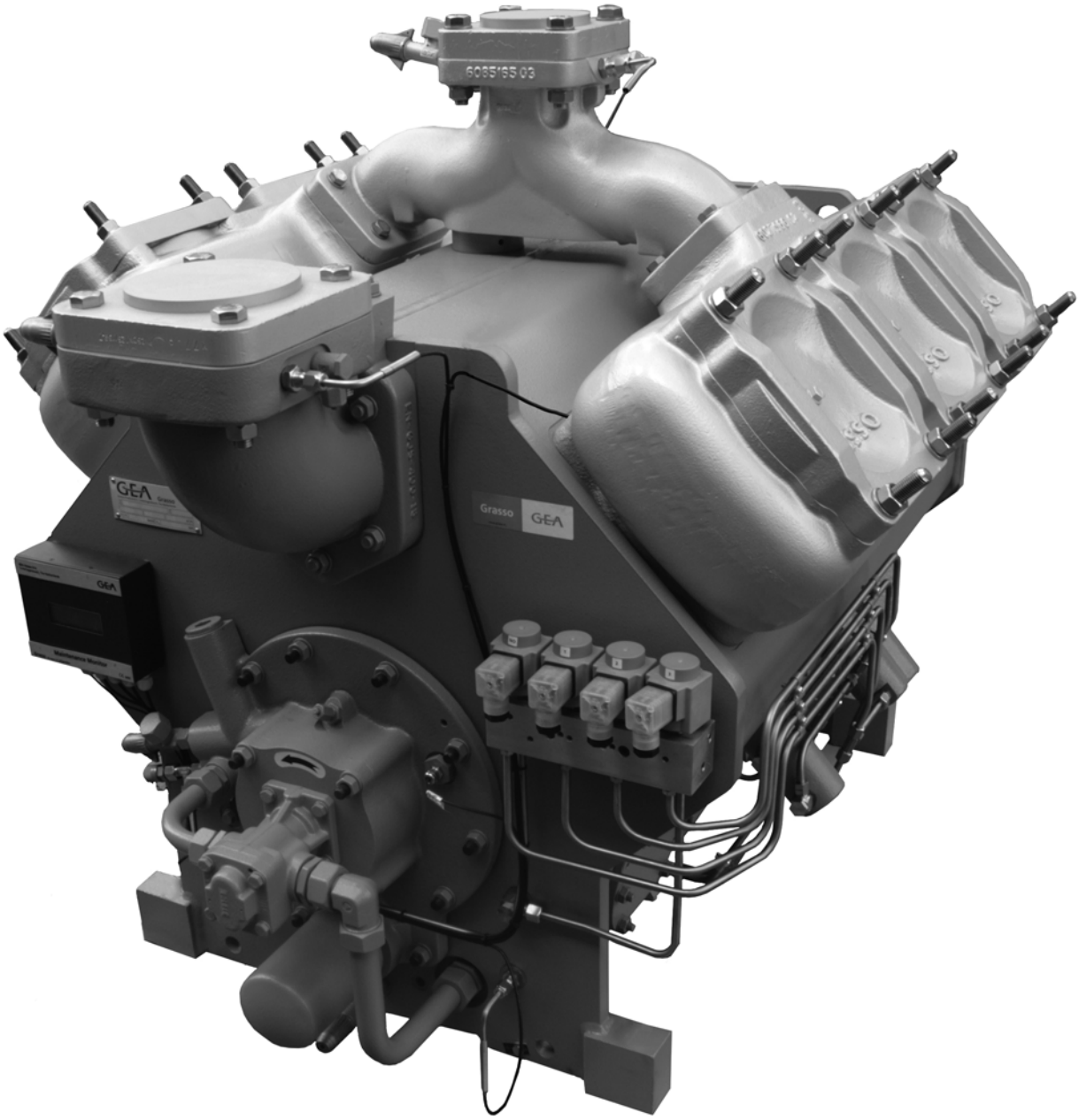
GEA Grasso
Refrigeration Division

Reciprocating Compressors for industrial refrigeration Series Grasso V

Installation and Maintenance Manual(IMM) 0089288



Copyright

Legal Notice

This publication has been written in good faith. However, **Grasso** cannot be held responsible, neither for any errors occurring in this publication nor for their consequences.

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

Safety

This manual is written with great care, but the contractor/installer is held responsible to examine this information and to take care of possible additional and/ or deviated safety measures.

Safety instructions

It is the task of the contractor/installer to inform and explain to his client the operation of the compressor (Package).
Do respect all federal, state or local safety regulations/legislations during installing, connecting and operating this compressor (package).

Construction changes

In compliance with the regulations of the Pressure Equipment Directive it is mandatory that no changes be made to the construction of pressurised parts such as the crankcase housing, suction filter housing etc.

Installer oriented information

The compressor (package) is filled with nitrogen to prevent penetration of moisture. Therefore, keep the compressor closed until the compressor (package) is being installed.

The compressor is not filled with oil.

After the successful initial run of the compressor (package) the warranty chart must be filled in and returned to Grasso. A warranty chart is attached to each compressor.

Table of Contents

Preface documentations

Typographic signs:

Indicates a WARNING. READ IT CAREFULLY!

Indicates an IMPORTANT note or procedure to which you should pay special attention.

Indicates a HINT.

General

1 All documentation can be downloaded via grasso-global.com.
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)

1) Product Information (PI)

Contents

All product information (engineering data) for this series compressor and the corresponding accessories. It is meant to be a guide to the selection of these components.

User group

Project engineers, application engineers, sales managers, product managers for both sales representatives, contractors and end-users.

2) Installation and maintenance manual (IMM)

(Supplied together with the compressor)

Contents

This manual will provide information on how to transport, install, start-up and maintain the compressor (package). It also contains a number of "Product Information Sheets" and the current "Parts List"

User group

To be used in the field by qualified personnel for both sales representatives, contractors and end-users.

3) Service Instruction Manual (SIM)

Contents

Description of (re)assembling, inspection, repair and part or total overhaul of the bare shaft compressor. This manual should be used together with the 'Installation and Maintenance Manual'.

User group

To be used in the field by qualified personnel of contractors.

4) Parts list (PL-xxx) *)

*) per compressor series (xxx)

Contents

All current parts of the compressor together with the design changes (if applicable) to previous supplied components ("History").

User group

Service and parts departments for both sales representatives, contractors and end-users.

5) Parts list (PL-Acc)

Contents

All current parts of the accessories together with the design changes (if applicable) to previous supplied components ("History").

User group

Service and parts departments for both sales representatives, contractors and end-users.

6) Service & Maintenance Schedules

Contents

Service and maintenance schedules up to the date of required overhaul of the bare compressor.

User group

Service and parts departments and in the field by qualified personnel for both sales representatives, contractors and end-users.

7) Instructions for accessories

(Supplied together with the compressor)

Contents

All the relevant mounting and installation instructions and spare parts information for those accessories supplied with the compressor.

User group

To be used in the field by qualified personnel for both sales representatives, contractors and end-users.

8) Directives

Equipment supplied according to Pressure Equipment Directive (PED 97/23/EG) regulations and 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

Cylinder numbering

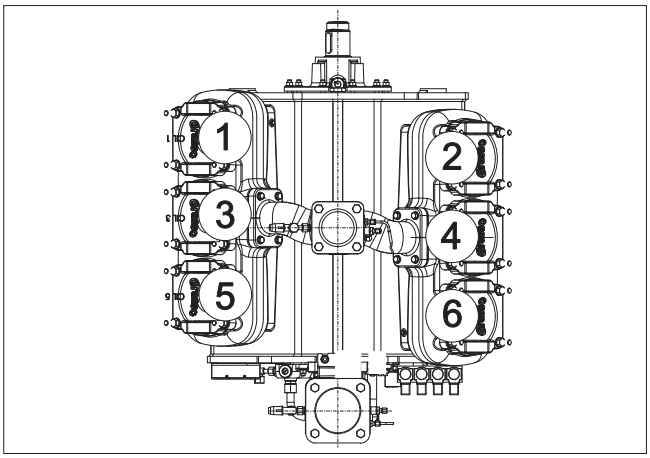


Fig. 1 Example cylinder numbering 6 cylinder compressor

Table 1 MAIN SETUP

NOTES:

Table 2 Main setup data

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 loading and unloading	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	> 30 °C and > $P_{saturated\ crankcase\ pressure}$ + 15 K	Indicated minimum value is the lowest oil temp. at which the compressor is allowed to be started.
Max. oil temperature	Refer to oil selection table/applied type of oil	Required oil viscosity; ≥ 10 cSt during operation at location of bearings The maximum temp. depends on the operating conditions of the compressor, the oil type used and (A minimum actual oil viscosity of 10 cSt in the bearings is always requried.
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 mimimum 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	
Max. intermediate pressure Max. suction pressure	X	
Pdischarge - Psuction	≤ 19.0 bar	Grasso V 700, 1100, 1400, 1800
	≤ 25.5bar	Grasso V 300, 450, 600
Superheat	>0 K	
Oil discharge - running in - filter	Factory mounted; to be replaced after max. 100 running hours by "normal" oil discharge filter element	
Oil discharge filter	Supplied loose; replacement for factory mounted running in filter	

1. INSTALLATION AND PREPARATION FOR USE

1.1 INSTALLATION

The compressor is not charged with oil, therefore, **DO NOT** start the compressor before it has been installed and prepared according to Grasso's instructions.

This section contains instructions for the proper installation of a Grasso compressor (package). Before the compressor (package) is ready for the initial start up, the installation instructions in the following paragraphs must be followed:

1. The Compressor (Package) should be levelled and securely anchored to the foundation.
2. All piping should be completed.
3. The system and the compressor are to be pressure tested for leaks (see. Section 1.2.1)
4. The system should be evacuated to remove air and moisture.
5. The electric wiring should be completed as per wiring diagrams. Do not energise the main power control cabinet until oil is added and the direction of rotation[1] has been checked.
6. The compressor is to be filled with the correct type and amount of lubricating oil and has to be pre-lubricated before the first start.
7. 'Open compressors' only;
   1 Open compressors;
   The drive system should be installed.
   2 (Semi) hermitic compressors;
   Mark R-S-T-N power supply in the terminal box of the motor.
8. The system should be charged with the correct amount of refrigerant.
9. The oil should be warmed up above minimum start up oil temperature (see "Product Information").
10. The control cabinet should be energised to check the package controls.

Do not forget to charge the oil separator (if present) initially with oil, to the level of the float assembly

1.1.1 MOVING INSTRUCTIONS AND STORAGE

For loose component or compressor package weights, refer either to the relevant component type plate or package lay-out or to the suppliers document. For bare compressor weights, see "Product Information".

Every precaution must be taken while moving the package to its final location. Pushing, pulling or climbing on any package component or piping, can easily create damage.

1.1.2 STORAGE

The compressor (package) is filled with dry nitrogen. Keep the system closed until the package is installed. If the compressor (package) is stored, it should be kept at all times in a dry location to prevent corrosion damage. If the compressor (package) is to be stored for a prolonged period of time, it should be checked weekly to ensure that the holding charge of dry nitrogen remains above atmospheric pressure.

1.1.3 HOISTING AND MOVING INSTRUCTIONS

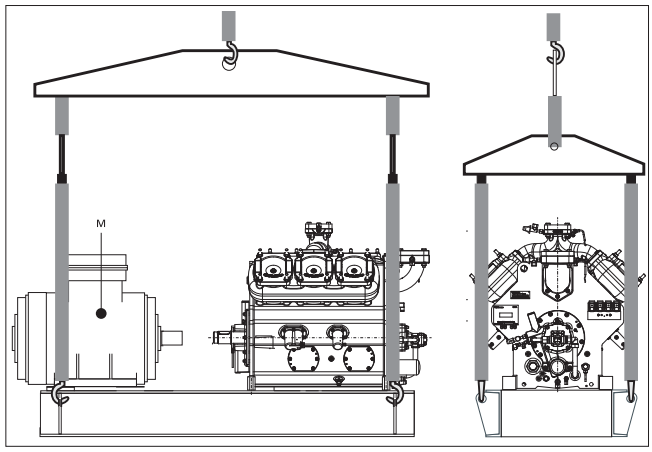


Fig. 1.1-1 Hoisting a compressor package

Packaged base frame:

The only places that can be used for safe hoisting of the package are the four hoisting eyes on the steel base frame as shown in the above figure. Prior to hoisting a compressor package with a V-belt drive arrangement, the factory mounted drive guard has to be removed. Attach spreader bars to the slings so as to prevent damage to piping and components.

DO NOT use the compressor or motor or oil separator hoisting eyes to move the package! These hoisting eyes are intended for lifting loose components only and not for the entire package!

Bare compressor or loose components:

Determine the dead weight of the particular component

1. The direction of rotation of the compressor cannot be checked for (semi) hermetic compressors. For these compressors the electrical connection should be marked, to be sure that the compressor has always the same direction of rotation!

(see "Product Information (ED)"), prior to moving a bare compressor or loose component. Use the hoisting eyes only, DO NOT sling from other compressor parts (see Fig. 1.1-2).

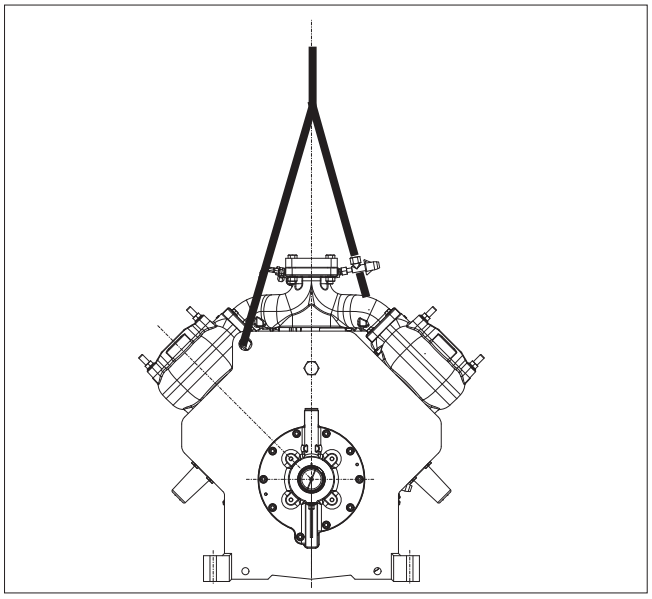


Fig. 1.1-2 Hoisting angle

Moving by fork-lift truck

The bare compressor or package can be transported with a fork-lift truck with the forks spread as much as possible between the skids. To simplify moving, the 2 wooden transport beams must still be mounted underneath the base frame and stored in this way, until the package is positioned above its approximate location.

1.1.4 REQUIRED FREE SPACE

For easy operating, servicing and maintenance access, the compressor (package) should be installed with sufficient free space around it.

Refer to "Product Information" for minimum requirements.

1.1.5 FOUNDATION REQUIREMENTS

Compressor (package) has to be mounted on a concreted block. On request, Grasso can calculate the exact dimensions of the concrete block, based on the compressor size and operating conditions.

This paragraph covers measures to be taken for a compressor (package) mounting on a concrete block. Two foundation arrangements are described:

1. Compressor package with steel base frame mounted on a concrete block.
   Following base frames are possible;
   a) Frame designed for mounting on concrete block. For more instalation details refer to; Section 1.1.5.1, Section 1.1.5.2, Section 1.1.5.3, Section 1.1.5.3.1, Section 1.1.5.3.2.
   b) Frame designed for mounting on vibration dampers.
   For more details in case mounting base frames on vibration dampers is applied, refer to separate instruction sheet and other order documentation like package drawing, supplied with the compressor package and consult Grasso if required.
2. Bare compressor direct mounted on a concrete block via grouted anchors.
   For more installation details refer to; Section 1.1.5.1, Section 1.1.5.2, Section 1.1.5.4.

1.1.5.1 CONCRETE STRUCTURE

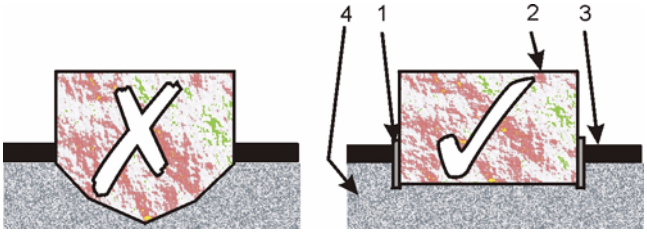


Fig. 1.1-3 Concrete block

Legend	
1	Cork board
2	Concrete base
3	(Concrete) Floor
4	Sand

The concrete block for compressor and motor or compressor package should have a profile as illustrated in Table on Page 10 and made according to the following recommendations:

- The concrete block should be set on firm footings or on a floor capable of carrying the weight of the concrete block and capable of absorbing the free forces and gas forces of the compressor during operation. The ground under the concrete block should be horizontal and flat.
- The top surface of the block should be level and even.
- There should be sufficient free space around the block to install corkboard (or similar).
- The block should be provided with anchor bolt recesses or holes according to the anchor bolt spacing as per package lay out drawing.

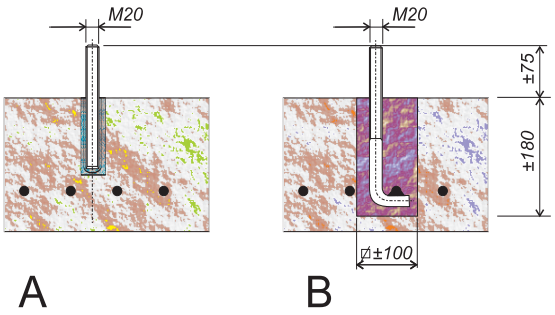


Table 1.1-1

Legend	
A	Chemical anchor
B	Grouted anchor, grounded to reinforcing steel

It is recommended to consult a concrete specialist/ constructor for the following items:

- The compound of the concrete with/without reinforcement.
- The exact grouting depth (dependent on the soil conditions).
- Installing foundation onto an existing floor, with sealing corkboard or vibration isolators.

1.1.5.2 ANCHORING

After the concrete block has cured the anchors should be installed as shown above and in case of a package in accordance with the package lay out drawing. Templates should be made to locate the anchor bolts or chemical anchors to match the holes in the bottom flange of the base frame.

Grout the mortar according to the supplier instructions. Install chemical anchors as illustrated in Fig. 1.1-4 and according to the instructions of the anchor supplier.

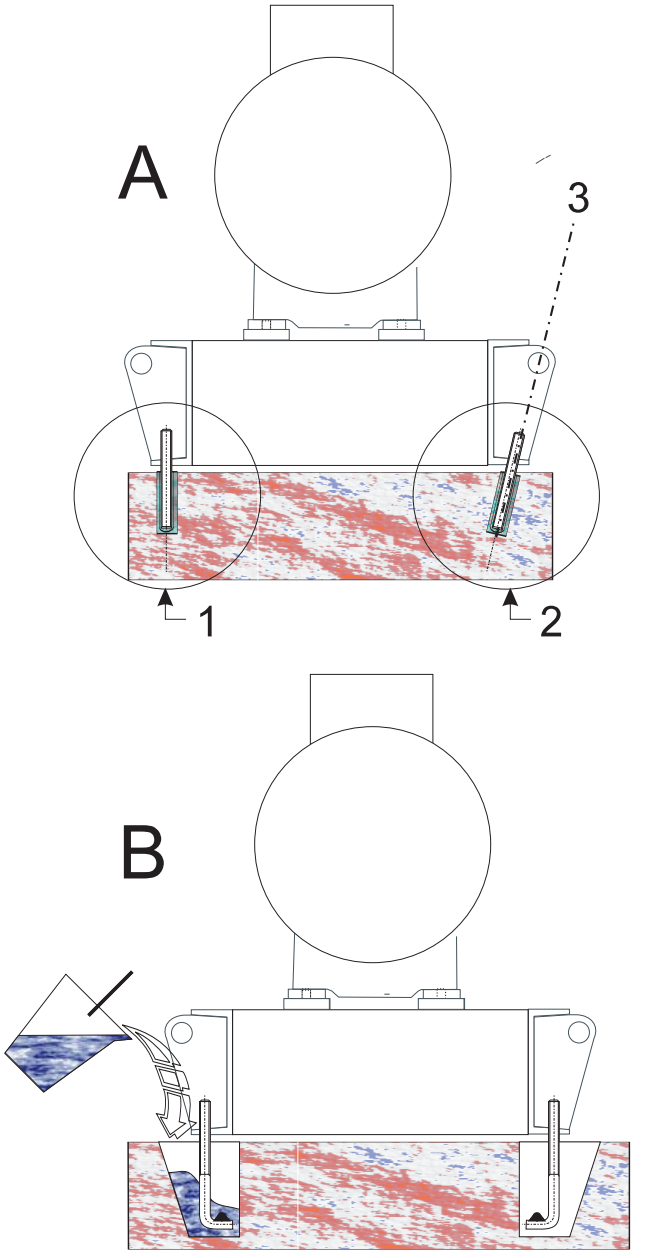


Fig. 1.1-4 Anchoring details

Legend	
A	Drilled chemical anchor (M20)
B	Grouted anchor recesses (M20)
1	Installed chemical anchor before placing the base frame
2	Installing chemical anchor after placing the base frame (base frame cannot be removed easily)
3	Drilling angle

1.1.5.3 MOUNTING THE BASE FRAME ON A CONCRETE BLOCK

General

After the space between base frame and concrete base has been filled-up with a filling grout, the package base frame must be secured tightly to the foundation block or floor.

1.1.5.3.1 LEVELLING THE BASE FRAME

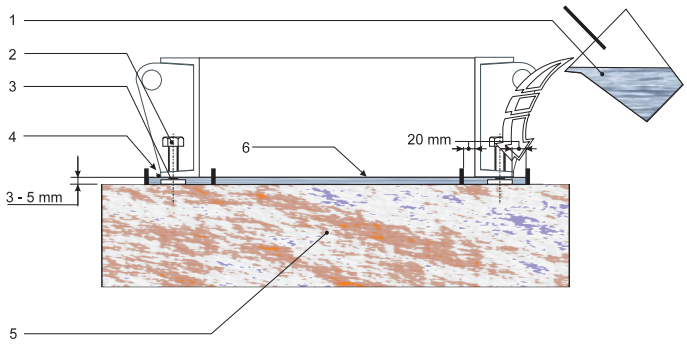


Fig. 1.1-5 Grouting details

Legend	
1	Self-levelling grout
2	Adjusting bolts (4x)
3	Washer
4	Temporary barrier strip around and inside frame
5	Complete cured concrete block
6	Grout layer

After the anchor filling mortar has completely cured the frame should be levelled with a space between block and lower frame flange of 3 - 5 mm*. This space is necessary for levelling using the base frame adjusting bolts with metal washers (supplied separately). The base frame should be levelled on each frame side. Adjust the frame on each adjusting place until all frame sides are horizontal.

This space largely depends on the sort of grout or mortar used. Determine this space according to the instructions of the grout or mortar supplier.

1.1.5.3.2 FINISHING WITH A SELF-LEVELLING GROUT

After levelling has been completed the adjusting bolt ends must be greased to avoid bonding to the self-levelling grout. The space between concrete block and frame must be completely filled with the self-levelling grout to ensure that the complete bottom surface of the base frame will be supported. Therefore, it is not allowed to use shims between concrete base and base frame.

Grouting must be carried out in accordance with the instructions provided by the grouting supplier. After complete de-aeration of the grouted layer, secure the base frame by tightening the anchor bolt nuts and remove all adjusting bolts. At this stage the drive system can be installed. These (accessories) installation instructions can be found in the order manual.

1.1.5.4 MOUNTING BARE COMPRESSOR ON A CONCRETE BLOCK

If base frame is not applied the approximately the same procedure of levelling the base frame has to be applied for the bare shaft compressor (refer Section 1.1.5.3). The mounting surfaces of the compressor feet must be level without any deviation and projecting at least 10 mm above the concrete base.

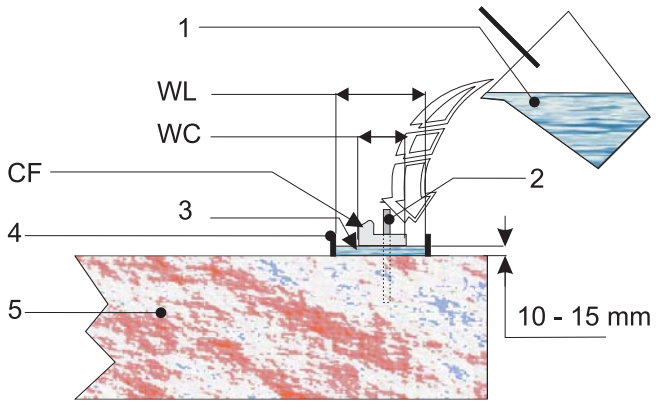


Fig. 1.1-6 Grouting details of bare compressor on concrete block

	Legend	
	1	Self leveling grout
	2	Foundation anchor
	3	Layer of self leveling grout (10 - 15 mm)
	4	Temporary barrier strip aroud each compressor foot
	5	Complete cured concrete block
	CF	Compressor foot
	WL	Width of grout layer (WL-WC > 40 mm)
	WC	Width of compressor foot (WL-WC > 40 mm)

1.1.6 CONNECTING TO REFRIGERATING SYSTEM PIPEWORK

STOP

DO NOT ground through the compressor when arc welding

After the compressor (package) has been levelled and secured to the foundation, the system piping may be connected. The suction line(s) and discharge line(s) should be installed and supported such that there is no load exerted on the compressor. The size and location of the suction and discharge connections, can be found in the "Product Information" (bare compressor) and in case of a package, the package lay out drawing.

In order to ensure that suction gas strainer can be removed easily, special attention for pipe work is required for (semi) hermetic compressors.

If an oil rectifier system is applied in the refrigeration system, the oil return line must be connected to the oil return connection (see "Product Information").

Never connect the oil rectifier return line to the suction line or to the suction gas filter.

Suspension of system pipework

To eliminate vibration transmission to the system piping, the following is recommended:

- Install all piping free of tension.
- Secure the piping by clips or brackets in two directions.
- Install (stop) valves, piping and accessories such, that there is no load exerted on the compressor.

1.1.7 CONNECTING THE POWER SUPPLY

Information about further electrical connections to be made (e.g. crankcase heater, drive motor starting equipment, thermal protection of drive motor, automatic start/ stop and other external electrical devices) can be found in the plant manual (not supplied by Grasso).

1.1.8 EARTHING CONNECTIONS

Grasso compressors and packages are equipped with litz-wires and earth connecting points.
To avoid leakage current flowing through the components, disconnect all litz-wires when arc-welding. After all installation functions are completed, reconnect the litz-wires and ground the package to earth.

1.1.9 SEPARATELY DELIVERED COMPONENTS

Check whether the sets/parts/components belonging to this compressor are supplied loose! (Refer to confirmation of order)

Mount these separately delivered sets, components and/or parts, according to the instruction as enclosed.

1.2 PREPARATIONS FOR USE

After the Compressor (Package) has been installed (excluding final connection of drive device), the following actions should be followed in the order given:

1.2.1 LEAK TEST OF COMPRESSOR AND SYSTEM

The compressor (package) has been pressure tested prior to leaving the factory. In case an additional leak test is required, this test is should be carried out with dry nitrogen.

DO NOT add oil to the compressor prior to pressure testing

A system leak test should be carried out over 24 hours to ensure that the system is tightly sealed.
Record during the pressure test, the pressure, ambient temperature and outside temperature. During the initial 6 hours a pressure drop of 2% is permissable. With respect to temperature variations, no further pressure loss should be detected in the remaining 18 hours.

1.2.2 EVACUATION/DRYING THE REFRIGERATING SYSTEM

For evacuation of compressor only, refer to Section 2.5

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. 5 mm Hg (=6.6 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, vand vi, otherwise, continue with the "Initial oil charge" procedure.

1.2.3 INITIAL OIL CHARGE

Used or filtered oil should NEVER BE added to a compressor under any circumstance.

Use only new oil as selected from the Grasso oil table.(Refer Chapter 6)

Oil charging via the suction line of the compressor is not allowed.

Procedure:

i) STATUS: System is dried and still evacuated.
ii) Charge the oil separator (if present) initially with oil .
iii) Close suction and discharge stop valves of compressor and oil return line of oil separator (if present).
iv) Charge the compressor crankcase with oil via the oil charge valve.

Pre-lubrication just before the first start is obligatory.

Filling of the afore mentioned components is also possible by means of a separate oil filling pump via the oil charge valves mounted onto the oil pump housing.

1.2.3.1 INITIAL OIL CHARGE

QUANTITY OF OIL TO BE FILLED (dm^3)				
Number of cylinders	Shaft seal housing incl. internal circuit of crankshaft	Oil filter	Oil pump	Crankcase (max/min)
V 300	0.7	1.5	0.9	17.0 / 12.5
V 450				23.9 / 17.6
V 600				34.6 / 25.5
V 700				22.4 / 16.5
V 1100				31.9 / 23.5
V 1400				45.6/ 33.6
V 1800				55.1/40.6

1.2.4 INITIAL REFRIGERANT CHARGE

Refrigerant charging should be done in accordance with the plant manual by qualified refrigeration engineers.

1.2.5 ADJUSTMENT OF INSTRUMENTS AND SAFETY DEVICES

1.2.5.1 CONTROL DEVICES

Refer to separate user manuals, in case an electronic control device is installed.

1.2.5.2 PRESSURE SETTINGS

Pressure safety limit switches				
Suction pressure[a]	Setting	5°C below design evaporating temp.	
	Min.	0.3 bar(a)	
Suction and intermediate pressure	Setting	Max.= depends on rotational speed, refer to Product Information (PI)	
Discharge pressure [a]	Setting	5°C above design condensing temp.	
	Max.	26 bar(a)	Grasso V 300 Grasso V 450 Grasso V 600
		24 bar(a)	Grasso V 700 Grasso V 1100 Grasso V 1400 Grasso V 1800
Lubrication oil pressure difference	Setting	Min. =1.3 bar	

a. Settings Pdischarge - Psuction must never exceed max. value as mentioned in Product Information

Oil pressure regulators		
Lubrication oil pressure difference[a]	Setting	2.0 bar
	Min. and max. at 50 °C oil temp.	Min.=1.3 bar Max.=4.5 bar
Control oil pressure difference	Setting	8.0 bar

a. The oil pressure regulator is adjusted at the works, but it may occur that this setting should be corrected during the initial run and also if the value <1.5 or >2.5 bar. The re-adjustment procedure is given in section "Re-adjustment of oil pressure regulator.

1.2.5.3 RE-ADJUSTMENT OF OIL PRESSURE REGULATORS

It is possible that after the compressor has been installed, the lubrication oil pressure regulator needs to be adjusted.

Location pressure regulators (control and lubricaton)

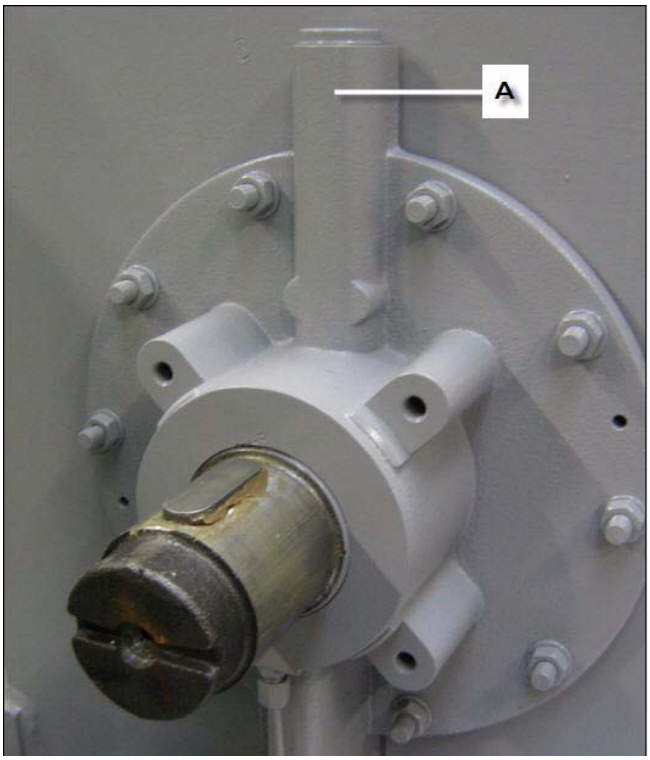


Fig. 1.2-1 Oil lubrication pressure regulator (A)

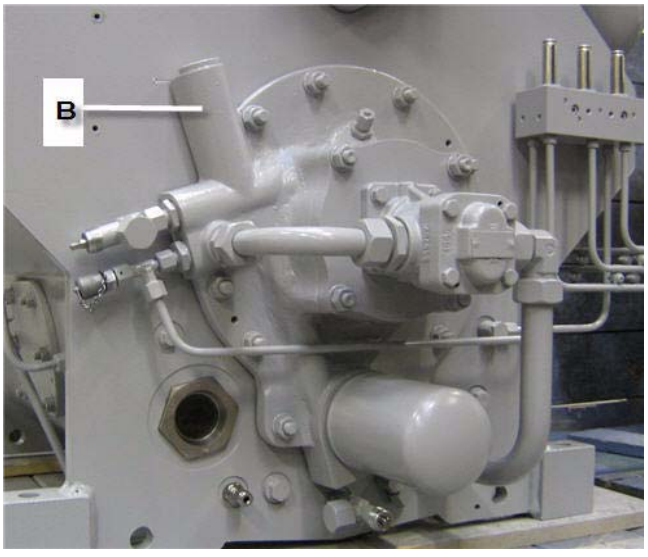


Fig. 1.2-2 Oil control pressure regulator (B)

Re-adjustment procedure:

REMARK: For settings, refer .

i) Run the compressor for 15 minutes until the crankcase oil is at its stable operating temperature [Toil] of 50 °C at which:

1) The lubricating oil pressure difference should be (A) according to .
2) The control oil pressure difference should be approx. (B) according to .
After the initial run the oil pressure differences should be slightly higher.

ii) Determine the lubricating oil pressure difference (difference between the pressure gauges of the oil and suction or [dOil]).
iii) Determine the control oil pressure difference (difference between the pressure gauges of oil pump discharge [1] and suction.
iv) Remove the plug of both oil pressure regulators if the pressures need to be re-adjusted.
v) Turn the slotted pin with a screwdriver clockwise or counter clockwise for a higher or lower oil pressure respectively, until the required control & lubricating oil pressure differences have been achieved [2].
vi) Replace both plugs.

REMARK: If the valve lifting fails, check the control oil pressure regulator!

1.2.6 CHECKING DIRECTION OF ROTATION OF MOTOR SHAFT

Prior to installing the intermediate coupling element or V-belts, the direction of rotation of the motor shaft must be checked. The direction of rotation can be determined from the arrow-sticker at the oil pump.

1.2.7 INSTALLING THE DRIVE GUARDS (IF PRESENT)

Only after the compressor is ready for the initial startup! Refer to the drive guard installing procedures included in the order documentation.

1.2.8 INITIAL OIL WARM UP

Prior to the initial start-up, the crankcase heater (if present) must be energised. For the min. oil temperature refer to "Product Information (PI)".

1.2.9 INITIAL START-UP

1.2.9.1 LIMITATIONS OF PART LOAD OPERATION AND START-UP

The capacity control serves to adapt the compressor capacity at any moment as closely as possible to the refrigerating capacity. In order to adjust the capacity, a number of cylinders can be put in or out of action either individually or collectively by means of solenoid valves.

Due to start-up limitations and to limitations of part load operation it may be that not all available part load steps are allowed under certain conditions. Use of incorrect control steps can damage compressor and/or components.

For a detailed description about start-up and part load limitations refer to the software program "Comsel".

1.2.9.2 WIRING LOGIC NORMALLY OPEN UNLOADED START SOLENOID

1 If compessor is NOT running then NO-solenoid is not energised.
2 Energise the NO-solenoid 10 - 20 seconds before starting.
3 If compressor starts then NO-solenoid is energised and de-energised by means of an auxiliary time relay.
4 Ensure that the NO-solenoid valve is not de-energised until full speed has been achieved and the specified lubrication oil pressure has been established.
5 Energise the NO-solenoid 5 seconds before stopping until the compressor is stopped completely.

1.2.9.3 FREQUENCY CONTROLLED COMPRESSOR

In case of frequency controlled compressors, a separate instruction 00.87.041 is required. If you don't have this instruction consult Grasso.

1.2.9.4 PRE-START CHECK LIST

The following Paragraph covers only the initial start of the compressor and not the complete refrigeration plant.

Be sure that all necessary system valves are open and that the refrigeration system is ready for start up. Use the following check to guarantee that no items of importance regarding the compressor (package) have been overlooked.

i) System is charged with refrigerant.
ii) Settings of safety limit switches are adjusted properly.
iii) Direction of rotation of compressor crankshaft is correct.
iv) Check capacity control:
1. Set the electrical capacity control switch to the position of the lowest part load step.
2. Check whether the manual control lever of each solenoid is in its lowest horizontal position.

If control lever of each solenoid is not in its lowest position, the compressor may be seriously damaged.

v) Oil level established in sight glass.
vi) Stop valves to the pressure gauges are open.
vii) Suction stop valve is closed (in case the evaporating temperature is much higher than the design evaporating temperature) and the discharge stop valve is open and in case of two- stage compressors

1. To be measured by means of a special control oil pressure gauge to be connected at position E on the oil pump.
2. Re-adjusting one regulator will affect the other one, so be sure that both regulators are properly (re-)adjusted.

that the stop valves in the intermediate circuit lines are open.

viii) Stop valve in the oil return line of the oil separator (if present) is closed.

When all items are verified, the compressor (package) is ready for the start-up.

1.2.10 STARTING AND STOPPING PROCEDURES

For all limitations refer to Table 1! The values in the main setup data tables, overrules the values as mentioned in the text.

When starting the compressor a distinction should be made between:

1.2.10.1 FIRST START

1) Notice "Pre-start check list", also consult the plant manual and verify the following items:
   – Check the oil temperature (refer to the "Product Information").
   – Check crankcase oil level (refer to Section 2.4.1).
2) Start the compressor and check whether the oil pressure increases.

The time interval between stopping and starting should be at least 2 minutes and between starting and re-starting 10 minutes.

3) Slowly open suction stop valve and watch suction pressure, which may not exceed the max. value.

Refrigerant liquid hammer, will damage the compressor; Dry gas (superheat) is always necessary!

4) In case of electrically operated capacity control: One or more cylinders will be energized.
5) Watch maximum allowable motor current (refer to motor type plate).
6) Watch discharge temperature and max. allowable motor current (refer to motor type plate).
7) Adjust pressure gauge stop valves, in order to avoid vibration of the pointers. (if present)
8) Open the stop valve in the oil return line from the oil separator (if present).
9) Open compressors only; After 50 hours of operation retighten the coupling bolts or check and/or correct the tension of the V-belts and retighten the foundation bolts (with due respect to the torque settings given by the supplier of the fasteners!).

1.2.10.2 RESTART

For the time interval between stopping and starting refer to Table 1.

Proceed to the complete starting procedure like “First start”

1.2.10.3 RESTART AFTER A SHORT STANDSTILL PERIOD OF TIME (LESS THAN 1 MONTH)

- Refer to Section 1.2.10.2.

1.2.10.4 RESTART AFTER A LONG STANDSTILL PERIOD OF TIME

After a seasonal standstill (1 till 6 months) or maintenance operations;

After a standstill period of time more than 1 month, pre-lubrication just before starting is always obligatory.

- Check settings of control and safety equipment.
- Proceed to the complete starting procedure.

Restarting compressor after a standstill period of time more than 6 months, consult your supplier. It is recommended to proceed with the initial start up procedure.

1.2.10.5 STOPPING THE COMPRESSOR

The compressor can be stopped at any moment, however, consult the supplier if further actions are required.

2. INSPECTION AND TROUBLE SHOOTING

2.1 PERIODICAL INSPECTION

These inspections should be made during the normal shut-down periods as much as possible, so the compressor is always ready to operate when required. If, at that time, the number of running hours slightly differs from the scheduled period below, the inspection should nevertheless be carried out.

In this way it will not be necessary to stop the compressor at inconvenient times.
The frequency of inspections is dependent on the type of installation, operating conditions and local regulations. In the case of automatically controlled plants, the periodical inspection are particularly important. The table below sums up all the points on the compressor that have to be inspected or maintained along with inspection and maintenance frequencies.

2.2 SURVEY OF PERIODICAL INSPECTIONS

Apart from the check points in the table below, the sound produced by the compressor also provides an indication of its mechanical condition. If abnormal sounds are audible, their cause should be traced and removed immediately in order to prevent serious breakdowns.

2.2.1 CHECK LIST PERIODICAL INSPECTION

Table 2.2-1 Check list periodical inspection

CHECK POINTS[a]	FREQUENCY			REMARKS
	daily	weekly	monthly	
Oil level in crankcase	·			Between 25% and 75% height of the sight glass. For topping up oil, refer to Section 2.4.1.
Colour of the oil			·	The oil should be transparently clear. A disappearing white colour points to dissolved refrigerant.
Lubricating oil pressure difference	·			
Min. control oil pressure		·		
Oil temperature max.		·		Refer to the "Product Information"
Oil leakage of shaft seal max.			·	In case of more than 1 cc/hr contact supplier.
Suction pressure		·		Check against design conditions. Refer to plant manual.
Discharge pressure		·		Refer to plant manual. For the max. allowable discharge pressure refer to the technical data of compressor.
Suction superheat Intermediate superheat		·		≥15 K required for R404A and R507, for other refrigerants ≥0 K
Discharge temperature max.		·		170 °C.
Oil temperature min.			·	During compressor standstill the lower part of the crankcase must remain warmer than the surroundings: ≥ 20 °C (NH_3) and ≥ 30 °C (halocarbons).
Cooling water temperature (if present)		·		Min. Actual condensing temperature + 10 K (≥ Tc + 10 K)
Condition of V-belts			·	Check belts for: 1) Wear (fraying, cuts etc.) and ensure that they do not touch the groove bottom. 2) Tension. Too low a tension gives rise to excessive flapping or oscillation in operation. For correct tension consult the instructions given by the V-belt supplier.
Adjustment and operation of pressure safety switches			·	Refer also to instructions of switch manufacturer.
Capacity control (if provided)		·		Refer Table 1.
Switching frequency of the compressor		·		
Number of operating hours			·	Check the number of operating hours in view of any maintenance operations to be carried out.

a. During the first 50 operating hours the compressor should be checked regularly for all the points mentioned above, at least twice every 24 hours and more frequently in cases where irregularities are found.

2.3 STEPS FOR LONGER SHUT-DOWN PERIODS (> 6 MONTHS)

To shut down a compressor for long term periods, proceed as follows:

i) Tightly shut both the suction and discharge stop valves and the stop valve of the oil return line (if present).
ii) Disconnect the power source from the compressor drive motor and the electrical control cabinet.
iii) Place a moisture absorbing compound (eg a dessicant such as silica gel) inside the control cabinet.
iv) Place warning tags on the electric system and all closed stop valves.

Prior to starting up after a shut down, change the oil (refer to) and exchange the oil filters. Determine the starting and stopping procedure from prior to start the compressor.

2.4 LUBRICATION DATA

Determine max Toil and set this value in the safety device.
Change the oil as soon as an oil analysis indicates contaminated oil.

It is expressly pointed out that it is not permitted to mix different types of oil. If another type of oil is used, first remove all the stale oil in the filters, oil pump, crankcase, shaft seal, oil separator and oil drains of the installation.

2.4.1 TOPPING UP OIL WITH COMPRESSOR OPERATING

Use Grasso's hand-operated oil pump, part. no. 18.13.121

Topping up oil is permitted during compressor operation.

Be sure that this oil is the same as in the plant (refer to Section 2.4).

Without affecting the operation of the compressor, the oil may be topped up by means of a separate oil pump. This pump enables the oil to be forced into the crankcase via the oil charging valve, against suction pressure.

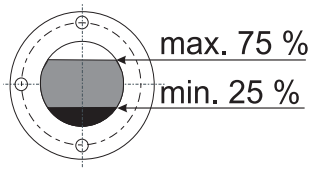


Fig. 2.4-1 Oil level in compressor sight glass

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

To evacuate the refrigeration system refer to Section 1.2.2,

Use always a vacuum pump or pump-down unit to evacuate the refrigerant from the compressor.

2.5.1 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.

2.5.2 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.

2.5.3 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)

2.5.4 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.

2.6 DRAINING AND CHANGE OF OIL

To top up oil see Section 2.4.1, Oil changing procedure:

i) Evacuate the compressor (refer to Section 2.5).
ii) Drain the oil via the oil charging/drain valve. Remove the cover of one or more service openings on the compressor side.
iii) Clean the inside of the crankcase with a non-fibrous cloth (do not use cotton waste!).
iv) Replace the service cover(s) with a new seal.
v) Charge crankcase with clean oil in accordance with the procedure.

2.7 REPLACEMENT OF OIL FILTERS

General

The frequency of exchanging oil discharge filter, oil suction filter and compressor suction gas filter(s) depends on the condition of the refrigeration system. Besides the maintenance schedules, it is recommended to exchange all filters when the compressor is overhauled and also in case the refrigeration plant has been modified.

An oil discharge oil running-in filter is factory mounted. This oil filter must be exchanged after max. 100 running hours. This oil filter cannot be cleaned.

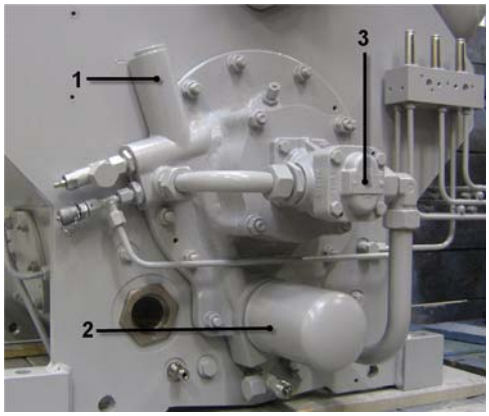


Fig. 2.7-1 Oil control pressure regulator (1), oil discharge filter(2), oil pump (3)

Oil discharge filter

Use the special tool for (dis)mounting the oil discharge filter element

Evacuate the compressor prior to exchange any filters.

2.8 DISMANTLING, INSPECTION AND RE-ASSEMBLY OF SUCTION AND DISCHARGE VALVES

A high working temperature and rapid temperature variations shorten the life time of the valves, which, for this reason, require regular inspection.

The suction and discharge valves of a refrigeration compressor are parts that are heavily loaded both mechanically and thermally. Wear and life time of the valves strongly depend on the working conditions of the compressor. It is recommended that valve condition is regularly checked.For dismantling, inspection and re-assembly of the valves, refer to the relevant paragraph of the Compressor Service Instruction Manual.

In order to reduce the downtime involved in the valve inspection, it is recommended to have as many complete valve assemblies in stock as there are cylinders on the compressor.These valves can be exchanged with the original valves; in this case, these original valves can be inspected and repaired or replaced if necessary later.

2.9 COMPRESSOR PURGING

Procedure to purge the compressor(after maintenance jobs):

STATUS:

Stop valves of suction, discharge and oil return line are still closed (refer to Section 2.5) and compressor is filled with oil (refer to Section 2.6).

i) Connect a vacuum pump to the evacuation/purging valve(s) and evacuate as prescribed by local regulations. For the location of these valves refer to the "Product Information".
ii) When evacuation is completed open the discharge stop valve.
iii) Watch suction and discharge pressure.

If suction pressure increases quickly, the discharge valve assy is leaking.

iv) Start compressor.
v) Slowly open suction stop valve.
vi) Open the stop valve in the oil return line of the oil separator (if present).
vii) For two stage compressor only;
   a. Two-stage system A/B: open liquid supply to interstage cooler.
   b. Two-stage system C/D: refer to the plant manual.
viii) If a Self-Limiting Automatic Purger is not installed, purge the refrigerating system (refer to the plant manual).

2.10 TROUBLESHOOTING TABLE GRASSO RECIPROCATING COMPRESSORS

The troubleshooting table shown overleaf may be helpful to quickly trace and remedy failures that interfere with the proper operation of the compressor. It is emphatically pointed out that the cause of a failure must often be sought in the refrigeration installation itself. Therefore, it is necessary besides this table also to consult the plant manual.

Table 2.10-1 Troubleshooting

FAULT	CAUSE	REMEDY
A Discharge pressure too high	1. Discharge stop valve not fully open	Open fully
	2. Discharge pressure gauge defective	Repair or replace
	3. Non-condensables in the system	Purge with a Automatic Purger
B Discharge temperature too high	1. Discharge pressure too high	See A
	2. Too many cylinders cut out	Cut in more cylinders
	3. Suction pressure too low	See D
	4. Excessive superheat of suction gas	Eliminate excessive superheat
	5. For two-stage compressors: interstage cooling does not operate properly	Repair
	6. Room temperature too high	Ventilate engine room better
	7. Discharge valve defective	Repair or renew
	8. Pressure relief valve is leaking	Repair or renew
	9. Water cooling is not working properly	Repair
C Suction pressure too high	1. Capacity control does not operate	Repair
	2. Compressor capacity too small	Refer to plant design
	3. Suction pressure gauge defective	Repair or renew
	4. One or more suction valves defective	Renew suction valve rings
	5. One or more discharge valves defective	Repair or renew
	6. Pressure relief valve is leaking	Repair or renew
D Suction pressure too low	1. Suction stop valve not fully open	Open fully
	2. Suction gas strainer blocked	Renew
	3. Injection control not adjusted correctly	Re-adjust control
	4. Too little refrigerant in installation	Top-up with refrigerant
	5. Suction pressure gauge defective	Renew
E Crankcase frosted or wet[a]  **Stop compressor and contact installation engineer**	1. Liquid refrigerant in crankcase due to:	
	1a. Room temperature too low	Provide for crankcase heating or, if provided, check it for proper operation
	1b. Oil return from separator contains liquid refrigerant	Consult plant manual
	1c. Installation operates too wet	Re-adjust installation and provide for superheat
	1d. Liquid separator too small	Consult plant manual
F All cylinders inactive while compressor is operating	1. Oil pressure for valve lifting mechanism too low (For Grasso V, 12, 12E and Grasso 10 only)	See J
	2. Incorrect wiring of capacity control	Refer to the "Product Information"
G Too high oil consumption	1. Type of oil not according to oil lubrication oil table (too thin oil)	Change oil type
	2. Compressor operates unloaded too frequently	Refer to design calculations
	3. No return from oil separator[b]	Check the operation of float valve in oil separator
	4. Restriction plug at the bottom of suction chamber in cylinder clogged	Clean plug
	5. Worn out oil scraper ring(s)	Replace ring(s)
	6. Loss of oil due to leakage	Repair
	7. Leaking shaft seal (max. 1 cc/hr) (Not for Grasso 7S and 8S)()	Repair shaft seal Refer to Section 2.2
	8. Oil level in crankcase too high	Drain/Refill with oil
	9. Oil separator is not initially filled with oil	Refer to section "Initial oil charge"
H Too high oil pressure during normal operation at working temperature	1. Lubricating oil pressure regulator not adjusted properly or defective	Re-adjust or renew
	2. Defective oil pressure and/or suction pressure gauge (if present)	Repair or replace

FAULT	CAUSE	REMEDY
J Too low lubricating oil pressure	1. Too little oil in crankcase	Top up oil
	2. Disturbed oil circuit: Oil suction and/or discharge filter is dirty	Renew the element of oil suction filter and/or oil discharge filter
	3. Lubricating oil pressure regulator not adjusted properly or defective	Re-adjust or renew
	4. Liquid refrigerant in crankcase	See E
	5. Defective oil pressure and/or suction pressure gauge (if present)	Repair or renew
	6. Worn bearings	Renew bearings
K Too low or no control oil pressure (For Grasso V, 12, 12E and Grasso10 only)	1. Failure of control oil pressure regulator in oil pump	Re-adjust or renew regulator
	2. A lack of oil in oil system	Add oil to the system
	3. Oil pump defect	Repair or renew oil pump

a. In case of R744 applications only, crankcase can be frosted or wet, during normal operating conditions.
b. During the initial start-up, the oil separator (if present) consumes oil before the first oil will be returned.

3. MAINTENANCE

3.1 POST START-UP MAINTENANCE

After the compressor has run for the initial 100 operating hours:

i) Drain the oil and refill the compressor with the correct amount of fresh oil.
ii) Replace the running oil discharge filter element with the "permanent" filter element in accordance with the filter replacement instructions.
iii) Inspect suction gas filter (refer to the Compressor Service Instruction Manual).
iv) Exchange or clean oil suction filter element.
v) Check the compressor shaft seal for leakage. If excessive (more than 1 cc/hr) replace the seal.
vi) 1) Retighten the coupling mounting bolts with the torque settings as given by the coupling manufacturer.
2) Verify and if necessary, correct the tension of the V-belts as given in the V-belt supplier's instructions.
vii) Verify and if necessary, correct the torque settings of all foundation bolts as given in Compressor Service Instruction Manual.

3.2 FIRST MAINTENANCE

For complete conditional service schedules and service intervals, refer to Guideline for Conditional maintenance.

After the refrigerating plant has been modified, the suction gas filter(s), the oil filters and the oil must be changed.

Maintenance	Number of operating hours	
	100[a]	> 100
Renewal of oil discharge filter	X	refer to Guideline for Conditional Maintenance
Inspection of suction gas filter(s)	X	
Inspection of oil suction filter (strainer)	X	
Oil analysis [b]	X	
Inspection leakage shaft seal	X	

a. Time dependent on pollution.
b. Consult your oil supplier.

3.3 DESCRIPTION MAINTENANCE ABC

General

The following maintenance has to be distinguished;
1 Small maintenance, Maintenance A, Yearly inspection
2 Medium maintenance, Maintenance B
3 Large mainenance, Maintenance C

Description maintenance A;

1 Replace/clean oil discharge filter, clean oil suction filter
2 Visual inspection of cylinders and crankcase
3 Visual inspection of cylinder no. 1
4 Check compressor running conditions
5 Check/test safety equipment

Description maintenance B;

1 Maintenance A +
2 Replace suction and discharge valve rings and springs ("top end" overhaul)
3 Inspecition of pistons and cylinder liners

Description maintenance C;

1 Maintenance B +
2 Major inspection/overhaul;
Depending on requirements and expectations, required actions have to be taken. (complete disassembly, replacement of bearings, inspection/replacement of all main components like crankshaft, cylinder liners, pistons, ...)

3.4 CHECKLIST MAINTENANCE A, B, C

Maintenance information as mentioned below is general for all Grasso reciprocating compressors. So not all data is relevant for all series and types.

3.4.1 COMPRESSOR

General remarks about check list;

1. Check list for compressor only; all other components have to be maintained according to their specific manuals (IMM and SIM).
   Refer also to Table 3.4-1.
2. All items of the list below marked "check", have to be checked visually and checked for proper working.
3. Some components have to be measured.
   For measuring details refer to SIM.
4. Measuring means also that visual inspection is required.
5. Visual inspections:
   The visual inspections during maintenance are of importance; measurements should be carried out at the moment that visually abnormalities are detected. The result of the inspection determines whether one or more parts have to be replaced. For more detailed information refer (SIM) and Installation and Maintenance Manual (IMM).
6. Oil and oil return systems:
   The quality of the oil effects the oil consumption and the life time of the moving parts.For oil return systems or systems in which soluble oil is being used, we advise to check (or have checked) the quality of the oil every 5000 hours and - if necessary - to renew the oil and/or filters. If the oil discharge filter is fitted with a pressure difference indicator, then the oil and filter should only be replaced when the indicator indicates <50%. If there is no indicator and/or oil analysis available, we advise to renew the oil. By regularly carrying out oil analyses and registering them in a log, aberrations will be noticed in an early stage, which may prevent or reduce resultant damage(s).

   Note 1:
   When renewing the oil, in the crankcase the oil in the oil separator and the oil return or oil rectifier system (if fitted) has to be renewed.

   Note 2:
   Pre-lubricate the compressor before re-starting. Used or filtered oil should NEVER be added to a compressor under any circumstance. Use only new oil as selected from the Grasso oil table. Oil charging via the suction line of the compressor is not allowed.

Maintenance compressor			Description	
A	B	C		
check	check	check	Capacity control	Solenoid valve and coils
	check	Replace		Seals of cap control piston / lifting mechanism
check	check	check	Compressor housing	Oil return orifice (LP and) HP
check	check	check	Crankcase heater	
	Visual inspection	Measure	Crankshaft	Main (and intermedediate) bearings, running surface
	Visual inspection	Measure;	Connecting rod	Cylinder located nearest to the shaft-end of the compressor: Big and small end bearing, running surface
Clean	Clean	Clean	Compressor housing	Inside and outside
Visual inspection	Measure	Replace	Cylinder liners	Cylinder located nearest to the shaft-end of the compressor
check	check	check	Drive	Coupling alignment
check	check	check	Motor Grasso 7S and 8S	Cable connections
check	check	check	Interstage cooler	Inspections and injection valves
	Replace	Replace	Filters	Oil suction filter
Replace. If oil diff. indicator is applied; Replace if indicator indicates <50%)	Replace	Replace		Oil discharge filter
check	Clean	Replace		Suction gas
check	check	check	Oil	Oil analysis recommended
If hygroscopic oil is applied: Replace	Replace	Replace		Oil refreshment compresssor, oil separator and oil system
	Visual inspection	Replace		Oil pump element, oil control and lubrication presssure regulator
check	check	check		Lubrication and control system
check	Clean	Clean		Oil separator, test oil return system
Clean	Clean	Clean		Oil cooler fan / heat exchanger
	Visual inspection	Replace	Piston	Rings
	Visual inspection	Measure		Gudgeon pin
	Visual inspection	Visual inspection	Relief valve(s)	
check	check	check	Shaft seal	Refrigerant leak range
	check	Replace		Seal assembly
Visual inspection	Replace	Replace	Compressor valves	Cylinder located nearest to the shaft-end of the compressor: Suction and discharge valves, springs, damper rings
check	Replace	Replace		Suction and discharge compressor valves
		Replace	Thrust bearing	Running surface

3.4.2 PACKAGE COMPONENTS

Table 3.4-1 Checklist package components

		Description/checkpoint
	1	Drive guard
	2	V-belts and alignment
	3	Coupling alignment
	4	Oil level float switch on compressor and oil separator
	5	Pressure safety switches
	6	Pressure gauges
	7	Thermostats and thermometers
	8	Electrical control system
	9	Oil return protection and oil return system
	10	Electric motor and thermistors (Consult motor manufacturer)
	11	Base frame, vibration dampers and bolts
	12	Piping
	13	Interstage cooler, interstage injection
	15	Oil cooler (oil side and air side) and fan
	16	Thermo-Master
	17	...
	...	..... etc .....

3.5 GRASSO MAINTENANCE MONITOR

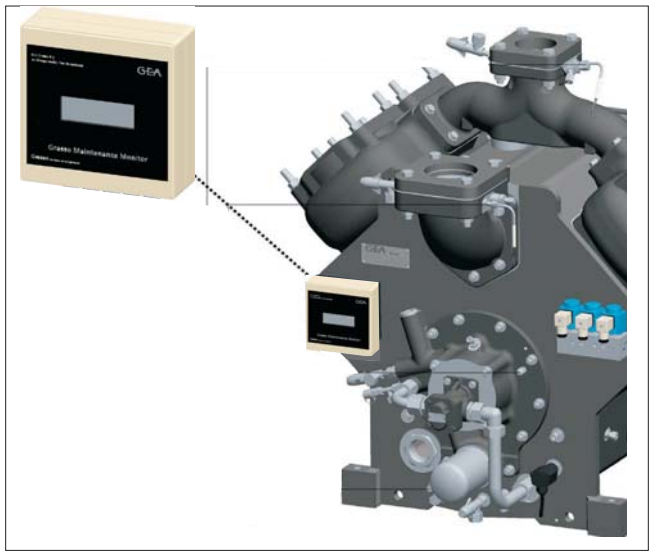


Fig. 3.5-1 Grasso Maintenance Monitor

Table 3.5-1 GMM connections

	GMM connections	
	1	Ethernet
	2	Power input (10 .. 30 VDC)
	3	Compressor speed sensor
	4	Discharge temperature sensor
	5	Oil temperature sensor

The Grasso micro processor controlled maintenance monitor is a unique standalone device for flexible "On time" maintenance. This equipment is fitted as standard on V series compressors and allows us to tune the maintenance to the actual running conditions. In other words: "On time maintenance"

This results in (nearly) all cases in longer service intervals and significantly less maintenance costs. For industrial refrigeration compressors this is a unique development. To maintain the highest level of reliability, even with extended service intervals, this series is fitted with the best possible components available.

This standalone device works independent from compressor controls like the Grasso GSC OP/TP and must be seen as an addition on the normal compressor control. In separate documents the complete maintenance philosophy and how to handle is explained in detail.

Besides this practical instrument Grasso is able to make, in advance, an analyses based on a theoretical profile of the compressor and the running conditions. In this way an indication of the running costs (Total Costs of Ownership, TCO) can be produced.

4. PARTS COMPRESSOR

Ref. nrs "*" = only available as a complete set.

Refer to , to find torques.

Refer , to find wear and tolerances.

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 01 COMPRESSOR HOUSING V					
1	RELIEF VALVE	V	2748950	1	
2	CRANKCASE	V 700-1	*	1	
3	CRANKCASE HEATER CONNECTION	KH1/KH6	*		Refer to Parts List Accessories and Product Information
4	CABLE CLAMP		1349005	1	
5	OIL LEVEL SWITCH CONNECTION	KH2	*		Refer to Parts List Accessories and Product Information
6	SIGHT GLASS	R2"	1226002	1	
7	NAME PLATE	R05	*	1	
8	PRESSURE SPRING	2x29x3x32	1131219	1	
9	DUMMY RELIEF VALVE	V	1116080	1	
10	FLAT WASHER	M5x13	1113013	1	
11	CYLINDRICAL PIN		1106645	1	
12	O-RING	3.53x21.8	0955212	2	
13	O-RING	3,53 x 65 EPDM	0952347	2,2,6,6	
14	O-RING		0952220	4/cyl	
15	ALU. SEALING RING	60 X 68 X 2	0914060	1	
16	ALU SEALING RING	33x39x2	0914033	1	
18	P AND/OR T CONNECTION	G13	*	1,1,2,2	Refer to Parts List Accessories and PInfo
19	STRAINER ELEMENT	2154 X 137	0716200	1	
20	SUCTION OIL STRAINER	390 - 1"NPT	0715228	1	
21	COUPLING MEMBER	1" NPT	0685034	1	
22	STOP VALVE	TAH8-12	0607011	1	
23	SCREW GUARD	G1"	0386034	1	
24	SWIVEL COUPLING	G13 X 30	*	1	To be used in combination with 0385155 or 0385157
25	TEMP. INSERT	6G13 X 76	0385157	1	To be used in combination with 0385136
27	P AND/OR T CONNECTION	G13	*	1,1,3,3	Refer to Parts List Accessories and PInfo
28	SWIVEL COUPLING	6G13	0339136	2	
29	NIPPLE COUPLING	28G33	0338275	1	
30	NIPPLE COUPLING	12G27	0338274	1	
31.	NIPPLE COUPLING	16G21	0338212	2,3,4,5	
32.	NIPPLE COUPLING	8G13	0338138	2	
33	NIPPLE COUPLING	12G13	0338131	1	
34	PIPE	22 X 2 X 608	0223560	1	
35	PLUG	G1"	0136234	1	
36	PLATE SCREW	2,9 X 5	*	4	
37	STUD BOLT	M16 X 260	0125855	4/cyl	
38	TENSION NUT	V - M16	0123910	4/cyl	
39	RESTRICTION PLUG	NPTF -18-Lx1.5	0123138	1/cyl	All cylinders single stage compressors and LP-cylinders two-stage compressors
40	SOCKET HEAD SCREW	M6x10	0104310	1	

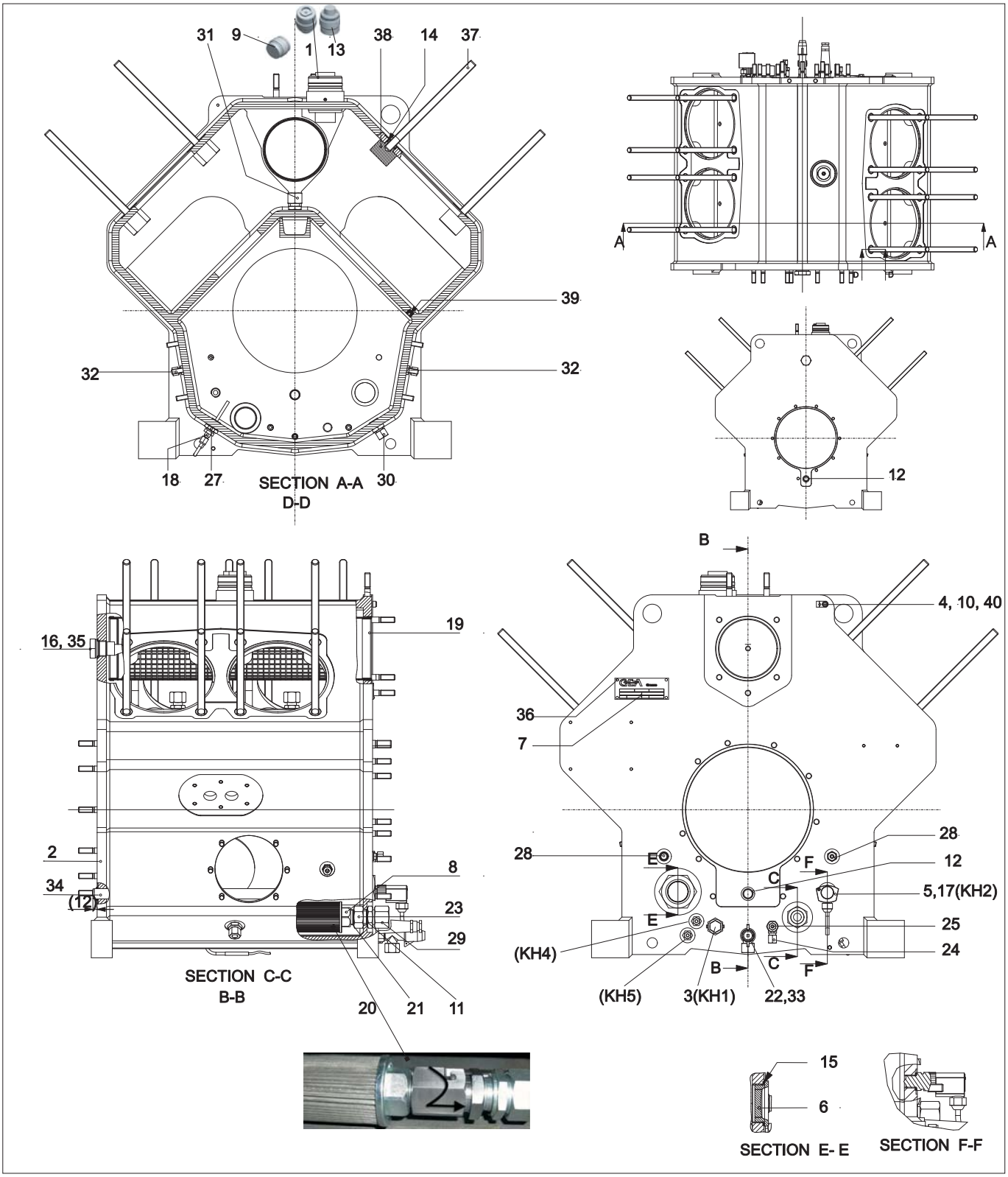


Fig. 4-1 Grasso V - 01

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 02A CYLINDER HEAD- AND SERVICE COVER V 700 / V1400					
1	CYLINDER HEAD	V 700	2148560	1	
2	DISTANCE BUSH	31 X 8,9 X 16,2	1116315	8	
3	FLAT WASHER	M16	1113801	16	
4	O-RING	3,55 X 209,14	0952822	2	
5	O-RING	3,55 X 99 EPDM	0952371	1	
6	ALU SEALING RING	13.5x20x1	0912014	2	
7	CYLINDER HEAD GASKET	GRASSO V-2	0907207	1	
8	CYLINDER HEAD COVER	V	0531112	2	
9	NIPPLE COUPLING	6G10	0338106	1	
10	SOLID CLAMPING SLEEVE INCL. O-RING	P6	0334596	1	
11	PLUG	G13S	0136134	2	
12	HEXAGON NUT	M16	0115816	16	
13	SERVICE COVER	V	0530182	1	
14	HEXAGON NUT (ZINC PLATED)	M10	0115510	6	for each support
15	FLAT WASHER	M10	1113501	6	
16	O-RING	3.53x136.12	0952363	1	

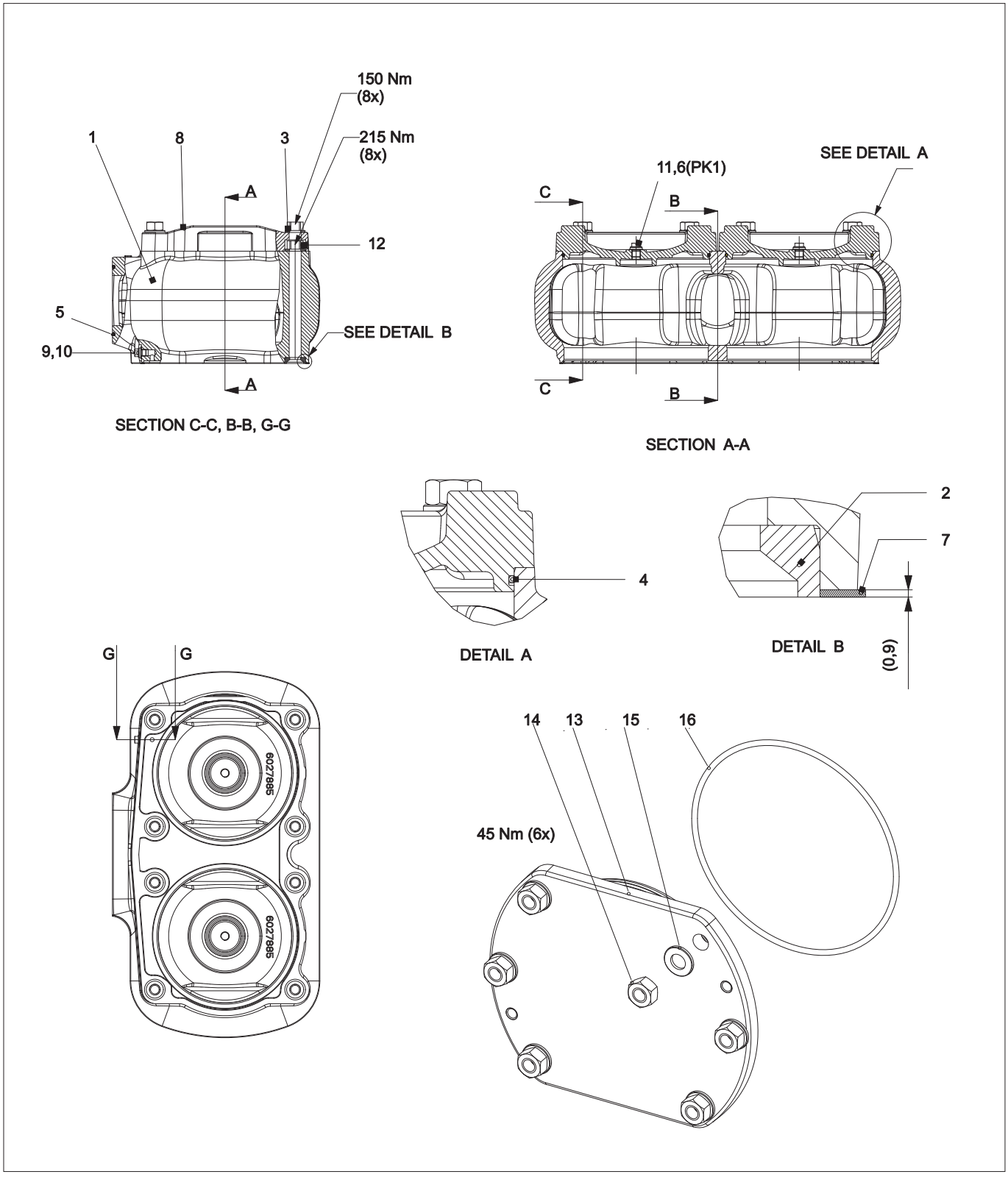


Fig. 4-2 Grasso V - 02A

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 02B CYLINDER HEAD- AND SERVICE COVER V 1100 / V1800					
1	CYLINDER HEAD	V 1100	2148566	1	
2	DISTANCE BUSH	31 X 8,9 X 16,2	1116315	12	
3	FLAT WASHER	M16	1113801	24	
4	O-RING	3,55 X 209,14	0952822	3	
5	O-RING	3,55 X 99 EPDM	0952371	1	
6	ALU SEALING RING	13.5x20x1	0912014	3	
7	CYLINDER HEAD GASKET	GRASSO V-3	0907211	1	
8	CYLINDER HEAD COVER	V	0531112	3	
9	NIPPLE COUPLING	6G10	0338106	1	
10	SOLID CLAMPING SLEEVE INCL. O-RING	P6	0334596	1	
11	PLUG	G13S	0136134	3	
12	HEXAGON NUT	M16	0115816	24	
13	SERVICE COVER	V	0530182	1	
14	HEXAGON NUT (ZINC PLATED)	M10	0115510	6	for each support
15	FLAT WASHER	M10	1113501	6	
16	O-RING	3.53x136.12	0952363	1	

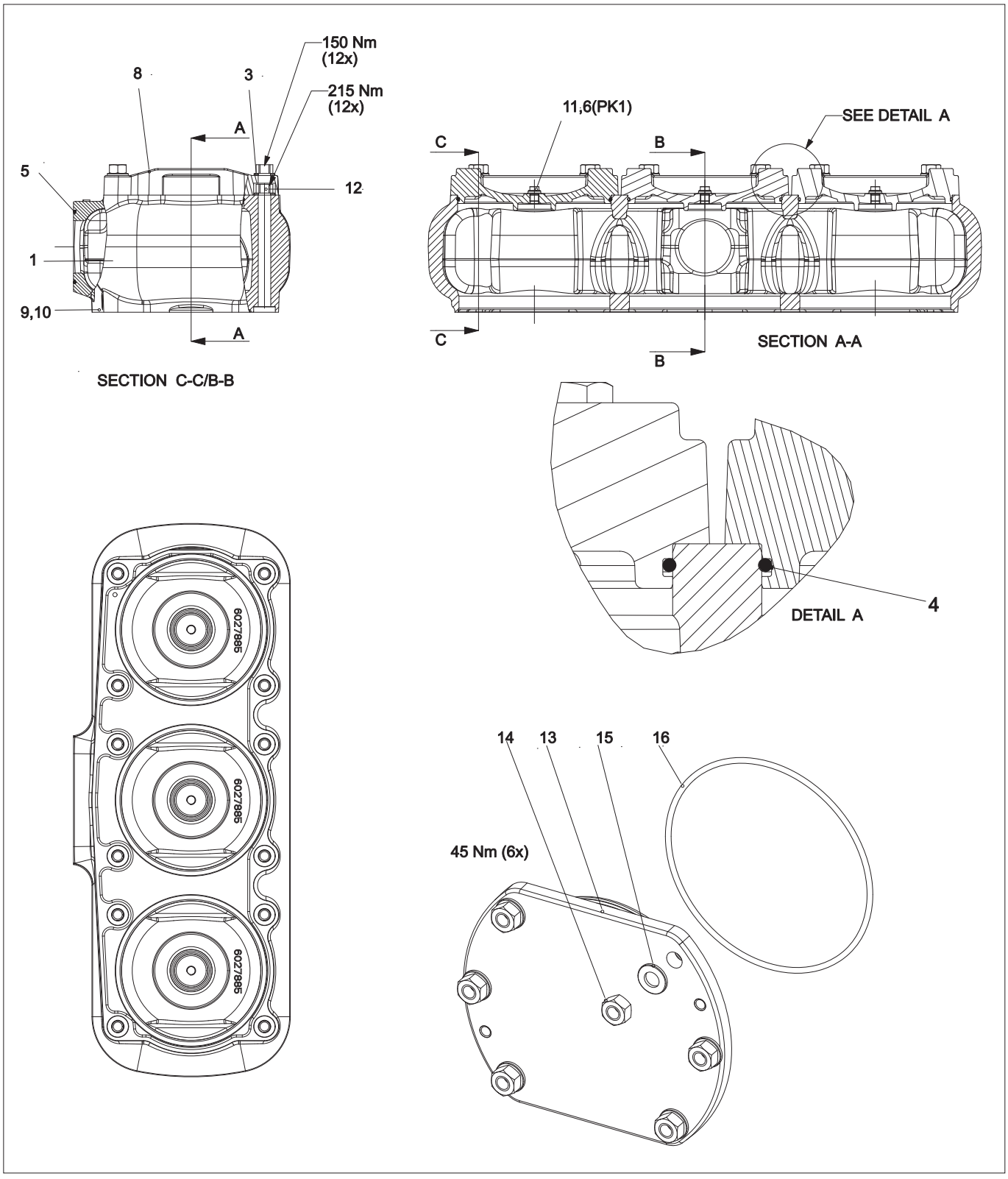


Fig. 4-3 Grasso V - 02B

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 03 BEARING COVER DRIVE SIDE					
1	SHAFT SEAL		0962290	1	
2	PLUG	G21-BZK	0365821	1	
3	PLUG	G33	0365833	1	
4	THRUST BOLT	G3/4"50 V	0135180	1	
5	PRESSURE SPRING	2x12,5x49,5	1131250	1	
6	LOCKING RING	28	1104028	1	
7	OIL BAFFLE PLATE	AZ V	1926210	1	
8	BEARING BUSH	V	1146112	1	
9	BEARING COVER	AZ V	2148010	1	
10	BEAMING BALL	W18	1119018	1	
11	NIPPLE COUPLING	6G10	0338106	1	
12	O-RING	2,65 X 16	0952270	1	
13	O-RING	5,3 x 250	0952552	1	
14	OIL DRAIN PIPE	6 X 197 X 70	0223206	1	
15	OIL SPLASH PLATE	AZ V	1926215	1	
16	DOWEL PIN	3 X 12	1106312	1	
17	ALU SEALING RING	21x27x2	0914023	1	
18	ALU SEALING RING	33x39x2	0914033	1	
19	FLAT WASHER	M12	1113601	10	
20	HEX. HEAD BOLT	M8x16	0110416	3	
21	HEXAGON NUT	M12	0115610	10	

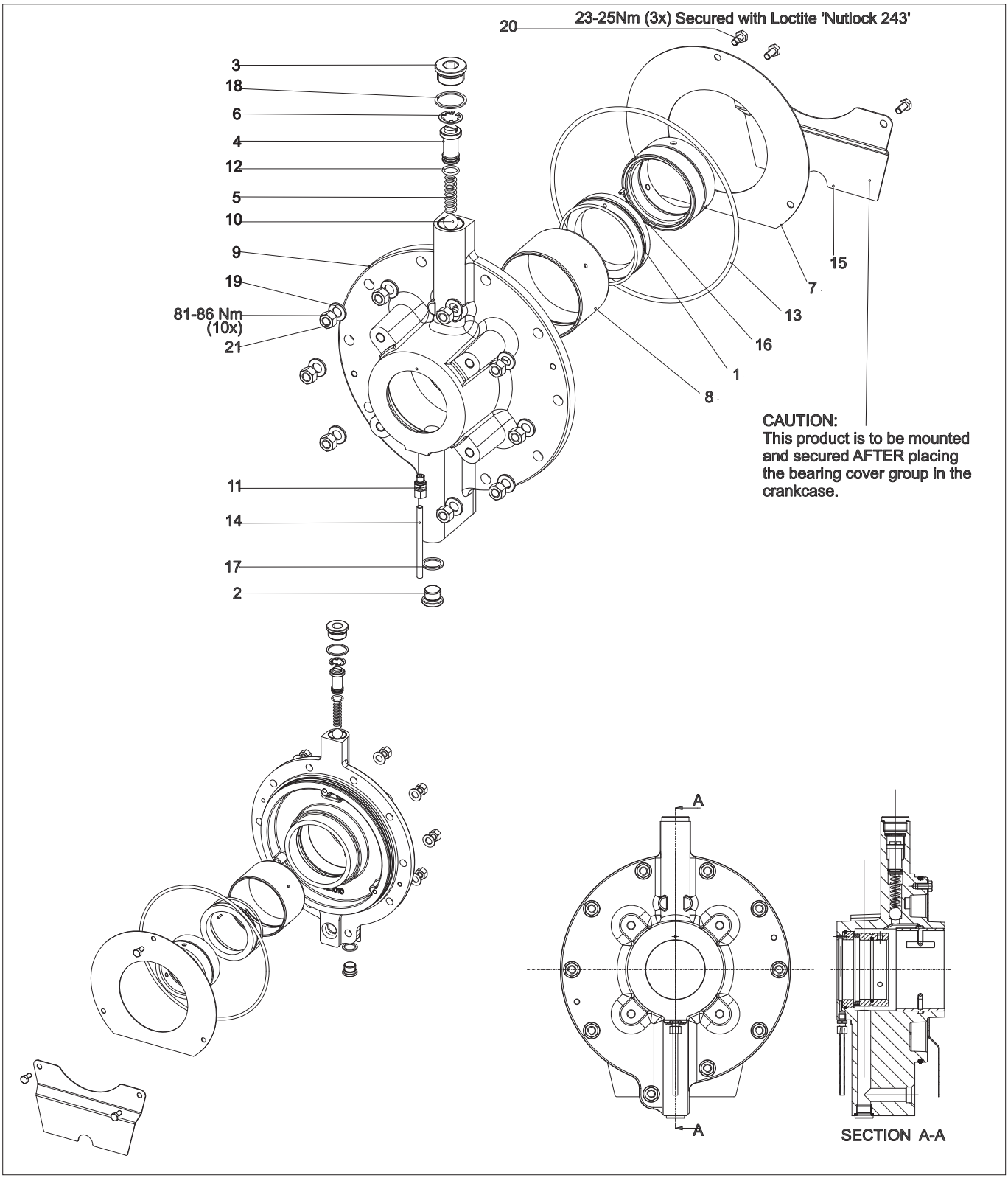
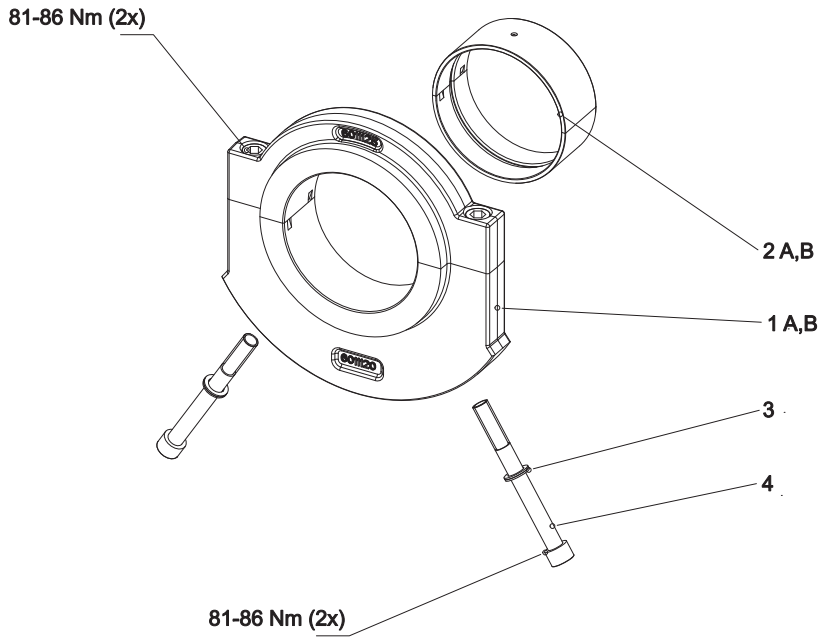
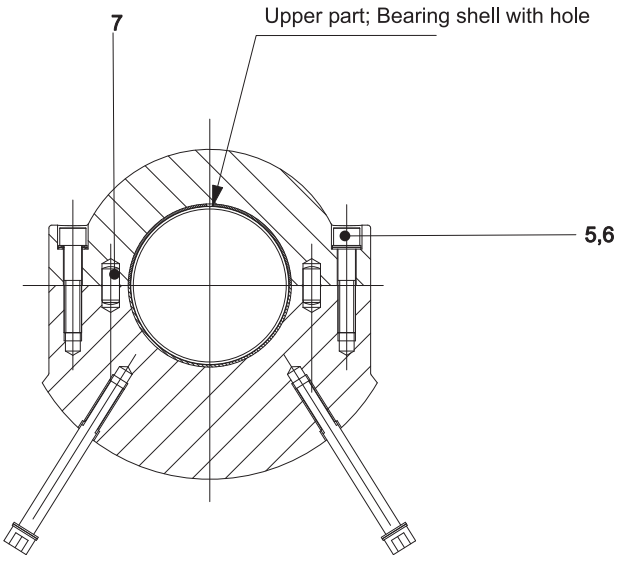


Fig. 4-4 Grasso V - 03

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 04 INTERMEDIATE BEARING					
1.A	BEARING BLOCK	105 x 45	1169910	1	Only for V 1100
1.B	BEARING BLOCK	105 x 55	1169914	-	1 x for V1400 and 2 x V 1800
2.A	BEARING SHELL	105 X 45	1144105	1	Only for V1100
2.B	BEARING SHELL	105 x 55	1144109	-	1 x for V 1400 and 2 x for V1800
3	LOCKING RING SET	13-ST-G.V.	1139600	2	
4	SOCKET HEAD SCREW	M12 X 120	0104612	2	
5	SOCKET HEAD SCREW	M12 X 60	0104661	2	
6	LOCKING RING SET	13-ST-G.V.	1139600	2	
7	DOWEL PIN	12x26	1106226	2	





SECTION A-A

Fig. 4-5 Grasso V - 04

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 05 BEARING COVER OIL PUMP SIDE					
1	SPRING BRACKET	V	2748000	1	
2	BEARING COVER	P.Z. V	2148000	1	
3	OIL BAFFLE PLATE	V	1926212	1	
4	CYLINDRICAL ROLLER THRUST BEARING		1148008	1	
5	HOUSING WASHER		1148006	2	
6	NEEDLE THRUST BEARING		1148002	1	
7	BEARING BUSH	V	1146112	1	
8	SHAFT WASHER	90 V	1138092	1	
9	DIE SPRING		1135226	8	
10	PRESSURE SPRING	2x12,5x49,5	1131250	1	
11	CARRIER DISC	55x8	1125006	1	
12	BEAMING BALL	W18	1119018	1	
13	FLAT WASHER	M12	1113601	10	
14	DOWEL PIN 8 X 28		1106829	2	
15	LOCKING RING	28	1104028	1	
16	SCREWED CABLE ENTRY	M12 X 1,5	0965420	1	
17	O-RING	5,3 x 250	0952552	1	
18	O-RING	142.47x3.53	0952389	1	
19	O-RING	2,65 X 16	0952270	1	
20	O-RING	1,78 X 6,07	0952185	1	
21	ALU SEALING RING	33x39x2	0914033	1	
22	ALU SEALING RING	21x27x2	0914023	1	
23	ALU SEALING RING	13.5x20x1	0912014	1	
24	OIL FILTER	V	0711027	1	
25	MEASURING COUPLING	8 mm	0645608	1	
26	STOP VALVE	TAH8-12	0607011	1	
27	PLUG	G33	0365833	1	
28	PLUG	G21-BZK	0365821	1	
29	T-COUPLING	8x8x8	0340408	1	
30	NIPPLE COUPLING		0338272	1	
31	NIPPLE COUPLING	12G21	0338211	1	
32	NIPPLE COUPLING	8G21	0338208	1	
33	NIPPLE COUPLING	6G13	0338136	1	
34	NIPPLE	G1" X 1 3/8	0328033	1	
35	STUD	M12 X 40	0151641	4	
36	PLUG	G1/4"	0136135	1	
37	THRUST BOLT	G3/4"50 V	0135180	1	
38	HEXAGON NUT	M12	0115610	14	
39	HEX. HEAD BOLT	M8x16	0110416	3	
40	SOCKET HEAD SCREW	M12 X 60	0104661	1	

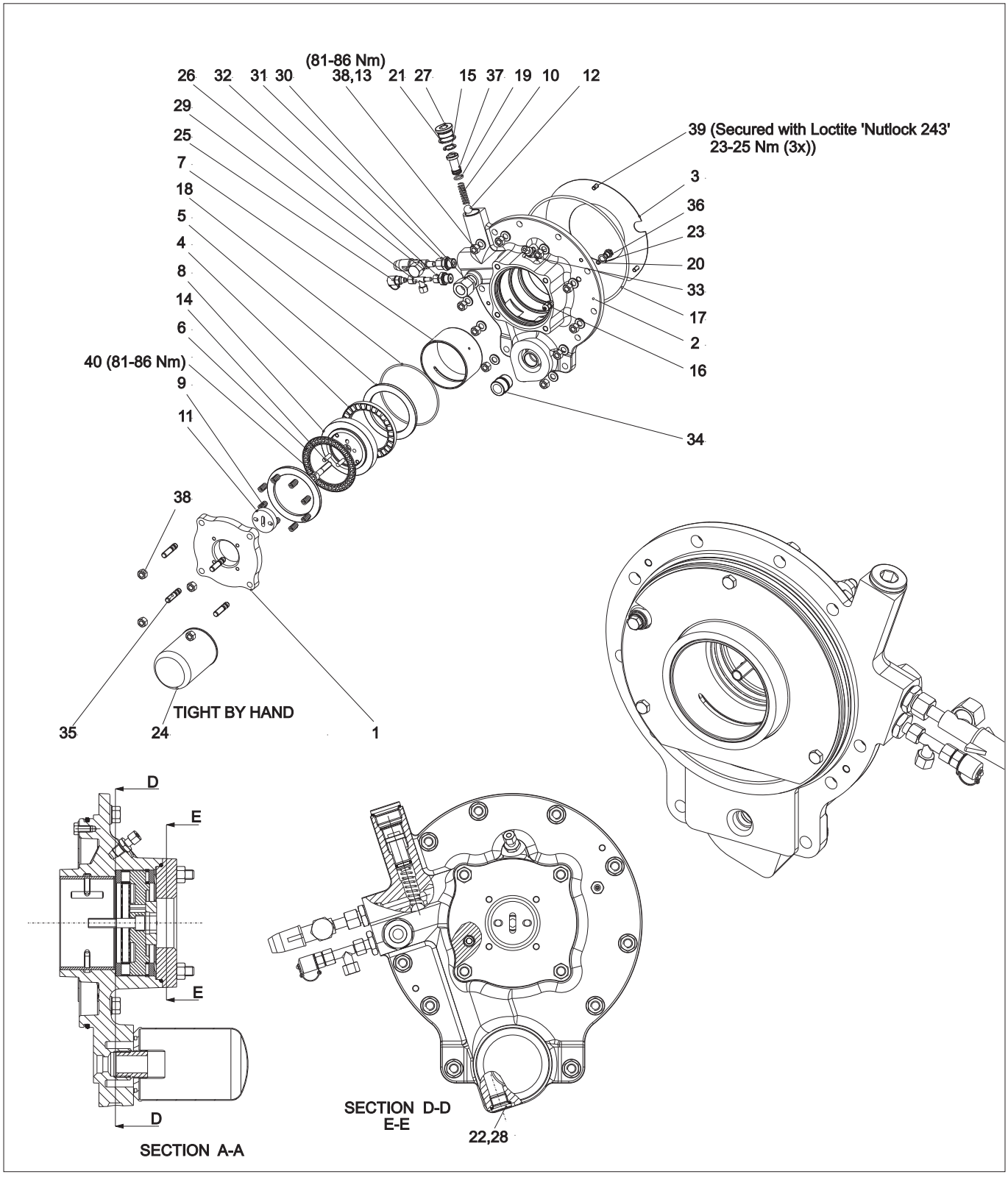


Fig. 4-6 Grasso V - 05

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 06 CRANKSHAFT					
1. V0700	CRANKSHAFT	V 700	2249400	1	
1. V1100	CRANKSHAFT	V 1100	2249600	1	
1. V1400	CRANKSHAFT	V 1400	2249800	1	
1. V1800	CRANKSHAFT	V 1800	2249500	1	
2	KEY	20 X 12 X 63	1102763	1	
3	POT SHAPE MAGNETWITH WIRE TACK M6		1316706	1	
4. V0700	SETSCREW	M12 x 16	0123616	3	
4. V1100	SETSCREW	M12 x 16	0123616	4	
4. V1400	SETSCREW	M12 x 16	0123616	5	
4. V1800	SETSCREW	M12 x 16	0123616	6	
5	DOWEL PIN 8 X 28		1106829	1	

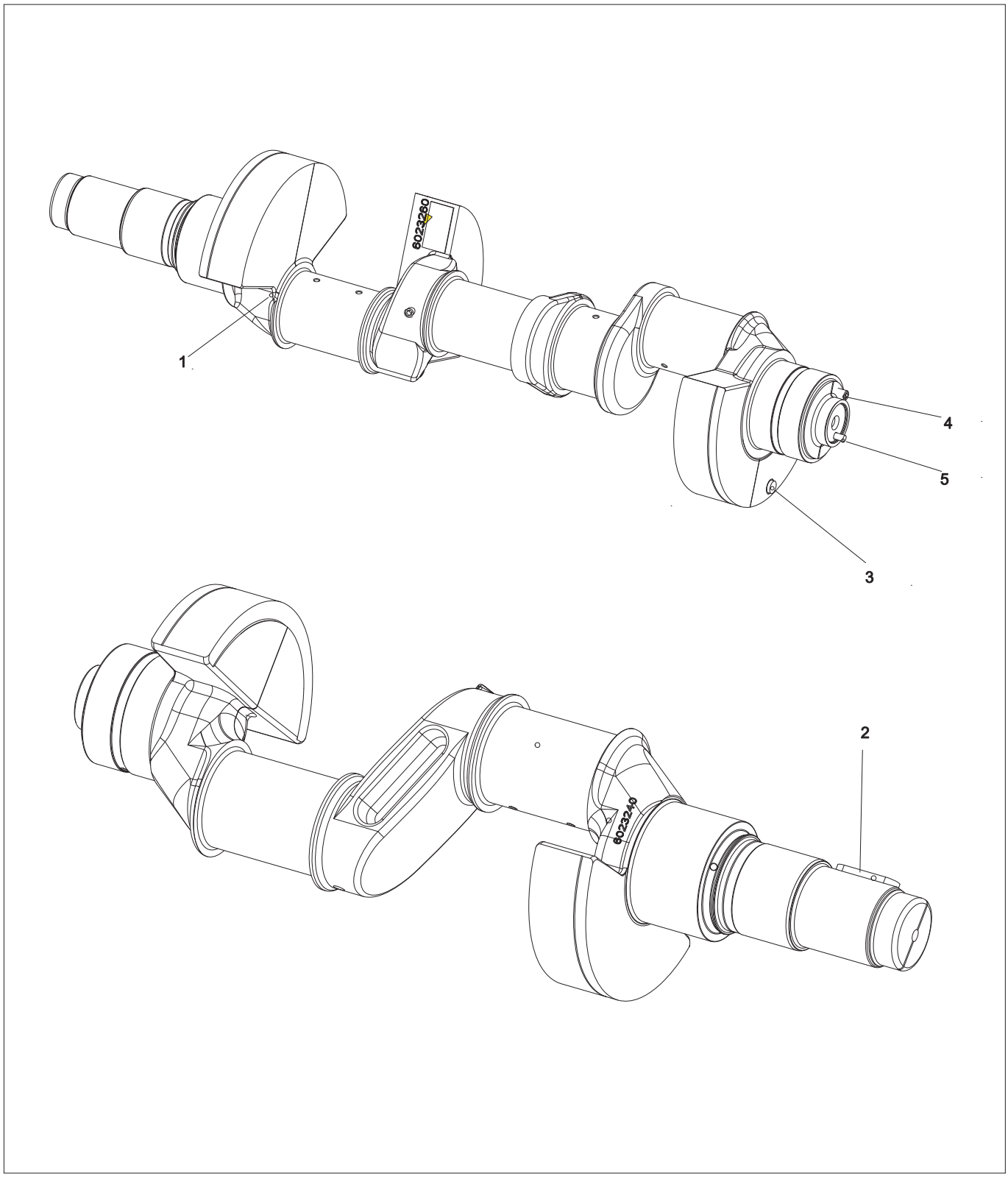


Fig. 4-7 Grasso V - 06

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 07 PISTON AND CONNECTING ROD					
1	PISTON ASSY	160X40X145	2471012	1	
1.1	GUDGEON PIN	26X40X120	2470040	1	
1.2	PISTON		*	1	
1.3	LOCKING RING	40	1104040	2	
1.4	SET OF PISTON RINGS	160X40X145	0974163	1	
2	CONNECTING ROD	S 275 LD	2471510	-	For single stage compressors and LP-cylinders in two stage compressors only
2.1	CONNECTING ROD	(aluminium alloy)	*	1	
2.2	BEARING BUSH	40x46x58	1146641	1	
2.4	BEARING SHELL	90x53	1144590	1	
2.5	CONNECTING ROD BOLT	MF16	0111810	2	
2.6	LOCKING RING SET	M16 / 13-ST-G.V.	1139800	2	in two pieces
2.7	HEXAGON NUT	MF16	0147805	2	

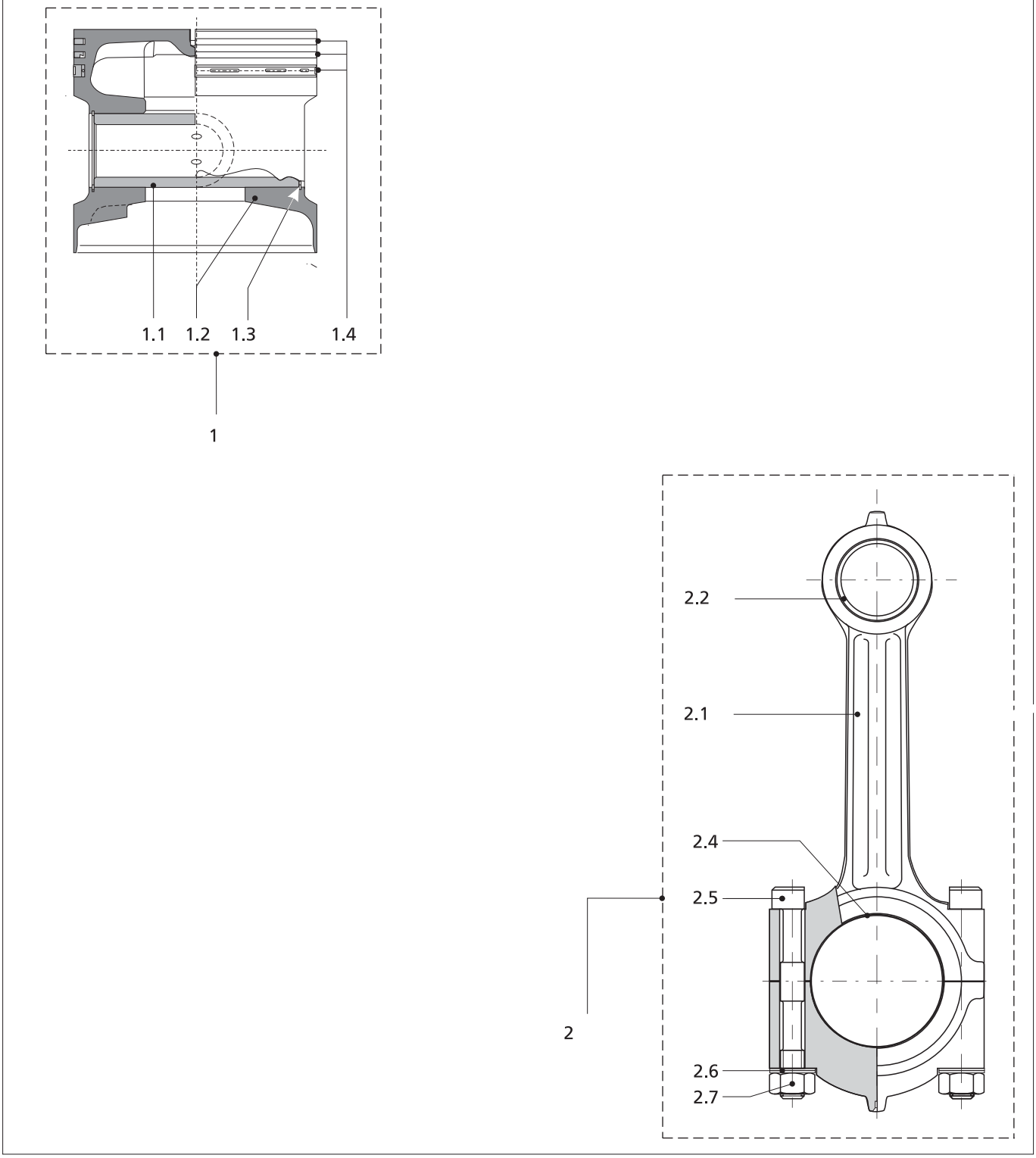


Fig. 4-8 Grasso V - 07

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 08A CYLINDER LINER AND DISCHARGE AND SUCTION VALVE - APPLICATION: NH3					
1	PRESSURE SPRING	18x88x2.4x115	1131181	1	
2	DISCHARGE VALVE	A3N-L	2771221	1	
2.1	LOCKING NUT	M12	0145600	1	
2.2	LOCKING RING SET	M6	1139300	6	
2.3	SOCKET HEAD SCREW	M5x40	0104240	3	
2.4	VALVE PLATE	A3N-INW	2770411	1	
2.5	VALVE PLATE	A3N-MID	2770421	1	
2.6	VALVE PLATE	A3N-UITW-L	2770442	1	
2.7	SET OF DISCHARGE VALVE RINGS		2070040	1	
2.7.1	VALVE RING	129,8x153,8x4	*	1	
2.7.2	VALVE RING	69,8x93,8x4	*	1	
2.7.3	SINUSOIDAL SPRING	129,8x154,1x0,8x11,5	*	1	
2.7.4	SINUSOIDAL SPRING	69,8x93,0x0,8x4,2	*	1	
2.8	STROKE LIMITOR	12E-A3N-L	2770471	1	
2.9	LOCKING RING SET	13-ST-G.V.	1139600	1	
2.10	FLAT WASHER	M 5B	1113001	3	
2.11	STUD	M12 X 70	0151670	1	
2.12	SOCKET HEAD SCREW	M6 X 45	0104345	6	
2.13	DOWEL PIN	3 X 8	1106308	1	
3	SET OF SUCTION VALVE RINGS & SPRINGS		2070036	1	
3.1	SINUSOIDAL SPRING	171 x 200 / E	*	2	
3.2	VALVE RING	RC12E - S	*	1	
4	SPECIAL TOOL "FREE-FLOW VALVE"		7343170	1	For correct disassembly and assembly of the "free flow" discharge valve
5	O-RING	3,55 X 206 EPDM	0952820	1	
6	O-RING	3,55 X 195 EPDM	0952399	1	
7	CYLINDERLINER ASSY	V - LS SL	2349013	1	
7.1	CAM RING VALVE LIFTING	V - S	2749242	1	
7.2	CYLINDER LINER	V - L S	2348013	1	
7.3	PRESSURE SPRING	0,63X 6,3X 12,5X 36,5	1131059	8	
7.4	FLAT WASHER	M 5B	1113001	8	
7.5	CYLINDRICAL PIN	S	1106587	8	
7.6	LOCKING RING	5	1103205	8	
7.7	WIRE RING	2 X 172	0123915	1	

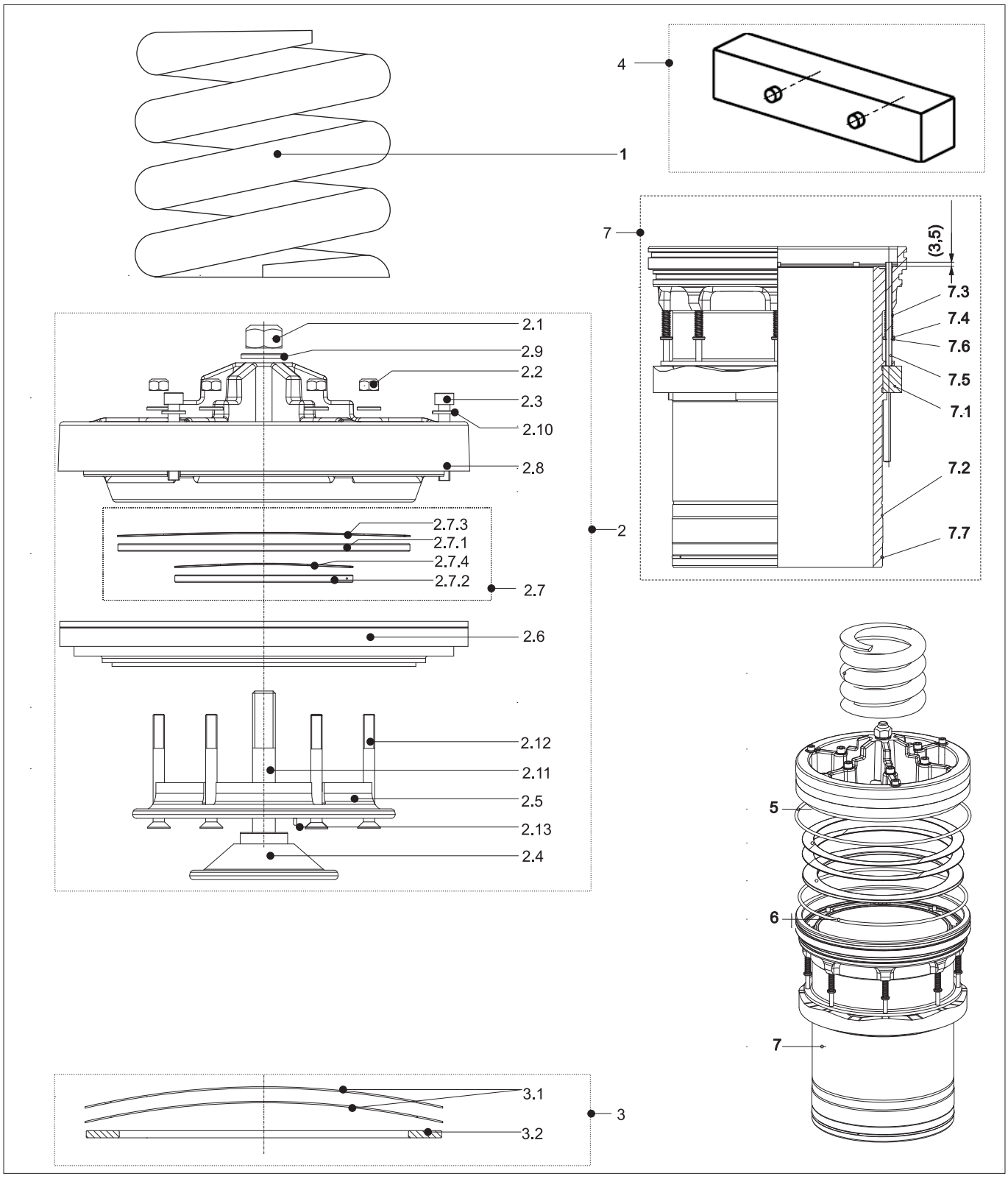


Fig. 4-9 Grasso V - 08A

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 08B CYLINDER LINER AND DISCHARGE AND SUCTION VALVE - APPLICATION: NH3 BOOSTER OR LOW PRESSURE TWO STAGE					
1	PRESSURE SPRING	18x88x2.4x115	1131181	1	
2	DISCHARGE VALVE	A3N-B	2771211	1	
2.1	LOCKING NUT	M12	0145600	1	
2.2	LOCKING RING SET	M6	1139300	6	
2.3	SOCKET HEAD SCREW	M5x40	0104240	3	
2.4	VALVE PLATE	A3N-INW	2770411	1	
2.5	VALVE PLATE	A3N-MID	2770421	1	
2.6	VALVE PLATE	A3N-UITW-B	2770432	1	
2.7	SET OF DISCHARGE VALVE RINGS		2070040	1	
2.7.1	VALVE RING	129,8x153,8x4	*	1	
2.7.2	VALVE RING	69,8x93,8x4	*	1	
2.7.3	SINUSOIDAL SPRING	129,8x154,1x0,8x11,5	*	1	
2.7.4	SINUSOIDAL SPRING	69,8x93,0x0,8x4,2	*	1	
2.8	STROKE LIMITOR	12E-A3N-L	2770471	1	
2.9	LOCKING RING SET	13-ST-G.V.	1139600	1	
2.10	FLAT WASHER	M 5B	1113001	3	
2.11	STUD	M12 X 70	0151670	1	
2.12	SOCKET HEAD SCREW	M6 X 45	0104345	6	
2.13	DOWEL PIN	3 X 8	1106308	1	
3	SET OF SUCTION VALVE RINGS & SPRINGS		2070039	1	
3.1	SINUSOIDAL SPRING	171 x 200 / E	*	2	
3.2	VALVE RING	RC12E - S	*	1	
3.3	VALVE RING	170,6x198,7x3	*	1	
4	SPECIAL TOOL "FREE-FLOW VALVE"		7343170	1	For correct disassembly and assembly of the "free flow" discharge valve
5	O-RING	3,55 X 206 EPDM	0952820	1	
6	O-RING	3,55 X 195 EPDM	0952399	1	
7	CYLINDERLINER ASSY	V - LS SL	2349013	1	
7.1	CAM RING VALVE LIFTING	V - S	2749242	1	
7.2	CYLINDER LINER	V - L S	2348013	1	
7.3	PRESSURE SPRING	0,63X 6,3X 12,5X 36,5	1131059	8	
7.4	FLAT WASHER	M 5B	1113001	8	
7.5	CYLINDRICAL PIN	S	1106587	8	
7.6	LOCKING RING	5	1103205	8	
7.7	WIRE RING	2 X 172	0123915	1	

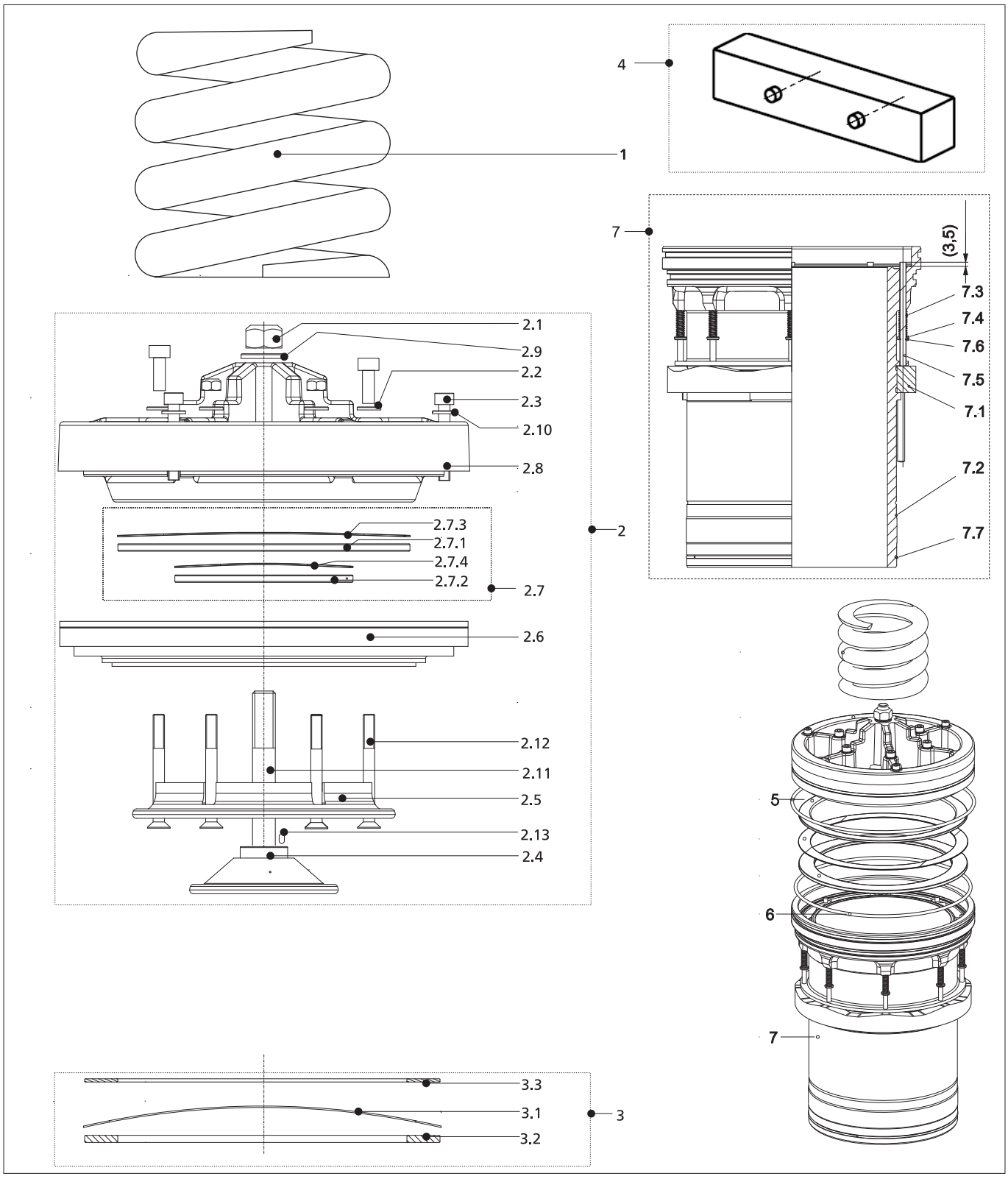


Fig. 4-10 Grasso V - 08B

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 09 VALVE LIFTING MECHANISM					
1.A	VALVE LIFTING ASSY V-D	double housing	2749205	1	
1.B	VALVE LIFTING ASSY V - E	single housing	2749206	1	
2	FLAT WASHER	M8	1113401	-	
3	O-RING	2.62x40.95	0952289	-	
4	HEXAGON HEAD BOLT	M8	0110420	-	
5.A	PUSH HANDLE VALVE LIFTING	V	2791027	2	
5.B	PUSH HANDLE VALVE LIFTING	V	2791027	1	
6.A	VALVE LIFTING HOUSING	double housing	2790210	1	
6.B	VALVE LIFTING HOUSING	single housing	2790205	1	
7.A	SHAFT GUIDE	V	2690712	2	
7.B	SHAFT GUIDE	V	2690712	1	
8.A	CONTROL PISTON	35x42	2690035	2	
8.B	CONTROL PISTON	35x42	2690035	1	
9.A	PRESSURE SPRING	3.2x25x12.5x 135	1131313	2	
9.B	PRESSURE SPRING	3.2x25x12.5x 135	1131313	1	
10.A	QUAD RING	3.53x28.17	0952328	2	
10.B	QUAD RING	3.53x28.17	0952328	1	
11.A	NIPPLE COUPLING	8G10	0338108	3	
11.B	NIPPLE COUPLING	8G10	0338108	2	

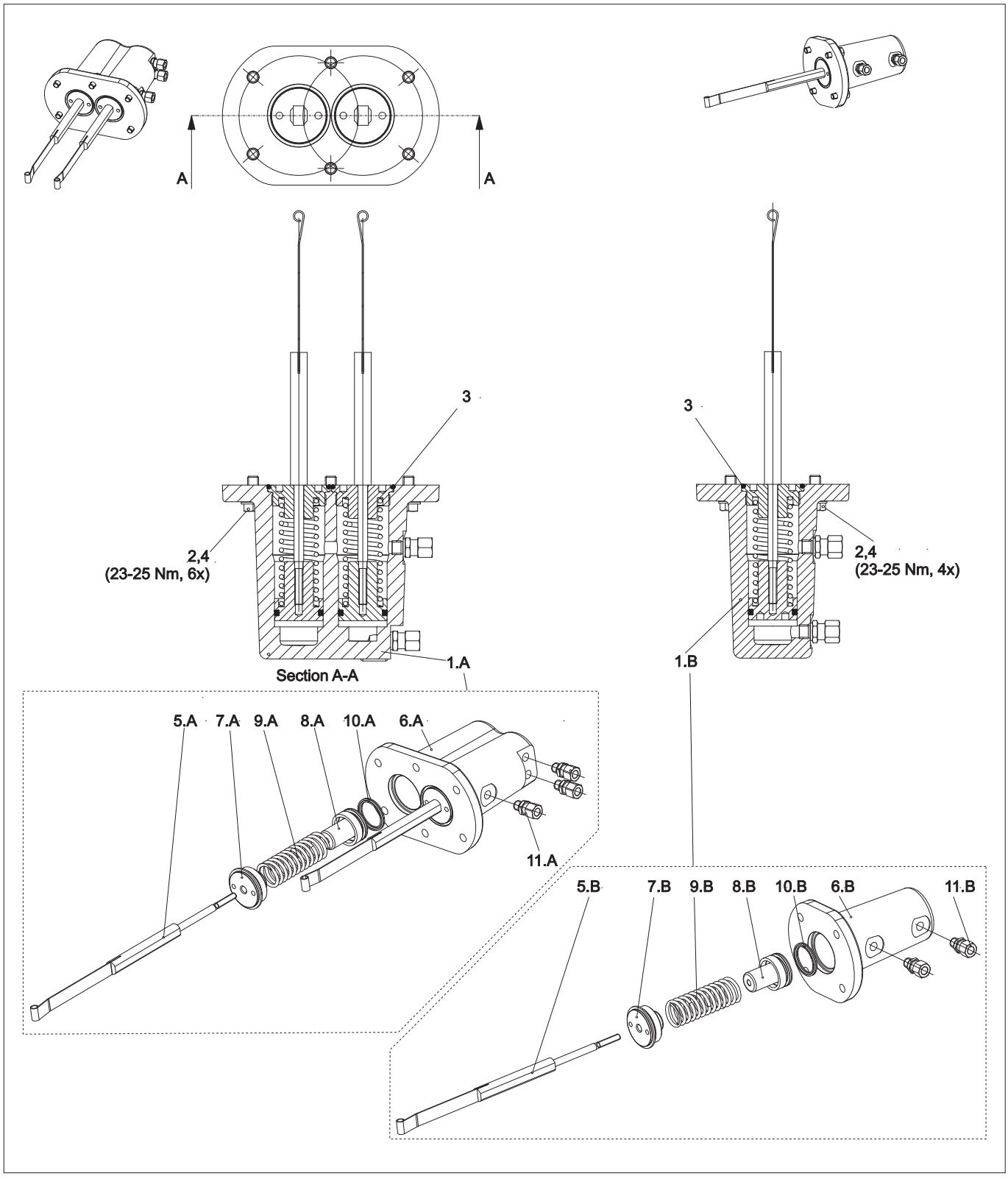


Fig. 4-11 Grasso V - 09

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 10 OIL PUMP					
1.A	OIL PUMP	V700/V1100	2648130	1	
1.B	OIL PUMP	V1400/V1800	2648135	1	
2	FLAT WASHER	M8	1113401	4	
3	O-RING	60x2.62	0952260	1	
4.A	OIL DISCHARGE LINE	22x2 R	0438307	1	STANDARD DIRECTION (CLOCKWISE)
4.B	OIL DISCHARGE LINE	22x2 L	0438308	1	NOT STANDARD DIRECTION (COUNTER CLOCKWISE)
5.A	OIL SUCTION LINE	28x3 R	0438305	1	STANDARD DIRECTION (CLOCKWISE)
5.B	OIL SUCTION LINE	28x3 L	0438306	1	NOT STANDARD DIRECTION (COUNTER CLOCKWISE)
6	STUD ELBOW	28xG1	0341329	1	
7	NIPPLE COUPLING	22G33	0338277	1	
8	HEXAGON HEAD BOLT	M8	0110420	4	

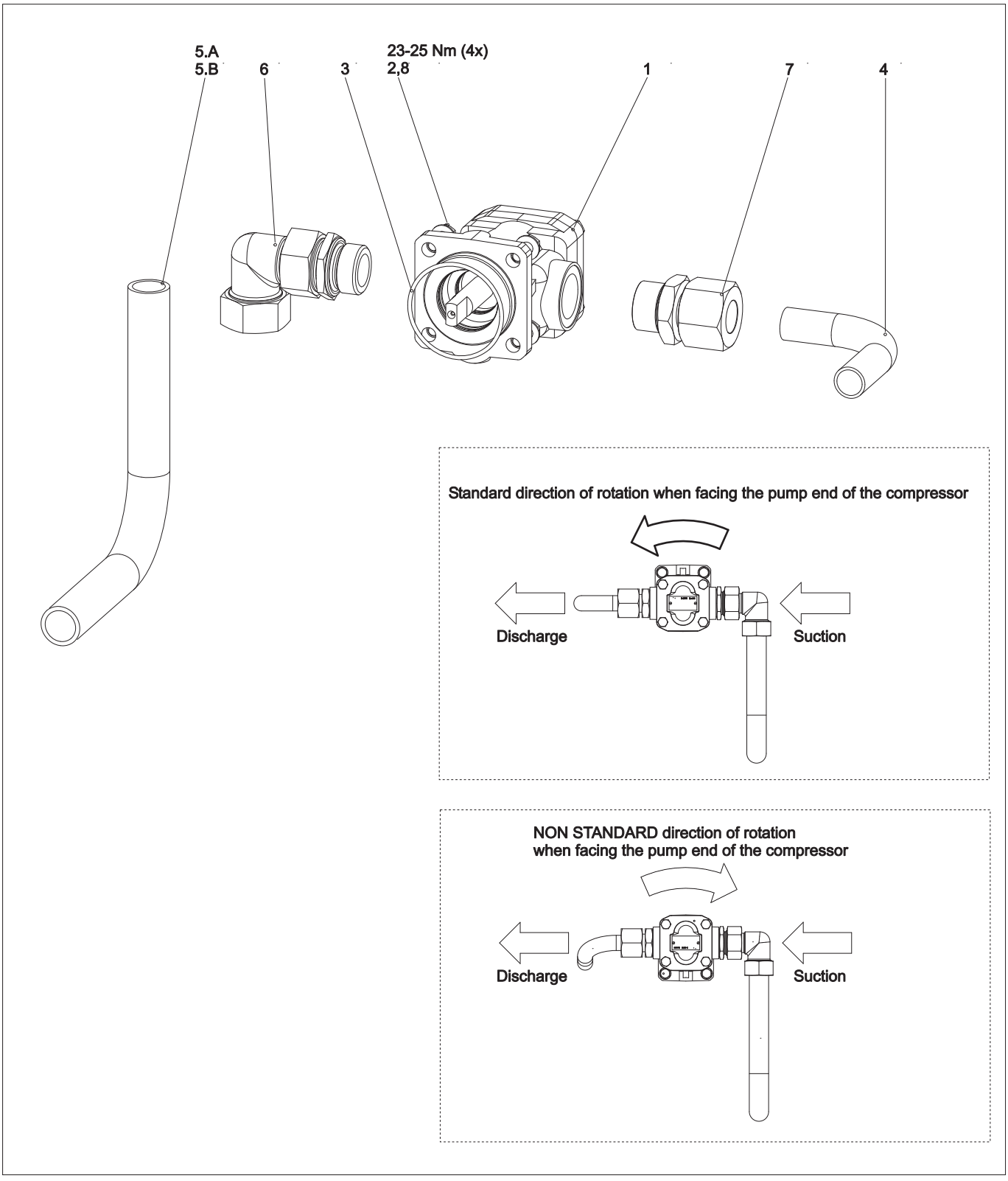


Fig. 4-12 Grasso V - 10

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 11A DELIVERY PIPE MANIFOLD V 700 AND V 1100					
1	DELIVERY PIPE MANIFOLD	V- DN80/100 1	2148575	1	
2	FLAT WASHER	M16	1113801	4	
3	FLAT WASHER	M12	1113601	8	
4	O-RING	3,55x110 EPDM	0952372	1	
5	STOP VALVE	TAH8-12	0607011	1	
6	BLIND PLATE	140	0554140	1	
7.A	WELDING FLANGE	DN 80 - V	0501091	1	V 700
7.B	WELDING FLANGE	DN 100 - V	0501116	1	V 1100
8	SWIVEL COUPLING	G13 X 30	*	1	To be used in combination with 0385155 or 0385157
9	TEMP. INSERT	6G13 X 76	0385157	1	To be used in combination with 0385136
10	POCKET	6 G13x60	0385136	1	
11	NIPPLE COUPLING	12G13	0338131	1	
12	SOLID CLAMPING SLEEVE INCL. O-RING	P6	0334596	1	
13	HEXAGON NUT	M16	0115810	4	
14	HEXAGON HEAD BOLT	M16x80	0110880	4	
15	HEX. HEAD BOLT	M12x50	0110650	8	

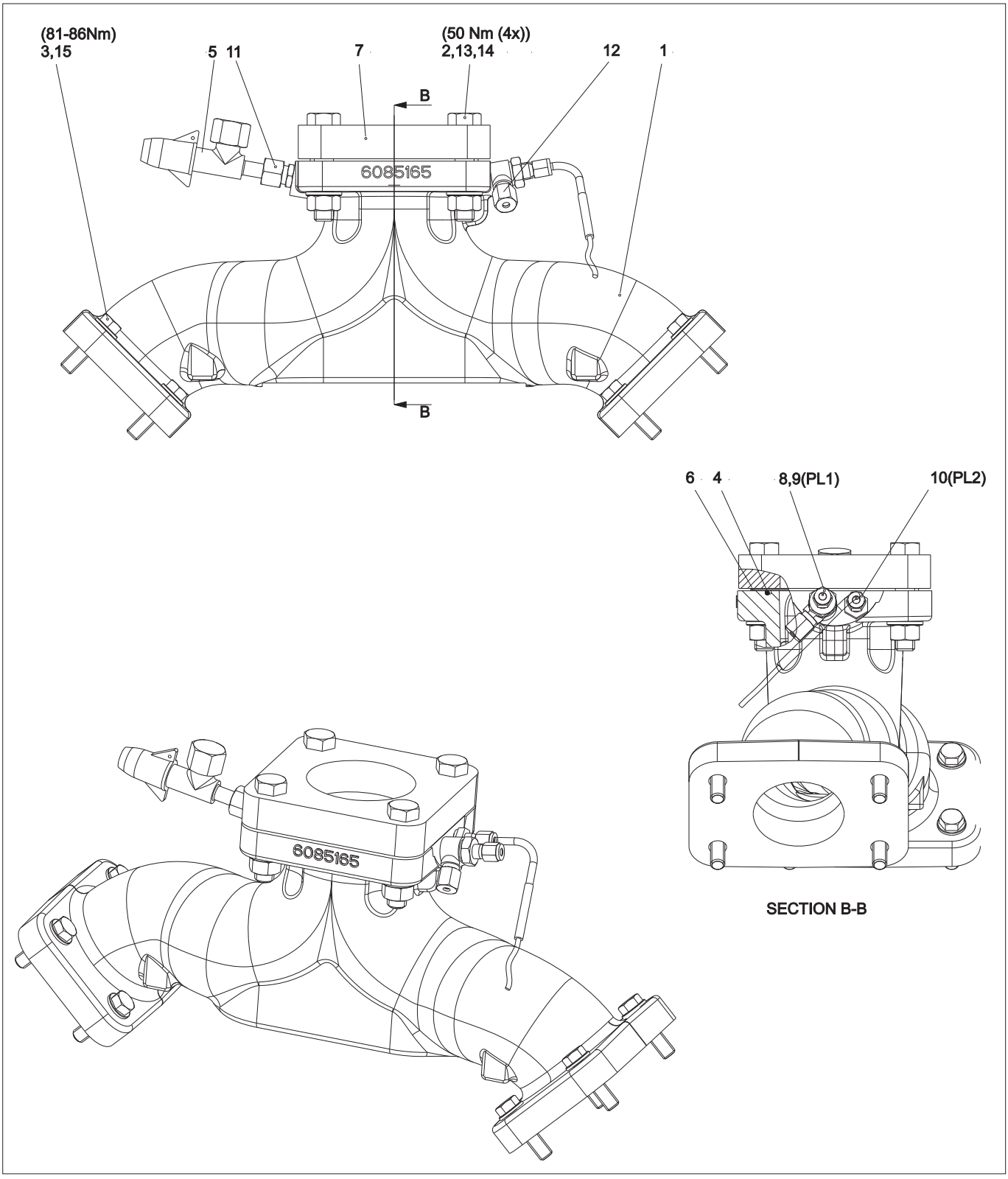


Fig. 4-13 Grasso V - 11A

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 11B DELIVERY PIPE MANIFOLD V 1400 - V 1800					
1	DELIVERY PIPE MANIFOLD	DN100 / 125	2148585	1	
2	FLAT WASHER	M12	1113601	8	
3	O-RING	3,53x158,34 EPDM	0952384	1	
4	O-RING	3,55x110 EPDM	0952372	1	
5	ALU SEALING RING	13.5x20x1	0912014	3	
6	WELDING FLANGE		0501333	1	
7	PLUG	G13S	0136134	3	
8	HEXAGON HEAD BOLT	M16x60	0110860	4	
9	HEX. HEAD BOLT	M12x50	0110650	8	
10	SWIVEL COUPLING	G13 X 30	*	1	To be used in combination with 0385155 or 0385157
11	TEMP. INSERT	6G13 X 76	0385157	1	To be used in combination with 0385136
12	POCKET	6 G13x60	0385136	1	
13	NIPPLE COUPLING	12G13	0338131	1	
14	SOLID CLAMPING SLEEVE INCL. O-RING	P6	0334596	1	
15	STOP VALVE	TAH8-12	0607011	1	
16	BLIND FLANGE	180	0554180	1	
17.A	WELDING FLANGE	DN 100-V	0501306	1	V700 and V1400
17.B	WELDING FLANGE	DN 125-V	0501330	1	V1100 and V1800

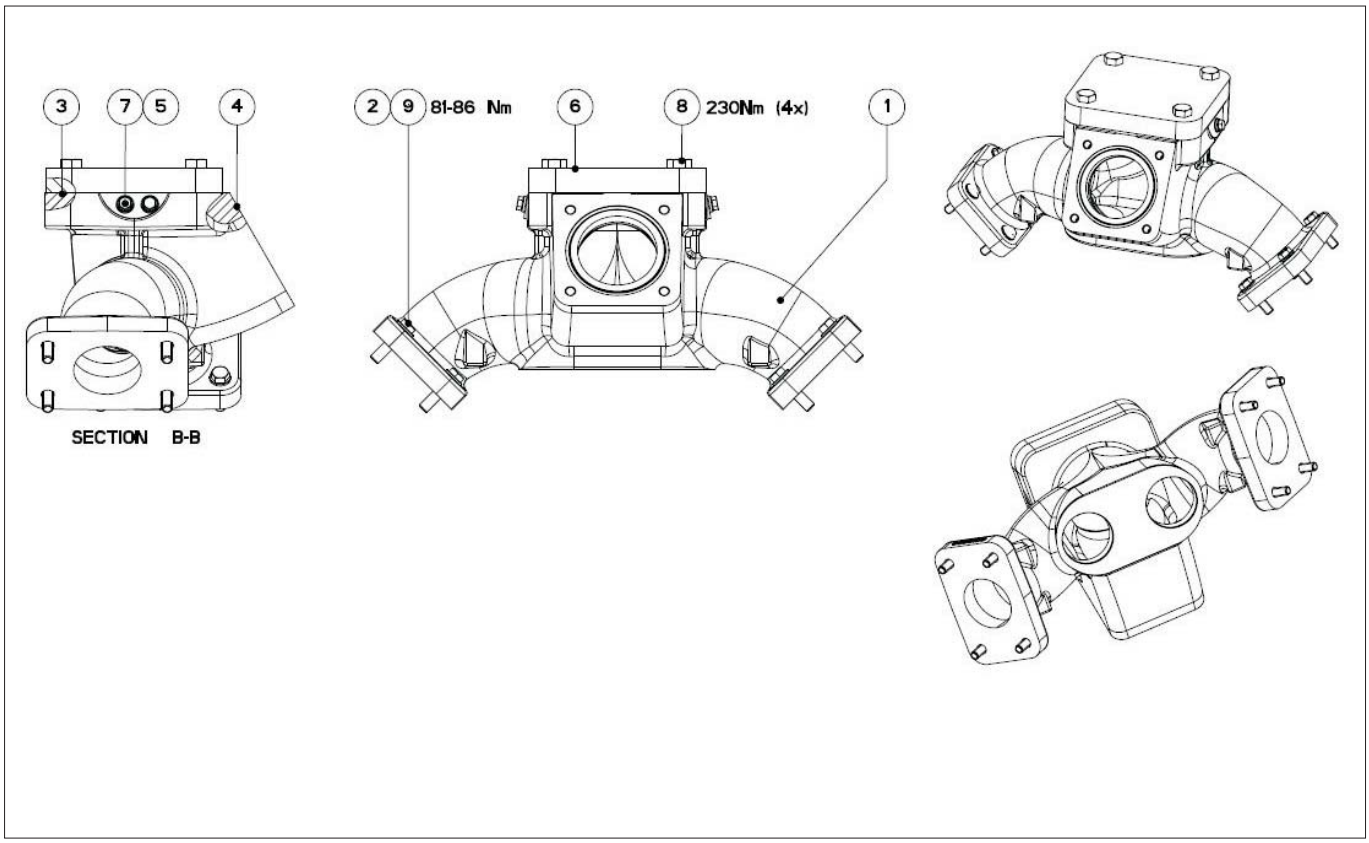


Fig. 4-14 Grasso V - 11B

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 12A INTAKE CONNECTION MANIFOLD V700 / V1100					
1	INTAKE CONNECTION MANIFOLD	V - DN125	2148105	1	
2	LOCKING RING	M16B - RVS2	1113883	4	
3	LOCKING RING	M12B - RVS2	1113683	7	
4	O-RING	3,53x158,34 EPDM	0952384	1	
5	O-RING		0952374	1	
6	STOP VALVE	TAH8-12	0607011	1	
7	BLIND FLANGE	180	0554180	1	
8.DN100	WELDING FLANGE	DN 100-V	0501306	1	V700 and V1400
8.DN125	WELDING FLANGE	DN 125-V	0501330	1	V1100 and V1800
9	SWIVEL COUPLING	G13 X 30	*	1	To be used in combination with 0385155 or 0385157
10	TEMP. INSERT	6G13 X 76	0385157	1	To be used in combination with 0385136
11	POCKET	6 G13x60	0385136	1	
12	NIPPLE COUPLING	12G13	0338131	1	
13	SOLID CLAMPING SLEEVE INCL. O-RING	P6	0334596	1	
14	HEXAGON HEAD BOLT	M16x100	0185810	4	
15	HEXAGON NUT	M16	0115817	4	
16	HEXAGON NUT	M12	0115617	7	

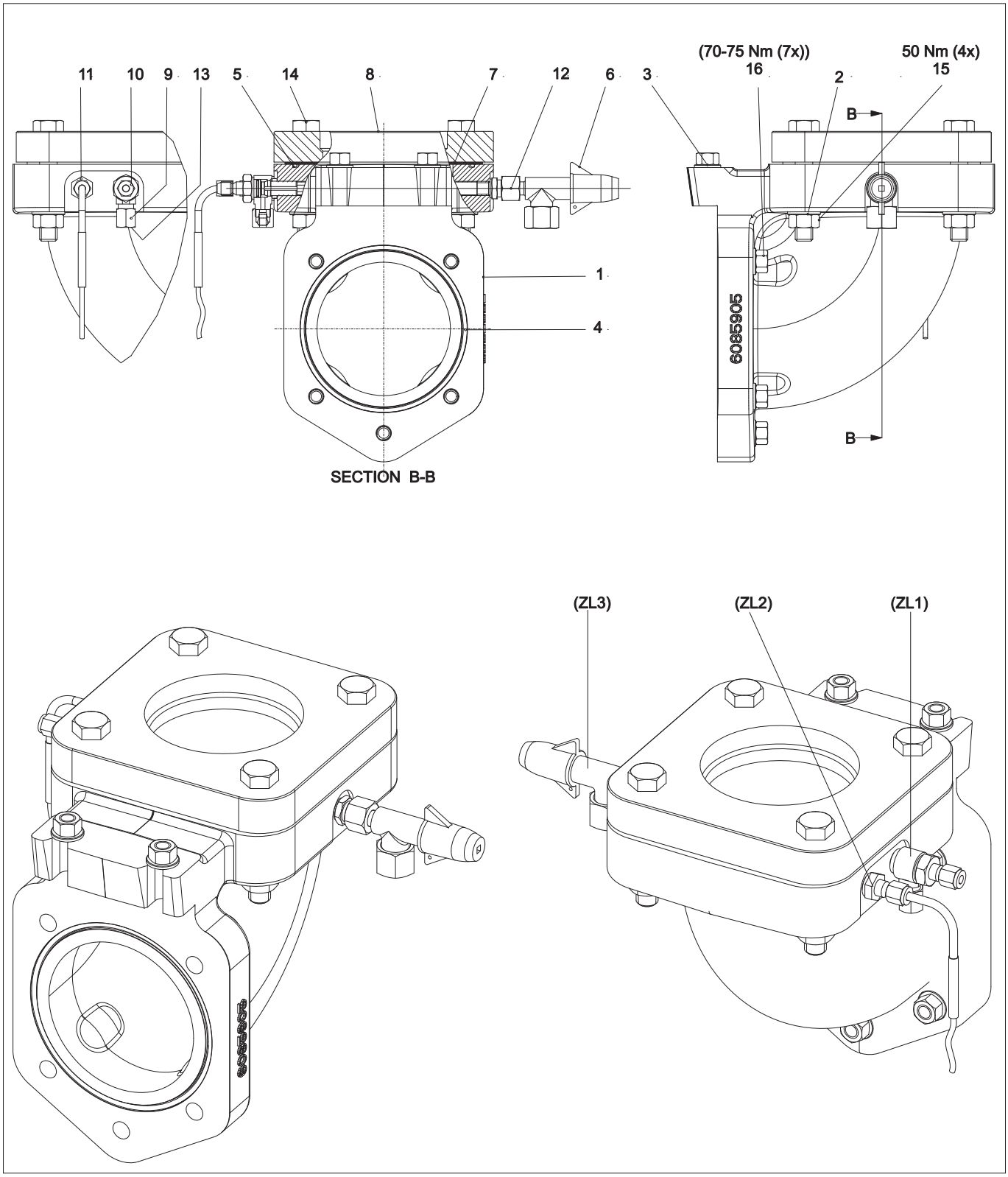


Fig. 4-15 Grasso V - 12A

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 12B INTAKE CONNECTION MANIFOLD V1400 / V1800					
1	INTAKE CONNECTION MANIFOLD	V - DN150	2148110	1	
2	LOCKING RING	M16B - RVS2	1113883	4	
3	LOCKING RING	M12B - RVS2	1113683	7	
4	O-RING		0952374	1	
5	O-RING	3,53x183,74 EPDM	0952346	1	
6	STOP VALVE	TAH8-12	0607011	1	
7	BLIND FLANGE	200	0554200	1	
8	WELDING FLANGE	DN 150-V	0501350	1	
9	SWIVEL COUPLING	G13 X 30	*	1	To be used in combination with 0385155 or 0385157
10	TEMP. INSERT	6G13 X 76	0385157	1	To be used in combination with 0385136
11	POCKET	6 G13x60	0385136	1	
12	NIPPLE COUPLING	12G13	0338131	1	
13	SOLID CLAMPING SLEEVE INCL. O-RING	P6	0334596	1	
14	HEXAGON HEAD BOLT	M16x100	0185810	4	
15	HEXAGON NUT	M16	0115817	4	
16	HEXAGON NUT	M12	0115617	7	

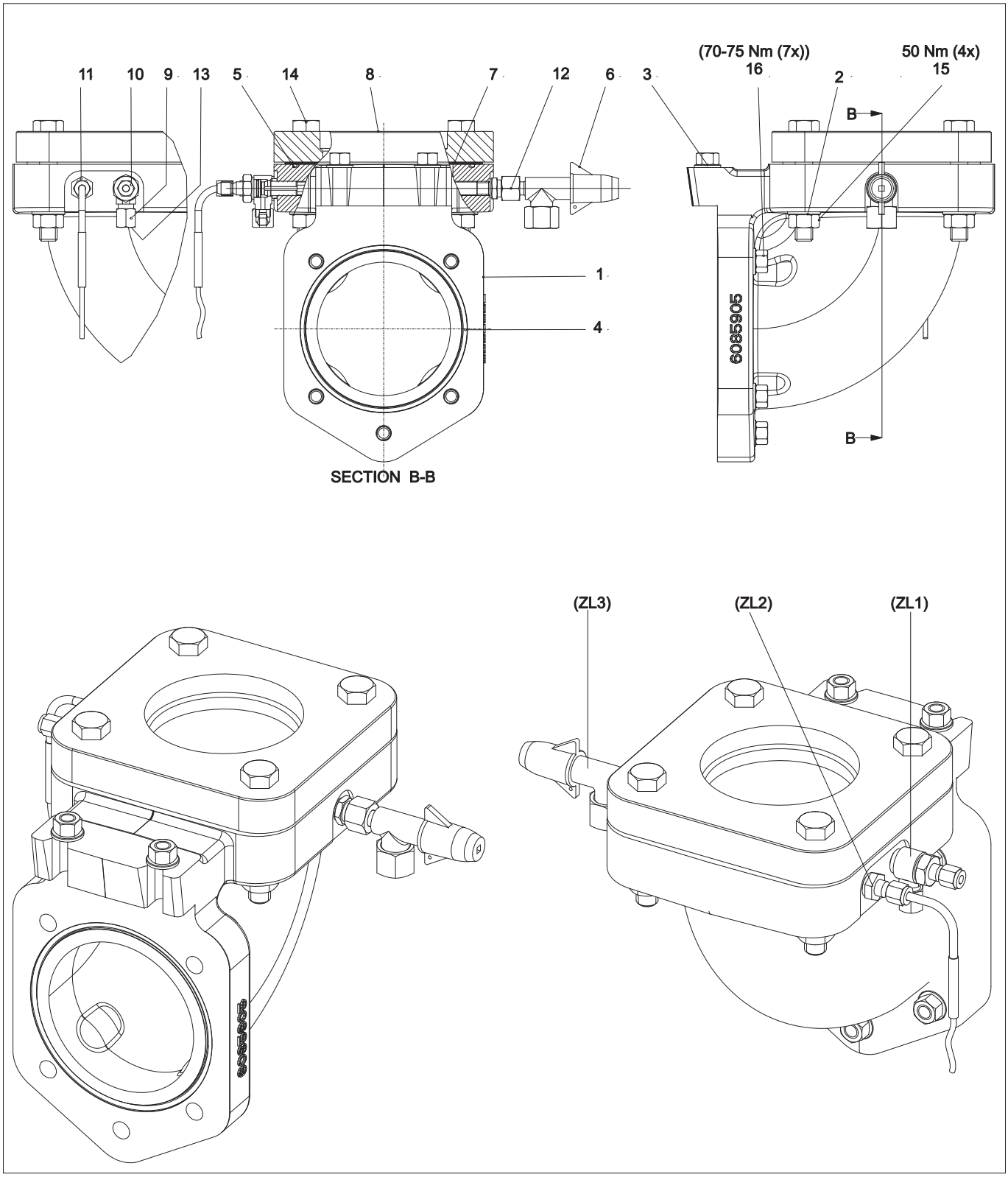


Fig. 4-16 Grasso V - 12B

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 13 GRASSO MAINTENANCE MONITOR					
1	SPACER, NYLON	6.6 3,1x6x30	1116731	1	
2	PLUG	G1/4"	0136135	1	
3	SCREWED CABLE ENTRY	M12 X 1,5	0965420	1	
4	MAGNETIC FIELD SENSOR		1298535	1	
5	O-RING	1,78 X 6,07	0952185	1	
6	ALU SEALING RING	13.5x20x1	0912014	1	
7	POT SHAPE MAGNETWITH WIRE TACK M6		1316706	1	
8	SOCKET HEAD SCREW	M6x10	0104310	4	
9	RING	6x12x3	0932006	4	
10	GRASSO MAINTENANCE MONITOR UNIT		1298510	1	

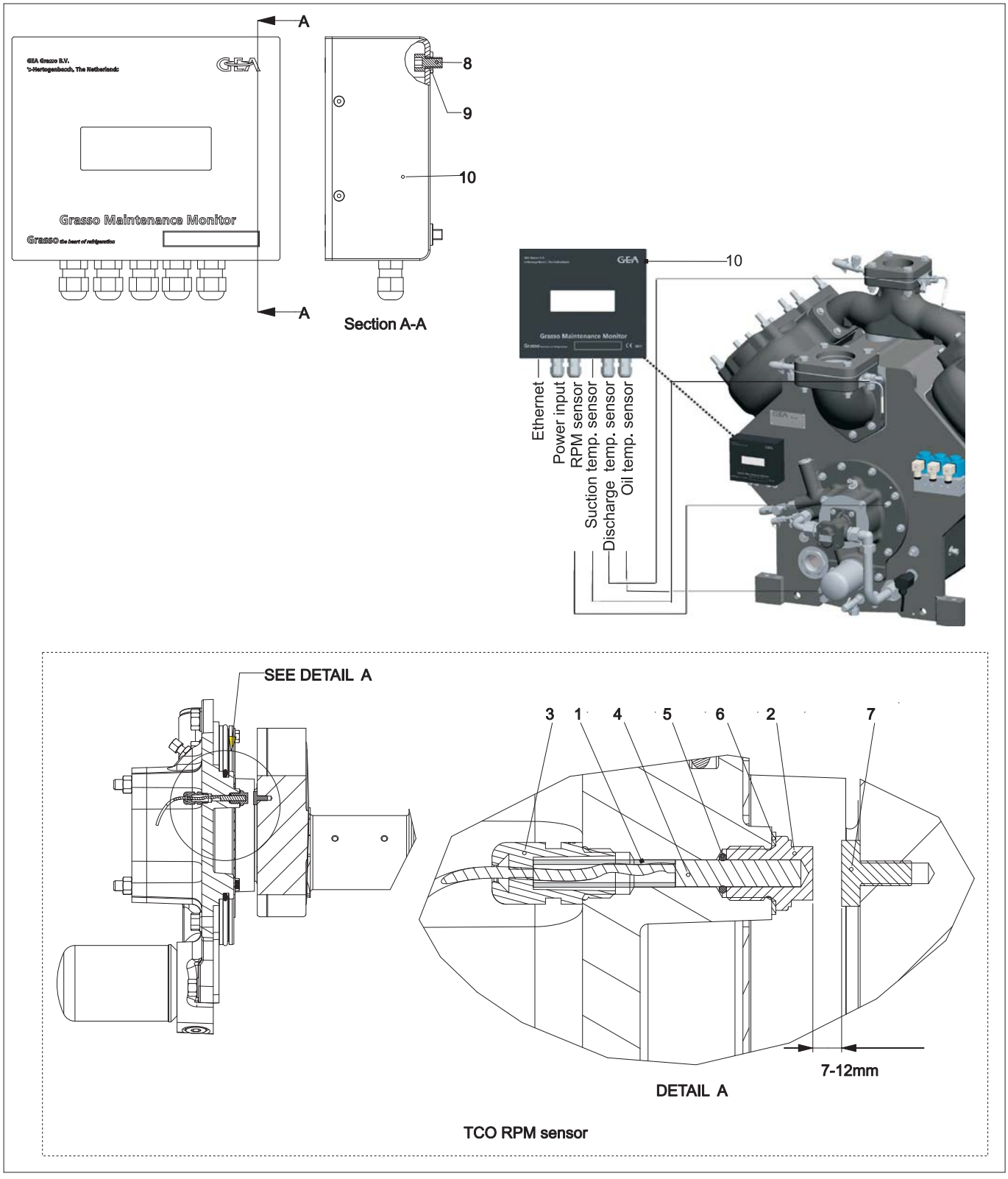


Fig. 4-17 Grasso V - 13

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 14 ELECTRIC CAPACITY CONTROL					
1	DISTANCE BUSH, TEFLON	9 x 30 x 10	1116732	2	
2	TOOTHED SPRING WASHER	M6	1113303	2	
3.A	VALVE BLOCK	EVRB 40	0682740	1	
3.B	VALVE BLOCK	EVRB 50	0682750	1	
4	CLAMPING SLEEVE	P8L	0334508	-	
5	NIPPLE	m12x1-8mm	0304512	-	
6	SOCKET HEAD SCREW	M6 x 60	0104360	2	
7	VALVE COIL	230V - 50/60Hz	1316230	-	
7/08	COILS AND CONNECTORS		*		Refer to Parts List Accessories
8	CONNECTOR	220/240 V AC/DC, DIN incl. LED	1316611	-	

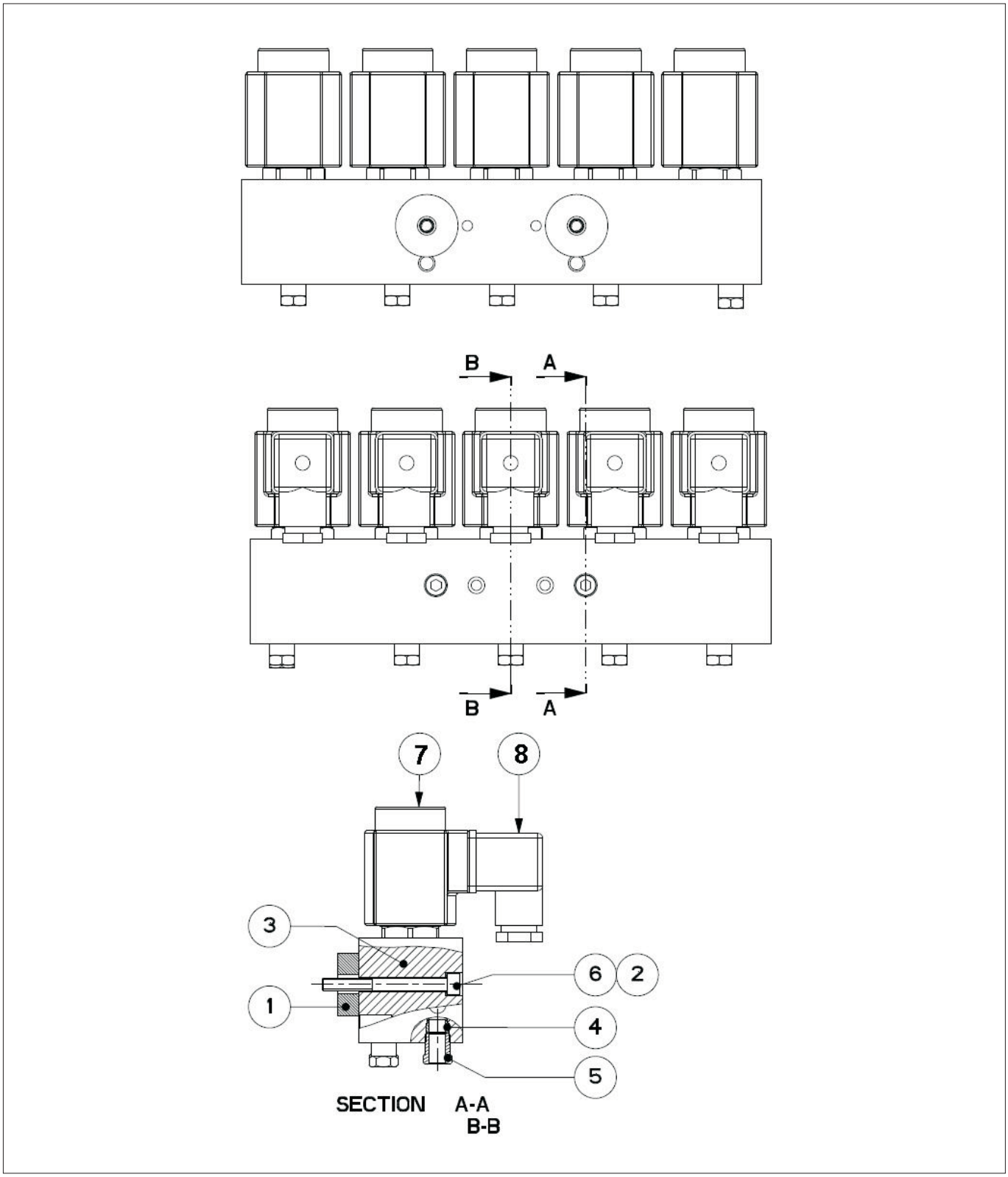


Fig. 4-18 Grasso V - 14

Item	Description	Dims.	Ref. No.	Qty	Remarks
Fig. Grasso V - 15 STANDARD SET OF PARTS AND TOOLS					
A	SPECIAL TOOL SET	Grasso V - L	2049010	1	
B	BASIC O-RING SET	Grasso V - L	2049017	1	
C	ADDITIONAL O - RING SET	Grasso V - L	2049018	-	for 2 cylinders

REFER TO 0087152 (DocNav)

SERVICE INSTRUCTION 00.87.152 V002

SPECIAL TOOL SET for V 700, V 1100, V 1400 and V 1800

This table below describes the instructions for use to (dis)assemble the V 700, V 1100, V 1400 and V 1800 Compressor or compressor components with Grasso special tools and should be carried out in conjunction with the Grasso V documents as mentioned below.
This special tool set TA contains the following items:

Item list of Set TA, Reference number 20.49.010:

Item	Qty	Description	To be used for	Ref. No.:
1	1	Piston sleeve 160	Fitting piston rings and springs	73.43.160
2	1	Piston spanner (T-handle) M8	Removing & fitting piston/con rod, removing control piston	73.40.009
3	1	Auxiliary pull bar	For removing cylinder liner	70.50.827
4	1	Cylinder liner push bolt M20	Fitting and clearance determination	70.50.822
5	1	Main Auxiliary bar	For removing cylinder liner	70.50.817
6	1	Threaded rod with nut M12	For removing cylinder liner	70.50.829
9	1	Oil charging line	Filling crankcase	15.25.113
12	1	Service Instruction Manual V	Maintenance, inspection, repair and overhaul	00.87.125
13	1	Control oil pressure measuring set	Control oil pressure during operation	20.38.121
14	-	Strap wrench (not in this toolset)	To remove oil filter	See page 3
15	1	Service instruction TA	Service jobs (this document)	00.87.152
16	1	Auxiliary push bar	For assemble cylinder liner	70.50.812
17	1	Camring fixation pin	Position cam ring valve lifting mechanism	70.11.372
18	1	Tool for shaftseal	Removing shaftseal	70.50.720
19	1	Block A3 valve	Dissassembly tool discharge valve	73.43.170
20	1	Claw spanner	(dis)mounting shaft guide bush of capacity control mechanism	73.40.110
21	2	Forcing screws	For removing bearing and service covers	01.10.440
22	-	Protect bearing cover bore before (re)assemble crankshaft (not in this toolset)	For (re)assemble crankshaft	See page 2

1/3

Fig. 4-19 Grasso V - 15

5. SUPPLEMENTARY PARTS

6. APPENDIX; Product Information (PI)

6.1 GENERAL LIMITS OF OPERATION GRASSO V

When operating the compressor, none of the limits of operation as stated in the table below must be exceeded.[1]

The diagrams overleaf represent the overall fields of application in which the individual operation limits are taken into account.

Table 6.1-1 General limits and fields of operation

1. In practice, it is not so much the individual operation limits as combinations of them that are decisive for the conditions under which a compressor may operate. To check the various possibilities in this respect, use should be made of the "fields of application").

REFRIGERANT				NH_3
Compressor speed	n	Grasso V 300 Grasso V 450 Grasso V 600	min.	500 min^{-1} for direct drive 600 min^{-1} for V-belt drive
		Grasso V 700 Grasso V 1100 Grasso V 1400 Grasso V 1800		500 min^{-1} for direct drive 700 min^{-1} for V-belt drive
		Grasso V 300 Grasso V 450 Grasso V 600	max.	1500 min^{-1}
		Grasso V 700 Grasso V 1100 Grasso V 1400 Grasso V 1800		1200 min^{-1}
Suction pressure = evaporating pressure =crankcase pressure	p_o/t_o	Grasso V	min.	0.3 bar(a) -55 °C
		Grasso V 300 Grasso V 450 Grasso V 600	max.	7.0 bar(a) 13 °C
		Grasso V 700 Grasso V 1100 Grasso V 1400 Grasso V 1800		7.0 bar(a) 13 °C
Suction superheat	delta-t	Grasso V	min.	>0 °C
Actual suction temperature	t_a	Grasso V	min.	-50 °C
Discharge pressure = condensing pressure tc = saturated condensing temperature This pressure is also the maximum allowable pre-set value of the HP safety switch. CAUTION!: When adjusting the HP and/or LP safety switch, care should be taken that the pressure difference $\Delta p=(p_C-p_o)$ never exceeds 26.0 bar.	$P_s{}^a/t_c$	Grasso V 300 Grasso V 450 Grasso V 600	max.	26.0 bar(a) 60 °C
Discharge pressure = condensing pressure This pressure is also the maximum allowable pre-set value of the HP safety switch. CAUTION!: When adjusting the HP and/or LP safety switch, care should be taken that the pressure difference $\Delta p=(p_C-p_o)$ never exceeds 19.0 bar.		Grasso V 700 Grasso V 1100 Grasso V 1400 Grasso V 1800		24.0 bar(a) 56 °C
Design pressure	$PS_s{}^b$	Grasso V	-	26.5 bar(a) This pressure deviates from the so called max. discharge pressure=condensing pressure (allowed during operation) as stated in the table.

REFRIGERANT				NH_3
Discharge temperature	t_e	Grasso V	max.	+170 °C This is the actual discharge temperature, measured directly in the gas flow just before the discharge connection. The given value also applies to the LP stage of two-stage compressors.
Pressure ratio per stage (p_c/p_o or p_c/p_m or p_m/p_o) Pressure ratio limits are not absolute but arbitrary values based on practical considerations	j	-	min.	1.5
			max.	10
Pressure difference	delta-p	Grasso V 300 Grasso V 450 Grasso V 600	max.	(p_c - p_o) <= 25.0 bar
				The standard built-in overflow safety valve(s) (p_c - $p_{ambient}$) <= 25.0 bar
		Grasso V 700 Grasso V 1100 Grasso V 1400 Grasso V 1800	max.	(p_c - p_o) <= 19.0 bar
				The standard built-in overflow safety valve(s) (p_c - $p_{ambient}$) <= 25.5bar
Oil temperature in crankcase	t_{oil}	°C	min.	>10°C and > $T_{saturated\ crankcase\ pressure\ at\ stand\ still}$ + 15 K Indicated minimum value is the lowest oil temperature at which the compressor is allowed to be started.
			max.	< 70 °C, depending on type of oil, refer The maximum oil temperature depends on the operating conditions of the compressor and the oil type used. A minimum actual oil viscosity of 10 cSt in the bearings is always required.

a. "Ps" is mentioned on type plate of the compressor
b. "PSs" is mentioned on type plate of the compressor

6.2 PART-LOAD POWER CONSUMPTION AND ALLOWED PART LOAD STEPS COMSEL

To determine the allowed partload steps for the design conditons and the corresponding partload power consumption refer to software program Comsel.

6.3 DIAGRAMS

Table 6.3-1 Solenoid valve/cylinder numbering for electric capacity control

Compressor type	Solenoid				
	UNL NO	No. 1 NC	No. 2 NC	No. 3 NC	No. 4 NC
	Cylinder number / solenoid valves				
300	1	2	3	4	-
450	(1+2)	5	(3+4)	6	-
600	(1+2)	6	(3+4)	(5+7+8)	-
700	1	2	3	4	-
1100	(3+4)	2	(5+6)	1	-
1400	(5+6)	7	8	(2+4)	(1+3)
1800	(7+8)	5	6	(9+10)	(1+2+3+4)

Table 6.3-2 Capacity control steps

Compressor type	Capacity %[a]	Cylinders	Solenoids
300	25	1	-
	50	1 + 2	1
	75	1 + 2 + 3	1 + 2
	100	1 + 2 + 3 + 4	1 + 2 + 3
450	33	(1+2)	-
	50	(1+2) + 5	1
	67	(1+2) + (3 +4)	2
	83	(1+2) + (3+4) + 5	1+2
	100	(1+2) + (3+4) + 5 + 6	1+2+3
600	25	(1+2)	-
	37	(1+2) + 6	1
	50	(1+2) + (3+4)	2
	62	(1+2) + (3+4) + 6	1+2
	75	(1+2) +6 + (5+7+8)	1+3
	87	(1+2) + (3+4) + (5+7+8)	2+3
	100	(1+2) + (3+4) + 6 + (5+7+8)	1+2+3
700	25	1	-
	50	1 + 2	1
	75	1 + 2 + 3	1 + 2
	100	1 + 2 + 3 + 4	1 + 2 + 3

Compressor type	Capacity %[a]	Cylinders	Solenoids
1100	33	(3+4)	-
	50	(3+4) + 2	1
	67	(3+4) + (5+6)	2
	83	(3+4) + (5+6) + 2	1 + 2
	100	(3+4) +2 + (5+6) + 1	1 + 2 + 3
1400	25	(5+6)	-
	37	(5+6) + 8	2
	50	(5+6) + 8 + 7	1 + 2
	62	(5+6) + 8 + (1+3)	2 + 4
	75	(5+6) + (2+4) + (1+3)	3 + 4
	87	(5+6) + 7 + (2+4) + (1+3)	1 + 3 + 4
	100	(5+6) + 7 + 8 + (2+4) + (1+3)	1+ 2+ 3+ 4
1800	20	(7+8)	-
	30	(7+8) + 5	1
	40	(7+8) + 5 + 6	1 + 2
	50	(7+8) + 6 + (9+10)	2 + 3
	60	(7+8) + 5 + 6 + (9+10)	1 + 2 + 3
	70	(7+8) + 5 + (1+2+3+4)	1 +4
	80	(7+8) + 5 + 6 + (1+2+3+4)	1 + 2 + 4
	90	(7+8) + 6 + (9+10) + (1+2+3+4)	2 + 3 + 4
	100	(7+8) + 5 + 6 + (9+10) + (1+2+3+4)	1+ 2 + 3 + 4

a. Refer to the swept volume expressed as a percentage of the full-load swept volume

6. APPENDIX; Product Information (PI)

6.4 LUBRICATING OILS (CHOICE AND RECOMMENDATIONS)

The choice of oil for a refrigeration compressor should be made by taking into account the entire refrigeration system design and operation as well as the operating conditions of the compressor.

For lubrication of refrigeration compressors, several brands and types of specially developed lubricating oils are on the market. The choice of oil depends not only on its good lubrication properties (viscosity) and chemical stability at the operating conditions of the compressor, but also on the operating conditions of the refrigerating plant (solidifying and floc point, solubility).

Grasso has tested and approved for use in its reciprocating-compressors the brands and types of oil as listed tables below.
The choice of the lubricating oil depends on type of refrigerant and the operating conditions of the compressor.
The oil viscosity should always be more than 10 cSt.
A higher ISO-VG number should be chosen when refrigerant solubility in crankcase is expected.

Remarks

1. Using ISO VG100 oils to increase viscosity at high expected cranckcase-temperatures makes no sense as the friction-heat will increase that much, that the oil-temperature limit related to the minimum viscosity of 10 cSt will also be exceeded. Only in case of expected high refrigerant-concentrations in the cranckcase this viscosity-gradeoil is an alternative!
2. Using ISO VG46 oils to meet low pour point requirements is only acceptable if coupled to a high viscosity-index of at least 100, otherwise the working limits are so limited (again concerning the minimum required oil-viscosity of 10 cSt) that it can be used in medium evaporation-pressures, making no sense to use them als a low pourpoint alternative!

Some of the oil types listed in the tables may be marketed under other names and/or designations; these oils can also be used, provided their identity can be proved beyond any doubt. Application of other/alternavive oils is not permitted without the written consent of Grasso.

6.4.1 STRONGLY RECOMMENDED OIL TYPES

Table 6.4-1 Strongly recommended oil types for Grasso reciprocating compressors

Refrigerant used	Brand	Type designation
NH_3	CPI	CP-1009-68
	PETRO CANADA	Reflo 68A Reflo XL
	Klüber	Summit RHT-68
	TEXACO	Capella Premium 68
	SHELL	Clavus S-68 / Refrigeration Oil S2 FR-A[a]

a. Old name resp. new name; old name will be phased-out during 2010.

6.4.2 ACCEPTED NH_3 OIL TYPES

Table 6.4-2 Accepted NH_3 oil types for Grasso reciprocating compressors

Brand	Type designation	ISO VG number[a]
AVIA	FC 46	44
	FC 68	65
BP	Energol LPT-F 46	54
	Energol LPT 68	68
CASTROL	Icematic 299	56
CPI	CP-1009-68	69
EXXON MOBIL	Zerice S46	48
	Zerice S68	68
	Arctic 300	68
FUCHS	Reniso KS 46	47
	Renisso KC 68	68
KROON OIL	Carsinus FC 46/68	46
PETRO CANADA	Reflo 68A Reflo XL	58
Kuwait Petroleum	Q8 Stravinsky C	55
SHELL	1) Clavus 46	46
	1) Clavus 68	68
	1) Clavus G 46[b]	46
	1) Clavus G 68[b]	68
	Clavus S-68 / Refrigeration Oil S2 FR-A[c]	68
	1) Clavus G 100[b]	95

Brand	Type designation	ISO VG number[a]
SUN-OIL	Suniso 3.5 GS	43
	Suniso 4 GS	55
	Suniso 5 G	94
	Suniso 4 SA	57
TEXACO	Capella WF 68	65
	Capella Premium 68	67
TOTAL	Luneria FR 68	68
Klüber	Summit RHT-68	68

a. Viscosity grade number designation according to ISO Standard 3448.
b. For NH3 only possible if water and air are not present!
c. Old name resp. new name; old name will be phased-out during 2010.

1) These oils cannot be supplied anymore from approx. January 2011.

6. APPENDIX; Product Information (PI)

GEA Refrigeration Technologies

GEA Grasso GmbH

Holzhauser Straße 165, 13509 Berlin
Germany
Phone +49 (0)30 43 592 6, Fax+49 (0)30 43 592 777
www.grasso.de, info@grasso.de

GEA Refrigeration Technologies

GEA Refrigeration Netherlands N.V.
Technology Center Piston Compressors – GEA Grasso
P.O. Box 343, 5201 AH, 's-Hertogenbosch
The Netherlands
Phone: +31 (0)73 6203 911
www.grasso.nl, info@grasso.nl

CE