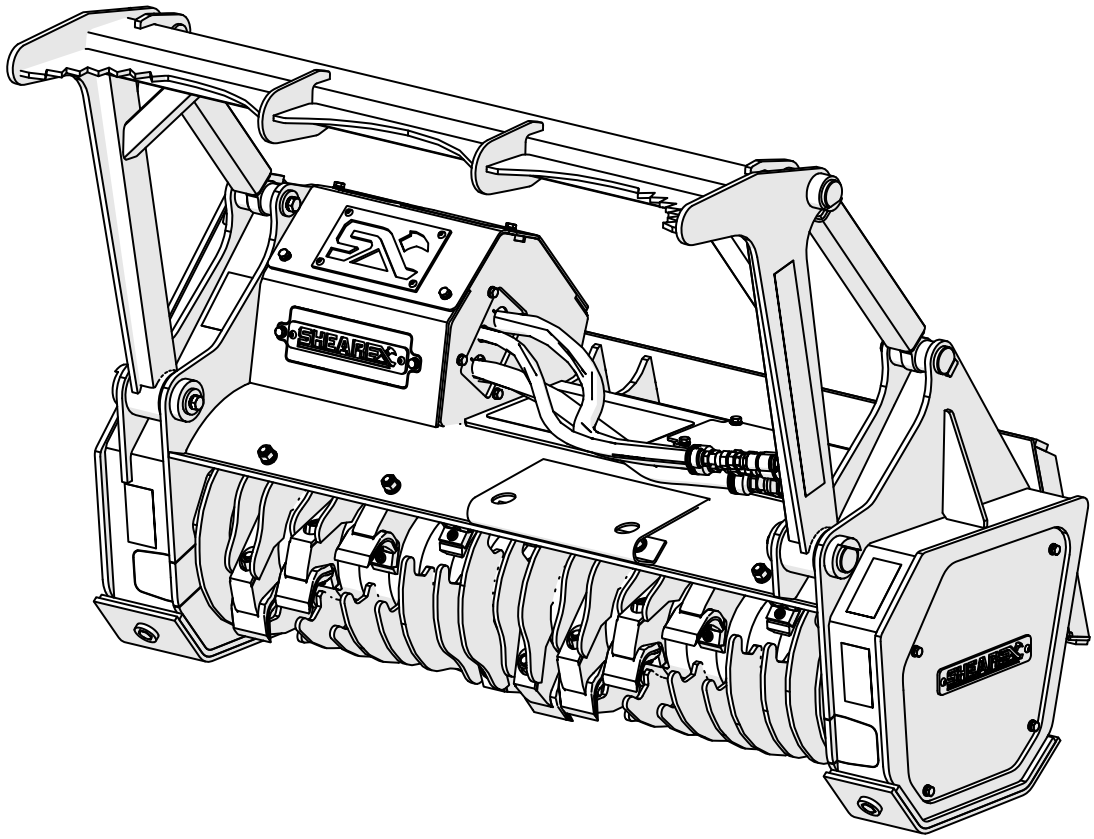
HM-60SR Mulcher
User's Manual

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1 General Information

1.1 Technical Help and Service

If you have any general questions or technical advice you need to address about your HM-60SR, please contact your dealer or your SHEAREX Technical Support.

It is our commitment to give you the most complete information we have.

Also, always feel free to give us your suggestions or report any concern about our products. Your suggestions will be studied carefully.



SHEAREX TECHNICAL SUPPORT

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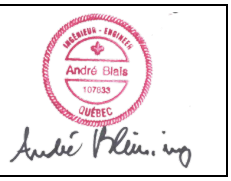
1.2 Manual Updates

To keep track of the revisions of the publications we produce, here is a list outlining the revision numbers, their description, and the specific pages and / or sections where the changes were made.

Revision Nb	Description	Section/page
0	First release of the document	All
1	Maintenance Kit Update/ Labels Locations	4.9, 4.10, 4.11

Although we take all necessary means to ensure the quality and accuracy of the information contained in this manual, omissions or errors are always possible.

In the eventual case (and indeed unintentional) where errors and omissions are found, please let us know and we will make sure to eliminate them in the subsequent revision.

Author :	André Blais, P.Eng./ Shearex Technical Support	
Date :	Aug. 23, 2022	

1.3 About this Manual

1.3.1 Contents

This *User's Manual* is designed to help you quickly find the information you need on your HM-60SR mulcher. It describes the main components, the assemblies, the hydraulic and electrical systems, the required maintenance, and safety precautions to take when working on the mulcher or periphery devices and recommended spare parts for.

SHEAREX may also provides a digital copy of this publication and all the documents related to this mulcher by calling or addressing short E-Mail to your Technical Support and through our user's library.

The digital format of the manual (.PDF), provides some useful tools from the Acrobat Reader® software for searching any information on parts and references. Links/shortcuts are included through the manual to speedup the research for necessary information.

The manual is divided in xx sections, related to the different aspects of your mulcher as follows:

- Section 1 – General Information, describes the *Technical resources* you have and the documentation related to and the *Environment, health and safety guidelines*, you should be involved to lead the on your new mulcher.
- Section 2 – Mulcher Description, gives an "overview" of the machine, its structure, the hydraulic and electrical (optional) systems and some detailed views of the main components.
- Section 3 – Maintenance Instructions, lists the tasks to perform to keep your machine in good work condition. It contains the necessary procedures for inspection and part replacement on the HM-60SR mulcher.
- Section 4 – Parts Lists, shows exploded views of the main sub-assemblies and lists the parts and some usable components which should be kept in stock or not.
- Section 5 – List of figures, lists views, drawings, schematics that were used through the manual for descriptions, explanations and instructions about operation and maintenance.
- Section 6 – Addendum, is a supplementary section for exhaustive description of system or topic that remained too much detailed for the rest of the manual.

1.3.2 Convention Employed



This sign at the beginning of the text indicates instructions on safety or hazards, which if ignored, will result in danger to the user, third persons or serious injuries.



This sign at the beginning of the text indicate important instructions prior/during operation or service, which if ignored, could result in damage to the machine or to other property.



This sign indicates information, tip, advice for the correct and economical operation and service of the equipment.



This symbol indicates that the intended operation must be carried out by specialized and "qualified" personnel so as not to compromise the safety or integrity of the equipment.

1.4 Health, Safety and Environment

1.4.1 Responsibilities vs Authorities

Each Country, Forest Research and Shared Services has a Health and Safety Policy and a Health and Safety Committee. Managers within these areas are responsible for ensuring health, safety and environment policies are put into practice day-to-day.

A. The relevant Executive Boards and Management Boards are responsible for ensuring:

- health and safety policy and procedures are readily available to all staff
- risks to health and safety are identified, assessed and appropriately managed
- effective communication and consultation with employees and other relevant stakeholders on health and safety matters
- appropriate training and other resources are available
- periodic audits are carried out

B. The operator is responsible of following common-sense rules and regulations stated by the local and government authorities[1] by:

- taking reasonable care of their own health and safety and that of others
- understanding how the health and safety policies and procedures apply to them and their areas of work;
- following all local and general instructions regarding environmental regulations, work safety rules for prevention of accidents;
- report any accidents or near misses

C. The owner must ensure that the maintenance manual of the HM-60SR mulcher is supplemented by company-internal instructions with respect to supervision, reporting, work organization, staff qualification etc.

D. All personnel engaged to work with this machine must have read and understood this SHEAREX *User's Manual* and will be aware of the warnings for safety and hazards contained in the separate documents for periphery devices.

[1] Crown Copyright, courtesy Forestry Commission (Sept. 3, 2018), licensed under the Open Government Licence

1.4.2 Safety Gear

1.4.2.1 Personal Protective Equipment (PPE)

A. Working clothes should be manufactured from materials which keep the workers' body dry and at a comfortable temperature. For work in hot and dry climates, appropriate clothing should be used to avoid excessive thermal insulation and allow respiration. Adequate protective clothing should be provided where there is a risk of UV radiation or biological hazards, such as poisonous plants, animals, and infections.

B. Clothing should be of a colour that contrasts with the forest environment, to ensure that workers are clearly visible.

C. The use of personal protective equipment should be regarded as a last resort when risk reduction by technical or organizational means is not feasible. Only in these circumstances should suitable personal protective equipment having regard to the specific risks be used.

D. Personal protective equipment for forestry work should include the relevant items listed in table 1, which identifies personal protective equipment required for specific tasks.

E. When tasks are performed using hazardous chemicals, personal protective equipment should be provided in accordance with Safety in the use of chemicals at work: An ILO code of practice (Geneva, 1993).

F. Personal protective equipment should comply with international or national standards.

G. There should be a sufficient supply of necessary personal protective equipment readily available to ensure that operatives are consistently aware that safety and health is of paramount importance.

1.4.2.2 PPE vs Type of Operation

Each employer should evaluate the need for personal protective equipment in the prevailing conditions.

The table[2] below shows the generally accepted practices in the use of this equipment. Workers should be provided with personal protective equipment as specified in table 1, except where the employer can demonstrate that no or other protective equipment affords the same or a higher level of protection. Here is below a list of the general tasks to perform and the safety gear that the operator must be provided with.

This list remains only a start that can be used as a "check list" to remind whom it may concerned to avoid injuries at the work site.

Parts of the body to protected	**Feet**	**Legs**	**Trunk, Arms, legs**	**Hands**	**Head**	**Eyes**	**Eyes/face**	**Hearing**
PPE Normally Appropriate	Safety boots/shoes	Safety trousers	Close fit. clothing	Gloves	Safety helmet	Goggles	Visor (mesh)	Earmuffs
Rotating knife/flail	✓		✓	✓				✓
Felling								
Hand tools	✓		✓	✓	✓			
Chain-saw	✓	✓	✓	✓	✓		✓	✓
Mechanized	✓		✓		✓			✓
Stacking/ loading	✓		✓	✓	✓			✓
Chipping	✓	✓	✓	✓	✓	✓	✓	✓

Fig. 1-1 Personal protective equipment (PPE) appropriate for forestry operations

[2] Source: *Safety and health in forestry work, Geneva, ILO 1998*

1.4.3 Maintenance Hazards

1.4.3.1 Electrical Hazards

Only skilled and fully trained personnel who are familiar with the inherent dangers are permitted to work on the electrical system. In cases where the machine has to be working under power, an additional skilled person should be called in who can take the necessary steps in emergency situations.

Prior for maintenance or repairs on the electrical system:

1. Stop the machine and place the breaker in "OFF" position. Attach a lockout device, lock and tag.
2. Disconnect the machine (e.g. battery, breaker) and periphery devices from the mains and ensure that the power cannot be reconnected.

1.4.3.2 Hydraulic Hazards

1. Before carrying out any work on the hydraulic system, switch off the machine and the hydraulic power unit and ensure that the power cannot be inadvertently switched back on again.
2. Afterwards ensure that the hydraulic system is no longer under pressure. Let the pressure drop slowly to "0" on all pressure gauges.
3. Make sure that all mechanisms are stable so nothing will unexpectedly drop or move due to a lack of pressure.

1.4.3.3 Periphery Hazards

Without request and permission obtained from SHEAREX, it is not permitted to carry out modifications or extensions to the HM-60SR mulcher or periphery devices.

For replacements of any parts of the machine, use exclusively original accessories and spare parts provided by the SHEAREX.

Observe the instructions in the documents for periphery devices and all local safety regulations.



Work on the electrical, pneumatic, hydraulic and on periphery systems is only to be carried out by skilled personnel.

1.4.4 Labelling

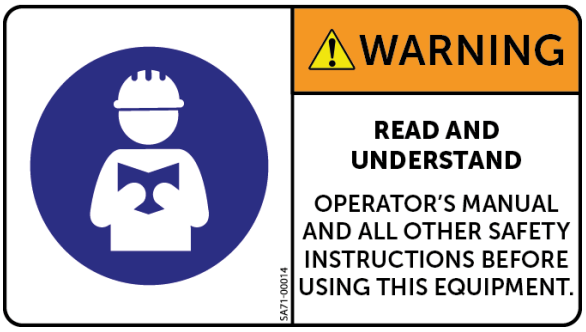
The labels used for this mulcher operation purposes have been developed to quickly warn the user on the important topics and actions to take (immediate or not) for the safety and the good operation of the equipment.

We develop and currently use "common sense" icons, stickers apposed on the mulcher frame as reminders for the maintenance and operation. Foreign language labels may be supplied under special request.

Pay attention to the labels apposed on the mulcher frame, they can same you time, avoid severe injuries and even save life!

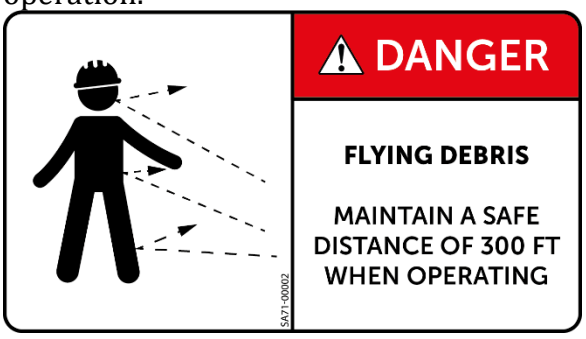
READ AND UNDERSTAND the Operator's (User's) Manual and all other safety instructions before using this equipment.

1.4.4.1 Read and Understand!



1.4.4.2 Flying Debris

Since the rotor turns at 2500 rpm at the ground level, chips and debris may be projected on long distances. They can cause severe injuries for those who stand too close to the equipment during operation.



1.4.4.3 DANGER – Stand Clear 300'

This label remains particularly important for people around who are not involved with the operating equipment. Standing in front or rear of an operating equipment always remain hazardous.



1.4.4.4 Cut Hazard

The mulcher rotor is provided with 21 sharpened blades which, running or not, may easily cut hand and body skin.

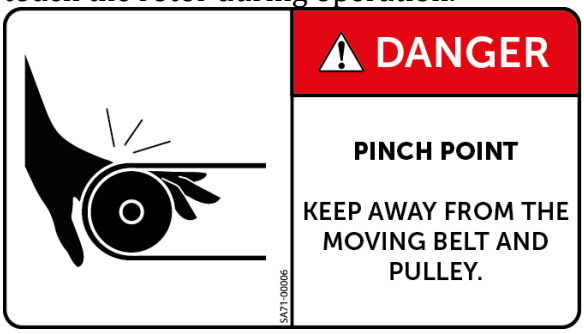
During storage, maintenance, and operation, always use the right tools and methods to avoid such injuries.



1.4.4.5 Pinch Point

Except some conditions where speed reading or adjustment procedure is on-going, NEVER stand close or let any laces, cordons, shirt, or scarf close to the rotating part of the equipment.

Part/clothes can easily be trapped, or body be killed by the rotor if someone touch the rotor during operation.



1.4.4.6 Crush or Cut Hazard (hands)

Since the mulcher is a quite heavy machine and the rotor has high rotation inertia, always get your hands, feet, and part of your body out of its way.



1.4.4.7 Crush or Cut Hazard (feet)

Since the mulcher is quite a heavy piece of equipment and the rotor has high rotation inertia, it takes a long time to stop.
Always get your feet, and any part of your body out of its way.



1.4.4.8 Beware of Slippery Surface

During maintenance works around the mulcher or getting out of the carrier cabin after operation session, oil may be spilled on the surfaces that remain slippery.



1.4.4.9 High Pressure Oil

Oil leaks may appear just as drops under hydraulic lines and could also appear as a thin jet almost invisible but that can get through your skin. Don't inspect oil leak with your bare hands.

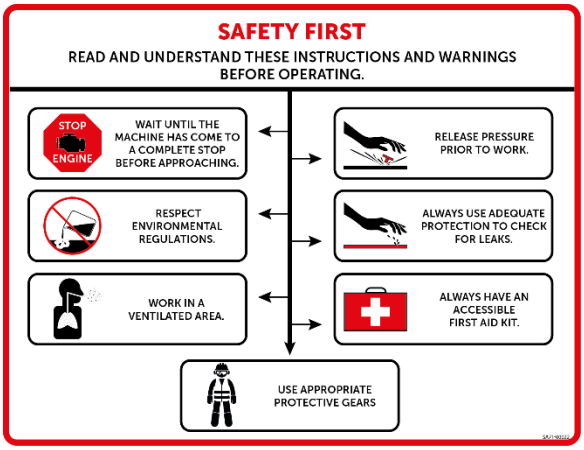


1.4.4.10 Hot Surface Inside

Temperature for bearing and hydraulic oil may get higher than 100°C. Use a thermal gun instead of your own hands prior to check for overheating problem.



1.4.4.11 Safety First



2 Mulcher Description

2.1 Model Identification

SHEAREX inc produces many model mulchers but your new mulcher has a unique model number that describes some of its characteristics.

Although your productivity is largely depending of the CTL, tractor or carrier to be used, this HM-60SR mulcher is *Operationally Adaptative* according to the motor control which can be hydraulic (ref. : **6.2 TWO-POSITION HYDRAULIC CONTROL (TADA)**) or electronic (on development).

The motor will adapt to the equipment you currently use to deliver the maximum performances.

Since the parts you may need are specifically related to the model mulcher currently used, refer to this number for further information requests.

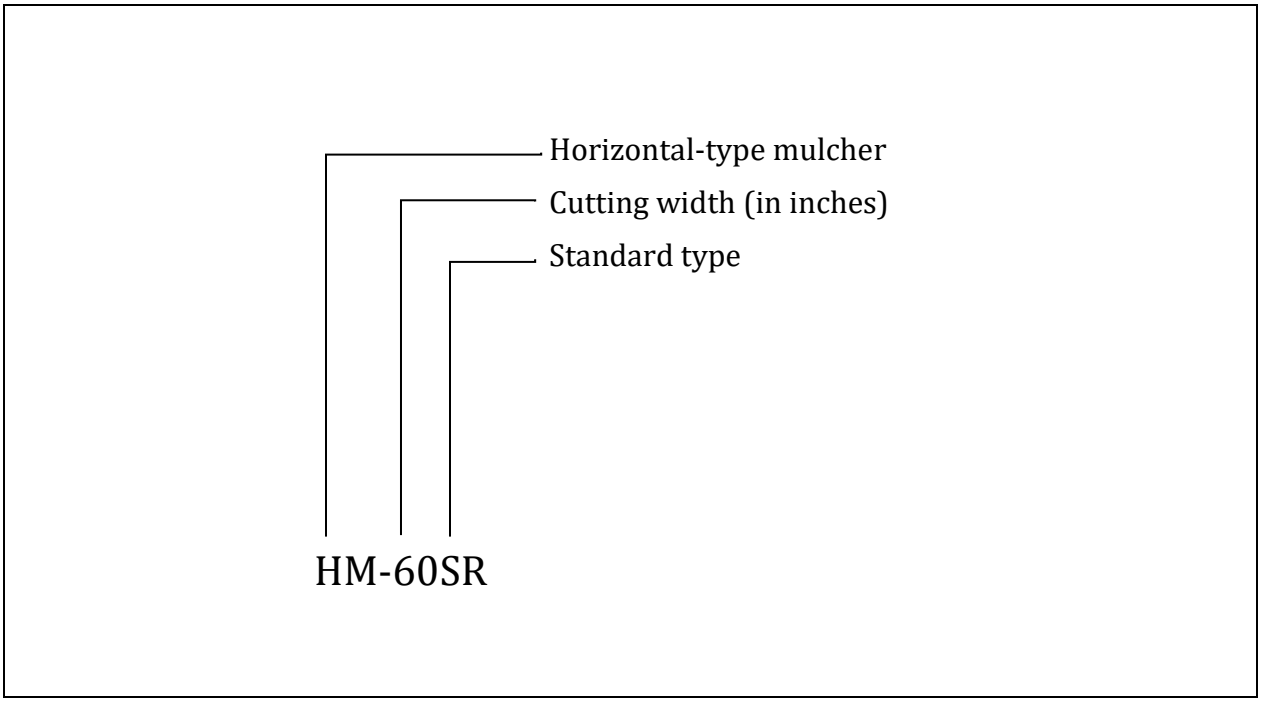


Fig. 2-1 Model Number Identification

2.2 Specifications

The HM-60SR is a ground-use type mulcher which has been built to deliver maximum performance for heavy duty operations on a large range of wood species.

It is the new generation of machine specifically designed for landscaping services, forestry work or just to refresh and enhance vegetation coverage.

The table below shows the main specifications of the HM-60SR mulcher.

HM-60SR Specifications		
Cutting Width	149 cm	58.63 in
Rotor Diameter	45 cm	17.63 in
Exterior height	130 cm	51.25 in
Exterior width	185 cm	73 in
Target material	20 cm	8 in
Required Hydraulic Flow	87 L/ min	23 gpm
Max. operating pressure	410 Bar	6000 psi
Rotor Speed	2600 rpm	
Typical Weight	1130 Kg	2500 lbs
Number of Blades	21	

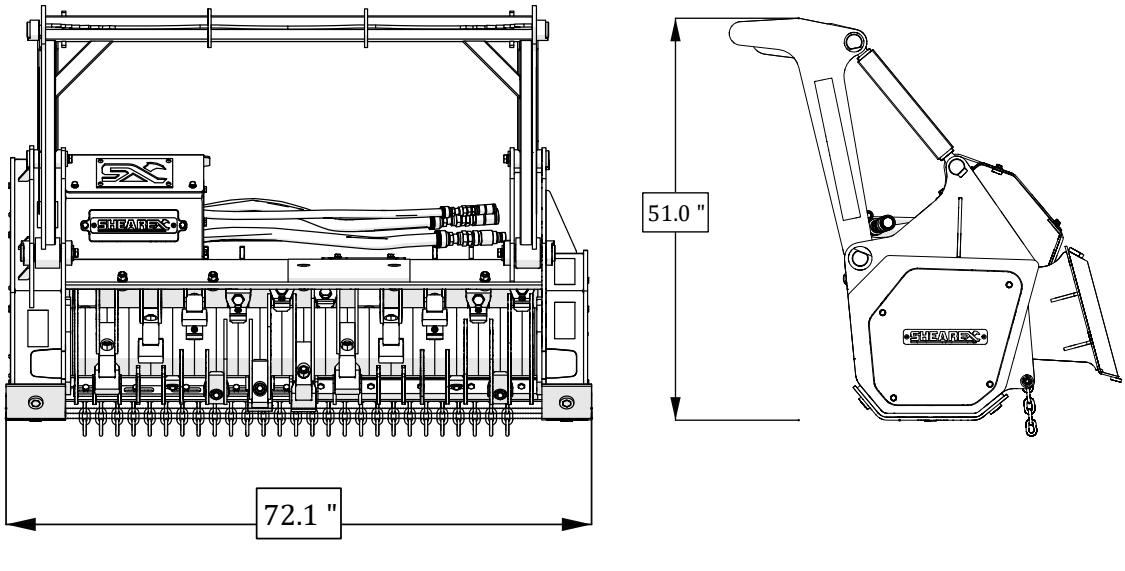


Fig. 2-2 Mulcher Dimensions

2.3 Structure Description

2.3.1 Frame

The frame is the main structural element which support the rotor and its bearing ass'y, the hydraulic motor, the two pulleys, the cogs belt and the push-bar that can be hydraulically actuated (option). The attachment bracket makes part of the frame (i.e. no fasteners) for lightweight and resistance purposes.

It is designed in a single piece with a reduced number of metal plates, fairing and fasteners to limit the occurrence of parts loosening and time for checkup.

To protect the frame from the chips and debris generated by the rotor, an internal circumferential liner remains bolted inside the rotor enclosure as a conveniently removable wear part.

Two replaceable skid plates are bolted under the RH and LH side of the frame. Since they are still in contact with the ground, they may have to be changed more often according to the soil/ground the mulcher is working on.

2.3.2 Rotor

The rotor is the toughest part of the mulcher since it must "convert" 40-50% of the hydraulic power of the CTL (Compact Track Loader) for cutting/mulching the material at a very high speed (2500 –2600 rpm).

The type of material to be mulched still varies from soft pine wood, spruce tree, or fir to the hardiest type of wood ass cedar tree, palm tree and citrus tree in the southern regions where fruit trees cultures renewable are requested.

As tough the material may be, as sharpened the blade/cutter must be, so they are. The blades are made of specially hardened steel (forged, tempered, and machined) to resist the day-to-day work and last longer (approx. 150-200 hrs) according to the operating methods and the type of soil encountered.

To solidly keep the blades against the rotor while transmitting the rotor power to the blades and to endure continuous shocks without distortion, the blade supports are made of specific type of steel that withstands heavy duty work. The blade supports are welded around the rotor arbor as well as the mulch control rings that help to limit the penetration of the rotor in the material.

2.3.3 Push Bar

The push bar is a good addition to the mulcher and give a hand to the operator while keeping the material away from the mulcher frame but giving a sort of control of the method used by the operator. In fact, the common way to use the push bar is first mulching the tree to make it fall to the ground and continue to work on horizontally which is easier and more productive since the material will have such tendency to get pulled/caught by the rotor.

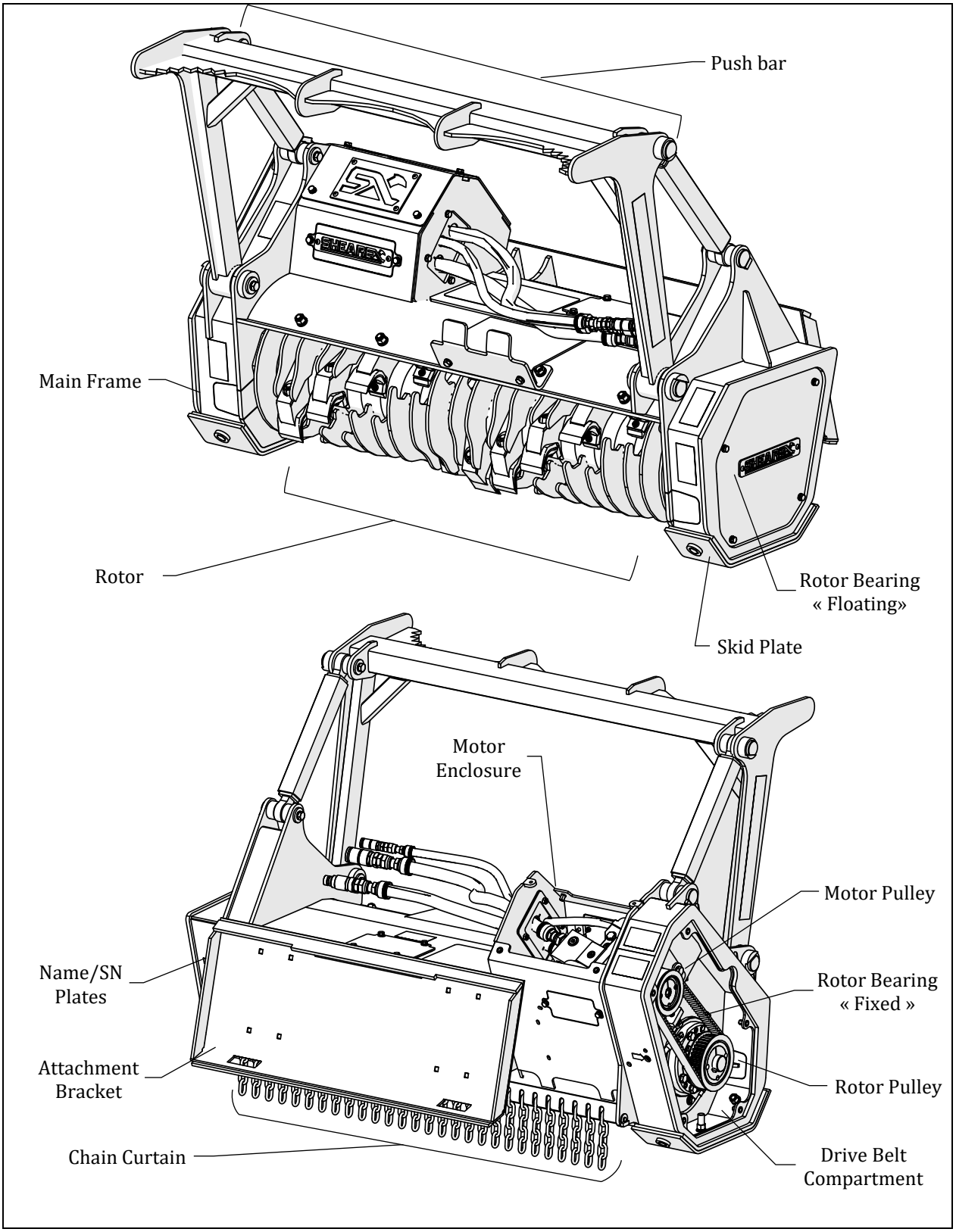


Fig. 2-3 Structure Description

2.4 Drive System

2.4.1 Hydraulic Motor

The HM-60SR mulcher drive system is provided with a piston motor featured with variable displacement bent axis design which allow the control of the speed and torque hydraulically or electronically.

Model type: H1-B-080-	
Max. displacement (V_{gmax}) [cc]	80
Max. torque @ V_{max}, 450 bars [N·m (lbf·ft)]	572 (421)
Max. flow @ V_{max}, 2600 rpm [L/min (gal/min)]	208 (55)[3]*
Max. working pressure [bar (psi)]	450 (6500)
Rated case pressure [bar (psi)]	3 (44)
Rated speed [rpm] @ V_{gx} (6° angle)	5300*
Weight [kg (lbs)]	34.8 (76.9)

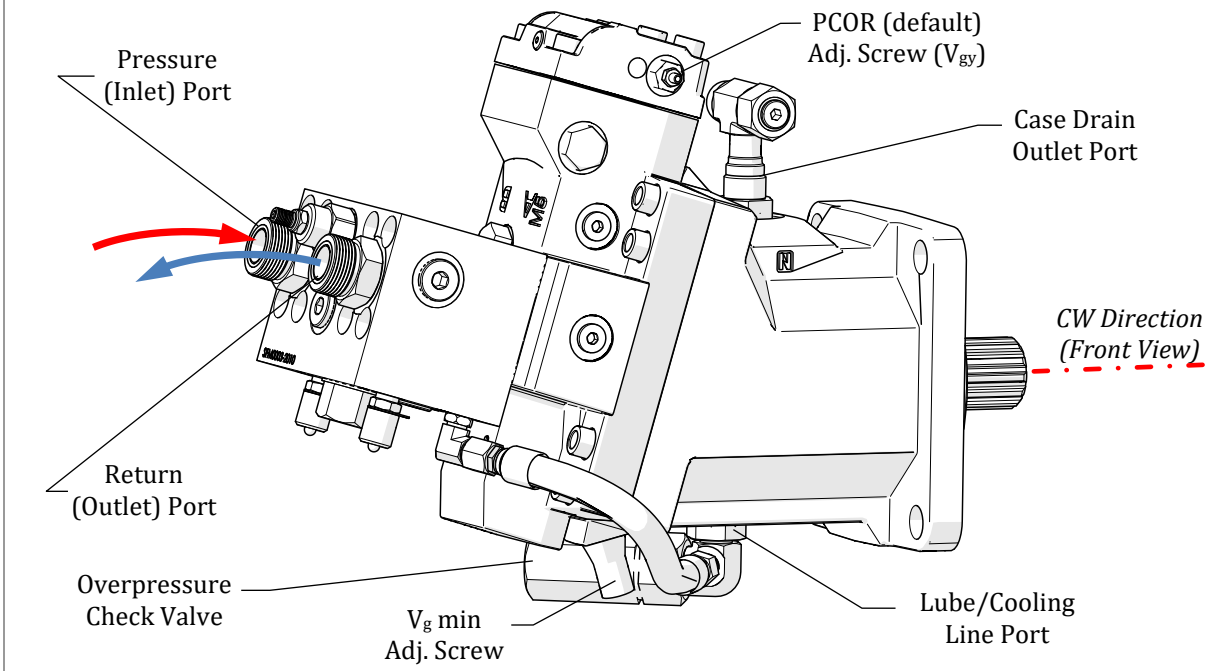


Fig. 2-4 H1B110- Hydraulic Motor Description (TADA Type Motor Shown)

[3] HM-60SR mulcher rotor limit speed should not exceed 2600 rpm, adjust flow and V_g min speed accordingly.

2.4.2 Drive Box

The HM-60SR mulcher drive system use a hydraulic motor coupled to an upper pulley that transfer the power by a cog transmission belt to a lower pulley mounted on the main rotor shaft.

The motor is mounted to an adjustable mounting plate bolted to the frame, but the height remains adjustable for belt tension purposes. To transfer the power from the motor to the upper pulley, a taper lock bushing is tightened to the motor shaft. In the same way, the lower pulley is mounted to the rotor shaft with a 1½"I.D taper lock bushing.

Nbr	Description	PN
1	Hydraulic Motor (80cc)	SA21-00006
2	Taper Lock (TL) Bushing for the motor shaft	SFM0004-2010
3	Motor Pulley (30 teeth)	SA31-00003
4	Drive Belt	SA32-00002
5	Taper Lock Bushing for the rotor shaft	SA33-00004
6	Rotor Pulley (38 teeth)	SA31-00004

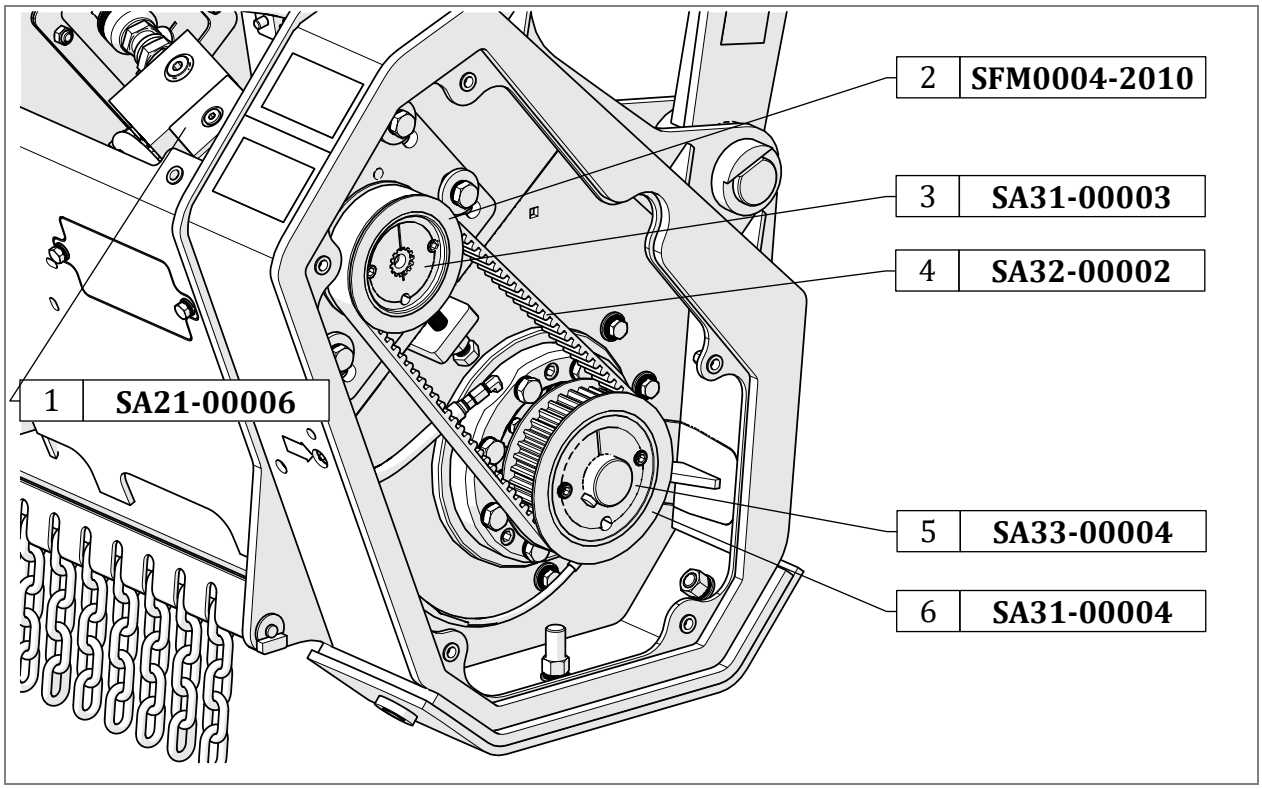


Fig. 2-5 Mulcher Drive System (RH Side)

2.4.3 Rotor Ass'y

The rotor is provided with a "fixed config." bearing on the RH side and a "floating config." bearing on the LH side which means that one bearing will not constrain the other.

The RH roller bearing is mounted in a housing where the rotation is free but side move is not allowed, so it has one degree of freedom.

The LH roller bearing is mounted in a housing where the rotation is free and the side move is allowed, so it has two degrees of freedom.

Nbr	Description	PN
1	Rotor Ass'y (Steel tube, rings, blade supports)	SFM0004-5002
2	Floating Bearing Housing Ass'y (LH)	SFM0001-5004
3	Fixed Bearing Housing Ass'y (RH)	SFM0001-5003
4	Blade	SFL01-10

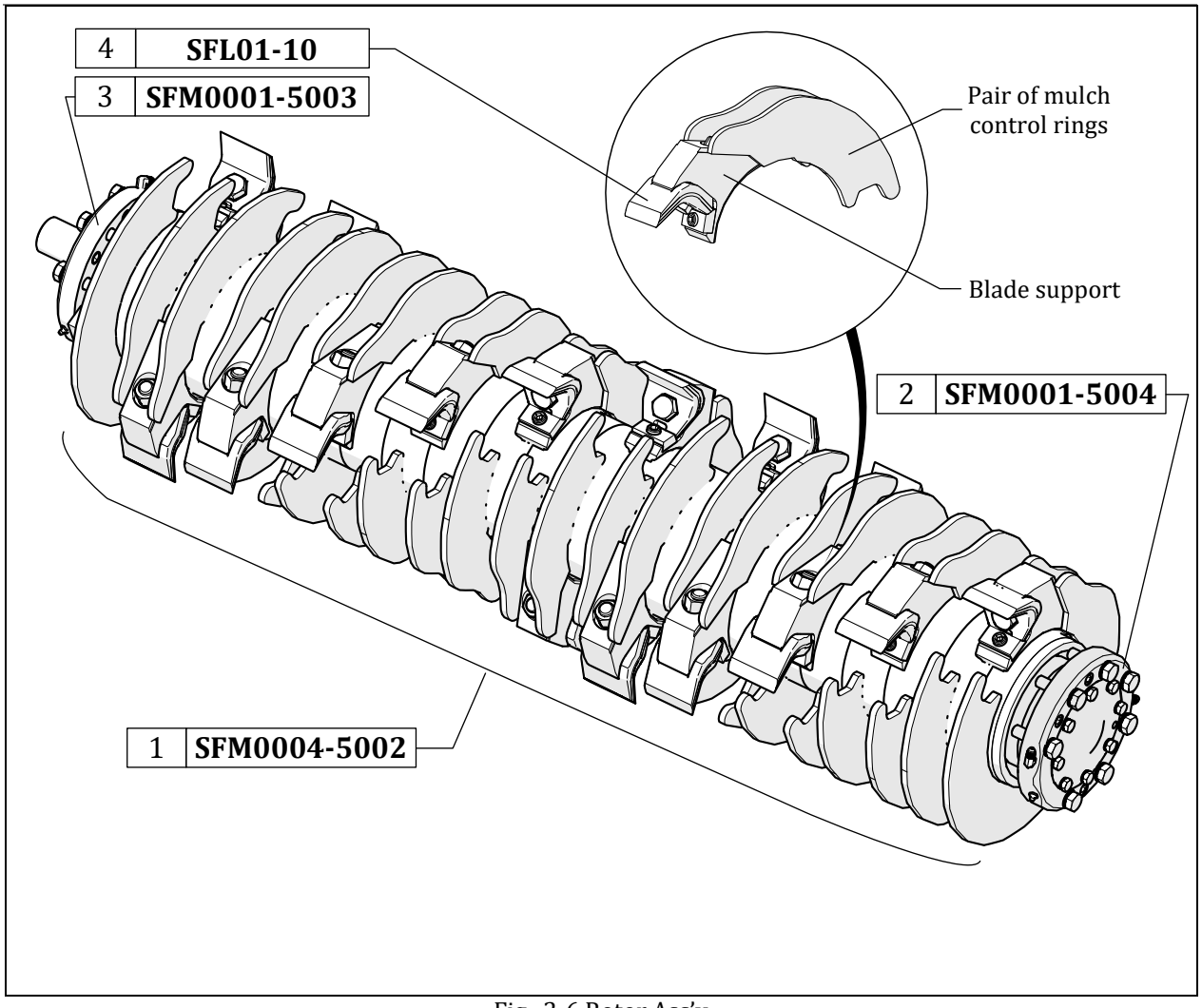


Fig. 2-6 Rotor Ass'y

2.5 Hydraulic System

2.5.1 Hydraulic Block Purposes

The motor is provided with a block assembly made for the following purposes:

A. Collecting all the hoses adapters for the service and return pressure.
B. Protecting the motor from high pressure peaks or surge by an adjustable relief valve.
C. Allowing free spinning when flow suddenly stop using internal check valve.
D. Delivering "fresh" oil from the block to the motor housing

The hydraulic block ass'y is made of the following parts:

Nbr	Description	PN
1	Hydraulic Block	SFM0003-2010
2	Motor Relief Valve	SA28-00001
3	Check-Valve-CXHA-XAN	SA28-00002
4	Motor Flushing Hose	SFM0004-5010
5	Pressure Test Adapter	SA02-00004

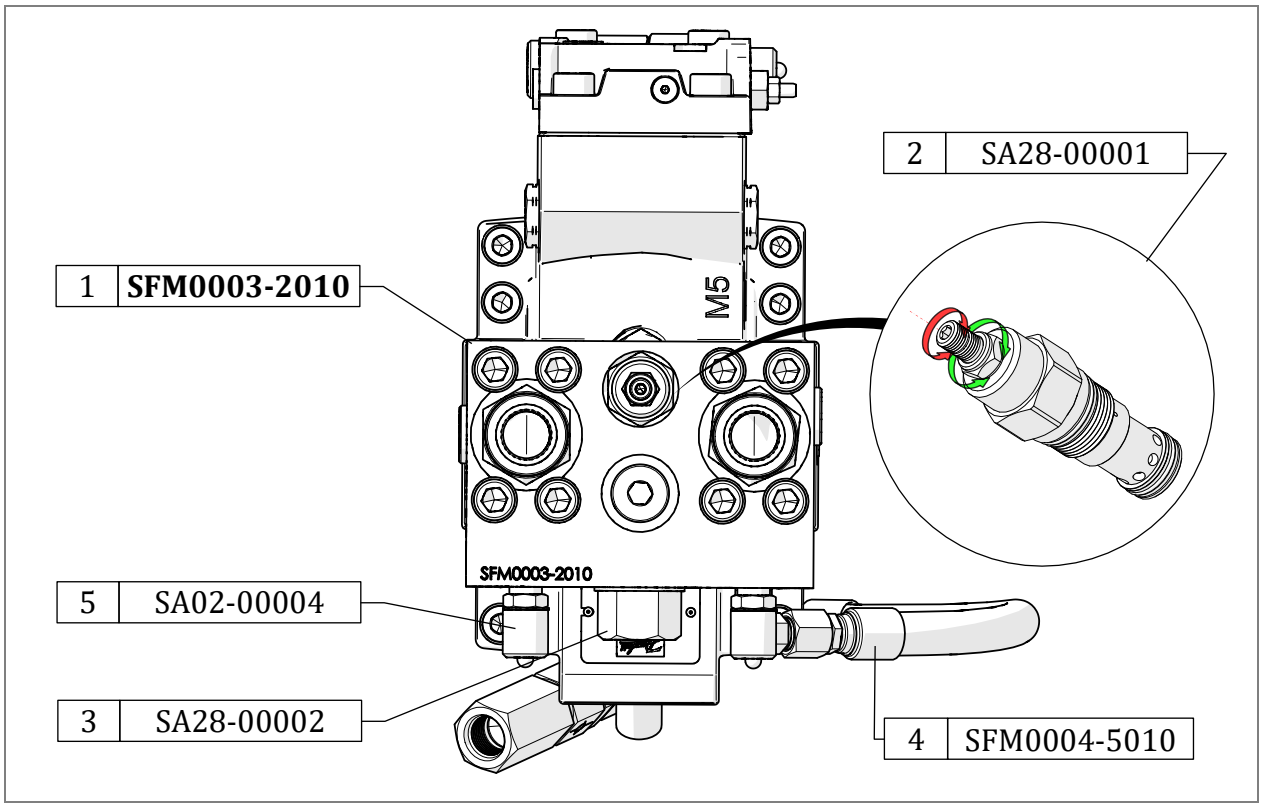


Fig. 2-7 Hydraulic Block Ports and Features

2.5.2 Lines and Quick Disconnects

The mulcher is provided with a set of 3 main hoses which supply the hydraulic motor (through a hydraulic block) with the oil flow coming from the carrier.

The set of hoses includes the necessary adapters, fittings and quick disconnects to be coupled to the carrier bulkhead adapters.

Nbr	Purpose	Hose Dimension
1x	Pressure (P) Line/ SAEM34 Fitting	#16 (1.00″ ID)
1x	Return (R) Line/ SAEF34 Fitting	#16 (1.00″ ID)
1x	Drain (D) Line/ SAEF12 Fitting	#10 (0.625″ ID)[4]

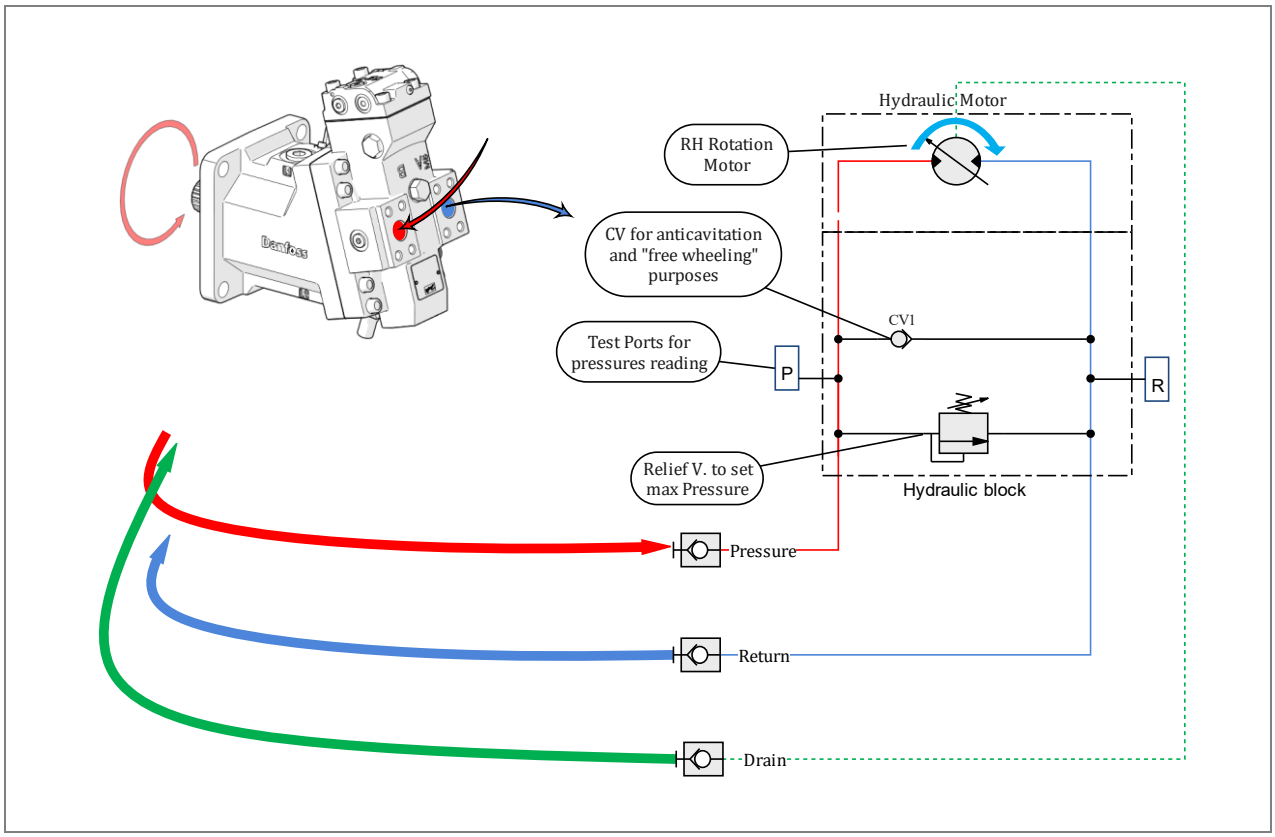


Fig. 2-8 Hoses & Quick Coupler Fittings Identification

[4]If the CTL is an ASV, Bobcat, or Kubota, the case drain line MUST be updated to comply with Shearex mulching head requirements.

2.5.3 Recommendations

2.5.3.1 System Requirements

A. Since loop flushing is typically not used in OC-applications it is essential to provide enough cooling capacity. When needed, this can be done by motor case cross flushing. The flow rate needs to be adjusted to the cooling demand.

B. Also, we recommend keeping the mulcher turning at low speed for five minutes allowing the oil to reach the motor and fill all the hoses and piping.

C. Under normal operating conditions, the rated case pressure must not be exceeded. During cold start, case pressure must be kept below maximum intermittent case pressure. Size drain plumbing accordingly.

D. The highest case drain outlet port must always be used for the return flow to the cooler or tank.

E. The plumbing must not allow the oil to drain down nor be replaced with air in the control or rotating group.

F. For good operation of the motor, the minimum pressure in the inlet port and the outlet port, measured at gage ports MA and MB, must be equal or higher as 15 bar (220 psi).

G. The oil must remain at this level; the motor case, the control system and the working lines connected to Port A and B must always be kept full of oil, whether in a dynamic or static condition otherwise the motor can suffer permanent damages.

2.5.3.2 Fluid Specifications

Properties		**Range**	
Viscosity	Minimum, maximum	7 to 1600 [49 to 7416]	mm^2/s [SUS]
	Recommended	12 to 80 [66 to 366]	
Temperature	Minimum, maximum*	-40 to 115 [-40 to 240]	° C [°F]
	Recommended	104 [220]	
Cleanliness[5]	Required per ISO 4406	22/18/13	
	Efficiency (return line)	$\beta_{35\text{-}45} = 75$ ($\beta_{10} \geq 2$)	
	Rec.'d inlet screen mesh	100 to 125 µm	

*Cold Start: t ⩽ 3 min., P ⩽ 50 bar (725 psi), n ⩽ 1000 rpm

[5] Filter βx-ratio is a measure of filter efficiency defined by ISO 4572. It is defined as the ratio of the number of particles greater than a given diameter ("x" in microns) upstream of the filter to the number of these particles downstream of the filter.

3 Maintenance Instructions

3.1 Pre-work Check List

To help you remind the steps to pay attention prior and during Maintenance, we prepared a checklist.

A.	Wait for Machine to Stop	✓
B.	Release Pressure Prior to Work	✓
C.	First Aid Kit	✓
D.	Individual Protection Equipment	✓
E.	Respect Environmental Regulations	✓
F.	Handle Gas and Oil with Care	✓
G.	Work in a Ventilated Area	✓
H.	Walk Around Inspection	✓

Only persons sufficiently qualified for the work involved and who have the necessary knowledge of the HM-60SR mulcher are permitted to install, operate, service and if necessary, repair the machine.

3.2 Work to be Scheduled

In this section, we recommend the usual timeframe for preventive maintenance to be made for a good and long-lasting operation of the mulcher.

You can considerer this as a start since it may be part of a more extended schedule that would include all your tools and machinery.

Check lists are commonly available to make sure that all the items in this chart will be covered and fulfill our recommendations.

We conveniently use some icons and symbols to remind the user that some specific work must be achieved to maintain the equipment in good state of order.

	Task to perform	10	50	500	1000
1.	✓ Clean dust and debris ✓ Check for leaks, lose or damaged parts, odor of fuel, odor of burned devices ✓ Listen for any unusual system noise(s) that can indicate that service is required ✓ Notice all fire risks and make necessary repairs immediately				
2.	✓ Sharpen the blade using the Go-no-go Shape Gauge (GSG) provided ✓ Check the blade tightness (Torque = 400 lbf·ft) using the socket provided with your Maintenance and Repair Kit				
3.	✓ Grease the RH and LH rotor bearings as required, 2-3 squirts/ day				
4.	✓ Inspect the hydraulic panel condition, the actuator (cylinder) ✓ Check for any interference and the range of motion of the main panel				
5.	✓ Grease the hydraulic panel hinge (i.e. pins)				

Inspection Date:_____

Comment:	
	☐
	☐
	☐
	☐

Fig. 3-1 Suggested Check List for Preventive Maintenance

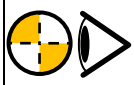
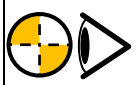
3.3 Reminder Icons

We conveniently use some icons and symbols to remind the user that some specific work must be achieved to maintain the equipment in good state of order.

Legend:

Inspect/ Adjust	Lube	Fill-in	Drain	Filter
				

3.4 Inspection and Maintenance Schedule

	Task to perform	10	50	500	1000
1.	✓ Clean dust and debris ✓ Check for leaks, lose or damaged parts, odor of fuel, odor of burned devices ✓ Listen for any unusual system noise(s) that can indicate that service is required ✓ Notice all fire risks and make necessary repairs immediately				
2.	✓ Sharpen the blade and check profile using the sharpening gauge provided (GSG) ✓ Check the blade tightness (Torque = 400 lbf·ft) using the socket provided with your Maintenance and Repair Kit				
3.	✓ Grease the fixed and floating rotor bearings as required, 2-3 squirts/ day				
4.	✓ Clean/inspect the hoses, adapters, fittings (in and out) from the motor compartment to the hyd. cylinder for oil leakage ✓ Check hoses condition and make sure all fittings are tight				
5.	✓ Inspect the fixed and floating rotor housings for grease leakage from the housings or lube lines and adapters. ✓ Check the drive belt for wear, alignment, and tension				
6.	✓ Inspect the blade support and the rings for wear and major damages				
7.	✓ Clean and inspect the rotor inner plate and anvils for wear and damages				
8.	✓ Check hydraulic motor parameters: ✓ Case drain pressure: ≤ 45 psi ✓ Return line pressure: 150psi ≤ Pr ≤ 250psi ✓ Service line pressure: : ≤ 6000 psi			 As needed	

	Task to perform	10	50	500	1000
9.	✓ Remove the drive belt and perform and exhaustive inspection of the belt and pulleys ✓ Replace parts as needed				
10.	✓ Check the rotor bearing for vertical or side play (tol ≤ 0.010")				
11.	✓ <u>ON THE CARRIER</u>: check oil level of the hyd. reservoir and fill it up as needed				
12.	<u>ON THE CARRIER</u>: ✓ Check filter element condition or the filter electrical clogging indicator (if installed). ✓ The filter should be changed whenever the fluid is changed or whenever the filter indicator shows that it is necessary to change the filter.				
13.	<u>ON THE CARRIER:</u> ✓ Change hydraulic oil: It is recommended that the fluid and filter be changed per the vehicle/machine manufacturer's recommendations or at the following intervals:			 1st	 2nd and after
	The hydraulic oil must be changed according to manufacturer's recommendation or as scheduled above.				

3.5 Blade Maintenance

3.5.1 Inspection

3.5.1.1 Safety First

Prior to start inspection of the blades, some care must be taken to make sure it will be made in safe conditions to protect the personnel, the environment, and the equipment.

Make sure the carrier has been turned off, switch is locked and rotor is blocked to avoid unexpected rotation and injuries against the blades.

3.5.1.2 Looking for Productivity

It is recommended that you replace the blade when the use of the sharpening gauge becomes impossible.

Blades must be inspected according to the following criteria:

1. Thoroughly clean the rotor and the blade/holders prior starting the inspection.
2. Inspect the blade support for *wear* and precision of the surfaces and chamfers. The blade must always well seat on the top.
3. Inspect the blade support weld seams for crack or missing pieces.
4. Inspect the support shim (according to model) for wear since the blade should remains tight on the blade support.

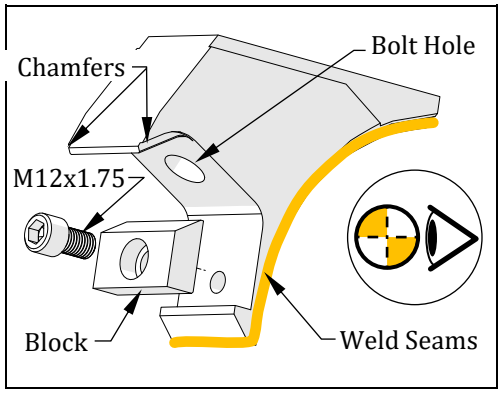


Fig. 3-2 Blade Support Inspection

5. Verify the bolt hole alignment and straightness, it could be distorted after severe impacts with rocks or unexpected "materials".
6. Inspect the blade if the remaining length is acceptable since a short blade will let more debris and mulches wear the blade support itself.
7. Inspect the rings for worn parts, cracks, and quality of the weld seams. Do not wait the ring to be loose. If needed, grind the worn weldment along the ring to make a new one.

Do not wait for the rings to come off. If necessary, grind the worn part along the fin to weld a new one. Call your technical support to order a new one.

Do not let the rotor turn with blades that are broken, cracked or out-of-limit, severe damages may occur anytime.

3.5.2 Blade Lifetime

The blades lifetime is currently depending on the three following factors:

- The material that blade is made of, so, a more hardened/tempered unit should last longer when used in the same conditions as the other similar blade;
- The wood species where the mulcher is used;
- The composition of the soil where the CTL is working on. That can be normal earth ground, sand and earth type ground, gravel type ground, soil containing rocks & stones;
- The mulching methods/working conditions currently used by the operator i.e. that can be more aggressive than another. Experienced technician who well knows the principles of operation of the mulcher hydraulic motor expect the motor to shift in high torque while working on tough material but "don't push the machine until it stalls". In the same way, he will sharpen the rotor blades regularly not waiting they'll become completely blunt so demanding more energy from their equipment and more time to finish a project.

3.5.3 Blade Selection

According to the expected work to be done, the selection of the right type blade with the required properties must be done. We recommend the use of the genuine parts SHEAREX to make sure it will not affect the rotor balance and good operation.

3.5.4 Sharpening

3.5.4.1 Parts List

To perform blade sharpening easier, we included some tools in the MRK as the items described below:

Qty	Description	PN
1x	Sharpening Tool (gaz, electric, …)	N/D
1x	Cubitron Carbide Paper New parts to be purchased by the user	SA03-00003
1x	Sharpening Gauge	SFG0000-1000

3.5.4.2 Instructions

1. Block the rotor to avoid rotation during blade sharpening, if needed. Use the electric sharpener provided with the *Maintenance Kit* and the carbide paper recommended which is made specifically for that purpose.

2. Start sharpening the flat surface of the blade, allow few seconds/blade. Sharpen the blade with the flat of the grinding disc or Cubitron® paper. This will ease to keep the shape and cutting angle of the blade.

3. Using the sharpening gauge, take some readings to check the angle and the shape of the blade tip/edge. When the blade becomes too short, the gauge will no longer be usable, as well as the blade.

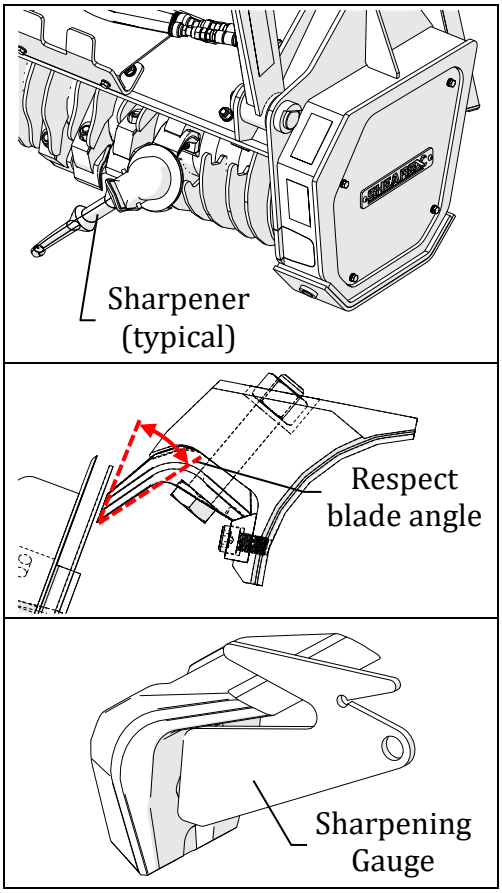


Fig. 3-3 Sharpening the Flat Surface

Do not over-sharpen the blade, or stand tool too much time on the surface, it would overheat and change the hardness and mechanical properties of the blade.

3.5.5 Blade Replacement

3.5.5.1 Parts List

Prior to replace the used parts by a new one, refer to the items listed below. Replace the bolts, nuts, and washers with new ones every time the blades are changed.

Qty	Description	PN
21x	Blade New parts to be purchased by the user	SFL01-10
21x	Bolt, M20	SA11-00058
21x	Nut, M20	SA12-00018
21x	Lock Washer, NL-M20	SA13-00006

Replace the blades in pair, 180° apart, to keep the rotor balanced

3.5.5.2 Screws and Nuts

The screws and nuts used for blade mounting on the blade supports ARE NOT typical material that you can find in any common hardware store nearby. They are made of hardened/tempered steel properly designed for your mulcher purposes.

Therefore, it is recommended to replace these components by the genuine parts.

3.5.5.3 Lock Washers ("Nord Lock")

Nord-Lock[6] lock washers are currently used to make sure the nuts will not be loosening during operation.

They have cams on one side with a greater rise than the pitch of the bolt. They have radial teeth on the opposite side. The washers are installed in pairs, cam face to cam face.
When the bolt and/or nut is tightened, the teeth grip and seat the mating surfaces while the movement remains only across the face of the cams.

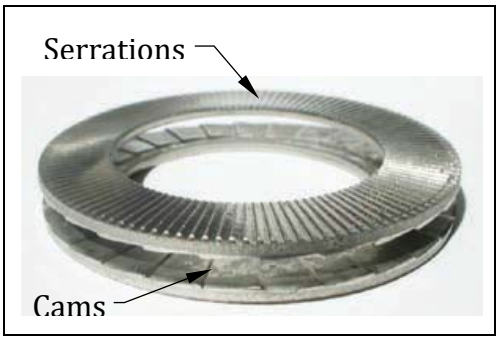


Fig. 3-4 Lock Washer Design

[6] Nord-Lock® is a pair of washers with a wedge-locking action meeting DIN 25 201

3.5.5.4 Instructions

1. Block the rotor to avoid rotation during blade removal.
2. Install the blade nut socket provided with the MRK on the blade nut.
3. Using an extension bar to ease the work, loosen the M20 nut of the blade and remove the M20 nut, the NL-M20 lock washer, the bolt and the used-up blade.
4. Install a new set of blades, bolts, lock washers and nut to the blade support.
5. Install the socket on the blade nut.
6. Install a 200-500 lbs-ft torque meter (with 3/4" drive) on the socket.
7. Using an extended bar or an impact wrench to ease the work, tighten the nut as specified.

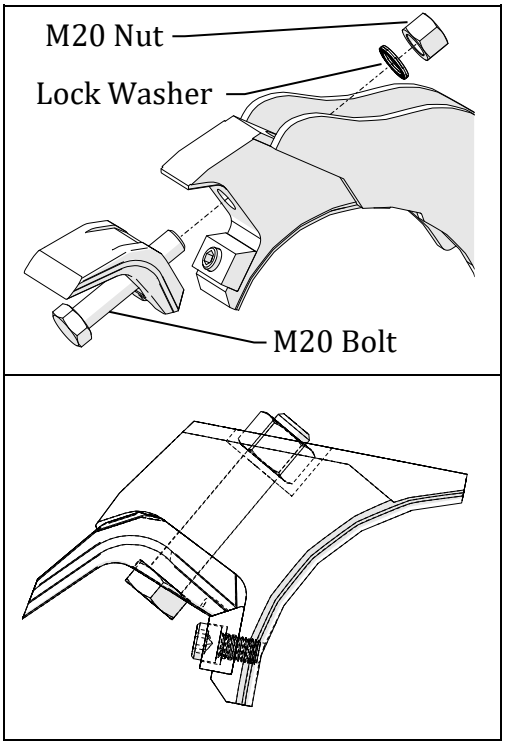


Fig. 3-5 Blade Installation

Blade nut torque	**709 N-m/ 523 ft-lb**

A. When screws are re-used, make sure you install them with the same nut and in the same orientation.

B. Pay attention to replace lock washers in the right position.

3.6 Drive System Inspection

3.6.1 Inspection

3.6.1.1 Motor Compartment

Mulched material can always enter in the transmission system during operation.

Prior to turn on the mulcher, make sure there is no material in the motor enclosure or obstructing the pulleys and belt rotation.

1. Remove the HM10 x 1.5- screws, the NL-M10 lock washers, and FW-M10 flat washers from the motor compartment panel and panel from the frame.
2. Thoroughly clean the motor compartment and ensure that no oil leak occurred during operation. If leak is found, it may come from adapter, O-ring or seal that must be replaced.
3. Reinstall the motor compartment panel.

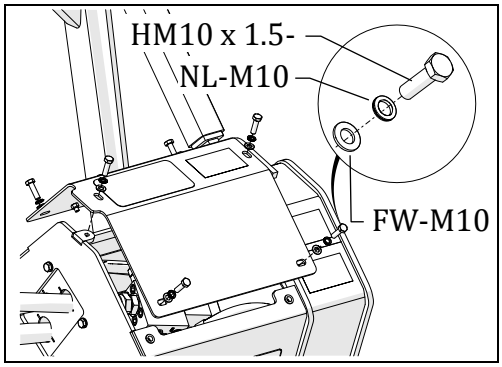


Fig. 3-6 Motor Compartment Panel Removal

3.6.1.2 Drive Belt Compartment

1. Remove the HM10 x 1.5- screws, the NL-M10 lock washers and flat washers from the panel and remove the panel from the frame.
2. Clean the drive compartment from mulch, dirt and ensure there is no oil leak or grease leak behind the pulleys.
3. Ensure the taper lock (TL) bushings are tightened, and the pulleys are well aligned, and they all remain in good condition.
4. Inspect the drive belt for rubbing, tearing and obvious damages. If needed, fix the root cause, and make necessary adjustments.

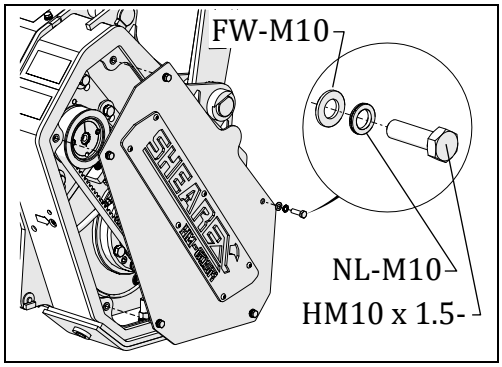


Fig. 3-7 Drive Box Panel Removal

5. Measure the play in the drive belt (1/2"≤ play ≤ 3/4" (see belt tightening…..).
6. Manually turn the rotor to make sure the belt is free.
7. Install the drive belt compartment panel and the motor compartment panel.

Since the belt is made from very robust material, some wear (10% - 20%) on the sides remains acceptable.

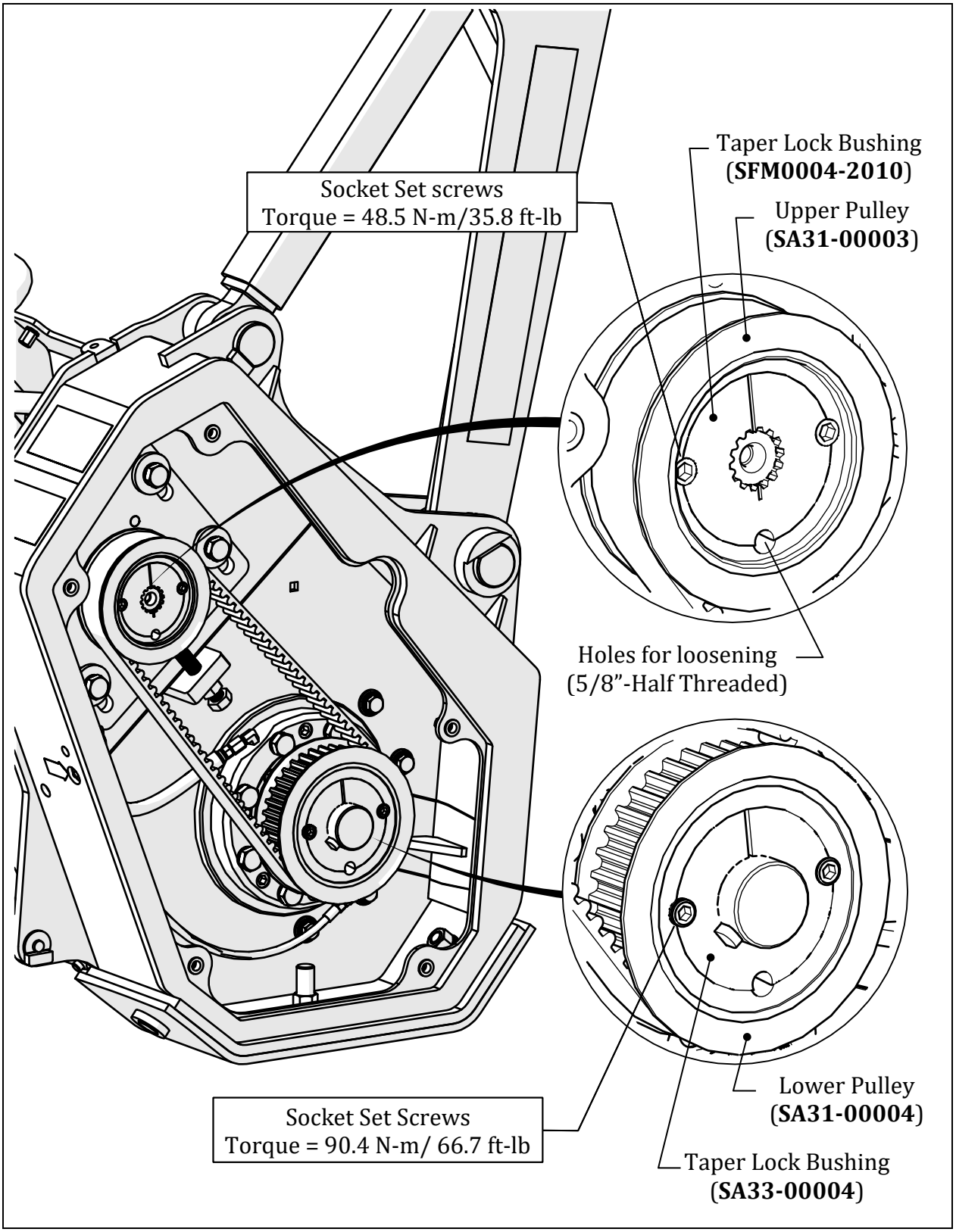


Fig. 3-8 Drive Compartment/Pulleys Description

3.6.2 Pulleys Inspection

3.6.2.1 Motor Pulley Adjustment

To remove or readjust motor pulley, the TL bushing must be loosened using the same socket head screw made for tightening purpose:

1. Take off the drive belt compartment panel.
2. Take off the (2x) 5/8" socket set screws (i.e. CPS-10 x 11) from the motor taper lock (TL) bushing half-threaded holes.
3. Insert one socket set screw in the empty hole of the TL bushing and tighten the screw. Since the screw is used as a "puller", this will separate the bushing from the pulley. If not, knock around the solid flange of the pulley with a punch.
4. Slide the TL bushing/ pulley ass'y in its proper position or out of the shaft, if needed.
5. Perform the inspection of the parts.

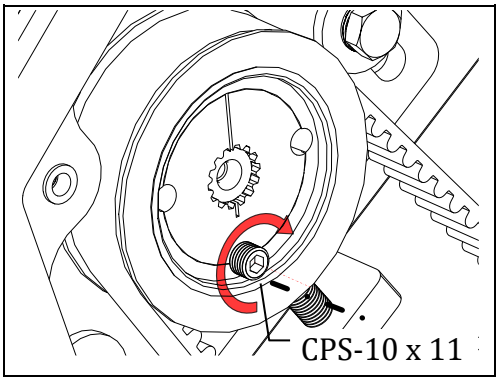


Fig. 3-9 Motor TL Bushing/Pulley Loosening

Pay attention to the motor shaft seal. Trace of oil leak is the sign that overpressure occurred in the case drain of the motor leading the shaft seal to leak.

Don't over-torque the set screws to free the bushing. If necessary, use a small wedge in the slot of the bushing or hit the pulley center with punch.

6. Slide the TL bushing with the motor pulley on the splined shaft.
7. "LIGHTLY" lubricate and install the screws into the half-threaded holes (on pulley).
8. Slightly tighten the socket set screws of the TL bushing while gently hit the bushing with a punch to make sure that the parts are not seized with each other.
9. Make sure the motor pulley is aligned with the rotor pulley. If not, release the TL bushing and slide it inwards or outward accordingly.
10. Tighten the 2 x 5/8" socket set screws.

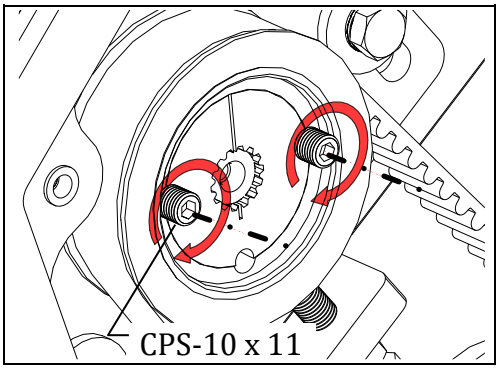


Fig. 3-10 Motor TL Bushing/Pulley Tightening

TL Bushing Screw Torque	**48.5 N-m/35.8 ft-lb**

11. Close/install the access panel.

3.6.2.2 Rotor Pulley Adjustment

To remove or readjust the rotor pulley, the TL bushing must be loosened using the same socket head screw made for tightening purpose:

1. Take off the drive belt compartment panel.
2. Take off the (2x) 5/8" socket set screws (i.e. SS-10 x 11) from taper lock (TL) bushing.
3. Insert one socket set screw in the empty hole of the taper lock bushing and tighten the screw. Since the screw is used as a "puller", this will separate the bushing from the pulley.
4. Slide the taper lock bushing with the pulley gently in its proper position or out of the shaft, if needed.
5. Perform the inspection of the parts.

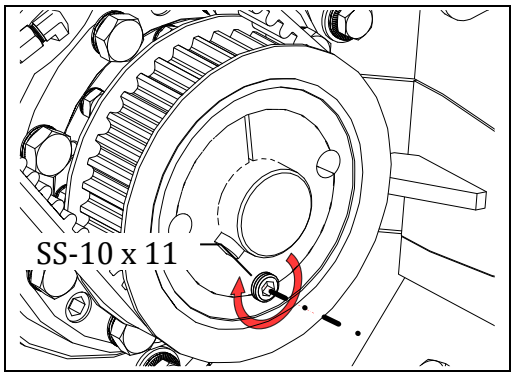


Fig. 3-11 Rotor TL Bushing/Pulley Loosening

Pay attention to the rotor RH arbor. Trace of grease leak around the rotor bearing housing is the sign that the rotor arbor seal is defective. If so, further investigation should be performed to make sure the shaft seal and the bearing are in good condition.

Don't over-torque the set screw to free the bushing from the pulley. If necessary, use a small wedge in the slot of the bushing or hit the pulley center with a punch.

6. Slide the taper lock bushing with the rotor pulley on the keyed shaft.
7. Make sure shaft key is in proper location.
8. "LIGHTLY" lubricate and install the screws into the half-threaded holes (on pulley).
9. Slightly tighten the 2 socket set screws of the TL bushing while gently hit the TL bushing with a punch to make sure that the parts are not seized with each other.
10. Make sure the rotor pulley is aligned with the motor pulley. If not, release the TL bushing and slide it inwards or outward accordingly.
11. Tighten the 2 socket set screws.

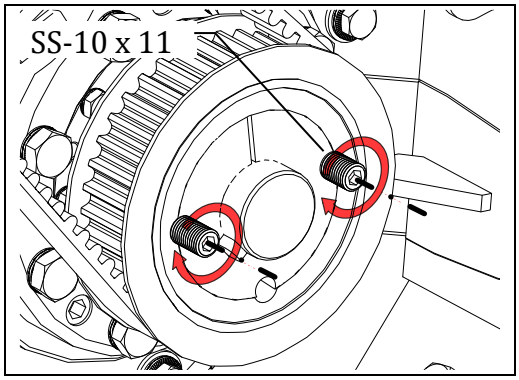


Fig. 3-12 Rotor TL Bushing/Pulley Tightening

TL Bushing Screw Torque	**90.4 N-m/ 66.7 ft-lb**

12. Install the belt compartment panel.

3.6.2.3 Belt Tension Adjustment

The belt tension is adjustable with the use of a M16 x 2- "tension" screw which push the motor plate up for tightening. A locknut prevents the screw to self loosen.

To adjust the belt, proceed as follows:

1. Slightly loosen the motor plate screws (M16 x 2 - 60x38).
2. Loosen the M16 x 2 lock nut.
3. Measure the belt play and adjust as needed letting a 1/2" to ¾" (1 cm – 2cm) play on the side since the belt must remain free to slide back-and-forth on the pulleys.
4. Adjust the belt with the tension screw M16 x 2 – 80 x 80:
   - Turn screw RH ↷ for tightening.
   - Turn screw LH↶ for loosening.

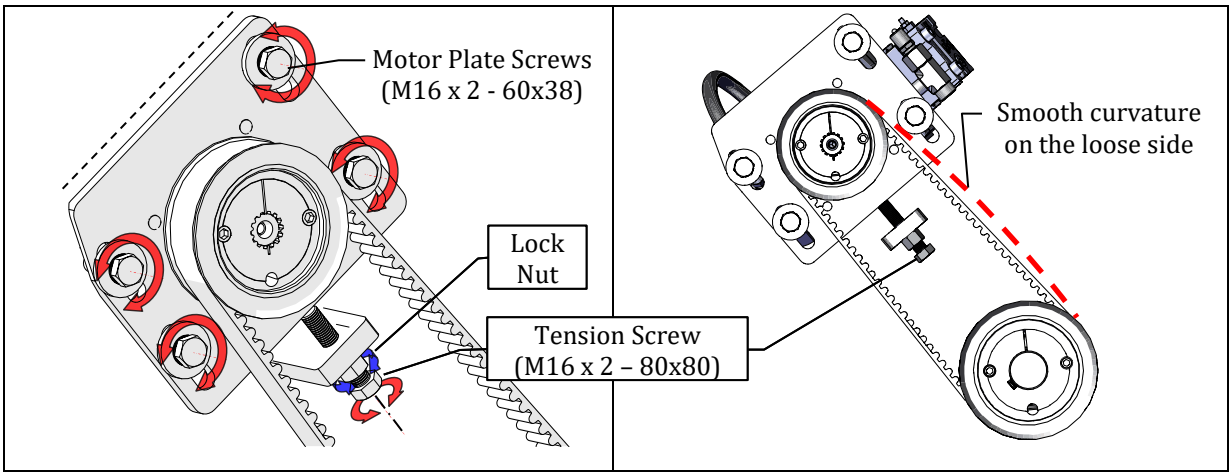


Fig. 3-13 Belt Tightening Devices

5. Firmly tighten the M16 x 2 locknut.
6. Tighten the M16 x 2 – 60x38 – tension screw.

Lock nut torque (M16)	**202 N-m/ 149 ft-lb**

7. Start the mulcher and observe if the belt is self aligning on the 2 pulleys. At rated speed (i.e. 2600 RPM), the belt should be straight on the tension side and have a smooth curvature with no vibration on the loose side.

Since the Kevlar-reinforced belt tends to shrink when warming, tightening belt too much will create radial "overload" on the motor shaft that may lead the bearing to overheat during operation.

3.7 Rotor Inspection and Maintenance

3.7.1 Bearing Lubrication

3.7.1.1 Part/Tool List Recommended

A grease (manual) gun may be conveniently used to perform the bearing lubrication through the 2 grease fittings located on the frame:

Qty	Description	PN
1x	Grease gun	N/D
1x	Grease cartridge Alimex or equiv.	SA12-00018

3.7.1.2 Grease Requirements

The bearings have already been greased in our facilities with Alimex™[7] type grease. It is made of a *Calcium Sulfonate Complex* product. Since this type of grease may not be available in all regions, make sure the lubricant you will be using instead is compatible with the one currently used for the mulcher bearings.

The rated speed of the rotor is 2600 rpm and the operating temperature of the bearing should be 45°C to 60°C (113°F to 140°F).

In order to withstands such speed and temperatures, make sure to always use an "EXTREME PRESSURE" (i.e. EP) designation grease. NLGI[8] grade 2 grease is a suitable type product for such application since it keeps its physical properties through a large range of temperature.

3.7.1.3 Grease Port Locations

Each bearing housing is mounted with a grease port (i.e. zert) and a vent.

The grease port is identified by a label apposed closeby.

The vent purpose is to release the pressure from the inside the bearing during operation and allow a grease outlet if ever too much grease was mistakenly pumped inside.

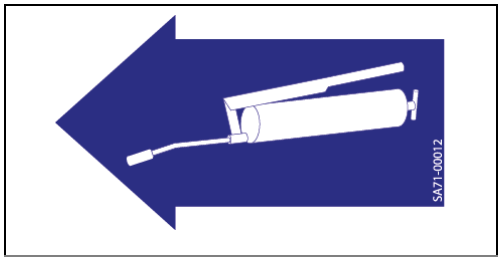


Fig. 3-14 Grease Port Location Label

[7] Alimex (by Lubri-Lab) is a food process type grease and made for high-speed/ high temp. applications.
[8] National Lubricating Grease Institute

3.7.1.4 Instructions

1. Locate the grease port behind the mulcher on the LH side of the frame.
2. Use the grease gun and apply **2-3** squirts into the grease adaptor of the LH bearing through the small flexible hose to the bearing. Grease volume injected may vary according to the grease gun.
3. Locate the grease port behind the mulcher on the RH side of the frame.
4. Apply **2-3** squirts into the grease adaptor of the LH bearing housing.
5. Turn the rotor manually to help greasing the bearing empty spaces.

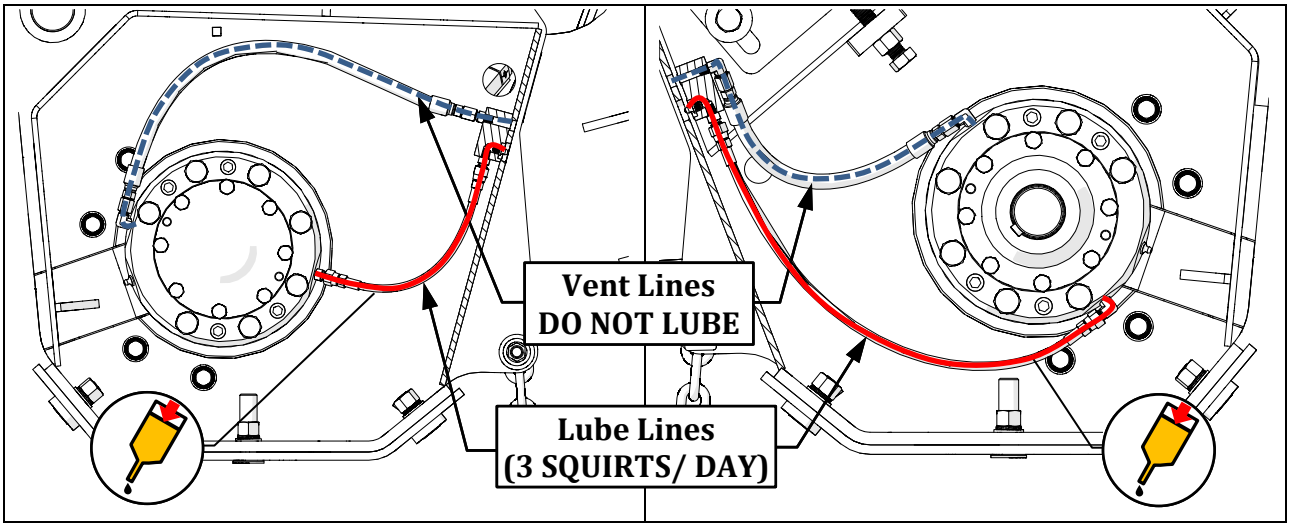


Fig. 3-15 LH/RH Bearings Lube and Vent Lines Location

Do not overfill the bearing, it may lead the bearing temperature to get higher than normal. Too much grease may damage the bearing seal and will overflow through the large flexible hose out of the vent.

From time to time, after bearing lubrication, verify the temperature of the bearing housing with an infrared thermometer (max 100°C/ 212°F) or through the Plus+ One Controller monitor.

3.7.2 Bearing Wear Evaluation

3.7.2.1 Awareness

Unusual vibrations from the rotor may come from an unbalanced rotor that lost some metal piece such as a blade tip, weldments or from a "lack" in the rotor bearings such as:

- Worn bearing that need to be changed.
- Loose bearing ass'y (RH side) that need to be tightened.

Since the maximum tolerance for radial play or side play is about 0.010", the most usual way to evaluate the bearing wear is to measure the clearance between the outer race and the top roller inside the bearing.

3.7.2.2 Tools List

Here is the tools and devices needed to measure the bearing wear:

Qty	Description	Purpose
1x	Lifting Bar	Clearance evaluation
1x	Support Block	Clearance evaluation
1x	Feeler Gauge	Clearance evaluation

3.7.2.3 Instructions

To quickly evaluate un-tightened parts on the rotor or wear on the rotor bearings, lower the mulcher to the ground and proceed as follows:

1. Insert the lifting bar under the RH side of the rotor.
2. Install a support block at balancing point and try to move the rotor up and down:
3. If a vertical play is measured but "out-of-tolerance", the rotor bearing will certainly have to be replaced.
4. If a side play is measured but "out-of-tolerance, the rotor bearing may have to be changed but some untightened parts may also be the cause.
5. Check the vertical play for the LH side of the rotor.

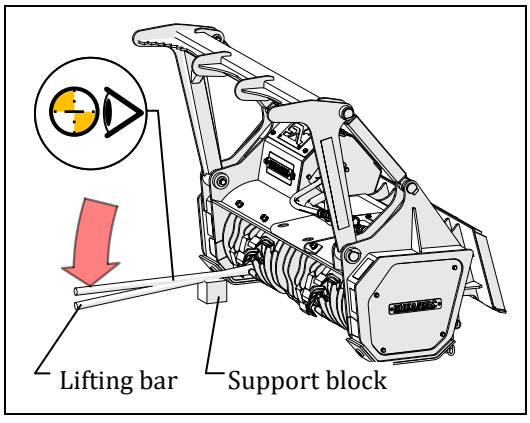


Fig. 3-16 Bearing Wear Checkup

When the bearing clearance is over the maximum tolerance, proceed further with the inspection of the rotor bearings.

3.7.3 Rotor Bearing Evaluation/ Removal

3.7.3.1 RH Bearing Housing Removal

1. Stabilize the mulcher on a support frame.
2. Remove the drive compartment door/panel.
3. Remove the lower pulley ass'y (ref. **3.6.2.2**).
4. Remove the rotor shaft key.
5. Remove the cover (PN: SFM0001-2049) with the seal (PN: SA26-00002) from the bearing housing (PN: SFM0001-2048).
6. Using a feeler gauge, take some readings of the MAX gap between the bearing outer race and the upper rollers (max tol. = 0,010"), otherwise, complete this removal procedure.
7. Remove the hoses, the adapters, electrical cable, and sensors (when equipped) from the bearing housing.
8. Unfold the locking tab of the lock washer (PN: SA13-00002).
9. Remove the lock nut (PN: SA12-00002) from the long axle.
10. Remove the lock washer.
11. Remove the bearing housing screws (PN: SA11-00007) and the 4 socket head screws (PN: SA11-00018).

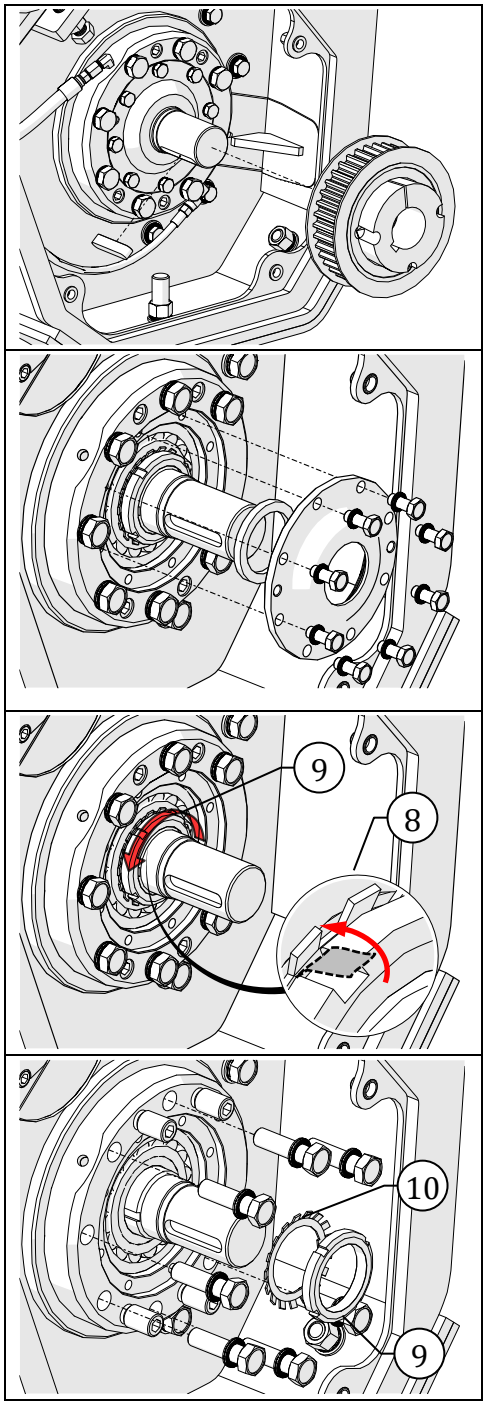


Fig. 3-17 RH Bearing Housing Removal (1/2)

12. From either side, in 3 mounting screw holes, insert/tighten 3 socket head screws (PN: SA11-00060) through the housing holes until they are slightly tight on the rotor. They will secure the rotor in place while pulling the bearing housing out.

13. Install 2 "puller screws" (PN: SA11-00011) in the housing cross side holes from where the short socket head screws were removed.

14. Tighten 2 puller screws evenly to make the bearing housing come out of the mounting flange ring.

15. Pull the RH housing out of the frame.

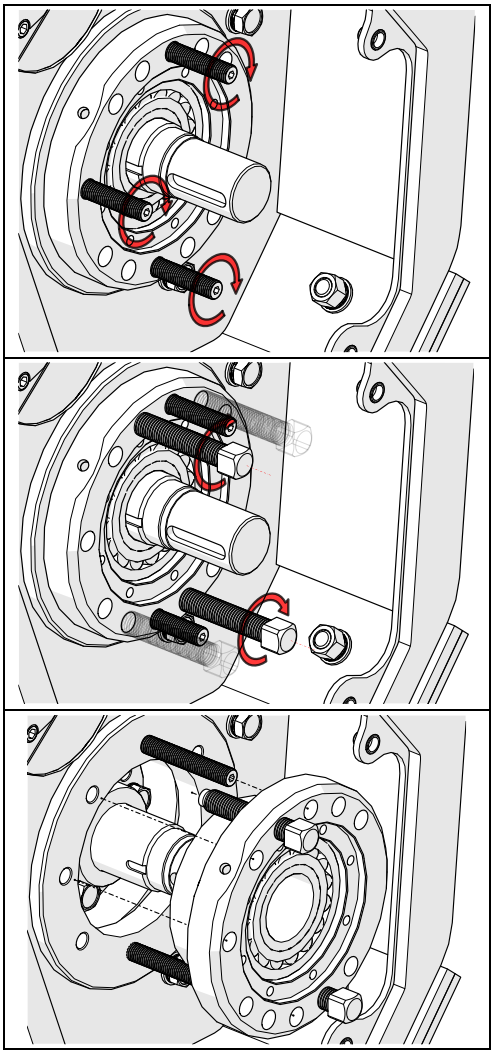


Fig. 3-18 RH Bearing Housing Removal (2/2)

16. Put the bearing housing ass'y on a worktable.

In order to carefully extract the bearing housing, tighten puller screws evenly, one after the other; it will prevent damage to the rotor shaft.

17. Using a puller for a safe and smooth extraction, disassemble the bearing ass'y and inspect the bearing housing inner bore, roller bearing and shaft seal for damage, overheating, and seal defect.

3.7.3.2 RH Bearing Housing Installation

To install the rotor RH bearing housing back in place, proceed as follows:

1. Clean the RH (long) rotor shaft where the bearing inner race will be mounted.
2. Spread some lubricant (i.e. grease) on the RH shaft surface and on the inner surface of the bearing housing flange.
3. Temporarily install the mounting cover (PN: SFG0001-2009) on the bearing housing to protect the bearings and keep them in place during housing installation.
4. Slide the bearing housing (PN: SFM0001-2048) along the 2 head socket screws that hold the rotor in position on the frame.
5. Install temporarily the 4 longest mounting screws (PN: SA11-00012) , tighten them and remove.
6. Install temporarily the 4 medium mounting screws (PN: SA11-00008), tighten them and remove.
7. Install the housing screws (PN: SA11-00007) with the lock washers and tighten until a 1/8″ gap remains between the housing and the frame.
8. Remove the 3 socket screws (PN: SA11-00060) previously used for support and alignment.
9. Remove the mounting cover (PN: SFG0001-2009) from the bearing housing.
10. Install the remaining housing screws and tighten (**T= 289 N-m/ 213 ft-lb**).

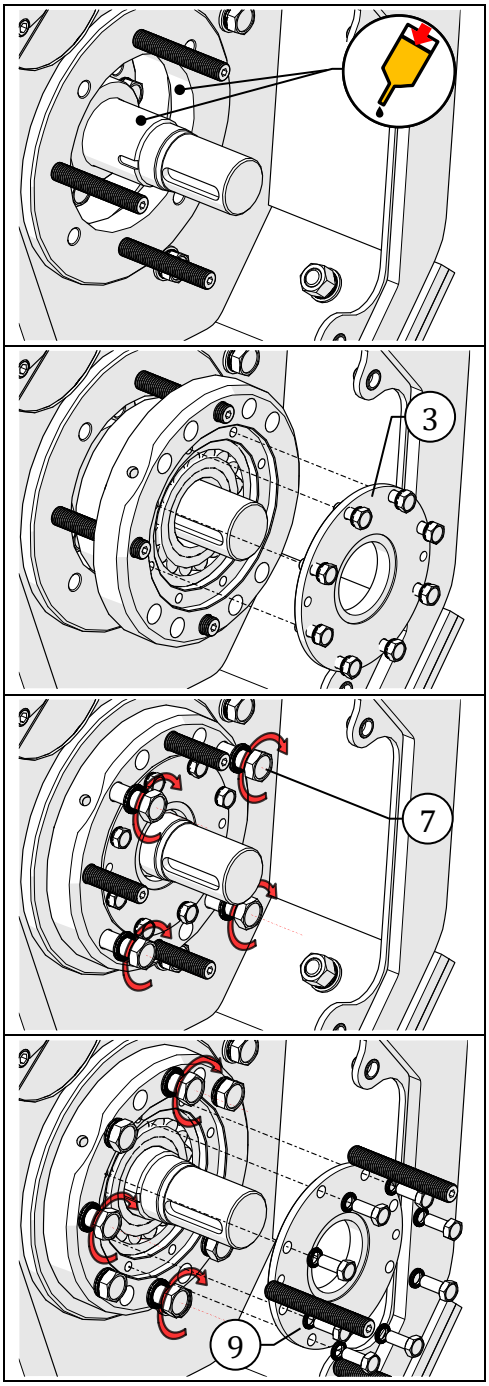


Fig. 3-19 RH Bearing Housing Installation (1/2)

11. Check that the bearing is well seated by gently knock on using the mounting socket (PN: SFG0001-4002).
12. Install the lock washer (PN: SA13-00002) and the lock nut (PN:SA12-00002) in place until it seats firmly against the bearing.
13. Turn the lock nut with the tool provided (PN: SFG0001-4001) just to align the next lock washer tab with the nut notch.
14. Fold down the lock washer tab into one notch of the lock nut.
15. Install the lubrication and vent hoses fitting to the corresponding housing inlet fittings.
16. Start greasing the bearing housing using the greasing point until you see grease coming between the bearing rollers and the bearing race.
17. Thoroughly clean the bearing housing cover from potential impurities.
18. Install the housing cover (PN: SFM0001-2049) with the sealing gasket (PN: SA26-00002).
19. Torque housing cover screws firmly (**T= 67 N-m/ 49 ft-lb**).
20. Complete greasing of the bearing housing with 1/3 of a grease tube.
21. Manually turn the rotor to make sure it rolls easily.

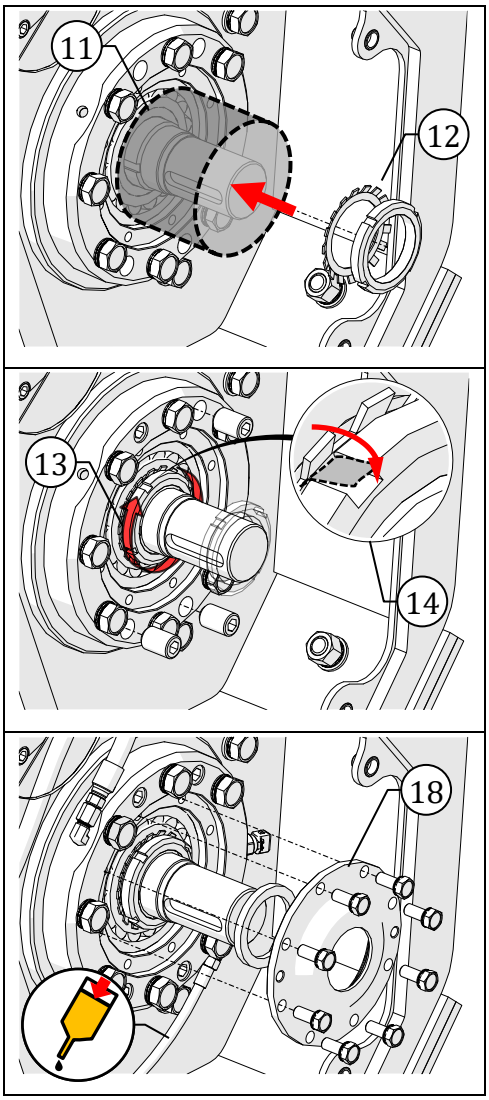


Fig. 3-20 RH Bearing Housing Installation (2/2)

Lube-grease frequency/ rotor bearing	Grease QTY required
Daily lubrication	2-3 squirts a day
New bearing	1/4 of a grease tube (200 gr)

22. Install the shaft key on the rotor end.
23. Install the rotor pulley (ref.: **3.6.2.2**) and the belt.

3.7.3.3 LH Bearing Housing Removal

To access the rotor bearings for inspection/replacement or to remove the rotor from the frame, proceed as follows:

1. Stabilize the mulcher on wooden beams or other supports, to prevent the rotor from falling after the bearing housing is removed.
2. Remove the LH bearing compartment door/panel.
3. Remove the cover (PN: SFM0001-2050) from the bearing housing (PN: SFM0001-2048).
4. Using a feeler gauge, take some readings of the MAX gap between the bearing outer race and the rollers to make sure the bearing is in the specs, otherwise, complete this procedure.
5. Remove the lube hose/fittings and vent hose/fittings.
6. Remove the bearing housing screws (PN: SA11-00007).
7. Remove the 4 short socket head screws (PN: SA11-00018).
8. From either side, in 3 mounting screw holes, insert/tighten 3 retaining/alignment screws (PN: SA11-00060) through the housing holes until they are slightly tight on the rotor. They will secure the rotor in place while pulling the bearing housing out.
9. Insert 2 "puller screws" (PN: SA11-00011) in 2 housing cross side holes from where the short socket head screws were removed.
10. Tighten the 2 puller screws evenly to make the bearing housing come out of the mounting flange ring.

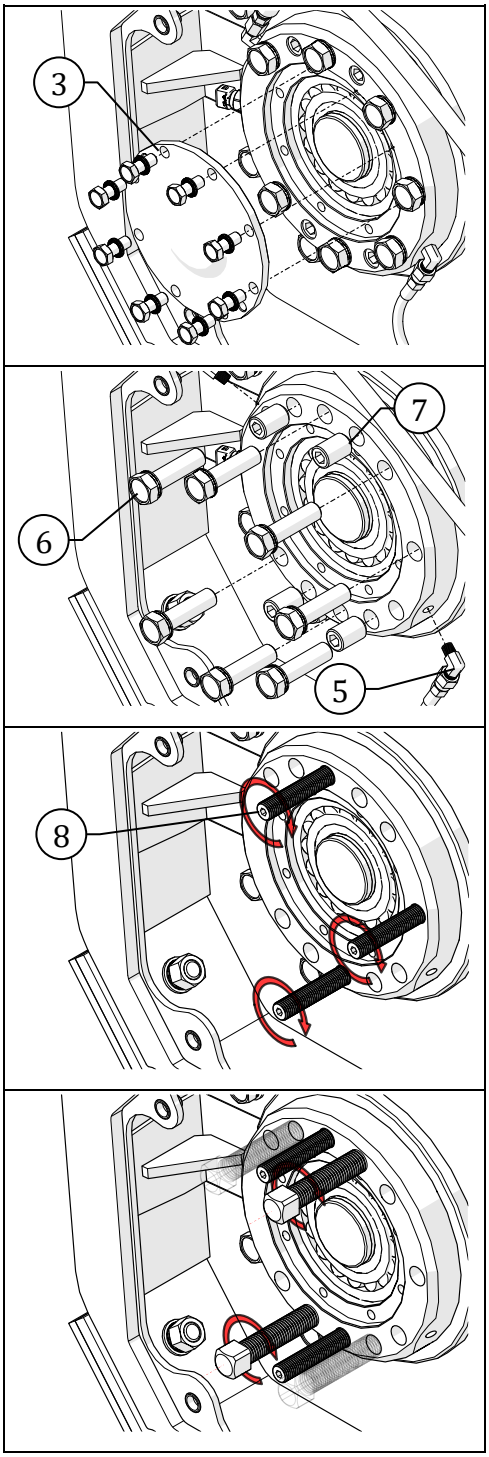


Fig. 3-21 LH Bearing Housing Removal

11. Remove the housing (PN: SFM0001-2048).

In order to carefully extract the bearing housing, tighten each puller screw evenly, one after the other; it will prevent damage to the rotor shaft.

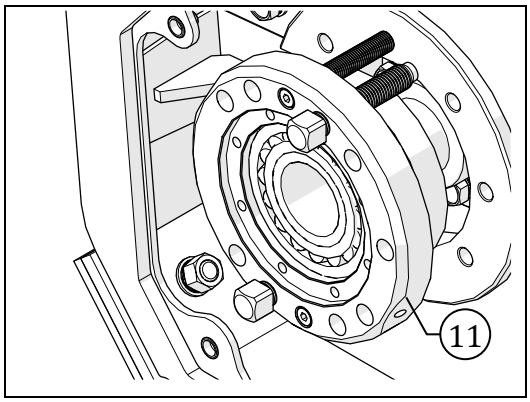


Fig. 3-22 LH Bearing Housing Removal (2/2)

12. Put the bearing housing ass'y on a worktable.

13. Using a puller for a safe and smooth extraction, disassemble the bearing ass'y and inspect the bearing housing inner bore, roller bearing and shaft seal for damage, overheating, and seal defect.

3.7.3.4 LH Bearing Housing Installation

To replace a rotor bearing housing back in place, proceed as follows:

1. Thoroughly clean the shaft corresponding to the bearing housing to be mounted.
2. Apply grease compound or appropriate grease on the shaft and on the inner surface of the bearing housing enclosure.
3. Temporarily install the mounting cover (PN: SFG0001-2009) on the bearing housing to protect the bearings and keep them in place during housing installation.
4. Slide the bearing housing (PN: SFM0001-2048) in its location along the 3 head socket screws (PN: SA11-00060) that hold the rotor in position on the frame.
5. Install temporarily the 4 longest mounting screws (PN: SA11-00012) , tighten them and remove.
6. Install temporarily the 4 medium mounting screws (PN: SA11-00008), tighten them and remove.
7. Install the housing screws (PN: SA11-00007) with the lock washers and tighten until a 1/8″ gap remains between the housing and the frame.
8. Remove the 3 retaining/alignment (PN: SA11-00060) previously used for support and alignment.
9. Remove the mounting cover (PN: SFG0001-2009) from the bearing housing.
10. Install the remaining housing screws and tighten (**T= 289 N-m/ 213 ft-lb**).

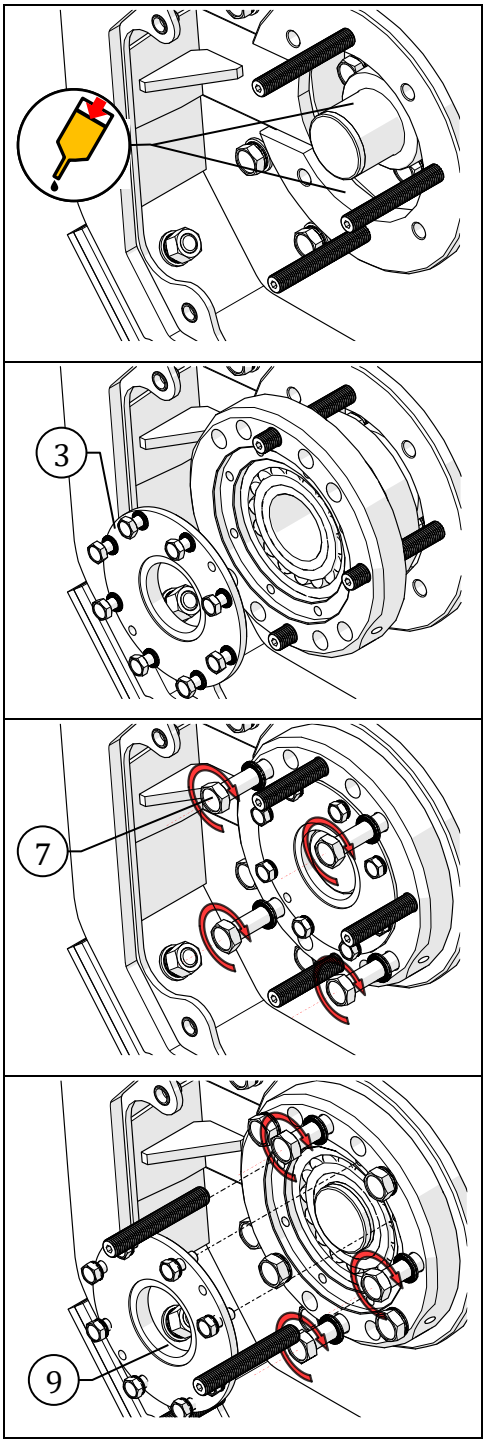


Fig. 3-23 RH Bearing Housing Installation (1/2)

11. Check that the bearing is well seated by gently knock on using the mounting socket (PN: SFG0001-4002) or properly sized tube.
12. Reinstall the lube hose/fittings and vent hose/fittings.
13. Start greasing the bearing housing using the appropriate grease fitting until you see grease coming between the bearing rollers and the bearing race.
14. Thoroughly clean the bearing housing cover from grease and potential impurities.
15. Install the housing cover (PN: SFM0001-2050).
16. Torque housing cover screws firmly (**T= 67 N-m/ 49 ft-lb**).
17. Complete greasing of the bearing housing with 1/3 of a grease tube.
18. Manually rotate the rotor to make sure it rolls easily.

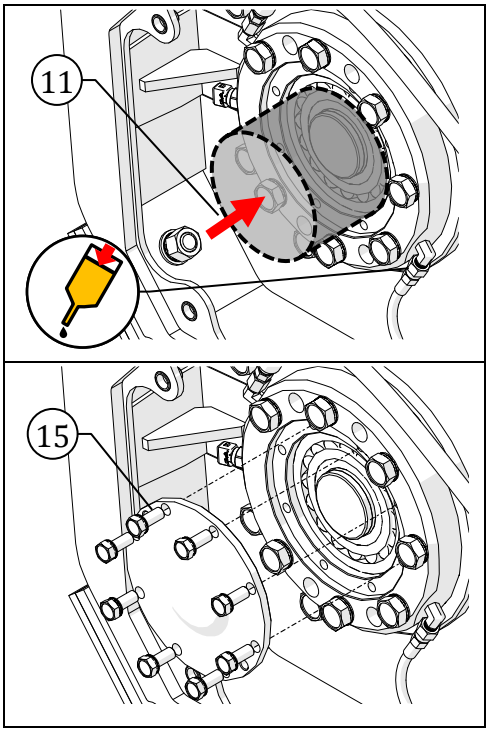


Fig. 3-24 RH Bearing Housing Installation (2/2)

Lube-grease frequency/ rotor bearing	Grease QTY required
Daily lubrication	2-3 squirts a day
New bearing	1/4 of a grease tube (200 gr)

3.7.3.5 Bearing Removal from Housing

To remove the bearing and shaft seal from a rotor bearing housing, proceed as follows:

1. Put rotor bearing housing face down on a worktable or other clean and flat surface.
2. Push the bearing downwards.
3. Take off the rotor shaft seal (PN: SA26-00001) from the bearing housing.

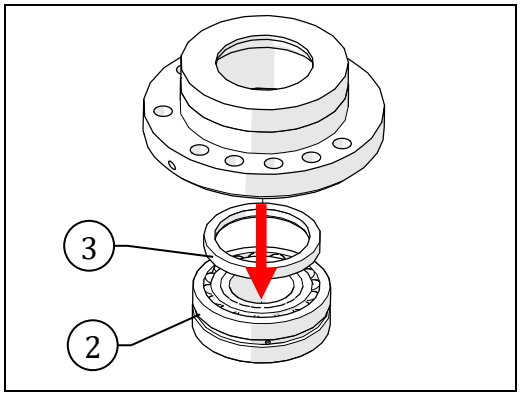


Fig. 3-25 Rotor Bearing Extraction

Use a flat screwdriver, taking care not to damage the seal enclosure in the bearing housing.

3.7.3.6 Bearing Installation (in Housing)

To easily assemble the bearing housing with all related components, use a manual press, as follows:

1. Thoroughly clean the bearing housing from grease and dirt.
2. Check that there is no sign of wear inside the bearing housing at the bearing level and replace the shaft seal if needed (PN: SA26-00001) with new one.
3. Using the appropriate jig, insert the shaft seal (PN: SA26-00001) inside the bearing housing (PN: SFM0001-2048).
4. Using the mounting cover provided with the MRK (PN : SFG0001-2009), insert the bearing (PN:SA34-00001) inside the bearing housing.

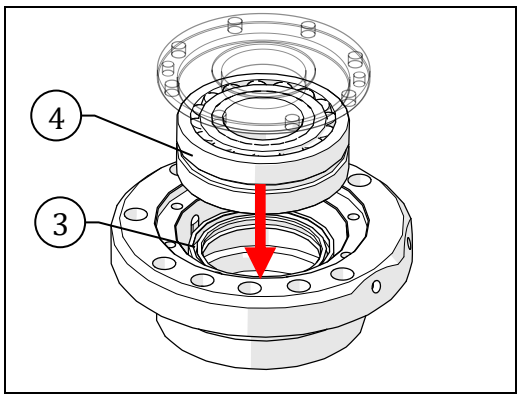


Fig. 3-26 Rotor Bearing Installation

3.8 Anvil Maintenance

3.8.1 Inspection

1. Thoroughly clean the anvils and surrounding components to clearly see the parts.
2. Inspect the anvils for wear and damages.
3. Replace anvil if any major damage or excessive wear.

Damaged and torn out parts can seriously damage the frame or it could come into contact with the blades, and be projected to a considerable distance.

3.8.2 Replacement

3.8.2.1 Parts List

Prior to replace the used parts by a new one, refer to the items listed below. Replace the bolts, nuts, and washers with new ones every time an anvil part is changed.

Qty	Description	PN
1x	Anvil	SFM0004-2002
5x	Bolt, M12 x 50	SA11-00047
5x	Flat Washer M12	SA13-00008
5x	Lock Nut, M12	SA12-00008

3.8.2.2 Instructions (replacing 1 unit)

1. Remove the M12 lock nuts and the M12 flat washers from the back side of the mulcher wear plate.
2. Remove M12 x 50 bolts from the anvil.
3. Remove the damaged anvil and dispose of it properly.
4. Install a new anvil with bolts, washers and lock nut as needed.
5. Tighten anvil nut (**T = 116 N-m/ 86 ft-lb**).

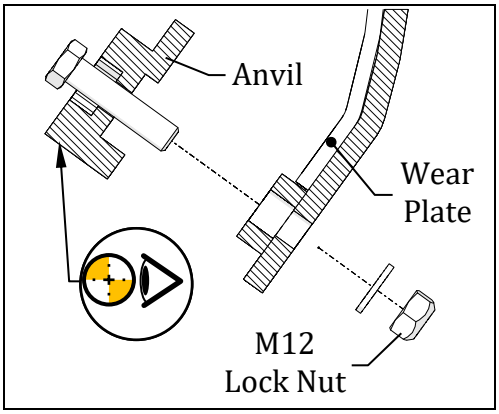


Fig. 3-27 Anvil Replacement

3.9 Wear Plate Maintenance

3.9.1 Inspection

Wear plate is installed into the frame where the rotor is housed. This replaceable part is used to protect the frame from abrasion and rotating debris from the rotor.

1. Visually inspect the liner and frame. Pay special attention to the critical wear areas.
2. Replace wear plate when steel wall has lost its protective properties (e.g. thickness reduction, frequent holes through the wall, lost of structural properties).

3.9.2 Replacement

3.9.2.1 Parts List

Prior to replace the used parts by a new one, refer to the items listed below. Replace the bolts, nuts, and washers with new ones every time the wear plate is changed.

Qty	Description	PN
1	Wear Plate	SFM0004-4011
5	Bolt	SA11-00023
5	Washer	SA13-00010
5	Lock Washer	SA13-00005
5	Nut	SA12-00006

3.9.2.2 Instructions (replacing 1 unit)

1. Remove the bolts, washers, and nuts from the top of the wear plate.
2. Loosen the anvils to let some free space between the wear plate and anvil.
3. Slide/rotate the wear plate around the rotor to take it out of the mulcher.
4. Install a new wear plate as needed.
5. Tighten nut (**T = 289 N-m/ 213 ft-lb**).

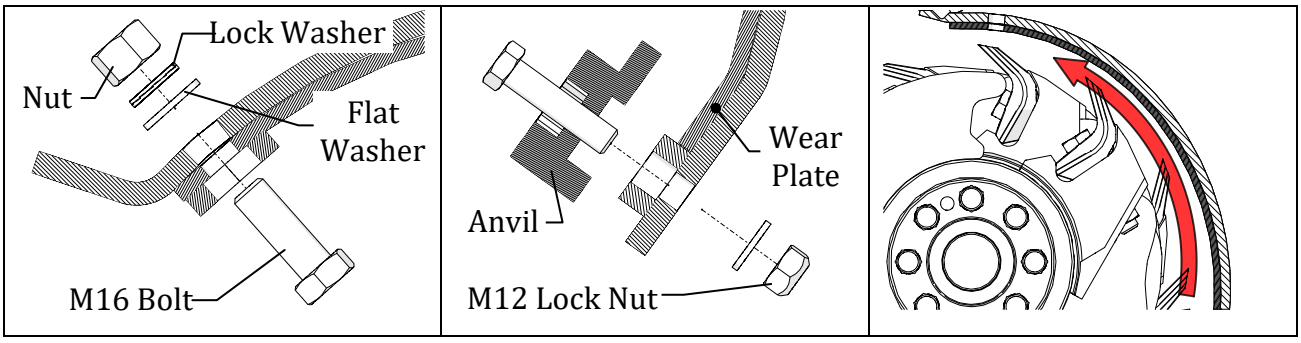


Fig. 3-28 Wear Plate Removal (3 steps)

4 Parts Lists

4.1 Frame

No	Description		QTY	PN
1	Push-bar		1	SFM0004-4003
2	Upper Push Bar Pin		2	SFM0003-2008
3	Lower Push Bar Pin on the Frame		2	SFM0003-2012
4	Upper Push Bar Pin on the Frame		2	SFM0003-2008
5	Absorber Sleeve (Hendrickson)		2	SA37-00001
-	Hex. Bolt M16x2-35x5, Gr 10.9 (289 N-m/ 213 ft-lb)		6	SA11-00043
-	Lock Washer, Nord-Lock-M16-Zinc		6	SA13-00005
-	Flat Washer OD 2" x ID 11/16"		6	SFM0001-1062
6	Push Bar Arm Square Tubing		2	SFM0001-4010
7	RH Door Ass'y	*When tightening bolts/screws, air gun use is not recommended*[9]	1	SFM0004-1034
8	LH Door Ass'y		1	SFM0004-1027
9	Motor Housing Cover		1	SFM0004-3014
10	Access Plate		1	SFM0003-1049
-	Bolt M10X1.5-35X35-10.9Z (67 N-m/ 49 ft-lb)		19	SA11-00046
-	Bolt M10X1.5-35X35-10.9Z (61 N-m/ 45 ft-lb)		_	SA11-00046
-	Lock Washer, Nord-Lock-M10-Zinc		19	SA13-00003
-	Flat Washer M10, Zinc		19	SA13-00013
11	Back Access Plate		1	SFM0004-1044
-	Screw M12-1.75 x 30-30-10.9Z (116 N-m/ 86 ft-lb)		2	SA11-00015
-	Lock Washer, M12-19.5 x 13 x 2.7(mm), Zinc		2	SA13-00009
-	Flat Washer M12-13.2 x 23.6 x 2.5(mm), Zinc		2	SA13-00008
12	Base Plate of Attachment Bracket (built-in)		1	SFM0003-3010
13	Hose Protection Plate		1	SFM0004-3019

[9] Since Hex. Rivet Nut M10-1.5 type fasteners are used, proper tightening torque is recommended.

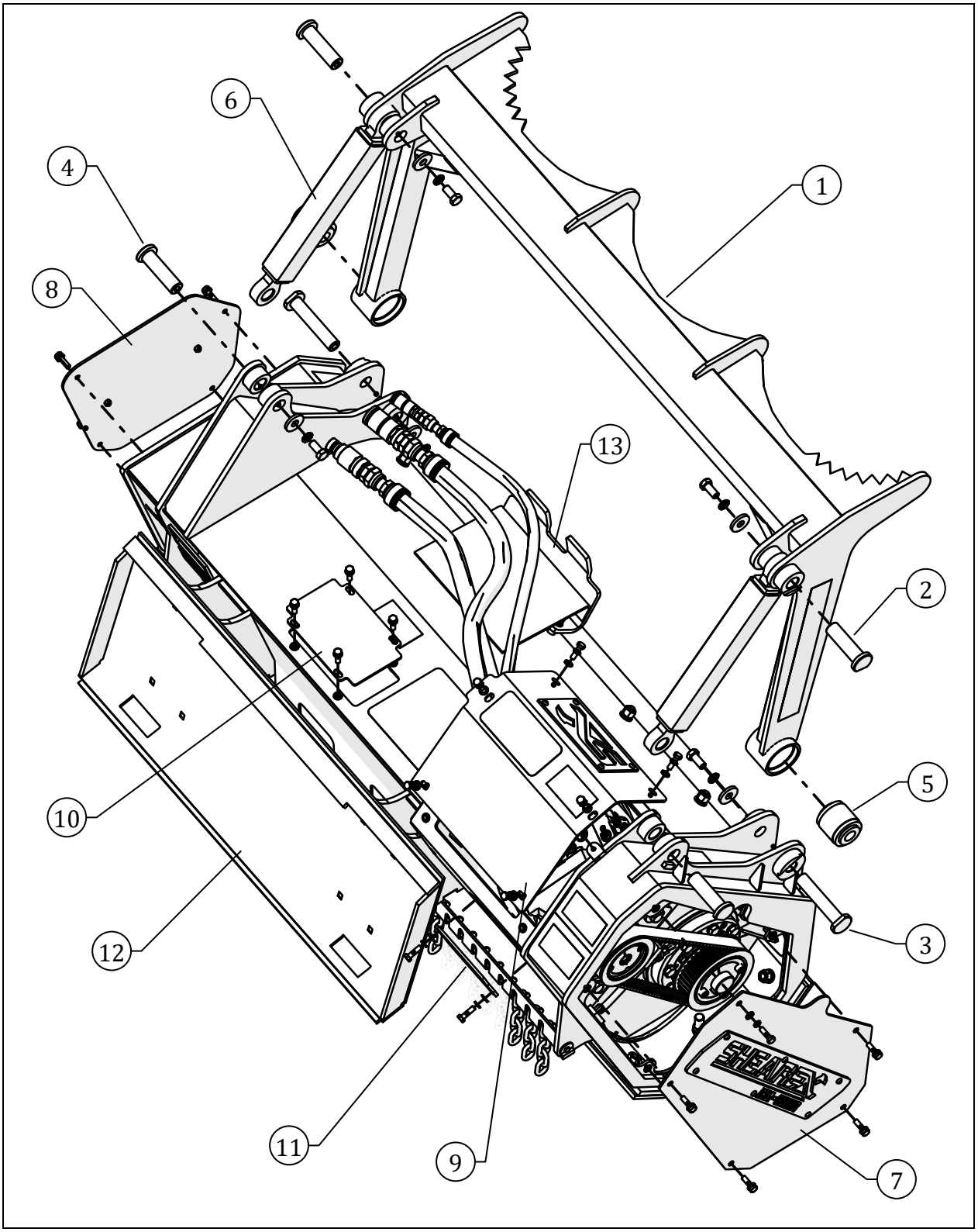


Fig. 4-1 Frame Parts List

4.2 Rotor Assembly (SFM0004-5002)

No	Description	QTY	PN
1	Rotor (Welded Core)	1	SFM0004-4002
2	Long Axle (RH)	1	SFM0001-2052
3	Screw M16-2.00 x 70-38, 10.9Z (289 N-m/ 213 ft-lb)	8	SA11-00008
4	Lock Washer -M16-Zinc	8	SA13-00005
5	Shaft Key, 0.5X0.5X2.375	1	SA38-00001
6	Short Axle (LH)	1	SFM0001-2053
7	Screw M16-2.00 x 70-38, 10.9Z (289 N-m/ 213 ft-lb)	8	SA11-00008
8	Lock Washer -M16-Zinc	8	SA13-00005
9	Blade	21	SFL01-10
10	Bolt M20X2.5-95X46-Gr.12.9 (709 N-m/ 523 ft-lb)	21	SA11-00058
11	Hex (Head) Nut- M20X2.5-Gr.12	21	SA12-00018
12	Lock Washer NL-M20	21	SA13-00006
13	Blade Support 2"	21	SFM0001-2064
14	Blade Support Wear Plate	21	SFM0001-2063
15	Screw M12X1.75-20X20-GR.12.9 (136 N-m/ 100 ft-lb)	21	SA11-00204
16	Lock-Washer, M12-7.5 x 12.4 x 2.6(mm)	21	SA13-00173
17	Rotor Short Ring	10	SFM0004-1043
18	Rotor Medium Ring	20	SFM0004-1041
19	Rotor Long Ring	10	SFM0004-1042
20	Rotor End Ring (Long Axle Side)	1	SFM0004-1040
21	Rotor End Ring (Short Axle Side)	1	SFM0004-1051

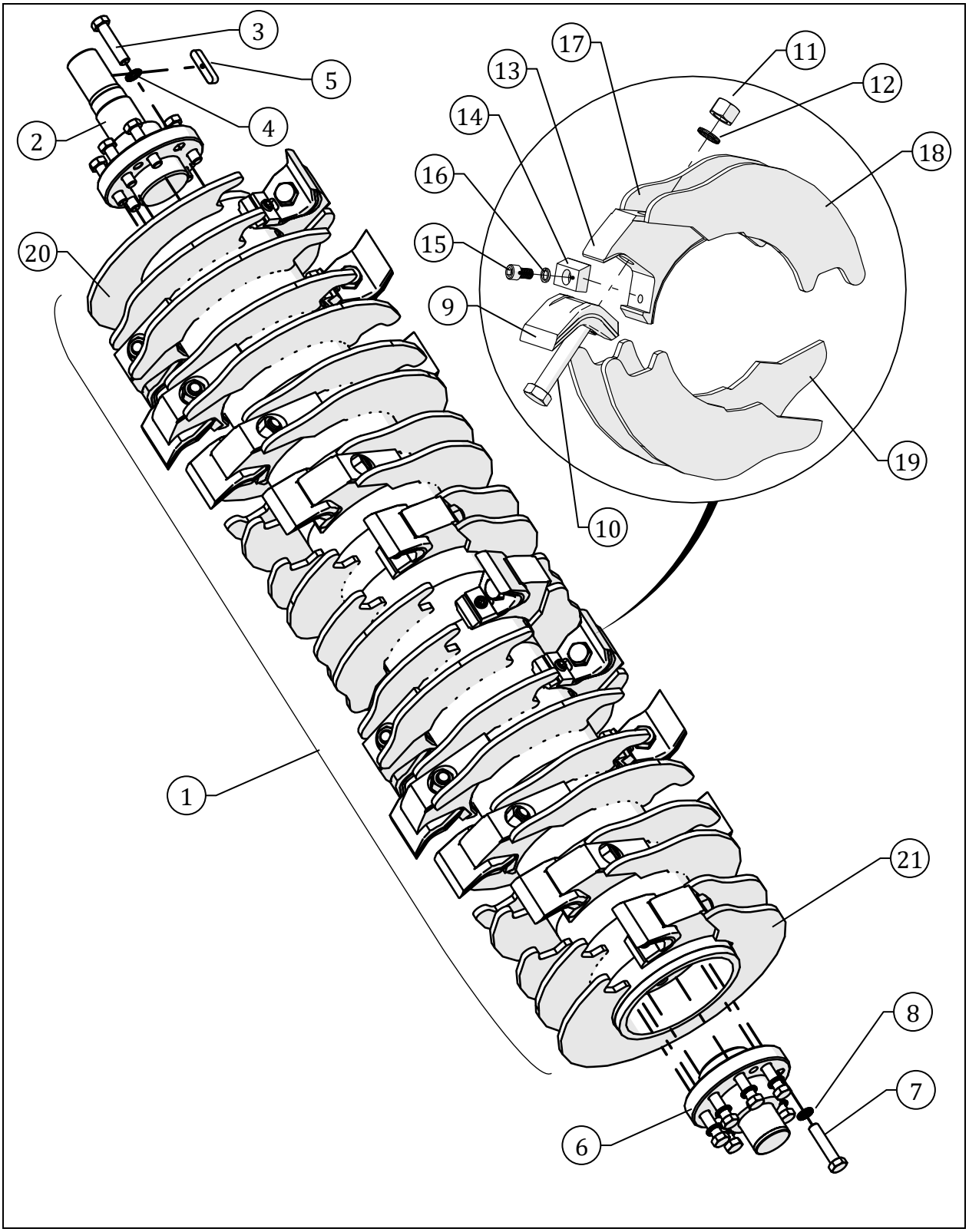


Fig. 4-2 Rotor Parts List

4.3 RH Bearing Assembly (SFM0001-5003)

No	Description	QTY	PN
1	Bearing Housing	1	SFM0001-2048
2	Screw M16X2.0-60X38-Gr.10.9 (289 N-m/ 213 ft-lb)	7	SA11-00007
3	Lock Washer, M16-Zinc	7	SA13-00005
4	Screw M20X2.5-30X30-Gr.8.8 (176 N-m/130 ft-lb)	4	SA11-00018
5	Seal 90-110-12-DLV	1	SA26-00001
6	Bearing-22312	1	SA34-00001
7	Lock Washer	1	SA13-00002
8	Lock Nut, KM12-M60X2.0	1	SA12-00002
9	Seal 55-72-7-FPM-BABSL	1	SA26-00002
10	Bearing Cover	1	SFM0001-2049
11	Screw, M10X1.5-25X25-10.9Z (67 N-m/ 49 ft-lb)	8	SA11-00002
12	Lock Washer, NL-M10	8	SA13-00003
13	Lube Hose, HB-Synflix-R7-02, JICF04	1	SFM0004-5004
14	Vent Hose, HB-2Wires- JICF04	1	SFM0004-5003
15	Straight-Adapter-NPTFM02-JICM04	1	SA23-00004
16	90°-Adapter-NPTFM02-JICM04	3	SA23-00002
17	Hydraulic-Grease-Nipple-0.125-Straight	1	SA23-00005

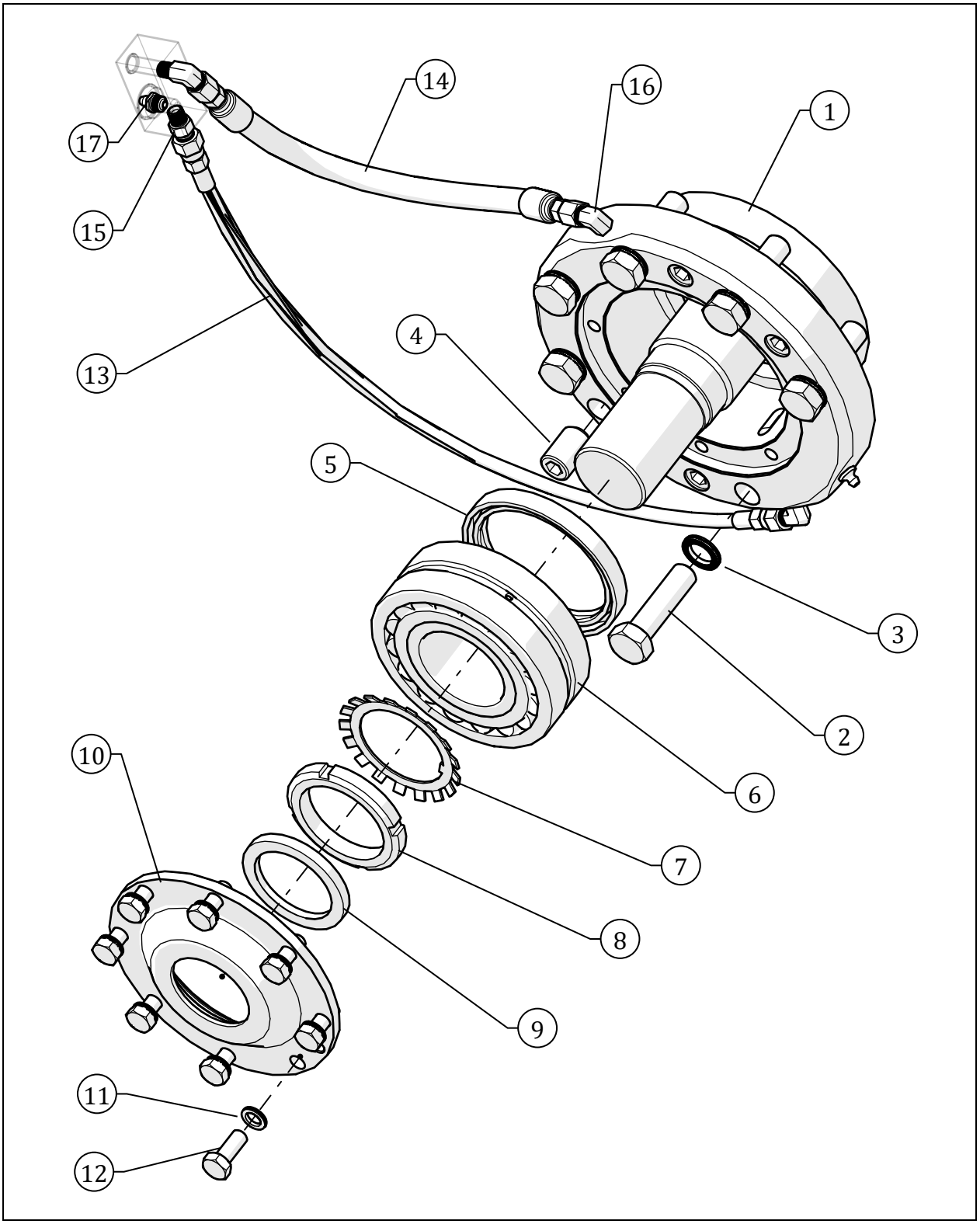


Fig. 4-3 RH Bearing Parts List

4.4 LH Bearing Assembly (SFM0001-5004)

No	Description	QTY	PN
1	Bearing Housing	1	SFM0001-2048
2	Screw, M16X2-60X38-10.9Z (289 N-m/ 213 ft-lb)	7	SA11-00007
3	Lock Washer, M16-Zinc	7	SA13-00005
4	Hex Socket Set Screw (176 N-m/130 ft-lb)	4	SA11-00018
5	Seal-DLV-90-110-12	1	SA26-00001
6	Bearing-22312	1	SA34-00001
7	Cover	1	SFM0001-2050
8	Screw, M10X1.5-25X25-10.9Z (67 N-m/ 49 ft-lb)	8	SA11-00002
9	Lock Washer, NL-M10	8	SA13-00003
10	Lube Hose, HB-Synflix-R7-02	1	SFM0004-5005
11	Vent Hose, HB-2Wires-GH793-4-6500PSI	1	SFM0004-5006
12	Straight-Adapter-NPTFM02-JICM04	3	SA23-00004
13	90°-Adapter-NPTFM02-JICM04	1	SA23-00002
14	Hydraulic-Grease-Nipple-0.125-Straight	1	SA23-00005

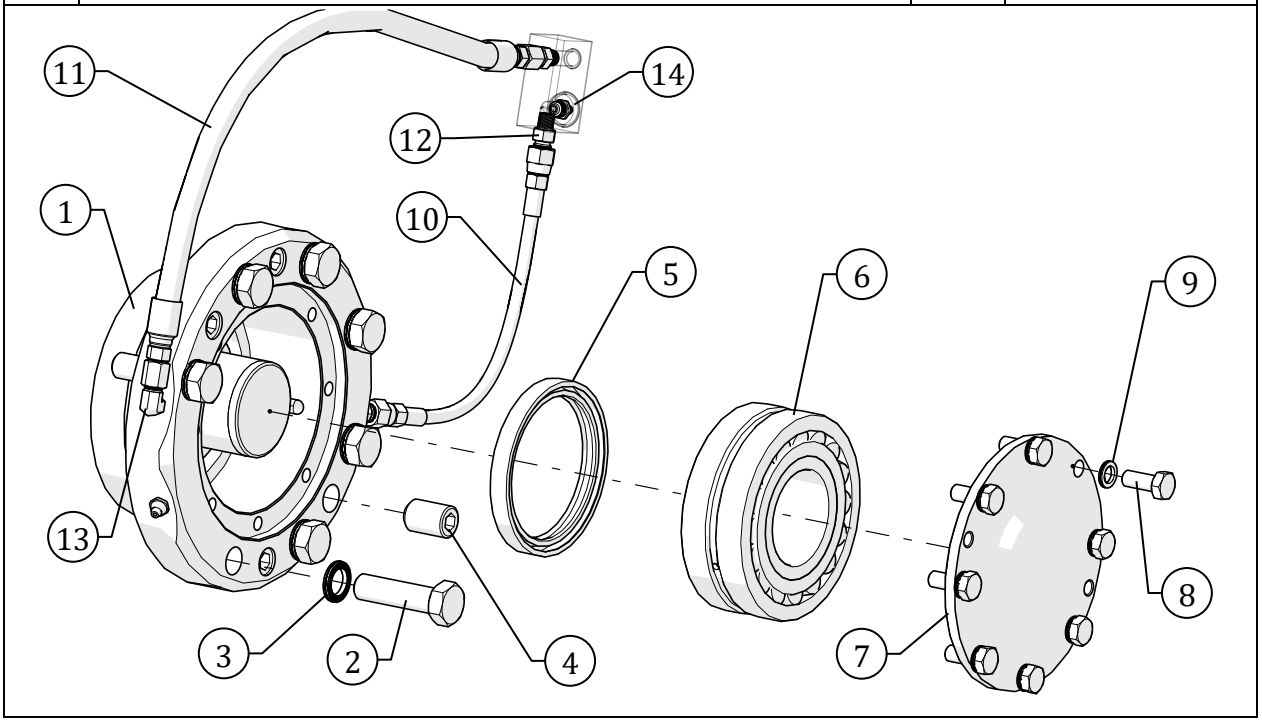


Fig. 4-4 LH Bearing Parts List

4.5 Drive System

No	Description	QTY	PN
1	Pulley Gates 14MX-30S-37	1	SA31-00003
2	Taper Lock Bushing 2517 for 30 Teeth Pulley	1	SFM0004-2010
3	Set-Screw- 10X11-Gr.8 (48.5 N-m/35.8 ft-lb)	2	CPS-10X11-2000X2000
4	Timing-Belt-1400-14-68	1	SA32-00002
5	Pulley Gates 14MX-38S-37	1	SA31-00004
6	Taper Lock Bushing (3020) 2"	1	SA33-00004
7	Screw, CPS10X11- -Gr.8 (90.4 N-m/ 66.7 ft-lb)	2	SA11-00055
8	Motor Bolting Plate HM-60	1	SFM0004-2009
9	Scr., M16x2-55X55-10.9 (290 N-m/ 213 ft-lb)	4	SA11-00031
10	Lock Washer - M16-Zinc	4	SA13-00005
11	Flat Washer OD 2" x ID 11/16"	4	SFM0001-1062
12	Screw, M16X2-80X80-8.8Z (202 N-m/ 149 ft-lb)	1	SA11-00048
13	Hex (Lock) Nut, M16X2.0-Gr.10-Zinc	1	SA12-00006

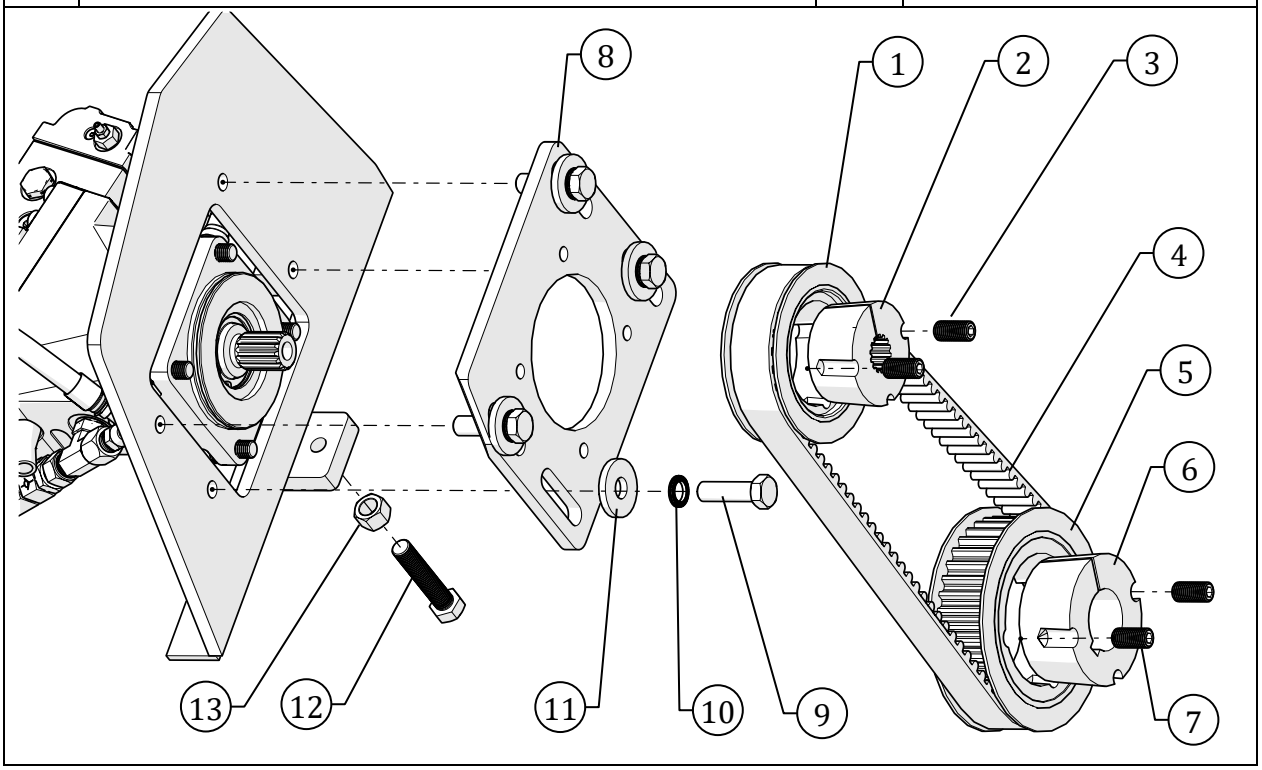


Fig. 4-5 Drive System Parts List

4.6 Motor and Hydraulic Block

No	Description	QTY	PN
1	Hydraulic Motor -80cc (Hydraulic Control)	1	SA21-00006
2	Screw M14-2.00 x 35-35, 10.9Z (186 N-m/ 137 ft-lb)	4	SA11-00025
3	Lock Washer M14-15.2 x 23.0 x 3.4mm	4	SA13-00014
4	Straight-Adapter – ORBM10-ORFM10	1	SA23-00085
5	T Adapter ORFM10-ORFF10-ORFM10	1	SA23-00049
6	Cap-ORFF10 Machined SAE06	1	SFM0001-2062
7	Pressure Test Adapter 1620 serie 9/16-18-UNF	1	SA02-00005
8	T Adapter JICM10-ORBM10-JICM10	1	SA23-00082
9	Straight Adapter JICF10-JICM06	1	SA23-00083
10	Flushing Hose w JICF06 (2x)	1	SFM0004-5010
11	Straight Adapter JICF10-NPTM08	1	SA23-00084
12	Check Valve 75 PSI, NPTFF08	1	SA28-00021
13	90°-Adapter-ORBM06-JICM06	1	SA23-00016
14	Shaft Seal (motor)	1	SA26-00010
15	O-Ring Seal (Flange, 1"-6000)	2	SA26-00003
16	Hydraulic Block	1	SFM0003-2010
17	Screw -M12X1.75-100X36, 12.9 (136 N-m/ 100 ft-lb)	8	SA11-00201
18	Lock-Washer M12-7.5 x 12.4 x 2.6(mm)	8	SA13-00173
19	Socket Head Plug, ORBM10	3	SA27-00036
20	Socket Head Plug, ORBM08	1	SA27-00035
21	Flow Regulator NPT02-27 Plug Hex Socket	1	SFM0001-2055
22	Pressure Test Adapter - 7/16-20-UNF	2	SA02-00004
23	Check Valve -CXHA-XAN	1	SA28-00002
24	Straight-Adapter-ORBM16-ORFM16	2	SA23-00037
25	Relief Valve, 150-6000 psi, RPGE-LCV	1	SA28-00001

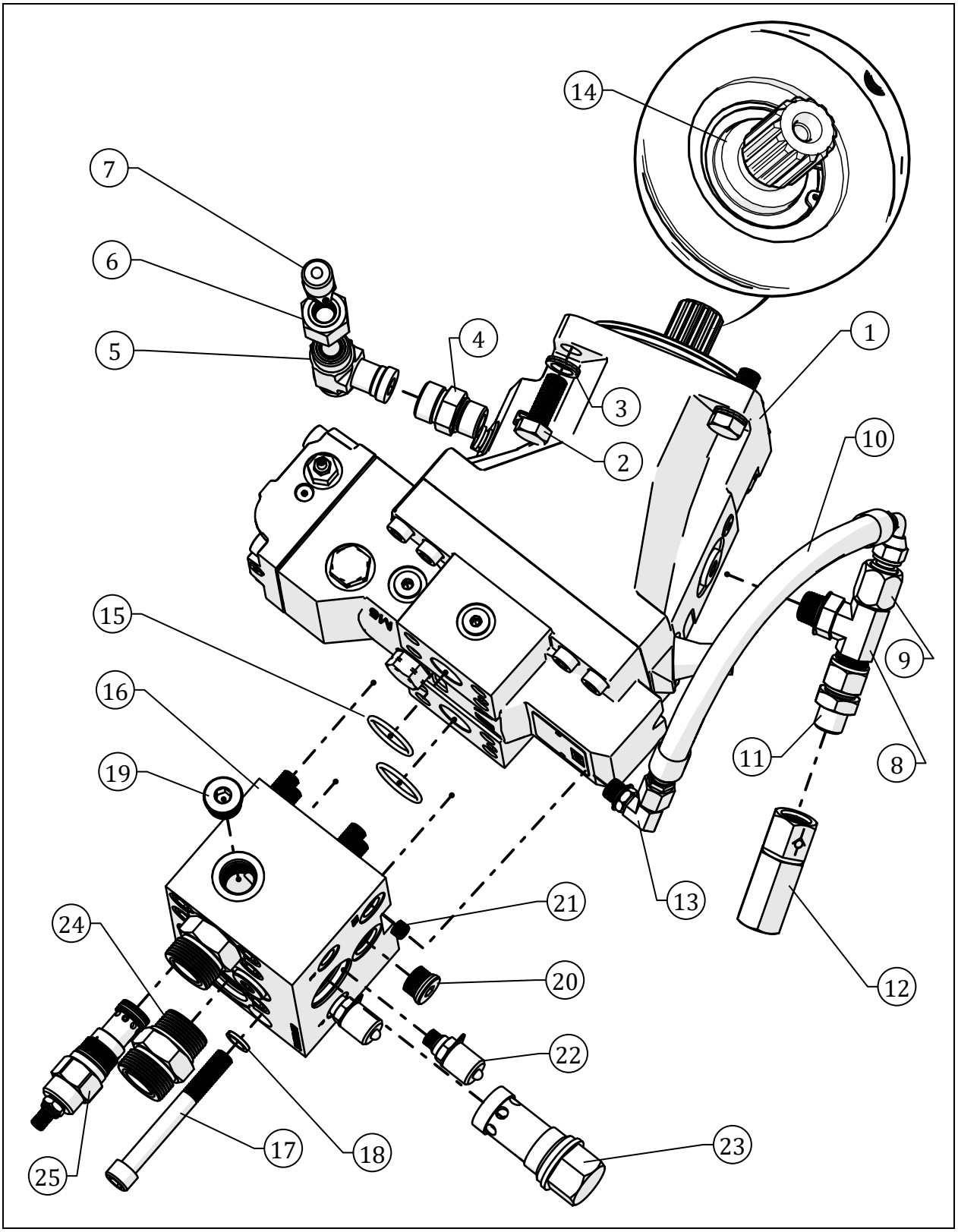


Fig. 4-6 Motor and Hydraulic Parts List

4.7 Hydraulic System

No	Description	QTY	PN
1	Hydraulic Hose Ass'y, Pressure 6000 psi, 43" Lg	1	SFM0004-5008
2	Hydraulic Hose Ass'y – Return, 6000 psi, 37.5" Lg	1	SFM0004-5009
3	Hydraulic Hose Ass'y – Drain 3800 psi, 55.5" Lg	1	SFM0004-5007
4	Quick-Coupler-Faster-FFH12-SAEM34	1	SA23-00032
5	Quick-Coupler-Faster-FFH12-SAEF34	1	SA23-00012
6	Quick-Coupler-Faster-FFH06-SAEF12	1	SA23-00011
7	Straight-Adapter-ORBM12-ORFM16	2	SA23-00033
8	Straight-Adapter-ORBM08-ORFM10	1	SA23-00034

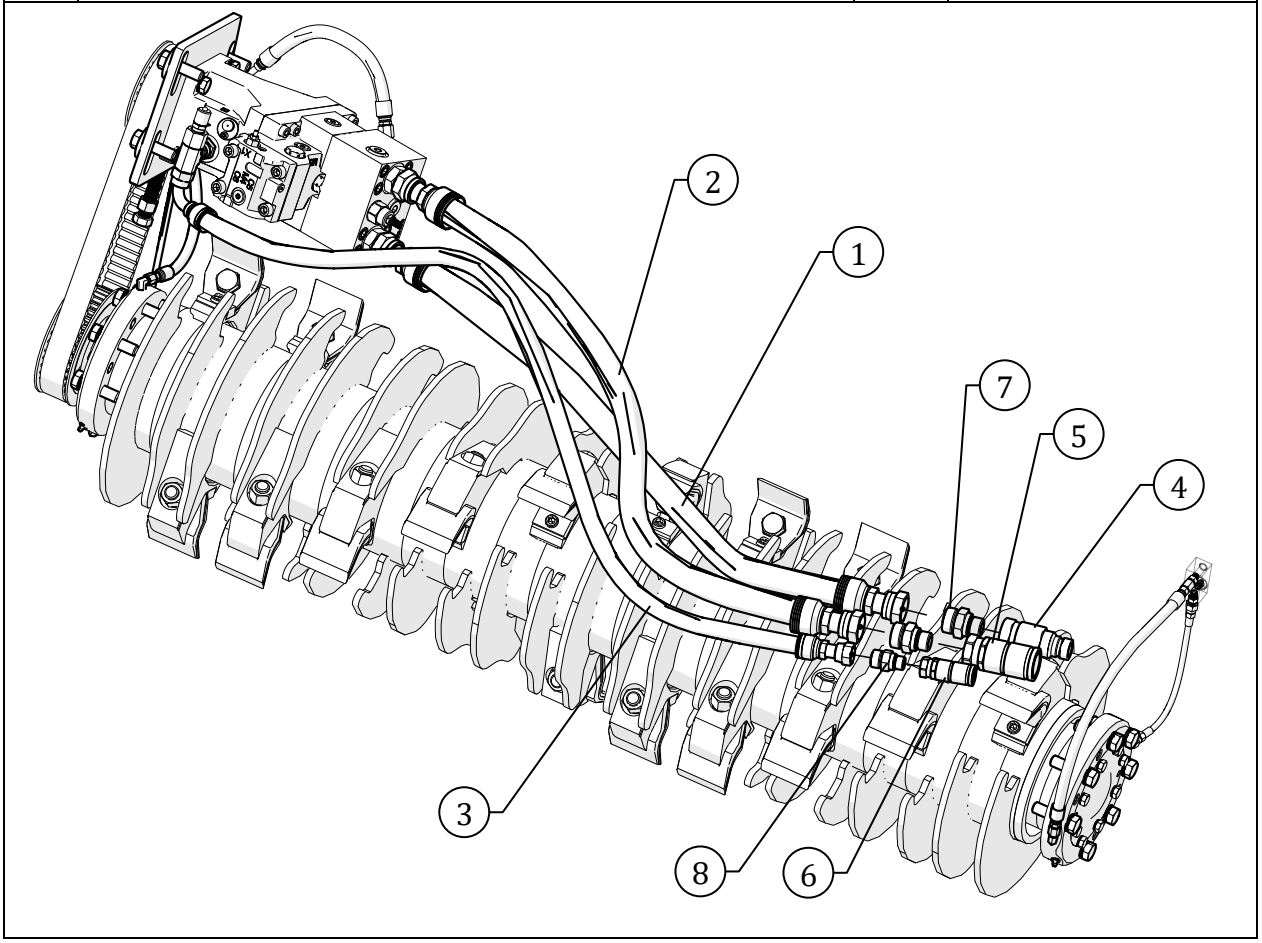


Fig. 4-7 Hydraulic Parts List

4.8 Protective Devices

No	Description	QTY	PN
1	Wear Plate	1	SFM0004-4011
2	Bolt M16X2-45X45-10.9Z (289 N-m/ 213 ft-lb)	5	SA11-00023
3	Flat Washer FW-M16	5	SA13-00010
4	Lock Washer	5	SA13-00005
5	Nut M16X2.00-10.9Z	5	SA12-00006
6	Anvil	2	SFM0004-2002
7	Bolt M12X1.75-50X30 - 10.9Z (116 N-m/ 86 ft-lb)	10	SA11-00047
8	Flat-Washer-M12-23.6X13.2X2.5-Zinc	10	SA13-00008
9	Hex-Lock-Nut M12X1.75-Gr.8-Zinc	10	SA12-00008
10	RH Guard for Rotor	1	SFM0003-4011
11	LH Guard for Rotor	1	SFM0003-4004
12	Bolt, M16X2-35X35-10.9Z (289 N-m/ 213 ft-lb)	8	SA11-00043
13	Lock Washer	8	SA13-00005
14	Flat Washer FW-M16	8	SA13-00010
15	LH Wear Pad (M16x2.00 Screw Included)	1	SFM0004-4005
16	RH Wear Pad (M16x2.00 Screw Included)	1	SFM0004-4006
17	Bolt, M16X2-45X45 - 10.9Z (289 N-m/ 213 ft-lb)	4	SA11-00023
18	Socket-Hd C'sunk Screw-M16X2.0-45X45-Gr 10.9	2	SA11-00042
19	Flat Washer FW-M16	6	SA13-00010
20	Lock Washer	6	SA13-00005
21	Nut, M16X2.00 - 10.9Z	6	SA12-00006
22	Chain Plate	1	SFM0004-3011
23	Rod for Chains Ass'y	1	SFM0004-4004
24	3/8" Chain-(5 Meshs)-Grade-70-Length: 7 5/8"	28	SA39-00001
25	Flat Washer M12-13.2 x 23.6 x 2.5	1	SA13-00008
26	Hex-Lock-Nut-M12X1.75-Gr.8-Zinc (81 N-m/ 60 ft-lb)	1	SA12-00008
27	Stopper Plate for Hoses of HM-60SR	1	SFM0004-3019
28	Screw M16-2.00 x 55-55, 10.9Z (289 N-m/ 213 ft-lb)	2	SA11-00004
29	Folded Plate Hose Protection	1	SFM0004-3020
30	Screw M12X1.75-35X35-Gr.8.8-Z (81 N-m/ 60 ft-lb)	2	SA11-00025
31	Flat Washer M12-13.2 x 23.6 x 2.5(mm), Zinc	2	SA13-00008
-	Lock Nut-M12X1.75-Gr.8-Zinc	2	SA12-00005

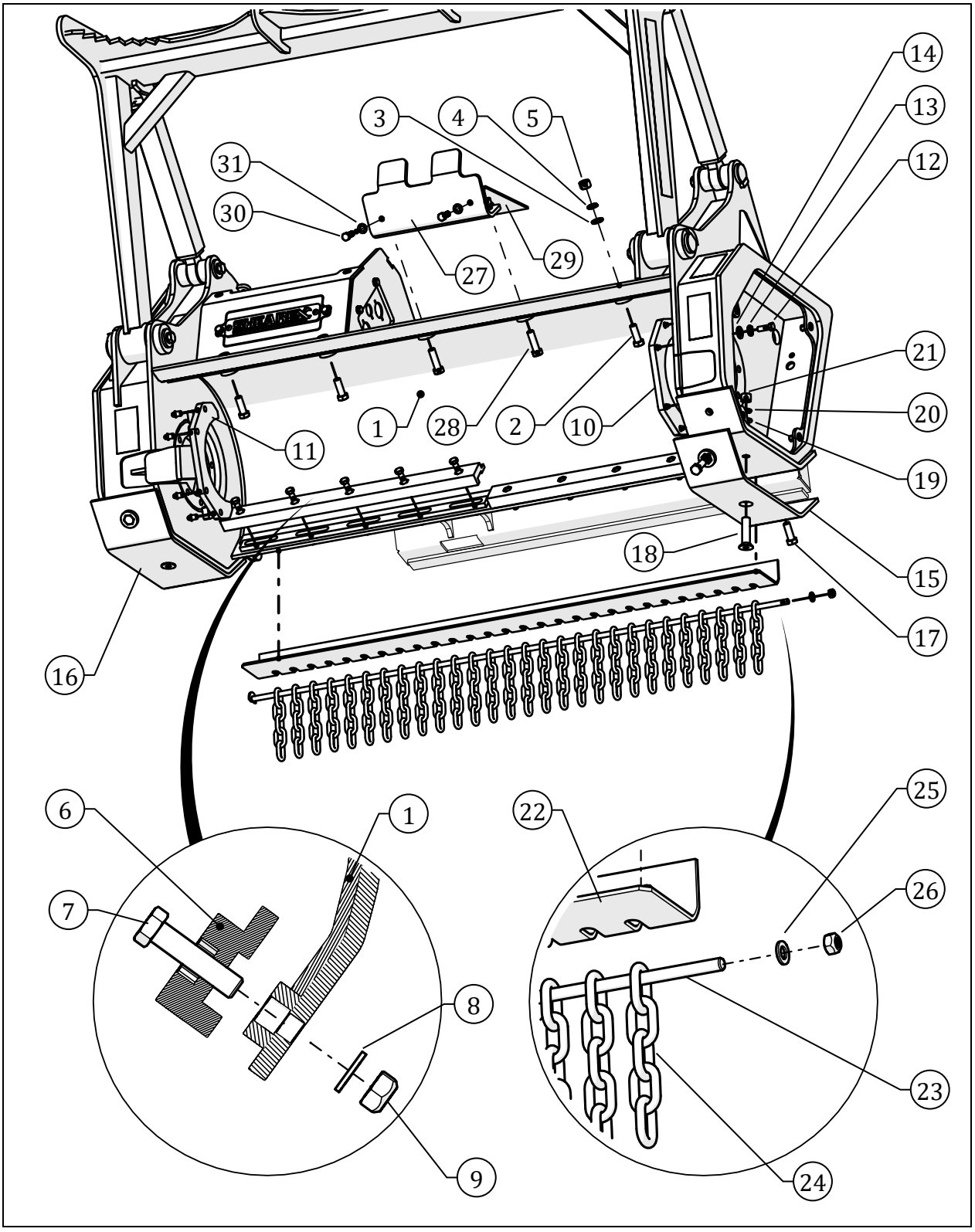


Fig. 4-8 Protective Devices Parts List

4.9 Labels Location on the Mulcher

The operator should always make sure the safety labels are still on the mulcher and legible for all people around. Here are the locations of the labels listed at section **1.4.4 LABELLING**.

No	Description	QTY	NP
1	Safety Label "DANGER – Stand Clear 300 ft"	2	SA71-00021
2	Cut Hazard – Handle Blade Carefully	2	SA71-00003
3	Model/Serial Number Plate	1	SA71-00000
4	Patent Nb Plate	1	SA71-00023
5	Read and Understand (horizontal)	1	SA71-00014
6	Pinch Point	1	SA71-00006
7	Grease Point (LH/RH)	2	SA71-00011
8	Hot Surface – DO NOT TOUCH	1	SA71-00020
9	Flying Debris - Maintain a safe distance of 300 ft …	2	SA71-00001

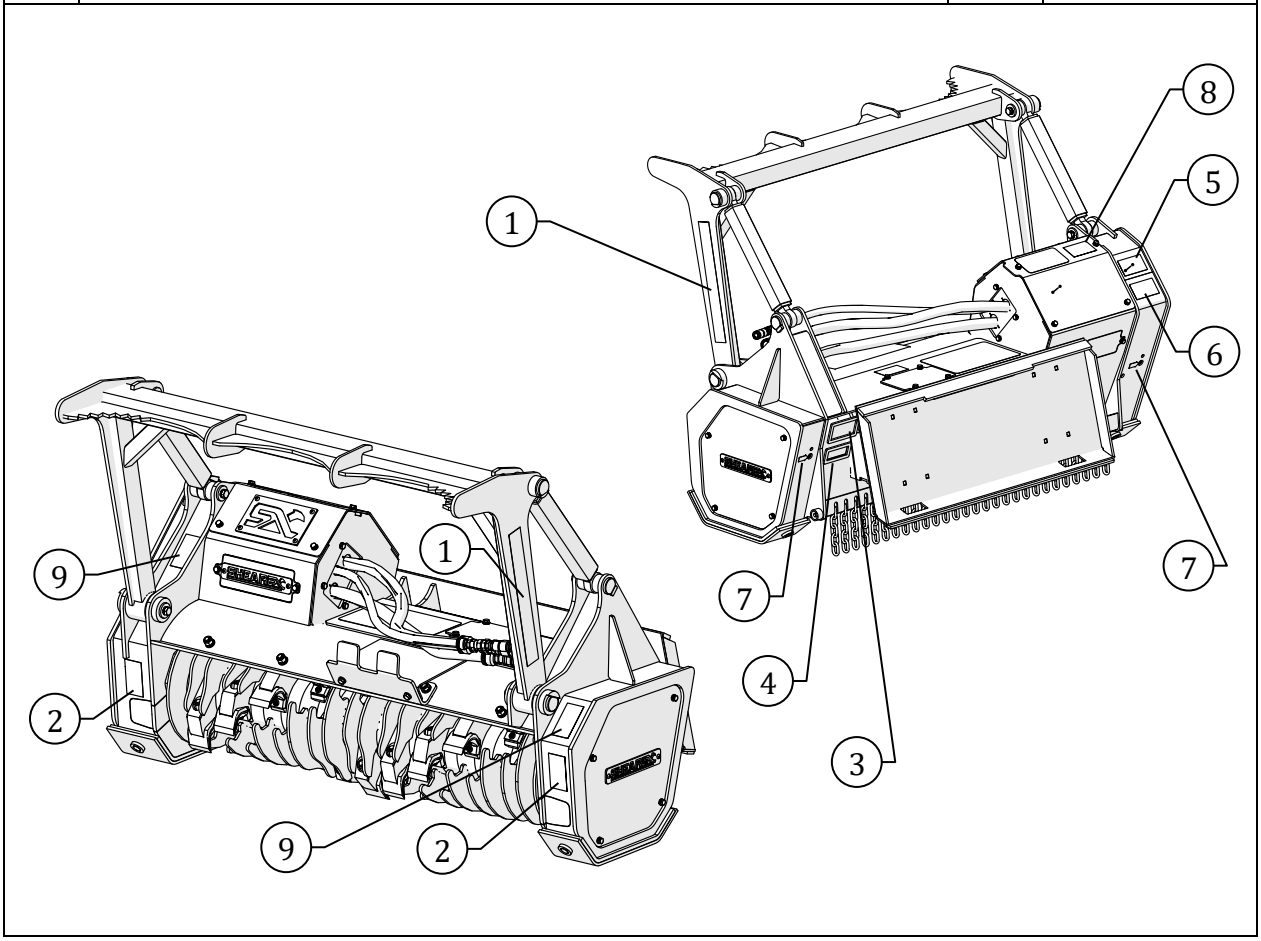


Fig. 4-9 Safety/Warning Labels Locations

4.10 Maintenance Kit

The safety gear is the responsibility of the operator as well as the general maintenance tools for the mulcher.

However, with the purchase of a new mulcher, the Maintenance and Repair Kit (PN: SFM0004-7001-MK) provides some spare parts and tools to help the operator start the basic maintenance and specific work/task to perform on the mulcher.

Nevertheless, we still recommend the user to keep spare parts in stock to avoid delays and extra fees related to the late or "in a hurry" deliveries.

This Maintenance Kit the following items:

No	Description	QTY	PN
1	Steel Plate 6 1/4" for 3M carbide paper	1	SFZ0000-1002
2	3M Cubitron Carbide paper, gr. 36- 6¼ in	5	SA03-00003
3	Blade Sharpening Gauge	1	SFG0000-1000
4	Blade Nut Mounting Socket - 30 mm x ¾" Drive	1	SA03-00001
5	Blade 1- type 20	21	SFL01-20
6	Lock Washer M20-21.4 x 30.7 x 4.11(mm), Zinc	21	SA13-00006
7	Écrou hex. M20-2.50, Gr. 12.9	21	SA12-00018
8	Vis à tête hex. M20X2.5-95X46-Gr.12.9	21	SA11-00058
9	Grease Cartridge Alimex (400gr/ch)	1	SA03-00002
10	Wear Plate of the Blade	3	SFM0001-2063
11	Socket Hd Cap Screw M12-1.75 x 20-20mm, Gr.12.9, Black	3	SA11-00204
12	Lock-Washer, M12-7.5 x 12.4 x 2.6(mm), Black	3	SA13-00173

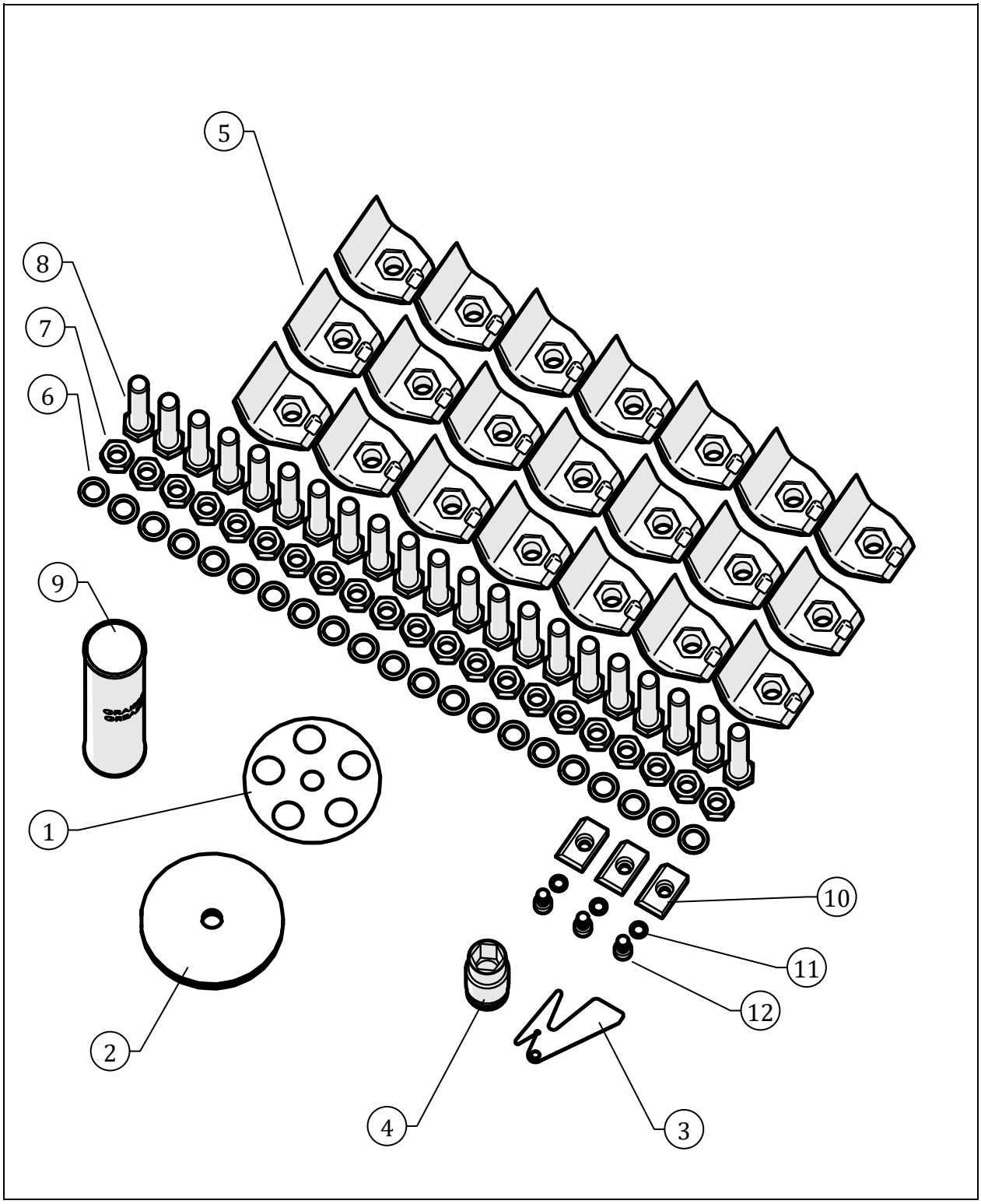


Fig. 4-10 HM-60SR Maintenance Kit[10]

[10] The number of parts shown above may be different from one model set to another.

4.11 Bearing Tool Kit (Optional)

After a while, the rotor bearing will eventually need to be overhauled and/or replaced. Since the replacing parts nor tools for the bearing change are not provided with the purchase of a new mulcher, it is up to the user to get the recommended tools for this purpose from his own facilities or our optional "Bearing Tool Kit" (PN: SFM-7001-RBK).

This bearing tool kit includes the following items:

No	Description	QTY	PN
1	Bearing Insertion Tool	1	SFG0001-4002
2	Tool/Socket for KMT 12 Nut	1	SFG0001-4001
3	Mounting Cover	1	SFG0001-2009
4	Socket Set Screw M16 x 2 x 100-100 mm	6	SA11-00060
5	Extracting Screw M20-2.50 x 100-100 -Ext. Tip	4	SA11-00011
6	Hex. Cap Screw M16-2.00 x 70-38, Gr. 10.9 Zinc	4	SA11-00008
7	Flat Washer M16-17 x 30 x 2.7(mm), Zinc	4	SA13-00010
8	Hex. Cap Screw (long) M16-2.0 x 90-90, Gr. 8.8, Zinc	4	SA11-00012

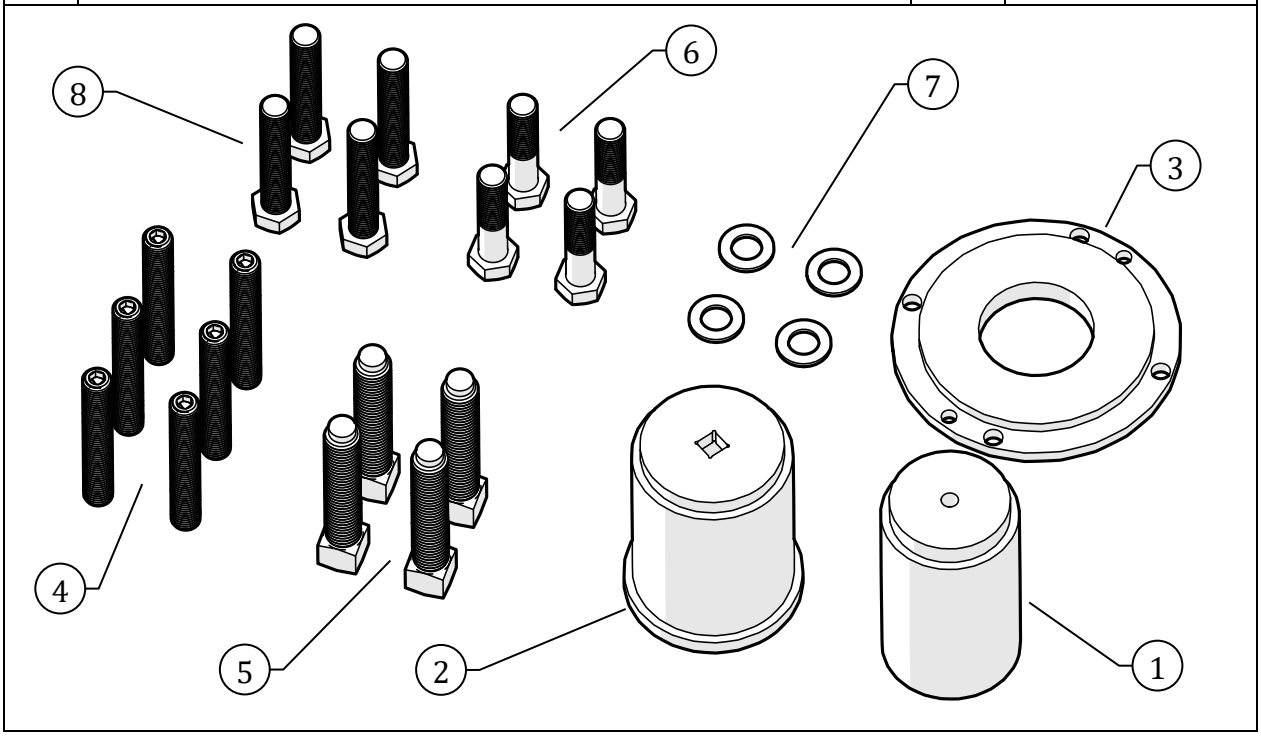


Fig. 4-11 Bearing Tool Kit[11]

[11] The number of parts shown above may be different from one model set to another.

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6 Addendum - Hydraulic Motor Operation

6.1 Terminology

To ease the reading and quick acquisition of the knowledge to operate and maintain the mulcher in good state of order, we used many terms and abbreviations through out this manual.

V_{gmax}:	Max, theoretic possible motor displacement per revolution (in^3/rev)	
V_{gx}:	Minimum displacement setting of desired unit (in^3/rev)	
V_{gy}:	Maximum displacement setting of desired unit (in^3/rev)	
V_g:	Motor displacement per rev. (in^3/rev)	
x :	Minimum displacement (%)	
y :	Maximum displacement (%)	
p_e:	Entering "High" pressure (psi)	
p_o:	Outlet "Return" pressure (psi)	
η_v:	Motor volumetric efficiency	
η_{mh}:	Mechanical-hydraulic efficiency	
η_t:	Motor total efficiency	
Δp:	Entering P° – Outlet P° (psi)	$= p_e + p_o$
M_e:	Output torque (lb•in),	$= \frac{V_g \bullet \Delta p \bullet \eta_{mh}}{2 \bullet \pi}$
Q_e:	Input flow (US gal/min),	$= \frac{V_g \bullet n}{1000 \bullet \eta_v}$
P_e:	Output power (HP),	$= \frac{V_g \bullet n \bullet \Delta p \bullet \eta_t}{396\,000}$
n:	Speed (rpm)	$= \frac{Q_e \bullet 231 \bullet \eta_v}{V_g}$

6.2 Two-Position Hydraulic Control (TADA)

6.2.1 Principle of Operation

The hydraulic two-position motor is actuated by a servo valve internally supplied by the *Pressure Compensator Override* (PCOR) through an integral system shuttle check valve.

Since the oil displacement (volume) is directly proportional to the angle of the motor pistons, more angle the pistons have, more oil is required for one rotation of the motor shaft. The output speed depends on the flow CTL pump is delivering and the pistons displacement of the motor. For RH rotation, the oil must enter through port B.

The max speed is adjustable by the use of an adjustment screw (V_{gx}) which set the minimum displacement/angle of the motor while the maximum displacement (V_{gy}) pressure is also adjustable by the PCOR screw.

1. When not working, in the non-actuated state, the hydraulic (incoming) pressure applies both sides of the servo piston and keeps the motor at minimum displacement as long as the high loop pressure remains below the pressure compensator setting.
2. If the high loop pressure rises above the pressure compensator setting, the porting spool ports the larger diameter of the servo piston to tank.
3. Since the servo piston is actuated, the motor strokes in the direction of maximum displacement swivelling the lens plate to give the motor pistons more angle, from V_{gx} to V_{gy}, and raising the output torque of the motor.

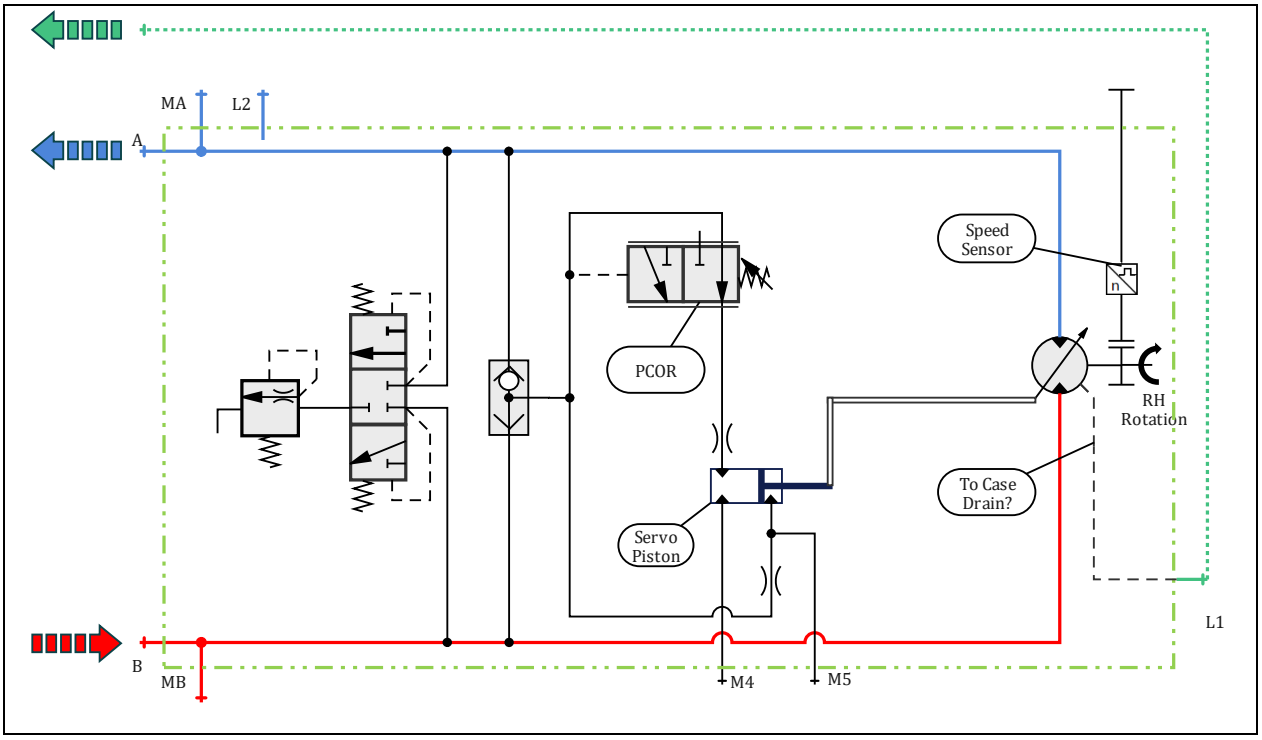


Fig. 6-1 TADA Motor Control Schematic

6.2.2 Two-Position Control vs PCOR Pressure

The diagram below shows the characteristic curve of the hydraulic motor with the *Operating Pressure vs Motor Displacement.*

The displacement "start setting range" is adjustable from V_{gx} towards V_{gy} by the PCOR set screw from 160 bar (2321 psi) to 300 bar (4351 psi).

The mechanic/ operator must adjust the start of control pressure after some trials and tests with the CTL to compromise the best performances from the mulcher and the CTL. Some rule of thumb prescribes to calculate 50% of the hyd. power/ max flow rate as the pressure to set paying attention to the following:

- If the shifting point is too low, the motor will easily/constantly shift in max displacement not reaching the suitable speed to get rotational energy and;
- If the shifting point is too high, the motor will slow down (because of its low torque) at a low speed before shifting so recovering will be quite long unless getting back from material.

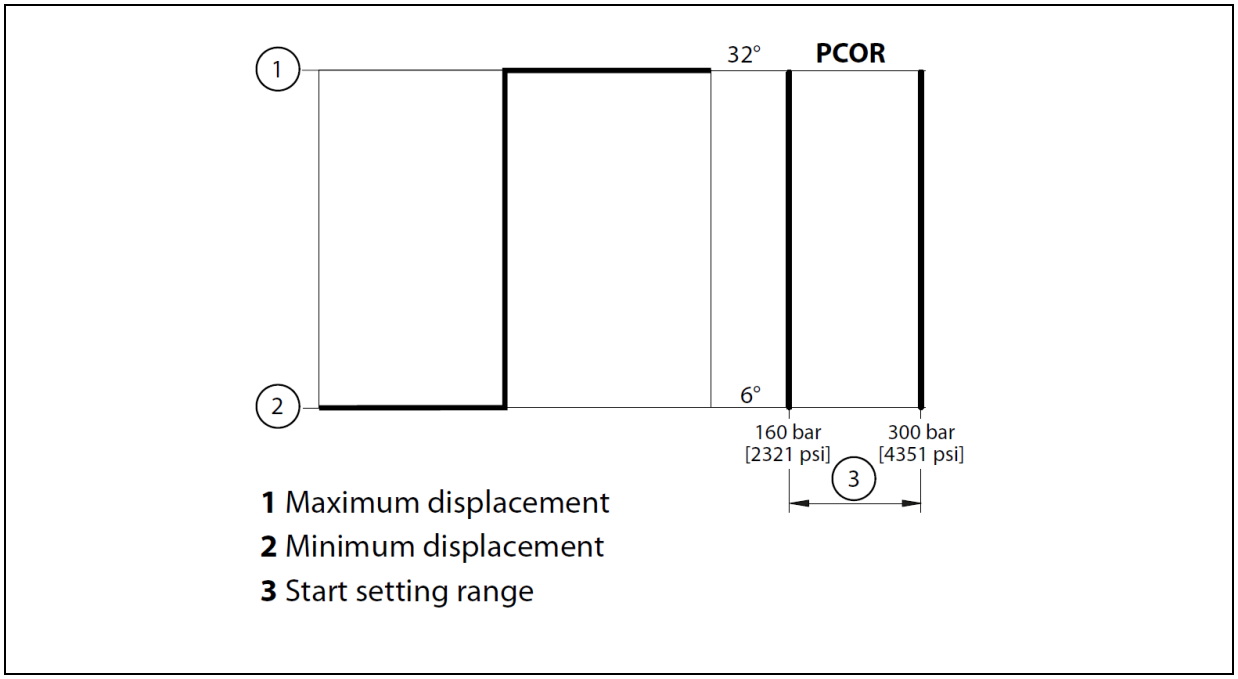


Fig. 6-2 Motor Displacement vs PCOR Pressure