

Reciprocating Compressors for industrial refrigeration GEA Grasso 10

Service Instruction Manual

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SAFETY INSTRUCTIONS



Hint!

This manual must be carefully read and understood prior to installing and servicing the compressor (package)

General Safety

All service operations described in this servicemanual are only to be carried out by well-trained/qualified personnel and even then only after this service manual has been read carefully and is fully understood.

Personal safety

Observe all (inter)national and/or local safety standards, measures and regulations during reinstalling, repairing and connecting the compressor (package).

Mechanical safety

If the compressor does not have to be removed from its base, it is advisable to put warning labels on vital parts of the compressor saying that the plant is out-of-operation and must not be started up.

If the compressor has to be opened for service, the refrigerant has to be pumped down and the electric supply has to be cut off.

After having run the initial 100 operating hours, it is essential (in both new and modified plants) to replace the red running-in discharge oil filter element with the permanent grey filter element. Also replace the running-in suction gas filter element.

Check the direction of rotation is correct before restarting the compressor.

PREFACE

General

1. All documentation can be downloaded via our web site.
2. Grasso's technical manuals includes "generic paragraphs"; this means that **it can occur** that not all data as described is relevant for the current compressor series as mentioned in this manual. (For instance, not all compressor series are suitable for all mentioned refrigerants or not all compressor series includes two-stage compressors)

Directives

Equipment is based on Pressure Equipment Directive (PED 97/23/EG) regulations and according to Machine Directive (MD 2006/42/EG) regulations.

The applied standards are:

NEN-EN-IEC 60204, NEN-EN-ISO 12100, NEN-EN-ISO 13857, NEN-EN 378

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GENERAL INFO SIM



Warning!

Never change positions of parts when re-assembling the compressor. E.g. cylinder liners, suction valves, discharge valves and relief valves have to be replaced always in the original position.

All bolts and nuts have to be mounted according to the torques as given in table "Survey of torques for bolts and nuts" as available in this manual. If you cannot find this information, consult Grasso.

General

This compressor service manual is intended to be used in the field by qualified personnel of refrigeration installers or contractors for proper(re)assembly, inspection, repair and part or total overhaul of Grasso single-stage and two-stage piston compressors.

Installation and maintenance instructions

The manual should also and always be used together with the corresponding "Installation and Maintenance Manual" (IMM) meant for the operator. The IMM is supplied with every compressor or compressor package.

Additional design details

Additional design details are available in the manual "Product Information"

How to read the pages of this manual

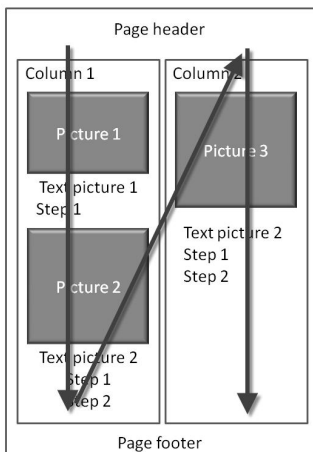


Fig.1



Hint!

When "[Tool set]" is mentioned in this manual, the tool as shown in the picture is part of the Grasso V tool set, which can be supplied by Grasso.

Important tables, refer to Chapter 5, Page 59!



Hint!

Tables like "Wear limits and tolerances" and "Torques for bolts and nuts" can be found at Chapter 5, Page 59

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CYLINDER NUMBERING

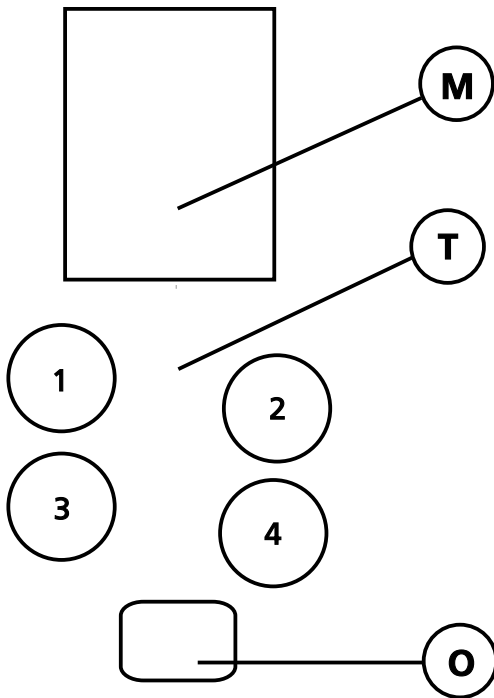




Fig.2: Cylinder numbering Grasso reciprocating compressors

Legend	
1, 2, 3, ...	Cylinder numbers
T	Top view of compressor
M	Motor/Drive end of compressor
O	Oil pump of compressor

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GENERALINFO

Main setup data Grasso 10		
Description	Value	Remark
Start frequency	max. 6 starts per hour	
Time interval between stopping and re-starting	min. 2 minutes	
Time interval between starting and re-starting	min. 10 minutes	
Time interval between capacity steps	min. 3 minutes	For continuous minimum part-load (i.e. more than 30 minutes) consult Grasso. Adjust the steps between up and down loading, in such a way that the system is running stable.
Oil level	25-75% crankcase sight glass	
Min. oil temperature	> 10 °C and > Pcrankcase + 15 K	
Max. oil temperature	Refer to oil selection table/applied type of oil	Required oil viscosity; ≥ 10 cSt during operation at location of bearings
Control oil pressure	suction pressure + 8 bar	
Lubricating oil pressure difference	between 1.3 and 4.5 bar Setting approx. 2.0 bar	After a minimum of 15 minutes running time at an oil temperature of approx. 50 °C (122 °F)
Max. discharge temperature	170 °C	
Min. suction pressure	0.3 bar (a)	
Max. intermediate pressure Max. suction pressure	8.5 bar (a)	
Pdischarge - Psuction	≤25.0 bar	
Superheat	>0 K for NH ₃ , R22 >15K for R507/R404A/R134a	
Oil suction filter	Blue coloured filter element	
Oil discharge - running in - filter	Red coloured filter element	 <p>Hint! Factory mounted; to be replaced after max. 100 running hours by permanent oil discharge filter element</p>

Main setup data Grasso 10		
Description	Value	Remark
Oil discharge - permanent - filter	Grey filter element	 <p>Hint! Supplied loose; replacement for factory mounted running in filter</p>
Direction of rotation of compressor drive shaft	Counterclockwise when facing shaft end	

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1 REPAIR AND OVERHAUL

1.1 INTRODUCTION

Compressor and plant

All activities described can be carried out without taking the compressor off its base and without detaching it from the plant. In case of complete overhaul, it may, however, be useful to carry this out detached from the plant in a separate working area, whether or not in a workshop equipped for this purpose.

Accessories

This chapter only deals with the disassembly and assembly of a so-called "bare compressor" in standard design. This implies that, depending on the dismantling degree, it may be necessary to first completely or partially remove certain accessories.

It is recommended to distinctly mark the dismantled accessories or parts of them (for instance oil control lines and pressure gauge or safety switch lines, transducers, pressure and temperature sensors, V-belt pulleys and torsionally-stiff coupling) in order to avoid mistakes at reassembling.

Tools

For proper performance of the operations, at least the standard service tools and materials should be available.

Besides, for certain operations additional special GRASSO tools are required, which can be obtained as a complete standard service set.

Service Sets

Worn out parts are to be replaced by new parts which are available in sets with a brief service manual.

General

Although all the assembly and disassembly procedures shown relate to the two-stage compressor, they are basically applicable universally to all compressors. If not, it is explicitly stated in the text.

1.2 EVACUATION/DRYING THE REFRIGERATING SYSTEM

For evacuation of compressor only, refer to Section 1.3, Page 13

Procedure to evacuate and to dry a system:

- i. STATUS: System is filled with nitrogen and no oil has been added (oil prevents any trapped moisture from boiling off).
- ii. Verify that all valves in that part of the system to be evacuated are opened (refer also to the plant manual).
- iii. Connect vacuum pump to the evacuation/purging valve(s) of the compressor (for location of these valves refer to the "Product Information" or to a connection as mentioned in the plant manual and evacuate the system to approx. 6 mBar.
- iv. Break vacuum by charging dry nitrogen into the system.
- v. Repeat step iii, "Connect vacuum pump ...".
- vi. Wait approx. 24 hours.
- vii. If pressure has increased (system still contains moisture), repeat steps iv, and vi. Otherwise, continue with the "Initial oil charge" procedure.

1.3 EVACUATION, LEAK TESTING AND START-UP OF THE COMPRESSOR/PACKAGE

To evacuate the refrigeration system refer to Section 1.2, Page 13,

Always use a vacuum pump or pump-down unit to evacuate the refrigerant from the compressor.

1.3.1 EVACUATION OF REFRIGERANT BEFORE SERVICING

Procedure to evacuate the compressor:

1. Switch off main control panel
2. Remove main fuses
3. Close shut-off valves
4. Remove the refrigerant by means of a vacuum pump or pump-down unit, via the evacuation/purging valve(s) as prescribed by local safety regulations. For the location of these valves refer to the "Product Information".
5. Drain the oil from the compressor and oil separator, oil return /oil rectifier system if present.

1.3.2 LEAK-TIGHTNESS AFTER SERVICING

The necessary safety precautions should be taken before carrying out the leak-tightness test. To check leak-tightness use dry nitrogen at a positive pressure which is less than the admissible operating pressure of the low pressure stage.

1.3.3 EVACUATION AFTER SERVICING

After the pressure test has been completed, the compressor (package) must be evacuated and undergo a vacuum test. Evacuation is used to remove air and moisture from the compressor (package)

1.3.4 START-UP AFTER SERVICING

1. STATUS: Compressor (package) is dried and still evacuated.
2. Charge the oil separator, if present, with oil. See the appropriate Product Information for the correct quantity.
3. Charge the compressor crankcase with oil via the oil charge valve until the minimum level is seen at the sight glass at the level as indicated in IMM.
It is mandatory to pre-lubricate the oil circuit by adding the final quantity of oil via the charge valve mounted onto the oil pump by means of a separate oil filling pump. The required oil level is indicated in the IMM.
4. Re-install all accessories such as coupling, V-belt guard etc.
5. Open the shut-off valves.
6. Check the start-stop procedure.
7. Check all safeties and controls.
8. Re-install the main fuses.
9. Start up the compressor.
10. Check running condition.

Note:

The job isn't finished until the paper work is done! Complete the service report, e.g. Grasso report 00.89.062.

1.4 GENERAL RECOMMENDATIONS



Caution!

Always use new gaskets, O-rings and locking rings when reassembling after inspection or repair.

Use a torque wrench to tighten the threaded connections. (Survey of torques for bolts and nuts)

1. Do not disassemble more compressor parts than is necessary for the purpose (inspection, repair, overhaul).
2. Use clean and well-conditioned tools.
3. Make sure that there is a clean and neatly arranged working area well-equipped to provide temporary and adequately protected storage of dismantled components. Preferably use a table or working bench with a clean, moisture-free and non-scratching surface.
4. Immediately clean every dismantled part, check it for wear or damage and oil the machined surfaces of bright parts. The oiling is particularly important when the parts are not to be reassembled until after some time. Otherwise they will certainly become rusty.
5. The dismantled parts of every cylinder (cylinder liner, piston, connecting rod, valves) or of other main components should be kept together separately and marked if necessary. Thus they can later be replaced in their original place in the compressor.
6. All major parts that are not beyond repair have to be checked before reassembly for wear by measuring them and comparing the outcome with the wear limits and tolerances given in documentation.
7. Always replace damaged or worn compressor parts that are beyond repair by new GRASSO standard spare parts. These parts can always be fitted into the compressor without previous inspection or readjustments (if applicable, e.g. valves, connecting rods, etc.).
8. When fitting any moving parts, it is recommended to oil all running surfaces.

2 DISASSEMBLY

2.1 FLYWHEEL REMOVING

For many service and repair operations the flywheel has to be removed.

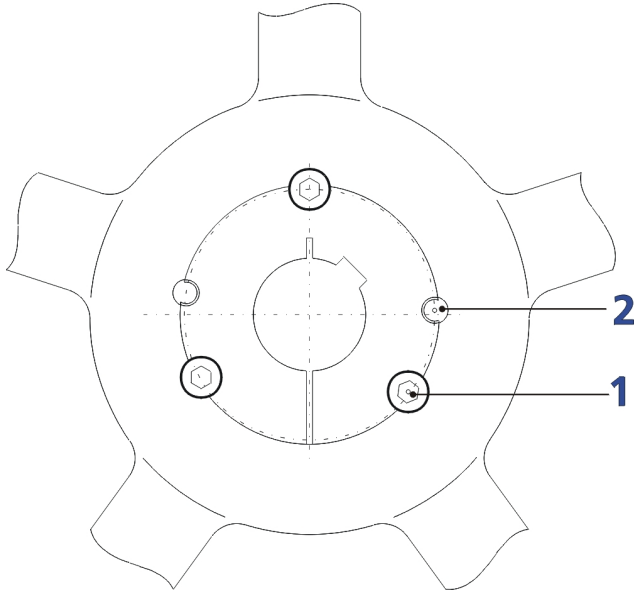


Fig.3: Taperlock

1. Slacken all screws by several turns, remove one or two according to number of jacking off holes (2). Insert screws in jacking off holes after oiling thread and point of grub screws or thread and under head of cap screws.

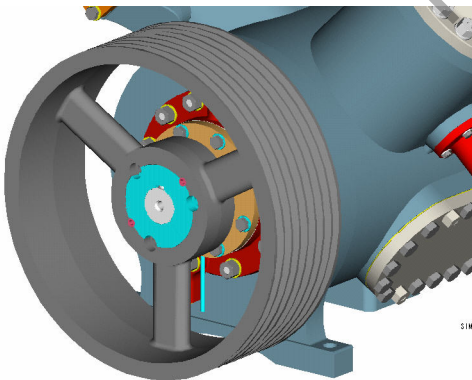


Fig.4

2. Tighten screws alternately until bush is loosened in flywheel hub and assembly is free on the shaft.
3. Fix a sling over the flywheel. Pull sling in such a way that flywheel can still move freely on shaft.

4. Now slide flywheel hanging in sling, away from compressor.

2.2 DISMANTLING SUCTION GAS FILTER

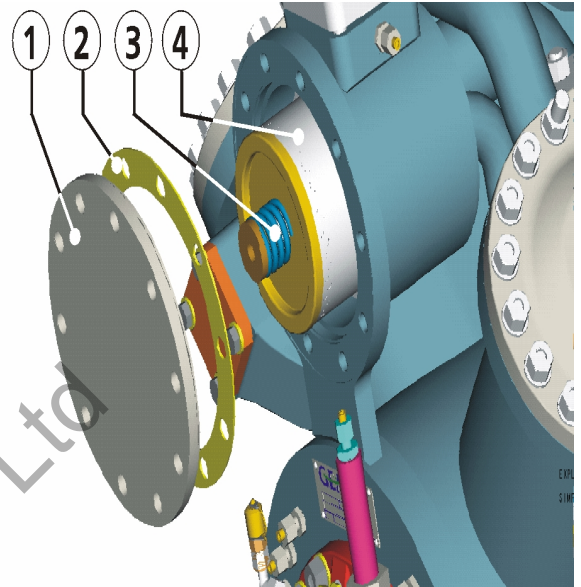


Fig.5

Legend	Description
1	Cover
2	Gasket
3	Compression spring
4	Filter

1. Remove the bolts from the cover of the suction gas filter housing.
2. Remove the cover with the compression spring and filter mounted to it from the housing.
3. After the circlip ring has been removed from the centring pin, the filter can be easily removed / serviced.
4. Remove the gasket from suction gas filter housing and replace a suction filter if it is dirtied.

2.3 DISMANTLING THE PRESSURE RELIEF VALVE HOUSING

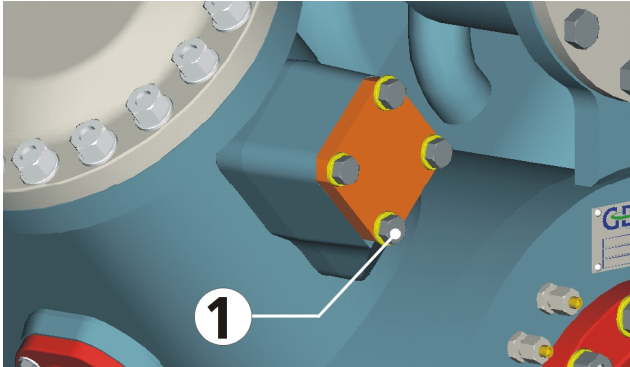


Fig.6: Back pressure dependent relief valve

The back pressure dependent relief valve is mounted against the cylinder jacket.

1. Unscrew all the hexagonal M12 bolts (1) out of the cylinder jacket.
2. Remove the entire valve.



Warning!

If there is any doubt about the proper performance of a back pressure relief valve, then the relief valve should be renewed immediately. When a pressure relief valve works improperly, discharge gas starts circulating through the cylinder head, which makes this cylinder head feel much warmer compared to other cylinder heads.

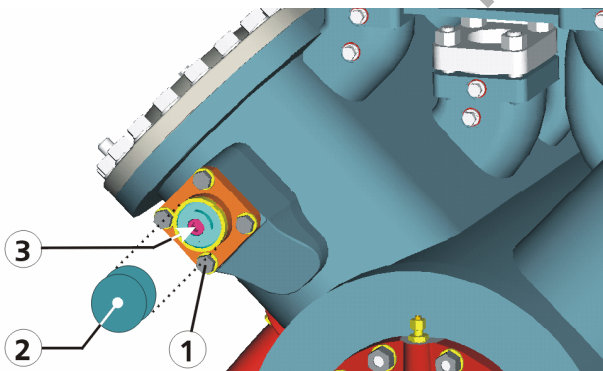


Fig.7: Back pressure independent relief valve



Hint!

For regular service it is not necessary to remove the pressure relief valve. However, if it has worked once, it can be dismantled/serviced as described in this manual.



Warning!

As shown in fig. Figure 7, Page 16 a central allen head bolt (3) is protected by a cover (2). Never tighten this bolt: Its must be kept as an untightened bolt.

Never test the relief valve by closing the discharge valve of a running compressor. This will damage the seat of the relief valve.

2.4 REMOVING DISCHARGE VALVE ASSEMBLY

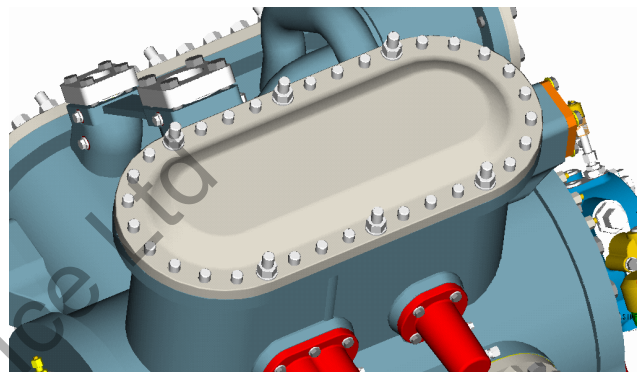


Fig.8

1. Remove dirt and paint particles from the cylinder head studs using a steel brush.
2. Oil all studs.
3. Remove all M16 nuts from the short studs.
4. Release the buffer spring tension by alternately unscrewing the nuts on the longer studs.

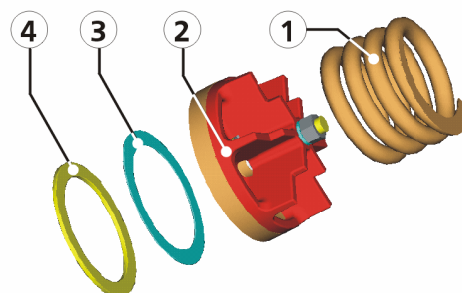


Fig.9

5. Remove the cylinder head cover, the buffer spring (1), the discharge valve assembly (2) with the suction valve sinusoidal spring (3) and the suction valve ring (4).

2.5 REMOVING THE PISTON/ CONNECTING ROD ASSEMBLY

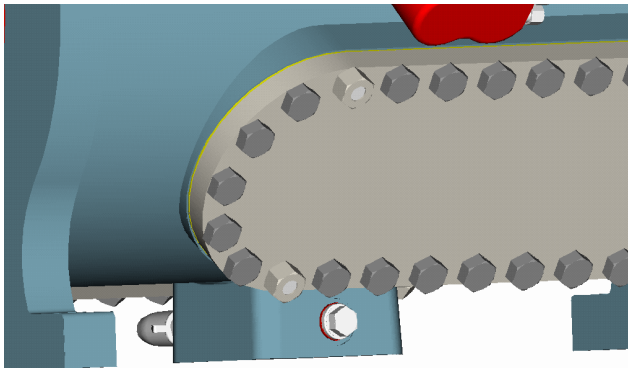


Fig.10

1. Place an oil drip tray under the service cover that is to be removed to collect the residual oil in the inclined crankcase openings.
2. Remove the crankcase cover with gasket opposite the cylinder under repair.
3. In the case of vertical cylinders, remove the opposing service cover.

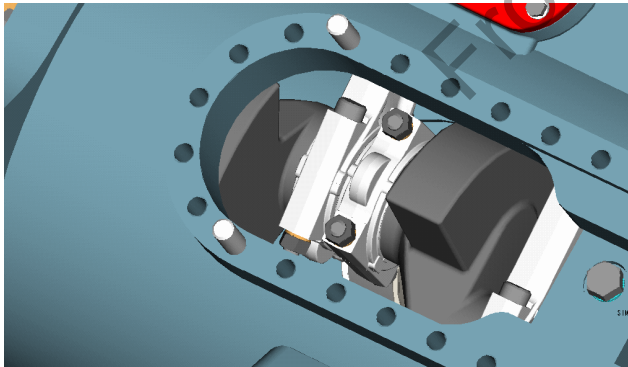


Fig.11

4. Rotate the crankshaft in such a way that the big end of the connecting rod becomes easily accessible.

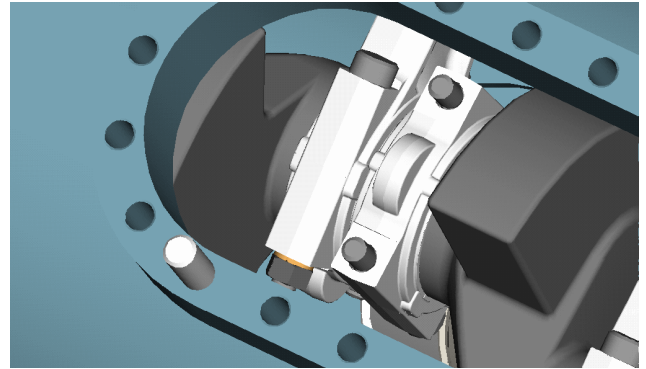


Fig.12

5. Unscrew the two MF12 nuts from the connecting rod bolts and remove the (double) locking rings.

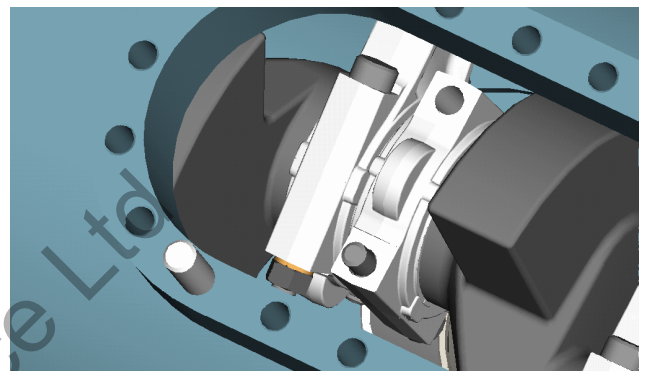


Fig.13

6. Tap up both connecting rod bolts a small amount so that the connecting rod cap can be removed easily.
7. Pull both connecting rod bolts back to their original places in the connecting rod.
8. After that, move the piston that is to be removed to top position by rotating the crankshaft by hand.

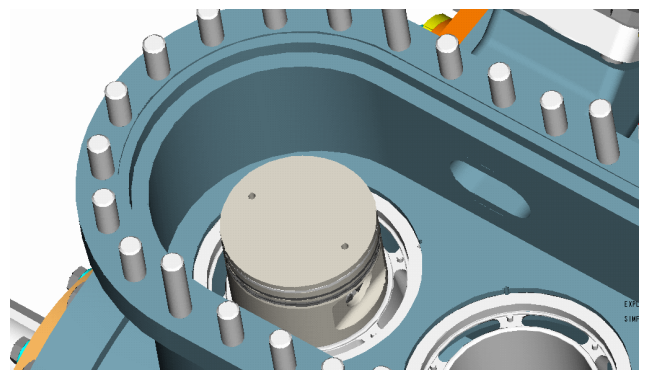




Fig.14

9. Insert the T-handles (from auxiliary tool set) into both threaded holes at the top of the piston and carefully pull the piston and the connecting rod out of the cylinder liner, making sure that the big end of the connecting rod does not damage the cylinder liner bore.

10.  **Hint!**
The connecting rod cap is marked and belongs to a specific connecting rod. There is only one way to refit it onto the connecting rod. Therefore machine numbers should always be situated on one side. Keep the corresponding connecting rod parts together!

11. Inspecting the cylinder liner bore

-  **Hint!**
Measure the bore at three places of the empty and cleaned cylinder liner, being at the top, in the middle and at the bottom, and replace if the bore is larger than is given in table “Wear limits and tolerances“.

2.6 REMOVING THE VALVE-LIFTING HOUSING AND THE CYLINDER LINER

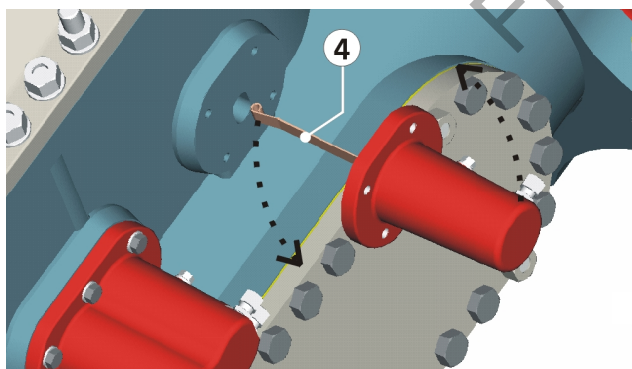


Fig.15

1. Disconnect the oil line(s) on the valve-lifting housing.
2. Mark the position of (each) valve-lifting housing on the corresponding mounting flange.
3. Remove the M8 bolts and washers of the cylinder jacket.

4. As shown by the dotted lines, move the housing in that direction (valve body up and push-handle downwards).
5. When the valve lifting housing is disconnected from the cylinder liner it can be removed outwards.
6. Remove and discard each o-ring from its groove of the mounting face in the valve-lifting housing.

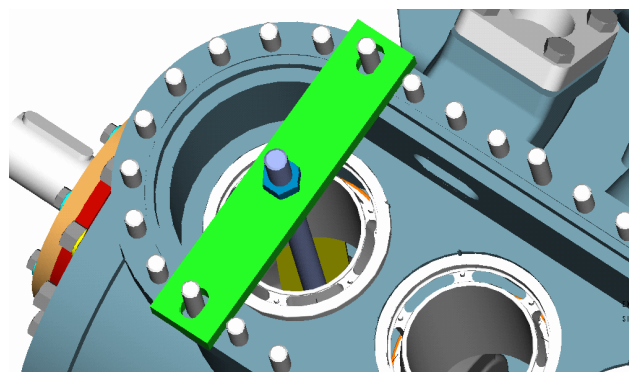


Fig.16

7. Place the longer bar¹ over two studs of the cylinder head.
8. Insert the threaded rod with nut and washer into this bar as shown above.
9. Place the short bar centrally across the bottom of the cylinder liner.
 - 9.a. Screw the threaded rod into this short bar until the assembly is fully closed.
 - 9.b. Now tighten the nut until the cylinder liner is loose.
 - 9.c. Remove the auxiliary tools and take out the cylinder liner by hand.

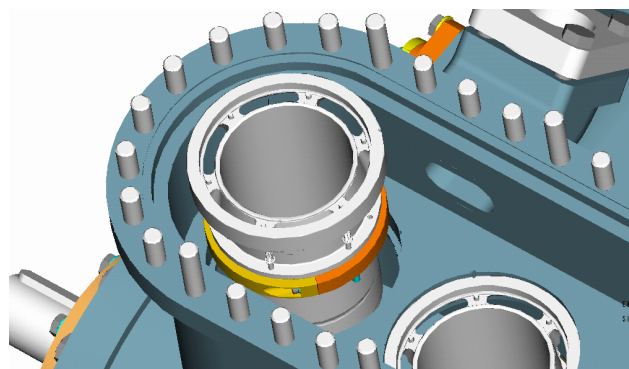


Fig.17

1 All these parts are included in the auxiliary tool set.

2.7 DISMANTLING THE ROTARY SHAFT SEAL

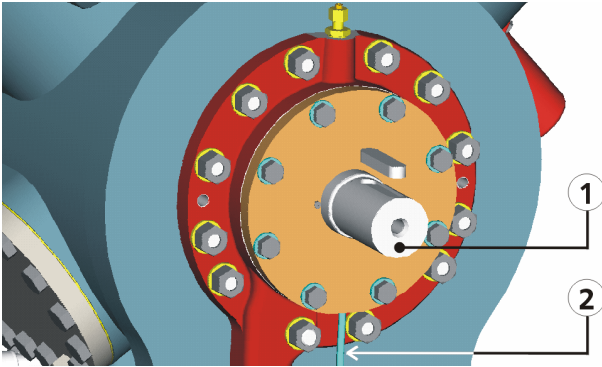


Fig.18

1. Remove drive (coupling or fly wheel)
2. Remove the drive key from the crankshaft driving end (1).

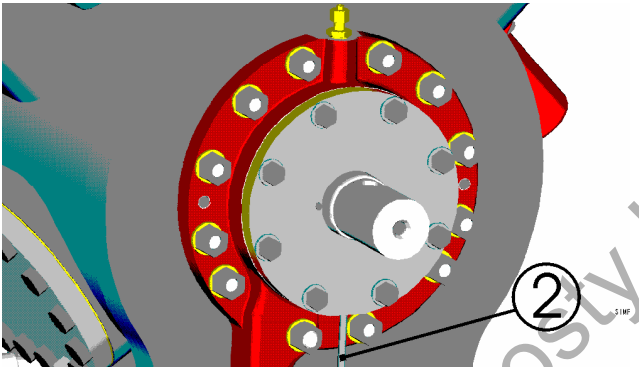


Fig.19

3. Unscrew the oil leakage drain (2) from the bottom of the shaft seal housing.
4. Place the oil drip tray under the shaft seal housing and remove the M12 bolts and washers from the shaft seal housing.

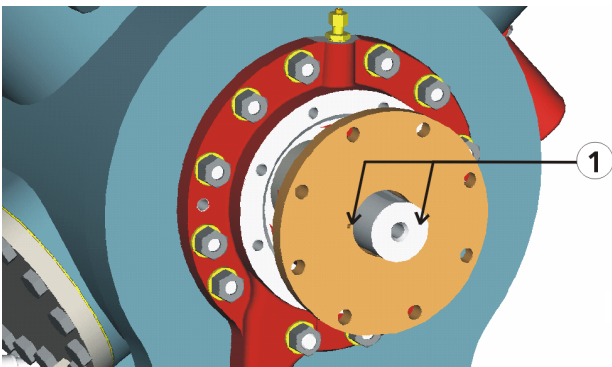


Fig.20

5. Slide the shaft seal housing over the shaft journal.

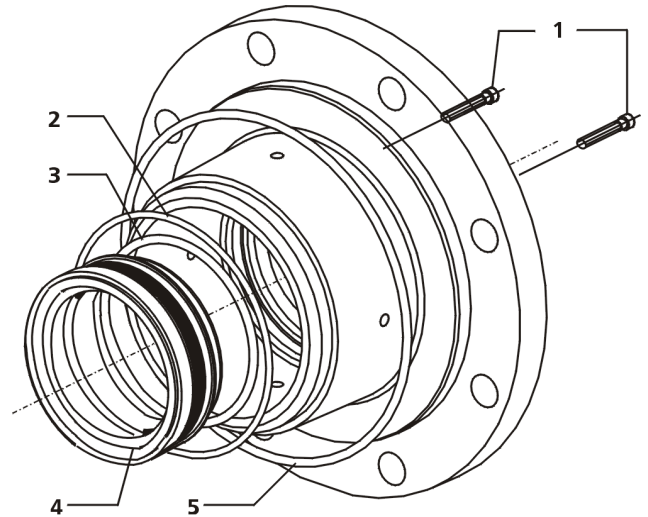


Fig.21



Warning!

Avoid touching the (black) carbon ring (if necessary wear gloves or rub your hands with oil).

6. Take the stationary slip ring (4) from the shaft seal housing by unscrewing both allen head screws (1). Remove the O-rings (3) from the counter slip ring and from the rear side of the housing (5 and 2). Put all shaft seal parts aside for inspection later on.

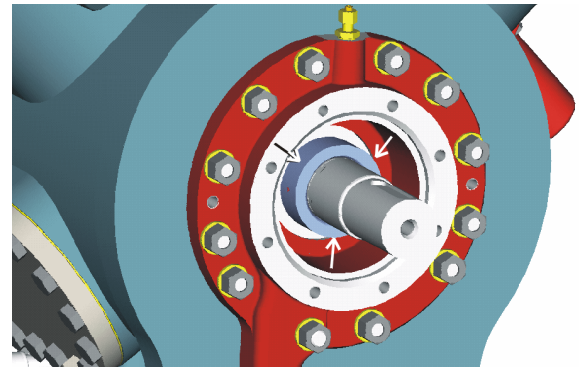


Fig.22

7. Remove the three grub screws at the circumference of the rotary slip ring using the M4 allen key from the auxiliary tool set.

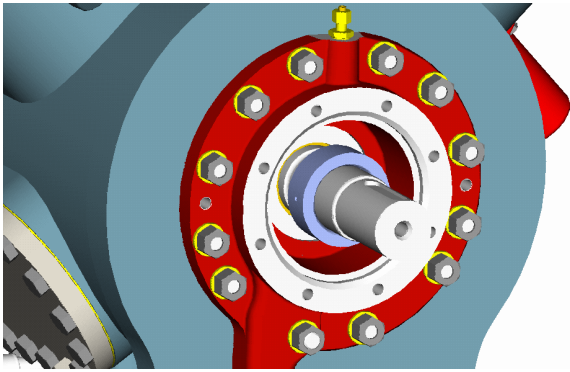


Fig.23

8. Place the legs of the pulley puller from the auxiliary tool set behind the rotary slip ring and carefully pull the slip ring until it is loose.

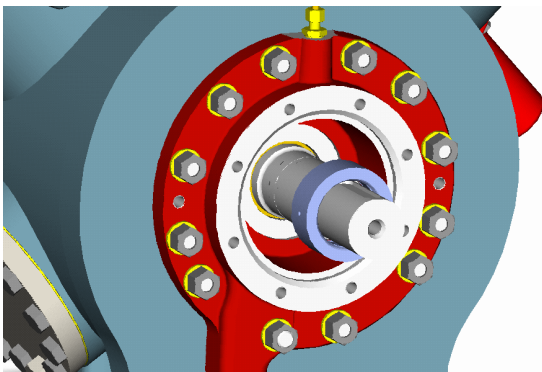


Fig.24

10. Slide the rotary slip ring from the shaft.
 - 10.a. Remove both internal o-rings and put all parts aside with the other shaft seal parts.

2.8 REMOVING OIL SUCTION AND OIL DISCHARGE FILTER HOUSING

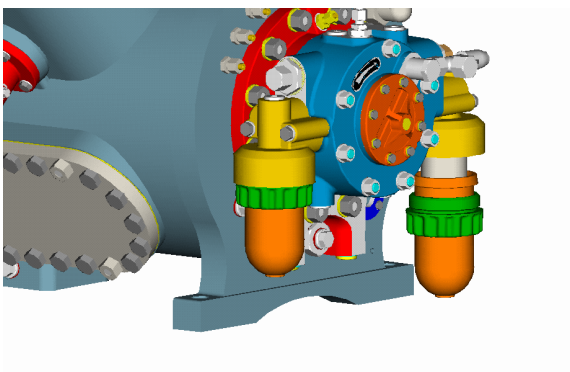


Fig.25

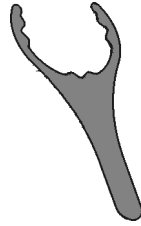


Fig.26: Special tool for removing oil filters



Hint!

Use the special tool key for removing oil filters.

1. In order to remove the entire oil suction filter (left) and/or the oil discharge filter (right), only the two M10 mounting bolts of each filter housing have to be removed.
2. Mark the filter housing to prevent interchange!

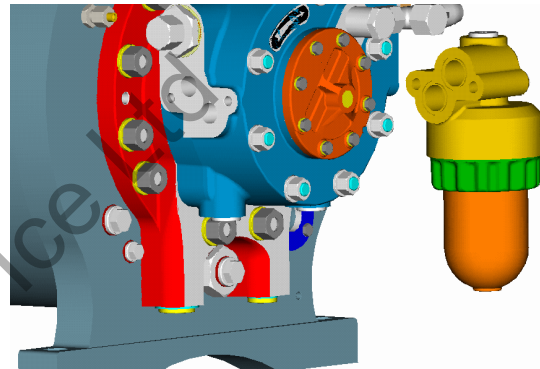


Fig.27



Hint!

If the filter elements only have to be inspected or replaced, unscrew the grooved filter nut whilst supporting the filter housing by hand. Place an oil drip tray under the filter housing to catch any spilled oil.



Hint!

As both filter housings are identical and can possibly be interchanged, every filter element is marked with a colour: - Red for the running-in oil discharge filter (replace after 100 operating hours at the most), - Blue for the oil suction filter and - Grey for the oil discharge filter.

2.9 REMOVING OIL PUMP ASSEMBLY

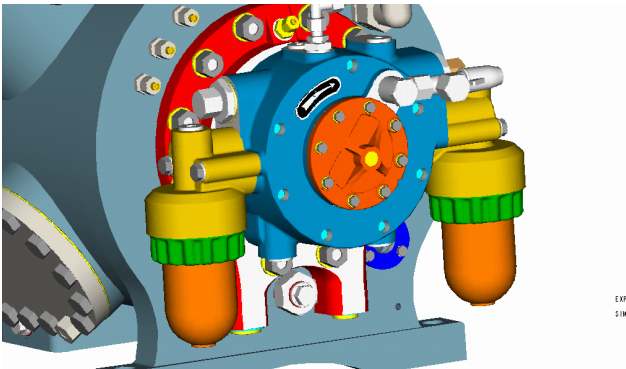


Fig.28

1. Put an oil drip tray under the pump to collect the residual oil.
 - 1.a. Unscrew the M12 nuts from the studs, remove the washers and slide the pump as a whole over the studs.



Hint!

If required, the oil pump can also be removed with both oil filters still mounted to it.

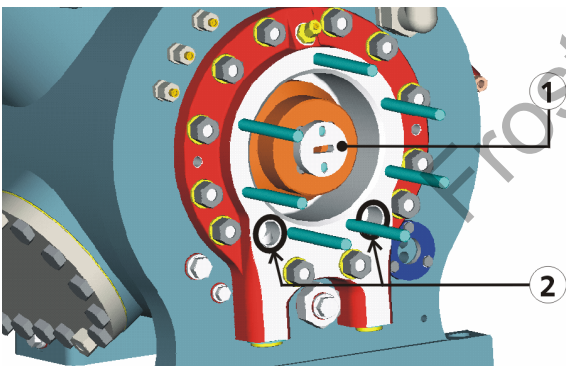


Fig.29

2. Pull the carrier disc (1) which is accessible after removal of the entire oil pump off the two securing pins.
 - 2.a. Remove the o-rings (2).

2.10 THRUST BEARING

Two types of thrust bearings have to be considered

1. Standard
 - 1.a Bronze, mark 2, (latest version), refer Figure 30, Page 22
 - 1.b Aluminium (old version), refer Figure 31, Page 22
2. Heavy duty

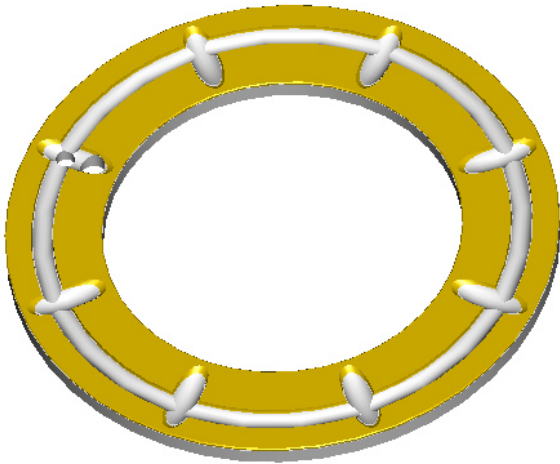


Fig.30: Standard bronze thrust bearing, "mark 2"

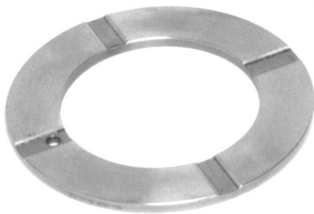


Fig.31: Old version of standard thrust bearing, aluminium.

2.10.1 DISMANTLING STANDARD THRUST BEARING

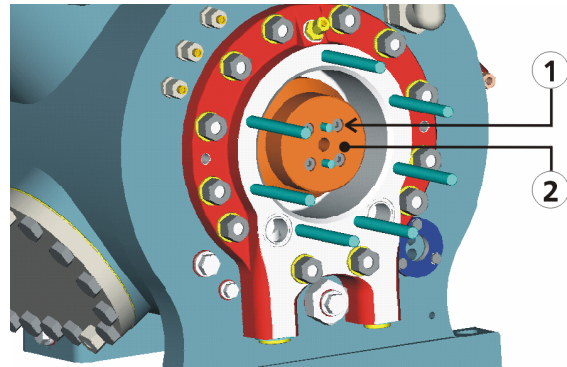


Fig.32

1. Remove the now accessible four M8 socket head bolts (1) connecting the hold down disc (2) to the crankshaft.
2. Carefully remove the hold down disc with the central dowel pin from the crankshaft.



Warning!

On the crankshaft side this hold down disc is provided with a lapped surface. Damage to this surface, as a result of rough use is very hard to repair and re-use of such a hold down disc can damage the compressor within a short time!

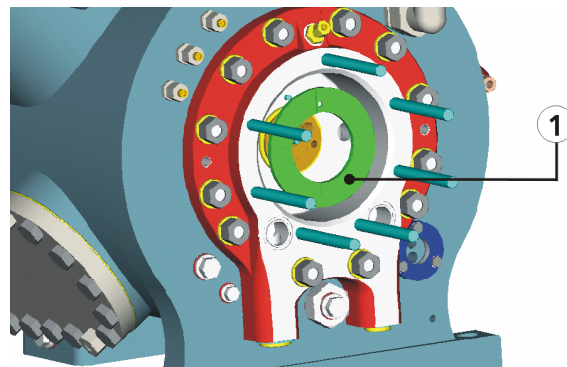


Fig.33

3. The released thrust bearing (1) can now be carefully removed with, for example, an allen key (from the new shaft seal set or auxiliary tool set).



Warning!

As the adhesive power behind the thrust bearing has to be overcome, the ring can suddenly slip off.

2.10.2 HEAVY DUTY THRUST BEARING CONSTRUCTION

In addition to the standard design there is an alternative "heavy duty" roller thrust bearing available for certain applications and consists of a twin type roller assembly. One main bearing for the outward pull of the crankshaft and a second one for inward push of the crankshaft during vacuum operation. The total assembly is pre-loaded by means of springs to ensure proper running conditions are achieved.



Hint!

Compressors fitted with roller thrust bearings can be easily recognised by an external oil overflow line running from the oil pump to one of the crankcase covers and a marking on the top of the oil pump. (Compressors fitted with the standard thrust bearing arrangement have an internal overflow back to the crankcase and no marking)

1. Remove the external oil line (1) which is connected from the top of the oil pump to the service cover.
2. Remove the oil pump. Unscrew the M12 nuts, take off the washers and slide the oil pump off the M12 studs
 - 2.a. Pay attention not to lose the springs or the spring retainer.
3. Remove the carrier disc.

Remove heavy duty thrust bearing

2.10.2.1 DISMANTLING HEAVY DUTY THRUST BEARING

Remove external oil line, oil pump and carrier disc

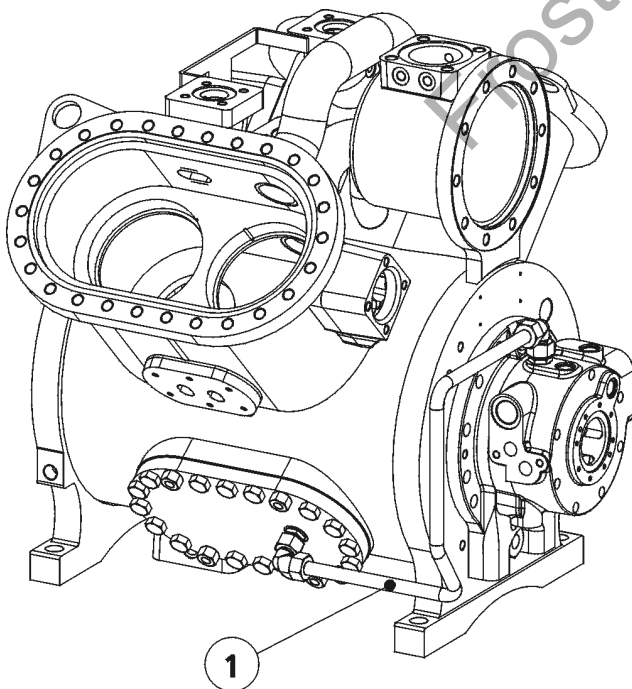


Fig.34: External oil line

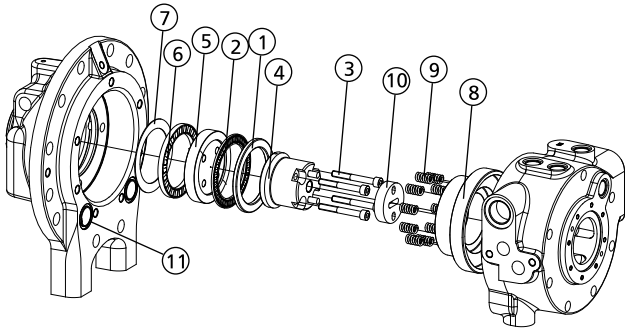


Fig.35: Heavy duty thrust bearing Grasso 10



Warning!

All running surfaces of the washers in contact with the cylindrical roller thrust bearing and the needle thrust bearing are hardened and smooth machined. Damages to these surfaces as a result of rough use are very hard to repair and reuse of such rings can damage the compressor within a short time

1. Remove the 7 mm. thick housing washer (1) from the hold down disc (4).
2. Remove the needle thrust bearing (2) from the hold down disc (4).
3. Remove the now accessible four M10 socket bolts (3) and the hold down disc (4) which is connected to the shaft washer (5).
4. Remove the shaft washer (5) from the crankshaft.
5. Remove the cylindrical roller thrust bearing (6) from the crankshaft.
6. The released 1 mm. thick thrust washer (7) can be carefully removed with a wire hook as shown Figure 36, Page 24.

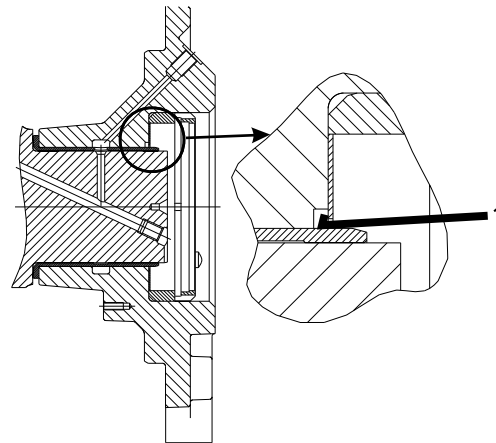


Fig.36: Remove thrust washer with hook (1)

- 6.a. The bearing cover has been equipped with three round shaped chambers to create space for a wire hook to grip behind the thrust washer for removal.



Warning!

As the adhesive power behind the 1 mm. thick thrust washer (7) has to be overcome, the ring can suddenly slip off.

7. Remove the spring retainer (8) from the oil pump housing.
8. Remove the springs (9) from the spring retainer(8)

2.11 REMOVING CRANKSHAFT, INTERMEDIATE BEARING AND MAIN BEARINGS

Introduction

1. Before starting, the following components must have been removed:
 - 1.a. All discharge valves
 - 1.b. All pistons and connecting rods
 - 1.c. Shaft seal and key
 - 1.d. Oil pump
 - 1.e. Thrust bearing



Hint!

In case of direct drive, preferably remove the crankshaft via the pump side.

Intermediate bearing in 3, 6 and 8 cylinder compressors

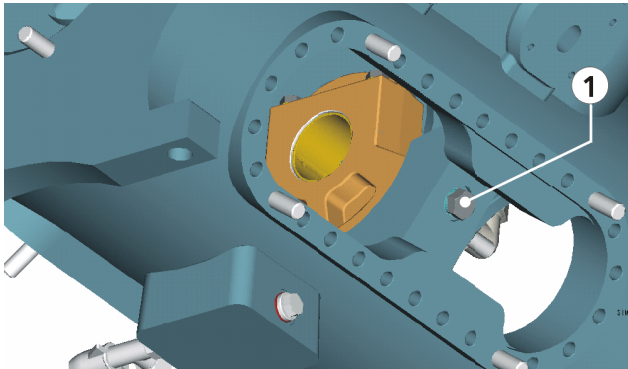


Fig.37

1. Remove both M16 bolts (1) with corresponding locking rings from the intermediate bearing support in the crankcase.

All compressors

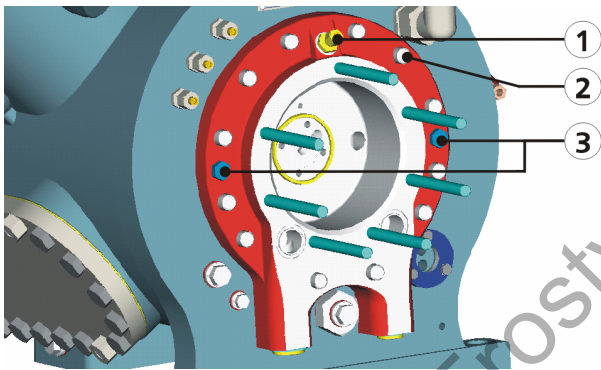


Fig.38

1. Remove the lubrication oil pressure connection (1) on top of the bearing cover on the pump side.
2. Unscrew all M12 (2) nuts from the bearing cover studs.
3. Screw two M12 (jacking) bolts (3) into the threaded holes on both sides of the bearing cover.
4. Tighten these two bolts evenly and alternately until the bearing cover is loose.

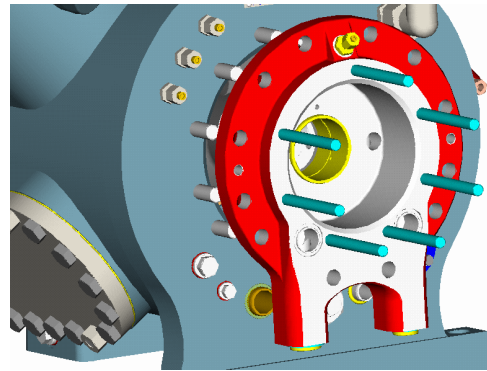


Fig.39

5. Remove the bearing cover with the corresponding O-ring on the pump side. Now the crankshaft only rests in the bearing cover on driving side. (and on the intermediate bearing of the 3, 6 and 8 cylinder compressor)

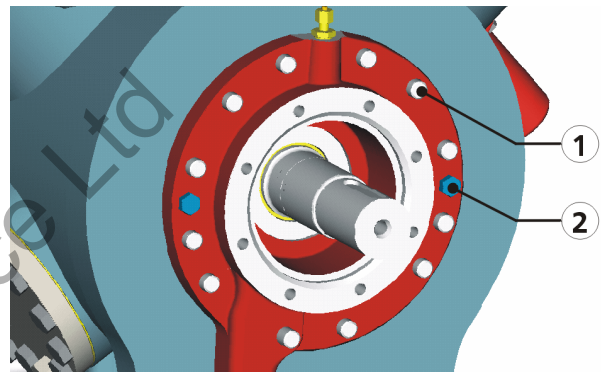


Fig.40

6. Assisted by a second person, now carefully remove the crankshaft from the crankcase through the opening on oil pump side.
7. Put the crankshaft down in a clean area.
8. If the main bearing has to be inspected only, there is no need to remove the parts mentioned.
9. Remove and discard o-rings (fig. 2.10-5 pos 1)

Removing the crankshaft

The crankshaft can more easily be removed by making a simple tool as shown in Figure 41, Page 26.

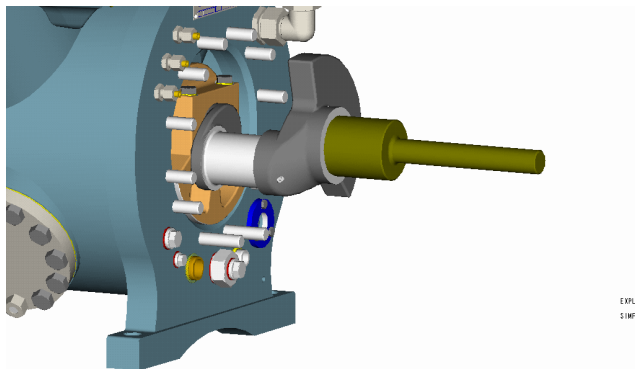


Fig.41

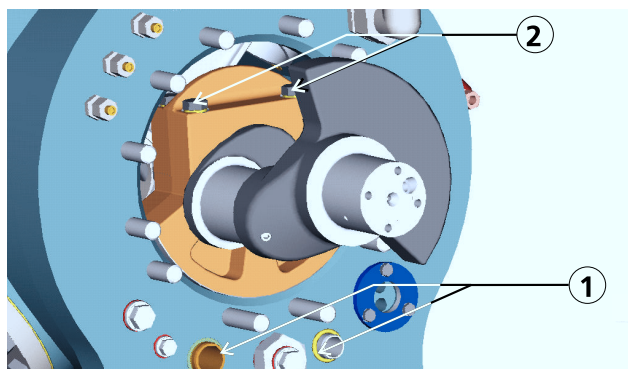


Fig.42

1. With the 3, 6 and 8 cylinder compressor, unscrew the four M16 intermediate bearing bolts (Figure 42, Page 26, pos 2).
2. Remove both bearing block halves from the crankshaft and prepare them for inspection by reassembling them to each other leaving out the crankshaft.



Hint!

The crankshaft can more easily be removed by making use of a simple tool (fig. 2.10-6). This method B (with auxiliary) is described below.

**Oil connection line/Sleeve for heating element/
Line coupling pieces**

1. All these parts can remain in place for cleaning purposes later on.

3 INSPECTION AND PREASSEMBLY



Warning!

All bolts and nuts have to be mounted according to the torques as given in table "Survey of torques for bolts and nuts" as available in this manual. If you cannot find this information, consult Grasso.

3.1 PRESSURE RELIEF VALVE ASSEMBLY

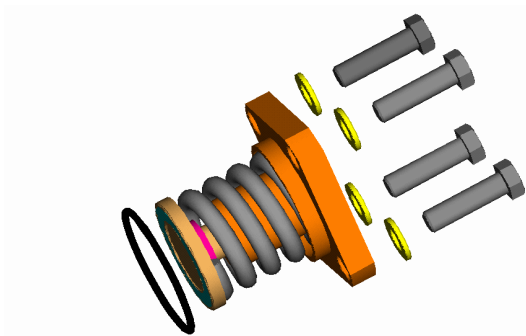


Fig.43: Back pressure dependent relief valve

Back pressure dependent relief valve

1. A defect pressure relief valve must be replaced. Repair is not possible. In these cases a new pressure relief valve has to be ordered (acc. safety regulation).

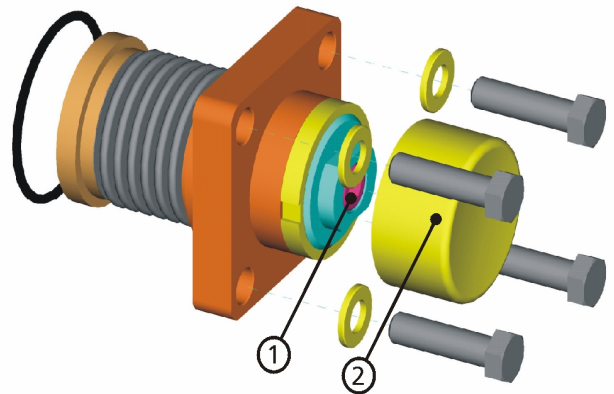


Fig.44: Back pressure independent relief valve

Legend	
1	Central bolt
2	Cap

Back pressure independent relief valve

1. This pressure relief valve is equipped with a protection cover. This cover must always remain in place! Its function is only to prevent repairing the central bolt.

The cause of a malfunctioning pressure relief valve is usually a minor damage in the teflon seal of the pressure assembly (not visible here). Check the valve seat in the crankcase jacket. If damage or wear of the teflon ring is detected, check whether this can be remedied by polishing/sandpapering. Slight wear can be remedied with polishing paper.

3.1.1 Warning independent pressure relief valves

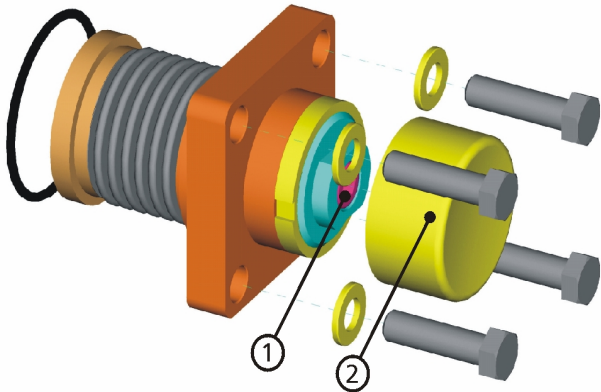


Fig.45: Back pressure independent relief valve

Legend	
1	Centre bolt
2	Cap



Warning!

The centre bolt (1) of the pressure independent relief valve is **NOT** tightened. **NEVER** tighten this bolt! Tightening this bolt will damage the compressor. (If this bolt is tightened, the relief valve is permanently opened.)



Hint!

Normally it's not required to remove cap(2).

3.2 LUBRICATING OIL PRESSURE REGULATOR

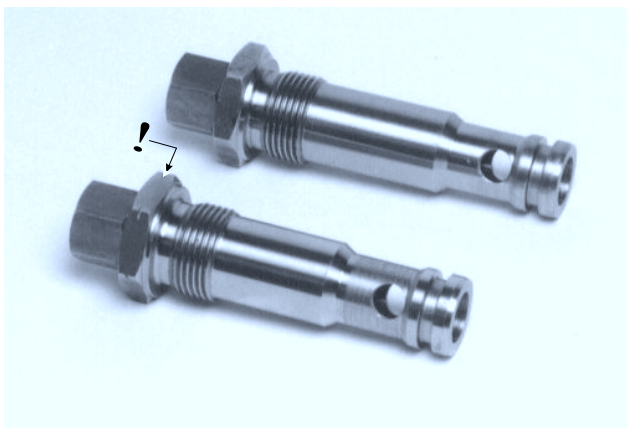


Fig.46: Oil pressure regulators

1. The lubricating oil pressure regulator (not equipped with a groove in the hexagon nut) (see Figure 46, Page 28) is fitted in the left-hand side of the pump and can be taken out with the help of a ring spanner or socket spanner 41, provided that the oil suction filter has been removed.

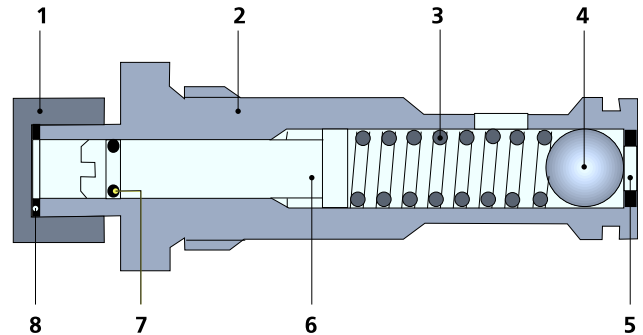


Fig.47

Legend	
1	Cap
2	Housing
3	Pressure spring
4	Ball
5	Circlip ring
6	Set bolt
7	O-ring
8	Alu-ring

2. Renew O-ring (7) and Alu-ring(8)

All parts forming the regulator do not need wear inspection, but it is recommended to clean all (disassembled) regulator parts, to oil them with compressor oil and to reassemble.



Hint!

The pressure can be adjusted with a screwdriver only during operation.

3.3 CONTROL OIL PRESSURE REGULATOR

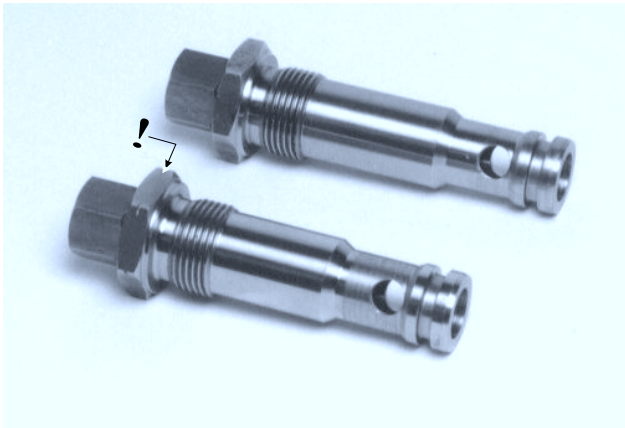


Fig.48: Oil pressure regulators

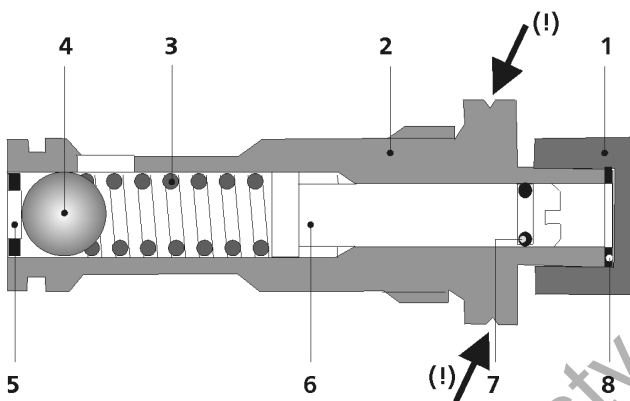


Fig.49: Control oil pressure regulator

1. The control pressure regulator (equipped with a groove in the hexagon nut, see lower regulator in Figure 48, Page 29) fitted in the right-hand side of the pump can be taken out with a ring spanner or socket spanner 41, provided that the oil discharge filter has been removed.
2. Disassemble, inspect and reassemble as described in relation to the lubrication oil pressure regulator.

3.4 VALVE-LIFTING CONTROL MECHANISM

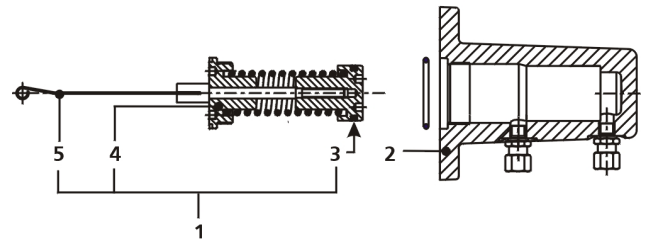


Fig.50

Legend	
1	Piston assembly
2	Housing
3	Quad ring

The valve-lifting control mechanism mainly consists of two parts: the control piston assembly (1) and the housing (2).

For inspection/servicing the control piston assembly the pin wrench {Tool set} is needed to release the control piston from the housing:

1. Place the housing in the vice such that the control piston assembly can be unscrewed with the pin wrench.



Hint!

In the case of irreparable damage or wear of any part, a complete control piston assembly has to be ordered.

2. The condition of the compression spring can be checked by measuring the force required to compress the spring into the housing. The force required should be 26 kg or more. If less than 26 kg the control piston assembly should be renewed.
3. For renewal of the control piston assembly, disassemble as given in the next procedure:
4. 4.a. Clean the control piston bore in the valve-lifting housing and check this for wear or slight damage (which may be remedied with polishing paper) and replace the housing if the bore is over value as given ()

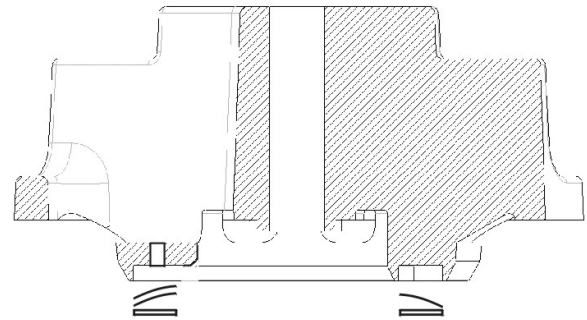


Hint!

The valve-lifting control mechanisms must be fitted in the original position.

- 4.b. Fit the control piston assembly in the oiled valve housing, with a new quad ring using the pin wrench.

Check the eye of the push handle is in the correct vertical hook-up position.



3.5 DISCHARGE VALVE ASSEMBLY

General

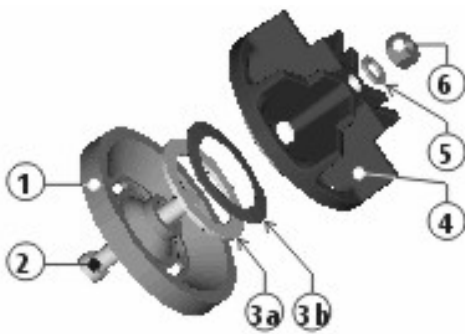


Fig.51

- 1. Put an 8 mm allen key into the central bolt of the discharge valve assembly.
 - 1.a. Clamp the allen key into the vice and remove the M16 nut (6) from the central bolt (2), the double locking ring (5), the discharge valve stroke limiter (4), the sinusoidal spring(s) (3b) and valve ring (3a).
 - 1.b. Thoroughly clean all valve parts and the valve seat (1).

Fig.52: Left= "H valve model"; Right="L valve model"

- 2.a. Inspect the discharge valve stroke limiter and the valve ring area for wear.
- 2.b. In case of wear [shifting of valve ring and valve spring(s)] or damage due to another cause, the discharge valve stroke limiter has to be renewed.



Fig.53

- 3.a. Replace the discharge valve sinusoidal spring(s) when they are damaged/ discoloured and when the untensioned height "h" is less than:
 - 4.5 mm for the sinusoidal springs of the both "L" and "H"-valve model.
 Also replace the valve seat if the total wear of the seat is over 0.2 mm.

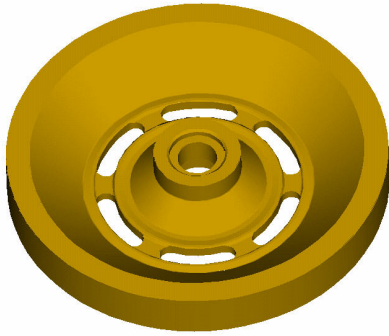


Fig.54

- 4.a. Check the discharge valve seat for damage, wear or scoring. If during this inspection the stroke limiter appears to have made contact with the piston, the connecting rod bearings have to be checked as well; the clearance should then be determined.

Preassembling the discharge valves

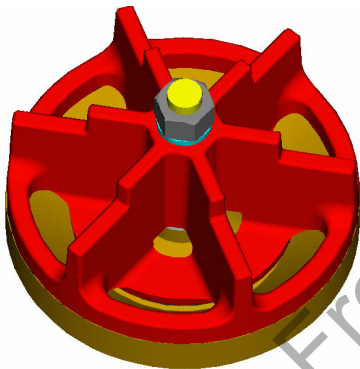


Fig.55

1. Place each sinusoidal spring (with the convex side facing the stroke limiter) and the discharge valve ring into the stroke limiter.
 - 1.a. Place the combined suction/discharge valve over it.
 - 1.b. If necessary, adjust the clamped valve ring and valve spring(s) with a screwdriver until the cam of the stroke limiter touch the valve seat.
 - 1.c. Fit the (M16) central bolt with a nut and a new double locking ring {for fitting into position see fig. Figure 51, Page 30}.
 - 1.d. Tighten this bolt/nut joint to the torque as given in table "Wear limits and tolerances".



Hint!

To check leakage of the discharge valves, a leak test after 4 running hours of the compressor is strongly recommended. Refer Section 4.15, Page 58.

Suction valve

1. Replace the suction valve sinusoidal spring(s) when they are damaged or discoloured and when the untensioned height "h" is less than 11.5 mm ("H"-valve model) or < 4.5 mm ("L"-valve model).
 - 1.a. Also replace the valve seat if the total wear of the valve seat is over 0.2 mm.
 - 1.b. Also check the suction valve ring and replace it if there is any sign of damage.

3.6 PISTON/CONNECTING ROD



Fig.56

General

1. Place the assembly upside down on the working bench and remove one circlip ring from the gudgeon pin bore.

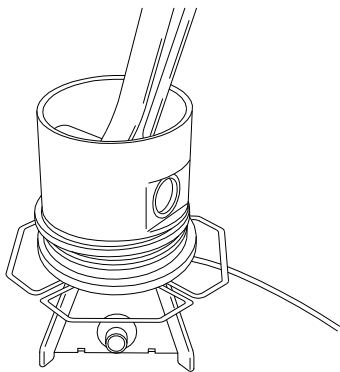


Fig.57

2. Heat the piston to approximately 80 °C
3. NEVER HEAT WITH OPEN FLAME! Pouring a little spirit into the piston and lighting it works just as well.
 - 3.a. Push the gudgeon pin out of the piston.
 - 3.b. Check the (cooled) gudgeon pin for wear and measure the outer diameter using an outside micrometer and replace the pin if the diameter is smaller than as given in table "Wear limits and tolerances".



Fig.58: 16

Connecting rod

1. Assemble the bearing shells and the connecting rod cap together.
 - 1.a. Tighten the nuts on the connecting rod bolts to the torque given in table "Survey of torques for bolts and nuts Grasso 10".
 - 1.b. Measure the bore of the clamped bearing with an inside micrometer and replace if it is larger than as given in table "Wear limits and tolerances".
 - 1.c. Check the bronze bearing bush (for the LP cylinders) in the small end of the connecting rod for wear or damage.

- 1.d. With an inside micrometer measure the bore of the still fitted bronze bearing bush and replace if it is larger than as given in table "Wear limits and tolerances".
- 1.e. Insert a new bearing bush by lowering the non-heated bearing bush into the small end of the connecting rod which has been heated to approx 100 °C.
- 1.f. Check the condition of both needle bearings (for the HP cylinders) and replace if necessary.
- 1.g. Insert new needle bearings as described for the bearing bush.

Piston

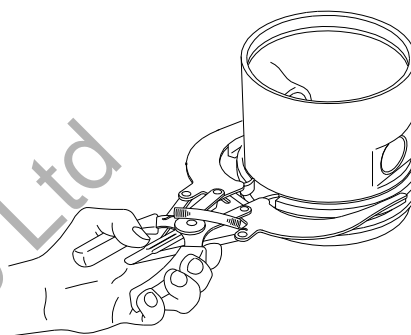


Fig.59

1. Remove the two piston rings and oil scraper ring using the appropriate piston ring pliers.
 - 1.a. Check the piston grooves for burrs, notch effects and cracked or broken grooved edges.

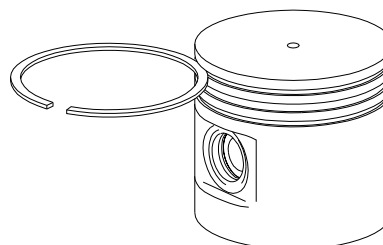


Fig.60

2. Roll each piston ring and oil scraper ring in the corresponding groove around the piston to trace parts that have become wedged. This can be remedied, for example, by using a smooth file.

3. 3.a. Also check the rest of the piston for wear or damage.



Fig.61

4. Check the gap in each piston ring by placing it in an unworn part of the cylinder liner. These unworn parts can be found at about 15 mm from the top and the bottom of the cylinder liner. The maximum gap may not exceed 1.2 mm.

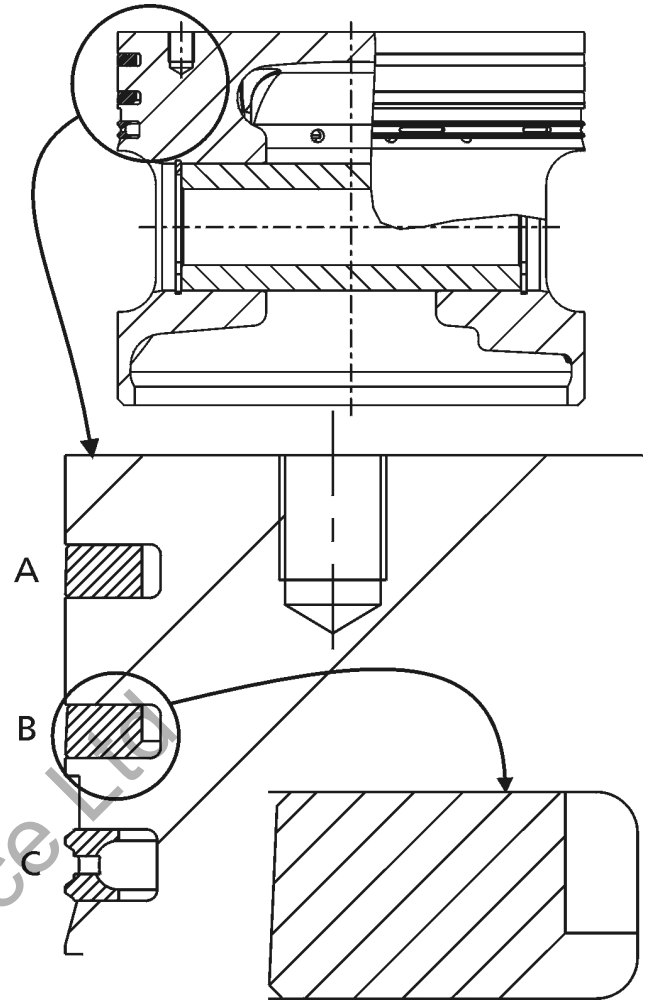


Fig.62: Piston

Legend	
A	Minute ring (chrom)
B	Reverse torsional (RT) minute ring (black)
C	Oil control ring

Preassembling the piston/connecting rod



Warning!

Never use new piston rings in combination with a worn out cylinder liner.

1. If the piston rings and oil scraper ring are no longer on the piston, fit them in the sequence as shown. Never use a combination of old and new rings. While placing the rings, pay attention to the word "TOP" on each ring.



Fig.63

2. Clean the connecting rod and blow out the oil passageway in the connecting rod.
 - 2.a. When replacing the bearing bushes or needle bearings, heat the small end of the connecting rod to approximately 80 °C.
 - 2.b. Insert the bronze bearing bush (for LP cylinders) or the needle bearing (for HP cylinders) into the small end of the connecting rod.
 - 2.c. Check that the needle bearings project equally on both connecting rod ends.
 - 2.d. Let the connecting rod cool off in ambient air.
 - 2.e. Fit the bearing shells in both connecting rod ends. Due to the built-in fixing cams one assembled position is possible.

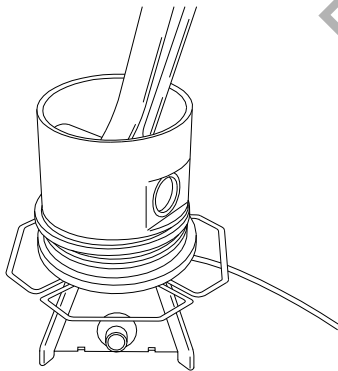


Fig.64

3. Heat the piston to approximately 80 °C, NEVER HEAT WITH AN OPEN FLAME!
4. Pouring a little spirit into the piston and lighting it works just as well.
 - 4.a. Degrease the gudgeon pin and oil it.
 - 4.b. Check whether the gudgeon pin fits properly into the connecting rod.

- 4.c. Place the connecting rod into the piston and slide the oiled gudgeon pin through the piston into the connecting rod onto the still fitted circlip ring.

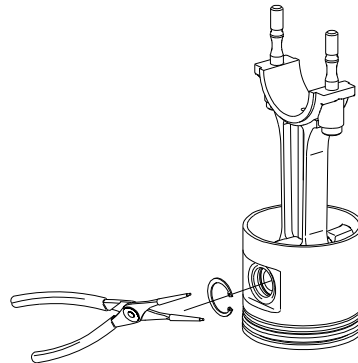


Fig.65

5. Lock the gudgeon pin with the other circlip ring.

3.7 CYLINDER LINER AND VALVE-LIFTING MECHANISM

General

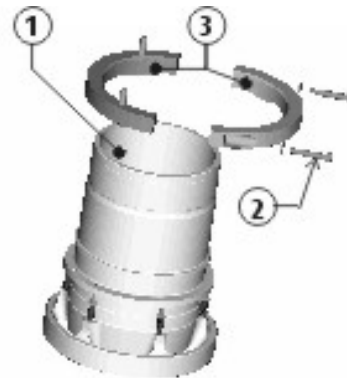


Fig.66: Remove cam ring

1. Refer to Figure 66, Page 34. Place the cylinder liner upside down on the working bench, unscrew both fitted bolts (1), remove both locking rings (2) and subsequently remove both cam ring halves (3) from the cylinder liner.

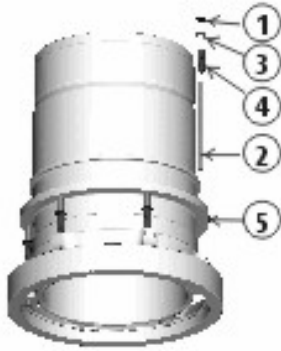


Fig.67: Remove others

2. Refer to Figure 67, Page 35. If necessary, remove the circlips (1) of the 6 push pins (2) and subsequently the 6 push pins, the washers (3) and springs (4).



Fig.68: Cilnder liner

3. Clean all parts
 - 3.a. Check the suction valve ring seat in the cylinder liner collar for damage or locally worn away honing marks.
 - 3.b. It is not necessary to check the cylinder liner diameter if the honing marks in the cylinder liner bore are still completely there. Irregularities can be carefully polished out with abrasive paper.
 - 3.c. Check the outer surface of the cylinder liner especially the operating area of the cam ring for damage and polish out slight damage with abrasive paper.
 - 3.d. Also check the assembled cam ring (pos 1, 2 & 3 of fig. Figure 66, Page 34 on the inside.
 - 3.e. After truing up the inner and/or outer surfaces, check whether the cam ring moves smoothly around its running face of the cylinder liner.

Preassembling the valve-lifting mechanism

1. Before starting, oil all parts with compressor lubricating oil.
 - 1.a. Place the cylinder liner, with the collar down on the working bench.
 - 1.b. Mount the 6 push pins (2) through the holes of the lowest guide ring (5) of the cylinder liner, fit the washers (3) and springs (4) and subsequently insert the push pins through the holes of the cylinder liner collar.
 - 1.c. Place the circlips (1) on the push pins so the washer will be inbetween the spring and locking ring.
 - 1.d. Assemble the cam ring around the cylinder liner with the cams facing downwards onto the cylinder liner. Tighten the bolts to the torque as given in Section 5.1, Page 59.

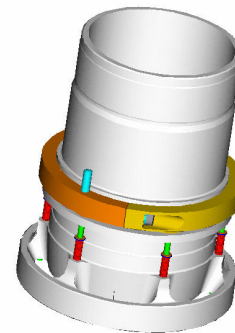


Fig.69

- 2.a. Check that the push pins drop just beneath the suction valve ring when resting on the lower part of the cam ring.



Hint!

Type of push pin depends on refrigerant and operating condition of the compressor (Type 'L' or 'H'). Be sure that push pins of different compressors will not be exchanged. Refer Parts Manual for additional information.

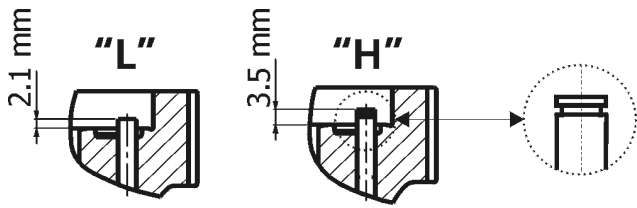


Fig.70

3.8 OIL PUMP AND OIL FILTERS

General

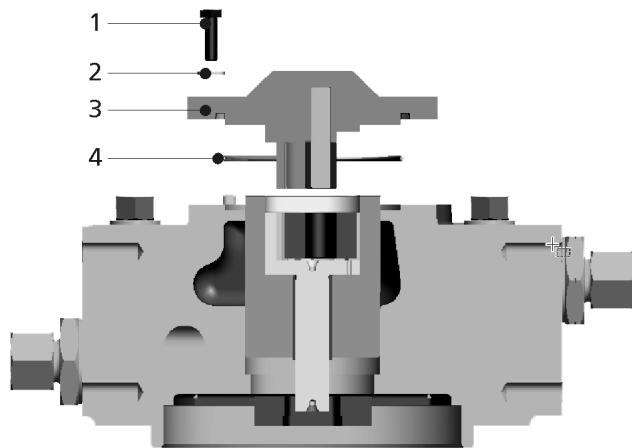


Fig.71

1. Place the pump on the working bench and unscrew the eight M6 fixing bolts (1) in the pump cover out of the housing and remove the washers (2) and the pump cover (3) with the integrated pump element.
 - 1.a. Remove the O-ring (4).

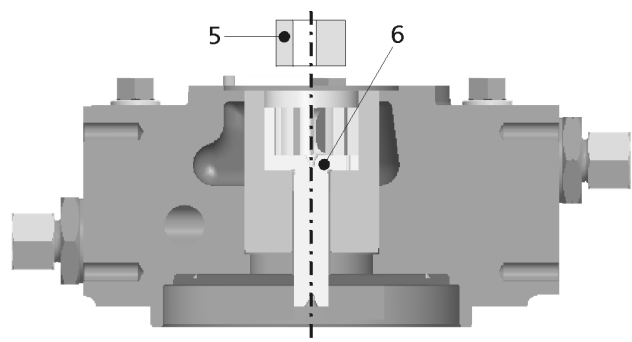


Fig.72

2. Remove the pump gear (5) from the crown wheel (6) of the pump element/bearing assembly.
3. Clean the pump housing and the pump cover with a non-fibrous cloth

Removing the pump element/bearing assembly

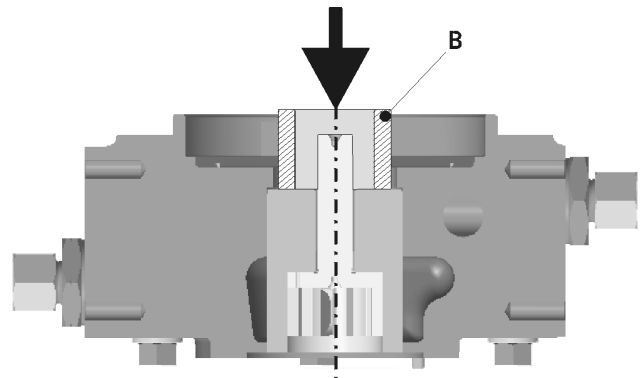


Fig.73

1. Place the pump housing with the pump cover fixing face in central position and pointing downwards under a press (take precautionary measures that the fixing pin, indicated with arrow! does not break).
 - 1.a. Place an auxiliary bush (B) with an outer diameter $\varnothing D < 60\text{mm}$ and an inner bore $\varnothing d > 45\text{mm}$ over the crown wheel shaft. In this position the pump element/bearing assembly can easily be pressed out with a hydraulic press.

Inserting a new pump element

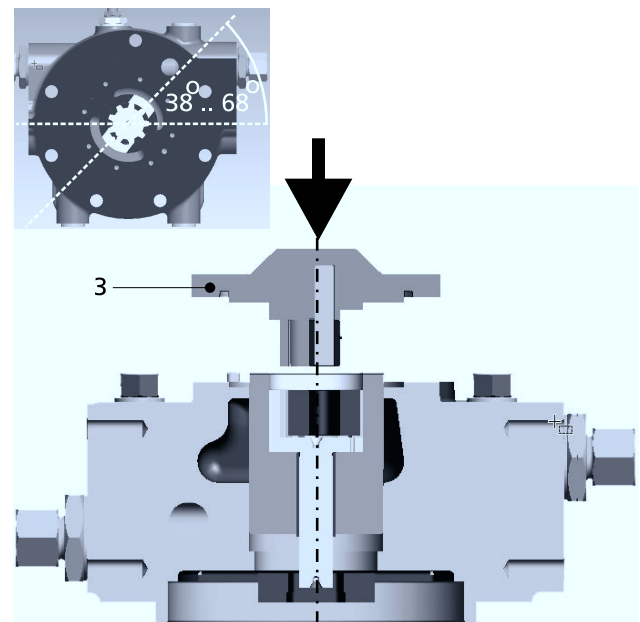


Fig.74

1. Ensure that the bore and the contact face in the pump housing are clean and oiled.


2. Place the pump housing with the bearing cover fixing face in central position and pointing downwards, using the pump cover(3)(!), under a press.

Make sure the oil canals in the oil pump assembly are aligned with the oil canals in the oil pump housing.

The oil pump direction is determined by the position of the cover.

3. Carefully press the pump element into the housing with the cover until the contact face has been clearly reached.

Take care the positioning pin is aligned with the oil pump cover.

4.  **Hint!**
Check that pump element can be rotated by hand!

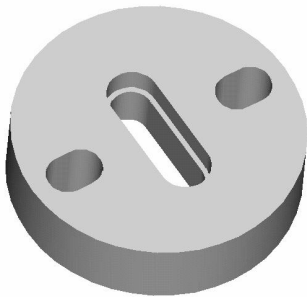


Fig.75: Carrier disc

5. Remove the carrier disc from the crankshaft journal and check the condition of the slot and the holes of the carrier disc.

Reassembling the oil pump

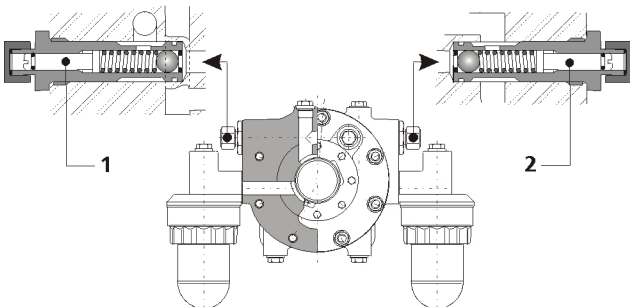


Fig.76

1. Lightly oil all parts mentioned below before reassembly!

- 1.a. Insert into the housing: new O-rings in the internal oil passageways, the plugs provided with new alu-washers, the lubricating oil pressure regulator (1) in the left-hand part of the housing and the control pressure regulator (2) in the right-hand part of the housing.



Hint!

The shorter control pressure regulator has a groove on the hexagon nut. The longer lubricating oil pressure regulator does not have a groove.

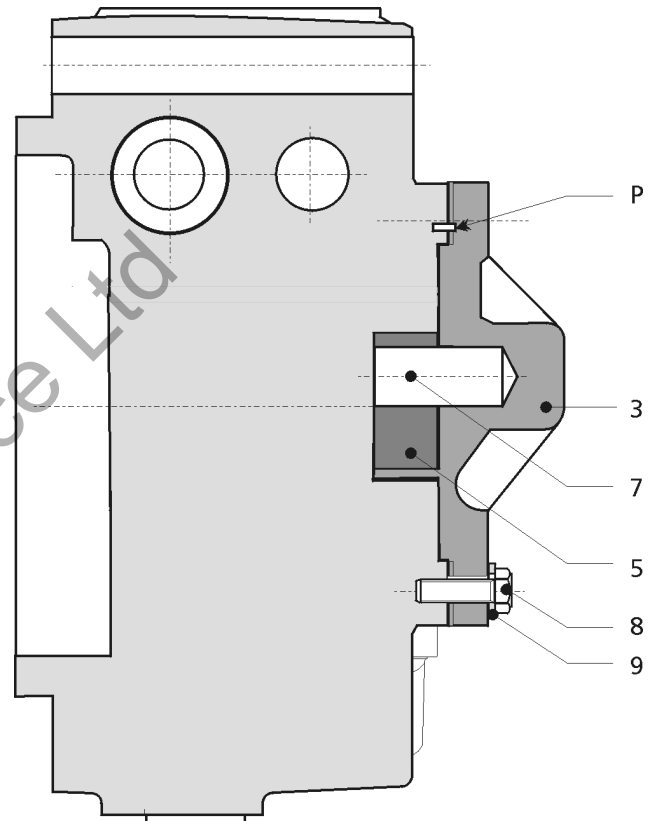


Fig.77: Pump detail

2. Slide the pump gear (5) onto the shaft (7) of the pump cover (3).
 - 2.a. Place the pump housing on its side and insert the preassembled pump cover element provided with a new O-ring in such a way that the fixing pin (P) fits into the corresponding hole.
3. Tighten the eight M6 bolts (8) provided with washers (9) in the pump housing to the torque given in table "Survey of torques for bolts and nuts"(Chapter 5, Page 59).

- 3.a. Check that the pump rotates smoothly; if this is not the case, the pump element is not pressed far enough inside the oil pump housing.
- 3.b. Place the preassembled pump in a separate clean area to be mounted onto the bearing cover later.

Filter elements



Hint!

Filter elements can also be replaced when the filter housings are still mounted to the compressor.

Use special tool to remove oil filters

1. In order to reach the oil suction filter or oil discharge filter element, only the lower housing half has to be removed by supporting the housing and unscrewing the grooved nut.

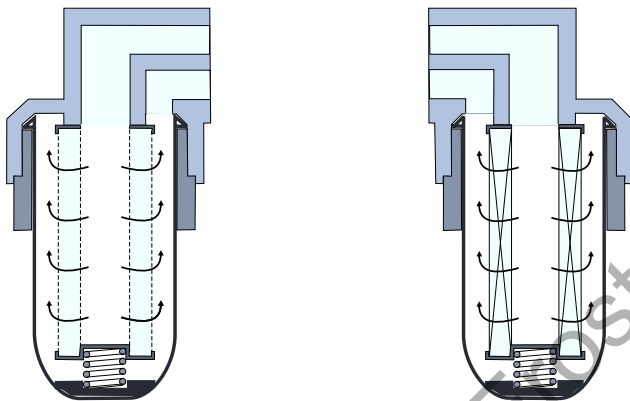


Fig.78: Oil suction and oil discharge filter

- 1.a. Pay attention to the residual oil in this filter bottom
- 1.b. For a total inspection both the upper filter housings can be removed from the pump housing by unscrewing both M10 bolts.
- 1.c. Remove the filters as described
- 1.d. Whilst the the oil suction filter element is cleanable, it should be replaced in case of damage or serious pollution.
- 1.e. The red "running-in" oil discharge filter element is to be replaced by a grey one after 100 running hours.
- 1.f. Renew a polluted grey-marked oil discharge filter element.

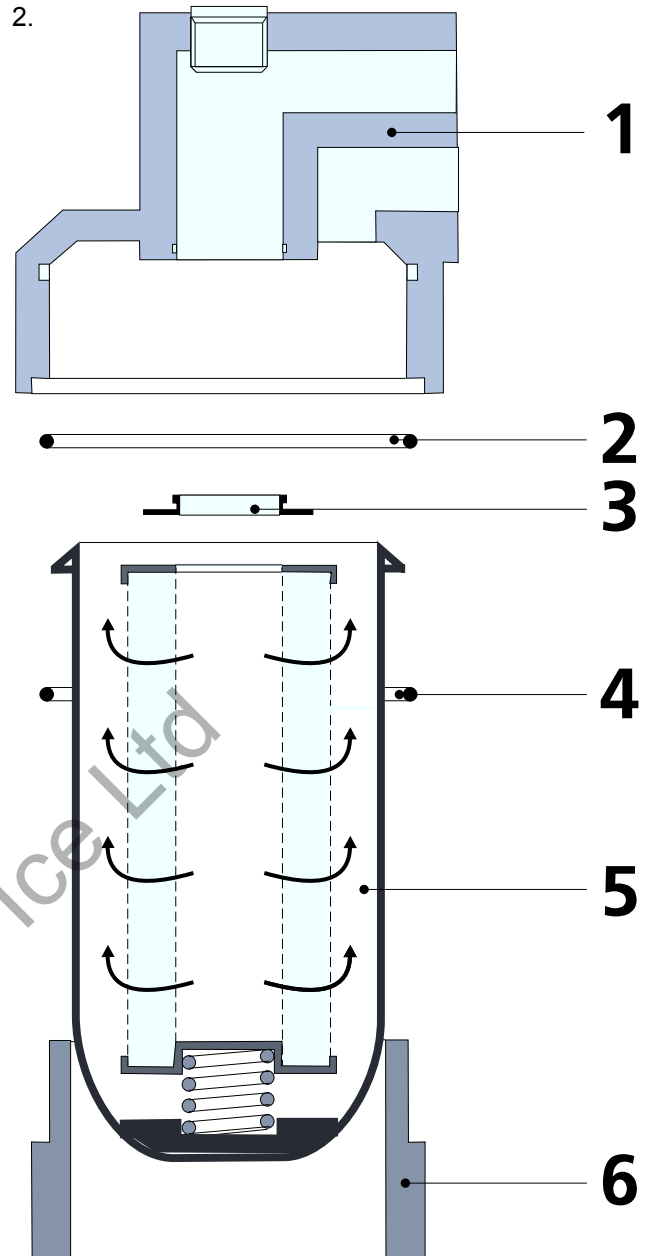


Fig.79

Remove the O-rings (2 and 4) and the seal (3).

- 2.a. Clean both filter housings (1 and 5) and the internal (connecting) passageways.
- 2.b. Insert each filter in the corresponding filter housing and reassemble them with a new set of seals², a washer (3) and new O-rings (2 and 4).

² Only available as set under Ref. No. 09.90.030.



Hint!

In order to avoid damaging the seals, the filter housing (5) should not revolve together with the grooved nut (6).



Hint!

After having dis-assembled the discharge filter element, check this for contamination, in particular for the presence of aluminium and/or white metal slide-bearing particles which would require further investigation in other parts of the compressor. In this case, regularly check the oil quality by means of an oil analysis.

Verwijderd nav wijzing oliepomp, KK, 8 mei 2008

3.9 MAIN BEARINGS

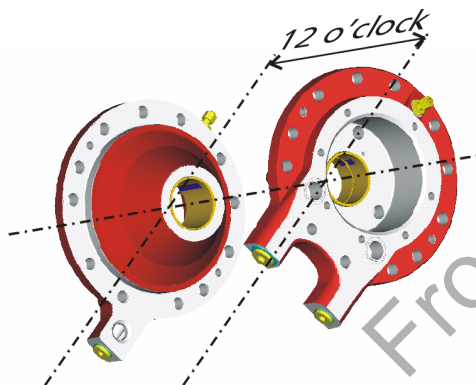


Fig.80: 41

General

1. Check both main bearing bushes, while they are in their respective bearing covers, for worn out white metal inner lining.
 - 1.a. Replace the bush(es) if the inner lining shows abnormal wear and also if the bore is over 65.092 mm.
 - 1.b. Especially check those crankshaft parts rotating in the bearing covers. Eliminate slight damage using fine polishing paper.
 - 1.c. Check the thrust face on the collar of the bearing bush on oil pump side for wear and replace it if the oil grooves show signs of wear.

Preassembling the bearing covers

1. Bearing cover on driving side:

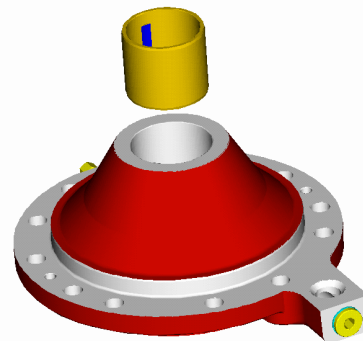


Fig.81: 42

2. When replacing a bearing bush, proceed as follows:
3. Push or press (using a hydraulic press) the old bearing bush out of the bearing cover.
 - 3.a. Draw, for instance with a felt pen, a longitudinal line and over the full length on the outside of the new bearing bush above the centre of the oil chamber.
4. Oil the bearing bush and place it with the internal chamfer facing upward and over the bore in the bearing cover in such a way that the oil passage-way is in line with the locking pin.

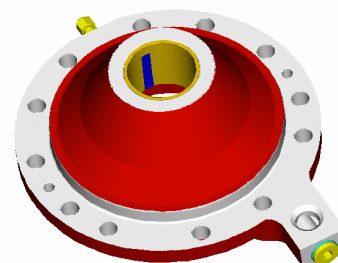


Fig.82: 43

- 4.a. Slowly press the bearing bush (using a hydraulic press) into the bearing cover, making sure that the bearing bush is not displaced.

1. Bearing cover on pump side;

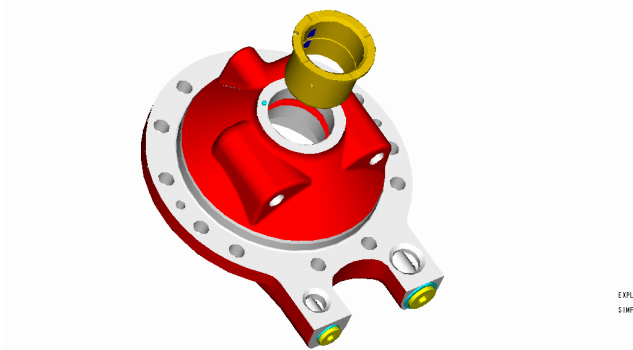


Fig.83: 44

When the bearing bush requires replacement, proceed as follows:

2. Push or press (using a hydraulic press) the old bearing bush out of the bearing cover.
 - 2.a. Draw a longitudinal line, for instance with a felt pen, on the outside of the new bearing bush from the centre of recess "A" (to the left of oil chamber "B") as far as the collar-less end.

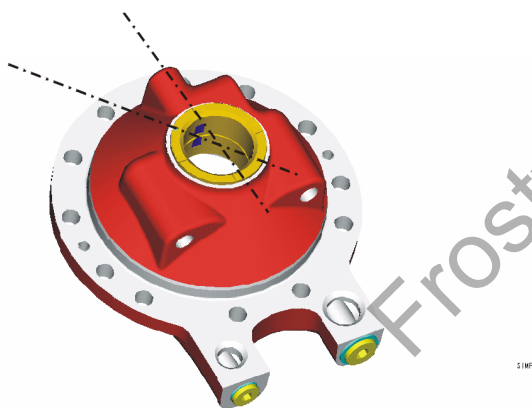


Fig.84: 45

3. Oil the bearing bush and position it above the bore in the bearing cover, so that the line drawn with the (felt) pen is in line with the locking pin.
 - 3.a. Slowly press the bearing bush (using a hydraulic press) into the bearing cover, making sure that the drawn line is not displaced, in order for the locking pin on the left-hand side (projecting 3 mm above the bearing cover) to be pressed entirely into recess "A".
 - 3.b. Blow through using compressed air all oil passageways and finally fit the nipple couplings into place.

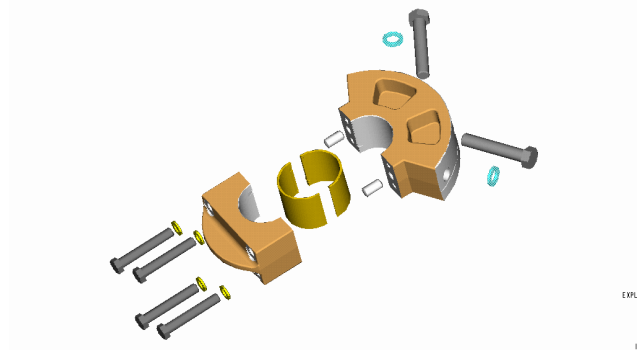


Fig.85: 46

4. Inspect the intermediate bearing for visual wear and for possible scoring of the white metal inner lining.
 - 4.a. Assemble the intermediate bearing with the stamped-in numbers on one side and tighten the intermediate bearing bolts (see table "Survey of torques for bolts and nuts Grasso 10").
 - 4.b. Measure the inside diameter and replace the split bearing shell when it is over 65.092 mm.

3.10 ROTARY SHAFT SEAL

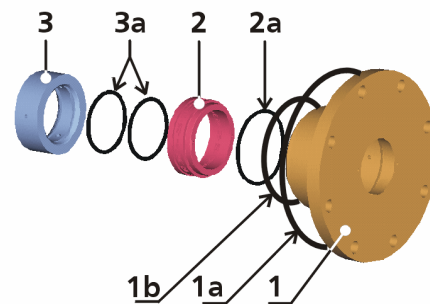


Fig.86



Hint!

Avoid touching the carbon part! Preferably rub your hands with oil or wear gloves before servicing.

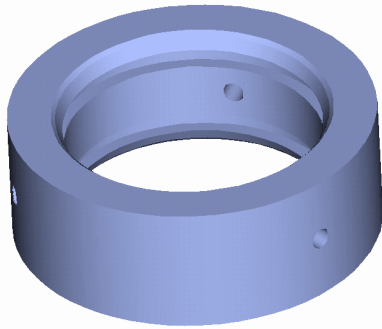


Fig.87

1. Remove both internal O-rings (3a) from the rotary slip ring (3) and O-ring (2a) in the stationary counter slip ring (2).
 - 1.a. Check both sliding surfaces of counter slip ring (3) and rotary slip ring (2) for wear or damage.
 - 1.b. Clean the housing (1) and all other parts.
 - 1.c. When one of the sliding surfaces is affected, replacement of both parts is required.
 - 1.d. Renew all O-rings (1a, 1b, 2a & 3a) by new ones.
2. Renew the entire shaft seal in the case of damage or wear of the rotary slip ring.

3.11 CRANKSHAFT

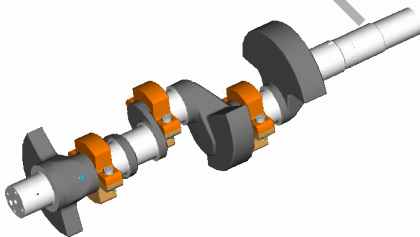


Fig.88: 49

General

1. Only with 2 & 3-cylinder compressors, mark the location and position of each spacer on their respective crankshaft journals and subsequently remove each spacer (compensating mass) from the crankshaft and reassemble both halves, separately from the crankshaft.

2. Thoroughly clean the entire crankshaft:
 - 2.a. Check whether the axial oil passageways in the crankshaft are unobstructed by cleaning them with compressed air or a brush.
 - 2.b. In order to be sure that the lubricating oil transmission within the crankshaft will proceed smoothly, unscrew the socket head screws locked with centre punches out of the crankshaft webs.
 - 2.c. Remove the dirt accumulated in the oil passageway (in the case of damage to bearings white metal particles) with a 6 mm rod.
 - 2.d. Brush and blow out the crankshaft again until all oil passageways are unobstructed.

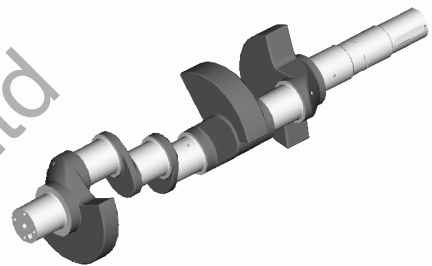


Fig.89: 50

- 2.e. After cleaning, reassemble all oil passageway sealing bolts (socket head screws) and lock them with centre punches.

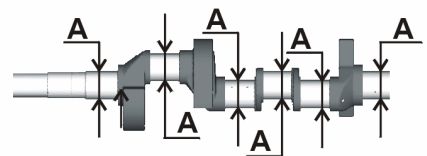


Fig.90: 51

3. Check the diameters of the shaft journals and shaft ends with an outside micrometer in at least 2 directions and dead square to the measuring surface.
 - 3.a. "A" should be at least 64.95 mm.

- 3.b. Should these measurements show that the shaft diameter(s) is (are) just beyond the tolerance limits and there is any doubt about the serviceability of this crankshaft, then it is recommended to contact our service department.

Preassembling the crankshaft

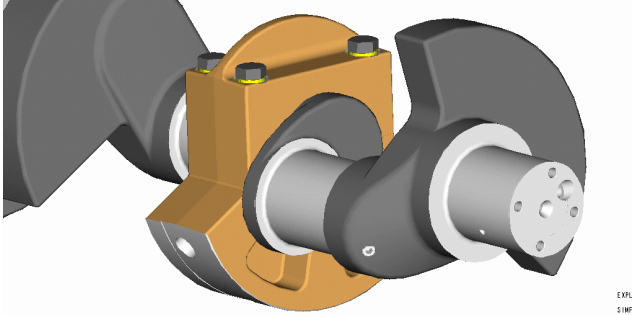


Fig.91: 52

1. In the case of 3, 6, and 8-cylinder compressors, place the shells of the intermediate bearing into the bearing block.
 - 1.a. Oil both bearing shells well and fit the intermediate bearing on the crankshaft (intermediate bearing halves with stamped-in numbers on one side).
 - 1.b. Tighten the four M12 bolts to the torque given in table "Survey of torques for bolts and nuts Grasso 10".
 - 1.c. Check that the intermediate bearing freely revolves around the crankshaft.

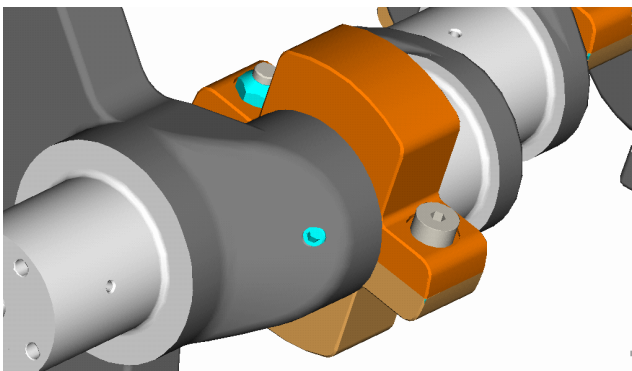


Fig.92: 53

2. In the case of a 2 & 3 cylinder compressor only, fit each spacer (mind location/position!) onto its own original crank web using two M10 bolts and nuts and tighten these to the torque as given in table "Survey of torques for bolts and nuts Grasso 10".

3.12 THRUST BEARINGS

Besides a standard mounted thrust bearing, a heavy duty thrust bearing can be mounted (optional)

3.12.1 STANDARD BRONZE THRUST BEARING, MARK 2



Hint!

Refer Section 2.10, Page 22

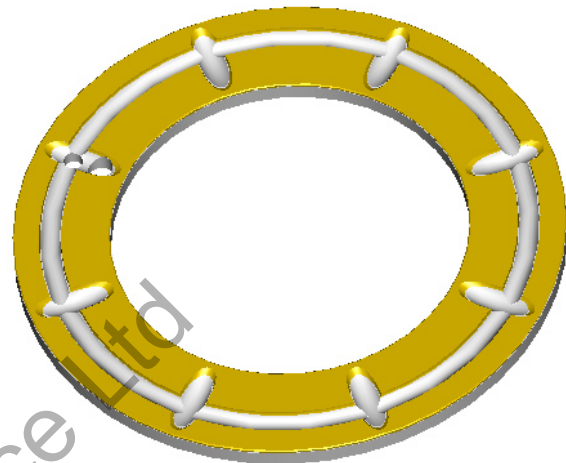


Fig.93: Standard bronze thrust bearing; refer also Figure 31, Page 22

1. Clean the thrust bearing and check the lapped running surface on the bronze side for (ir)regularly worn oil grooves and for material deposits.
 - 1.a. Replace this thrust ring if it shows signs of wear and when the thickness is less than 5.50mm.

3.12.2 HEAVY DUTY THRUST BEARING

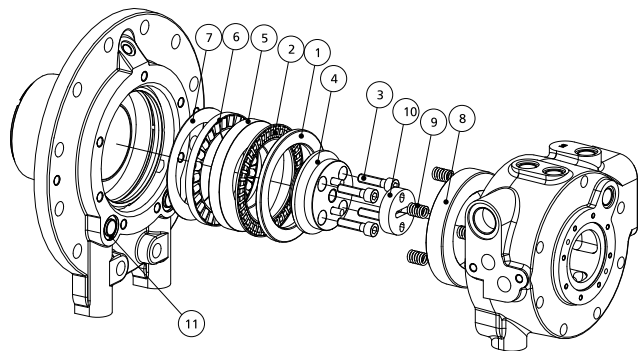


Fig.94: Heavy duty thrust bearing

1. Clean all thrust bearing parts. Check all running surfaces which are in contact with the cylindrical roller thrust bearing and the needle thrust bearing for (ir)regular wear and other damage such as pits, marks or scratches.
 - 1.a. Replace the complete heavy duty thrust bearing set when the rollers, needles or running surfaces show signs of wear.

3.13 CRANKCASE

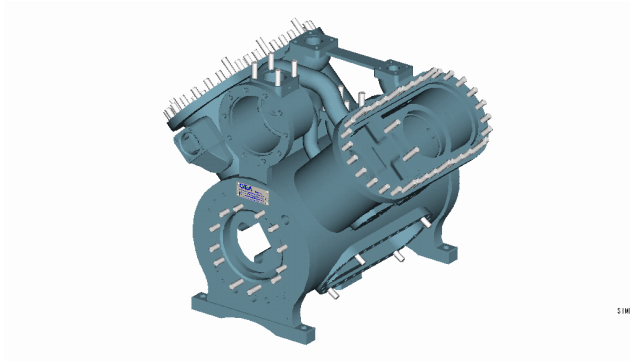


Fig.95: Crankcase

1. Thoroughly clean the crankcase interior and dry it with a non-fibrous cloth.
 - 1.a. Inspect all exterior gasket faces and remove possible residual gasket material.
 - 1.b. Thoroughly blow through all connections on the inside and on the outside.
 - 1.c. Clean the sight glass.
 - 1.d. Do not forget to remove the gasket remains from the flanges of the main connections of the compressor!

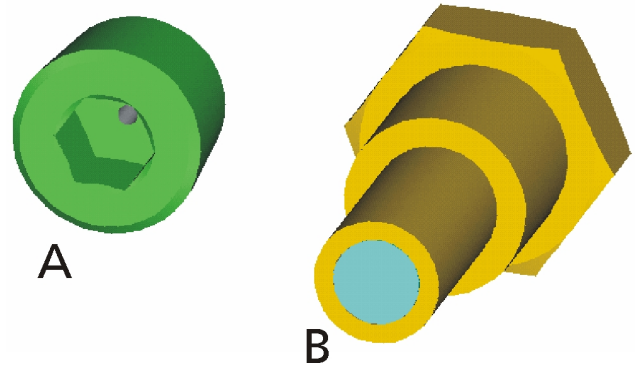


Fig.96: Oil return plugs

Legend	
A	LP (Suction pressure - crankcase)
B	HP (Intermediate pressure - crankcase)

1. Remove the oil return plug from the lowest landing of the cylinder jackets for the LP cylinders {see left plug A}
 - 1.a. Inspect the return plugs, clean them and tighten them after refitting.



Warning!

Do not remove or modify the insert of plug B. This insert is a specially designed filter (orifice)

4 REASSEMBLING



Warning!

All bolts and nuts have to be mounted according to the torques as given in table "Survey of torques for bolts and nuts" as available in this manual. If you cannot find this information, consult Grasso.



Hint!

All O-rings have to be oiled before assembling. Refer .

4.1 CRANKSHAFT, MAIN BEARINGS AND INTERMEDIATE BEARING

4.1.1 Bearing cover driving side

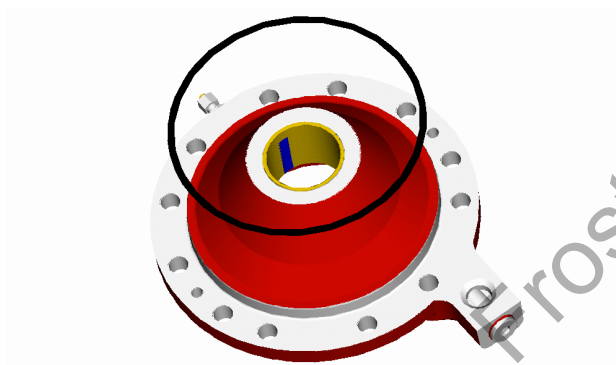


Fig.97

1. Place a new O-ring on the rear side of the bearing cover.
2. Place the bearing cover on the driving side in such a way that the hole in the lug of the bearing cover aligns with the internal oil passageway pipe.(also fitted with new O-ring)

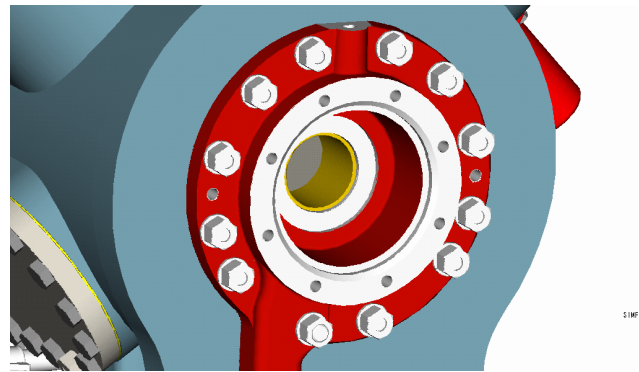


Fig.98

- 2.a. Then slide the bearing cover over the crankcase studs.
- 2.b. Screw all M16 nuts provided with washers on the studs and tighten them alternately and crosswise to the torque given in table "Survey of torques for bolts and nuts Grasso 10".

4.1.2 Assembly procedure of 2 and 4-cylinder compressors

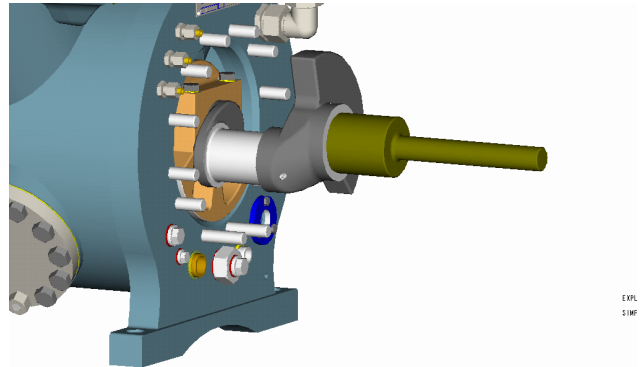


Fig.99

1. Insert the crankshaft through the crankcase opening on the oil pump side into the opposing bearing cover.

4.1.3 ASSEMBLY PROCEDURE 3, 6 AND 8-CYLINDER COMPRESSORS

1. With assistance and using auxiliary tools, insert the crankshaft through the crankcase opening on the pump side into the crank-

shaft now rests on the intermediate bearing block).

- 1.a. Remove the auxiliary tools, clean the shaft journals and oil them.

4.1.4 Pump side

1. Bearing cover oil pump side (with two lugs):

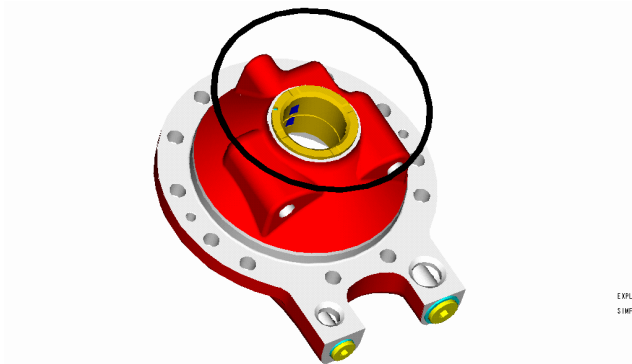


Fig.100

2. Place a new O-ring on the rear side of the bearing cover.

- 2.a. Place a new O-ring on both pipes of the internal oil passageway.

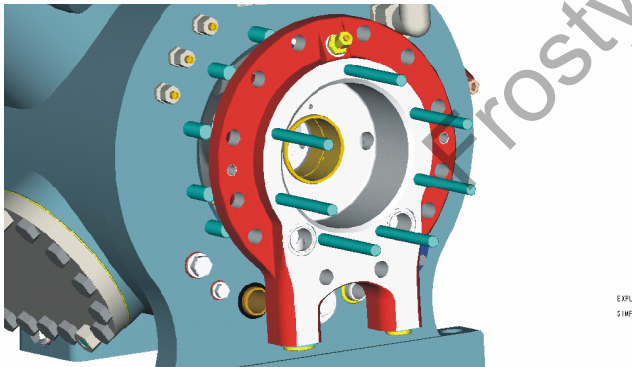


Fig.101

3. Place the cover in such a way that the holes in each lug of the bearing cover are opposite the pipes of the internal oil passageways and slide the bearing cover over the crankcase studs.

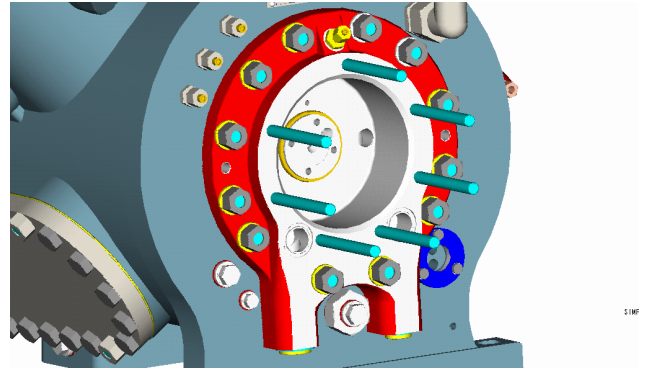


Fig.102

4. Screw all M16 nuts provided with washers on the studs.
5. Finally tighten the nuts alternately and crosswise to the torque given in table "Survey of torques for bolts and nuts Grasso 10".
- 5.a. Check that the crankshaft rotates freely.

4.1.5 Standard thrust bearing

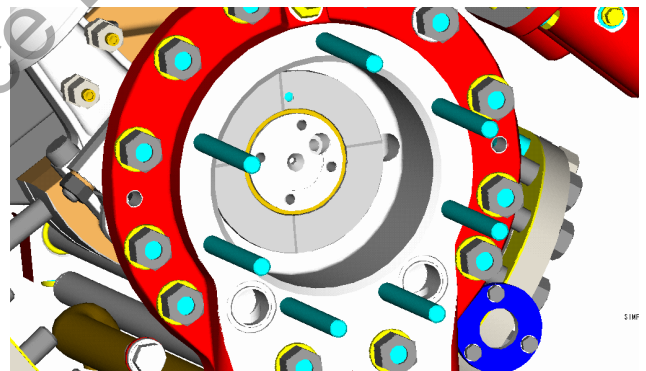


Fig.103: Old version of thrust bearing (Refer also to Section 2.10, Page 22)

1. Fit the oiled thrust ring with the oil grooves facing outwards on the crankshaft on oil pump side in such a way that the locking pin in the bearing cover fits into the hole in this thrust ring surface.
2. Check whether the crankshaft boss is still clean and oiled.

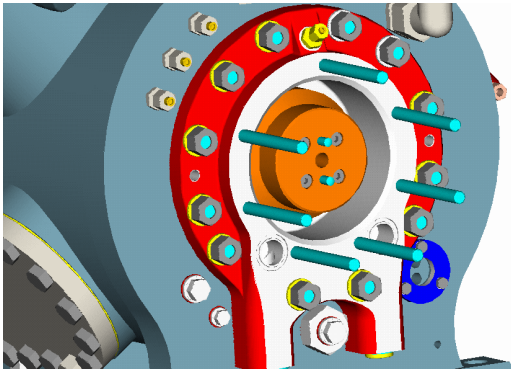


Fig.104

- 2.a. Fit the hold down disc onto the crankshaft boss, using the four M8 Allen head screws with the torque given in table “Survey of torques for bolts and nuts Grasso 10“.
- 2.b. Check that the crankshaft rotates freely.

4.1.6 Oil pump assembly for standard thrust bearing

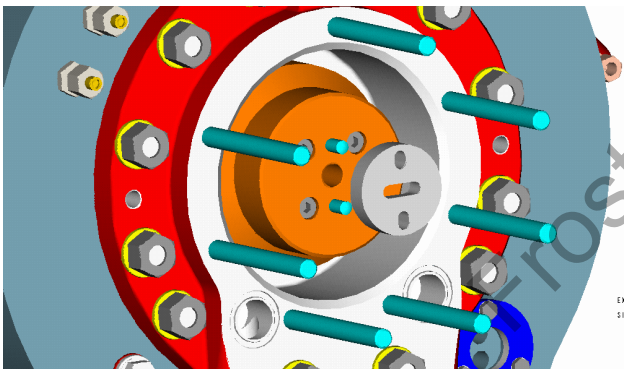


Fig.105

1. Place the carrier disc on the hold down disc.



Hint!

The enlarged slot of the carrier disc must face the crankshaft.



Hint!

Position the slot of the carrier disc in vertical or horizontal position by rotating the crankshaft.

2. Place a new O-ring on the rear side of the fully pre-assembled oil pump.
 - 2.a. Slide the oil pump over the studs of the bearing cover.

- 2.b. Position the carrier lug of the pump element in the slot in the carrier disc.
- 2.c. Push the oil pump fully against the bearing cover and screw the M12 nuts with washers on the studs.
- 2.d. Tighten all nuts evenly and crosswise to the torque given in table “Survey of torques for bolts and nuts“.

4.1.7 Heavy duty thrust bearing and oil pump

The reassembling of the heavy duty thrust bearing is split into two parts, the heavy duty thrust bearing itself and the oil pump.

- 1.
2. Check whether all components are clean, including the inside of the bearing cover and crankshaft on oil pump side.

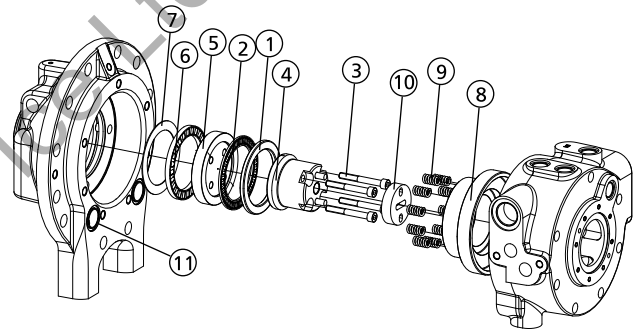


Fig.106: Heavy duty thrust bearing



Hint!

Pos. 1, 2, 4, 5, 6 and 7 can be mounted together at any angle of rotation.

3. Fit the oiled 1 mm. thick thrust washer (7) on the crankshaft on oil pump side.
 - 3.a. The thrust washer (7) can be used on both sides.
4. Fit the oiled cylindrical roller thrust bearing (6) on the crankshaft on oil pump side.
 - 4.a. The cylindrical roller thrust bearing (6) can be used on both sides.
5. Fit the oiled shaft washer (5) on the crankshaft on oil pump side. The shaft washer is recessed to fit **exactly** around the crankshaft.

6. Fit the oiled hold down disc (4) into the shaft washer (5), using the four M10 socket head screws (3) with the torque given in Section 5.1, Page 59.
 - 6.a. Check whether the crankshaft rotates freely.
7. Fit the oiled needle thrust bearing (2) onto the hold down disc (4).
 - 7.a. The needle thrust bearing (2) can be used on both sides.
8. Mate the oiled 7 mm. thick housing washer (1) against the needle thrust bearing (2).
 - 8.a. The housing washer (1) must be mated with its running surface against the needle thrust bearing (2), it can not be used on both sides.
9. **Oil pump assembly for heavy duty thrust bearing**
10. Place the carrier disc (10) on the hold down disk (4).
 - 10.a. The enlarged slot of the carrier disc (10) must face the crankshaft.



Hint!

Position the slot of the carrier disc (10) in vertical or horizontal position by rotating the crankshaft

11. Place 2 new O-rings around the oil in- and outlet holes at the bearing cover (11).
12. Check whether the oil pump is clean.
13. Place the oiled spring retainer (8) in the pump housing counter bore.
14. Insert the oiled springs (9) in the holes of the spring retainer (8).
15. Place a new O-ring on the rear side of the fully pre-assembled oil pump.
16. Position the carrier lug of the pump element with the slot in the carrier disc.
17. Slide the oil pump over the studs of the bearing cover. Taking care not to dislodge springs (9) and spring retainer (8)
18. Push the oil pump as far as possible towards the bearing cover and screw the M12 nuts with washers on the studs.

- 18.a. The oil pump cannot be pushed fully against the bearing cover, because of the springs
 - 18.b. Check all springs to be present and in place.
 - 18.c. Tighten bearing covernuts to the torque given in the Section 5.1, Page 59.
 - 18.d. Check that the crankshaft rotates freely
 - 18.e. Checking axial play of crankshaft
19. Reinstall the external oil line. It is connected from the top of the oil pump to the service cover.

4.1.8 CHECKING AXIAL PLAY OF THE CRANKSHAFT

4.1.8.1 Checking axial play of crankshaft; Procedure for 2 and 4 cylinder compressors

1. For this measurement a magnetic (clock) gauge with an extended spindle can be set up on the bearing cover.

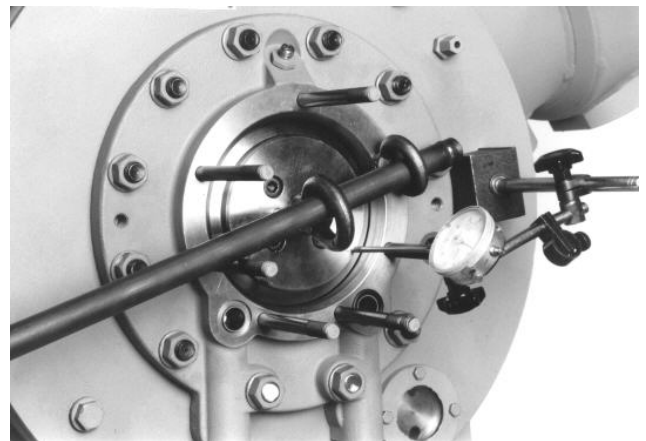


Fig.107

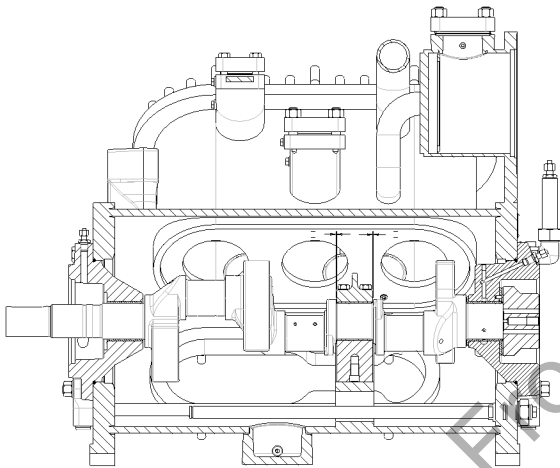
- 1.a. Remove one stud and screw in the M12 eye bolt.
- 1.b. Screw the M16 eye bolt into the threaded hole in the crankshaft.
- 1.c. Pull out the crankshaft and set the gauge to 0.00 (zero).
- 1.d. Push the crankshaft inside and check/write down the axial play on the gauge.

For every compressor the play may be between 0.05 and 0.85 mm.

Contact the service department of Grasso if the axial play is not within the tolerance limits.

4.1.8.2 Checking axial play of crankshaft; Procedure for 3, 6 and 8 cylinder compressors

1. Measure the axial play proceeding in the same way as for the 2 and 3 cylinder compressors.
 - 1.a. Position the intermediate bearing block and fit handtight the 2 sets of toothed spring washers and the M16 bolts in the bearing support.
 - 1.b. Check that the crankshaft rotates freely.



SCALE : 0.500 TYPE : ASSEM NAME : RC4210_COMPRESSOR SIZE : E
REP : 4-29

Fig.108

- 1.c. Subsequently, firmly tighten the bearing block(s) after the intermediate bearing(s) has(ve) been adjusted in accordance with the drawing (measure "=" + 0.5 mm).
- 1.d. Further tighten the intermediate bearing bolts to the torque given in table "Survey of torques for bolts and nuts Grasso 10"..

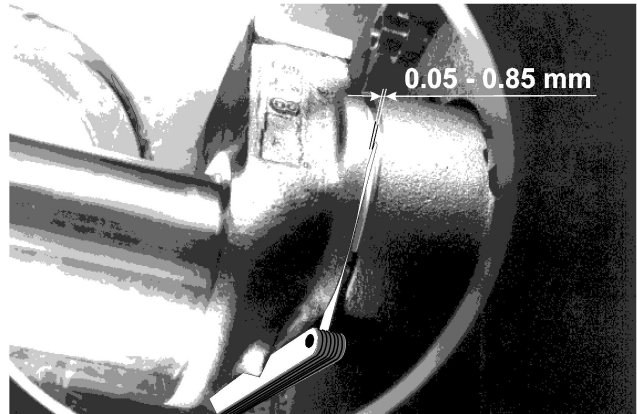


Fig.109

2. If there is no clock gauge available, the axial play can also be measured with the help of feeler gauges at the collar of the pump end main bearing. Here again the axial play is measured by the difference between the pulled out and pushed in crankshaft (see also measuring procedure with clock gauge).

4.2 OIL SUCTION/DISCHARGE FILTER, LUBRICATING/CONTROL OIL PRESSURE REGULATOR

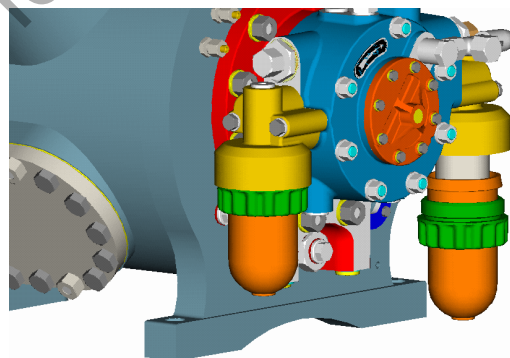


Fig.110

Oil discharge filter



Hint!

After the first 100 operating hours the red-marked discharge filter has to be replaced with a grey-marked filter element!

1. Fit the preassembled (red³/grey) marked discharge filter housing using the two M10 bolts with washers on the right-hand side of the pump.
3. Always fit a new red-marked oil discharge filter element into a modified plant.

- 1.a. Tighten the bolts to the torque given in table "Survey of torques for bolts and nuts Grasso 10".

Oil suction filter

1. Fit the preassembled (marked blue) suction filter housing using the two M10 bolts with washers on the left-hand side of the pump.
 - 1.a. Tighten the bolts to the torque given in table "Survey of torques for bolts and nuts Grasso 10".

Lubricating oil pressure regulator (without groove)

1. Install the lubricating oil pressure regulator with a new aluminium ring on the left-hand side of the pump.
 - 1.a. Finally fit the cap nut handtight on the regulator.



Hint!

Final adjustment of a reassembled lubricating oil pressure regulator must be done during compressor operation. This adjustment procedure is described in the Grasso 10 - Installation and Maintenance Manual.

Control oil pressure regulator (with groove)

1. Install the control pressure regulator with a new aluminium ring on the right-hand side of the pump.
 - 1.a. Finally fit the cap nut handtight on the regulator.



Hint!

Final adjustment of a re-assembled control oil pressure regulator must be done during compressor operation. This adjustment procedure is described in the Grasso 10 - Installation and Maintenance Manual.

4.3 Replacement piston rings and cylinder liners



Hint!

Recommendation/warning!

For major overhauls or every repair where piston rings are being replaced it is strongly recommended to replace the cylinder liners as well. This is very important for the next reasons:

For the best sealing between piston rings and cylinder liners, piston rings have to run in on the cylinder liner's inner surface. Therefore a new cylinder liner with a honing profile (crosshatching) in the best condition is absolutely required. Piston rings cannot run in properly on worn out or partly worn out cylinder liners. Without a decent honing profile no proper sealing between liners and rings can be achieved which may result in- or contribute to a bad performance of the compressor. Further on, this honing profile with the right crosshatching is demanded for a good lubrication between piston rings and liners and for the right oil distribution on the liner's inner surface.



Fig.111: New honing profile and crosshatching with the right angle

After being in operation for many running hours cylinder liners and piston rings will wear out and most cylinder liners will become unworn ridges (bumper rims or edges) due to the displacement of the piston rings inside the liner. The upper unworn ridge occurs at the upper death end and upper side of the upper piston ring and the lower ridge occurs at the death end of the lower side of the lower (oil scraper) ring. In many cases intermediate and oil scraper rings cause their own bumper ridges. (*Bumper steps*) Also, both upper and lower edge are set by the worn shape of the piston rings. This clearly explains why new piston rings can break when used in old/worn cylinder liners due to hitting the unworn bumper ridges at high speed. (*See also picture below*)

Therefore: Never install new pistons with new piston rings in old cylinder liners. It is strongly recommended to replace the cylinder liners too.

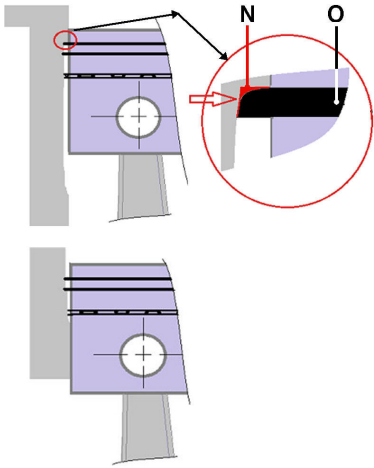


Fig.112: Don't use new piston rings on old cylinder liner

N	Shape of new piston ring (sharp)
O	Shape of old piston ring (rounded)

4.4 CYLINDER LINER

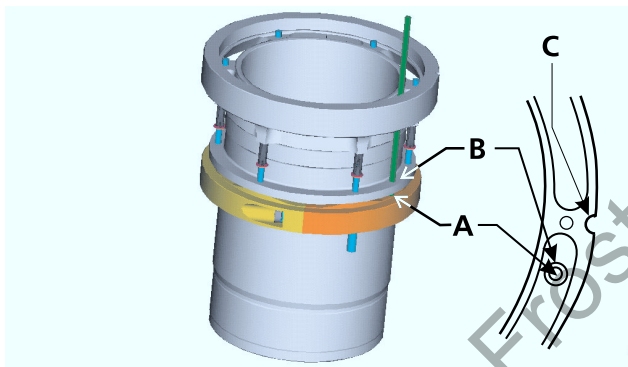


Fig.113: cylinder liner

Preparing the cylinder liner

1. Place the cylinder liner on a flat surface and rotate the cam ring such that the small hole ("A") is in line with the hole ("B") in the fixed rim of the cylinder liner.



Hint!

Don't forget to mount the gasket between cylinder liner and crankcase (refer Figure 114, Page 50)

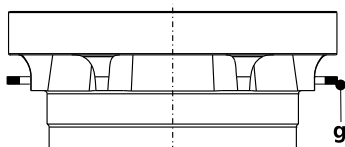


Fig.114: Gasket cilinderliner - crankcase (g)

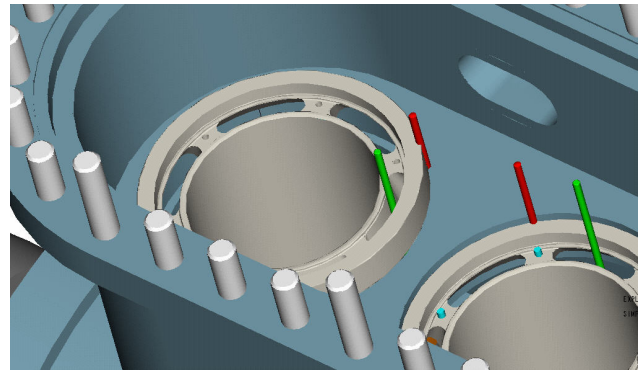


Fig.115

2. Fit one of the lock pins (auxiliary tool) through both holes from above.
3. Place the cylinder liner above the crankcase opening such that recess ("C") and the recess in the lower landing are in line with each other.
4. Lower the cylinder liner as far as possible and to prevent displacement of the cylinder liner during pressing, lock the cylinder liner by fitting the second lock pin through both (half) recesses.

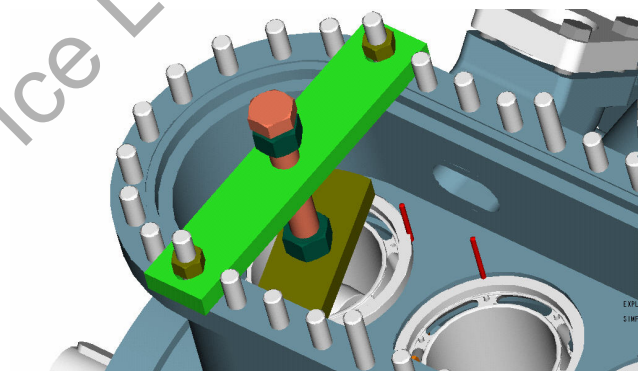


Fig.116

- 4.a. Place the short green bar⁴ on the upper cylinder liner collar and the long green bar over 2 cylinder head studs.
- 4.b. Fix the long bar with two M16 nuts and place a steel disc on the threaded hole in the lower bar to protect the threaded hole from being damaged.
- 4.c. Remove lock pin from recess "C". Leave other lock pin in the cylinder liner.
- 4.d. Screw the long M24 bolt into the long bar and tighten it turning clockwise until the cylinder liner is fully seated in the inner landing of the cylinder jacket.

⁴ Parts of the auxiliary tool kit.

- 4.e. Remove all auxiliary tools also the lock pin left behind in the cylinder liner, which is needed for the remaining cylinder liners to be installed.

4.5 VALVE-LIFTING CONTROL MECHANISM

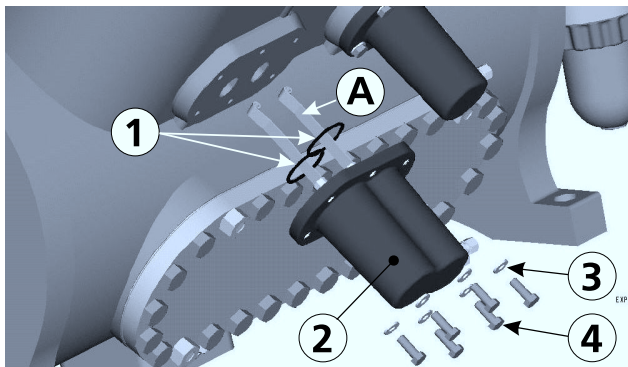


Fig.117

Installing a single or double capacity control valve

1. Fit o-ring(s) (1) in the groove(s) of the pre-assembled valves.

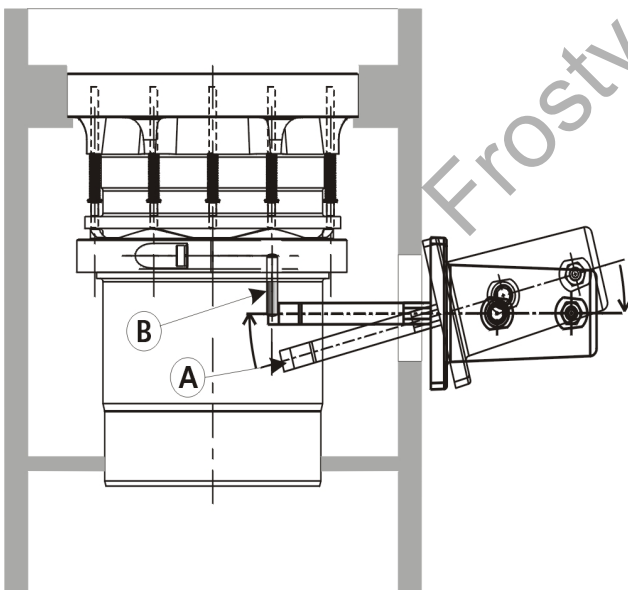


Fig.118

2. Insert push handle ("A") with nipple coupling(s) facing driven end, into the slotted hole(s) of the cylinder jacket as shown above.
3. Hook-up the push handle over the guide pin ("B").



Hint!

In case the guide pin can not hook-up in the lever proceed as follows:

4. 4.a. Put the push handle aside.
- 4.b. Reposition both holes (A and B, Figure 113, Page 50) by rotating the cam ring with the aid of the lock pin left behind into the cylinder liner.
- 4.c. Again follow-up the hooking-up instructions
- 4.d. Remove the lock pin from the cylinder liner.
- 4.e. Check the connection guide pin/push handle has been made by moving in and outwards.
- 4.f. Mount the valve housing (2) with the washers (3) and bolts (4) and tighten the bolts with the torque setting given in table "Survey of torques for bolts and nuts Grasso 10" (Section 5.1, Page 59).
- 4.g. Connect the control pressure oil line(s) to the housing.



Hint!

After assembling the valve lifting housing, the lever is in the unloaded position.

4.6 PISTON/CONNECTING ROD ASSEMBLY

1. Insert the connecting rod bolts into the big end of the connecting rod (make sure that the flat side of the bolthead is positioned correctly!).
 - 1.a. Place the bearing shells into the connecting rod.
 - 1.b. Oil bearing shells, piston and piston rings.

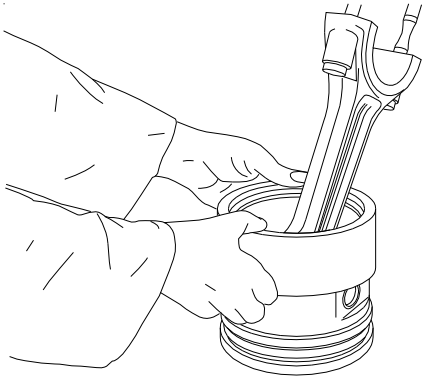


Fig.119

- 1.c. Slide the ring compression bush⁵ with the chamfered end pointing downwards over the connecting rod, the piston and the oil scraper ring and piston rings.
- 1.d. Oil and set the relevant crankshaft journal in the uppermost position.

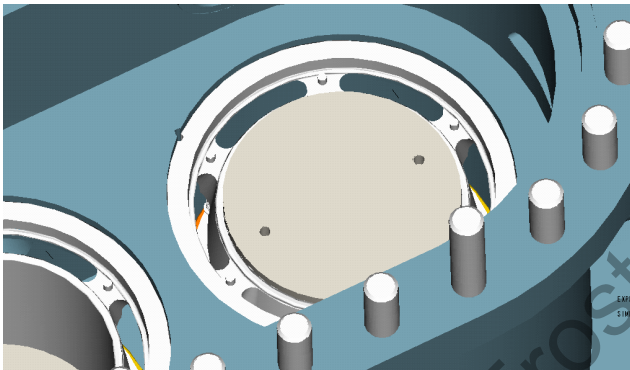


Fig.120

- 1.e. Screw the T-handle into the threaded holes of the piston.
2. Insert the piston/connecting rod assembly into the cylinder liner.
 - 2.a. Lower it very carefully until the ring compression bush contacts the cylinder liner and after that slowly push on until the piston is almost entirely located inside the cylinder liner.
 - 2.b. Check that the connecting rod properly embraces the crankshaft journal. Check that the bearing shell in the connecting rod has not been displaced.

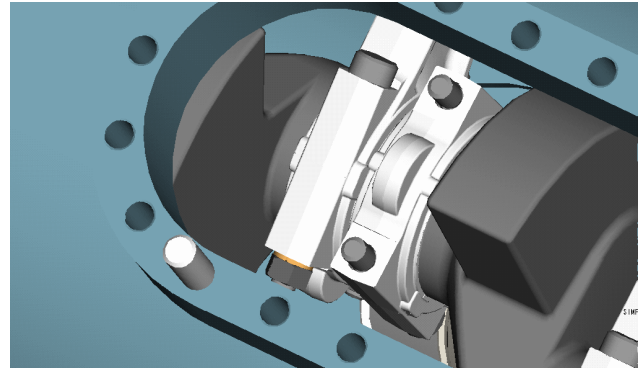


Fig.121

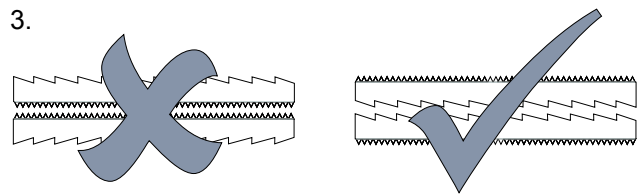


Fig.122: Double locking ring

Slide the corresponding connecting rod cap over the connecting rod bolts.

- 3.a. Fit both MF16 nuts with **new** (double) locking rings on the connecting rod bolts {see Figure 122, Page 52 }for the mounting position of the double locking rings} and tighten to the torque given in table "Survey of torques for bolts and nuts Grasso 10".



Hint!

Fit the connecting rod parts with the machine codes on one side.

4.7 DETERMINING THE PISTON CLEARANCE

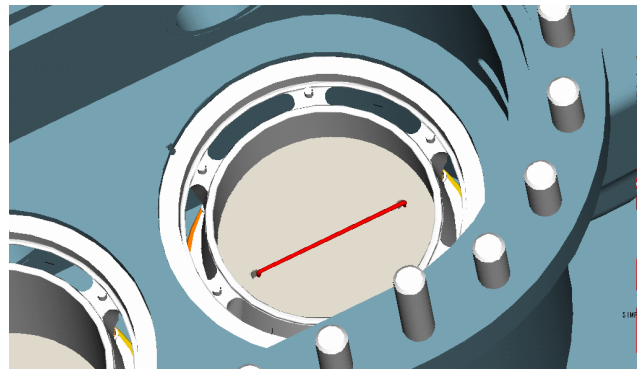


Fig.123

⁵ Parts of the auxiliary tool kit.

1. Place a 1mm thick lead or tin soldering wire which is buckled on both ends into the threaded holes of the piston.

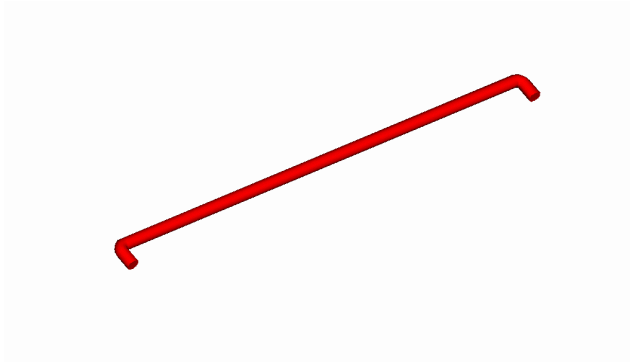


Fig.124

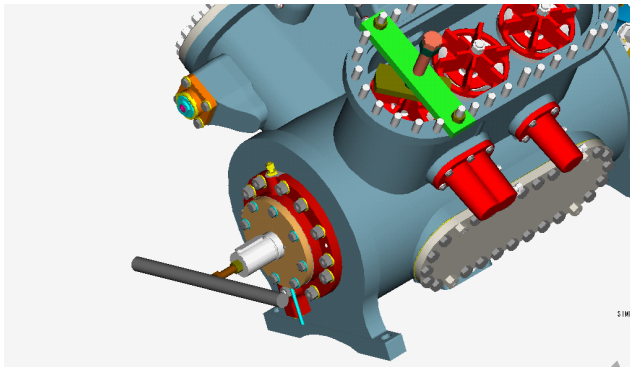


Fig.125

2. Oil the discharge valve assembly and place it on the cylinder liner.
 - 2.a. Place the green bar from the auxiliary tool kit on the studs as well as on the discharge valve centre.
 - 2.b. Screw two M16 nuts on the studs .
 - 2.c. Screw the M24 push bolt into the long green bar to secure the discharge valve in position and after that revolve the crankshaft two or three times.
3. Remove all measuring aids and measure the thickness of the flattened wire. This thickness, which is equal to the clearance, should be as given in Page 61(Piston clearance). If the measuring result is beyond these limits, it is necessary to contact the service department of Grasso Products.

4.8 SUCTION/DISCHARGE VALVE ASSEMBLY

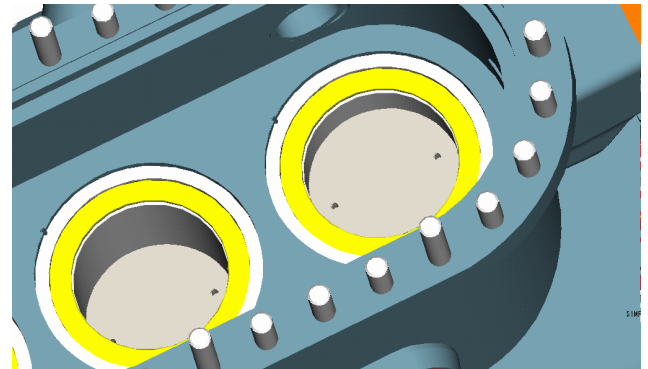


Fig.126: 33

1. Place the suction valve ring on its seat in the cylinder liner collar.

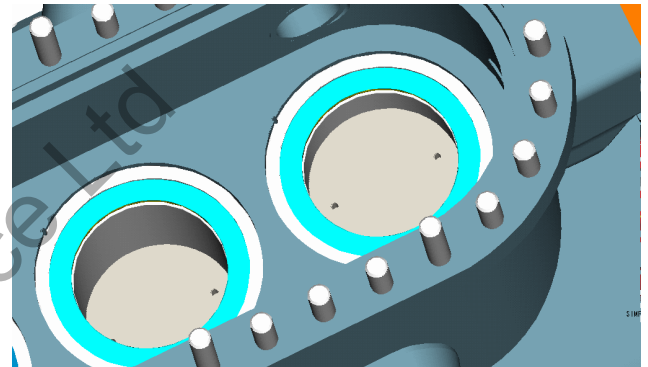


Fig.127: 34

- 1.a. Place the sinusoidal spring with the convex side pointing upwards on the suction valve ring.



Hint!

The sinusoidal springs in the inclined cylinders can easily fall out of the cylinder liner during assembly. This can be prevented by placing the sinusoidal springs in such a way on the valve ring that the springs touch the valve ring at the highest and the lowest point in the inclined cylinder liner.

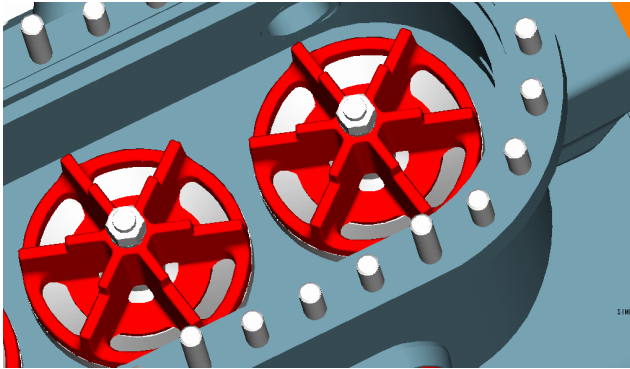


Fig.128: 35

2. Place the preassembled discharge valve assembly on the sinusoidal spring of the suction valve.
 - 2.a. Clean the sealing edge of the cylinder head cover and also the edge on the cylinder head itself.
 - 2.b. Rub both packing faces and the studs with grease.

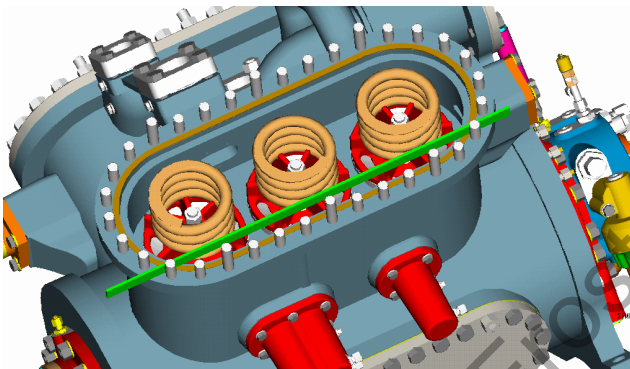


Fig.129: 37

3. Fit the buffer spring which can to be prevented from tipping by a steel strip placed against the two studs.

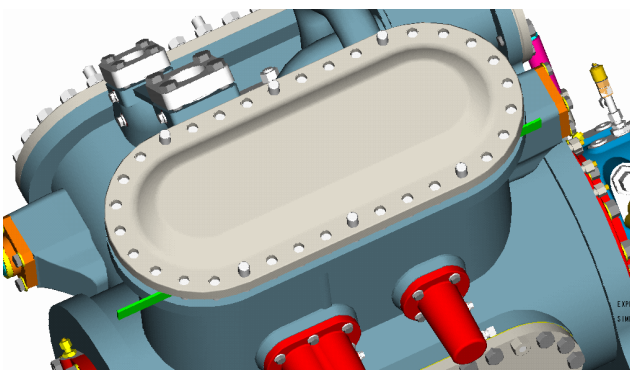


Fig.130: 38

4. Insert a new gasket into the cylinder cover groove and place the cylinder head cover over the studs on the buffer spring.

- 4.a. Remove the strip.

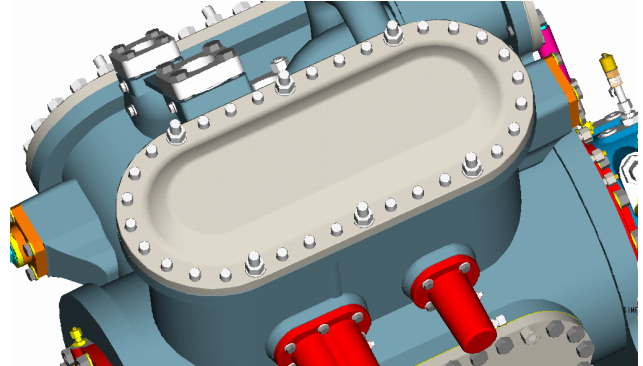


Fig.131: 39

- 4.b. Screw M16 nuts on the long and oiled studs.
- 4.c. Tighten these nuts alternately to the torque given in table "Survey of torques for bolts and nuts Grasso 10".
- 4.d. Subsequently, fit the other nuts in the same way.

4.9 ROTARY (SLIP RING) SHAFT SEAL

1. In the case of new parts, check that the protective foil has not been removed.



Warning!

Avoid touching the contact faces of these parts; slightly rub your hands with oil or wear gloves.

- 1.a. Especially inspect the crankshaft part where the O-ring moves.
- 1.b. Remove all (rubber) deposits by rubbing or polishing.
- 1.c. Oil all parts with compressor lubricating oil, as well as the crankshaft part where the shaft seal sits.

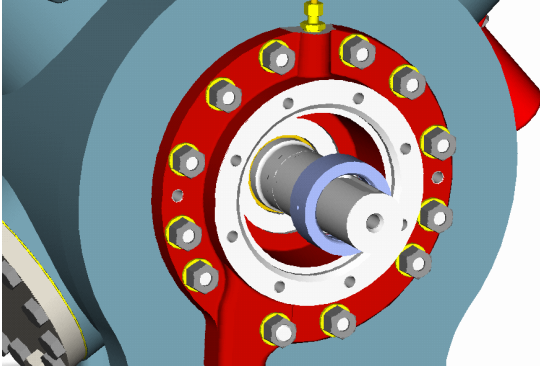


Fig.132: 40

- 1.d. Slide the rotary slip ring part (face with text towards the crankshaft boss) over the crankshaft and push through until the rear side is positioned against the crankshaft boss.

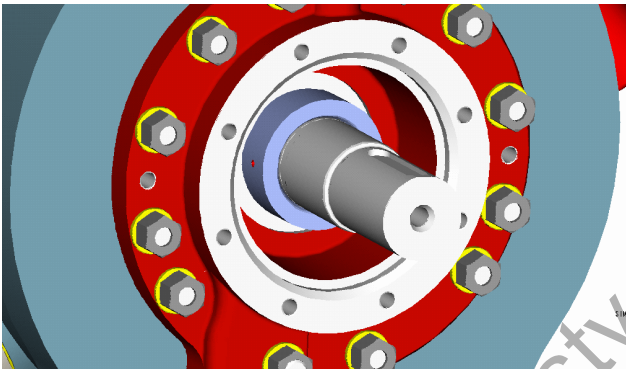


Fig.133: 41

2. Lock the slip ring on the crankshaft by tightening the three grub screws with the allen key⁶. (torque given in table "Survey of torques for bolts and nuts Grasso 10")

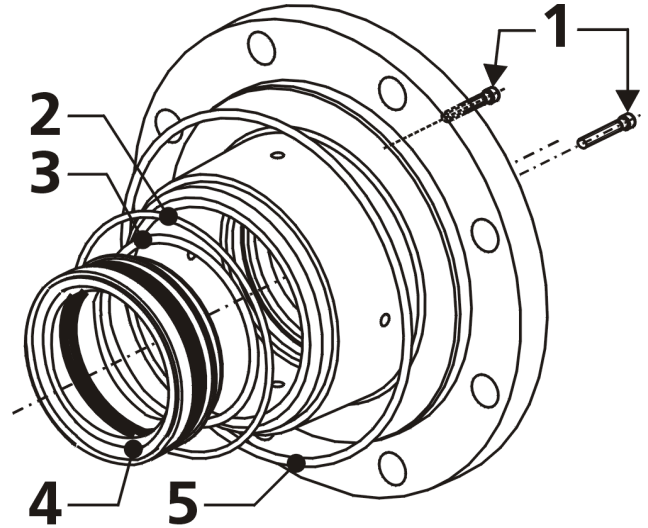


Fig.134

3. Insert the counter slip ring (4) with the O-ring (3) into the shaft seal housing.
 - 3.a. Screw the two allen head screws through the housing into the stationary slip ring.
 - 3.b. Tighten the screws alternately until the slip ring is properly seated.

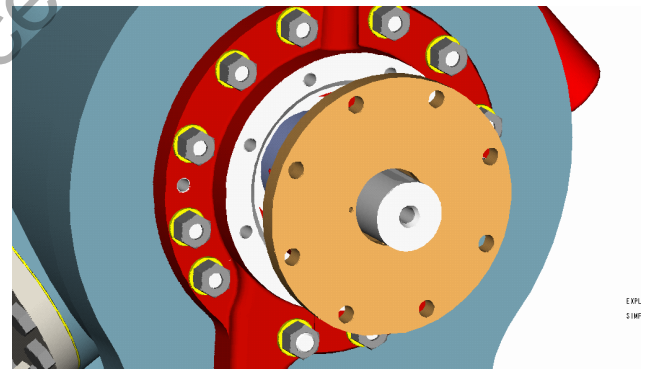


Fig.135: 42

- 3.c. Place new O-rings (2 and 5) into the groove of the cleaned shaft seal housing.

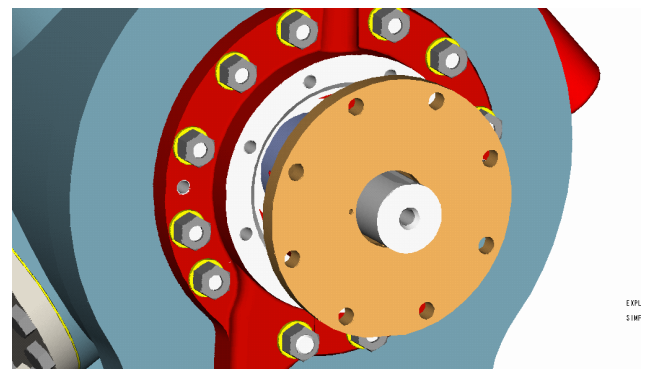


Fig.136: 42

6 Part of the auxiliary tool kit.

- 3.d. Mount the shaft seal housing (with oil leakage drain opening facing downwards) onto the crankcase.

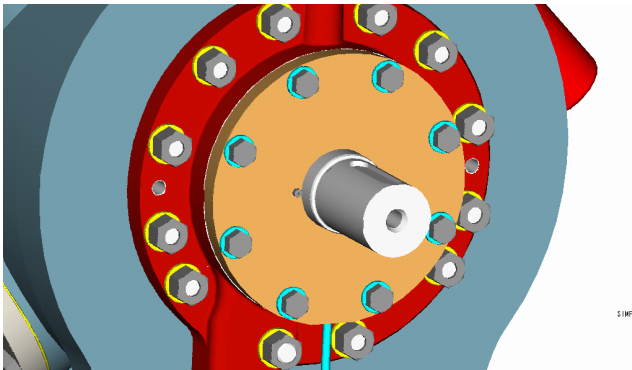


Fig.137: 43

4. Place the M12 nuts and tighten them alternately crosswise to the torque given in table "Survey of torques for bolts and nuts Grasso 10".
 - 4.a. Screw the oil leakage drain line into the bottom of the shaft seal housing.
5. Check that the crankcase is clean and dry and, subsequently, fit all crankcase covers with new gaskets.

4.10 SUCTION GAS FILTER

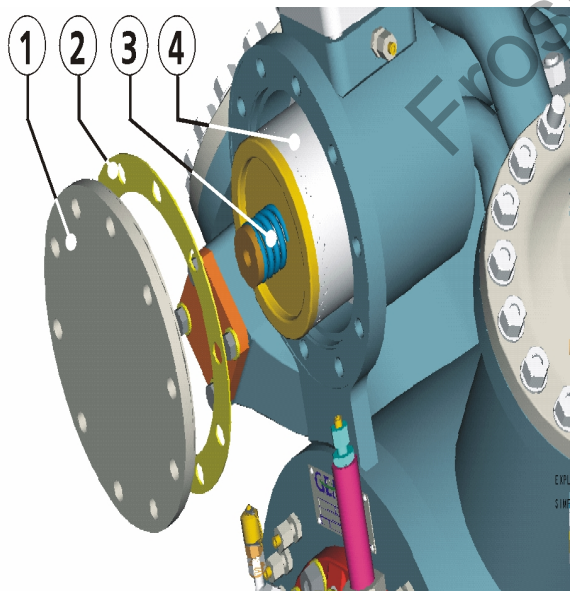


Fig.138

1. Place a new gasket (2) into the groove of the suction gas filter cover.

- 1.a. Slide the preassembled cover of the suction gas filter assembly into the housing in such a way that the centring profile around the filter fits into the fixed centring edge.
2. Screw the bolts into the housing and tighten them to the torque given in table "Survey of torques for bolts and nuts Grasso 10".

4.11 Running-in oil filter has to be installed after an overhaul or big repair



Hint!

This is why and when the running in oil filters are required:



Warning!

A running in oil filter has always to be installed after an overhaul or big repair for the 1st 100 hours of operation!

The oil and oil filters have to be replaced by new oil and filters.

Due to running-in wear of liners and piston rings, it's normal that the oil becomes grey during the 1st 100 operating hours.

After 100 operating hours, the oil could slightly become clear again.

4.12 PRESSURE RELIEF VALVE ASSEMBLY (see Section 3.1.1, Page 27)

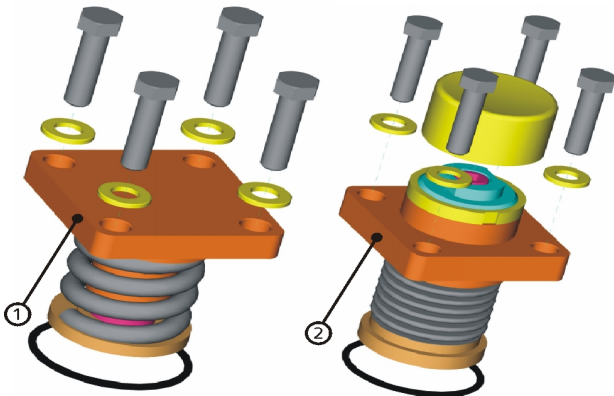


Fig.139: Relief valves

Legend	
1	Back pressure dependent
2	Back pressure independent



Warning!

DO NOT tighten the central bolt screwed in the flange head! (see Section 3.1.1, Page 27)

1. Place a new O-ring in (each) (in)dependent back pressure relief valve housing.
 - 1.a. Insert the pressure relief valve into the proper location against the cylinder jacket.
 - 1.b. Screw the four M12 bolts into the cylinder jacket and tighten them evenly and cross-wise to the torque given in table "Survey of torques for bolts and nuts Grasso 10".

4.13 OIL FILLING



Hint!

(Re)Fill with clean or fresh original oil only!

Prelubricate the lubrication oil circuit via the oil charge valve mounted on top of the oil pump housing (Figure 140, Page 57 pos 2)!

1. Oil filters and lubrication circuit

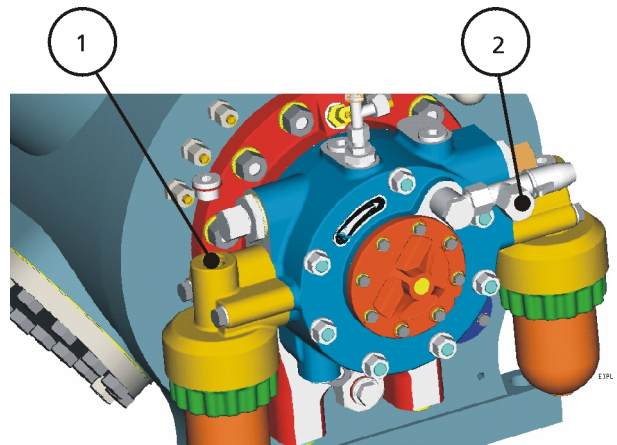


Fig.140

Pos.	Legend
1	Filling oil suction filter
2	Stop valve for pre-lubrication

1. Remove oil filling plug (1) and fill the oil suction filter with oil.
 - 1.a. Refit the oil filling plug (1) with new aluminium ring.
2. Connect oil filling pump pre-lubrication stop valve (2) and fill the oil discharge filter, shaft seal and crankshaft with oil to lubricate the oil circuit.

4.14 MOUNTING THE FLYWHEEL

Mounting procedure

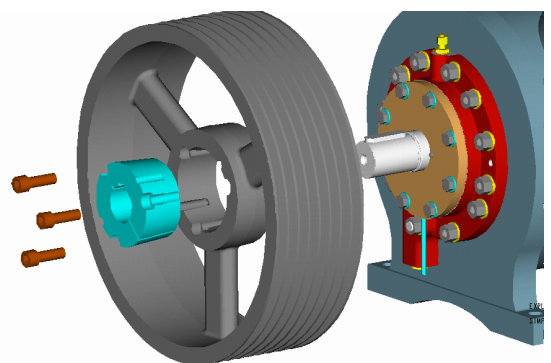


Fig.141: Flywheel

1. Remove the protective coating from the bore and outside of bush, and bore of hub. After ensuring that the mating tapered surfaces are completely

clean and free from oil or dirt, insert bush in hub so that the holes line up.

2. Springly oil thread and point of grub screws or thread and under head of cap screws. Place screws loosely in holes threaded in hub.
3. Clean shaft and tab the key into the crankshaft keyway.
4. Fit the hub and bush to shaft as one unit and locate in position desired, remembering that bush will nip the shaft first and then hub will be slightly drawn on to the bush.

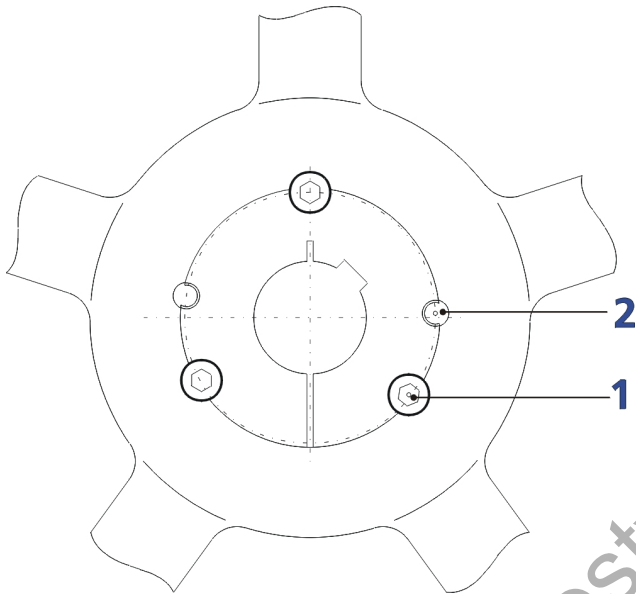


Fig.142

5. Using a hexagon wrench tighten screws (1) gradually alternately until all are pulled up very tightly.
6. Hammer against large end of bush, using a block or sleeve to prevent damage. This will ensure that the bush is seated squarely in the bore). Screws will now turn a little more. Repeat this alterate hammering and screw tightening once or twice until correct tightening torque of 113 N.m is obtained.
7. After drive has been running under load for a half or one running hour, stop and check tightness of screws.
8. Fill empty holes with grease to exclude dirt.

4.15 DISCHARGE VALVES, LEAKAGE TEST PROCEDURE

A leak test after 4 running hours of the compressor is strongly recommended;

1. Stop compressor
2. Immediately close the discharge stop valve and record the discharge pressure (must be at least 6 bar)
3. Measure the time it take for the discharge pressure to fall to 3 bar. (decrease from 6 to 3 bar)



Warning!

If equalizing time is less than 60 seconds, all the discharge valves have to be checked.

5 MISCELLANEOUS

5.1 SURVEY OF TORQUES FOR BOLTS AND NUTS GRASSO 10

Item	Threaded connection	Thread size	Torque in N.m. ⁷	Remarks
1	Bearing cover nuts (both sides)	M16	120	
2	Coupling bearing cover on pump side	M12	80	
3	Shaft seal housing nuts	M12	80	
4.1	Oil pump housing bolts	M12	80	
4.2	Pump element bolts	M6	7	
5	Connecting rod bolts	MF12	34 - 44	
6	Valve-lifting housing bolts	M8	17.5	
7	Coupling of the control line valve-lifting housing	G1/8"	-	tightened
8	Discharge valve (centre bolt)	M16	120	
9	Cylinder head nuts	M16	140	
10	Cylinder liner tie bolt - nut	M12	80	
11	Sight glass flange bolts	M6	7	
12	Crankcase side cover bolts	M16	120	
13	Pressure relief valve cover bolts	M12	80	
14	Pressure relief valve assembly mounting bolts	M12	80	
15	Oil discharge filter bolts	M10	35	
16	Oil suction filter bolts	M10	35	
17	Suction filter housing bolts 2, 3 and 4 cyl. compressor	M16	120	
18	Suction filter housing bolts 6, 9 and 12 cyl. compressor	M12	80	
19	Bearing block bolts	M12	80	
20	Intermediate bearing block bolts	M16	120	

⁷ 1 N.m = 0,102 kgf.m = 0,738 lbf.ft

Item	Threaded connection	Thread size	Torque in N.m. ⁷	Remarks
21	Counterweight bolts	M16	120	
22	Crankshaft spacer ring bolts	M10	35	
23	Standard and heavy duty thrust bearing (pressure piece) socket head screws	M8	23	
24	Shaft seal (locking) screws	M4	19	
25	Socket head screw of disc/lever	M10	35	
26	Sealing plug	G1/4"		tightened
27	Sealing plug	G1/2"		tightened
28	Hand nut suction/discharge filter	M90X3		handtight
29	Threaded rod auxiliary tool	M12		--
30	Lubricating oil pressure regulator - hexagon	M27		tightened
31	Control oil pressure regulator - hexagon	M27		tightened
32	Crankshaft sealing plugs	M10		centre punch
33	Non-return valve in cylinder liner collar	G1/4"		tightened
34	Tapered plug in cylinder liner collar	G1/4"		tightened
35	Push bolt from auxiliary tools	M12		tightened
36	Pulley puller for shaft seal	M8		
37	Foundation bolts	M20		tightened
38	Drive coupling bolts			see service instruction
39	Hub securing bolts (4x)	M12		tightened
40	Hub securing (centre) bolt	M16	120	
41	Shaft seal - Crankshaft	M5	4 - 5	
42	Bolts cam ring valve lifting mechanism	M 5	5	Refer Figure 68, Page 35

⁷ 1 N.m = 0,102 kgf.m = 0,738 lbf.ft

5.2 WEAR LIMITS AND TOLERANCES



Hint!

Not only do the wear limits determine whether a part is to be replaced, but moreover the condition of the part;

have the honing or grinding tracks of precision machined butting or running faces not been worn off irregularly, are there any visible discolouring of material, has the roundness remained cor-

rect and are there any signs of glazing of grind. All these wear factors make a part virtually unserviceable, even if this part remains within its wear limits.

Wear limits and tolerances				
Item	Description of part	Ref.	Limits (mm)	Remarks
1	Main bearing bush pump side	11.46.061	Max. internal diameter 65 ^{+0.110}	When fitted
2	Main bearing bush driving side	11.46.762		
3	Bearing bush small end of the connecting rod	11.46.336	30 ^{+0.15}	When fitted
4	Bearing bush big end of the connecting rod	11.44.336	Max. internal diameter 65 ^{+0.105}	When fitted
5	Crankshaft (main bearing and crankshaft journal)	22.91.xxx	Min. external diameter 65 ^{-0.057}	
6	Crankshaft (intermediate bearing)	22.91.xxx	Min. external diameter 65 ^{-0.057}	
7	Crankshaft (axial play)	22.91.xxx	min. 0.05 - max. 0.85	
8	Cylinder liner	23.90.110	Max. internal diameter 110 ^{+0.090}	
9	Gudgeon pin	24.20.310	Max. internal diameter 30 ^{-0.006}	
10	Piston rings	20.90.315	max. gap 1.2	Measured in non-scored part of cylinder liner
11	Control pressure piston for valve lifting	26.90.035	diameter 34.80	
12	Control pressure piston housing	27.90....	max. 35.062; Ra 0.2 ... 0.6	
13	Spring valve lifting housing	11.31.313	max. 135.0; min. 130.0	
14	Lever	27.91.007	shaft min 6.90	
15	Shaft guide	26.90.720	7.015	
16	Intermediate bearing	11.44.666	65.09	When fitted
17	Buffer spring	11.31.183	max. 118.0; min. 113.0	
18	Piston clearance	8 cylinder compr.	0.3 ... 0.95	Grasso 810/6210
		Other types	0.35 ... 0.95	All types except Grasso 810/6210

5.3 REQUIRED SERVICE TOOLS AND MATERIALS

In order to properly carry out the disassembly, inspection and assembly procedures described in this manual, the service engineer should possess the following tools, measuring equipment and aids.

Description		
-Spanners:	Ring spanners and socket spanners (metric):	8-10 (2x) -13-14-17-19-24-27-30-32-36 -41
	Hexagon socket head spanners (metric):	8-13-10-17
	Torque spanners (metric)	19-24-30-36
	Pin-face wrench (metric) for shaft seal	M4
-Measuring equipment:	Inside micrometer of 0-50 mm	
	Inside micrometer of 50-100 mm	
	Outside micrometer of 0-50 mm	
	Outside micrometer of 50-112 mm	
	Depth micrometer of 0-50 mm	
	Vernier gauge of 10"	
	Feeling gauges of 0.05-1.00 mm	
	Magnetic gauge with extended plunger	
Misc:	Grasso special tool kit TA	various service activities
	Vacuum pump	
	Centre punch	

Description	
Circlip pliers	
Hammer (steel)	
Hammer (soft)	
Pair of pliers	Remove split pin valve-lifting mechanism
Loctite	243
Lead or tin soldering wire 2 mm	for measuring piston clearance
Polishing paper	
Polishing (compound) paste	
(two) Screwdrivers (small)	e.g. for removing shaft seal
Screwdriver (large)	removing key
Abrasive linen	
Silicon grease	
Wire brush	
Piston ring pliers	
Grease	
Self-made (crankshaft) auxiliary tool	removing and inserting crankshaft
Auxiliary tools for shaft seal	
Steel strip	support buffer spring
Oil drip tray	
Tube brush ø10 mm	cleaning crankshaft oil passageways
Bar ø6 mm	cleaning crankshaft oil passageways
Compressed air device	cleaning e.g. crankshaft oil passageways

Description		
	Hydraulic press	
	Heater approx. 80 °C	removing and inserting connecting rod bearings

5.4 GRASSO SPECIAL TOOLS AND AIDS

Certain operations which require fitting and removing pistons and cylinder liners can be substantially simplified by using special tools and aids which are obtainable as standard auxiliary tool kit, ref. no 20.90.215 and instruction 00.87.611

5.5 FITTING INSTRUCTIONS FOR PIPE COUPLINGS AND DOUBLE LOCKING RING

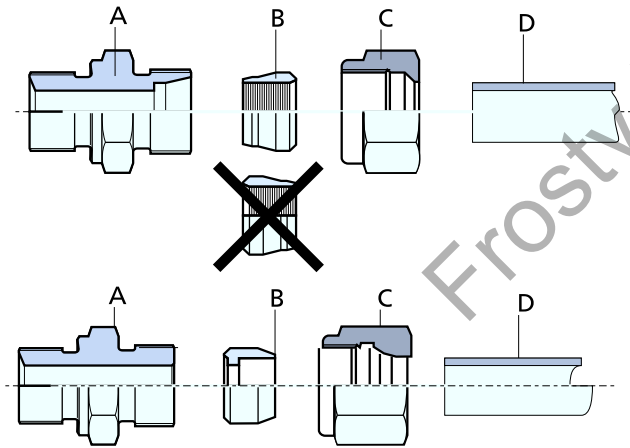


Fig.143: Pipe couplings

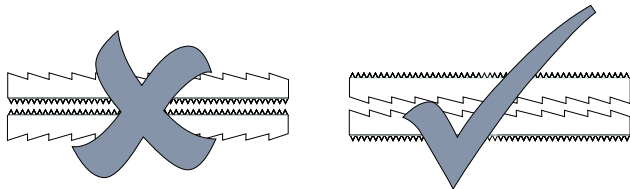


Fig.144: Double locking ring

5.6 MASS OF SEPARATE COMPONENTS AND COMPRESSORS

Item	Description	Mass (kg)	Remarks
1	Bearing cover drive end (assembly)	20	
2	Bearing cover oil pump end	20	
3	Oil pump housing, complete with filters	29	
4	Cylinder liner assy	5	
5	Intermediate bearing assy	8	
6	Crankshaft	210	31.3 with two spacers
7		310	47.2 with three spacers
8		410	27.5
9		610	41.4
10		810	57.9
11		2110	47.2 with three spacers
12		3110	27.5
13		4210	41.4
14		6210	57.9
15		Relief valve assy	2.5

For weights of bare shaft compressor and flywheel, refer to Product Information (ED), as enclosed.

5.7 RELIEF VALVE POSITIONS

Relief valves Grasso 10		
Compressor	Valve type onto cylinder number	
	Back pressure dependent (Standard)	Back pressure independent (Option)
210	2	2
310	3	3
410	3	3
610	5	5
810	2 + 7	2 + 7
2110	-	3 + 1
3110	-	3 + 2
4210	-	5 + 2
6210	-	7 + 2

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