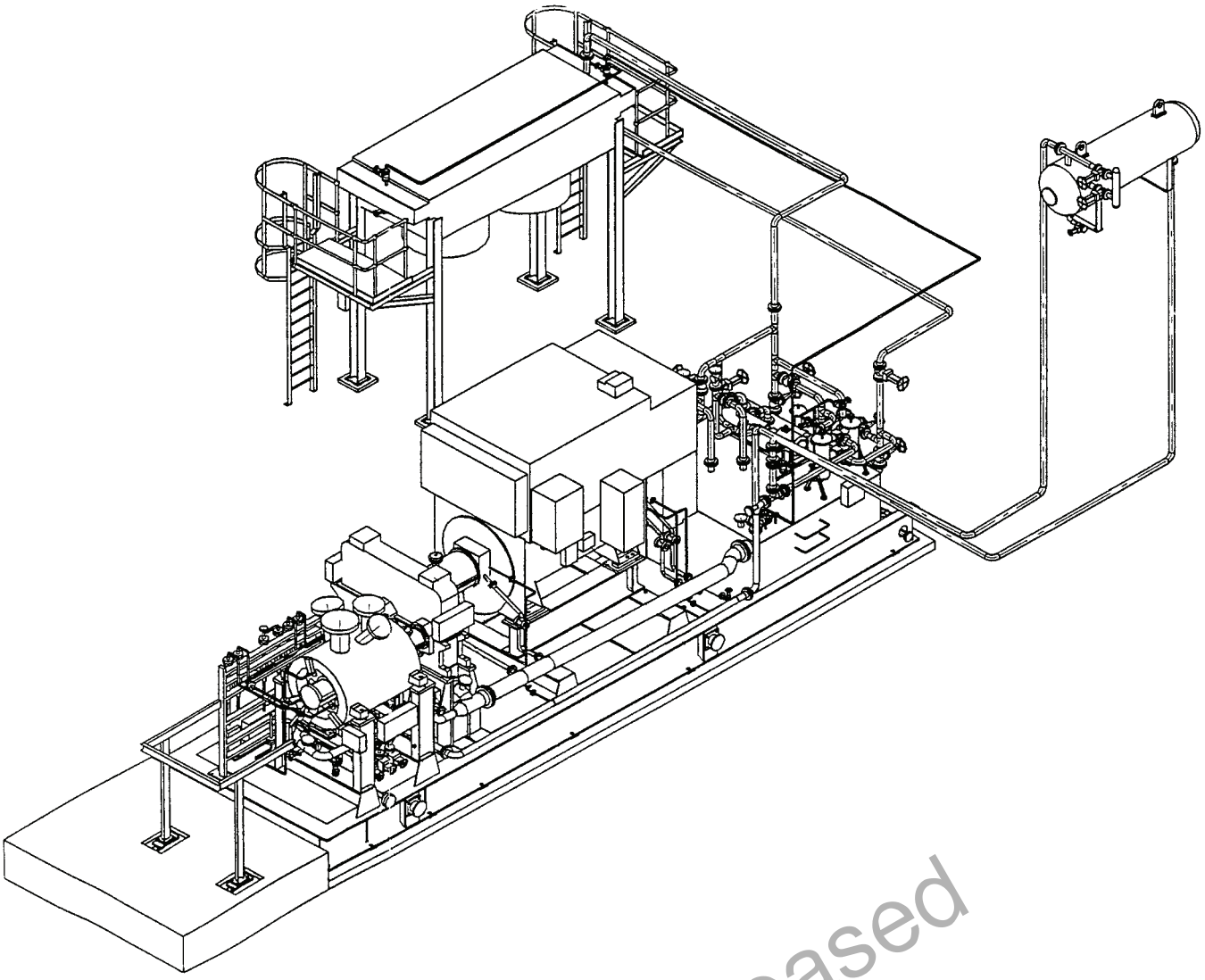
Operation Manual
Compressor Unit RV 042/04
SAMEX 3/4 310 102



Contents overview

Operation Manual

for

GHH BORSIG "Export Gas" Centrifugal Compressor Unit

Type	RV 042/04
Machine No.	23-1815 / 23-1816
Job No.	310 102
Code word	SAMEX 3/4
Year built	1998

User

Name	KHALDA Petroleum Co.
Address	Road 290 - New Maadi
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	Cairo, Egypt

Engineering / Purchaser

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Purchaser order No.	97-M0901
Job No.	SG-0187
Requisition No.	MGB-101
Item No.	SA-K-2911/21
Project name	Western Desert Gas Development Project; Salam Field

Manufacturer

GHH BORSIG Turbomaschinen GmbH

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10	10	15.1	**SAMEX 3:** TAB 01 Documents	–	–	–	
			Replace Dwg. No. 304855-00/02 Rev.4 with Dwg. No. 304855-00/02 Rev.5	2	1	9	
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			Replace Dwg. No. 304855-01/07 Rev.1 with Dwg. No. 304855-01/07 Rev.2	7	1	9	
			Replace Dwg. No. 304855-01/07 Rev.3 with Dwg. No. 304855-01/07 Rev.4	8	1	9	
			Replace Dwg. No. 304855-01/07 Rev.1 with Dwg. No. 304855-01/07 Rev.2	9	1	9	
			Replace Dwg. No. 304855-01/07 Rev.2 with Dwg. No. 304855-01/07 Rev.3	14	1	9	
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11	10	15.2	**SAMEX 4:** TAB 01 Documents	–	–	–	
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			Replace Dwg. No. 304855-03/07 Rev.1 with Dwg. No. 304855-03/07 Rev.2	6	1	9	
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			Replace Dwg. No. 304855-01/07 Rev.2 with Dwg. No. 304855-01/07 Rev.2	9;old 9;new	1	9	
			Replace Dwg. No. 304855-01/07 Rev.3 with Dwg. No. 304855-01/07 Rev.3	14;old 14;new	1	9	
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			Replace Dwg. No. 304855-03/07 Rev.2 with Dwg. No. 304855-03/07 Rev.2	14;old 14;new	1	9	
			Replace Dwg. No. 304855-03/07 Rev.2 with Dwg. No. 304855-03/07 Rev.2	22;old 22;new	1	9	

1 Important notes

1.1 General

The contents of this Operation Manual refer only to the compressor unit delivered by us.

The contents of the Operation Manual correspond with the required expertise of the operating personnel. It is assumed that the personnel assigned to operate the compressor unit has been instructed accordingly, read and understood the entire Operation Manual and is able to operate the compressor unit properly. The personnel must have sufficient knowledge and experience to immediately detect irregularities and to initiate corresponding measures. This also applies to unit parts which are not expressly stated in this Operation Manual.

Since it is not possible to state every situation in connection with the operation of the supplied compressor unit, please contact us if any questions arise in this regard.

We have taken special care in compiling the Operation Manual. Should nevertheless inaccuracies be detected or causes for doubt arise, do not hesitate to contact us.

Also follow any further instructions for operating the compressor unit given by our assembly or startup personnel.

Features, data and similar properties stated in this Operation Manual are, unless contractually agreed otherwise, descriptions and not assured properties. The information stated in the Operation Manual does not alter the contractual conditions as a basis for supply.

Unless stated otherwise all pressures are to be understood as gauge pressures.

All listed drawings not inserted between the texts can be found in Chapter 9 “Drawings and lists” or Chapter 10 “Documentation for subcontracted components”.

We reserve the right to carry out modifications on our products, however, are not obliged to carry out these modifications on products already supplied.

The edition status of the Operation Manual is established on the sheet preceeding the table of contents. Any revisions carried out by us at a later date are recorded on this sheet and submitted to the owners of the Operation Manual subject to the condition that they update the Operation Manual.

The Operation Manual must be available in the vicinity of the compressor unit at all times.

1.2 References

This Operation Manual uses the following safety references:

i NOTICE
Information already described is supplemented here and serves to facilitate work.

! **WARNING !**
Nonobservance of this reference may lead to damage or destruction of the compressor unit.

⚠ **DANGER !**
Nonobservance of a warning may lead to injuries or death of persons and/or to heavy damages to compressors.

Also observe corresponding references in the documentation of subcontracted components (refer to Chapter 10).

1.3 Safety

DANGER !
Operate the compressor unit with the prescribed media within the specified limit values only.
Danger to life of operating personnel during operation of the compressor unit!

Do not carry out any modifications on the compressor unit, without prior approval by GHH BORSIG.
Danger to life!

Access to the compressor unit by unauthorized persons is prohibitted.

The user is responsible for strict adherence to the work safety and accident prevention regulations.

DANGER !
The user shall ensure that the persons working in the area of the compressor unit apply the required safety equipment for protection and especially in areas with a noise level over 85 dB(A) use corresponding hearing protection and that unobjectionable communication is safeguarded. The noisy area shall be correspondingly marked by the user.
Risk of grave damage to hearing!

The user is responsible for the operational safety of the compressor unit.

DANGER !
For safety reasons, any inspection, maintenance, repair and replacement work on compressor train must be carried out by GHH BORSIG Service personnel only!
If any work has been carried out improperly, this may result in damage to or destruction of the compressor unit.
Danger to life of and risk of injury to maintenance and operating personnel!

NOTICE
Store the special tools or devices and standby parts supplied with the compressor on site to enable smooth service by GHH BORSIG without delay.

1.4 Liability

GHH BORSIG is not liable for any damages which arose during the assembly or the initial startup of the compressor unit if this work was not carried out or supervised by GHH BORSIG Service personnel. Liability is also excluded if such damages arose due to improper operation of the compressor unit or if parts other than the original spare parts have been installed.

1.5 Service

Our Machinery Service Department is responsible for all questions of aftersales service after the compressor unit supplied by us has been commissioned. They will provide you with the required advice on operation of the compressor unit, procurement of spare parts, storage of standby parts as well as inspection and repair. Please also consult our Machinery Service Department if you make any unusual observations entailing causes and effects which cannot be clearly judged. In connection with engineering orders our Machinery Service Department conducts examinations on the possibilities of modifications or retrofitting and, if required, carries out the modification or retrofitting of compressor units as well.

When submitting inquiries, please always state
the Machine No. “23-1815 / 23-1816”,
the code word “SAMEX 3/4”,
the Job No. “310 102”
and if necessary the designation of the parts concerned with the Group No. or Ident. No. and Serial No. according to the drawings and spare part lists.

If it is necessary to assign our specialists to carry out work or consulting on site, please state an order number in writing or in urgent cases by telephone and then submit a written order later.

Postal address	GHH BORSIG Turbomaschinen GmbH Egellsstraße 21 D-13507 Berlin
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2 Description

2.1 General

The compressor described here is a GHH BORSIG export gas compressor module Type RV 042/04 with auxiliary equipment.

In addition to the compressor the scope of supply comprises the following subcontracted components: electric motor, coupling 1 (between electric motor and gear unit), the gear unit, coupling 2 (between gear unit and compressor), the lube oil system (for electric motor, gear unit and compressor) as well as the gas seal with the gas sealing system.

In order to ensure operational safety of the compressor module and to reduce the extent of maintenance and repair work to a minimum, it is absolutely necessary to carefully read this operation manual (including the documentation of the subcontracted components).

If you should have any problems or questions, do not hesitate to contact GHH BORSIG.
In addition please refer to Section 1.5 “Service“.

2.2 Electric motor

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.1 “Electric motor”) regarding main drive.

2.3 Coupling 1

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.2 “Couplings“) regarding steel laminate coupling.

2.4 Gear unit

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.3 “Gear unit“) regarding gear unit with forced shaft driven main oil pump.

2.5 Coupling 2

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.2 “Couplings“) regarding steel laminate coupling.

2.6 Compressor

General

The turbocompressor operates as a radial compressor.

The design of the turbocompressor can be seen in the following sectional drawing Please refer to Chapter 9 “Drawings and lists”, Section 9.3 “Sectional drawing“.

The compressor casing has a barrel design with two compressor casing covers on the front side.

The diaphragm package, refer to Section 2.6.9 “Diaphragms”, is bolted to the compressor casing cover on the axial bearing side and together with the compressor rotor is horizontally located in the compressor casing.

The diaphragm package, impeller seals, shaft seals, balance piston seal and shaft seals on the oil side consist of two parts.

The compressor casing is sealed on the atmosphere side by gas seals and shaft seals on the oil side.

The sealing of the bearing housing is carried out by parting joint sealant, please refer to Section 7.6.

The bearing functions of the compressor rotor (refer to Section 2.6.13 “Compressor rotor”) in the compressor are carried out by one axial bearing and two radial bearings.

Shaft vibration, axial displacement and keyphases are monitored by eddy current proximity probes.

Chamber designation

0000.1	seal gas chamber
0000.2	buffer gas chamber
0000.3	<not applicable>
0000.4	clean gas inlet chamber
0000.5	venting chamber to flare

0000.6	atmospheric venting chamber
0000.7	venting chamber shaft seal on oil side / control drain shaft seal on oil side
0000.8	flushing gas chamber for shaft seal on oil side

Component designation

Compressor casing

2071.1	parting joint disk with bolt
2102.1	compressor casing
2102.2	compressor casing cover
2102.3	compressor casing cover
2102.4	shear ring
2102.5	shear ring
2102.6	O-ring
2102.7	O-ring
2102.8	O-ring
2102.9	O-ring
2102.10	O-ring
2102.11	O-ring

Diaphragms

2105.1	O-ring	
2131.1	inlet diaphragm	Stage I
2132.1	inlet diaphragm	Stage III
2151.1	reversing diaphragm	Stage I/II
2151.2	return diaphragm	Stage I/II
2152.1	reversing diaphragm	Stage III/IV
2152.2	return diaphragm	Stage III/IV
2161.1	twin volute	

Labyrinth seals

2251.1 balance piston seal

2261.1 labyrinth seal

2261.2 labyrinth seal

2261.3 shaft seal Stage I/II

2261.4 shaft seal Stage III/IV

2261.5 shaft seal on oil side

2261.6 shaft seal on oil side

2261.7 O-ring

2261.8 O-ring

2271.1 impeller seal Stage I

2271.2 impeller seal Stage II

2271.3 impeller seal Stage III

2271.4 impeller seal Stage IV

Shaft seals

2240.1 gas seal

2240.2 gas seal

Bearing housing on radial bearing side

2301.1 bearing housing

2301.2 gasket

2301.3 sealing plate

Bearing housing on axial bearing side

2311.1 bearing housing

2311.2 bearing housing cover

2311.3 gasket

Bearing

2371.1 radial bearing

2371.2 radial bearing

2374.1 axial bearing

Monitoring

2398.1 shaft vibration monitoring

2398.2 shaft vibration monitoring

2398.3 axial displacement monitoring

2398.4 keyphasor monitoring

Shaft

2401.1 shaft

2410.1 guide disk

2410.2 thrust collar

2410.3 holding piece

2410.4 caulking wire for sealing strip rings of the shaft

2410.5 sealing strip rings of the shaft

2410.6 sealing strip rings of the shaft

2410.7 sealing strip rings of the shaft

2410.8 sealing strip rings of the shaft

2410.9 sealing strip rings of the shaft

2410.10 sealing strip rings of the shaft

2410.11 shaft nut

2410.12 shaft nut

Impeller

2441.1 impeller Stage I

2442.1 impeller Stage II

2443.1 impeller Stage III

2444.1 impeller Stage IV

Coupling 2

8522.1 coupling hub

8522.2 coupling sleeve

8522.3 coupling sleeve, intermediate piece

8561.1 coupling disposition

2.6.1 Shaft vibration monitoring

An eddy current proximity probe (4) is bolted and secured in the externally adjustable shaft vibration monitoring (1) which is positioned without contact to the compressor rotor (5) by bolting the holder (2) into the bearing housing (3) .

The measuring point is located next to the radial bearing (refer to Section 2.6 “Compressor”)

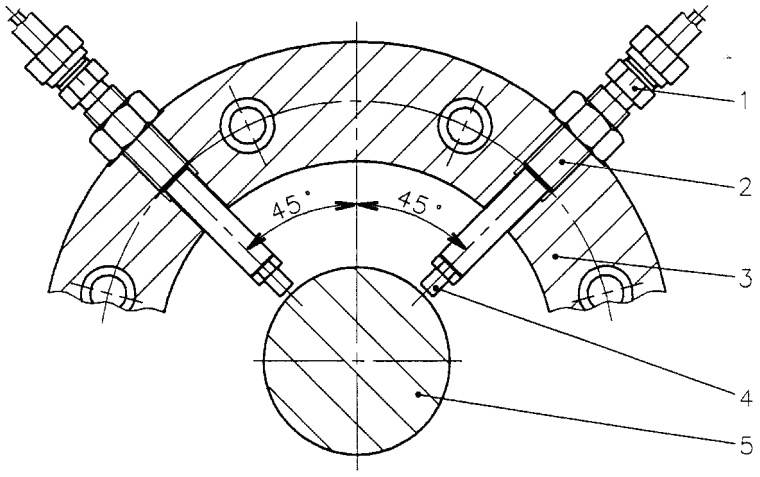


Illustration 1 Section of shaft vibration monitoring

2.6.2 Axial displacement monitoring

An eddy current proximity probe (4) is bolted and secured in the externally adjustable axial displacement monitoring (1) which is positioned without contact to the guide disk (5) of the compressor rotor (6) by bolting the holder (2) into the bearing housing cover (3).

It monitors the axial displacement of the compressor rotor. The measuring point is located next to the axial bearing (refer to Section 2.6 “Compressor”).

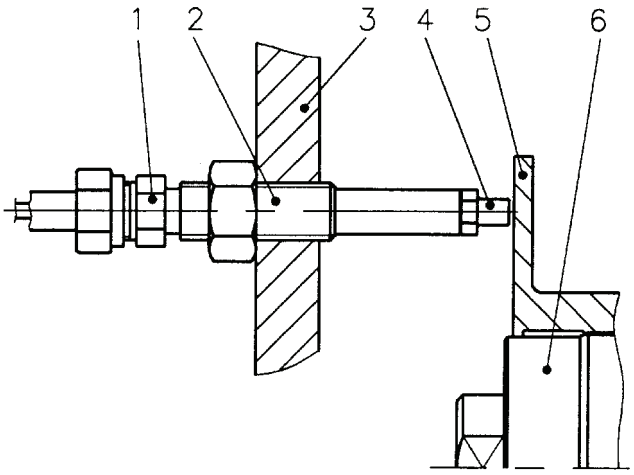


Illustration 2 Section of axial displacement monitoring

2.6.3 Keyphasor monitoring

An eddy current proximity probe (4) is bolted and secured in the externally adjustable keyphasor monitoring (1) which is positioned without contact to the guide disk (6) of the compressor rotor (7) by bolting the holder (2) into the bearing housing cover (3) to correaspond with the height of the impulse bore (5).

The measuring point is located next to the axial bearing (refer to Section 2.6 “Compressor”).

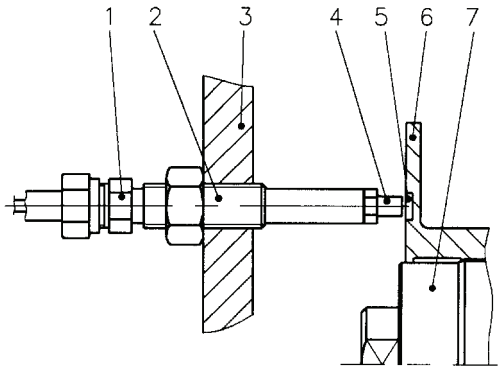


Illustration 3 Keyphasor monitoring

2.6.4 Axial bearing

The axial bearing has a symmetrical design and can be loaded in both directions of thrust. The thrust is absorbed by tilting pads (2) and (11).

The tilting pads function depending on the direction of rotation.

The tilting edge is located off center of the tilting pad. The tilting pads (2) and (11) are fastened to the axial bearing housing (4) by means of holding bolts (10) with nozzle bores (3).

The axial compressor rotor is positioned by means of adjustment rings (5).

A cylindrical pin (7) in the upper part of bearing housing (6) and axial bearing housing (4) secures the axial bearing housing (4) against turning.

The temperature probes (12) for babbit metal measuring are located through the bores in the axial bearing housing (4) and in the tilting pads (2) and (11) and led to the babbit metal layer of the tilting pads.

On each load side the oil is led to the nozzle bores (3) of the holding bolts (10) via ring grooves (8) and bores (9) in the axial bearing housing (4). The surfaces of the thrust collar (1) are hereby directly coated with oil and in connection with an immediate, unrestricted oil removal results in a low friction loss for axial bearings of this design.

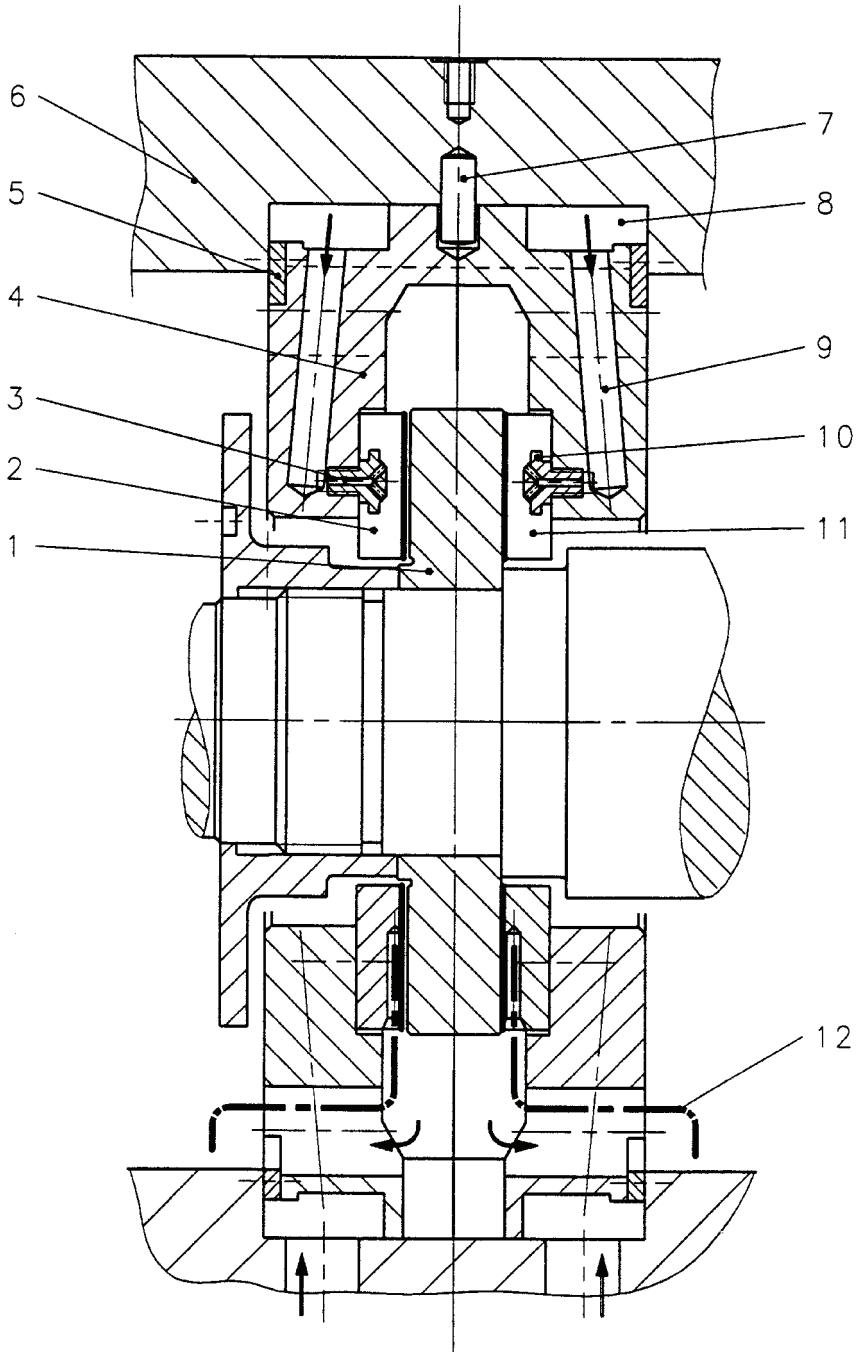


Illustration 4 Axial bearing

Sectional drawing Part No. 2374.1 (Section 2.6 “Compressor“)

2.6.5 Radial bearing

The radial bearing has four tilting pads (3). They are enclosed in the 2-segment casing (6) and allow a tilting movement. This ability of movement provides the favorable lube wedge between compressor rotor (4) and tilting pad (3). This characteristic safeguards smooth operation of the compressor rotor (4) in both directions of rotation.

The tilting pads function independently of the direction of rotation.

Sealing rings (5) seal off the radial bearing. The shell halves of the segment casing (6) and intermediate ring (8) are secured with a parting joint bolt and centering pin (12 and 13). A cylindrical pin (7) in the segment casing (6) and intermediate ring (8) as well as a cylindrical pin (9) in the intermediate ring (8) and upper part of bearing housing (11) secure the radial bearing against turning.

The temperature probes (2) for babbit metal measuring are located through bores in the segment casing (6) and tilting pad (3) to the babbit metal layer of the tilting pad.

The tilting pads (3) of the radial bearing are supplied with oil via orifice bores (1) in the segment casing (6).

The bearing oil temperature is measured by the thermometer (10).

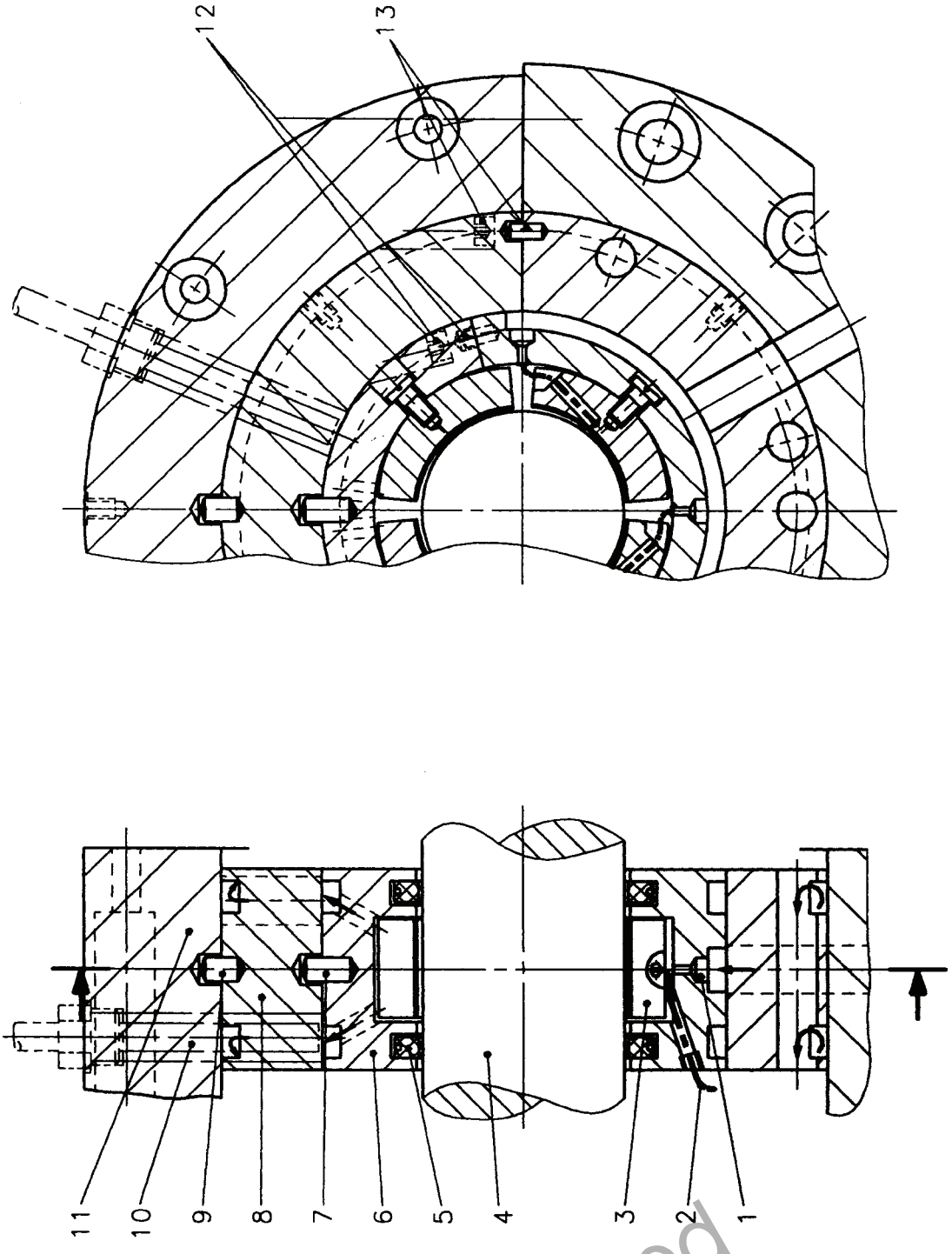


Illustration 5 Radial bearing

Sectional drawing Part No. 2371.1 and 2371.2 (Section 2.6 “Compressor“)

2.6.6 Shaft seal on oil side

Refer to Sectional drawing in Section 2.6 “Compressor“ regarding parts numbers and designations.

The shaft seal on oil side (2261.5 to 2261.6), with caulked sealing strips, can be impinged with seal gas (nitrogen) in Chamber 0000.1 and thus prevents oil from the bearings entering the gas seal. This connection is blanked off at the casing covers.

It consists of two parts and is held to the compressor casing cover by a two-part ring.

2.6.7 Gas seal

Refer to Sectional drawing in Section 2.6 “Compressor“ regarding part numbers.

The gas seal (2240.1 and 2240.2) seals off the compressor to the atmosphere and prevents the medium from entering the atmosphere.

For further descriptions of the gas seal refer to Chapter 10 (Section 10.4 “Gas seal and gas sealing system”).

2.6.8 Compressor casing

Design

The compressor casing is forged and consists of compressor casing shell, nozzles and lugs.

The compressor casing covers are axially held in the compressor casing shell by means of shear rings.

The lower parts of bearing housing are fastened to the compressor casing covers by means of cylinder bolts and locked by means of conical pins. This connection may not be loosened nor changed.

The upper parts of bearing housing are fastened by means of cylinder bolts and can be vertically mounted.

The sealing surfaces of the compressor casing cover and the compressor casing are machined to a finish and shall be protected against any kind of damage during assembly. Even minute damages can lead to leakage.

Testing

Hydrostatic presssure testing for strength and a gas pressure test for leakage integrity were conducted on the compressor casing.

Designation (refer to the following drawings)

3.1	compressor casing
3.2	compressor casing cover on axial bearing side
3.3	compressor casing cover on radial bearing side
3.4	bearing housing on axial bearing side
3.5	bearing housing on radial bearing side
3.6	guide bolts of removal device of the diaphragm package
3.7	thread for load yoke bolt
3.8	thread for load yoke bolt (for lifting the entire compressor)
3.9	lifting bolt
3.10	key guide
3.11	compressor casing lug
3.12	assembly area for removal device
3.13	suction nozzles
3.14	discharge nozzles
3.15	-
3.16	-
3.17	drain
3.18	lifting bolt for diaphragm package removal
3.19	nameplate
3.20	bearing housing cover
3.21	cover clamp

Connections (refer to following drawings)

Designation	
4.1	oil inlet radial bearing
4.2	oil inlet axial bearing
4.3	bearing oil outlet
4.4	-
4.5	-
4.6	temperature measuring oil outlet radial bearing
4.7	-
4.8	cable duct babbit metal measuring axial bearing
4.9	cable duct babbit metal measuring radial bearing
4.10	axial displacement monitoring
4.11	shaft vibration monitoring
4.12	keyphasor monitoring
4.13	clean gas supply
4.14	venting to flare
4.15	seal gas
4.16	buffer gas
4.17	atmospheric venting
4.18	flushing gas for shaft seal on oil side
4.19	venting shaft seal on oil side
4.20	control drain shaft seal on oil side
4.21	chamber pressure sealing surface cover

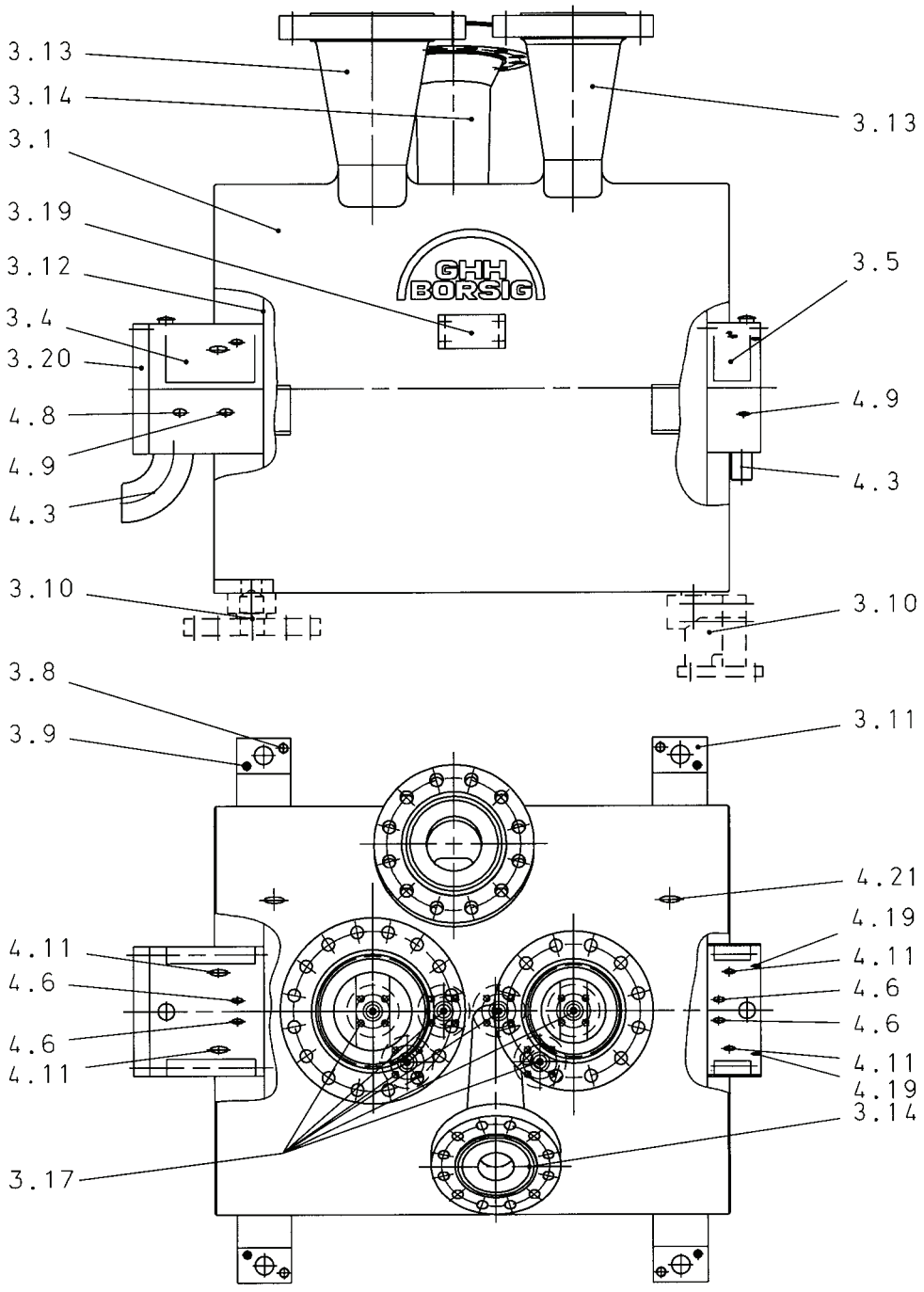
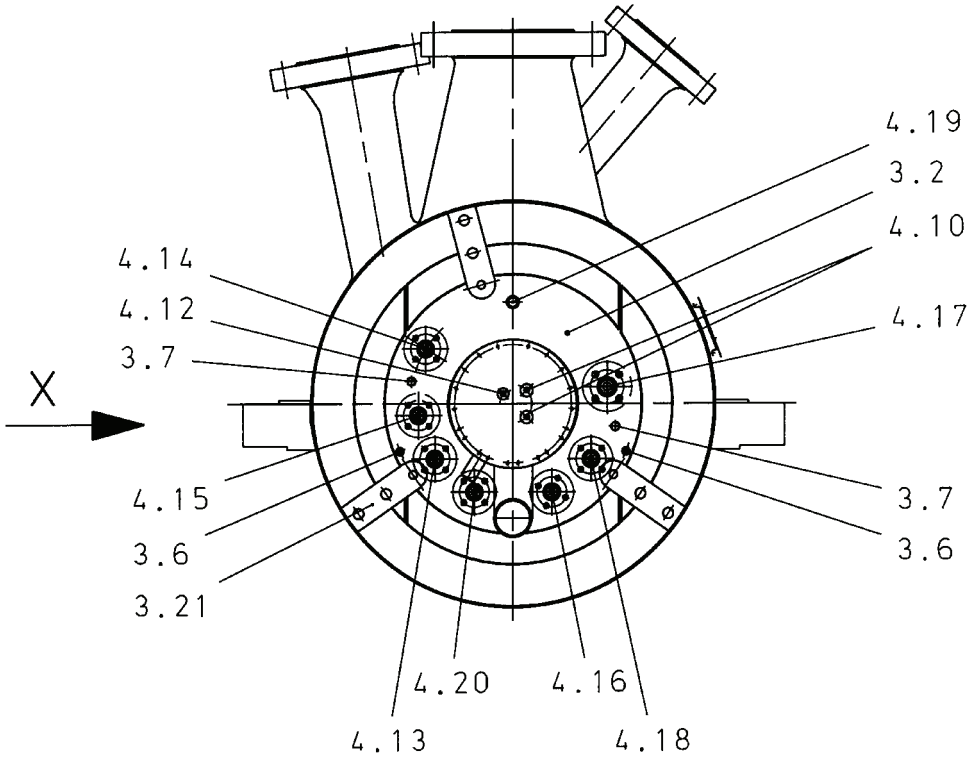


Illustration 6 Compressor casing



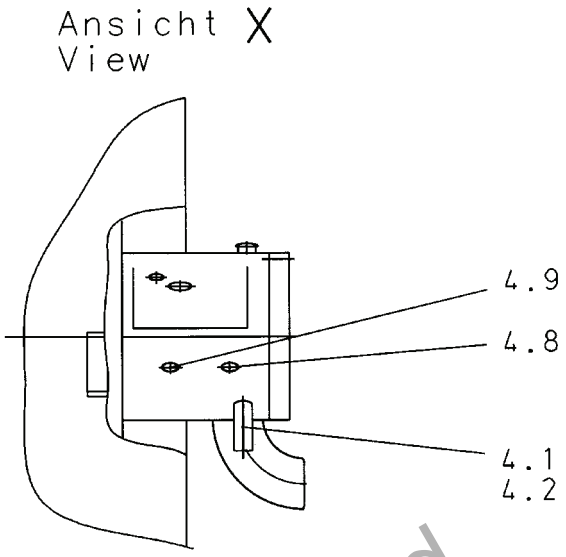


Illustration 7 Compressor casing on axial bearing side

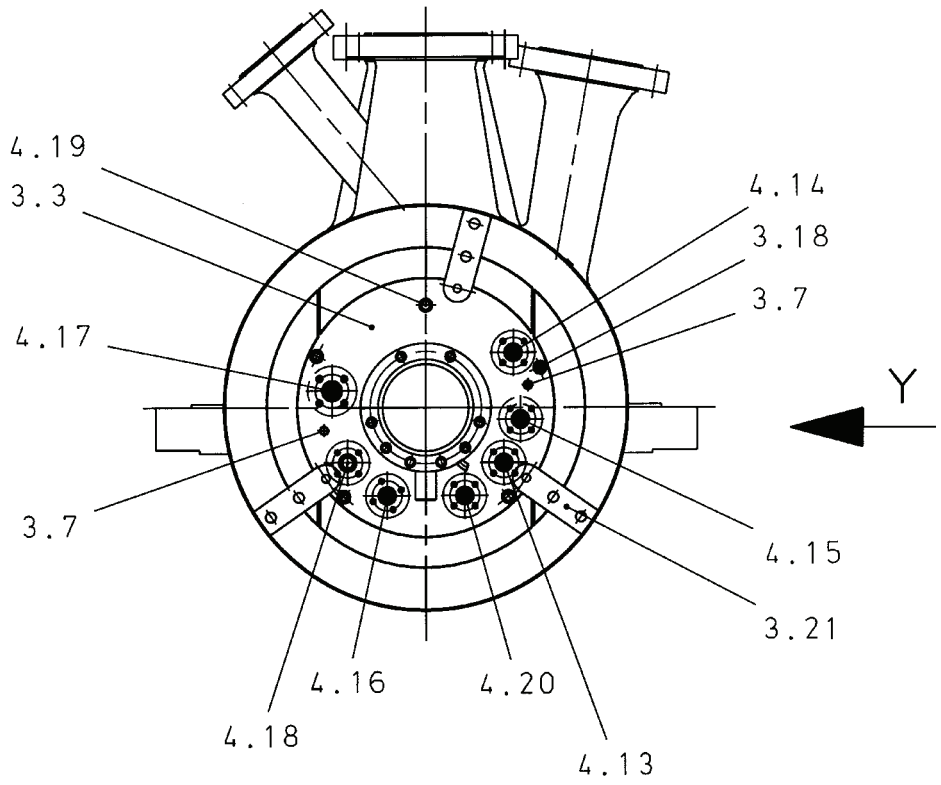


Illustration 8 Compressor casing on radial bearing side

2.6.9 Diaphragms

Refer to Sectional drawing in Section 2.6 “Compressor” regarding part numbers and designations.

The inlet diaphragms, reversing diaphragms, return diaphragms, and the twin volute (2131.1, 2132.1 to 2151.1, 2152.1, 2151.2, 2152.2 and 2161.1) are diaphragms. They consist of two parts and are bolted onto the parting joint.

The reversing diaphragms are bolted to the return diaphragms and secured with pins.

The diaphragms are bolted to the impeller seals, shaft seals and the balance piston seal to form a diaphragm package.

2.6.10 Labyrinth seal

Refer to Sectional drawing in Section 2.6 “Compressor” regarding part numbers and designations.

The labyrinth seal (2261.1 and 2261.2), with caulked sealing strips in the compressor rotor, can be impinged with seal gas (nitrogen) in Chamber 0000.1 to increase the pressure ahead of the gas seal.

These connections at the casing covers are blanked off.

It consists of one part and is bolted at the compressor casing cover (2102.2 and 2102.3).

2.6.11 Impeller seal and shaft seal

Refer to Sectional drawing in Section 2.6 “Compressor” regarding part numbers and designations.

Impeller seal

The impeller is sealed from the suction to the discharge side by an impeller seal (2271.1 to 2271.4) with sealing strips caulked in the seal.

It consists of two parts, is axially led in the diaphragm by means of a groove and is held in the upper part of the diaphragm by a parting joint disk with bolt (2071.1) .

Shaft seal

Each impeller stage is sealed from the other by a shaft seal (2261.3 to 2261.4) with sealing strips caulked in the compressor rotor.

It consists of two parts, is axially led in the diaphragm by means of a groove and held in the upper part of the diaphragm by a parting joint disk with bolt (2071.1).

2.6.12 Balance piston seal

Refer to Sectional drawing in Section 2.6 “Compressor” regarding part numbers and designations.

The balance piston seal (2251.1) equalizes the gas thrust of the back-to-back impeller stages to a large extent. The pressure gradient is reduced by the sealing strips caulked in the compressor rotor.

The balance piston seal consists of two parts, is axially lead in the diaphragm by means of the groove, held in the upper part of the diaphragm by parting joint disk with bolt (2071.1) .

It is radially adjusted with threaded pins. This adjustment may not be changed.

2.6.13 Compressor rotor

General

The shaft (3) is manufactured out of alloyed, forged steel. It is connected to the compressor rotor by means of a:

- guide disk (1) via a central threaded union.
- thrust collar (2) via fitting key connection.
- sealing strips (4) caulked in shaft with caulking wire.
- impellers (5) via shrink-fit connection.
- shaft nut (2410.11 and 2410.12) via threaded union.
- coupling hub (6) via shrink-fit connection.
- holding piece (7) via threaded bolt and cylinderical pin connection.

If necessary, firmly position the threaded pins of the components connected with the shaft. These threaded pins are secured against turning by caulking points.

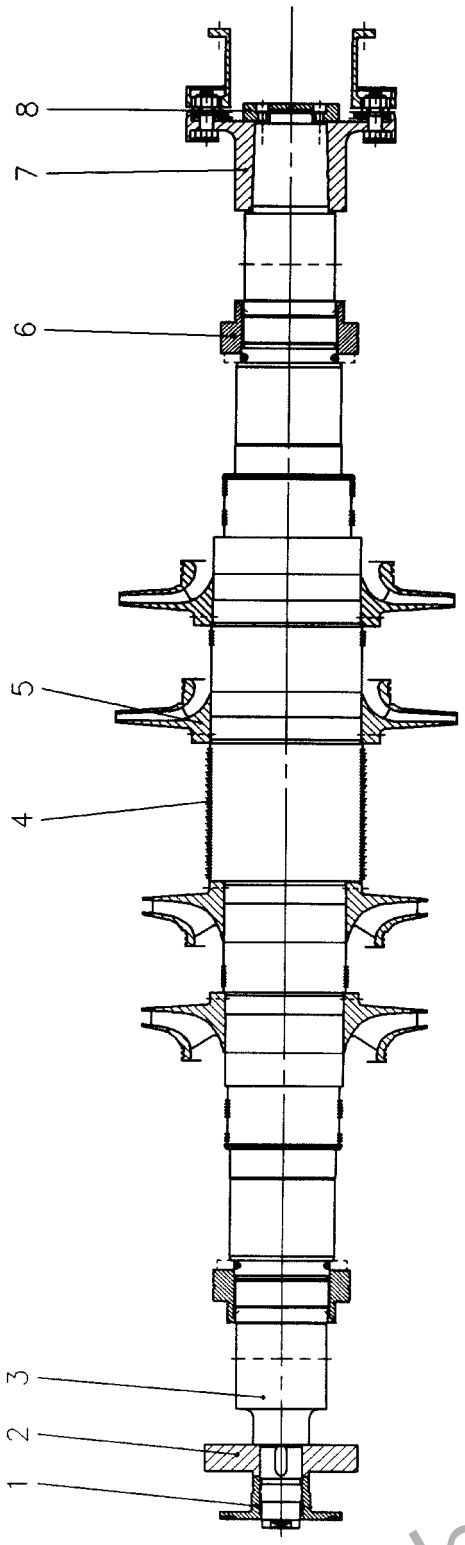


Illustration 9 Compressor rotor

Coupling area

The coupling hub (1) is positively locked onto the coupling stem by means of a shrinkfit.

The holding piece (3) is fastened to the cylinder bolts (4) and cylindrical pins (7) at the front side of the shaft. The cylinder bolts (4) and cylindrical pins (7) are secured by caulking points.

The centering diameters (6) located on the front side of the holding piece (3) for the balancing coupling, the pressure oil groove with supply bores (2) and the centering bore (5) are required for repair and replacement work.

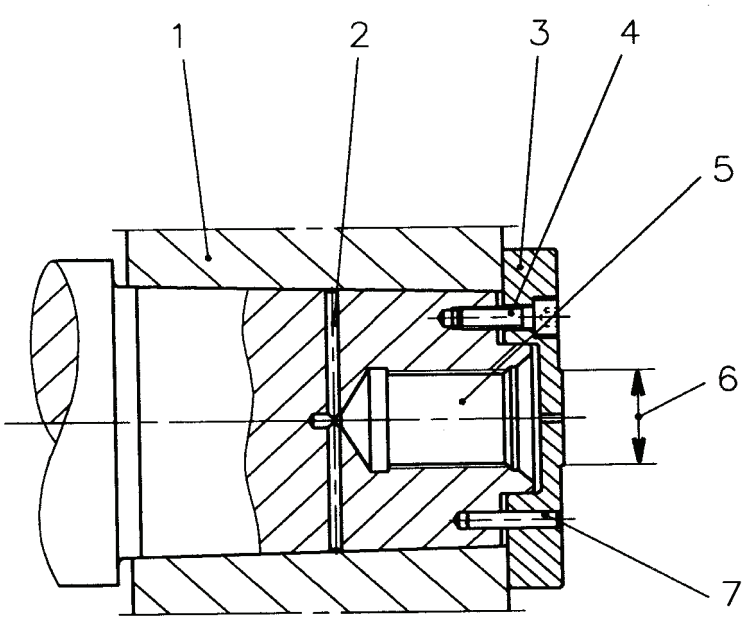


Illustration 10 Coupling area

Impeller area

The impeller is shrunkfit on the shaft.

The torques required under various operating conditions are transmited by a shrinkfit. Additional cylindrical pins (6) in shaft and hub disk (4) safeguard unobjectionable seating of the impeller on the shaft even if operating conditions change, i.e. speed, temperature or pressure changes, which may arise individually or also in any combination. The cylindrical pins (6) are secured by threaded pins (5). The threaded pins (5) themselves are secured againgst turning by caulking points.

Grooves for the labyrinths of the impeller seal are machined in the cover disk (1) in order to keep reflow of supplied gas within calculatable limits.

Testing

The manufacturer subjected the impeller to dynamic balancing, overspeed testing and the surfaces were tested using the dye penetration procedure.

Component designation (refer to the following drawing)

1 cover disk

2 blade of a 2-D impeller

3 blade of a 3-D impeller

4 hub disk

5 threaded pin

6 cylindrical pin

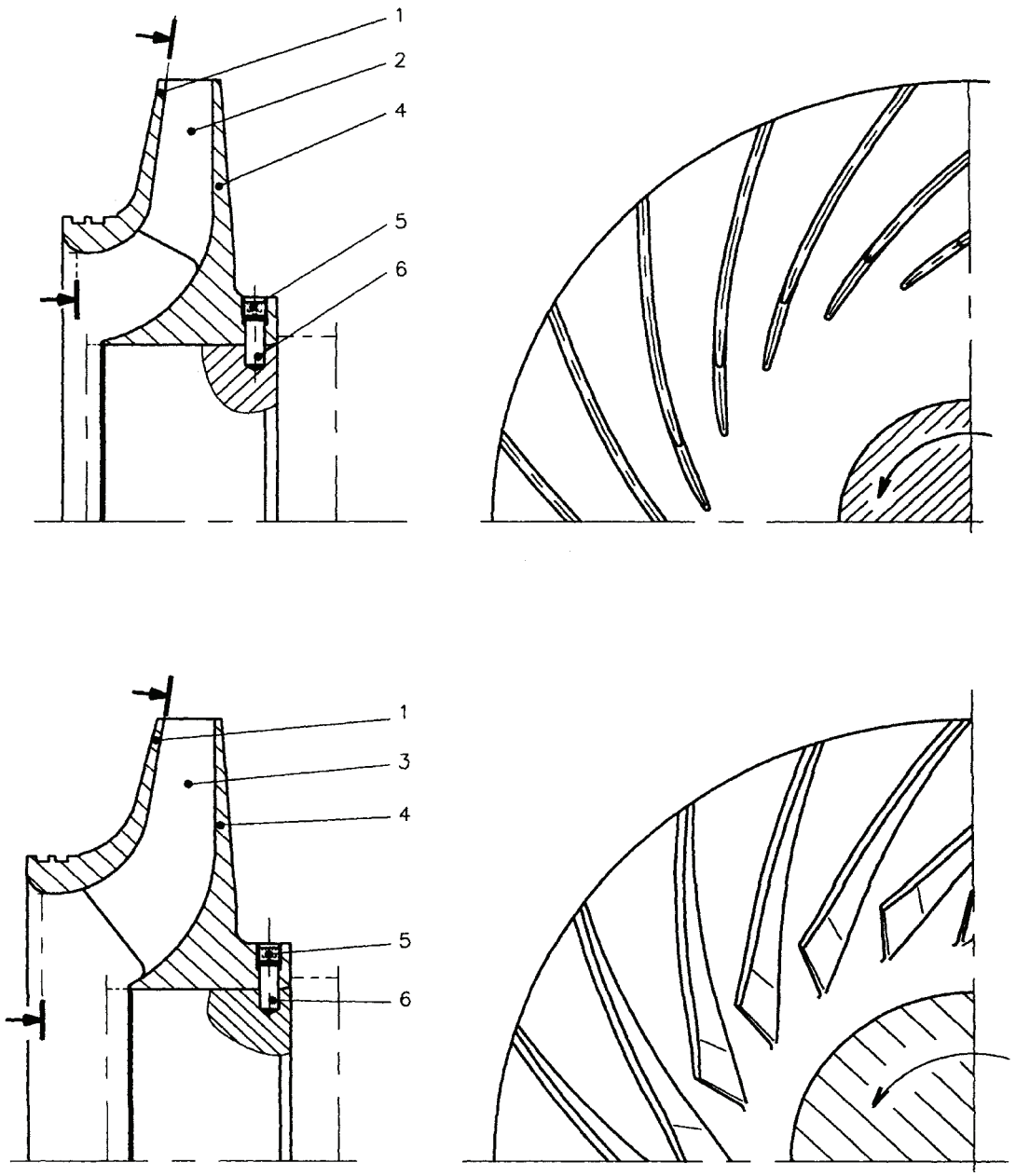


Illustration 11 Impeller area

Axial bearing area

The centering bore (2) and the key surface (1) are required for repair and replacement work.

The measuring surface for axial displacement monitoring and the impulse bore (3) for keyphasor monitoring and speed monitoring are located on the front side of the guide disk (5). The guide disk (5) is positioned by a threaded pin (8) and secured by caulking point. The bore (4) is required for assembly tools.

The thrust collar (6) of the axial bearing is mounted in one line to transmit the residual axial thrust. The thrust collar (6) is connected to the shaft by means of a fitting key (7).

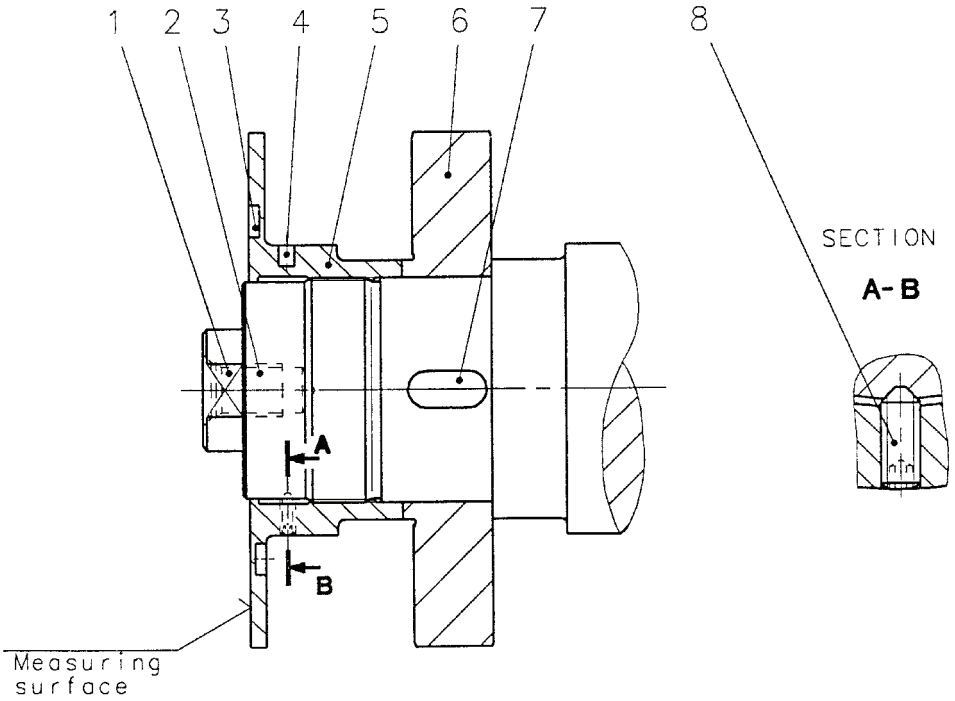


Illustration 12 Axial bearing area

2.7 Lube oil system

2.7.1 General

This lube oil system serves as:

1. lube oil supply for:

1.1 compressor

1.2 gear unit

1.3 electric motor

2.7.2 Index of applied accessory parts

Refer to Chapter 10 “Documentation for subcontracted components“, Index “Lube oil system”.

2.7.3 Description of function

Lube oil system

Prior to initial startup of the oil pumps the oil reservoir **SA-K-2911/21-T1** must be filled up to the top mark (7300 l). The oil must have a temperature of at least 10 °C (driver design).

During further startups the oil reservoir may be filled only up to the maximum mark (the remaining oil is located in the unit). The range between the maximum and the minimum mark is the range of operation. If during operation the oil level falls below a min. allowable value of approx. 4000 l, the level switch **29LS101/151** signals alarm.

The oil level is indicated by a level indicator **29LG101/151**.

The oil reservoir is equipped with electric immersion heaters **SA-K-2911-E1,E2** / **SA-K-2921-E1,E2** wich are flanged on.

The immersion heaters are directly installed in the oil space.
The level switch **29LS101/151** in the oil reservoir **SA-K-2911/21-T1** is provided as an overheating guard for the immersion heaters.
The alarm point is also the lowest allowable operating level.

The immersion heaters are equipped with temperature controlers 29TC101A,B/29TC 151A,B and limiters 29TSH101A,B/29TSH151A,B, which operate automatically.

The oil reservoir **SA-K-2911/21-T1** is equipped with an atmospheric breather.

The main oil pump **SA-K-2911/21-P2** is direct-driven and is located at the gear unit.

The auxiliary oil pump **SA-K-2911/21-P1** is driven by a motor for auxiliary oil pump**SA-K-2911/21-PM1** .

Each pump is equipped with a safety valve **PSV-P101A,B** as a means of protection against overload.

When pressure drops, the auxiliary oil pump is automatically switched on by the pressure switch **29PSL105/155**.

The auxiliary oil pump is switched off by hand.

Replacement of the auxiliary oil pump in the oil system is possible during operation, the corresponding valves and bypass lines are provided.

- The control valve **29PCV102/152** holds oil pressure constant to 2.0 bar (g), the impulse line is connected downstream of the oil filter **SA-K-2911/21-S1A,B**.

Excess oil flows back into the oil reservoir **SA-K-2911/21-T1**.

A single oil cooler **SA-K-2911/21-E3** and twin oil filters **SA-K-2911/21-S1A,B** are provided to safeguard continuous operation. Two coupled 3-way switchover valves allow changing over during operation; the corresponding shutoff part can now be serviced (filter element cleaned or replaced).

The oil filters are connected by a filling line with a valve. Through this line operationally warm oil flows through the standby oil filter, via venting lines with valve, orifice **29RO104A,B and 29RO154 A,B** and sightglass back to the oil reservoir.

The valves in the venting lines of the single oil cooler (air cooled) and oil filter in operation are closed.

The temperature control valve **29TCV103/153** holds the temperature downstream of the oil cooler (air cooled) constant to the value of 45-60 °C.

- An impulse is given to the pneumatically activated control valve by means of a temperature transmitter.

The normal pressure loss at an oil temperature of 45 °C amounts to approx. 1.0 bar.

A fouled filter (increased pressure loss 0.8 bar) is signalled by the differential pressure switch **29PDI104/154**.

The pressure switch **29PSL105/155** downstream of the oil filter monitors oil pressure.

If oil pressure drops to 1.5 bar(g), the auxiliary oil pump is automatically put on line.

This pressure switch is arranged between an orifice **29RO105/29RO155** and a valve in a line leading to the oil reservoir **SA-K-2911/21-T1** at a constant oil flow rate of 5 l/min to the oil reservoir.

A functional check can be carried out at any time during operation by slowly closing the valve downstream of the switch and observing pressure drop. Then re-open this valve.

The system pressure downstream of oil filter corresponds with the required lube oil pressure 1.7 - 2 bar (g). No further control is required.

The prescribed bearing oil pressures are set directly upstream of the bearing points by fixed orifices **29RO108/158/159A/B** bored by manufacturer.

If lube oil pressure downstream of control valve **29PCV102/152** drops to 1.3 bar(g),

- a preliminary alarm is signalled by pressure switch **29PS107/157**.
- (e.g. power failure, auxiliary oil pump could be switched on), the compressor is switched off by the pressure switch **29PS106/156**.

If an emergency switchoff is caused by power failure (no oil pump available), the following safety devices are provided:

An overhead tank **SA-K-2911/21-T2** arranged 6 meters over the center of the compressor takes over the entire lube oil supply for 4 minutes.

During this time the compressor should have come to a standstill.

During normal operation operationally warm oil constantly flows through the overhead tank **SA-K-2911/21-T2** via a bypass line with orifice in the supply line at approx. 5 l/min, the oil flows back to the oil reservoir **SA-K-2911/21-T1** via a sightglass.

A valve is arranged parallel to the orifice to fill the overhead tank quickly. This valve remains closed during normal operation. If the level in the overhead tank falls below 98 Vol. % = 1250 l, then alarm is signalled by the level switch **29LSL106/156**. At the same time the switch takes over the function of “interlocking the compressor unit” (at 50 Vol. %).

Drain system on gas side (Seal gas system)

The compressor is equipped with gas seal (2240.1 and 2240.2). Seal gas prevents oil from the bearings entering the gas seal. Please refer to Sections 2.6.6 “Shaft seal on oil side” and 2.6.7 “Gas seal”.

2.7.4 Compressor startup interlocking

The following conditions avoid premature startup of the compressor:

a) **29TAL103/153** downstream of the oil cooler **SA-K-2911/21-E3**. The oil temperature must amount to at least 35 °C.

b) **29LSL106/156** at lube oil overhead tank **SA-K-2911/21-T2**. The tank volume must amount to at least 98 Vol. % = 1270 l.

c) **29PSLL106/156** (switch off) ahead of compressor/electric motor. The oil pressure must amount to al least 1.1 bar (g).

2.7.5 Lube oil supply for electric motor

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.1 “Electric motor“) regarding the technical description of the lube oil supply for the electric motor.

2.7.6 Lubrication of coupling 1

Refer to Chapter 9, Index 8, “Coupling disposition (Motor/Gear)“ regarding residual oil draining of coupling 1.

2.7.7 Lube oil supply for gear unit

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.3 “Gear unit“) regarding the technical description of the lube oil supply for the gear unit.

2.7.8 Lubrication of coupling 2

Refer to Chapter 9, Index 8, “Coupling disposition (Gear/Compr.)“ regarding residual oil draining of coupling 2.

2.7.9 Bearing lubrication at compressor

The lube oil system supplies lube oil to the axial bearing and the radial bearings. The supply line branches off to the corresponding bearing housing of the compressor.

The bearing housing on the axial bearing side has only one connection for the lube oil supply of the axial bearing and radial bearing. The oil is distributed to the corresponding bearing by means of bore branches of the oil inlet bore (Connection No. 4.1 and 4.2, refer to illustrations in Section 2.6.8 “Compressor casing”).

Refer to Section 8.5.2 “Axial bearing and radial bearing“ regarding the technical data on bearing lubrication at compressor.

2.8 Gas sealing system

The shaft seal on the oil side (2261.5 and 2261.6) can be impinged with seal gas to prevent oil from entering the gas seal from the bearings and destroying the gas seal. In this case the connections at the casing cover are blanked off.

Please refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.4 “Gas seal and gas sealing system”).

2.9 Inert gas system

Inert gas is used to flush the sealing chambers in the compressor. It consists of nitrogen which is routed in the chambers via double filter.

Two coupled 3-way switchover valves enable changing from one filter to another. Please refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.4 “Gas seal and gas sealing system”).

2.10 Flare gas system

Residual gases are routed to the flare from the venting chambers of the gas seals and flared off.

Please refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.4 “Gas seal and gas sealing system”).

3 Operation

3.1 General information on startup

General

The final startup regulations can only be described based on knowledge of the entire unit as well as the influences of the PLS (programmable logic controller) on the control and monitoring of the compressor.

For this reason it is necessary to establish this description after obtaining full knowledge of the entire unit and after gaining experience of the entire unit from the startup by the user or the manufacturer.

Prerequisites

All components of the entire unit influencing compressor operation are completely assembled and functionable. In addition please refer to the operation manual from the manufacturer of the entire unit.

All certificates of inspection and acceptance have been issued (pressure testing, leakage integrity tests).

Operating utilities are available and all persons responsible have been duely instructed.

All protective devices are assembled.

The lube oil system is filled and flushed.

All measuring instruments are calibrated and the setpoints are adjusted.

Functional testing of monitoring and control systems have been carried out.

Work has been carried out according to Chapter 7 “Assembly“.

3.2 Startup of lube oil system

Carry out startup according to the following list, which also corresponds with the approximate sequence.

Prior to startup observe the following sections:

- Description of the oil system (refer to Section 2.7 “Lube oil system” and Chapter 10 “Documentation for subcontracted components“, Section 10.19 “Oil system“) and

- Preparation for startup of the oil system (refer to Section 7.12.6 “Preparatory measures for startup of oil system”)

1. Flushing should have been completed.

2. Prior to startup the oil should have a temperature of at least 35 °C.

   If required, take oil heater into operation.

2.1 In order to decrease heating-up period,

- the auxiliary oil pump can be switched on (bypass valve around 29PCV102/152 was already opened). After attaining the temperature, switch off pump and close valve for bypass line.

2.2 Local panel must be ready for operation.

3. Auxiliary oil pump

! WARNING !
Before switching on the auxiliary oil pump the shaft seals on the oil side are impinged with seal gas!

The shaft seals on the oil side must be impinged with seal gas before switching on the auxiliary oil pump so that no lube oil from the bearings can enter the gas seal due to the oil pressure.

Risk of grave damage to the gas seal.

3.1 Oil pumps

- Take auxiliary oil pump into operation.
- Vent and fill main oil pump as necessary by means of bypass and orifice 29RO101/151.

4. Vent oil cooler (air cooled) and oil filter until oil flows through the sightglasses installed in the venting lines. Then close shutoff valves in the venting lines on the oil side of the oil cooler (air cooled) and oil filter in operation. (The other shutoff valves remain open).

5. Slowly close manual control valve in bypass line at control valve **29PCV102/152** and check the pressure gauge 29PI102A/B / 152 A/B, pressure may amount to max. 8 bar(g). (Since the temperature is still below the operating temperature of 45 °C, the differential pressure gauge **29PDI104/154** at the twin oil filter indicates an excessive value at this time.)

6. Vent impulse line for control valve **29PCV102/152**.

7. Check and set the oil pressures in the supply lines and bearings of the main driver motor and the gear unit. Refer to Section 9.13 “Signal list“ for normal values.
8. Vent impulse lines of the measuring instruments.
9. Orifices which have been set by the manufacturer are located upstream of the bearing locations of the main driver motor and the gear unit.
10. Check the sightglasses and flow indicators in the oil drain traps for oil flow.
11. Check automatic cut-in switching of the auxiliary oil pump, refer to Section 3.5.2 “Check automatic switching to auxiliary oil pump”.
12. Check whether the overhead tank is filled. (Oil flow in sightglass in overflow line of overhead tank). In order to fill the overhead tank more quickly slowly open the manual control valve in the non-return valve bypass line to the overhead tank and close again after filling.
13. Startup of the turbocompressor unit.

! **WARNING !**
Caution: Only warm oil with a min. of 35 °C may enter the compressor during startup. Do not take the turbocompressor unit into operation before the overhead tanks are filled (refer to Pt. 12).

14. Switch off heaters, however, only after oil in the bearings of the running compressor unit warms up to normal oil temperatures. Refer to Section 9.13 “Signal list“ for normal values.
15. Adjust air cooler by means of the temperature contoler 29TCV103/153. Refer to Section 9.13 “Signal list“ for normal values.
16. Readjust the oil pressures/temperatures by means of 20 PCV 102/152 and 29TCV103/153, also refer to Pt. 7.
17. Check the sightglasses or flow indicators in the oil drain traps for flow.
18. Switch off auxiliary oil pumps and set to “AUTOMATIC”.
19. Adjust the seal gas with the manual control valve (downstream of the filter F-410A,B).

3.3 Startup with process gas

1. The supervisor informs all stations involved of the startup.
2. Observe the user's instructions.
3. Instruct the operating personnel.
4. Utilities and auxiliary energies like seal gas, inert gas and instrument air must be connected and available in the required amount, pressure, temperature and purity. In addition the line to the flare must be connected.
5. All measuring and control equipment must be ready to function.
6. Electric energy supply must be safeguarded.
7. Keep a record of operation.
8. Check differential pressures and the corresponding desired values.
9. The compressor unit must be in a mechanically unobjectionable condition.
10. Observe the brief instructions which are mutually compiled by both the user and the GHH BORSIG Service.
11. During long-term compressor standstill take the lube oil system into operation at least once a week for approx. 1 hour. In addition observe Section 3.6.4 "Measures for conservation during long-term compressor standstill".
12. If process gas continues to flow through the inoperative compressor, the compressor rotor must be turned prior to startup to safeguard thermal balance.

3.4 Operation

Take the following readings of data not automatically compiled every four hours and recorded in writing, refer to Section 3.7 "Compiling operation data":

- axial displacement of the compressor rotor
- shaft vibrations
- key phases
- suction pressure
- suction temperature
- intermediate pressures
- intermediate temperatures

- discharge pressure
- discharge temperature
- seal gas differential pressure, if the seal gas line is connected
- seal gas flow rate of the gas seal
- bearing oil pressure
- oil temperature downstream of oil cooler
- temperature at the bearing locations
- level at oil reservoirs.

Please refer to Section 9.13 “Signal list“ for the desired values.

In addition supervise the machine unit with regard to smooth operation, scraping noises as well as oil, gas and water leakages.

3.5 Supervision during operation

At regular intervals record all data not automatically compiled in writing. Make a note of deviations of single values in a report and investigate the causes. Carefully file issued reports for further reference, they are an essential basis for detecting any further defects. Refer to Section 3.7 “Compiling operation data“.

In addition supervise the machine unit with regard to smooth operation, scraping noises as well as oil, gas and water leakages.

Operating data which is determined for compressor safety are automatically monitored by limit sentries. Limit sentries give only an acoustic and optic alarm if manual intervention is possible after signal has been emitted and no immediate danger exists for the compressor. Limit sentries respond if immediate danger exists for the compressor, switch off the driving machine without any time lag. An optic and acoustic alarm is signaled upon shutdown.

Refer to Section 9.13 “Signal list” for limit values.

3.5.1 Operating and monitoring the lube oil system

Oil reservoir

Monitor the oil reservoir **SA-K-2911/21-T1** for sufficient oil filling. (Max. = 4850 l; min. = 4000 l)

Supply temperatures and pressures

Monitor supply temperatures and pressures and, if necessary, readjust by means of available control valves **29PCV102/152** and **29TCV103/153**.

Bearing temperatures and pressures

Monitor bearing temperatures (in the bearings) and bearing pressures (in the supply lines) and, if necessary, readjust the oil flow

- by means of control valve
- by means of adjustment butterfly valves/orifices in the supply lines

(Refer to Section 9.13 “Signal list“ for normal values).

Oil flow

Check the regular oil flow at the sightglasses or flow indicator in the oil drains.

Check, whether the following unit parts can be kept operationally warm by constant oil flow:

- oil cooler (air cooled)
- standby oil filter
- overhead tank
- overflow lines of switch 29PS105/155

Safety devices and control mechanisms

All safety devices and control mechanisms must be located in normal position.

Oil cycles

Eliminate all oil leakages in the oil cycles immediately, since oil contacting hot parts be a source for fire.

Use only foam or tetrachlorine carbon to extinguish any oil fires.

Differential pressure at oil filter

When differential pressure at oil filter **29PDI104/154** rises to 0.8 bar, switch over to the standby oil filter immediately and replace the filter element.

Oil temperature

At temperatures below + 50 °F = + 10 °C take heaters in operation.

3.5.2 Check automatic switching to auxiliary oil pump

Falling oil pressure

Prerequisite:

- main oil pump is in operation.
- auxiliary oil pump is switched to ”AUTOMATIC”.
- compressor may be in operation.

1. Slowly close shutoff valve in bypass line of pressure sentry **29PSL105/155** ahead of the orifice, until the corresponding pressure is decreased to 1.5 bar(g).
2. The auxiliary oil pump must automatically take over oil supply and provide the same pressure as the main oil pump at the switching point (refer to Section 9.13 ”Signal list“ regarding corresponding values.
3. After conducting a check bring all valves back into normal position, shut off the auxiliary oil pump by hand and subsequently set to ”AUTOMATIC”.

3.5.3 Oil checks

Refer to Section 8.7.1 “Lube oil requirements and recommendations“ regarding oil checks.

If necessary, oil can be replenished at any time by means of the filling nozzles.

3.6 Shutdown

3.6.1 Shutdown under normal circumstances

Brief instructions for startup and shutdown (also in case of disturbances in operation) has been compiled by both the user and the GHH BORSIG assembly or startup personnel upon initial startup. These brief instructions are positioned in the vicinity of the compressor where it cannot be overlooked. Shut down the compressor accordingly.

WARNING !
After switching off the compressor unit, maintain oil supply until the compressor unit is at a complete standstill.

WARNING !
When the compressor unit is switched off, maintain seal gas supply to seal off lube oil from the gas seal (if connection is provided) until the lube oil pressure following shutoff of the oil pumps drops to atmospheric pressure.

WARNING !
If long-term standstill was carried out, the compressor unit must be conserved, refer to Section 3.6.4 “Measures for conservation during long-term compressor standstill”.

DANGER !
If shutdown is carried out for reasons of assembly work on compressor casing, first close off compressor on the suction and discharge sides and purge from dangerous gases by conducting flushing procedure.
Danger to life!

Keep a written record every time the compressor unit is switched off, refer to Section 5.5 “User documentation for maintenance and repair”.

3.6.2 Shutdown of the lube oil system

After taking the compressor (if connection is provided) unit out of operation, the auxiliary oil pump must remain in operation.

The period during which the pump continues operation after being switched off depends on the cooling off period of the compressor unit, which is approx. 1/2 to 1 hours.

Hereby maintain constant oil temperature at approx. 35 - 45 °C.

- If necessary shut off the oil cooler (air cooled) and - if required - take the tank heater in operation.

In case of power failure of the main oil pump or auxiliary oil pump refer to Section 3.6.3 “Shutdown in cases of malfunctioning”.

The compressor on the gas side is sealed by the gas seal.

The cooler must be drained during pump and power failure.

3.6.3 Shutdown in cases of malfunctioning

A brief description for startup and shutdown (also in cases of malfunctioning) has been compiled by both the user and the GHH BORSIG assembly or startup personnel upon initial startup. This brief description is positioned in the vicinity of the compressor where it cannot be overlooked. Shut down the compressor accordingly.

In cases of extensive malfunctioning and great danger to the compressor unit, shut down the compressor unit immediately by using the emergency-off switch regardless of the load condition. (The overhead tank has additional provisions for coasting down in cases of emergency.)

WARNING !
If one of the automatic shutdown switches of the compressor unit responds, keep oil supply in operation until the compressor unit is at a complete standstill.

WARNING !
Maintain the seal gas supply to seal off the medium against the atmosphere, after the compressor unit is switched off, until the internal casing pressure drops to atmospheric pressure.

WARNING !
In case of malfunctioning of the gas seal or complete inoperability of the gas seal, a corresponding alarm is signaled, but the compressor is not automatically shut off. In addition refer to Section 10 “Documentation for subcontracted components“(10.4 “Gas seal and the gas sealing system“).

DANGER !
If assembly work on the compressor casing is necessary due to malfunctioning, first close off the compressor on the suction and discharge side and purge from dangerous gases by conducting flushing procedure.
Danger to life!

If the compressor unit switches off because the setting of the safety limit values has been exceeded, determine the cause and if necessary, carry out inspection, refer to Section 5.3 “Inspection”. The compressor unit may be taken back into operation when the cause for damage has been detected and eliminated.

A written record is to be made each time the compressor unit is switched off, regardless of whether this was carried out manually or automatically by the safety equipment. Refer to Section 5.5 “User documentation for maintenance and repair”.

3.6.4 Measures for conservation during long-term compressor standstill

The conservation measures for the subcontracted components of the compressor or the compressor unit are described in Chapter 10 “Documentation for subcontracted components“. They apply to:

- electric electric motor, Section 10.1 “Electric motor“
- couplings, Section 10.2 “Couplings“
- gear unit, Section 10.3 “Gear unit“
- lube oil system, Section 10.19 “Lube oil system“
- gas sealing system, Section 10.4 “Gas seal and the gas sealing system“.

1. Compressor standstill up to four weeks

No conservation measures are required for compressor standstill up to four weeks.

Maintain lube oil, seal gas and gas seal system in operation.

Take the following meaures on the process gas side:

WARNING !
The flange connections on the suction and the discharge side of the compressor may not be loosened!

- The compressor must be pressure relieved and the process gas line shut off. In addition please refer to operation manual of entire unit on the user’s site.

WARNING !
The process gas is highly corrosive!

- Flush the compressor with inert gas to remove the process gas from the inside of the compressor. In addition please refer to operation manual of entire unit on the user’s site.

Refer to renewed startup 3.1 “General information on startup”.

2. Compressor standstill between four weeks and six months

Compared with the measures for compressor standstill up to four weeks, take the lube oil, seal gas and gas seal system out of operation and examine the compressor and unit components for corrosion every six weeks.

Further measures necessary for the protection of the compressor depend on the ambient conditions at the time of compressor standstill (especially temperature and humidity). Please contact GHH BORSIG Service regarding further procedures and measures necessary for renewed startup. Refer to Section 1.5 “Service”.

! **WARNING !**
Be sure to follow the instructions of GHH BORSIG Service. Insufficient safety measures may lead to grave corrosion damages to the compressor unit!

External temperature changes of even 27 °C lead to changes in volume of approx. 10 % in one system.

Since in principle the lube oil systems are not sealed against gas, these volume changes cause breathing cycles whereby moisture enters the unit.
This moisture in connection with oxygen in the air may entail undesired corrosion.

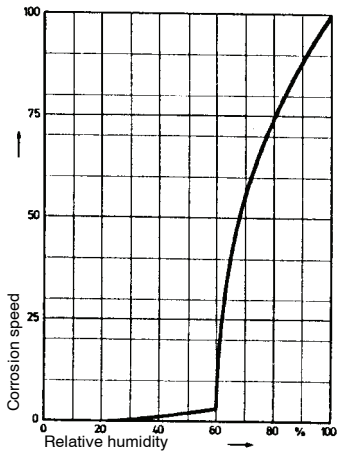


Illustration 13 Corrosion speed of steel depending on rel. humidity according to Vernon

Nitrogen or dry air flushing (dew point - 30 °C) of the system / compressor

Close off atmospheric shaft passages at gear unit, oil pumps and valve spindles with silicon caoutchouc or viscous grease.

Close off openings at tanks, etc.

Provide sealing between process gas connection and compressor with sealing plates (1mm). Install nitrogen supply and allow outlet to the venting of bearing housings to remain open.

Drying the breathing air

This procedure allows ventilation by temperature change via the filling nozzles at the tank. A tank filled with drying pearls is fastened onto this nozzle. This tank can also be a pipe piece with flange.

Flush unit with nitrogen.

All other openings to the atmosphere are carefully closed as described.

Checks

Check compressor and unit components every 6 weeks for signs of corrosion.

Check drying pearls at regular intervals to be determined and if necessary replace them.

Renewed startup

Prior to renewed startup carefully remove all means of corrosion protection applied to the compressor unit.

Refer to Section 3.1 “General information on startup” for renewed startup.

3. Compressor standstill over 6 months

In addition to the measures stated above the compressor rotor and the internals of the compressor must be conserved.

WARNING !
Lack of conservation may lead to grave damages to compressor unit!

During conservation measures of the process gas space no oil may contact the gas seals.

Consult GHH BORSIG Service regarding conservation work and renewed startup of the compressor unit! Refer to Sections 1.3 “Safety” and 1.5 “Service”.

DANGER !
For safety reasons assembly work (also for conservation or or conservation removal work) on compressor unit may be carried out by GHH BORSIG Service only!
Renewed startup may also be carried out by GHH BORSIG Service only!
Work improperly carried out may lead to damage or destruction of the compressor unit.
Danger to life of and risk of injury to maintenance and operating personnel!

3.7 Compiling operating data

All relevant operating values are compiled by the user with the aid of electronic data processing. The user must safeguard that the electronic processing equipment correctly compiles all values and signals deviating data to the operating personnel so that the procedures can be evaluated by a specialist immediately and if necessary remedial action can be initiated. Moreover, all operating data is stored by the electronic data processing system to enable the concrete operating situation to be reconstructed at a later date. This data shall be filed correctly for future reference.

4 Malfunctioning

4.1 Electric motor

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.1 “Electric motor”) regarding main driver.

4.2 Coupling 1

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.2 “Couplings“) regarding laminate steel coupling.

4.3 Gear unit

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.3 “Gear unit“) regarding forced shaft driven main oil pump.

4.4 Coupling 2

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.2 “Couplings“) regarding laminate steel coupling.

4.5 Compressor

4.5.1 Surging of the compressor

WARNING !
Surging of the compressor over a long period of time is not allowed. Immediately switch off the compressor after the first signs of surging.

Causes

- Compressor operates in instable operating range.
- Surge limit control is incorrectly set.

- Bypass or blowoff valve of surge limit control is jammed (caught).
- Bypass or blowoff valve of surge limit control is closed.
- Valve in the discharge line of the compressor is closed.
- No or insufficient consumption of the supplied flow. In case of parallel operation of several compressors and incompatibility of characteristic curves of the individual compressors, one compressor is perhaps not running within a stable range under certain operating conditions.

Remedies

- Check surge limit control consisting of valve, controller, impulse switch and electrical equipment.
- Check valve position of surge limit control in bypass or blowoff discharge line and open.
- Connect consumer.

The following damage can occur

- Radial vibrations arising from the uneven operation of the compressor rotor can cause radial bearing damage.
- Abrupt changes in the direction of compressor rotor thrust can cause axial bearing damage.
- Heavy surge shocks may cause rubbing of sealing strips.
- When discharge temperature increases greatly, the shrinkage of the impellers on the shaft is reduced and the cylindrical pins in the impellers are subject to increased load. Shaft distortion may be the result.
- Speed variations by periodic unloading of the compressor.
- Alternating load on couplings and gear unit. Rupture of the coupling may possibly arise.
- If motor-operated, motor base attachment subject to alternating load.
- Excitation to piping vibrations and foundation vibrations.
- Changes in alignment due to fixed points subject to overload.

4.5.2 Discharge temperature too high

Causes

- Compressor suctions in gas which is too warm.
- Bypass valve (surge limit control) open.
- No sufficient cooling in aftercooler, intermediate cooler or condenser.

Remedies

- Check cooling air.
- Examine whether bypass valve has to be open; check surge limit control.

The following damage can occur

- Due to excessive temperature in gas flow of the compressor, damage to the impellers may arise as a result of the reduction in material strength. The shrinkage of the impellers on the shaft is reduced and the cylindrical pins in the impellers subject to higher load. Shaft distortion may be the result.

4.5.3 Reversing direction of rotation (backward run)

Causes

- Gas expansion following shutdown of the compressor. Compressor thus acts as driver and rotates backward.
- Swing check valves or gate valves in gas line or non-return elements have failed.

Remedy

- Check and repair swing check valves or gate valves and non-return elements.

The following damage can occur

- In certain cases the compressor can be accelerated over design speed by gas expansion. This can lead to destruction of the entire shaft train.
- Gas thrust may arise during gas expansion. This can lead to destruction of the axial bearing.

- The temperature level of the impellers is increased, because the hot gases from the discharge side of the compressor flows through all impeller stages (with only slight cooling); consequently, decreasing impeller shrinkage. This can loosen the impellers from the shaft and thus lead to imbalance vibrations and bearing damage.
- Damage at axial bearing, because the pad function depends on the direction.

4.5.4 Axial displacement of the compressor rotor

Causes

- The axial thrust is too high.
- The oil supply of the axial bearing is impaired.
- The compressor surges, which can cause the oil film of the axial bearing pads to be briefly interrupted due to the abrupt increase of axial bearing load.

i NOTICE
The axial thrust resulting from the different surfaces of the impellers is equalized with the aid of the balance pistons. Under extreme changes in pressure ratio, due to a change in suction conditions or speed, however, the axial thrust can be changed.

Remedies

- Check pressure conditions (suction and discharge pressure).
- Check temperature at axial bearing and oil return in sight glass.
- Check position of bypass valve (surge limit control).
- In each case, check the axial bearing prior to restart of the compressor.

The following damage can occur:

- Damages to axial bearing.
- Axial rubbing of the impellers and sealing strips.
- Unallowable axial displacement of the coupling hubs – coupling damage.

4.5.5 Uneven run of the compressor rotor

Causes

- Surging of the compressor.
- Loose seat of the bearing.
- Incorrect bearing clearance.
- Change in alignment.
- Foundation excitation.
- Piping vibrations.
- Distorted compressor rotor (due to thermal influences).
- Imbalance of compressor rotor.

Remedy

- GHH BORSIG should be informed by all means, because defects may exist which can only be detected and eliminated by specialists.

The following damage can occur:

- Damages to radial bearing.
- Damages to axial bearing.
- Rubbing of sealing strips.

4.5.6 Bearing oil pressure too low

Causes

- Oil level in oil reservoir is too low, pumps suction in air.
- Defective main and auxiliary oil pumps.
- Fouled oil filter, differential pressure at indicator too high (normal 0.3 bar, max. 0.8 bar).
- Drain or vent oil cooler (oil cooled) or open oil filter.
- Control valve jammed in open position or bypass is open.
- Extremely large consumption due to damaged bearing locations.

Remedies

- Examine oil system beginning at oil reservoir.
- Check temperature, pressure and flow through the bearings. If there is a change compared with the normal values, eg. the pressure downstream of adjusting orifice has decreased, temperature increased, the machine unit must be shut down immediately if readjustment does not bring about improvement or the temperature has increased greatly.

The following damage can occur:

- If bearing oil pressure is too low, cooling and lubrication of the bearings is no longer sufficiently safeguarded. Heavy damages to compressor rotor may be the result.

4.5.7 Bearing temperature too high

Causes

- Oil level in oil reservoir too low, refer to Section 4.6.1.
- Bearing oil pressure too low, refer to Section 4.5.6.
- Oil temperature downstream of oil cooler too high, refer to Section 4.6.2.
- Bearing damage due to fouling.
- Bearing clearance too small.

Remedy

- Check the bearing clearances and if necessary replace bearing. Consult GHH BORSIG Service.

The following damages can occur:

- Damages to bearings.
- Rubbing of compressor rotor.
- Damage to machine.
- Premature aging of oil.

4.5.8 Shaft seal of the compressor rotor

Not connected!

1 Pressure of seal gas too low

Causes

- Supplied amount of seal gas too low
- Control valve of seal gas defective or incorrectly adjusted
- Indication instrument defective
- Measuring line clogged; sealed off
- Clearance of sealing strips has become enlarged

Remedies

- Adjust larger amount of seal gas
- Check indication instrument; replace
- Blow down measuring line (only if gas type allows)
- Insert new sealing strips

The following damages can occur:

- Detrimental gases can break through if seal gas pressure is not provided

2 Pressure of seal gas too high

Causes

- Supplied amount of seal gas too high
- Control valve of seal gas defective or incorrectly adjusted
- Indication instrument defective
- Measuring line defective, incorrectly connected

Remedies

- Decrease seal gas pressure; readjust control valve of seal gas

The following damages can occur:

- Consumption of seal gas too high

Not connected!

3 Chamber pressure of seal gas of the shaft seal on oil side too low

Causes

- Control valve of seal gas defective or incorrectly adjusted
- Indication instrument defective
- Measuring line defective, incorrectly connected

Remedy

- Increase pressure of seal gas; readjust control valve of seal gas

In addition please refer to Chapter 10 „Documentation for subcontracted components“ (Section 10.4 “Gas seal and gas sealing system“)

4 Amount of clean gas too low

Causes

- Pressure of clean gas too low
- Control valve of clean gas defective or incorrectly adjusted
- Filter of clean gas clogged
- Indication instrument defective
- (Not connected) Seal gas chamber pressure of labyrinth seal too high

Remedies

- Adjust larger clean gas pressure
- Change over to unfouled clean gas filter or replace filter
- Check seal gas chamber pressure of labyrinth seal, readjust
- Check indication instrument; replace

The following damage can occur:

- If the amount of clean gas is not sufficient, detrimental gases can enter and damage the gas seal, eg. due to dirt, and even cause failure of the gas seal.

5 Pressure of clean gas too low and clean gas differential pressure to flare pressure too low, reversing pressure

Causes

- Seal gas chamber pressure of labyrinth seal too low
- Control valve of seal gas defective or incorrectly adjusted
- Indication instrument defective
- Measuring line clogged; sealed off
- Clearance of labyrinth seal strips has become enlarged
- Pressure in flare line too high (amount of supplied clean gas too low)

Remedies

- Check seal gas chamber pressure of labyrinth seal; readjust
- Check indication instruments; replace
- Blow down measuring line (only if kind of gas allows)
- Install new sealing strips (adjust larger amount of clean gas)
- Check flare line

The following damage can occur:

- Reversing pressure under static conditions leads to an increase in static leakage. Under dynamic conditions the reversing pressure can lead to extensive damage to the gas seal

6 Seal gas chamber pressure of the labyrinth seal too high

Causes

- Control valve of seal gas defective or incorrectly adjusted
- Indication instrument defective

- Measuring line defective, incorrectly connected.

Remedy

- Reduce pressure of seal gas; readjust control valve of seal gas/seal air.

The following damages can occur:

- Consumption of seal gas too large.
- If seal gas chamber pressure is too high, detrimental gases can enter and damage the gas seal, eg. due to dirt, and even cause failure of the gas seal.

7 Reverse in direction of rotation (backward run)

Causes

- Gas expansion following shutdown of the compressor
- Compressor thus acts as driver and rotates backward
- Swing check valves or gate valves in gas line or nonreturn elements have failed

Remedy

- Check and repair swing check valves or gate valves and nonreturn elements

The following damage may occur:

- Gas seal is not suited for backward run; this may lead to total failure of gas seals

4.6 Malfunctioning of the oil system

4.6.1 Oil level in oil reservoir too low

Cause

- Leakage in oil system

Remedies

- Check oil supply unit for leakage
- Replenish with oil

- Use only oil of the same grade for replenishing

The following damage can occur:

- Malfunctioning in oil supply leads to consequential damages to the bearing of the compressor or to mechanical malfunctioning of the pumps

4.6.2 Oil temperature downstream of the oil cooler (air-cooled) too high

Causes

- Fouled oil cooler
- Fan defective
- Check this condition in units with temperature controler

Remedies

- Check oil cooler
- Check fan
- Set controler to different desired values and observe function

The following damages may occur:

- Bearing damages
- Rubbing of compressor rotor
- Damage to the compressor
- Premature aging of oil

4.6.3 Auxiliary oil pump does not start automatically if oil pressure drops

(Refer to Section 9.13 “Signal list“ regarding switching and setting values)

Causes:

- Operating voltage or control voltage for motor missing
- Malfunctioning in the electric section of the pump automatics

4.6.4 Oil pumps operate poorly

Causes:

- Nonreturn valves in the pressure lines jam
- Pumps and lines not vented
- Coupling damaged
- Blowoff pressure of safety valve of the oil pumps set too low, (Refer to Section 9.13 “Signal list“ regarding switching and setting values)

4.6.5 Oil pressure drops

Causes:

- Mechanical malfunctioning of the pumps; check pump sounds, only a slight rustling sound may be heard; check temperature of the pumps; the poorer the supply, the higher the heating up
- Leakage loss in the oil lines or their valves
- Fouled oil cooler or oil filter
- Fouled suction screen
- Oil pressure control valve jammed in open or closed position
- Extensive oil consumption in the bearings of the compressor unit

4.7 Gas sealing system

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.4 “Gas seal and gas sealing system”).

The possibility of seal gas supply is provided. The connections at the casing covers are blanked off by flanges.

The shaft seal on oil side (2261.5 and 2261.6) is impinged with seal gas and thus prevents oil from the bearings entering and destroying the gas seal.

5 Maintenance, inspection

5.1 Oil change

Refer to Section 8.7.1 “Lube oil requirements and recommendations“ regarding oil change.

5.2 Maintenance

5.2.1 Maintenance intervals and maintenance work

Maintenance intervals and maintenance work for the subcontracted components of the compressor unit are specified in Chapter 10 “Documentation for subcontracted components“. They comprise:

- electric motor, Section 10.1 “Electric motor“
- couplings, Section 10.2 “Couplings“
- gear unit, Section 10.3 “Gear unit“
- lube oil system, Section 10.19 “Lube oil system“
- gas sealing system, Section 10.4 “Gas seal and gas sealing system“.

GHH BORSIG differentiates between “Maintenance work following general startup”, “Maintenance work during operation” and “Inspection”.

The maintenance intervals stated by GHH BORSIG are recommendations and because of the interruptions in operation “Maintenance work following general startup” and ”Inspection” are conducted at the discretion of the user.

5.2.2 Maintenance work following general startup

Maintenance work for subcontracted components of the compressor unit is specified in Chapter 10 “Documentation for subcontracted components“. It comprises:

- electric motor, Section 10.1 “Electric motor“
- couplings, Section 10.2 “Couplings“
- gear unit, Section 10.3 “Gear unit“
- lube oil system, Section 10.19 “Lube oil system“
- gas sealing system, Section 10.4 “Gas seal and gas sealing system“.

Work which is carried out annually on the compressor comprises:

- visual inspection of axial bearing and radial bearing of the compressor,
- checking compressor alignment,
- checking safety devices and circuits for alarm and trip.

5.2.3 Maintenance work during operation

Maintenance work for the subcontracted components of the compressor unit is specified in Chapter 10 “Documentation for subcontracted components“. It comprises:

- electric motor, Section 10.1 “Electric motor“
- couplings, Section 10.2 “Couplings“
- gear unit, Section 10.3 “Gear unit“
- lube oil system, Section 10.19 “Lube oil system“
- gas sealing system, Section 10.4 “Gas seal and gas sealing system“.

Check compressor quarterly for:

- running behavior, compare data with that stated under ”Compiling operation data“
- bearing temperatures, compare data with that stated under “Compiling operation data“ at similar point of operation
- operating values of the compressor regarding degree of efficiency.

5.3 Inspection

DANGER !
For safety reasons inspection, repair and replacement work on the compressor train may be carried out by GHH BORSIG Service personnel only!
Work which is improperly carried out may lead to damage or destruction of the compressor unit.
Risk of injury or danger to life of the maintenance and operating personnel!
Contact GHH BORSIG Service regarding inspection work!
Refer to Sections 1.3 “Safety” and 1.5 “Service”!

Inspection of the subcontracted components of the compressor unit is specified in Chapter 10 “Documentation for subcontracted components“. It comprises:

- electric motor, Section 10.1 “Electric motor“
- couplings, Section 10.2 “Couplings“
- gear unit, Section 10.3 “Gear unit“
- lube oil system, Section 10.19 “Lube oil system“
- gas sealing system, Section 10.4 “Gas seal and gas sealing system“.

It is recommended to have the inspection work on the compressor carried out by a specialist of GHH BORSIG.

It is necessary to procure new O-rings, round sealing material, gaskets and sealing tapes prior to inspection.

GHH BORSIG recommends having the following inspection work on compressor carried out by GHH BORSIG specialists every 2 to 3 years.

Check the leakage integrity of the compressor casing/compressor casing cover to connections (4.21), refer to Section 2.6.8 “Compressor casing”, at compressor casing by measuring pressure.

If the compressor is still in operation, clock the coasting down time with a stop watch. This provides information on the mechanical condition of the compressor.

Uncover compressor, check bearing and sealing strip clearances.

Conduct dye penetration testing on the impellers.

Clean and conduct balance check on the compressor rotor.

During all inspections of machines for compressing media which is strongly corrosive as well as media containing solid matter, remove all internals, clean fitting seats and groove guides.

Check O-rings for damage, eg. cracks, hardening, swelling etc. If damage is detected, material of another quality might have to be used.

Replace O-rings, round sealing material, gasket and sealing strips of the compressor casing parting joint entirely during each inspection.

Check sealing areas at compressor for damages.

Check and if necessary correct alignment of electric motor / gear unit and gear unit / compressor.

Check instruments measuring flow and pressure, if necessary recalibrate.

Check safety devices.

5.4 Repair and replacement work

DANGER !
For safety reasons have inspection, repair and replacement work on the compressor train carried out by GHH BORSIG Service personnel only!
Work which is improperly carried out may lead to damage or destruction of the compressor unit.
Danger to life of and risk of injury to the maintenance and operating personnel!
Contact GHH BORSIG Service regarding inspection work!
Refer to Sections 1.3 "Safety" and 1.5 "Service".

5.5 User documentation for maintenance and repair

The user is obliged, to prepare a precise report on all maintenance and repair work.

Record at least the following data during each maintenance and repair:

1. Date and time of work.
2. Name of all persons participating in the performance of work.
3. Designation of the plant part subject to work.
4. Exact designation of the component parts concerned:
   - All parts which were replaced or machined.
   - All parts which were additionally removed and re-installed.
   - All parts which were affected by the work (any possible damages).
5. Report on the extent of work carried out.
6. If necessary, additional comments.

5.5.1 Assembly report for coupling hubs

(Please refer to Section 8.5.4 “Clearances”)
The coupling between electric motor / gear unit and gear unit / compressor

Record sheet

During each assembly of the coupling hub register and record:

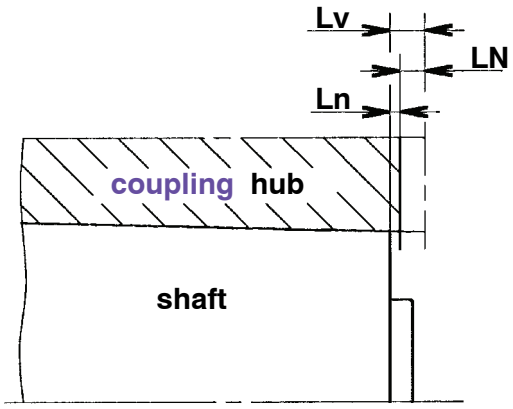


Illustration 14 Axial displacement

Dimension Lv (before)	=	..... mm
Dimension Ln (after)	=	..... mm
Difference=coupling hub onset size	LN	..... mm

Oil pressures (reading as accurate as possible)

Applied joint pressure at reducer

upon shrinkfit	Pk	=	..... bar
upon removing shrinkfit (Pk+400 bar)	Pk	=	..... bar

Oil pressure at hydraulic nut

upon shrinkfit	P	=	..... bar

6 Transport, handling and storage

6.1 Handling

6.1.1 Regulations for handling unpacked compressor unit

DANGER !
The lifting devices and fastening tackle must be suitable for carrying corresponding weight.
Danger to life if compressor unit falls down!

Weight of the compressor unit: approx. 63,000 kg complete with base frame.

The attachment points and the center of gravity are marked in the drawing.

Apply the fastening tackle as the drawing shows.

Use the fastening tackle or the traverse to balance out the center of gravity.

DANGER !
The compressor unit must by all means be lifted horizontally.
Danger to life if the compressor unit falls down or over!

First lift the compressor unit a few cm and check whether the compressor unit is suspended absolutely horizontally. If at a slant, lower compressor and balance out the center of gravity once again.

Only lift the compressor unit as high and as long as necessary.

Lower base frame on a level surface only.

Lifting device and fastening tackle are not part of the GHH BORSIG scope of supply.

Illustration 15 Handling the compressor unit

Please refer to Chapter 9 “Drawings and lists” , Index 10 “Handling instruction”.

6.1.2 Handling the electric motor

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.1 “Electric motor”) regarding handling the electric motor if necesssary to disassemble from base frame.

6.1.3 Handling the gear unit

Refer to Chapter 10 “Documentation for subcontracted components“ (10.3 “Gear unit“) regarding handling the gear unit, if necessary to disassemble from base frame.

6.1.4 Handling the compressor

DANGER !
For safety reasons maintenance work on the compressor train may be carried out by GHH BORSIG Service personnel only!
Work which has not been carried out properly can lead to damage or destruction of the machine unit.
Risk of injury and danger to life of the assembly and operating personnel!
Contact the GHH BORSIG Service regarding any assembly work!
Refer to Section 1.3 “Safety” and 1.5 “Service”.

6.2 Storage and conservation

6.2.1 Storage and conservation of unpacked compressor unit

Storage for max. 12 months (please refer to Section 6.2.2 - 6.2.5)

6.2.2 Storage and conservation of unpacked motor

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.1 “Electric motor”).

6.2.3 Storage and conservation of gear unit

Refer to Chapter 10 “Documentation for subcontracted components“ (10.3 “Gear unit“) regarding gear unit.

6.2.4 Storage and conservation of compressor

General

Upon delivery check the packing of compressor unit for damage, flaws must be corrected.

In addition refer to ”Conservation and inspection” farther below in this section.

Storage

NOTICE
The shipping crate of the compressor must be protected against rain and direct sun radiation and stored in the position marked.
If stored in the open air, the ground must be thoroughly removed of moisture because of the weight of the compressor. The shipping crate may not be stored directly on the ground, it must rest on supports (e.g. wooden beams).

In addition observe the following concerning storage of the shipping crate of the compressor:

- The storage location must be safely protected against rain, clean, well ventillated and free of corrosive vapors.
- The shipping crate must be covered with a permanently secured covering.
- It shall not be exposed to mold, insects and rodents.
- It shall be stored so that it is protected against mechanical damage.
- It shall be stored in a location enabling access at any time to inspect conservation.
- It should be stored in a location enabling access by a crane.

Conservation and inspections

The compressor treated with conservation agent, refer to Section 6.3.3 “Conservation agent for compressor“, is welded air tight in aluminum compound foil, drying pearls added and then packed in a shipping crate together with driving motor and gear unit on the original base frame.

An indicator is inserted in the aluminum compound foil; it is visible through the opening in the shipping crate so that conservation can be inspected.

Depending on the storage location and the air humidity, however, at least every 4 weeks, the indicator should be checked for change in color. The color of the indicator changes from blue to pink if humidity exists in the aluminum compound foil.

If the indicator has changed color, the conservation of the compressor must be inspected:

1. Open shipping crate, remove aluminum compound foil and bags with drying pearls from compressor.
2. Inspect conservation of the compressor. Should any work to correct flaws in the conservation of the compressor be necessary, refer to Section 6.3.3 “Conservation agent for compressor“.
3. Attach new bags with drying pearls to compressor.

NOTICE
If re-conservation of the compressor is necessary, the conservation agent first has to be thoroughly dried before the bags with drying pearls can be attached. The drying pearls should be replaced during dry weather only.

4. Weld the compressor air tight (e.g. using a vacuum cleaner), with a new indicator attached at an easily visible location on the closed shipping crate, in new aluminum compound foil once again.
5. Close shipping crate once again.

6.2.5 Storage and conservation of the gas sealing system

1. General

Upon delivery check the packing of the gas sealing system for damage, flaws must be corrected.

In addition refer to ”Conservation and inspection” farther below in this section.

2. Storage

NOTICE
The shipping crate of the gas sealing system must be protected against rain and direct sun radiation and stored in the position marked.
If stored in the open air, the ground must be thoroughly removed of moisture because of the weight of the gas sealing system. The shipping crate may not be stored directly on the ground, it must rest on supports (e.g. wooden beams).

In addition observe the following concerning storage of the shipping crate of the gas sealing system:

- The storage location must be safely protected against rain, clean, well ventillated and free of corrosive vapors.

- The shipping crate must be covered with a permanently secured covering.
- It shall not be exposed to mold, insects and rodents.
- It shall be stored so that it is protected against mechanical damage.
- t shall be stored in a location enabling access at any time to inspect conservation.
- It should be stored in a location enabling access by a crane.

3. Conservation and inspections

The gas sealing system not treated with conservation agent is welded air tight in aluminum compound foil, drying pearls added and then packed in a shipping crate.

An indicator is inserted in the aluminum compound foil; it is visible through the opening in the shipping crate for inspections of the packing.

Depending on the storage location and the air humidity, however, at least every 4 weeks, the indicator should be checked for change in color. The color of the indicator changes from blue to pink if humidity exists in the aluminum compound foil.

If the indicator has changed color, the packing of the gas sealing system must be renewed.

3.1 Open shipping crate, remove aluminum compound foil and bags with drying pearls from gas sealing system.

3.2 Attach new bags with drying pearls to gas sealing system.

i NOTICE
The drying pearls should be replaced during dry weather only.

3.3 Weld the gas sealing system air tight (e.g. using a vacuum cleaner), with a new indicator attached at an easily visible location on the closed shipping crate, in new alumininum compound foil once again.

3.4 Close shipping crate once again.

6.3 Conservation agent

6.3.1 Conservation agent for motor

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.1 “Electric motor”).

6.3.2 Conservation agent for gear unit

Refer to Chapter 10 „Documentation for subcontracted components“ (Section 10.3 “Gear unit“).

6.3.3 Conservation agent for compressor

WARNING !
The gas seals and the corresponding shaft areas may by no means be conserved and also may not come into contact with conservation agent.

Conservation agent

- For internals with installed compressor rotor SHELL ENSIS FLUID F
- For removed compressor rotor or standby rotor:

Bearing, shaft seal and coupling stem areas of the compressor rotor, as well as external surfaces of the impellers	TECTYL 506, manufactured by Valvoline
Blades of the impellers	SHELL ENSIS FLUID F

Duration of conservation agent protection according to specification

- SHELL ENSIS FLUID F: If stored indooors, 6 months.
- TECTYL 506: 12 to 18 months outdoors.
  With 2 coats up to 3 years under shelter.
  For long tropical protection at least 3 coats are necessary.

Removing the conservation agent

Corrosion protection must be removed entirely.

- SHELL ENSIS FLUID F: can be removed with test benzene, petroleum or halogenated hydrocarbons.
- TECTYL 506: with petroleum or chlorothene NU (if necessary, heat to 30 °C).

6.3.4 Conservation agent for gas sealing system

Gas seal

WARNING !
The gas seal installed in the compressor and the corresponding shaft areas may by no means be conserved and also may not come into contact with conservation agent.

Gas sealing system

The gas sealing system is welded air tight in aluminum compound foils and not treated with conservation agent, refer to Section 6.2.5 “ Storage and conservation of the gas sealing system”.

7 Assembly

DANGER !
For safety reasons the work on initial assembly of the compressor unit described in this chapter may be carried out
- only under instructions given by GHH BORSIG Service
- only by qualified personnel!
Strictly adhere to the instructions of the GHH BORSIG Service!
Work which is not properly carried out can lead to damage to or destruction of the compressor unit.
Danger to life of and risk of injury to assembly and operating personnel!
Refer to Sections 1.3 "Safety" and 1.5 "Service".

NOTICE
GHH BORSIG is not liable for any damages which arose during the assembly and the initial startup of the compressor if this work was not carried out or supervised by GHH BORSIG Service personnel.

7.1 Unpacking and removing conservation

7.1.1 Unpacking and removing conservation of the compressor unit

Please refer to Section 7.1.2 - 7.1.5.

7.1.2 Unpacking and removing conservation of the motor

Refer to Chapter 10 "Documentation for subcontracted components" (Section 10.1 "Electric motor").

7.1.3 Unpacking and removing conservation of gear unit

Unpacking and removing conservation of gear unit refer to Chapter 10 „Documentation for subcontracted components" (Section 10.3 "Gear unit").

7.1.4 Unpacking and removing conservation of compressor

DANGER !
For safety reasons assembly work on compressor may be carried out by GHH BORSIG Service personnel only.

Danger to the operating personnel if assembly work is improperly carried out!
Danger of injury!
Danger if heavy compressor parts fall down!
Danger arising from rotating compressor parts!
Danger to life!

WARNING !
Conservation of bearings, compressor rotor and internal parts of compressor may be removed by GHH BORSIG Service personnel only.
If assembly work which has not been authorized by GHH BORSIG is carried out, this results in loss of guarantee and may result in grave damages to the compressor.

Refer to Section 6.3.3 “Conservation agent for compressor“ regarding the conservation agent used.

7.1.5 Unpacking and removing conservation of gas sealing system

Refer to Section 6.3.4 “Conservation agent for gas sealing system” and Chapter 10 “Documentation for subcontracted components” (Section 10.4 ”Gas seal and gas sealing system”) regarding conservation agent used and removing the conservation agent.

- Open shipping crate.
- Remove aluminum compound foil, indicator and bag with drying pearls.
- Remove conservation from gas sealing system.

7.2 Foundation

Refer to Section 9.6 “Foundation plan“ regarding loads and securements.

The foundations shall be designed so that no signs of resonance can arise at the prevailing operating speeds. The guarantee for stability, unobjectionable vibration behavior and strength must be carried by the company performing foundation work.

Normal concrete is not suitable as grouting material. A special grouting material which is resistant against pressure, impacts and vibrations, does not shrink, disintegrate and is resistant against oil and water shall be used. It should fill out cavities well and bind quickly at sufficient processing time. The grouting must have a high degree of adhesive strength to both the foundation and the steel parts to be grouted.

7.3 Erection and alignment

In addition please refer to Section 10 “Documentation for subcontracted components“ (electric motor, gear unit and couplings) as well as all previous sections under Chapter 7 “Assembly“.

Alignment of the compressor unit (electric motor/gear unit/compressor) is carried out according to the Alignment diagram in which the various displacements of the shafts due to different heat expansions of the casing at operating temperature have been taken into consideration.

WARNING !
Prior to alignment remove the transport protection on the machine unit, inaddition refer to Section 7.4.3 “Removal of transport protection of compressor“ and Chapter 10 “Documentation for subcontracted components“ (electric motor, gear unit and couplings).

The base frame must be entirely lined and the anchor bolts tighten before final grouting of the base frame from the compressor unit.

Alignment of the compressor

In addition refer to the following drawing

1. Vertical alignment of the compressor

1.1 Loosen or remove bolts (5) with washers (4) and distance sleeves (7).

1.2 Tighten lifting bolts (3) in the compressor casing lugs (1).

1.3 Turn the lifting bolts (3) to lift the compressor and align vertically.

1.4 If necessary position shims (2) with corresponding thickness under the compressor casing lugs (1). Refer to Section 7.3.3 “Assembly parts for compressor“ regarding shims.

1.5 Locate lug bolts (5) with washers (4), centering collar showing upward, and distance sleeves (7) (if removed) in the compressor casing lugs (1), but do not bolt tightly to the base frame.

NOTICE
The distance sleeves (7) must protrude over compressor casing lugs (1) with the clearance of (6). Refer to Section 7.4.3 “Removal of transport protection of compressor“ regarding clearance.

1.6 If necessary align horizontally (refer to Point 2).

1.7 Firmly tighten lug bolts (5).

1.8 Lifting bolts (3) can be removed.

2. Horizontal alignment

2.1 Loosen lug bolts (5) if firmly tightened.

2.2 Assemble thrust pads (8) with lifting bolts (9) to the base frame (10) as illustrated.

2.3 Align the compressor horizontally by turning the lifting bolt (9) at the thrust pads (8).

2.4 Firmly tighten lug bolts (5).

2.5 Thrust pads (8) with lifting bolts (9) can be removed.

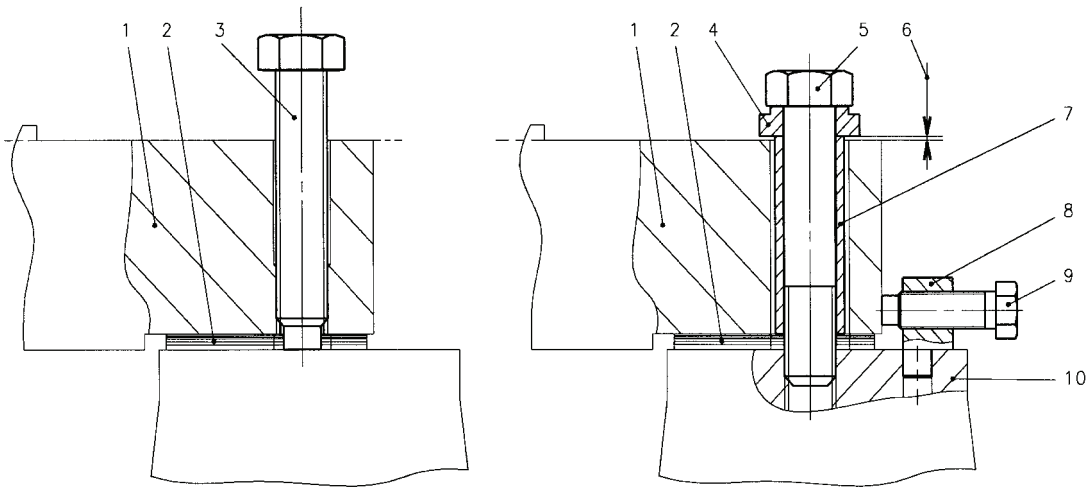


Illustration 16 Alignment of the compressor

7.3.1 Assembly parts for motor

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.1 “Electric motor”).

7.3.2 Assembly parts for gear unit

Quantity	Designation
8	stud bolt M30 x 170 for fastening gear unit
8	washer B31 for fastening gear unit
8	hex bolt M30
2	fitting key 30mg x 40 x60 for axial fixation of gear unit
2	fitting key 30mg x 20.5 x 105 for lateral fixation of gear unit
2	shims 60 x 912 x 3.2 mm (Illustration 17 / Illustration 18) consisting of layer sheets 0.05 mm thick for alignment of the gear unit
2	shims 60 x 752 x 3.2 mm (Illustration 17 / Illustration 18) consisting of layer sheets 0.05 mm thick for alignment of the gear unit
4	shims 60 x 205 x 3.2 mm (Illustration 17 / Illustration 18) consisting of layer sheets 0.05 mm thick for alignment of the gear unit
2	shims 60 x 912 x 3.2 mm (Illustration 17 / Illustration 18) consisting of layer sheets 1 mm thick for alignment of the gear unit
2	shims 60 x 752 x 3.2 mm (Illustration 17 / Illustration 18) consisting of layer sheets 1 mm thick for alignment of the gear unit
4	shims 60 x 205 x 3.2 mm (Illustration 17 / Illustration 18) consisting of layer sheets 1 mm thick for alignment of the gear unit
2	shims 60 x 912 x 3.2 mm (Illustration 17 / Illustration 18) consisting of layer sheets 2 mm thick for alignment of the gear unit
2	shims 60 x 752 x 3.2 mm (Illustration 17 / Illustration 18) consisting of layer sheets 2 mm thick for alignment of the gear unit
4	shims 60 x 205 x 3.2 mm (Illustration 17 / Illustration 18) consisting of layer sheets 2 mm thick for alignment of the gear unit

2	shims 60 x 912 x 1.6 mm (Illustration 17 / Illustration 18) consisting of layer sheets 0.05 mm thick for alignment of the gear unit Only for realignment by customer, if neccessary. Are supplied loosely as standby parts for assembly on job site.
2	shims 60 x 752 x 1.6 mm (Illustration 17 / Illustration 18) consisting of layer sheets 0.05 mm thick for alignment of the gear unit Only for realignment by customer, if neccessary. Are supplied loosely as standby parts for assembly on job site.
4	shims 60 x 205 x 1.6 mm (Illustration 17 / Illustration 18) consisting of layer sheets 0.05 mm thick for alignment of the gear unit Only for realignment by customer, if neccessary. Are supplied loosely as standby parts for assembly on job site.

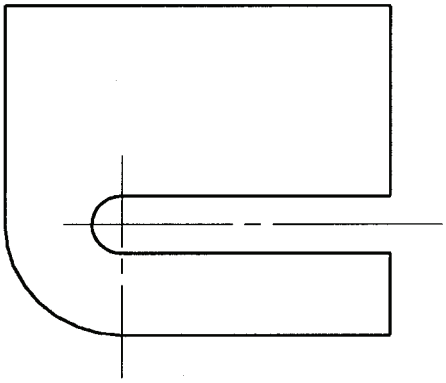


Illustration 17 Assembly parts for gear unit

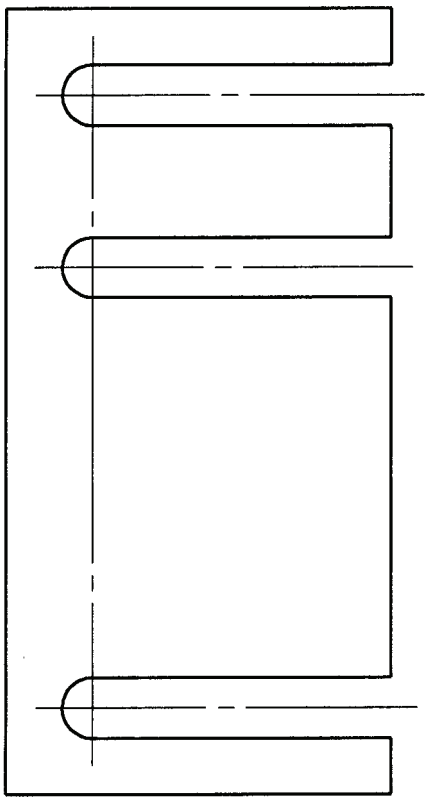


Illustration 18 Assembly parts for gear unit

7.3.3 Assembly parts for compressor

Quantity	Designation
1	Locking bolt G 1 for bearing housing cover
4	Distance sleeve dia. 48.3 / dia. 36.5 (Illustration 19) for compressor casing lugs
4	Hex bolts M 36 x 180 for compressor casing lugs
4	Washer dia.70 / dia. 36.5 x 17 mm (Illustration 19) for compressor casing lugs
4	Shim 160 x 100 x 1.6 mm (Illustration 19) consisting of layer sheets 0.05 mm thick for alignment of the compressor With dia. 40 mm bore Only for realignment on customer's premises, if neccessary. Are supplied loosely as standby parts for assembly on job site.
4	Shim 160 x 100 x 1 mm (Illustration 19) for alignment of the compressor With dia. 40 mm bore
4	Shim160 x100 x 2 mm (Illustration 19) for alignment of the compressor With dia. 40 mm bore
4	Shim 160 x 100 x 3,2 mm (Illustration 19) consisting of layer sheets 0.05 mm thick for wedge guide on the fixed point side With dia. 40 mm bore

Illustration 19.1

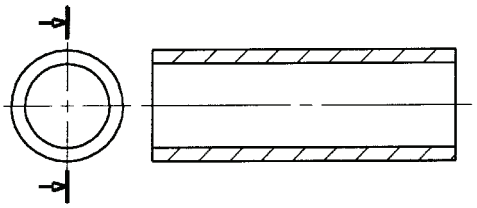


Illustration 19.2

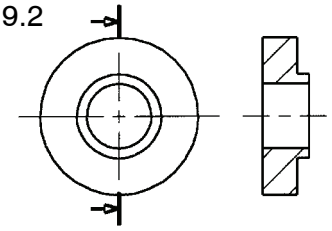


Illustration 19.3

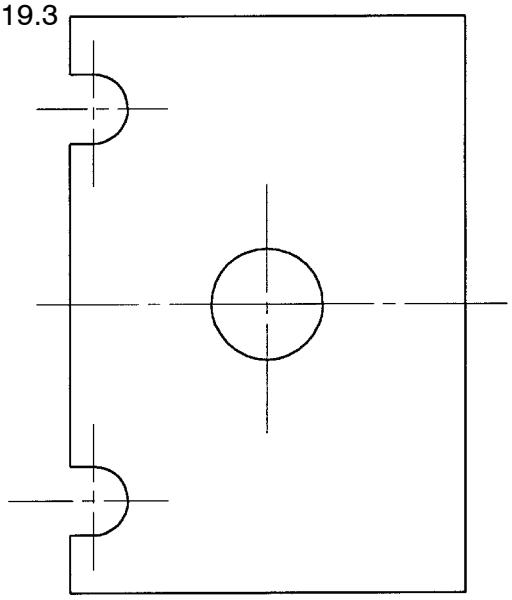


Illustration 19 Assembly parts for compressor

7.4 Transport protection

7.4.1 Removal of transport protection of motor

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.1 “Electric motor”).

7.4.2 Removal of transport protection of gear unit

Refer to Chapter 10 „Documentation for subcontracted components” (Section 10.3 “Gear unit“).

7.4.3 Removal of transport protection of compressor

1. Compressor

For compressor transport, tightly bolt the lugs of the compressor casing (1) to the base frame (5) using bolts (3) and washers (2).

The centering collar of the washers (2) center the bolts (3) in the lug bores and hold the compressor casing (1) into place, refer to Illustration 20.1.

WARNING !
Prior to compressor startup install the distance sleeve (7) and turn the washer (2) so that the centering collar is located below the bolt head, refer to Illustration 20.2. Firmly tighten bolt leaving a clearance (6) of 0.05 to 0.10 mm between washer (2) and

compressor casing lug (1), refer to Illustration 20.2.
Do not remove the shims (4) during this procedure.

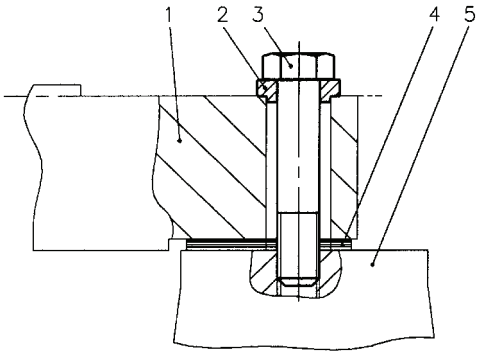


Illustration 20.1

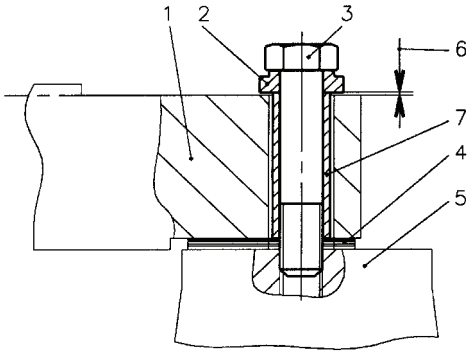


Illustration 20.2

Illustration 20 Transport protection

2. Compressor rotor

For compressor transport radially secure the installed compressor rotor with fixed radial bearings. Axial fixation is carried out on the axial side. For this purpose a threaded rod is bolted into the rotor bore and secured with a counter nut. The other end of the threaded rod is axially fixed and locked on both sides of the bearing housing cover by means of washers and counter nuts.

i NOTICE
Prior to startup remove polyethylene foil from the bearing location by removing the radial bearings.

Transport protection must by all means be removed prior to startup.

Refer to Section “Radial bearing” regarding disassembly and assembly. Refer to Section 1.3 “Safety” and 1.5 “Service”.

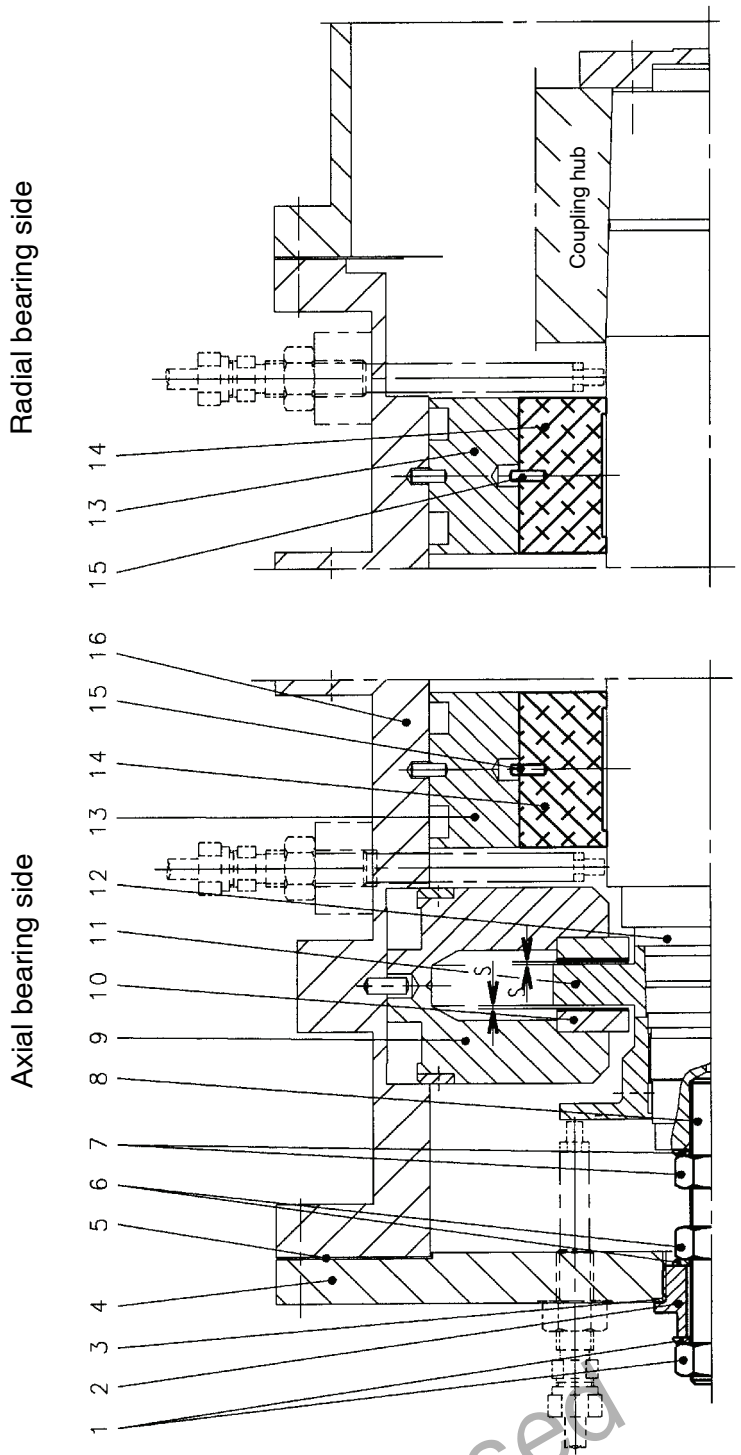


Illustration 21 Transport protection

7.5 Lubricant for assembly work on compressor

1.	gas seal (In addition also refer to Section 10.4 "Gas seal and gas sealing system" in Chapter 10 "Documentation for subcontracted components").	Chesterton anti-adhesive
2.	parting joint bolt	Molykote
3.	shaft seal on oil side, labyrinth seal, impeller seal, shaft seal, balance piston seal	copperfree Molykote
4.	diaphragms	copperfree Molykote
5.	O-rings in compressor casing	Parker Super-O-Lube (sealing and lubrication paste)

7.6 Parting joint sealant for compressor

1.	bearing housing and coupling disposition	Wevolic liquid
2.	diaphragms, impeller seals, shaft seals, labyrinth seals and balance piston seal	lead wire, dia. 1 mm round sealing material Viton B

7.7 Consumption material for compressor

1 Roll adhesive tape 19 mm wide to protect sensitive shaft areas

7.8 Distance setting of eddy current proximity probes

Axial „S_1":	1.5 ± 0.1 mm (shaft set to center of axial bearing clearance)
Radial „S_1":	1.2 ± 0.1 mm (shaft set to center of axial bearing clearance)
Setpoints:	Refer to Section 9.13 „Signal list"

7.9 Tightening torques

7.9.1 Bearing housing

Bolt tightening torque

1	parting joint bolts	M -	=	-	Nm
2	flange bolts of the upper part of bearing housing	M 20	=	335	Nm
3	flange bolts of the lower part of bearing housing	M 20	=	335	Nm

7.10 Special tools

NOTICE
Store the supplied special tools or devices on site. This serves to safeguard smooth service work by GHH BORSIG.

7.10.1 Special tools for electric motor

In addition refer to Chapter 10 “Documentation for subcontracted components” (Section 10.1 “Electric motor”) regarding special tools for electric motor and Section 7.10.3 “Special tools for compressor”

7.10.2 Special tools for gear unit

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.2 “Couplings“) regarding special tools for the gear unit and Section 7.10.3 “Special tools for compressor“.

7.10.3 Special tools for compressor

Quantity	Designation (Sheet 1 of 3)
1	Tool case with padlock
1	Set hydraulic assembly and removal device for coupling consisting of: a) compressor - gear unit, hydraulic nut M30 b) gear unit - electric motor, hydraulic nut M56 comprising: 1 hand lever pump HPE 2500 use for reducer 1 high-pressure hose A-578, L=2m use for reducer 1 hand lever pump HP 1600-2s use for hydraulic nut 1 high-pressure hose A 580, L=2m use for hydraulic nut
1	Set alignment device / measuring tools for compressor - gear unit consisting of: 1 measuring device holder M30 2 traverse holder 2 dial gauge 0-10
1	Set alignment device / measuring tools for gear unit - electric motor consisting of: 1 measuring device holder M56 2 traverse holder 2 dial gauge 0-10
2	Rotor lifting devices each consisting of: 1 semi-ring for shaft dia. 59 axial bearing side 1 semi-ring for shaft dia. 120 radial bearing side/coupling hub
1	Set alignment tools for compressor /gear unit consisting of: 16 thrust collar for compressor alignment 16 hex bolts M24 x 80

Special tools for compressor

Quantity	Designation (Sheet 2 of 3)
1	Assembly and removal device for internal part package
1	Set assembly tools for shear ring consisting of 1 assembly device for shear ring 6 assembly roll for shear ring
1	Set special tools for assembly of gas seal, consisting of 1 hook spanner B 58/62 for guide disk 1 hook spanner B 135/145 for nut spanner 1 counter holder 1 axial fixation tool 1 assembly and removal device
1	Set tools for wedge guide, consisting of 1 hook spanner B80/90 2 ring bolt M10
1	Set tools for diaphragm package , consisting of 6 yoke bolt M20 - 2 t 4 yoke bolt M16 - 1t
1	Tool for radial bearing 1 tweezers for cylindrical/conical pin
1	Tool for axial bearing 1 tweezers for cylindrical/conical pin 2 eye bolt M6x100
1	Set tools for bearing housing, consisting of 4 hex bolt M16x50 lifting bolt for upper part of bearing housing 2 ring bolt M10 1 socket spanner width: 17 - 290 long, 3/4" drive for axial fastening bolt for upper part of bearing housing

Special tools for compressor

Quantity	Designation (Sheet 3 of 3)
1	Set tools for coupling between compressor and gear unit and gear unit and electric motor consisting of: 1 torque spanner 1/2" 60 -300 Nm 1 socket spanner set width 17 - 1/2" 1 socket spanner set width 24 - 1/2"
1	Tools for compressor rotor, consisting of 1 ring bolt M20 for rotor transport 1 ring bolt M30 for rotor transport
4	Hex bolt BM30x200 for lifing the diaphragm package for disasembly (bolt into housing cover on radial bearing side)
4	Hex bolts BM16x160 for lifting off the shear ring from the groove
2	Ring bolts M 16 for assembly and removal device (diaphragm package)
1	Set hex bolt spanners each consisting of widths of 4, 5, 6, 8, 10, 14, 17, 19, 22, 27
1	Double-headed open-headed spanner 24x30
1	Star-shaped impact spanner 46
1	Single ring spanner 55
1	Double hex ring spanner 18x29
1	Double hex ring spanner 32x36

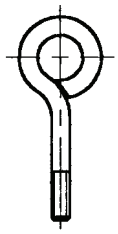


Illustration 22 Eye bolt

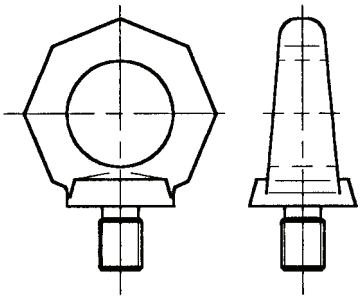


Illustration 23 Ring bolt

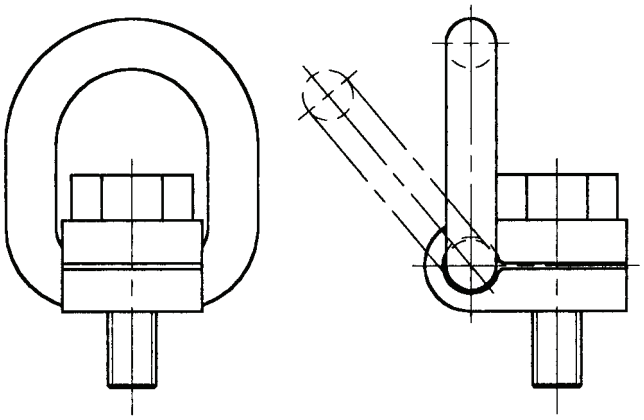


Illustration 24 Load yoke bolt

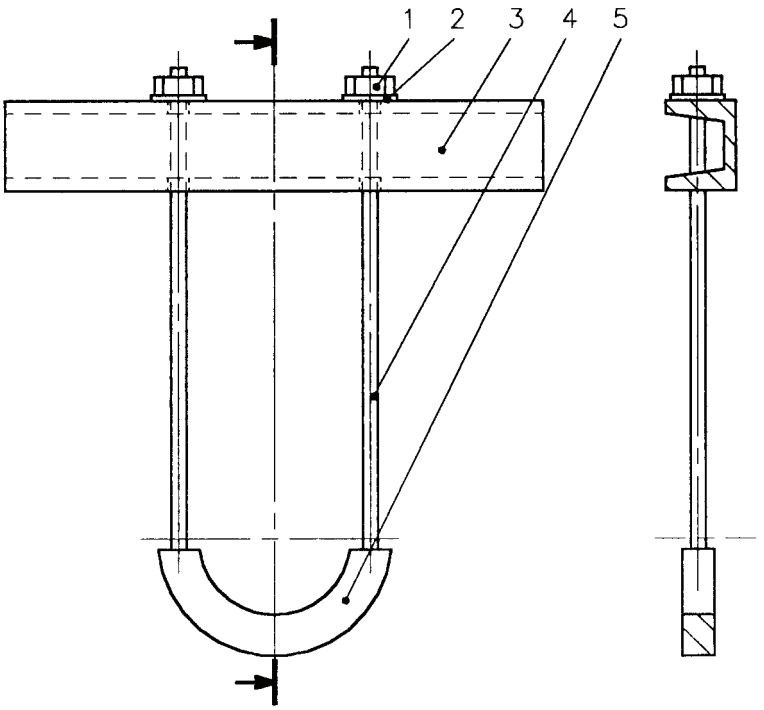


Illustration 25 rotor lifting device

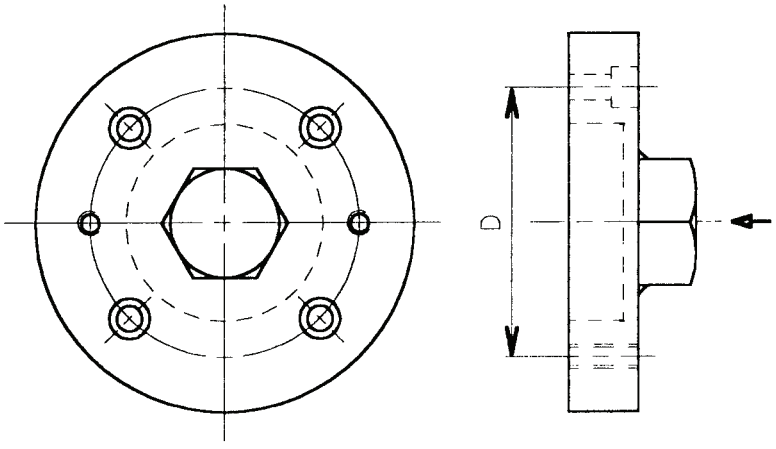


Illustration 26 Counter holder

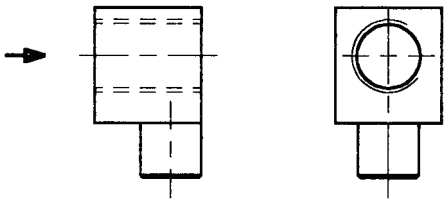


Illustration 27 Thrust pads

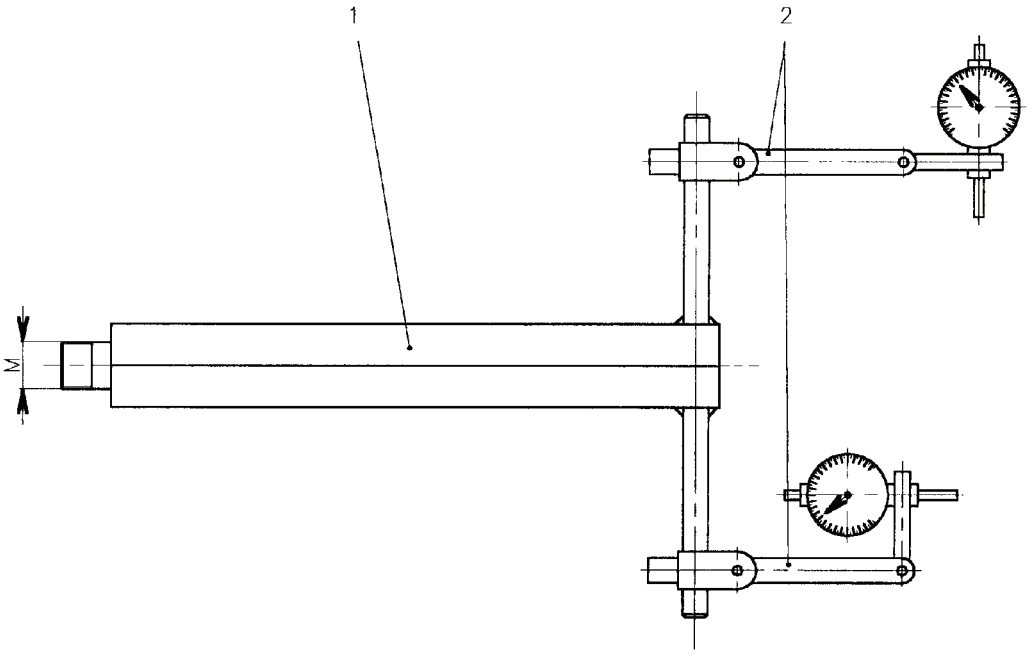


Illustration 28 Set measuring tools

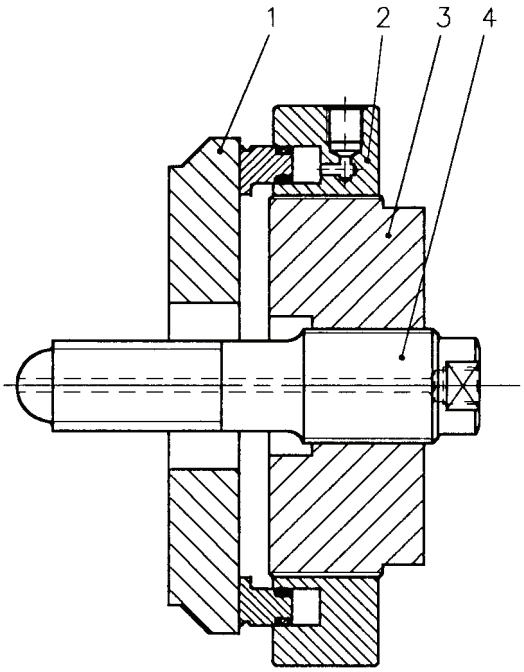


Illustration 29 Hydraulic assembly and removal device

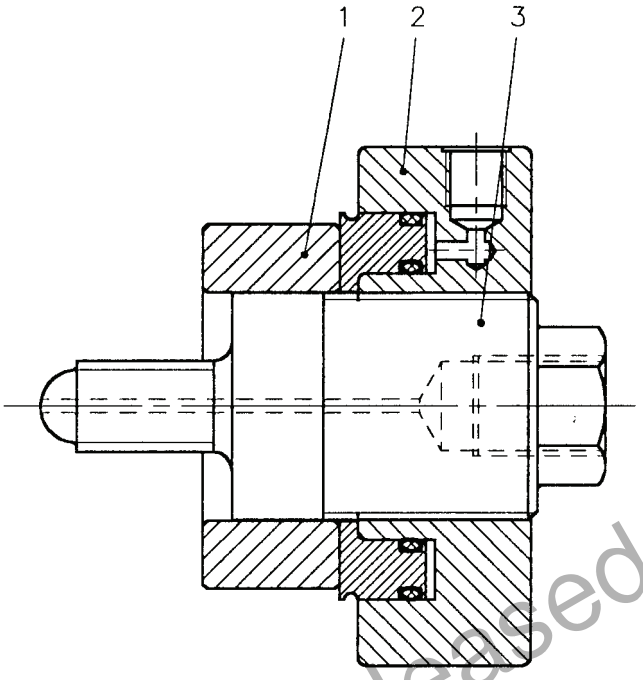


Illustration 30 Hydraulic assembly and removal device

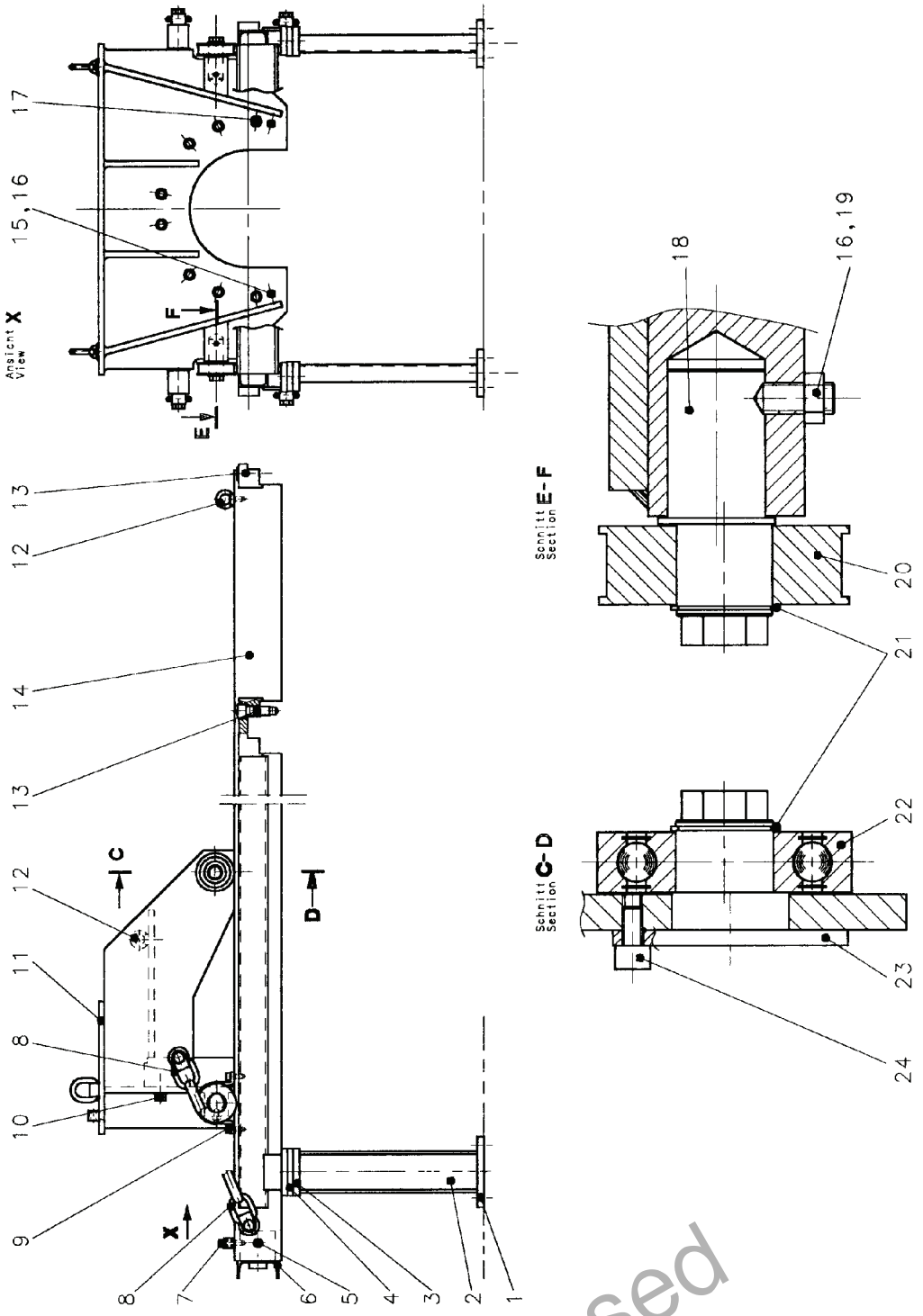


Illustration 31 Removal device

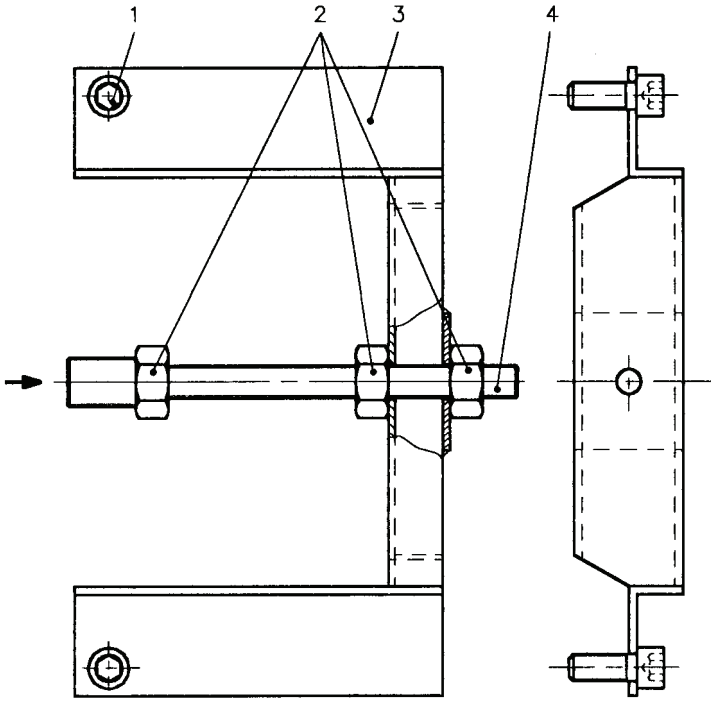


Illustration 32 Axial fixation tool

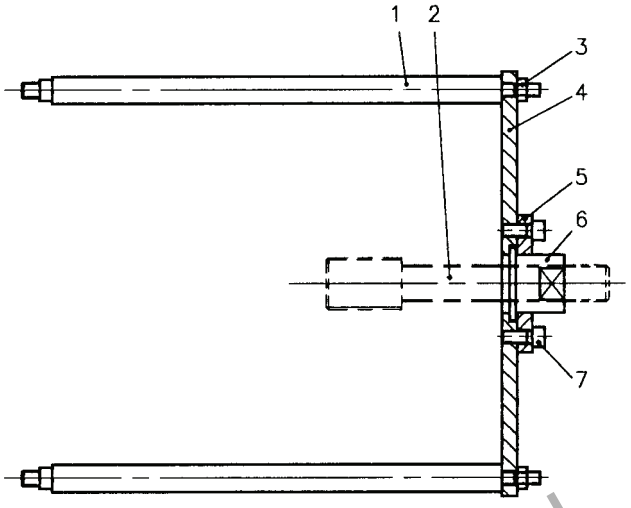


Illustration 33 Assembly and removal device

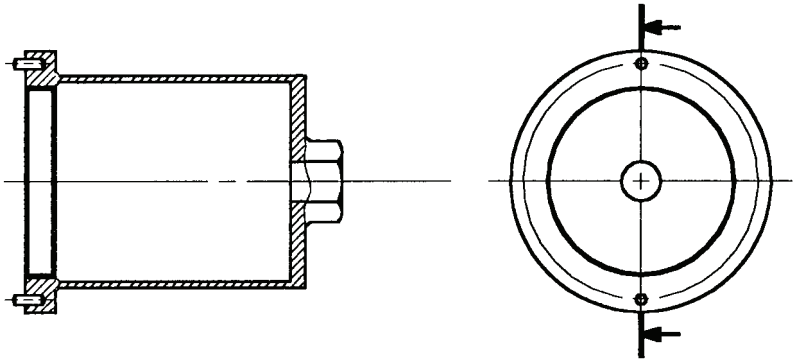


Illustration 34 Nut spanner

7.11 Flushing of the lube oil system

Prior to initial startup and every time after long-term standstill of the compressor unit

- (3 months at dry climate) and regardless of climatic conditions,

flush the oil systems prior to startup of the compressor for at least 24 hours with oil. However, conclude the flushing procedure only when the oil remains absolutely clean, i.e. no deposits can be found in the vicinity of the filter elements, in the bearings, etc.

The result of flushing with oil is proven by installing control strainers and subsequently flushing for approx. 1 hour (refer to ABI 614 - 4.3.3.7.2).

The strainer must be out of flat mesh, stainless steel wire No. 100, 0.1 mm in diameter and an open mesh width of 0.15 mm.

The max. size of the particles may not exceed 0.25 mm, and the particles must be irregularly distributed in the strainer.

The max. allowable amount of foreign matter is specified in the following list.

Tube nominal width mm	Maximum Amount of Foreign Matter
< 25	6
> 25 - 40	15
50	20
80	45
100	80

Preparation for flushing

1. Flushing oil: Fill the oil reservoir in correspondence with the regulations (refer to Section 8.6.6 “Oil reservoir”), however, at least with sufficient oil to enable the oil level at the oil reservoir sightglass to be read unobjectionably. Only the prescribed oil grade may be used (refer to Section 8.7.2 “Flushing oil recommendations“).
2. The best flushing result is achieved by running at high oil temperatures and high flow speeds in the piping, take the oil heater in operation or switch it off, as required.
   The max. allowable oil temperature amounts to 70 ˚C.
3. Centrifuging oil during the flushing procedure serves as a means of constantly cleaning the entire oil system.
4. If necessary, install wire strainers with a mesh width of approx. 0.08 mm between every 2 flanges to facilitate flushing.
5. It is recommended to bypass the bearings so that no dirt can enter the bearings themselves.
6. Following consumers are provided with

- additional bypass:

6.1 electric motor

6.2 gear unit

6.3 gas seal

7. Prior to flushing close the shutoff valves upstream and downstream of the control valves. Open bypass control valve (29PCV102/152 and 29TCV103/153).
8. Replace orifice in the supply line with a plug.

Flushing

1. Take auxiliary oil pump into operation.
2. Vent the oil cooler (air cooled) and the oil filter until oil is visible in the sightglasses. Then close shutoff valves in the venting lines.
3. Check the sightglasses or the flow indicator of single oil drains for passage.
4. During flushing switch over several times from one oil filter to another.
5. During flushing switch over several times to switch off the auxiliary oil pump for draining the overhead tank in order to include it in the flushing procedure.
6. During flushing via the bypass line of the control valves, the oil pressure is not controlled automatically, pressure and flow must be adjusted by hand via the bypass control valve.

After flushing

1. Switch off auxiliary oil pump.
2. Take oil heater out of operation.
3. Drain flushing oil from all tanks (if necessary).
4. Remove sludge from the oil reservoir and the oil filter. Clean oil reservoir.
5. Clean oil cooler bundle (air cooled), if necessary and replace oil filter elements.
6. Fill the oil reservoir with the prescribed initial oil filling.
7. Remove temporary bypasses, blanks and wire strainers.

7.12 Preparations for initial startup

7.12.1 Electric motor

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.1 “Electric motor”) regarding main drive.

7.12.2 Coupling 1

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.2 “Couplings“) regarding steel laminate coupling.

7.12.3 Gear unit

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.3 “Gear unit“) regarding gear unit with forced shaft driven main oil pump.

7.12.4 Coupling 2

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.2 “Couplings“) regarding steel laminate coupling.

7.12.5 Compressor

Prior to initial startup of turbocompressor observe all previous sections under Chapter 7 „Assembly“.

Moreover, check the switching and alarm points, refer to Section “Drawings and lists” (9.13 “Signal list“).

Flush the lube oil system and take it into operation.

Check oil pressure.

7.12.6 Preparatory measures for startup of lube oil system

Oil reservoir

1. Check oil reservoir for sufficient oil filling. Only the specified oil grade may be used. For replenishment use only the oil grade used for initial filling.
   Keep filling and transport devices extremely clean.
2. Drain any water collected by means of the reservoir drain valve. Eliminate the cause for water collecting.
3. Check whether the shutoff valves for 29LSL101/151 and 29LG101/151 are open.

4. Check whether operating and control voltage for the electric heaters of the oil reservoir is available. Switch on electric heater at oil temperatures below + 95 °F/ + 35 °C.

i NOTICE
The heating up period may amount up to 8 -1 2 hours depending on the ambient temperature.

Oil pumps SA-K-2911/21-P2 + SA-K-2911/21-P1

1. Check whether the shutoff valves at the oil pumps are open.
2. Check whether operating and control voltage for the electric motor of the auxiliary oil pump SA-K-2911/21-P1 is available.

Oil cooler SA-K-2911/21-E3

1. Check whether the shutoff valves at the oil cooler are in normal position.
2. Check whether the shutoff elements

2.1 in the venting line on the oil side are open,

2.2 of the cooler drains are closed.

2.3 The required orifices must be installed.

3. Check whether the temperature controls are connected.
4. Check whether operating and control voltage for the electric motor of the fan are available.
5. Check whether the temperature values for alarm and interlocking 29TSHL 103/153 correspond with the values in the Signal list (refer to Section 9.13 “Signal list“).

Oil filter SA-K-2911/21-S1A,B

1. Check whether the changeover device at the twin oil filter is switched so that oil flows through only one oil filter at one time.
2. Check whether the shutoff elements

2.1 in the venting lines and

2.2 in the filling lines are open,

2.3 the filter drains are closed.

2.4 The required orifices must be installed.

Control valves

1. Check whether

1.1 the shutoff elements ahead of and behind the control valve are open,

1.2 the manual control valve in the bypass is open,

1.3 the shutoff valve in the impulse line is open.

1.4 control air is available.

2. Check whether valves in bypass around 29PCV102/152 and 29TCV103/153 are open.

Oil pressure lines at the compressor

1. Check whether the fixed orifices ahead of the bearings are installed.

2. Check whether any wire strainers installed in the lines ahead of the bearings or between two flanges have been removed after flushing.

Overhead tank SA-K-2911/21-T2

1. Check whether all shutoff valves of the level sentries 29LS106/156 are open.

2. Check whether the filling valve ahead of the tank is open. When valve is closed the filling time is approx. 260 min..

3. Check whether the overhead tank drain is closed.

4. Check whether the orifice is installed in the swing check valve of the bypass line.

Instruments

1. Check whether

1.1 pressure gauge shutoff valves are open,

1.2 **Bypass line or impulse line:**

- Shutoff valves in the bypass line of the pressure switch ”auxiliary oil pump on line” **29PSL105/155** are open and the orifice **29RO105/155** is installed.
- Impulse line to level switch “auxiliary oil pump on line” **29PSL105/155** is connected.

7.12.7 Gas sealing system

WARNING !
Seal gas switching is located on oil side of shaft seal to protect gas seal!

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.4 “Gas seal and gas sealing system”).

7.13 Initial startup

7.13.1 Gas sealing system

WARNING !
Seal gas switching is located on oil side of shaft seal to protect gas seal!

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.4 “Gas seal and gas sealing system”).

7.13.2 Lube oil system

7.13.3 Initial startup of the machine

Prior to the initial startup of the machine please observe the previous sections in Chapter 7 “Assembly”.

1. The supervisor informs all stations involved of the startup.
2. Observe the user’s instructions.
3. Instruct the operating personnel.
4. Utilities and auxiliary engergies like seal gas, inert gas, instrument air must be connected and available in the required amount, pressure, temperature and purity. In addition the line to the flare must be connected.
5. All measuring and control equipment must be ready to function.
6. Electric energy supply must be safeguarded.
7. Keep a record of operation.
8. Oil flushing procedure must be completed.
9. Screens are recommended in suction lines for the protection of turbocompressors.

10. Check the direction of rotation before coupling.
11. Align shafts in cold condition. Check warm alignment for correction following test run.
12. Check differential pressure to desired values.
13. Check the connections according to flow sheet.
14. Suction and discharge gate valves must be closed.
15. All safety facilities must be assembled.
16. The machine unit is in a mechanically unobjectionable condition.
17. Commissioning of the machine unit is carried out by GHH BORSIG assembly personnel for startup.
18. The user and GHH BORSIG assembly and startup personnel mutually compile brief instructions for startup and shutdown (also during disturbances in operation). They must be exhibited at an easily visible location in the vicinity of the machine.

7.14 Checks following initial startup

Only conduct checks during compressor standstill.

The following checks are conducted to prevent damages or operating disturbances from arising at a later date:

- Refer to Section 7.3 “Erection and alignment” regarding alignment electric motor/gear unit and gear unit/compressor, .
- Refer to Section 7.3 “Erection and alignment” regarding firm seat of fastening bolts between compressor and base frame, gear unit and base frame and electric motor and base frame.
- Refer to Chapter 10 “Documentation for subcontracted components” (Section 10.2 “Couplings“) regarding threaded bolts on coupling flanges.
- Refer to Chapter 10 “Documentation for subcontracted components” (Section 10.1 “Electric motor”) regarding a check of bearings at electric motor.
- Refer to Chapter 10 “Documentation for subcontracted components” (Section 10.3 “Gear unit “)regarding a check of bearings at gear unit.
- Bearing checks at compressor must be conducted by GHH BORSIG Service personnel. Please refer to Section 5.4 “Repair and replacement work”.
- Leakage integrity tests of process gas, oil and seal gas connections.

8 Technical data

8.1 Electric motor

Refer to Chapter 10 “Documentation for subcontracted components“ (Section10.1 “Electric motor“) regarding technical data.

Tag No.	**SA-KM-2911/21**
Manufacturer	Siemens
Type/Size	1SJ1805-4JS90-Z
Design	IMB3
Serial No.	D98 411 504 01/02

Shaft end:

coupling stem dia.	dia. 200 mm

8.2 Coupling 1

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.2 “Coupling“).

Arranged between	electric motor and gear unit
Manufacturer	Renk
Type/Size	MTM 425
Design	laminated steel coupling
Serial No.	813569

8.3 Gear unit

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.3 “Gear unit“) regarding technical data.

Arranged between	electric motor and compressor
Manufacturer	Flender-Graffenstaden
Type/Size	TX80/9
Design	helical gear wheel
Serial No.	11855.03/04

1st shaft end:

coupling stem dia. wheel shaft	dia. 160 mm
coupling hub onset size LN	7.0 -7.6 mm*)

Applied pressure in joint at reducer **Pk 1846 bar**

DANGER !
The applied pressure in joint Pk at reducer may not exceed max. 2500 bar. Danger to life!

Oil pressure at the hydraulic nut **P = 1033 bar**

DANGER !
The oil pressure P at the hydraulic nut may not exceed max. 1600 bar. Danger to life!

*) Please refer to Chapter 10, Index 3, regarding gear unit manufacturer’s record for exact dimensions.

2nd shaft end:

coupling stem dia. pinion shaft	dia. 80	mm
coupling hub onset size LN	3.4 – 3.8	mm*)

Applied pressure in joint at reducer **Pk 1622 bar**

DANGER !
The applied pressure in joint Pk at reducer may not exceed max. 2500 bar. Danger to life!

Oil pressure at the hydraulic nut **P = 974 bar**

DANGER !
The oil pressure P at the hydraulic nut may not exceed max. 1200 bar. Danger to life!

*) Please refer to Chapter 10, Index 3, regarding gear unit manufacturer's record for exact dimensions.

8.4 Coupling 2

Refer to Chapter 10 "Documentation for subcontracted components" (Section 10.2 "Coupling").

Arranged between	gear unit and compressor
Manufacturer	Renk
Type/Size	MTR 224
Design	laminated steel coupling
Serial No.	813570

8.5 Compressor

GHH BORSIG “Export Gas” Centrifugal Compressor

Type:	RV 042/04
Machine No. :	23-1815 / 23-1816
Item No.:	SA-K-2911/21

8.5.1 Main data

Medium		CH_4, C_2H_6, C_3H_8	
Suction volume		3291	m^3/h
Suction pressure (gauge pressure		45.4	bar
Suction temperature		76.4	°C
Discharge pressure (gauge pressure)		103.9	bar
Discharge temperature		101	°C
Power input		4551	kW
Speed (100%)		13755	min^{-1}
1st critical speed		8434	min^{-1}
2nd critical speed		26149	min^{-1}
Direction of rotation looking in the direction of force flow		ccw	
Length		1750	mm
Width		1600	mm
Height		1770	mm
Weight	approx.	11000	kg
Sound level		85	dB (A)

8.5.2 Axial bearing and radial bearing

Axial bearing

Axial clearance	0.35 –0.42	mm *)
Oil requirement	47	l/min
Bearing oil gauge pressure (at Δt oil 15 – 20 °C)	0.80 –2.00	bar
Power loss	16.4	kW

Radial bearing

Diameter	95	mm
Diameter clearance	0.14 –0.17	mm *)
Diameter clearance for sealing ring	0.14 –0.20	mm *)
Oil requirement per bearing	14.3	l/min
Bearing oil gauge pressure (at Δt oil 12 – 15 °C)	0.8 –2.00	bar
Power loss per bearing	9.3	kW

*) Please refer to clearance record for exact value.

Oil grade

Refer to Section 8.7.1 “Lube oil requirements and recommendations”

Oil temperatures of the axial bearing and the radial bearing

	normal*	alarm**	stop**
Bearing oil inlet	45 ± 5 °C		
Bearing oil drain radial bearing	60 - 70 °C	73 °C	78 °C
Bearing oil drain axial bearing	57 - 67 °C	70 °C	75 °C
White metal measurement in radial bearing tilting pad	75 - 97 °C	100 °C	105 °C
White metal measurement in axial bearing tilting pad	75 - 97 °C	100 °C	105 °C

* Recommended value ** Maximumly adjustable setpoints

Section 9.13 “Signal list“ regarding actual setpoints.

If temperature suddenly changes more than 5 °C, conduct check on bearings and oil passages.

8.5.3 Compressor rotor

Length of the entire compressor rotor	1576	mm
Radial bearing clearance	1187.1	mm
Largest impeller diameter	358	mm
Total rotor mass	247.4	kg

1st shaft end (coupling stem dia. radial bearing side) dia. 80 mm

coupling hub onset size LN	3.4 - 3.8	mm *)

*) Please refer to clearance record for exact value.

centering diameter for balancing coupling	dia.	35 - 0.01	mm
Applied pressure in joint at reducer	Pk	1622	bar

DANGER !
The applied pressure in joint Pk at reducer may not exceed max. 2500 bar!
Danger to life!

oil pressure at the hydraulic nut	P	974	bar

DANGER !
The oil pressure P at the hydraulic nut may not exceed max. 1200 bar !
Danger to life!

8.5.4 Clearances

Refer to separate quality and material documentation regarding clearance record for compressor.

8.5.5 Gas seal

Refer to Section 10 “Documentation for subcontracted components“
(10.4 “Gas seal and gas sealing system) regarding technical data on gas seal.

Manufacturer	Pacific Wietz GmbH & Co KG
Type/Design	GASPAC/984

8.5.6 Shaft seal on oil side

Seal gas not connected!

8.6 Lube oil system

8.6.1 Lube oil supply for electric motor

Refer to Section 10 "Documentation for subcontracted components"
(10.1 "Electric motor") regarding technical data on lube oil supply of the electric motor.

8.6.2 Coupling lubrication, coupling 1

Not applicable! Only residual oil from the bearing (motor - gear unit) is drained.

8.6.3 Lube oil supply for gear unit

Refer to Section 10 "Documentation for subcontracted components"
(10.3 "Gear unit") regarding technical data on lube oil supply of the gear unit.

8.6.4 Coupling lubrication, coupling 2

Not applicable! Only residual oil from the bearing (gear unit - compressor) is drained.

8.6.5 Bearing lubrication at compressor

Refer to Section 8.5.2 "Axial bearing and radial bearing" regarding technical data on bearing oil lubrication at compressor.

8.6.6 Oil reservoir for lube oil system

Item No.	SA-K-2911/21-T1			
Manufacturer	Oeltechnik			
Total contents	8800 l			
Initial filling	7300 l	h =	1200	mm*
Max. service filling	4850 l	h =	800	mm*
Min. service filling	4000 l	h =	680	mm*
Min. flushing oil rate	7300 l	h =	1200	mm*
Settling time at maximum level	15	min		
Settling time at minimum level	12	min		

* Measured from bottom edge of leg

8.6.7 Oil heater

Item No.	**SA-K-2911-E1,E2 / SA-K-2921-E1,E2**
Manufacturer	Vulcanic
Type	ExH2F-4600
Heating output	6 kW
Specific area load	< 2 w/cm^2
Input voltage	415 V
Frequency	50 Hz
Type of enclosure	IP55
Type of protection	EExdeIICT6
Material	stainless steel

8.6.8 Main oil pump for lube oil system

Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.3 “Gear unit“) regarding technical data.

Item No.	**SA-K-2911/21-P2**
Manufacturer	Allweiler
Design	screw pump
Type	SNGX440-46
Type of driver	force drive by gear unit

8.6.9 Drive for main oil pump

Force drive by gear unit.
Refer to Chapter 10 “Documentation for subcontracted components“ (Section 10.3 “Gear unit“) regarding technical data.

Manufacturer (gear unit)	Flender
Type (gear unit)	TX80/9

8.6.10 Auxiliary oil pump for lube oil system

Item No.	SA-K-2911/21-P1	
Manufacturer	Leistritz	
Design	screw pump	
Type	L3MF 70/140	
Flow rate	4000	l/min
Suction gauge pressure	atm	bar
Supply gauge pressure	3.5	bar
Operating temperature	(60 - 80)	°C
Rated gauge pressure	8	bar
Rated temperature	100	° C
Test gauge pressure with water	12	bar
Oil viscosity at 40°C	46 $\pm$ 10 %	mm^2/s
Speed	1450	min^{-1}
Power input	5 - (9)	kW
Direction of rotation seen in direction of force flow	cw	
Set gauge pressure of safety valve	8	bar
Type of driver	electric motor	

8.6.11 Motor of auxiliary oil pump for lube oil system

Item No.	SA-K-2911/21-PM1
Manufacturer	Loher
Design	AC asynchronous motor
Type	CT4 11 kW
Rated input	10 kW
Rated speed	1500 min^{-1}
Voltage	415 V
Frequency	50 Hz
Connection	direct switching
Type of enclosure	IP 54
Type of protection	EExdeII CT4
Isolation class	F
Direction of rotation seen in direction of force flow	cw
Temperature	40 °C
Machine to be driven	auxiliary oil pump

8.6.12 Safety valve for oil pumps

Item No.		**PSV-P101A,B**	
Manufacturer		Consolidated	
Design *		proportional	
Type		1905 Gc/LS	
Medium		oil	
Amount of blow down		20,400	kg/h
Adjustment pressure		8	bar
Opening pressure	+10%	8.8	bar
Closing pressure	-10%	7.2	bar
Counter pressure		atm	bar
Operating pressure		(3.5 -4)	bar
Operating temperature		(60 -80)	°C
Rated pressure		8	bar
Rated temperature		100	°C
Test pressure with water		12	bar
Acceptance by		manufacturer	

* full stroke (V), proportional (P), therm. expansion (TE)

8.6.13 Oil pressure control valve

Item No.		29PCV102/152	
Manufacturer		Masoneilan	
Design		direct	
Type		526	
Medium		oil	
Flow rate	min.	80	l/min
	norm.	100	l/min
	max.	650	l/min
Adjustment pressure		1.7	bar

8.6.14 Oil temperature control valve

Item No.		29TCV103/153	
Manufacturer		Masoneilan	
Design		pneumatic	
Type		Varimax	
Medium		oil	
Flow rate	min..	20	l/min
	norm.	50	l/min
	max.	250	l/min
Adjustment temperature		45	°C

8.6.15 Oil cooler for lube oil system

Item No.	**SA-K-2911/21-E3**	
Manufacturer	Boldrocchi	
Design	air cooled	
Type	single with 2 motors	
Medium through the tubes	oil	
Oil flow rate per cooler	(235-255)	l/min
Operating pressure (gauge)	3.5	bar
Oil inlet temperature	81.4	°C
Oil outlet temperature	60 (45)	°C
Contents for tubes	200	l
Rated pressure (gauge)	8	bar
Rated temperature	100	°C
Test pressure with water	12	bar
Medium around tubes	air	
Amount of air per cooler	39060	m^3/h
Air inlet temperature	50	°C
Air outlet temperature	57	°C
Rated speed	720	min^{-1}
Power input / Rated input	2.7 / 3.6	kW
Direction of rotation, seen in direction of force flow	cw	
Driver	ADS motor	
Number of fans	2	
Amount of heat	140	kW
Arrangement	160	kW
Arrangement and calculation acc. to	ASME VIII, Div. 1	
Construction and hydrostatic test by	Lloyd's	

8.6.16 Fan for air cooling lube oil system

Item No.	**SA-K-2911/21-F1A,B**	
Manufacturer	COMET/COFIMCO	
Design	vertical	
Type	forced	
Flow rate	39060	m^3/min
Operating temperature	(50 - 57)	°C
Speed	720	min^1
Power requirement	2.7	kW
Direction of rotation seen in direction of force flow	cw	
Driver	electric motor	

8.6.17 Motor for fan for lube oil system

Item No.	**SA-K-2911/21-FM1A,B**	
Manufacturer	CEMP/ABB	
Design	3-phase AC asynchronous motor	
Type	vertical (forced draft)	
Rated power	3.6	kW
Rated speed	720	min^{-1}
Voltage	415	V
Frequency	50	Hz
Connection	direct starting	
Type of enclosure / protection	IP 55 / ExeIIAT3	
Isolation class	F	
Direction of rotation seen in direction of force flow	cw	
Temperature	40	°C
Machine to be driven	ventilator for air cooling of lube oil system	

8.6.18 Oil filter for lube oil system

Item No.	**SA-K-2911/21-S1A,B**	
Manufacturer	Boll u. Kirch	
Design	twin	
Type	2.93.2.220	
Filter element	paper	
Filter mesh (nominal)	10	µm
Flow rate (design data)	(235 -400)	l/min
Pressure loss in clean condition	0.8	bar
Max. allowable pressure loss	4	bar
Operating pressure (gauge)	3.0	bar
Operating temperature	(45 -60)	°C
Contents (total)	2 x 10	l
Rated pressure (gauge)	12	bar
Rated temperature	100	°C
Test pressure with water	12	bar
Arrangement and calculation acc. to	ASME VIII, Div. 1	
Construction and hydrostatic test by	Lloyd's	

8.6.19 Overhead tank lube oil system

Item No.	SA-K-2911/21-T2	
Manufacturer	Oeltechnik	
Contents	1300	l
Operating pressure (gauge)	atm	bar
Operating temperature	(45 - 60)	°C
Rated pressure (gauge)	1.0	bar
Rated temperature	100	°C
Test pressure (gauge) with water	1.5	bar
Arrangement and calculation acc. to	ASME VIII, Div. 1	
Construction and hydrostatic test by	Lloyd's	

8.7 Lube oil

8.7.1 Lube oil requirements and recommendations

Please refer to Chapter 9 "Drawings and lists",
Index 17, "Requirement and list of lubrication" KR 387.

8.7.2 Flushing oil recommendations

Please refer to Chapter 9 "Drawings and lists",
Index 17, "Requirement and list of lubrication" KR 387, Sheet 8.

8.8 Gas sealing system

The shaft seal on the oil side (2261.5 and 2261.6) is impinged with seal gas. If oil enters the gas seal from the bearings this may lead to destruction of the gas seal!

Refer to Chapter 10 "Documentation for subcontracted components"
(Section 10.4 "Gas seal and gas sealing system").

8.8.1 Buffer gas filter

Item No.	**SA-K-2911/21-S2A,S2B**
Manufacturer	Pacific Wietz

8.8.2 Inert gas filter

Item No.	**SA-K-2911/21-S3A,S3B**
Manufacturer	Pacific Wietz

8.9 Signal list KR 143

Please refer to Chapter 9 “Drawings and lists”, Index 13,“Signal list: Alarm/Trip settings”

8.10 Scope of supply

1. electric motor **SA-KM-2911/21**
2. coupling 1 with closed coupling disposition
3. gear unit
4. coupling 2 with closed coupling disposition
5. compressor Type RV 042/04, Tag No. SA-K-2911/21

5.1 shaft vibration monitoring

5.2 axial displacement monitoring

5.3 keyphasor monitoring

5.4 thermometer

5.5 thermoelements

5.6 gas seal

6. lube oil system

6.1 oil reservoir **SA-K-2911/21-T1**

6.2 oil heater **SA-K-2911-E1,E2** / **SA-K-2921-E1,E2**

6.3 main oil pump **SA-K-2911/21-P2**

6.4 auxiliary oil pump **SA-K-2911/21-P1**

6.5 safety valves for main and auxiliary oil pump **PSV-P101A,B**

6.6 oil pressure control valve **29PCV102/152**

6.7 oil temperature control valve 29TCV103/153

6.8 oil cooler **SA-K-2911/21-E3**

6.9 oil filter **SA-K-2911/21-S1A,B**

6.10 overhead tank **SA-K-2911/21-T2**

7. gas sealing system

Also:

- base frame
- piping and valves
- instrumentation
- cable connection between machine and terminal box
- logic (controller) diagram
- special tools
- standby parts

9 Drawings and lists

Index	Designation	Drawing No.	Sheet	Rev.
	Export Gas Compressor Unit Tag No. SA-K-2911/21	–	–	–
	DIAGRAMS			
1	P+I Diagram Tag No. SA-K-2911 (Samex 3)	0-256 66 05.3		E
	P+I Diagram Tag No. SA-K-2921 (Samex 4)	0-256 66 06.4		E
2	Performance curves: Cover sheet	Job 310 102		1
	Performance curves	Job 310 102	1 – 6	
	COMPRESSOR			
3	Sectional drawing	10000009132		01
	PROCESS GAS			
4	Suction strainer	2-118 95 01.6		B
	Stage 1: Design No.19 P+I Diagram Pos. 1.01			
	Stage 3: Design No.17 P+I Diagram Pos. 1.08			
	PLANT COMPONENTS			
5	Arrangement plan	0-256 72 69.8		6
6	Foundation plan	0-256 72 70.1		4
7	Base frame	0-256 86 74.1		A
8	Coupling disposition (E-Motor/Gear)	10000007949		
	Coupling disposition (Gear/Compr.)	2-256 87 00.3		
9	Alignment diagram	4-256 87 42.1	1 – 2	
10	Handling instruction	3-256 87 20.7		
	CONTROL/INSTRUMENTATION			
11	Data sheet (Samex 3) Cover sheet D001 – D009; 65 Sheets	10000006311	 1 –	 3 3
	Data sheet (Samex 4) Cover sheet D001 – D009; 65 Sheets	10000006318	 1 –	 3 3
12	Instrument index (Samex 3)	10000006304	1 – 9	3
	Instrument index (Samex 4)	10000006305	1 – 9	3
13	Signal list (Samex 3) Alarm/Trip settings	10000006286	1 – 5	3
	Signal list (Samex 4) Alarm/Trip settings	10000006287	1 – 5	3

10 Documentation for subcontracted components

Index	Supplier	Component Part	Type	Tag No.
		Export Gas Compressor Unit Manuals and drawings		**SA-K-2911/21**
		DRIVE COMPONENTS		
1	Siemens	**E-Motor** for main drive Cover sheet Documentation list	1SJ1805-4JE90-Z	SA-KM-2911/21
1.1	–	Technical data	–	–
1.2	–	Dimension drawing	–	–
1.3	–	Reports	–	–
1.4	–	Instructions	–	–
1.5	–	Additional documents	–	–
2	Renk	**Flexible disk couplings**	–	–
		Coupling 1 between Driver/Gear Dwg. No. W97002 703418	MTM 425	–
		Coupling 2 between Gear/Compr. Dwg. No. W97002 703520	MTR 224	–
3	Flender Allweiler	**High speed gear unit** with **Main oil pump**	TX80/9 SNGX 440-46	– SA-K-2911/21-P2
		COMPRESSOR	RV 042/04	SA-K-2911/21
4	–	**Gas seal and gas sealing system SAMEX 3**	–	–
4.1	Pacific	**Gas seal** stage 1 and 3 Dwg.No. 47813 90 01 Parts L.No.47813 90 11 Page 0, 1-5	984	–
4.2	Ganteför	**Gas sealing system** Table of contents; 1 sh.	–	–
4.2.1	Pacific	**GASPAC PANEL** Manual cover sheet	850	–
4.2.2	Ganteför	Certificate of Gaspac panel; 1 sheet	–	–
4.2.3	Ganteför	Test program and Test report; Sheet 1-5	–	–

Index	Supplier	Component Part	Type	Tag No.
4.2.4	Flowserve Ganteför	Device list: Instrument parts list No. 48160 90 1 1; Sh. 1–2 Instrument parts list No. A–97–11–07; Sh. 1–3	–	–
4.2.5	Pacific	P+I Diagram Dwg. No. 48160 97	–	–
4.2.6	Ganteför	10 Data sheets A–97–11–07	–	–
4.2.7	Pacific	Panel Dwg. No. 48160 90 0 1	850	–
4.2.8	Pacific	Panel Description Sh. 1–4	850	–
4.2.9	Ganteför	List of enclosures Sheet 1–4	–	–
4.2.9.1	Indufil	Buffer gas filter unit Inert gas filter unit	IDGL 1–25	SA–K–2911–S2A,S2B SA–K–2911–S3A,S3B
4.2.9.2	SOR	Diff. pressure switch	102W1–J912	29PDS111
4.2.9.3	Swagelok	Integral bonnet needle valve	–	–
4.2.9.4	Krone	Flow meter	H 250	29FIS112 29FIS113 29FIS115 29FIS116 29FIS117 29FIS118
4.2.9.5	Nupro	Check valve	SS–CH16F12–1 CHS12MM	–
4.2.9.6	Ganteför	Orifice	–	29RO117 29RO118
4.2.9.7	SOR	Pressure switch	6RM–J3–M4	29PS115 29PS117 29PS118
4.2.9.8	Wika	Pressure gauge	230.30.100	29PI117 29PI118
4.2.9.9	Wika	Diff. pressure gauge	732.14.160	29PDI114 29PDI111
4.2.9.10	Chemat	Ball valve	Capro 330 G3/4”	–

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4.2.9.11	Fine Tubes Ltd.	Material analysis	–	–
4.2.9.12	Waffenschmidt	Blind flange	–	–
4.2.9.13	Anderson	Gauge valve	M9	–
4.2.9.14	SOR	Diff. pressure switch	101RM-J3	29PDS114
5	–	**Gas seal and gas sealing system SAMEX 4**	–	–
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5.2	Ganteför	**Gas sealing system** Table of contents; 1 sh.	–	–
5.2.1	Pacific	**GASPAC PANEL** Manual cover sheet	850	–
5.2.2	Ganteför	Certificate of Gaspac panel; 1 sheet	–	–
5.2.3	Ganteför	Test program and Test report; Sheet 1-5	–	–
5.2.4	Flowserve Ganteför	Device list: Instrument parts list No. 48160 90 1 1; Sh. 1-2 Instrument parts list No. A-97-11-07; Sh. 1-3	–	–
5.2.5	Pacific	P+I Diagram Dwg. No. 48160 96	–	–
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5.2.7	Pacific	Panel Dwg. No. 48160 90 0 1	850	–
5.2.8	Pacific	Panel Description Sh. 1-4	850	–
5.2.9	Ganteför	List of enclosures Sheet 1-4	–	–
5.2.9.1	Indufil	Buffer gas filter unit Inert gas filter unit	IDGL 1-25	SA-K-2921-S2A,S2B SA-K-2921-S3A,S3B
5.2.9.2	SOR	Diff. pressure switch	102W1-J912	29PDS161
5.2.9.3	Swagelok	Integral bonnet needle valve	–	–

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5.2.9.5	Nupro	Check valve	SS-CH16F12-1 CHS12MM	-
5.2.9.6	Ganteför	Orifice	-	29RO167 29RO168
5.2.9.7	SOR	Pressure switch	6RM-J3-M4	29PS165 29PS167 29PS168
5.2.9.8	Wika	Pressure gauge	230.30.100	29PI167 29PI168
5.2.9.9	Wika	Diff. pressure gauge	732.14.160	29PDI164 29PDI161
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5.2.9.11	Fine Tubes Ltd.	Material analysis	-	-
5.2.9.12	Waffenschmidt	Blind flange	-	-
5.2.9.13	Anderson	Gauge valve	M9	-
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7	Masoneilan	Data sheet Item:2 Item:00110/00120		29... UCV001/051 UCV002/052
	Masoneilan	Flow control valve	41000 Model	-
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	Masoneilan	Electropneumatic transducer Air filter regulator	8007/8008 Models 77–4	–
	Masoneilan	Position transmitter Limit switch	496–8	29ZI001/051 29ZI002/052 29... ZLUO001/051 ZLUC051/052
8	Dr.Gebhardt	Anti surge controller and Performance controller **SAMEX 3** **SAMEX 4**	turbolog DSP	 29... FIC001,002 FIC051,052
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		Motor, Gear, Compr.		
9	Bently Nevada	**Foreword** of System manual **System overview** Part No.80171–01 **Proximity** **Transducer system** Manual Part No. 86130–01	 3300 3300 3300 5mm and 8mm	–
		Radial measuring	–	29*A,B *XE120/170 *XE122/172 *XE132/182 *XE134/184 29XE136/186 29XE137/187
		Axial measuring	–	29*A,B *ZE121/171 *ZE128/178 *ZE131/181

Index	Supplier	Component Part	Type	Tag No.
9(cont.)		Radial vibration transmitter	–	29*A,B *XT120/170 *XT122/172 *XT132/182 *XT134/184 29XT121/171 29XT128/178 29XT131/181
		Axial position transmitter	–	29*A,B *ZT121/171 *ZT128/178 *ZT131/181
		Keyphasor	–	29XE121/171 29XE128/178 29XE131/181
10	Bently Nevada	**Dual vibration monitor** Operation manual Part No. 86829-01 Maintenance manual Part No. 86830-01	3300/16	–
		Radial measuring	–	29XIS120/170 29XIS122/172 29XIS132/182 29XIS134/184
11	Bently Nevada	**Dual velocity monitor** Operation manual Part No. 130747-01 Maintenance manual Part No. 130748-01	3300/55	–
		Radial measuring	–	29XIS136/186
12	Bently Nevada	**Dual thrust position monitor** Operation manual Part No. 80178-01 Maintenance manual Part No. 80179-01	3300/20	–
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13	Bently Nevada	**Six channel Temperature monitor** Thermocouple RTD Operation manual Part No. 80182-01 Maintenance manual Part No. 80183-01	3300 3300/30 3300/35	–
		Temp. measuring	–	29TIS120/170 29TIS130/180 29TIS135/185 29TIS137/187 29TIS140/190
14	–	**Vibration transducer Interface + Power supply** (Integrated component of each control panel)	–	–
	Bently Nevada	**Vibration Transducer Interface** (Galvanic isolator) Manual Part No. 128132	–	–
	Bently Nevada	**Dynamic transmitor Module (DTM)** Part No. 132646-01	1800 System	–
	Bently Nevada	**Power supply** Installation and Maintenance manual Part No. 124625-01	1800/10	–
15 **15.1** **15.2**	Electromach	**Control panel** Manual for: **SAMEX 3** (Volume10) **SAMEX 4** (Volume11) Both Volumes acc. to **Index** sheets: TAB 01) Documents TAB 02)-26) Documentation for subcontracted components	–	–

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16.2	–	Hand lever pump High-pressure hose (Use for hydraulic nut)	HP 1600-2s A-580	–
16.3	–	Oil-Hydraulic nut	–	–
16.3.1	–	Coupling: Gear/Motor	S4287-M56	–
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		Motor		
17	–	Thermoelement (Refer to Index 1)	–	29*A,B,C,D *TE136/186 *TE137/187 29*A,B *TE138/188 *TE139/189 *TE140/190
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19		**LUBE OIL SYSTEM** for Export Gas Compressor Unit		SA-K-2911/21
	–	acc. Contents index sheet 1 – 3	–	–
19.1	Oeltechnik	Oil unit General arrangement Dwg. No.: 32 114-0 sh. 1 32 114-0 sh. 2 Parts list No.: 32 114-4 sh. 1 – 12	–	–
19.2	Oeltechnik	Oil reservoir Dwg. No.: 32 115-0 Parts list No.: 32 115-4 sh. 1 – 6	–	SA-K- 2911/21-T1
19.3	Oeltechnik	Run down tank Dwg. No.: 33 965-1 Parts list No.: 33 965-4 sh. 1 – 6	–	SA-K- 2911/21-T2
19.4		**Additional documents & Accessories**		
19.4.1	Leistritz	Auxiliary oil pump	L3MF 70/140	SA-K- 2911/21-P1
19.4.2	Loher	E-Motor for Auxiliary oil pump	CT4 11kW	SA-K- 2911/21-PM1
19.4.3	Consolidated	Pressure safety valve	1905Gc/LS	PSV-P101A PSV-P101B
19.4.4	Boll & Kirch	Lube oil filter	2.93.2.220.	SA-K-2911/ 21-S1A,B
19.4.5	Vulcanic	E-Heater (Samex 3) for oil reservoir with Temperature limiter Temperature thermostat	ExH2F-4600 ETHf-70/U ETHf-1	SA-K-2911 -E1,E2 29TC101A,B 29TSH101A,B
		E-Heater (Samex 4) for oil reservoir with Temperature limiter Temperature thermostat	ExH2F-4600 ETHf-70/U ETHf-1	SA-K-2921 -E1,E2 29TC151A,B 29TSH151A,B

Index	Supplier	Component Part	Type	Tag No.
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19.4.6.B	Heraeus	Thermocouple	WGB 11	29TE103/153
19.4.6.C	SOR	Pressure switch	4RN-KA5-M4-C2A	29PSL 105/155
19.4.6.D	SOR	Diff. pressure switch	101RN-KA3-M4-C1A	29PDSH 104/154
19.4.6.E	Wika	Pressure gauge	233.30.100	29PI 102A/152A 102B/152B
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19.5	Boldrocchi Comet Cemp	Oil cooler aircooled (horizontal) Handbook and dwgs. No.103943 Assembly No.104778 Marking with Fans for aircooling (vertical) and E-Motors for fans (vertical)	Single MAP 16-125-04 EEH 160-MA8	SA-K-2911/21-E3 SA-K-2911/21-F1A,B SA-K-2911/21-FM1A,B
19.6	NSW-Umwelttechnik	Oil mist separator (Mounted on the oil reservoir, Index 19.2) Documentation and Operation manual with drawings No. 1/89034/102-107 Sheet 1: Separator Sheet 2: Flow sheet	G 35 508 T/56-1001	-

Hinweis:
- **Die Überschriften dieser Seite werden in das Inhaltsverzeichnis übernommen.**
- **Die vorangehende Tabelle wird vor die Zeichnungen gestellt**
- **Diese Seite wird nicht in das BHB eingelegt!**

10.1 electric motor for main drive

10.2 Flexible disk couplings

10.3 gear unit with main oil pump

10.4 Gas seal and gas sealing system (SAMEX 3)

10.5 Gas seal and gas sealing system (SAMEX 4)

10.6 Alphaline transmitter

10.7 Flow control valve

10.8 Anti surge controller

10.9 Proximity transducer system

10.10 Dual vibration monitor (Radial measuring)

10.11 Dual velocity monitor (Radial measuring)

10.12 Dual thrust position monitor (Axial measuring)

10.13 Six channel temperature monitor (Temp. measuring)

10.14 Vibration transducer interface + Power supply

10.15 Manual for control panel

10.15.1 SAMEX 3 (Volume 10)

10.15.2 SAMEX 4 (Volume 11)

10.16 Special tools: hand lever pump and hydraulic nut

10.17 Thermoelement; Motor (Refer to Index 1)

10.18 Thermoelement/-indicator; Gear (Refer to Index 3)

10.19 lube oil system