BAUER
KOMPRESSOREN

INSTRUCTION MANUAL
AND SPARE PARTS CATALOGUE

HIGH PRESSURE
BREATHING AIR COMPRESSOR
225 bar/330 bar

PURUS/UTILUS 10

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INTRODUCTION

This manual contains operating instructions and maintenance schedules for the high pressure breathing air compressor

PURUS and UTILUS 10

All instructions should be observed and carried out in the order laid down to prevent damage and premature wear to the equipment.

While every effort is made to ensure the accuracy of the particulars contained in this manual, the manufacturing company will not, under any circumstances, be held liable for any inaccuracies or the consequences thereof.

WARNING

The breathing air produced with this unit is subject to strict quality standards. Ignoring the operating and maintenance instructions can lead to severe injury or death.

TÜV PRODUCT SERVICE GS geprüfte Sicherheit

Edition January 1994

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Change notice

Change no.	Change date
0	Basic edition May 1985
1	March 1986
2	November 1988
3	October 1990
4	September 1992
5	January 1994

Dear customer

We are happy to give you advice on any questions regarding your BAUER compressor and help as soon as possible with any arising problems.

You can contact us Mondays to Thursdays from 08^{00} till 16^{30}, Fridays from 08^{00} till 14^{00} on phone no. (089) 78049-0.

If you call the following extensions directly, it will save you time and continuous dialling.

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1. GENERAL

1.1. PURPOSE AND SHORT DESCRIPTION

The **PURUS** and **UTILUS 10** breathing air compressors are complete units for filling air tanks to a pressure of 225 bar (3,200 psi) or 330 bar (4,700 psi).

The compressor block **U10** is a 3-cylinder, 3-stage, air-cooled reciprocating piston compressor.

1.2. DESIGN AND MODE OF OPERATION

1.2.1. Design

The compressor unit comprises the following major assemblies:

- compressor block
- drive motor
- filter assembly
- filling assembly
- base plate

The design of the compressor system is shown in Fig. 1 and Fig. 2. For special equipment according to order see figures and parts lists in the annex.

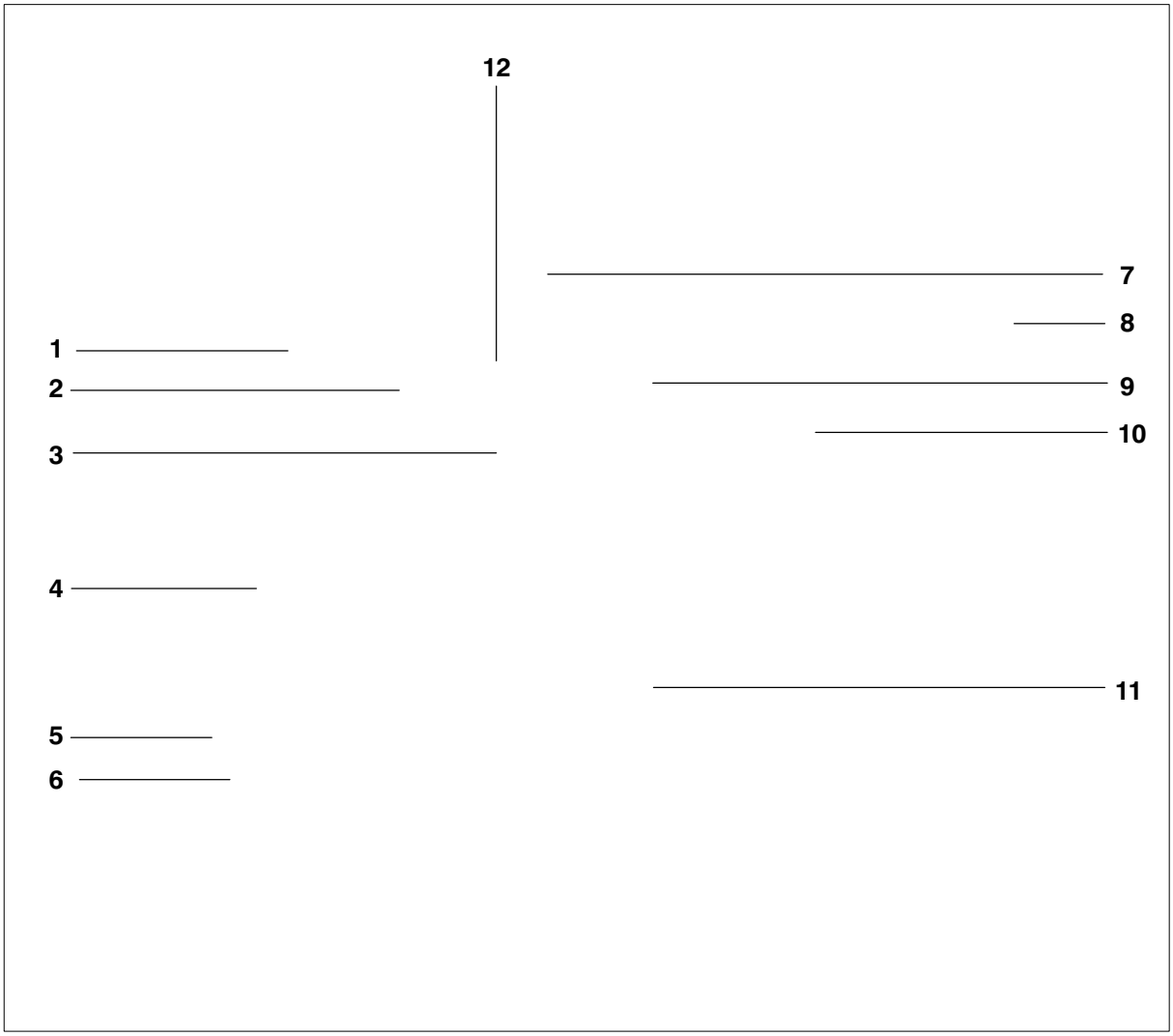


Fig. 1 Compressor unit with petrol engine

1 Safety valve, final pressure
2 Oil dip stick
3 Intake filter
4 Central filter assembly
5 Condensate drain valves
6 Pressure maintaining valve
7 Filling hose
8 Engine exhaust
9 Filling valve with final pressure gauge
10 Tank
11 V-belt cover
12 Air intake opening (for telescopic tube)

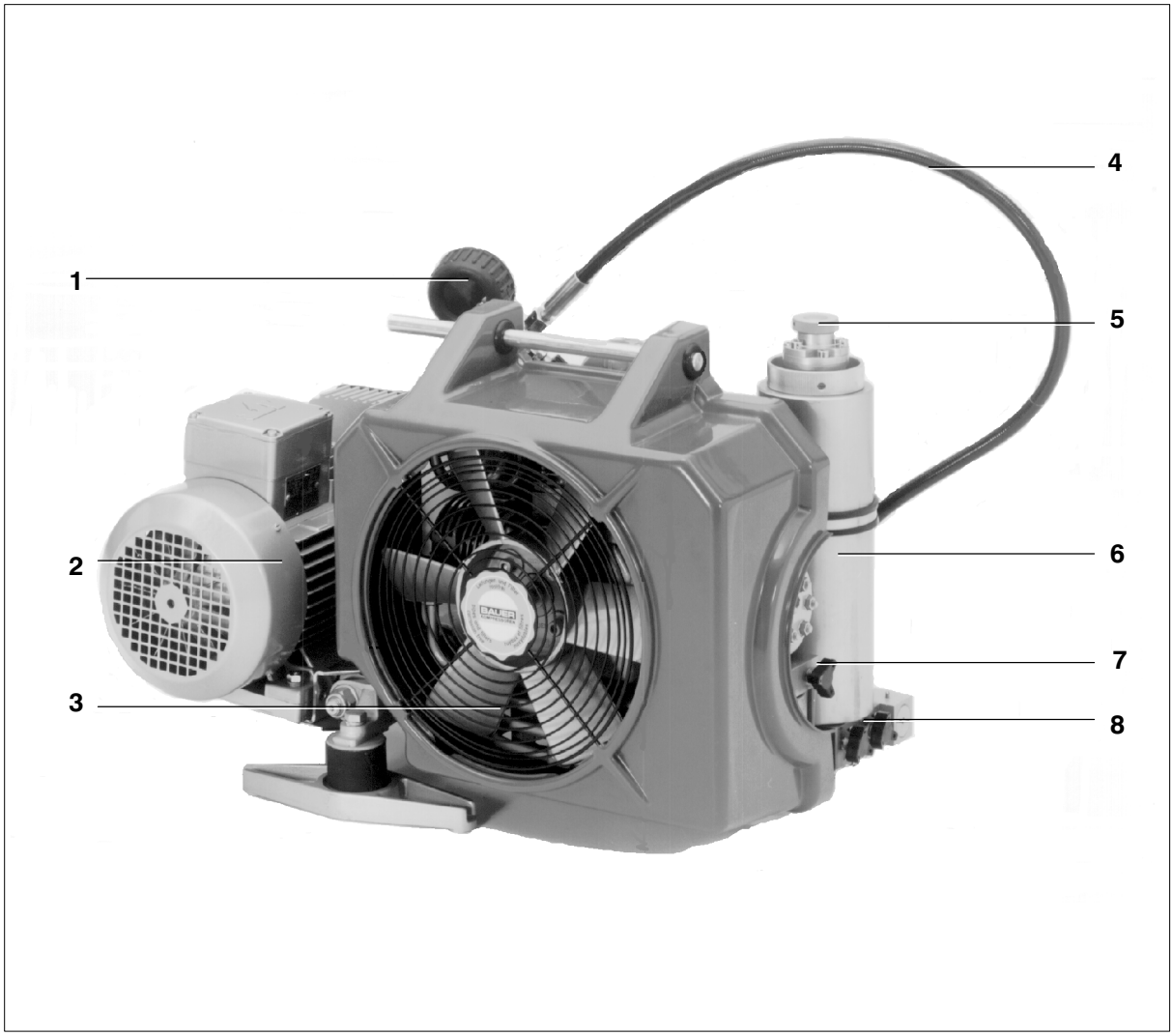


Fig. 2 Compressor unit with electric engine

1 Final pressure gauge
2 Drive engine
3 Fan-wheel cover
4 Filling hose
5 Final pressure safety valve
6 Central filter assembly
7 Condensate drain valve, intermediate separator
8 Condensate drain valves, filter system

1.3. CHANGE-OVER DEVICE PN 300/PN 200

1.3.1. Description

(Fig. 3) This device allows bottle filling to 200 bar (3,200 psig) with a 300 bar (4,700 psig) rated unit. Safety valve -B and filling device PN 200 bar are connected by opening change-over valve -A and the connected bottles can be filled with a 200 bar pressure, as described in "FILLING", see chapter 14.6.

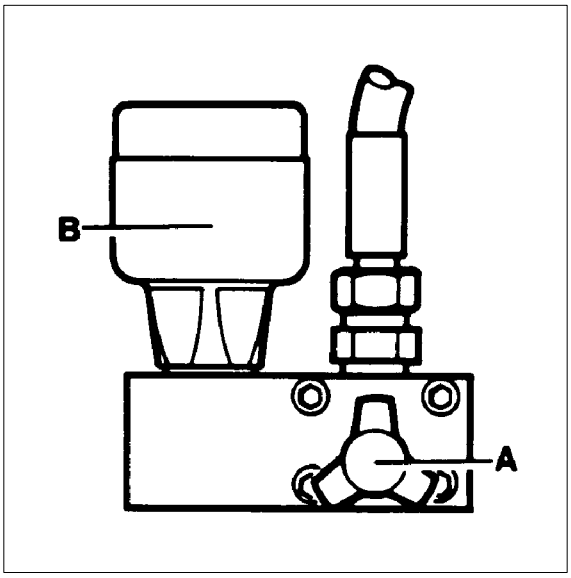


Fig. 3 Change-over device

1.4. TECHNICAL DATA

1.4.1. Compressor unit PURUS with petrol motor

Compressor unit	**P2B**	**P2B-H, -HU**
Delivery[a)]	80 l/min.	80 l/min.
Operating pressure	PN 200	PN 300
Pressure setting, final pressure safety valve	225 bar	330 bar
Sound pressure	87 dB(A)	87 dB(A)
Sound (immersion) power	100 dB(A)	100 dB(A)
Weight (approx.)	44 kg	44 kg
Compressor block	**U10, mod. 2**	**U10, mod. 2**
Number of stages	3	3
Number of cylinders	3	3
Cylinder bore 1st stage	60 mm	60 mm
Cylinder bore 2nd stage	28 mm	28 mm
Cylinder bore 3rd stage	12 mm	12 mm
Piston stroke	24 mm	24 mm
Speed	1,800 min^{-1}	1,800 min^{-1}
Intermediate pressure 1st stage	5.5 bar	6.5 bar
	80 psi	95 psi
Intermediate pressure 2nd stage	55 bar	65 bar
	800 psi	942 psi
Compressor block oil capacity	360 cm^3	360 cm^3
	12 fl. oz.	12 fl. oz.
Oil type	see chap. 2 lubrication	
Max. ambient temperature	+5 ... +45 °C	+5 ... +45 °C
	+43 ... +113 °F	+43 ... +113 °F
Max. permissible inclination of compressor[b)]	10°	10°
Drive motor	**Honda petrol engine**	
Manual start model (B)	GX 120 K1 Q1A8	
Power	2.9 kW/4 PS	
at nominal speed	3,600 min^{-1}	

a) free air delivered at tank filling from 0 to 200 bar

b) these values are valid only if the oil level of the compressor in normal position corresponds with the upper mark of the oil dipstick and may not be exceeded.

1.4.2. Compressor unit PURUS with three phase current motor

Compressor unit	**P3E**	**P3E-H, -HU**
Delivery[a)]	80 l/min.	80 l/min.
Operating pressure	PN 200	PN 300
Pressure setting, final pressure safety valve	225 bar	330 bar
Sound pressure	81 dB(A)	81 dB(A)
Weight (approx.)	44 kg	44 kg
Compressor block	**U10, mod. 2**	**U10, mod. 2**
Number of stages	3	3
Number of cylinders	3	3
Cylinder bore 1st stage	60 mm	60 mm
Cylinder bore 2nd stage	28 mm	28 mm
Cylinder bore 3rd stage	12 mm	12 mm
Piston stroke	24 mm	24 mm
Speed	1,800 min^{-1}	1,800 min^{-1}
Intermediate pressure 1st stage	5.5 bar	6.5 bar
	80 psi	95 psi
Intermediate pressure 2nd stage	55 bar	65 bar
	800 psi	942 psi
Compressor block oil capacity	360 cm^3	360 cm^3
	12 fl. oz.	12 fl. oz.
Oil type	see chap. 2 lubrication	
Max. ambient temperature	+5 ... +45 °C	+5 ... +45 °C
	+43 ... +113 °F	+43 ... +113 °F
Max. permissible inclination of compressor[b)]	10°	10°
Drive motor	**Three phase current**	
Operating voltage	400 V, 50 Hz	400 V, 50 Hz
Power	2.2 kW/3 PS	2.2 kW/3 PS
Speed	2,850 min^{-1}	2,850 min^{-1}
Size	90 L	90 L
Type of construction	B3	B3
Type of enclosure	IP54	IP54

a) free air delivered at tank filling from 0 to 200 bar

b) these values are valid only if the oil level of the compressor in normal position corresponds to the upper mark of the oil dip-stick and may not be exceeded.

1.4.3. Compressor unit PURUS with alternating current motor

Compressor unit	**P3W**	**P3W-H, -HU**
Delivery[a)]	80 l/min.	80 l/min.
Operating pressure	PN 200	PN 300
Pressure setting, final pressure safety valve	225 bar	330 bar
Sound pressure	81 dB(A)	81 dB(A)
Weight (approx.)	45 kg	45 kg
Compressor block	**U10, mod. 2**	**U10, mod. 2**
Number of stages	3	3
Number of cylinders	3	3
Cylinder bore 1st stage	60 mm	60 mm
Cylinder bore 2nd stage	28 mm	28 mm
Cylinder bore 3rd stage	12 mm	12 mm
Piston stroke	24 mm	24 mm
Speed	1,800 min^{-1}	1,800 min^{-1}
Intermediate pressure 1st stage	5.5 bar	6.5 bar
	80 psi	95 psi
Intermediate pressure 2nd stage	55 bar	65 bar
	800 psi	942 psi
Compressor block oil capacity	360 cm^3	360 cm^3
	12 fl. oz.	12 fl. oz.
Oil type	see chap. 2 lubrication	
Max. ambient temperature	+5 ... +45 °C	+5 ... +45 °C
	+43 ... +113 °F	+43 ... +113 °F
Max. permissible inclination of compressor[b)]	10°	10°
Drive motor	**Alternating current**	
Operating voltage	230 V, 50 Hz	230 V, 50 Hz
Power	2.2 kW/3 PS	2.2 kW/3 PS
Speed	3,000 min^{-1}	3,000 min^{-1}
Size	LS 90 PC	LS 90 PC
Type of construction	B3	B3
Type of enclosure	IP44	IP44

a) free air delivered at tank filling from 0 to 200 bar

b) these values are valid only if the oil level of the compressor in normal position corresponds to the upper mark of the oil dip-stick and may not be exceeded.

1.4.4. Compressor unit UTILUS 10 with petrol motor

Compressor unit	**U10B**	**U10B-H, -HU**
Delivery[a)]	110 l/min.	110 l/min.
Operating pressure	PN 200	PN 300
Pressure setting, final pressure safety valve	225 bar	330 bar
Sound pressure	87 dB(A)	87 dB(A)
Sound (immersion) power	100 dB(A)	100 dB(A)
Weight (approx.)	46 kg	46 kg
Compressor block	**U10, mod. 2**	**U10, mod. 2**
Number of stages	3	3
Number of cylinders	3	3
Cylinder bore 1st stage	60 mm	60 mm
Cylinder bore 2nd stage	28 mm	28 mm
Cylinder bore 3rd stage	12 mm	12 mm
Piston stroke	24 mm	24 mm
Speed	2,300 min^{-1}	2,300 min^{-1}
Intermediate pressure 1st stage	5.5 bar	6.5 bar
	80 psi	95 psi
Intermediate pressure 2nd stage	55 bar	65 bar
	800 psi	942 psi
Compressor block oil capacity	360 cm^3	360 cm^3
	12 fl. oz.	12 fl. oz.
Oil type	see chap. 2 lubrication	
Max. ambient temperature	+5 ... +45 °C	+5 ... +45 °C
	+43 ... +113 °F	+43 ... +113 °F
Max. permissible inclination of compressor[b)]	10°	10°
Drive motor	**Honda petrol engine**	
Manual start model (B)	GX 160 K1 QMC8	
Power	4.0 kW/5.5 PS	
at nominal speed	3,600 min^{-1}	

a) free air delivered at tank filling from 0 to 200 bar

b) these values are valid only if the oil level of the compressor in normal position corresponds with the upper mark of the oil dipstick and may not be exceeded.

1.4.5. Compressor unit UTILUS 10 with three phase current motor

Compressor unit	**U10 E**	**U10E-H, -HU**
Delivery[a)]	110 l/min.	110 l/min.
Operating pressure	PN 200	PN 300
Pressure setting, final pressure safety valve	225 bar	330 bar
Sound pressure	84 dB(A)	84 dB(A)
Weight (approx.)	44 kg	44 kg
Compressor block	**U10, mod. 2**	**U10, mod. 2**
Number of stages	3	3
Number of cylinders	3	3
Cylinder bore 1st stage	60 mm	60 mm
Cylinder bore 2nd stage	28 mm	28 mm
Cylinder bore 3rd stage	12 mm	12 mm
Piston stroke	24 mm	24 mm
Speed	2,300 min^{-1}	2,300 min^{-1}
Intermediate pressure 1st stage	5.5 bar	6.5 bar
	80 psi	95 psi
Intermediate pressure 2nd stage	55 bar	65 bar
	800 psi	942 psi
Compressor block oil capacity	360 cm^3	360 cm^3
	12 fl. oz.	12 fl. oz.
Oil type	see chap. 2 lubrication	
Max. ambient temperature	+5 ... +45 °C	+5 ... +45 °C
	+43 ... +113 °F	+43 ... +113 °F
Max. permissible inclination of compressor[b)]	10°	10°
Drive motor	**Three phase current**	
Operating voltage	400 V, 50 Hz	400 V, 50 Hz
Power	2.2 kW/3 PS	2.2 kW/3 PS
Speed	2,880 min^{-1}	2,880 min^{-1}
Size	90 L	90 L
Type of construction	B3	B3
Type of enclosure	IP54	IP54

a) free air delivered at tank filling from 0 to 200 bar

b) these values are valid only if the oil level of the compressor in normal position corresponds to the upper mark of the oil dip-stick and may not be exceeded.

1.4.6. Compressor unit UTILUS 10 with alternating current motor

Compressor unit	**U10W**	**U10W-H, -HU**
Delivery[a)]	110 l/min.	110 l/min.
Operating pressure	PN 200	PN 300
Pressure setting, final pressure safety valve	225 bar	330 bar
Sound pressure	84 dB(A)	84 dB(A)
Weight (approx.)	45 kg	45 kg
Compressor block	**U10, mod. 2**	**U10, mod. 2**
Number of stages	3	3
Number of cylinders	3	3
Cylinder bore 1st stage	60 mm	60 mm
Cylinder bore 2nd stage	28 mm	28 mm
Cylinder bore 3rd stage	12 mm	12 mm
Piston stroke	24 mm	24 mm
Speed	2,300 min^{-1}	2,300 min^{-1}
Intermediate pressure 1st stage	5.5 bar	6.5 bar
	80 psi	95 psi
Intermediate pressure 2nd stage	55 bar	65 bar
	800 psi	942 psi
Compressor block oil capacity	360 cm^3	360 cm^3
	12 fl. oz.	12 fl. oz.
Oil type	see chap. 2 lubrication	
Max. ambient temperature	+5 ... +45 °C	+5 ... +45 °C
	+43 ... +113 °F	+43 ... +113 °F
Max. permissible inclination of compressor[b)]	10°	10°
Drive motor	**Alternating current**	
Operating voltage	230 V, 50 Hz	230 V, 50 Hz
Power	2.2 kW	2.2 kW
Speed	3,000 min^{-1}	3,000 min^{-1}
Size	LS 90 PC	LS 90 PC
Type of construction	B3	B3
Type of enclosure	IP44	IP44

a) free air delivered at tank filling from 0 to 200 bar

b) these values are valid only if the oil level of the compressor in normal position corresponds to the upper mark of the oil dip-stick and may not be exceeded.

1.5. AIR FLOW DIAGRAM

See Fig. 4. The air is drawn in through telescopic tube (necessary for units with petrol engine) -1, intake filter -2; compressed to final pressure in cylinders -3, -4, -5; recooled by inter-coolers -6, -7, and after-cooler -9. The pressures of the single stages are protected by safety valves -10, -11, -12.
The compressed air is pre-cleaned in intermediate separator -8 and purified in filter system P21 -13. Intermediate separator and filter system P21 are drained by means of condensate drain valves -15. Pressure maintaining valve -16 provides a constant pressure within the filter assembly.
The compressed, purified air is passed through filling hose -17 and filling valve -18 to the bottles to be filled. Filling pressure is indicated at pressure gauge -19.
On HU model with change over device it is possible to fill bottles with 200 bar nominal pressure by opening valve -21 at filling valve -18. Safety valve -20 is adjusted to a blow off pressure of 225 bar.

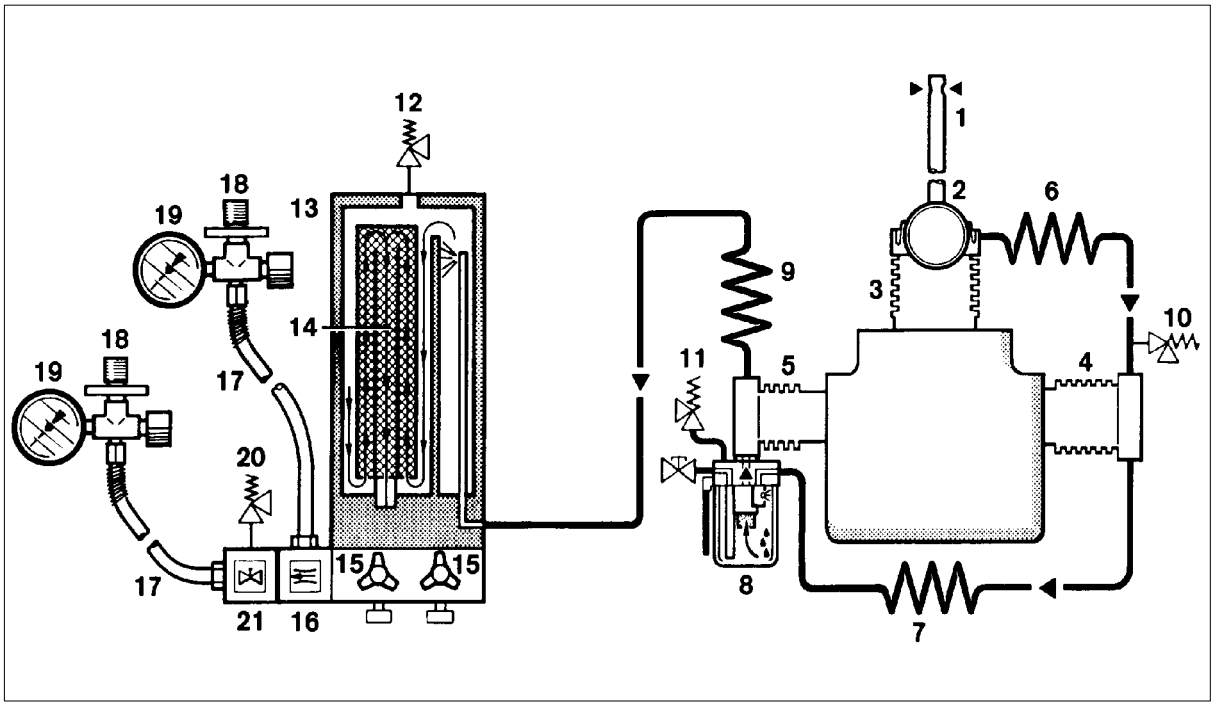


Fig. 4 Air flow diagram

1 Telescopic air intake
2 Intake filter
3 Cylinder 1st stage
4 Cylinder 2nd stage
5 Cylinder 3rd stage
6 Inter-cooler 1st/2nd stage
7 Inter-cooler 2nd/3rd stage
8 Intermediate separator 2nd/3rd stage
9 After-cooler
10 Safety valve 1st stage
11 Safety valve 2nd stage
12 Final pressure safety valve
13 Filter system P21
14 TRIPLEX longlife cartridge
15 Condensate drain valve
16 Pressure maintaining valve
17 Filling hose
18 Filling valve
19 Final pressure gauge
20 Safety valve, final pressure PN 200
21 Change over device*)

*) optional extra

2. LUBRICATION

2.1. OIL LEVEL CHECK

Check oil level daily prior to putting compressor into operation. Check using oil dipstick. Take care that dip stick is inserted completely. Note that the oil level must be between minimum and maximum dipstick notches (see Fig. 5).

Oil level must not go down below min.-mark but also not exceed max.-mark as this will cause excessive lubrication of compressor and result in valves sooting up.

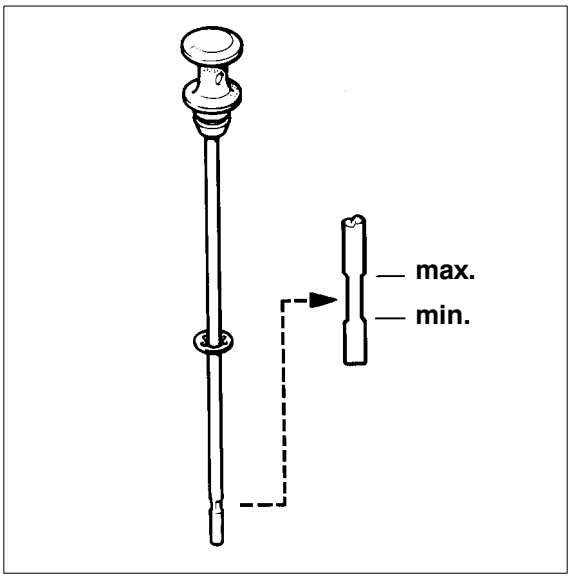


Fig. 5 Oil dipstick markings

2.2. TYPE OF OIL

For proper care and maintenance of the compressor, using the correct oil is of vital importance. Depending on the application of the compressor the requirements placed on the oil are:

- low deposits
- no carbonizing effect, especially in the valves
- good anti-corrosive properties
- emulsification of the condensate in the crankcase
- physiological and toxicological suitability.

Due to the thermal load on the compressor only high quality oil should be used. You are recommended to restrict oils to those which have been approved by us and are listed in our lubricating oil list. This list is available through our Technical Service Department.

2.2.1. Synthetic lube oils

For operation under severe conditions such as continuous running and/or high ambient temperatures we recommend the following synthetic compressor oil, only:

Part No. N 19745 (synthetic oil with corrosion protection)

This oil is tested in our compressors and has proved excellent quality under ambient temperatures between +5 °C (41 °F) and +45 °C (113 °F). The change intervals will be as shown in para. 2.3.

NOTE

All our compressor units are delivered with oil (which, depending on the model is filled into the crankcase, or separate in the consignment), part no. N 19745.

2.2.2. Mineral lube oils

For operation under less severe conditions we can also recommend **High Pressure Compressor Oil, part no. N 16725**, due to its preservative properties and the price advantage. This oil meets the specifications of VD-L group 150 according to German standard DIN 51506. It is suitable for operation under ambient temperatures between +5 °C (41 °F) and +35 °C (95 °F).

2.2.3. Changing the oil type

If you should wish to use a mineral oil (e.g. part no. N 16725) on later oil changes, no problems should arise, but:

CAUTION

To avoid severe damage to the compressor unit when changing from a mineral oil to a synthetic oil, the following measures should be strictly adhered to.

- Drain mineral oil completely while still warm.
- Change or clean oil filter, valves, coolers, separators, purifiers and all pneumatic tubes and hoses from deposits.
- Fill compressor with synthetic oil.
- After approx. 100 operating hours clean or replace filter again. If oil filter is badly soiled, check lubricating oil for degree of contamination, and change oil again if necessary.
- Perform subsequent oil changes according to chapter 2.3.
- Refill compressor with synthetic oil only.

2.3. OIL CHANGE

Part. No. N 16725	every 1,000 operating hours, at least annually
Part. No. N 19745	every 2,000 operating hours, at least bi-annually
Oil capacity	**approx. 360 cm^3 (12 fl. oz.)**

BAUER compressor oil is available in the following quantities:

Qty.	**Mineral oil, Part. No. N 16725**	**Synthetic oil, Part. No. N19745**
1 l	Part. No. 070699	Best.-Nr. 070693
5 l	Part. No. 070700	Best.-Nr. 070694
20 l	Part. No. 070701	Best.-Nr. 070695

Change oil also prior to laying up the compressor. When changing oil, also change the lubricating oil filter.

- Run compressor warm.
- Drain oil while still warm by means of oil drain plug. Refill with oil through the oil filler neck. Replace the sealing, reinstall drain plug and tighten well.
- Oil level is checked with oil dipstick, see Fig. 5 - oil level is correct if at upper mark.

3. INTAKE FILTER

3.1. DESCRIPTION

A dry micronic filter is used to filter intake air (Fig. 6).

3.2. TELESCOPIC INTAKE TUBE

All units are equipped with a telescopic intake tube which is placed behind the belt guard. The use of it is also recommended for electric power driven compressor units.

The telescopic intake tube has to be inserted in opening 5, Fig. 6 and is necessary to ensure clean air.

3.3. INTAKE FILTER MAINTENANCE

Filter cartridge must be changed at regular intervals according to maintenance schedule in chapter 15.

- Remove knurled nut (1) and take off plastic cap (2). Remove filter cartridge (3, part no. N4823) and clean with brush or by blowing air inside out.
- Turn cartridge through 90° when replacing. Replace dirty cartridge once it has been turned three times and thus made used on all sides.
- Clean filter housing inside with a damp cloth. Take care to prevent dust from entering intake pipe.
- Replace O-ring (4, part no. N4877) if damaged.

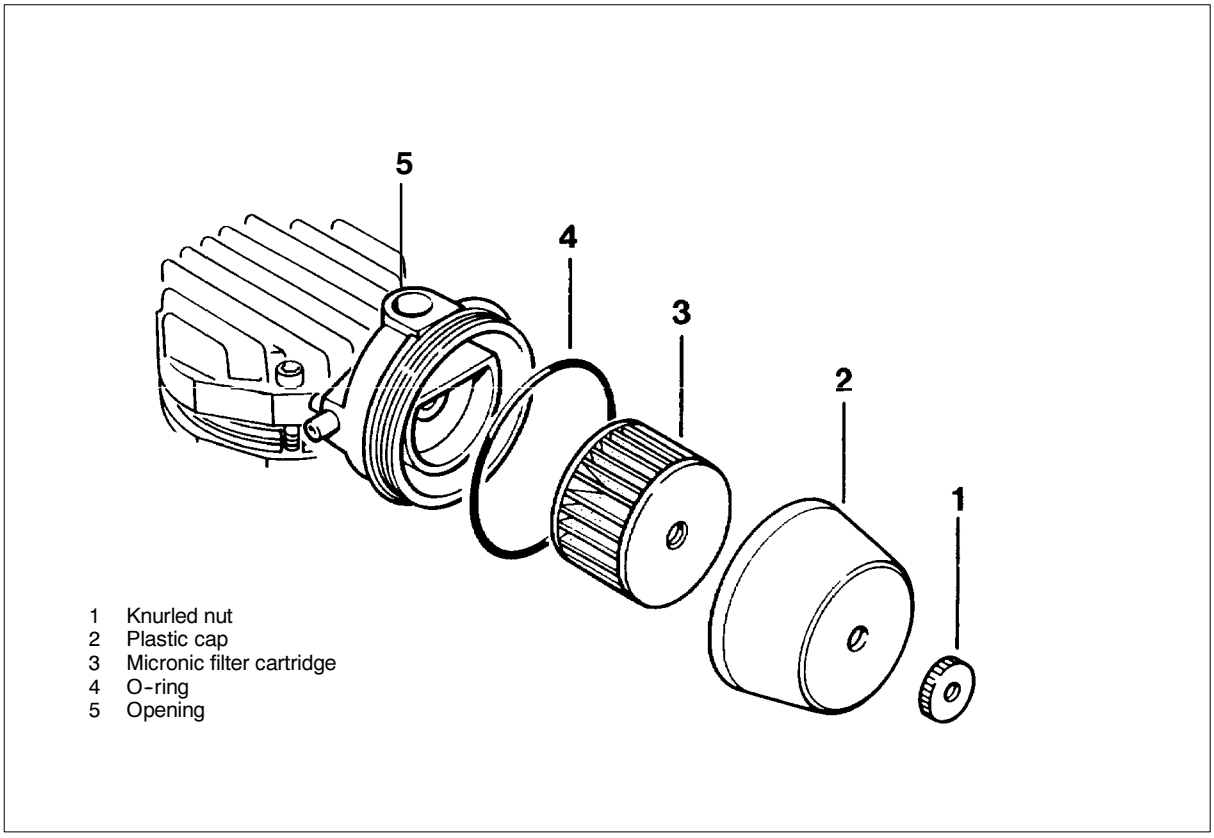


Fig. 6 Intake filter

4. INTERMEDIATE SEPARATOR

4.1. FUNCTIONAL DESCRIPTION

An intermediate separator is mounted on the compressor between 2nd and 3rd stage. It is designed to remove water and oil accumulating due to cooling the compressed medium down after the compression process. Separation is achieved by means of a nozzle (1, Fig. 7). A sintered metal filter (2) is provided additionally to remove dirt contamination.

4.2. INTERMEDIATE SEPARATOR MAINTENANCE

Proper operation will rely on the intermediate separator being properly serviced.

Drain off condensate every 15 to 30 minutes.

Clean sintered filter element as follows (for maintenance intervals refer to chapter 15):

- To remove sintered filter element, remove knurled nut (3).
- Remove filter housing (4).
- Remove nut (5), and take out sintered filter element (2).
- To clean filter element, the best method is to use hot soapy water and to blow dry with compressed air.

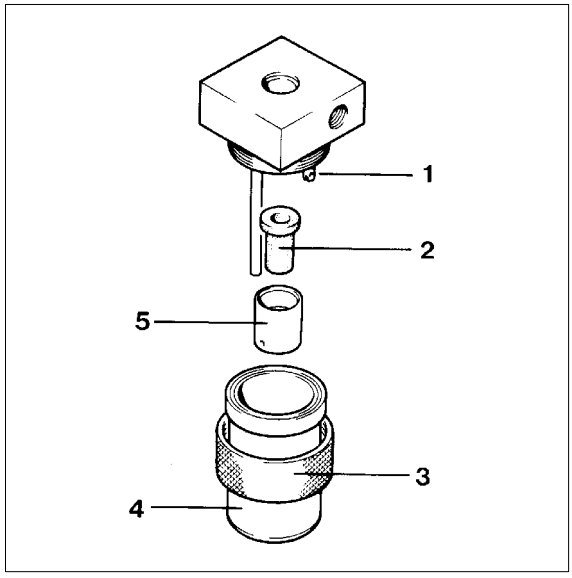


Fig. 7 Intermediate separator

5. FILTER SYSTEM P21

5.1. APPLICATION AND SUMMARY DESCRIPTION

Air leaving final stage is cooled in the after-cooler to approx. 10 - 15 °C (18 - 27 °F) above ambient temperature and then enters filter system **P21** with **TRIPLEX** longlife cartridge (Fig. 8). The filter assembly consists of separator and cartridge chamber. In the separator surrounding the cartridge chamber liquid oil and water particles are reliably separated from the compressed medium by a pipe nozzle.

Residual oil and water vapors are then removed by the **TRIPLEX** longlife cartridge. The air leaving the filter assembly is then free of oil, taste and smell.

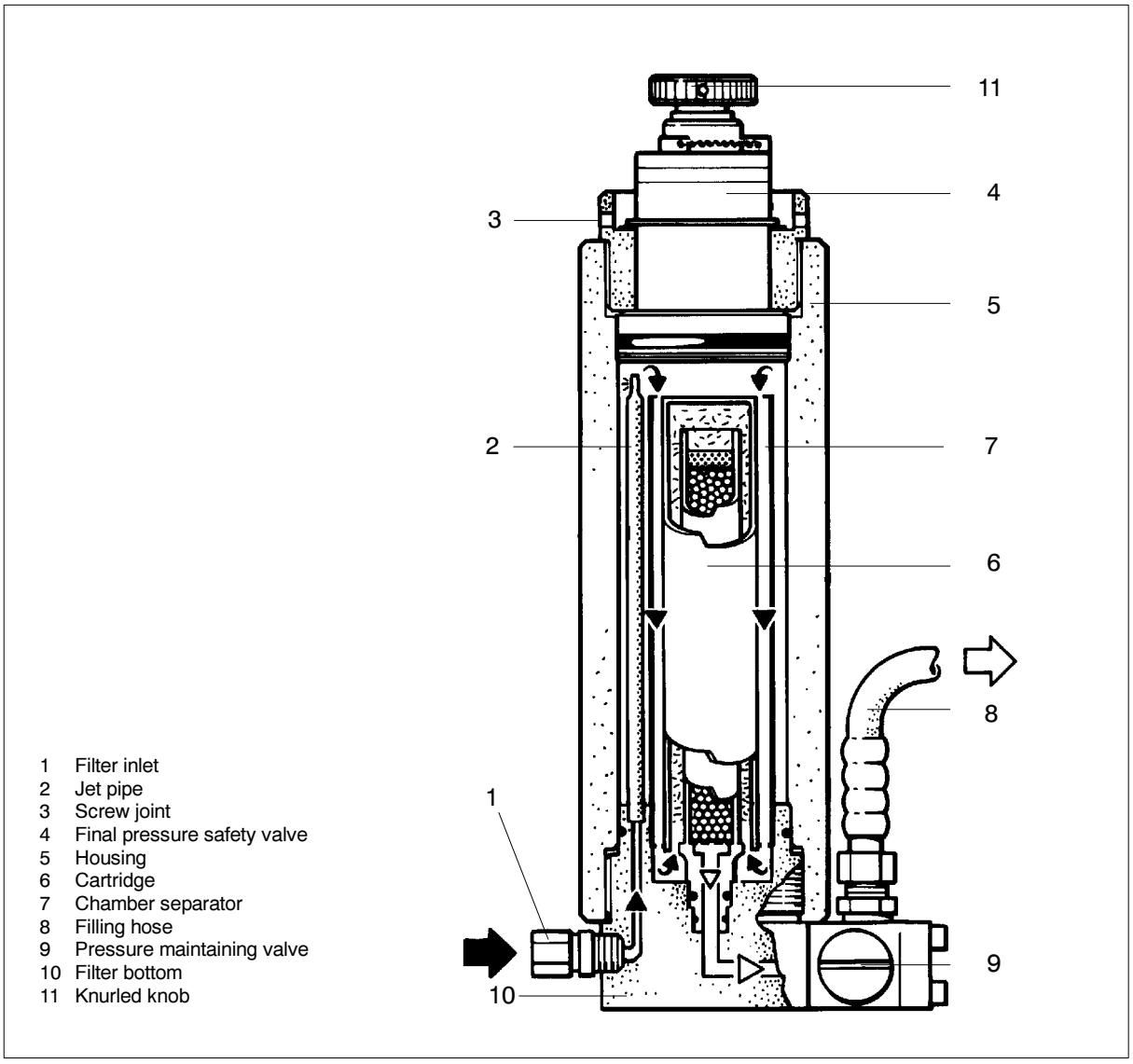


Fig. 8 Filter system P21

5.2. CARTRIDGE SAFETY BORE

The filter system **P21** is designed to prevent pressurizing in the absence of the filter cartridge. A bore provided in the filter bottom is sealed air-tight only if the cartridge is in place (Fig. 9).

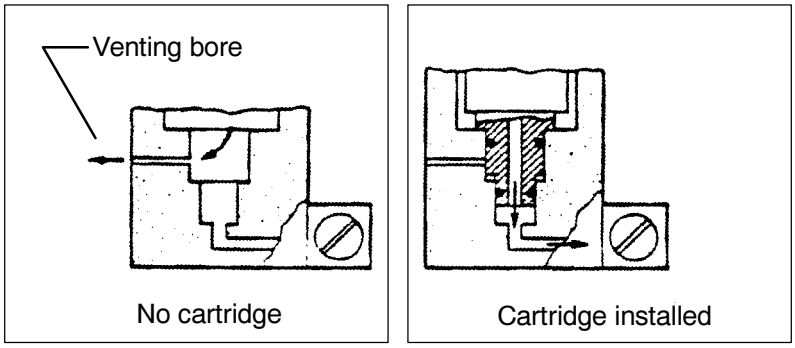


Fig. 9 Safety bore

NOTE

No pressure build up without cartridge!

Without cartridge the venting bore is not sealed, the air escapes into the atmosphere, no pressure can be built up and thus it is ensured, that unfiltered air is not supplied to the consuming device.

The venting bore is also used to check the O-rings on the cartridge pin. If air is leaking out of the venting bore even though a cartridge is installed, the O-rings are either broken or were damaged on installation.

Remove and check cartridge. If necessary replace cartridge or O-rings.

5.3. LIFETIME

WARNING

The filter system is subject to dynamic load. It is designed for a certain number of load cycles, which originate from an abrupt pressure loss at condensate drain (1 load cycle i.e. condensate drain = 1 depressurization, 1 pressurization). After reaching the max. number of load cycles the filter assembly must be replaced, otherwise the housing may burst due to material fatigue.

The max. number of load cycles for the P21 Central Filter Assembly part no. KB 062211-410 is **4,500** if operated at the max. allowable pressure difference range of 330 bar (4,700 psi). For a pressure difference of 225 bar (3,200 psi) the max. no. of load cycles is **63,000**.

To avoid exceeding the max. number of load cycles the operating hours should be recorded in the table in chapter 16.3.1 of this instruction manual. On condition that a max. number of four cycles per hour is not exceeded (condensate is drained every 15 minutes) the max. number of operating hours is 1,125 for 330 bar units. It is not necessary to record the operating hours for 225 bar units as the theoretical filter housing lifetime is 15,750 operating hours.

5.4. GENERAL INSTRUCTIONS FOR FILTER MAINTENANCE

- **The purifier cartridge must be replaced according to the table in the annex.**
- **Depressurize** system before starting any maintenance work.
- **Dry** inside of filter housing with a clean cloth before installing new cartridge and check for corrosion.
- **Lubricate** threads and O-rings as well as threaded part of cartridge with white petrolatum DAB 9 order no. N 19091 or WEICON WP 300 white order no. N 19752.
- **Record** number of pressure bottles and/or operating hours to ensure exact attention to maintenance intervals (if an hour meter is installed observe number of operating hours as indicated to ensure exact attention to the maintenance intervals).
- **Change** cartridge before reactivating a compressor unit after out-of-service periods of more than 6 months.
- **Leave** cartridge in the filter as long as unit is out of service.
- **Keep** all condensate drain valves and taps closed. Keep a minimum pressure of approx. 50 to 80 bar (700 to 1,100 psi) within the system to prevent moisture entering the compressor piping and filter system.
- The nozzle type oil and water separator is maintenance-free.

CAUTION

For safety reasons only CO removal cartridges part no. KB 059183 should be used on compressor units with petrol engine.

On units with electric engine either CO removal cartridge part no. KB 059183 or TRIPLEX cartridge part no. KB 057679 should be used.

Units with petrol engine are delivered with CO removal cartridge part no. KB 059183 as standard, units with electric engine are delivered with TRIPLEX cartridge part no. KB 057679 as standard.

When changing from electric engine to a petrol engine also replace cartridge part no. KB 057679 with cartridge part no. KB 059183.

5.5. REPLACEMENT INTERVALS

For replacement intervals see table in the annex of this instruction manual.

5.6. CONDENSATE DRAINAGE

Drain condensate from separator and cartridge chamber regularly by slowly opening drain valves

- before each filling procedure
- during filling procedure every 15 minutes.

5.7. CARTRIDGE CHANGE

NOTE

Never remove spare cartridge from its packing prior to actual use. Otherwise the highly sensitive filling material will adsorb moisture from the ambient air, become saturated, and are useless.

- Depressurize filter system P21 by opening condensate drain valves.
- Unscrew knurled nut (3, Fig. 8) on top of the filter.
- Extract old cartridge and insert a new one.

NOTE

The used cartridge must be disposed of according to local regulations.

6. PRESSURE MAINTAINING VALVE

6.1. DESCRIPTION

A pressure maintaining valve is mounted at the outlet of the filter system P21.

It ensures that pressure is built up in the filter even from the start of delivery, thus achieving a constant, optimum filtration. It will also guarantee proper working conditions for the final stage cylinder.

The pressure maintaining valve is adjusted to **150 ±10 bar (2,175 psi)**.

6.2. MAINTENANCE

The pressure maintaining valve (Fig. 10) is adjusted at the factory to the required pressure and normally does not require regular maintenance or readjustment. In case of readjustment becoming necessary, loosen jam nut (2) and set screw (3). Adjust screw (1) to the required pressure using a suitable screw-driver.

Clockwise = increase pressure
Counter-clockwise = decrease pressure

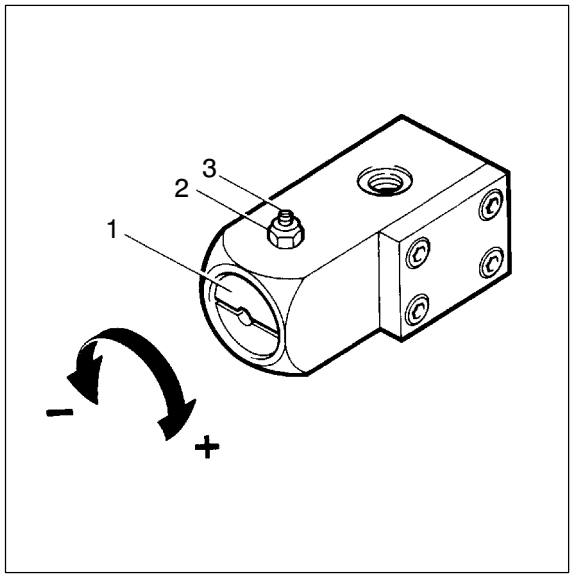


Fig. 10 Pressure maintaining valve

7. SAFETY VALVES

7.1. DESCRIPTION

All 3 compressor stages are protected by safety valves as follows

1st stage	**8 bar (116 psi)**
2nd stage	**80 bar (1,160 psi)**

The safety valve for protection of the last stage is mounted on top of the filter system P21 and is adjusted to the operating pressure of the unit see 1.4., Technical Data, but

max.	**225 bar (3,200 psi)**
for model -H max.	**330 bar (4,700 psi).**

The safety valves are sealed at the factory and adjusted to the corresponding pressure. If one of the intermediate pressure safety valves blows off, the valves in the next stage are not closing properly, affording valve check. The cause of the trouble is usually the inlet valve of the next stage. See also chapter 9.

7.2. MAINTENANCE

7.2.1. Operating check

The final pressure safety valve has to be checked regularly before starting each filling process.

For this purpose the safety valve can be vented manually. Turn knurled knob on top of the valve clockwise until valve blows off (Fig. 11).

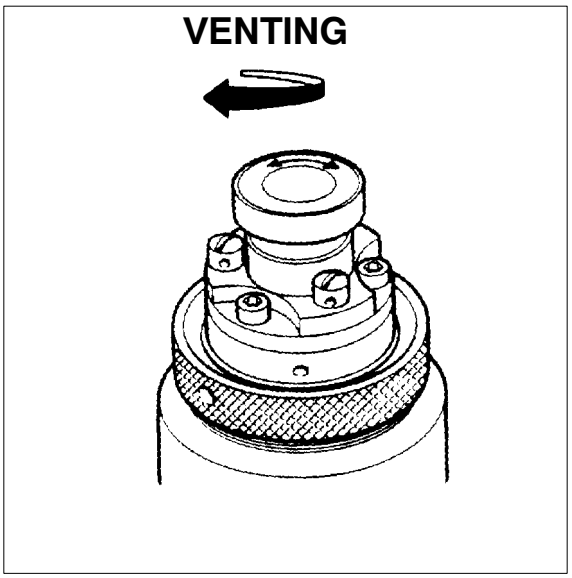


Fig. 11 Venting the final pressure safety valve

8. PRESSURE GAUGES

8.1. DESCRIPTION

8.1.1. Final pressure gauge

The final pressure gauge shows a red mark indicating the maximum operating pressure.

8.2. MAINTENANCE

If a pressure gauge indicates excessive pressure, and the corresponding safety valve does not blow off or indicates the pressure as being too low, check the pressure gauge for proper operation.

We recommend that pressure gauges are checked from time to time. For this purpose we have developed a special test pressure gauge with an adaptor which immediately recognizes any deviations in readings. For any further information please contact our Technical Service Department.

Slight deviations during operation are normal and can be ignored. Excessive inaccuracy will require the pressure gauge to be readjusted or sent back for repair.

9. VALVES

9.1. FUNCTIONAL DESCRIPTION

The valve heads of the individual stages form the top part of the cylinders. The intake and pressure valves are fitted inside the valve heads. Note that the valves are operated by the flow of the medium. On the suction stroke, the intake valves open and the medium flows into the cylinders. At the start of the compression stroke the intake valve closes and the medium opens the pressure valve, Fig. 12.

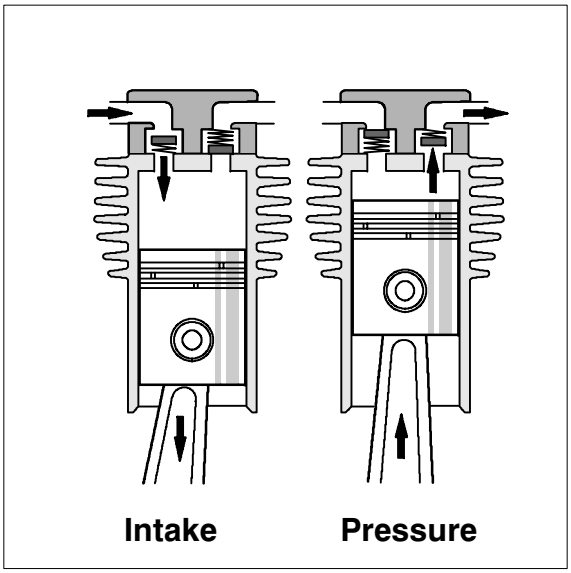


Fig. 12 Valve operation

9.2. INITIAL OPERATIONAL CHECK

After maintenance work on the valves, valves should be checked. Note that the intake line to the valve heads should be warm and outlet piping should be hot. Valves are then operating properly.

If the intake pipe to the valve head of the second stage heats up excessively, and the first stage safety valve blows off, either the intake or pressure valve of second stage is malfunctioning. It is therefore necessary to remove the valve head and to check and clean these valves, or to replace them.

9.3. GENERAL INSTRUCTIONS FOR CHANGING THE VALVES

- **Always replace** valves as a complete set.
- **Carefully clean** dirty valves. Never use a sharp tool for this purpose. Soak the valves in diesel oil or petroleum and clean with soft brush.
- **Check** individual components for excessive wear. If the valve seat and valve disks are dented, replace the valves.
- **Valve head screws** must be tightened with a torque wrench (see tightening torque values chapter 18).
- **Check** the valve space in the valve heads for dirt and clean, if necessary.
- **Use only** satisfactory gaskets and O–rings on reassembly.
- **Observe** the correct sequence when fitting together again.
- **After finishing** all maintenance work on the valves, turn the compressor manually using the flywheel and check whether all items have been correctly installed.
- **30 minutes after restarting** the compressor unit stop unit, let it cool down to ambient temperature and retighten valve studs and cap nuts. Otherwise valves could work loose due to setting of the gaskets.
- **Remove and check** the valves every **1,000 operating hours.**
- **Replace** the valves every **2,000 operating hours** to avoid fatique failure.

9.4. CHANGING THE VALVES OF THE 1ST STAGE

Intake and pressure valves of the 1st stage are combined in one plate valve under the valve head, see Fig. 13.

- Loosen two cap nuts from tube connectors and remove after-cooler.
- Remove four allen screws (5) from valve head (1). Take off valve head.
- Remove gasket (2) and plate valve.
- When re-installing the valve, check that mark "TOP" is facing upwards. Also pay attention to the orientation of the valve: check that the two eye-shaped inlet openings of the intake valve are facing the intake filter side. The crossbar of gasket (2) seals these openings with respect to the outlet openings of the pressure valve.

1 Valve head
2 Gasket
3 Plate valve
4 O-ring
5 Valve head screw

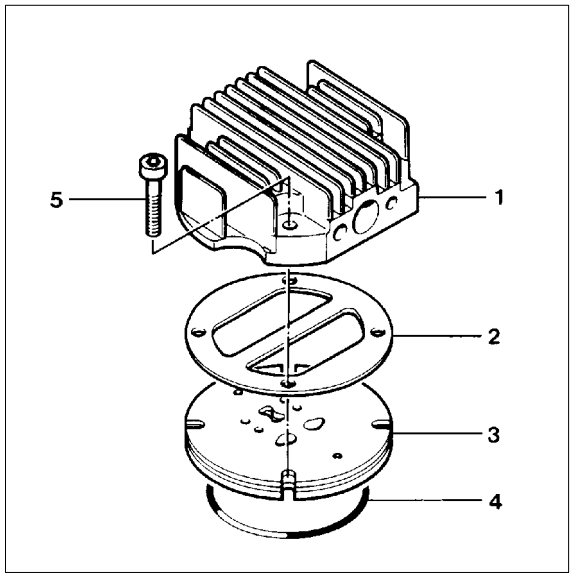


Fig. 13 Valve head 1st stage

9.5. CHANGING THE VALVES OF THE 2ND STAGE

Both, pressure and intake valves can be serviced from outside, see Fig. 14.

- Remove two captive nuts (1) and spring-washers (2).
- Remove plate (3).
- Remove valves (4) and (7) using two screwdrivers as shown in Fig. 16.
- Assemble in reverse sequence. Position spring-washers with curved side facing upwards. Fasten nuts so that plate (3) is parallel to the valve head. Torque with 10 Nm (1 kpm).

1 Nut
2 Spring-washer
3 Plate
4 Pressure valve
5 O-ring
6 Valve head
7 Intake valve
8 Valve head screw

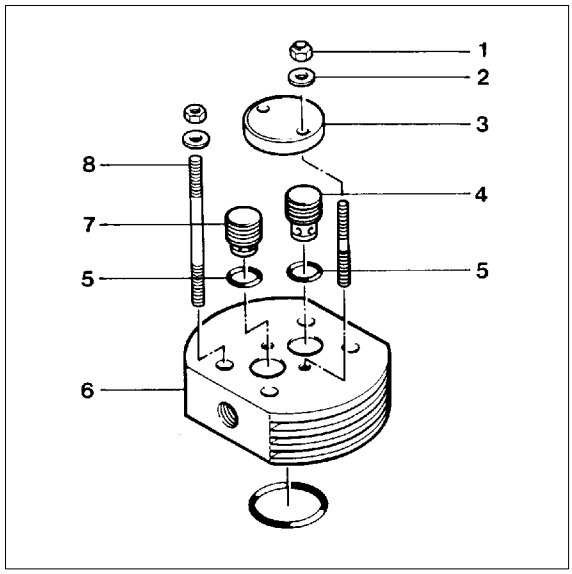


Fig. 14 Valve head 2nd stage

9.6. CHANGING THE VALVES OF THE 3RD STAGE

On this valve head, the valves are arranged on the upper and lower side due to the small diameter of the 3rd stage, see Fig. 15.

For removal and installation of the intake valve (4) use special tool which is also part of the tool set delivered with the unit.

Pressure valve (3) is merely inserted into valve head (5). It is sealed by O-ring (2) and fixed to the valve head by bolt (1).

CAUTION

Change intake and pressure valve of 3rd stage together only.

Removal of 3rd stage pressure valve (3).

- Unwind screw (1) a couple of turns.
- Remove allen screws (7), take off valve head cover (6).
- Put two screwdrivers into the groove of pressure valve body, see Fig. 16. If necessary turn valve loose at first using a 13 mm spanner on the flat surfaces.
- Lift out pressure valve (3) together with O-ring (2).

Reinstall pressure valve (3) in reverse sequence:

- Put O-ring (2) into valve head (5). Check O-ring for abrasion.
- Insert pressure valve (3). Install valve head cover (6).
- Fasten valve head with allen screws (7) and washers (8).
- Screw in and torque stud (1) with 20 Nm (2 kpm).

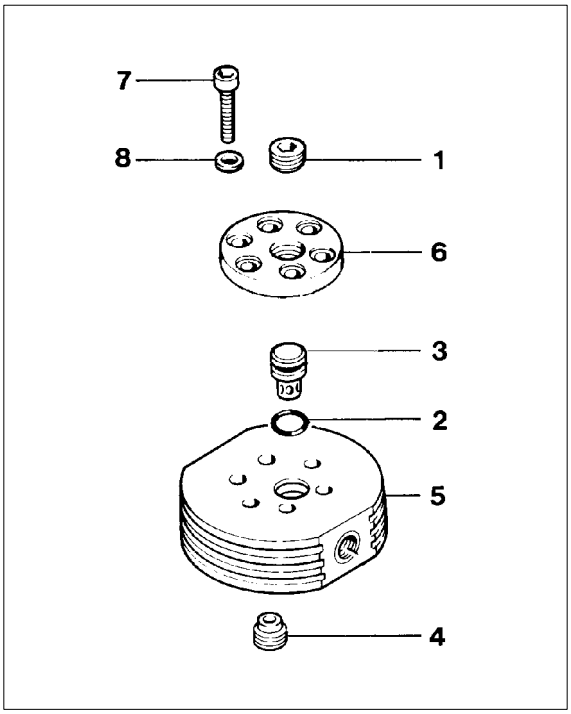


Fig. 15 Valve head 3rd stage

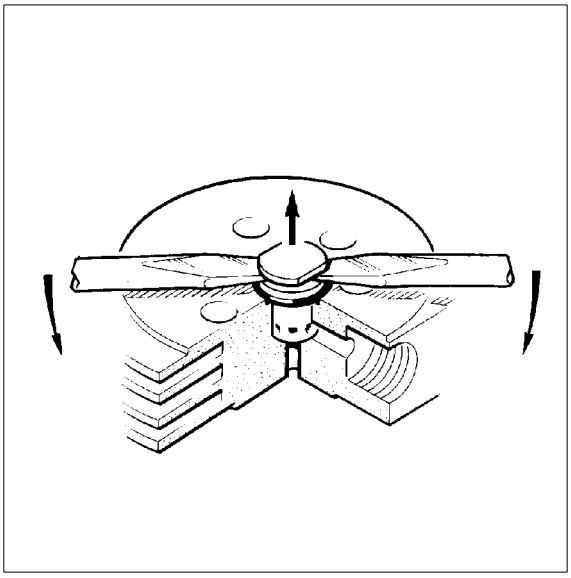


Fig. 16 Removal of 3rd stage pressure valve

10. ELECTRICAL SYSTEM

This section describes the standard electrical system.

NOTE

For schematic diagram, see annex.

The electrical equipment of the compressor unit consists of:

- drive motor M1
- electric control system

To start the electric motor and enable the functioning of the controls as well as the monitors, the following components are essential:

- main switch Q1 and
- main fuse, both to be installed by the customer.

10.1. Drive Motor

The compressor unit is driven by an electric motor by means of V-belts. Check the V-belts regularly for tension and wear. See chapter 12.

Except for external cleaning, the drive motor requires no servicing. The motor bearings may need lubricating, depending on the model. Please observe the instructions written on the motor.

10.1.1. Motor protection switch for units with three-phase motor

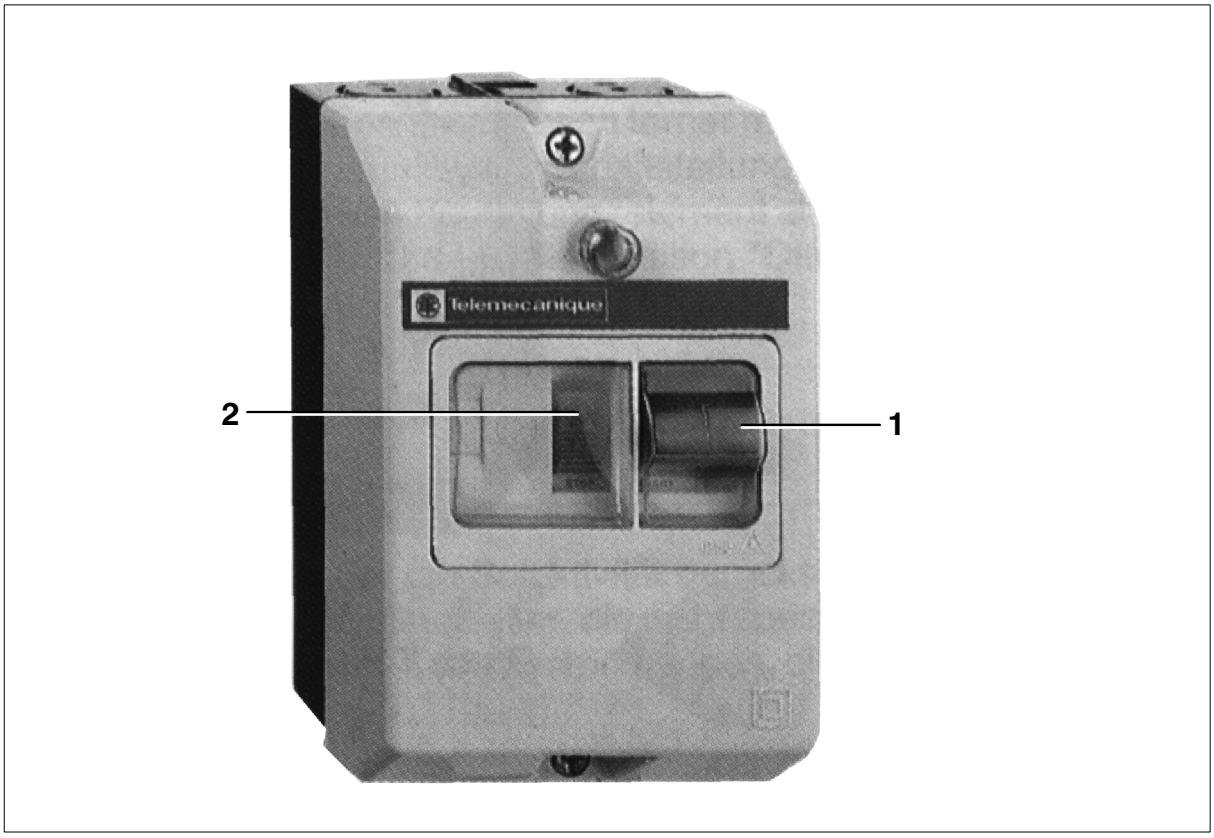


Fig. 17 Motor protection switch

Protection of the motor is ensured by the thermomagnetic releases integrated into the motor protection switch. The response value of the electromagnetic releases (protection against short-circuit) is preset.

The motor is switched on manually by pressing the start button (1). It is switched off either manually by pressing the stop button (2) or automatically by a thermic release.

For safety of the operating personnel all voltage carrying parts have a protective cover.

NOTE

The motor can only be restarted by pressing the start-button.

11. COOLING SYSTEM

11.1. GENERAL

The cylinders of the compressor block, the intermediate coolers and the after-cooler are air-cooled.

For this purpose, the compressor is equipped with a fanwheel connected to the counter-weight at the crankshaft end opposite to the V-belt pulley. It draws the cooling air through the fanwheel cover from the surroundings.

Refer to chapter 14 for proper installation and cooling air supply.

For maximum ambient temperature, see Technical Data, chapter 1.4.

12. SAFETY REGULATIONS

12.1. GENERAL

WARNING

The compressors described in this manual are not suitable for compression of oxygen. EXPLOSION occurs if an oil lubricated compressor is operated with pure oxygen or gases with an oxygen content of more than 21%!

CAUTION

Always shut down and decompress the complete system prior to carrying out any work on the compressor.

CAUTION

Always disconnect the system from mains supply prior to carrying out any work on compressor systems with electric drive motor.

WARNING

Never open filling valves when under pressure and not connected as highly compressed air emerging can cause serious accidents.

WARNING

Never repair pressure lines by soldering or welding.

WARNING

Ensure intake air is free from noxious gas, exhaust fumes and solvent vapour.

CAUTION

Check the complete system for leakage from time to time by brushing all fittings and couplings with soapy water or spraying with leak test spray. Repair any leakage.

CAUTION

Filling hoses must be in satisfactory condition and threads undamaged. Pay particular attention to damage on the interface from hose fitting to hose. If the rubber is scored, hose must be discarded otherwise water can enter and attack wire gauze causing it to rust and thus endangering pressure tightness.

12.2. SAFETY REGULATIONS (Germany only)

A compressor is identified by German law as being a filling system if pressure cylinders are filled by the system, especially when these cylinders are made available for third parties. The start-up and operation of compressor systems for use as filling stations is governed in the Federal Republic of Germany by the following regulations:

a- Pressure vessels regulations (DruckbehV) as of 23 December 1993,

b- Technical regulations for pressure gases (TRG 400, 401, 402, 730).

If a high pressure compressor is used as an industrial plant for filling pressure vessels or for the supply of pneumatic systems, the following regulations apply:

c- Accident Prevention Regulations (UVV):

- UVV compressors (VBG 16),
- UVV pressure vessels (VBG 17).

If an industrial unit is used as a filling station, a. and b. will also apply. With regard to the manufacturer, all regulations have been observed and the compressor is designed accordingly.

Copies of the above regulations are available through the usual outlets, e.g. in Germany from:

Carl Heymanns Verlag
Luxemburger Str. 449
50939 Köln

Beuth-Vertrieb GmbH
Burggrafenstr. 4 - 7
10787 Berlin

In accordance with the regulations for prevention of accidents, all compressor units have to undergo an acceptance test at their location before bringing them into service. Consequently the containers must be registered with the relevant supervising authorities, presenting the receiver test certificates supplied with the unit. The test certificates must be kept carefully, as they will be required for possible inspections by the supervising authorities.

No guarantees whatsoever are valid for damage caused or favoured by the non-consideration of these directions for use. The maintenance of our compressors should be carried out by qualified and reliable personnel only.

Excerpts from the above regulations are given below. We strongly recommend that they are observed.

- According to item 10 of the regulations concerning pressure vessels, pressure vessels shall undergo regular inspection:

  (1) Vessels from groups IV and VII shall undergo regular inspection carried out by a qualified inspector at intervals stated in paragraphs 4 and 9.

  (2) Vessels from group 1, which are used for gas, combustible corrosive or toxic vapours or liquids, as well as vessels from groups II, III and IV shall undergo regular inspection carried out by a qualified inspector on a date set by the operator according to the mode of operation and the medium compressed.

  (3) Regular inspection shall include the inspection of interiors and pressure. For vessels that will be heated by fire, exhaust fumes or electrically, regular inspections shall also include exterior inspection, carried out, as a rule, on pressure vessels in use. Interior inspection (according to section 1) shall be carried out, if this cannot be done in its entirety, pressure inspection or other equivalent inspection shall be carried out. Pressure inspection (ref. section 1) must be replaced by non-destructive inspection if pressure inspection is not possible due to the construction of the vessel or the mode of operation.

(4) Interior inspection of pressure vessels from groups IV and VII shall take place every 5 years, pressure inspection every 10 years and exterior inspection every 2 years.
The supervising authority is authorised in particular cases to:
1. lengthen inspection intervals, providing safety is guaranteed
2. shorten inspection intervals, if this is necessary to protect employees or other persons.

(5) If inspection intervals for pressure vessels are included in traffic regulations concerning internal transport, these supersede intervals stated in paragraph 4 section 1.

(6) Interior and pressure inspection intervals commence after the first inspection on reception and following re–location after the new reception inspection.
Inspections must be carried out, at the latest, 6 months after the renewal date. Contrary to section 1, the intervals begin:
1. after the construction inspection, if this took place 2 years before the first reception inspection
2. after the last interior examination, if this took place 2 years before the new reception inspection.

(7) The inspection interval is considered completed if the inspection takes place during the calendar year in which it is due.

(8) If the pressure vessel is not in use on the day of inspection, the inspection due should be carried out before it is used again.

(9) If an additional inspection is carried out, the interval for the following inspection begins after the additional inspection, as long as the additional inspection corresponds with the scheduled inspection.

(10) Pressure vessels from groups IV or VII shall only be used again, after the inspection is due, if the inspection has already taken place within the stated period and if the authorised inspector has certified the vessel satisfactory according to inspection guidelines.

(11) If the authorized inspector has not declared the pressure vessel to be in perfect condition, the supervising authority shall decide on the outcome.

(12) §9, para. 9 will be applied accordingly.

- **Regulations governing the handling of pressure vessels (DruckbehV). Paragraph 15 of these regulations (dating from 23 December 1993) requires that a mobile pressurized tank – in this case a compressed air cylinder – shall only be filled with gas or air under pressure if:**

  a) the cylinder is identified with the mark and date of inspectorate approval together with the inspection interval;

  b) when the inspection interval has not expired (inspection interval is governed by paragraph 23 of the regulation);

  c) the cylinder or tank in question exhibits no defects which could result in a hazard to those concerned or third parties (e.g. faulty valve).

Only compressed air cylinders shall be filled with the system – never oxygen cylinders. the connecting screw thread (DIN 477) shall be designed to make direct connection of oxygen cylinders impossible. The use of connecting unions is prohibited.

- **TRG 402, operating filling systems**

  2. Personnel and personnel instruction

  2.1 Filling systems shall only be operated and maintained by persons who:

  1. are more than 18 years of age
  2. are competent and trained in the use of the system
  3. can be expected to do their job satisfactorily.

2.2 Supervised operations can also be executed by persons who do not fulfil requirements stated in 2.1. items 1 and 2.

2.3 Prior to starting their job and periodically in reasonable intervals, however at least once a year, operating personnel are to be instructed regarding the following subjects:

1. the particular hazards involved in handling compressed gases
2. safety regulations, especially those of the TRG
3. what to do in case of fault, damage and accident
4. how to use fire extinguishers and other safety equipment
5. operation and maintenance of the filling systems according to the instruction manual [a)] (see item 3.1).

2.4 A written record shall be kept with regard to the instructions of 2.3 requiring the signature of the employee as acknowledgement of instruction.

2.5 Items 2.3 and 2.4 also apply to persons who are only temporarily involved.

3. Operation

3.1 An operating manual[a)] in plain, understandable language must be provided for each and every filling system and must detail procedures to ensure correct operation and to avoid hazards and accidents.
Copies of these instructions and translations thereof must be available to the operating and maintenance personnel at all times.

3.2 High risk work (in conjunction with the maintenance of such systems) which cannnot be carried out according to item 3.1 in the instruction manual must only be carried out according to separate, written instructions by the contractor or his representative in which the responsibilty for supervision activities is clearly stated[b)].

3.6 If pressurized gases can be isolated in sections of a filling system which can be closed so that the pressure can become hazardous under the effects of heat, measures must be taken to ensure that the pressure is relieved immediately after isolating the section, unless means are already provided for eliminating the occurence of a hazardous pressure [c)].

3.7 Empty cylinders or tanks must be filled as quickly as possible and filled cylinders or tanks shall be removed from the premises as quickly as possible (see TRG 401 item 3.2, sentence 2, No. 2). Empty or filled cylinders and tanks shall not be placed where they obstruct an escape route, it is therefore prohibited to place tanks or cylinders in passageways and stairways of any kind.

5. Filling procedure

5.1 A pressurized gas tank or cylinder shall be filled only with the pressurized gas as identified on the tank or cylinder and only to the amount stated on the tank resulting from the corresponding pressure, weight or volume (see para. 15, section 2, DruckbehV).

6. Procedure after filling

6.3 Defects on cylinders and filling tanks

Should a filled pressurized gas cylinder or tank prove to leak on inspection in a way which does not permit immediate remedy or should the filled cylinder or tank exhibit a defect of any kind which could result in a hazard to the handling personnel or third parties, said cylinders or tanks shall be immediately rendered harmless by discharge (see para. 21, section 1, DruckbehV).

9. Testing and servicing filling systems

9.1 Testing filling system leakage

9.1.1 Filling systems and selection of such systems shall only be put into operation for the first time after a major modification or after repair when they have been checked for leakage by an authorised technician or on order of the contractor by an inspector. Testing by the technician shall only be carried out under supervision of the contractor or his representative.

9.1.2 For the purpose of testing, a pressurized gas shall be used which is available in gaseous form under the condition of testing. If the gas is flammable or highly toxic, it is mandatory that the necessary safety measures be taken. The test gas shall not aggravate the materials of the system being tested, resulting in hazardous reaction. Where there is a possibility of the test gas reacting with the pressurized gas of the system, the system must be adequately flushed. On systems intended for pressurized gases which are sensitive to moisture, the test gas must be free from water or the system must be suitably dried on completion of testing. On filling systems utilizing oxygen, the test gas must be free from oil. [d].

9.1.3 The pressure shall be elevated gradually in increments until the highest operating pressure of the system is attained.

9.1.4 Testing shall be documented and the documents duly held in a safe place. The documentation shall identify:

1. date of testing
2. persons responsible for supervision
3. persons responsible for inspection
4. description of the system or sub–system being tested
5. test gas
6. description of the method of testing
7. any defect noted and how these defects were remedied.

9.2 Testing flexible piping

9.2.1 Flexible piping (i.e. hose pipes and articulated pipes) must be tested prior to first time operation and at least once every six months (hose pipes) or at least once a year (articulated pipes) and according to actual requirements to ensure satisfactory condition (i.e. no wear and tear or leakage). This shall be carried out by the manufacturer or the persons responsible for the filling operation.

9.2.2 Testing as per item 9.2.1 shall include the following individual tests:

1. visual inspection inside and outside to the extent possible to ascertain general conditions.
2. pressure testing to 1.5 times the highest service pressure.

9.2.3 Pressure testing hoses shall be carried out with water[e] or , if possible, with natural oil on articulated pipes, otherwise water. The test pressure shall be maintained for at least 10 minutes. Hoses shall be first tested when extended and then when rolled up (drum diameter approx. 30 times hose diameter).

9.2.4 The results of testing shall be certified by the manufacturer prior to first time operation and later testing shall be documented by the filling inspector. These certificates shall be filed in a safe place. The certificate shall identify:

1. date of testing
2. persons responsible for testing
3. nature and identification of the pipe tested
4. test medium
5. description of test method
6. any defects established and how they were remedied.

In addition, the manufacturer's test certificate shall identify the material and rated pressure. The certificate relating to the hose pipes shall state that the hose is suitable for the pressurized gas.

9.3 Maintenance

9.3.1 Infrequently used closing devices shall be checked at suitable intervals.

9.3.2 Items coming into contact with oxidizing pressurized gases shall be inspected for signs of oil grease in suitable intervals and cleaned as may be required.

10. Shutting down the system, reporting accidents and damage.

10.1 Should a filling system not be in proper condition, thus constituting a hazard for operating personnel or third parties, the system shall be shut down immediately (see para. 30, section 3, DruckbehV).

10.2 Any person operating a filling system is obliged to report any accident to do with the operation of the system in which a person has been killed or health damaged and shall file the details with the supervising authorities and the responsible accident insurance without delay (see para. 34., DruckbehV).

10.3 Item 10.2 also applies when a pressurized gas container having a capacity in excess of 1 litre (1.05 quarts) is split open or explodes inside or outside the filling system (see para. 34, DruckbehV).

---

a) See this Instruction Manual

b) The instructions for maintenance and repair are given in chapters 2 to 11 of this Instruction Manual

c) Does not apply to the compressor itself but to the filled compressed air cylinders

d) The only test medium to be used in conjunction with the compressor system is compressed air, i.e. the air produced by the compressor itself.

e) Filling hoses are to be dried thoroughly inside and outside after pressure testing

13. LOCATION, OPERATION

CAUTION

The compressor unit is not seawater resistant. At operation in salty air spray compressor with anticorrosive protection (e. g. Quicksilver Corrosion Guard). Electric driven units should be operated and stored below deck. Units with petrol engine should also be stored below deck after the filling process.

13.1. OUTDOOR LOCATION

For installation observe the following:

- Locate the unit level.
- On units employing petrol engine it is most important that only clean air be used, position compressor in direction of wind so that exhaust fumes are blown away from the unit.
- Turn unit as soon as wind direction changes.
- Take care that no vehicles are in direct vicinity with engines running.
- Do not operate unit in the vicinity of open fire (flue gas!).

CAUTION

Keep unit away from inflammable items. Do not smoke while petrol tank is open and while unit is in operation.

13.2. INDOOR LOCATION

CAUTION

Petrol driven units must not be operated indoors.

- Ensure adequate ventilation.
- Here too, air must be free from exhaust fumes and hazardous vapours (e.g. smoke, solvent vapours, etc.).
- If possible install unit in such a manner that the compressor fan can get fresh air from outside, for instance through an opening in the wall.
- Ensure that an adequate exhaust air opening is provided.
- When locating the compressor in small rooms where natural ventilation is not ensured, measures must be taken to provide artificial ventilation (this also applies when other systems having high radiation are operating in the same room).

  Artificial ventilation is effected by installation of a fan in the exhaust air opening.

13.3. ELECTRICAL INSTALLATION

For installation of electrical equipment observe the following:

- Comply with regulations of local electricity supply company.
- Arrange for the electrics to be connected by an electrician only.
- Ensure correct installation of protective conductor.
- Check conformity of motor tension and frequency with those of electric network.
- Operate electric units only on mains sockets equipped with fault current circuit breaker according to DIN VDE 0664 with a nominal differential current of less than 30 mA (up to 16 A in single-phase AC circuits).
- For units not connected through a plug, but permanently installed, a main switch must be provided which has a contact gap of 3 mm minimum on each pole.
- Fuse motor correctly (see table on next page; use slow-blow fuses, only).
- Immediately after start-up check direction of rotation for agreement with arrow on unit.

Voltage	110 V	127 V	220 V	**230 V**	240 V	250 V	**380 V**	415 V	440 V
three-phase-motor 2.2 kW (3 h.p.)	25 A	25 A	16 A	**16 A**	16 A	16 A	**10 A**	10 A	10 A
single-phase-motor 2.2 kW (3 h.p.)	35 A	35 A	20 A	**20 A**	20 A	20 A	**----**	----	----

NOTE

If power supply cable is to be replaced, use cable of same type, only!

13.4. MOTOR MOUNTING

The provided drive motors are equipped with a hinged motor plate (A, Fig. 19) and a V-belt pulley. They are mounted on the torsion bar axle (C, Fig. 18).

- First insert motor with its V-belt pulley into frame opening (Fig. 19) and slip hinged motor plate onto torsion bar axle until pins -A engange into slots in motor plate A, Fig. 19).
- Then push motor in direction to frame until pin -B locks in hole of motor plate. To ensure correct mounting firmly press hinged motor plate onto torsion bar axle. Pin -B must engage correctly!
- Then lift motor, place V-belt onto both V-belt pulleys (Fig. 20).
- Release motor - V-belt will be stressed by torsion bar axle.
- Fasten belt guard.

Removal of motor is performed in reverse order. Petrol engines are fastened in addition by a hexagonal screw mounted on the frame of the compressor unit (D, Fig. 18). Tighten screw regularly.

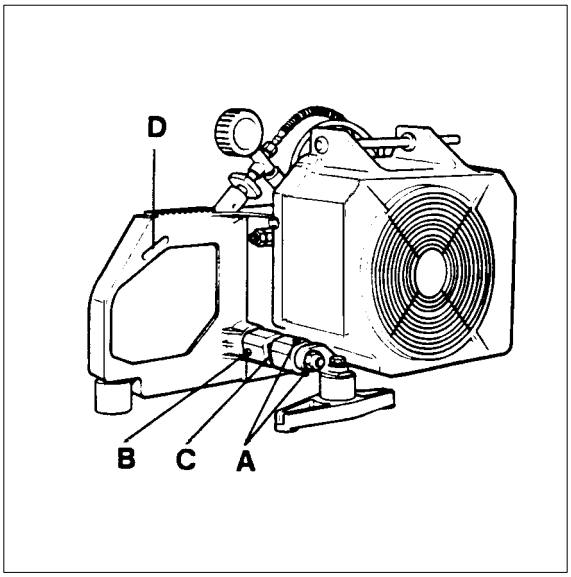


Fig. 18 Hinged motor plate

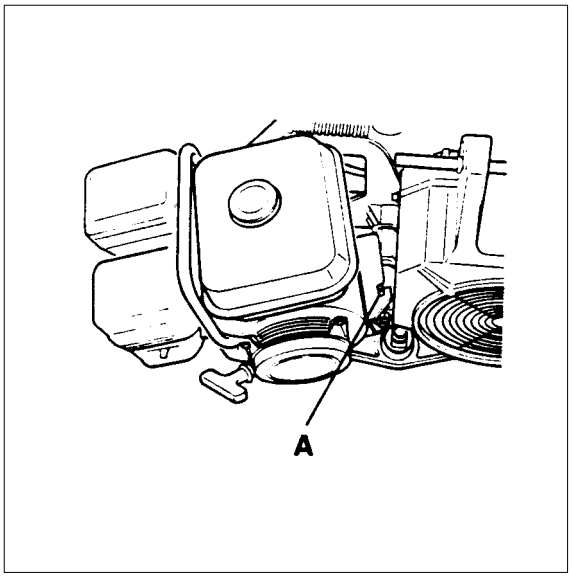


Fig. 19 Frame opening

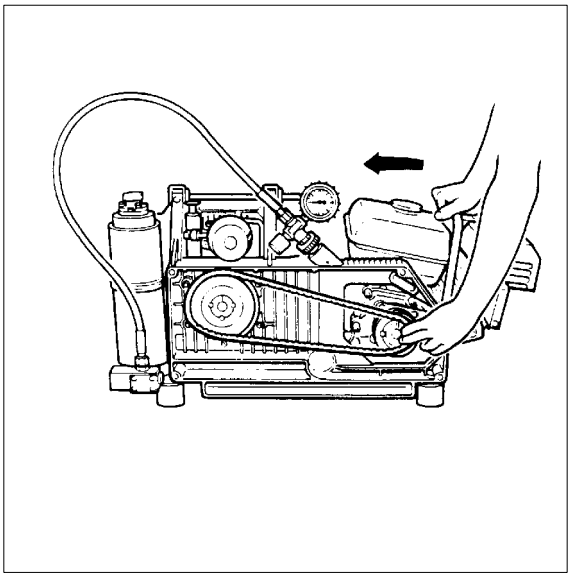


Fig. 20 V-belt pulleys

13.5. OPERATION

13.5.1. Preparation for operation

NOTE

All compressor units are tested prior to delivery to the customer, so after correct installation of the unit there should be no problem putting it into operation, observing the following points:

- Prior to **first** operation read Instruction Manual carefully. Make sure that all persons handling the compressor and the filling station are familiar with the function of all controls and monitors.
- Prior to **first** operation or operation subsequent to maintenance work, turn the compressor manually using the flywheel to ensure that all parts are turning free.
- Prior to **each** operation check the oil level according to chapter 2 and determine whether maintenance is necessary in accordance with chapter 15.
- Prior to **first** operation or operation subsequent to repair work operate unit for at least 5 minutes with open condensate valves (pressureless) to ensure proper lubrication of all parts before pressure is built up.

Units with petrol engine, additionally:

- Check engine oil level according to manufacturer's instruction manual.
- Check fuel tank. Top up if necessary.
- Open fuel shut-off valve.

13.5.2. Starting the unit

Units with electric drive motor:

- **Three-phase current:** the motor is switched on manually by pressing the start button (1, Fig. 21).
- **Alternating current:** Set 0-I switch to I.
- If final pressure is reached and safety valve blows off, open condensate drain valves and drain condensate. Unit is then ready for operation.

Fig. 21 Motor protection switch

Units with petrol engine:

- Open condensate drain valves on the filters so that motor starts without load.
- Set choke to position START. Start engine with recoil starter or crank handle. As soon as motor runs smoothly return choke to normal operating position.
- Close condensate drain valves and run unit to final pressure. Check final pressure safety valve and pressure gauge.
- As soon as final pressure is reached and final pressure safety valve blows off, open condensate drain valves and drain condensate – unit is ready for filling operation.

13.6. FILLING PROCEDURE

13.6.1. General

The filling valve connection is of the manual type and permits connection to air tanks without using tools. An O-ring is provided for self-sealing due to internal overpressure.

Compressed air tank filling valves for a pressure in excess of 200 bar are standardized (DIN 477, sheet 5) and connectors for 200 and 300 bar are different and cannot be mixed up. To ensure safe air tank removal after filling, the valve has an integral venting bore. Therefore always close tank valve first before closing filling valve.

During filling procedure bottles will warm up due to recompression. After removing, allow to cool down, bottles may then be reconnected and topped up to the respective maximum filling pressure.

WARNING

To meet the CO_2 maximum rating value in breathing air bottles, please observe the two following chapters 13.6.2. and 13.6.3.

13.6.2. Intake air quality

At routine tests, CO_2 values beyond the permissible values are noted from time to time. Closer investigations often show that the compressed air is taken from rooms in which one or more persons are working. At insufficient ventilation, the CO_2 value in the surrounding air can increase quite fast because of the exhaling of CO_2. CO_2 values from 1,000 to 5,000 ppmv in workrooms are not unusual (MAK-value (max. workroom concentration) is 5,000 ppmv). Another additional increase is caused by cigarette smoking, producing approx. 2g CO_2 ($\approx$ 2,000 ppmv) per cigarette. These pollutions add up to the basic pollution of approx. 400 ppmv. The technically caused excessive increase of CO_2 during the filling process and the CO_2 peak at taking the unit into operation. **Because of the reasons stated above and for your own security, the filling of breathing air bottles is not allowed in rooms used as workrooms.**

13.6.3. Scavenging the compressor unit

CO_2 is present in the atmosphere with a natural amount of 350 – 400 ppm_V. The molecular sieve used in the purifier for drying the breathing air is, as well as other capabilities, able to adsorb CO_2 which is accumulated in the cartridge. After shut-down of the compressor, adsorbed CO_2 may be desorbed again due to the partial pressure decrease. The now free CO_2 then gets washed out of the cartridge when the compressor is started again.

To avoid increased CO_2 contents in the compressed breathing air, it is absolutely necessary to fill the air bottles according to chapter 13.6.5., also refer to **WARNINGS** in chapter 13.1.

13.6.4. Connecting the bottles

- Connect air bottle to filling valve (see Fig. 22).

NOTE

On models of 300 bar rated filling pressure do not attach bottles unless rated for this presssure (note pressure stamped on tank neck).

- Air bottles with international filling connector can be connected with filling adaptor (Part no. 08487-635) to the German filling connector (see Fig. 23).

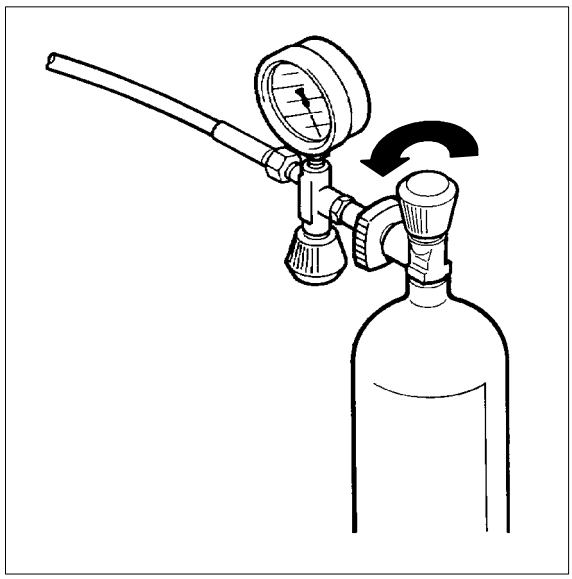


Fig. 22 Connecting air bottle

NOTE

The international connector is not permitted in the Federal Republic of Germany. In other countries it is allowed only for pressures up to 200 bar (2,850 psi). This filling connector cannot be used on 300 bar (4,350 psi) models due to constructive measures.

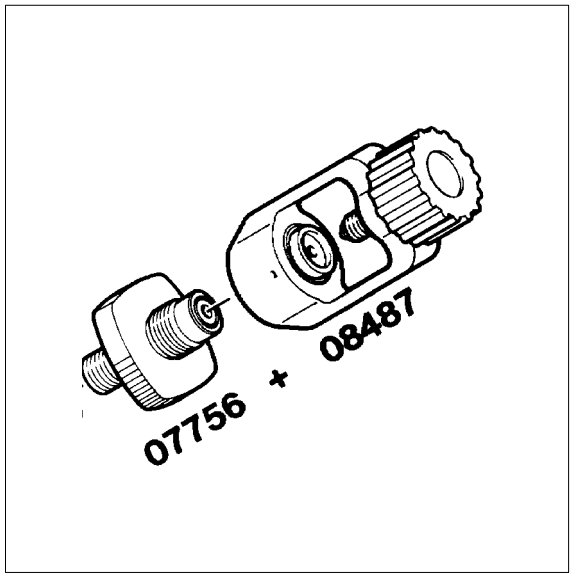


Fig. 23 International filling connector

13.6.5. Filling the bottles

WARNING

Never open filling valve unless bottle is connected to filling hose. Hose whipping due to pressurized air outstream can cause serious injury!

- Open filling valve (1, Fig. 24).
- Open bottle valve (2) – bottle will be filled. Drain condensate regularly during filling.

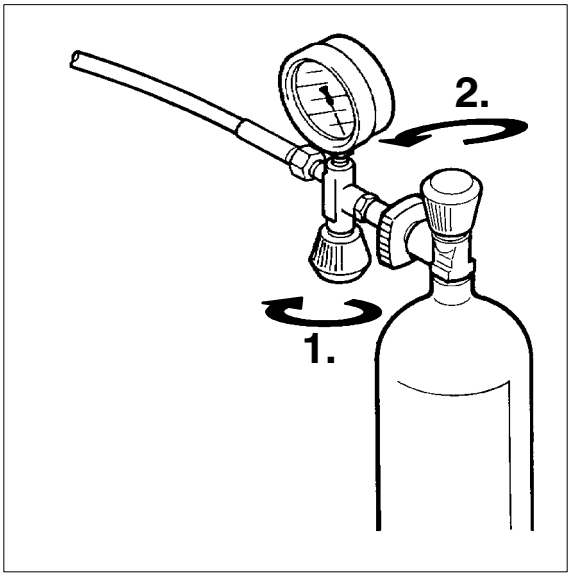


Fig. 24 Filling air bottle

NOTE

The filling procedure should not be interrupted for more than 10 minutes to avoid increased CO_2-values in the air filled into the bottles.

13.6.6. Removing the bottles

- Upon reaching final bottle pressure **close bottle valve first (1, Fig. 25), then filling valve** by returning handle to closed position (2).
- Remove compressed air bottle.

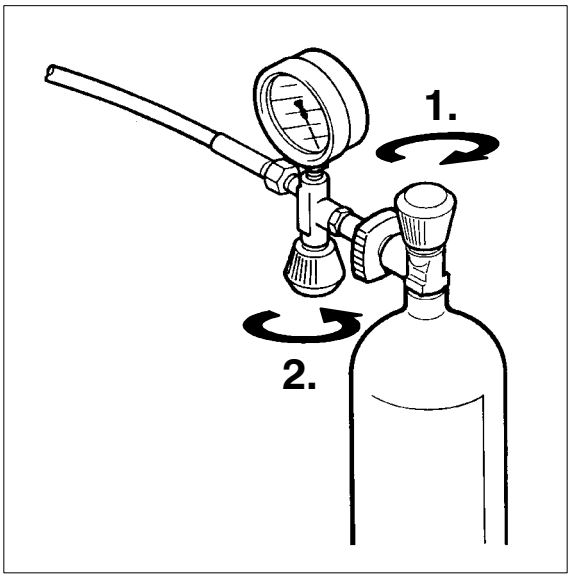


Fig. 25 Removing air bottle

13.7. SHUT-DOWN PROCEDURE

- Close filling valve.

Units with electric motor:

- **Three-phase current:** the motor is switched off either manually by pressing the stop button (2, Fig. 26) or automatically by a thermic release.
- Vent unit by means of filling valves to approx. 80 bar (1,150 psi) then decompress with drain valves to remove all moisture in filters and oil and water separator. Close all valves again.
- Check the oil level in the compressor and top up, if necessary. Also check whether the compressor needs servicing in accordance with maintenance schedule – see chapter 15.
- **Alternating current:** set 0 – I switch to 0.
- Vent unit by means of filling valves to approx. 80 bar (1,150 psi) then decompress with drain valves to remove all moisture in filters and oil and water separator. Close all valves again.
- Check the oil level in the compressor and top up, if necessary. Also check whether the compressor needs servicing in accordance with maintenance schedule – see chapter 15.

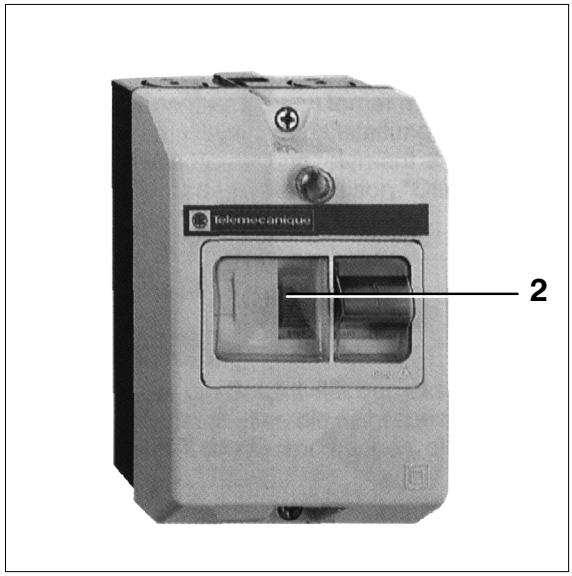


Fig. 26 Motor protection switch

Units with petrol engine:

- Shut down petrol engine with stop button or stop lever.
- Vent unit by means of filling valves to approx. 80 bar (1,150 psi) then decompress with drain valves to remove all moisture in filters and oil and water separator. Close all valves again.
- Check the oil level in the compressor and top up, if necessary. Also check whether the compressor needs servicing in accordance with maintenance schedule – see chapter 15.

14. MAINTENANCE

14.1. MAINTENANCE RECORD

We recommend that all maintenance work is recorded in a service book, showing the date and details of the work carried out. This will help to avoid expensive repairwork caused by missed maintenance work.

If it is necessary to claim against the warranty, it will help to have proof that regular maintenance work has been carried out and that the damage has not been caused by insufficient maintenance. Please refer to section 23 of our general terms and conditions.

For this purpose, the following maintenance control sheets are provided (copy as required). Please mark the appropriate box(es) to show what maintenance work has been carried out and the number of hours of service, then sign and date.

14.2. MAINTENANCE INTERVALS

NOTE

Change TRIPLEX longlife cartridge according to chapter 5!

NOTE

The used cartridge must be disposed of according to local regulations.

14.3. MAINTENANCE SCHEDULE

Maintenance of drive motor/engine according to manufacturer's operating instructions.

After first 25 operating hours	Chapter	Date	Signature
Check tightness of O-rings	3./5.		
Check V-belt	--		
Check tightness of all cooler-pipes and couplings	--		
Check cooler-brackets	--		
Check function of torsion bar axle	14.		
Check zero position on final pressure gauge when depressurized	8.		
Tighten valve head bolts and pressure studs	9.		

Every 125 operating hours	Chapter	Date	Signature
Clean intake filter cartridge and replace if necessary	3.		
Check V-belt	10.		

Every 1000 operating hours, at least annually	Chapter	Date	Signature
Check and clean sintered metal filter element of intermediate separator	4.		
Valve overhaul	9.		
Replace intake filter cartridge	3.		
Oil change mineral oil	2.		

Every 2000 operating hours, at least bi-annually	Chapter	Date	Signature
Change compressor oil (BAUER compressor oil, part no. N 19745). For alternative types of oil see ”Lubricating Oil List” available through BAUER customer service.	2.		

Annually or as required	Chapter	Date	Signature
Perform a breathing air quality check with **BAUER** AirLab IV test unit or equivalent	--		

After repair work	Chapter	Date	Signature
Check functioning and tightness of filling valve	--		
Clean intake filter and intake filter cartridge	3.		
Check tightness of O-rings	3./5.		
Check V-belt	10.		
Check tightness of all cooler-pipes and couplings	--		
Check cooler-brackets	--		
Check zero position on final pressure gauge when depressurized	8.		

After storage and preservation	Chapter	Date	Signature
Check functioning and tightness of filling valve	--		
Clean intake filter and intake filter cartridge	3.		
Check tightness of O-rings	3./5.		
Check V-belt	10.		
Check tightness of all cooler-pipes and couplings	--		
Check cooler-brackets	--		
Check zero position on final pressure gauge when depressurized	8.		

14.3.1. RECORD FOR OPERATING HOURS

Date	Minutes	Total

Date	Minutes	Total
Subtotal:		

Date	Minutes	Total
Subtotal:		

Date	Minutes	Total
Subtotal:		

15. STORAGE, PRESERVATION

15.1. PREPARATORY WORK

If the compressor is to be put out of service for a long period, it is good practice to preserve the unit in accordance with the following instructions:

- Prior to preserving, the compressor must run warm, i.e. it has to be run up to the specified service pressure, at which it must be maintained for approx. 10 minutes.
- Then open the filling valve and operate the compressor for a further 5 minutes at the adjusted minimum pressure of 150 bar (pressure maintaining valve).
- After 5 minutes shut down the compressor and drain off filter system P21 completely; the pressure will then fall to 0. Reclose filling valve.
- Remove filter head, lubricate the threads with white vaseline (DAB 9) and reclose filter.
- **Ensure that the filter cartridge remains in the filter!**
- **Make sure that the compressor is kept indoors in a dry room, free of dust.**
- After prolonged idle periods, the oil in compressor and engine will age. It must be drained and replaced with fresh oil after 2 years at the latest.

15.2. REACTIVATING THE COMPRESSOR

Before reactivating the compressor, carry out the following checks:

- Change the filter cartridge of filter system P21.
- Check all pipes, filters and valves for leakage.
- Retighten all the couplings.
- Check the oil level of the compressor.
- Check the motor/engine in accordance with the manufacturer's instructions.
- Start the compressor with open filling valve for about 5 minutes until it runs warm.
- Close the filling valve and run the system up to final pressure, until the final pressure safety valve blows.
- At any fault refer to the trouble-shooting table, section 18, and remedy.
- When running properly, stop the system. The compressor is ready for operation.

16. REPAIR INSTRUCTIONS

16.1. GENERAL

Preventive maintenance usually involves replacing the valves, gaskets and sealing rings as well as carrying out the maintenance work.

Repair work can be carried out on the compressor block to a certain extent but a certain experience and skill is necessary. It should be noted, however, that

- no repair should be carried out on the crankcase nor on the bearings
- safety valves are not repaired but always replaced completely.

NOTE

For all further repair instructions refer to applicable workshop manual.

17. TROUBLE-SHOOTING

Trouble	Cause	Remedy
Drive motor (electric)		
Motor will not start	Electric circuitry faulty	Check all fuses, terminal connections, wire leads, make sure that motor data complies with mains supply
Motor/engine runs eccentrically	V-belt worn	Replace
Motor protection switch is switching the unit off	Unsufficient voltage because of weak power supply	Swtich off other consuming devices
	Power supply cable to long or to thin	Use suitable cable
Drive motor (petrol)		
Engine will not start	See engine instructions	See engine instructions
Motor/engine runs eccentrically	V-belt worn	Replace
Compressor block		
Compressor does not attain final pressure	Condensate drain valve(s) leaking	Tighten and reseal
	Final pressure safety valve defective (blows too soon)	Replace safety valve
	No cartridge in central filter (air escaping through cartridge safety bore)	Replace cartridge
	Vent screw for final pressure safety valve not in operating position	To vent, unscrew until completely open
Air delivery drops	Intake filter soiled	Clean or replace filter cartridge
	Pipe coupling leaking	Retighten couplings
	Excessive wear of 3rd stage piston	Replace piston and sleeve of 3rd stage
Intermediate pressure safety valve blows	Intermediate pressure too high because of defective inlet or pressure valve of the following stage	Check/replace inlet or pressure valve
	Safety valve leaking	Replace safety valve
Air escaping through cartridge safety bore	Cartridge missing	Insert cartridge
	Cartridge installed but O-rings defective	Check/replace O-rings
Taste of oil in the air	TRIPLEX cartridge saturated	Replace cartridge
	Unqualified lubricant being used	Replace oil with an approved brand

Trouble	Cause	Remedy
Compressor overheats	Insufficient cooling air	Inlet and pressure valve of one stage leaking; direction of rotation incorrect
	Ambient temperature too high	Check location; ambient temperature max. +45 °C (113 °F); check valves, clean/replace
	Direction of rotation is wrong	Correct direction of rotation
	Inlet and pressure valve of one stage is leaking	Check valves, clean/replace if necessary

18. TABLES

18.1. TIGHTENING TORQUE VALUES

NOTE

Unless otherwise specified in text, the following torque values apply. All valve head screws require torque wrench tightening! The indicated torque values are valid for bolts in greased condition. Replace self-retaining nuts on reassembly.

Bolt or screw	Thread	Max. torque
Hex and allen head	M 6	10 Nm (7 ft.lbs)
Hex and allen head	M 8	25 Nm (18 ft.lbs)
Hex and allen head	M 10	45 Nm (32 ft.lbs)
Hex and allen head	M 12	75 Nm (53 ft.lbs)
Hex and allen head	M 14	120 Nm (85 ft.lbs)
Hex and allen head	M 16	200 Nm (141 ft.lbs)
Pipe connections (swivel nuts):		Finger-tight + 1/2 turn

18.2. TORQUE SEQUENCE

Tighten valve head and cylinder bolts/nuts equally in the sequence shown in Fig. 27.

Be sure to tighten all parts in **cold** condition only.

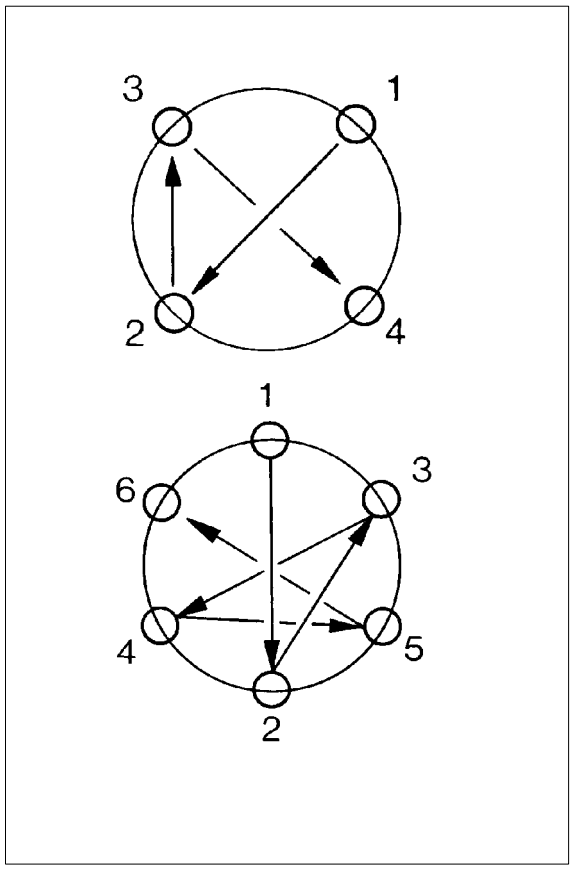


Fig. 27 Torque sequence

18.3. LUBRICATION CHART

Usage	Lubricants
O-rings, rubber and plastic parts, filter housing threads	WEICON WP 300 WHITE part no. N 19752 or White petrolatum DAB9 part no, N 19091
Sealing rings	Universal grease
Bolts, nuts, studs, valve parts, CU gaskets and pipe connectors (threads, cap nut and compression rings)	WEICON ANTI-SEIZE AS 040 P part no. N 19753 or equivalent compounds with copper or MoS_2 additives
Paper gaskets	Apply silicon compound on both sides before assembly e.g. WACKER silicon compound, part no. N 18247
High temperature connections, e.g. valve heads/ cylinders	Temperature resistant compound, e.g. WACKER silicon compound, part no. N 18247

For all lubricating oils refer to chapter 2 or lubricating oil list available through **BAUER** Service Department.

18.4. ADHESIVE AND SEALANT CHART

Usage	Adhesives and Sealants
Screws	Loctite 2701
Seals for conical threads	Loctite 511
Metal - metal seals High temperature connections, e.g. valve heads, cylinders	Temperature resistant compound, e.g. WACKER E10, part no. N18247
Paper gaskets	Loctite FAG 2

18.5. TESTING AGENTS

Usage	Testing agents
Tube connectors, tubes	Leakage test spray, part no. FM0089

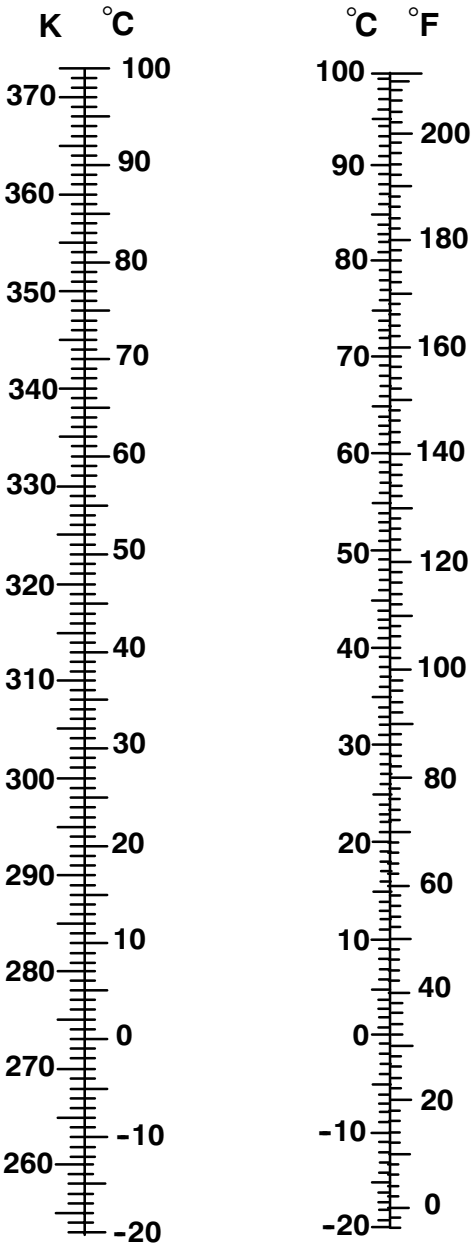
18.6. CONVERSION TABLE bar - psi

bar	psi	bar	psi	bar	psi	bar	psi	bar	psi
1	15	56	812	111	1,610	166	2,407	230	3,335
2	29	57	827	112	1,624	167	2,422	235	3,408
3	44	58	841	113	1,639	168	2,436	240	3,480
4	58	59	856	114	1,653	169	2,451	245	3,553
5	73	60	870	115	1,668	170	2,465	250	3,625
6	87	61	885	116	1,682	171	2,480	255	3,698
7	102	62	899	117	1,697	172	2,494	260	3,770
8	116	63	914	118	1,711	173	2,509	265	3,843
9	131	64	928	119	1,726	174	2,523	270	3,915
10	145	65	943	120	1,740	175	2,538	275	3,988
11	160	66	957	121	1,755	176	2,552	280	4,060
12	174	67	972	122	1,769	177	2,567	285	4,133
13	189	68	986	123	1,784	178	2,581	290	4,205
14	203	69	1,001	124	1,798	179	2,596	295	4,278
15	218	70	1,015	125	1,813	180	2,610	300	4,350
16	232	71	1,030	126	1,827	181	2,625	305	4,423
17	247	72	1,044	127	1,842	182	2,639	310	4,495
18	261	73	1,059	128	1,856	183	2,654	315	4,568
19	276	74	1,073	129	1,871	184	2,668	320	4,640
20	290	75	1,088	130	1,885	185	2,683	325	4,713
21	305	76	1,102	131	1,900	186	2,697	330	4,785
22	319	77	1,117	132	1,914	187	2,712	335	4,858
23	334	78	1,131	133	1,929	188	2,726	340	4,930
24	348	79	1,146	134	1,943	189	2,741	345	5,003
25	363	80	1,160	135	1,958	190	2,755	350	5,075
26	377	81	1,175	136	1,972	191	2,770	355	5,148
27	392	82	1,189	137	1,987	192	2,784	360	5,220
28	406	83	1,204	138	2,001	193	2,799	365	5,293
29	421	84	1,218	139	2,016	194	2,813	370	5,365
30	435	85	1,233	140	2,030	195	2,828	375	5,438
31	450	86	1,247	141	2,045	196	2,842	380	5,510
32	464	87	1,262	142	2,059	197	2,857	385	5,583
33	479	88	1,276	143	2,074	198	2,871	390	5,655
34	493	89	1,291	144	2,088	199	2,886	395	5,728
35	508	90	1,305	145	2,103	200	2,900	400	5,800
36	522	91	1,320	146	2,117	201	2,915	405	5,873
37	537	92	1,334	147	2,132	202	2,929	410	5,945
38	551	93	1,349	148	2,146	203	2,944	415	6,018
39	566	94	1,363	149	2,161	204	2,958	420	6,090
40	580	95	1,378	150	2,175	205	2,973	425	6,163
41	595	96	1,392	151	2,190	206	2,987	430	6,235
42	609	97	1,407	152	2,204	207	3,002	435	6,308
43	624	98	1,421	153	2,219	208	3,016	440	6,380
44	638	99	1,436	154	2,233	209	3,031	445	6,453
45	653	100	1,450	155	2,248	210	3,045	450	6,525
46	667	101	1,465	156	2,262	211	3,060	455	6,598
47	682	102	1,479	157	2,277	212	3,074	460	6,670
48	696	103	1,494	158	2,291	213	3,089	465	6,743
49	711	104	1,508	159	2,306	214	3,103	470	6,815
50	725	105	1,523	160	2,320	215	3,118	475	6,888
51	740	106	1,537	161	2,335	216	3,132	480	6,960
52	754	107	1,552	162	2,349	217	3,147	485	7,033
53	769	108	1,566	163	2,364	218	3,161	490	7,105
54	783	109	1,581	164	2,378	220	3,190	495	7,178
55	798	110	1,595	165	2,393	225	3,263	500	7,250

18.7. CONVERSION TABLE psi – bar

psi	bar	psi	bar	psi	bar	psi	bar	psi	bar
1	0.07	61	4.21	310	21.38	910	63	3,400	234
2	0.14	62	4.28	320	22.07	920	63	3,500	241
3	0.21	63	4.34	330	22.76	930	64	3,600	248
4	0.28	64	4.41	340	23.45	940	65	3,700	255
5	0.34	65	4.48	350	24.14	950	66	3,800	262
6	0.41	66	4.55	360	24.83	960	66	3,900	269
7	0.48	67	4.62	370	25.52	970	67	4,000	276
8	0.55	68	4.69	380	26.21	980	68	4,100	283
9	0.62	69	4.76	390	26.90	990	68	4,200	290
10	0.69	70	4.83	400	27.59	1,000	69	4,300	297
11	0.76	71	4.90	410	28.28	1,010	70	4,400	303
12	0.83	72	4.97	420	28.97	1,020	70	4,500	310
13	0.90	73	5.03	430	29.66	1,030	71	4,600	317
14	0.97	74	5.10	440	30.34	1,040	72	4,700	324
15	1.03	75	5.17	450	31.03	1,050	72	4,800	331
16	1.10	76	5.24	460	31.72	1,060	73	4.,900	338
17	1.17	77	5.31	470	32.41	1,070	74	5,000	345
18	1.24	78	5.38	480	33.10	1,080	74	5,100	352
19	1.31	79	5.45	490	33.79	1,090	75	5,200	359
20	1.38	80	5.52	500	34.48	1,100	76	5,300	366
21	1.45	81	5.59	510	35.17	1,110	77	5,400	372
22	1.52	82	5.66	520	35.86	1,120	77	5,500	379
23	1.59	83	5.72	530	36.55	1,130	78	5,600	386
24	1.66	84	5.79	540	37.24	1,140	79	5,700	393
25	1.72	85	5.86	550	37.93	1,150	79	5,800	400
26	1.79	86	5.93	560	38.62	1,160	80	5,900	407
27	1.86	87	6.00	570	39.31	1,170	81	6,000	414
28	1.93	88	6.07	580	40.00	1,180	81	6,100	421
29	2.00	89	6.14	590	40.69	1,190	82	6,200	428
30	2.07	90	6.21	600	41.38	1,200	83	6,300	434
31	2.14	91	6.28	610	42.07	1,210	83	6,400	441
32	2.21	92	6.34	620	42.76	1,220	84	6,500	448
33	2.28	93	6.41	630	43.45	1,230	85	6,600	455
34	2.34	94	6.48	640	44.14	1,240	86	6,700	462
35	2.41	95	6.55	650	44.83	1,250	86	6,800	469
36	2.48	96	6.62	660	45.52	1,260	87	6,900	476
37	2.55	97	6.69	670	46.21	1,270	88	7,000	483
38	2.62	98	6.76	680	46.90	1,280	88	7,100	490
39	2.69	99	6.83	690	47.59	1,290	89	7,200	497
40	2.76	100	6.90	700	48.28	1,300	90	7,300	503
41	2.83	110	7.59	710	48.97	1,400	97	7,400	510
42	2.90	120	8.28	720	49.66	1,500	103	7,500	517
43	2.97	130	8.97	730	50.34	1,600	110	7,600	524
44	3.03	140	9.66	740	51.03	1,700	117	7,700	531
45	3.10	150	10.34	750	51.72	1,800	124	7,800	538
46	3.17	160	11.03	760	52	1900	131	7,900	545
47	3.24	170	11.72	770	53	2,.000	138	8,000	552
48	3.31	180	12.41	780	54	2,100	145	8,100	559
49	3.38	190	13.10	790	54	2,200	152	8,200	566
50	3.45	200	13.79	800	55	2,300	159	8,300	572
51	3.52	210	14.48	810	56	2,400	166	8,400	579
52	3.59	220	15.17	820	57	2,500	172	8500	586
53	3.66	230	15.86	830	57	2,600	179	8,600	593
54	3.72	240	16.55	840	58	2,700	186	8,700	600
55	3.79	250	17.24	850	59	2,800	193	8,800	607
56	3.86	260	17.93	860	59	2,900	200	8,900	614
57	3.93	270	18.62	870	60	3,000	207	9,000	621
58	4.00	280	19.31	880	61	3,100	214	9,100	628
59	4.07	290	20.00	890	61	3,200	221	9,200	634
60	4.14	300	20.69	900	62	3,300	228	9,300	641

18.8. TEMPERATURE CONVERSION TABLE



18.9. MISCELLANEOUS CONVERSION TABLES

Linear measures

	cm	m	km	in	ft	mile
cm	1	0.01	1×10^{-5}	0.3937	0.03281	6.21×10^{-6}
m	100	1	0.001	39.37	3.281	6.21×10^{-4}
km	1×10^{5}	1000	1	3.94×10^{4}	3281	0.6214
in	2.540	0.02540	2.54×10^{-5}	1	0.08333	1.58×10^{-5}
ft	30.48	0.3048	3.05×10^{-4}	12	1	1.89×10^{-4}
mile	1.61×10^{5}	1.609	1.609	6.34×10^{4}	5280	1

Volume measures

	cm^3	litre	m^3	in^3	ft^3	gal
cm^3	1	0.001	1×10^{-6}	0.06102	3.53×10^{-5}	2.64×10^{-4}
litre	1000	1	0.001	61.02	0.03532	0.2642
m^3	1×10^{6}	1000	1	6.10×10^{4}	35.31	264.2
in^3	16.39	0.01639	1.64×10^{-5}	1	5.79×10^{-4}	0.00433
ft^3	2.83×10^{4}	28.32	0.02832	1728	1	7.481
gal	3785	3.785	0.00379	231.0	0.1337	1

Flow rates

	l/sec	gal/min	ft^3/sec	ft^3/min	l/min
l/sec	1	15.85	0.03532	2.119	60
gal/min	0.06309	1	0.00223	0.1337	3.785
ft^3/s	28.32	448.8	1	60	1699.2
ft^3/min	0.4719	7.481	0.01667	1	28.32
l/min	0.0167	0.2642	0.0005885	0.03532	1

Pressure conversion table

	mm Hg	inch Hg	inch H_2O	ft H_2O	atm	psi	kg/cm^2	bar	kPa
mm Hg	1	0.03937	0.5353	0.04460	0.00132	0.01934	0.00136	0.0010	0.133
inch Hg	25.40	1	13.60	1.133	0.03342	0.04912	0.03453	0.0340	3.395
inch H_2O	1.868	0.07355	1	0.08333	0.00246	0.03613	0.00254	0.0025	0.249
ft H_2O	22.42	0.8826	12	1	0.02950	0.4335	0.03048	0.0300	2.984
atm	760	29.92	406.8	33.90	1	14.70	1.033	1.0130	101.375
lb/in^2	51.71	2.036	27.67	2.307	0.06805	1	0.07031	0.069	6.895
kg/cm^2	735.6	28.96	393.7	32.81	0.9678	14.22	1	0.981	98.066
bar	752.47	29.575	402.164	33.5136	0.9870	14.50	1.02	1	100
kPa	7.525	0.2960	4.021	0.3350	0.0098	0.1450	0.01	0.01	1

19. ANNEX

- **Parts lists, standard**
  Air flow diagram, standard
  Lubricating oil list