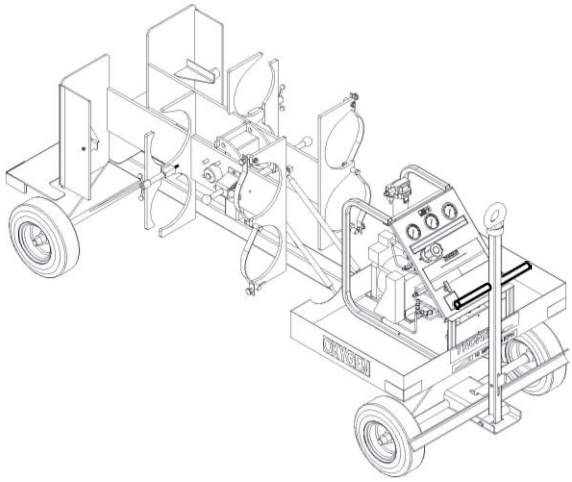
OPERATION & SERVICE MANUAL



Model: 20-4523-0000
Four Cylinder Tiltable Oxygen Cart
with Booster and Manifold/Regulator

CE

12/2018 - Rev. 04

CAUTION

It is MANDATORY that this instruction manual be read and understood by all persons operating this High Pressure Oxygen Booster.

Tronair, Inc.
1 Air Cargo Pkwy East
Swanton, OH 43558

Phone: (419) 866-6301 | 800-426-6301
Web: www.tronair.com
Email: sales@tronair.com

REVISION	DATE	TEXT AFFECTED
01	09/2013	Original release
02	06/2016	Major revision
03	11/2018	Modified 8.1 Trailer
04	12/2018	Modified Parts List
04	01/2022	corrected Oxygen Booster PN

TABLE OF CONTENTS

PAGE

This product can not be modified without the written approval of Tronair, Inc. Any modifications done without written approval voids all warranties and releases Tronair, Inc., its suppliers, distributors, employees, or financial institutions from any liability from consequences that may occur. Only Tronair OEM replacement parts shall be used.

CAUTION!

It is MANDATORY that this instruction manual be read and understood by all persons operating this High Pressure Oxygen Booster.

1.0 PRODUCT INFORMATION

1.1 DESCRIPTION

The Tronair Four Cylinder Cart with Booster is designed to minimize the handling of oxygen cylinders in loading and unloading, transporting and servicing process and to provide boosted compressed gas for an aircraft.

The high pressure regulator is for regulating booster output pressure from 15 - 2250 psi (115 bar).

The booster provides the capability of boosting remaining lower pressure oxygen from supply cylinders to the required higher aircraft system pressure; up to 2250 psig maximum. The booster system provides high regulated pressure output. The transport cart allows a single operator to load full oxygen cylinders and transport them to service the aircraft, without ever having to lift the cylinders. The unique quality of this cart is the operator never has to lift a cylinder, which can weigh between 120 and 175 lbs., onto the cart. The cart has a very narrow footprint and a tight turning radius allowing for easy maneuverability.

Consumer Requirement: This Oxygen Booster utilizes an air driven pressure amplifier, requiring 145 PSIG maximum air pressure input at 80 SCFM volume.

Cart may be used to supply either internal aircraft systems or portable aircraft bottles.

DANGER!

TO AVOID SERIOUS INJURY, LOSS OF LIMB OR DEATH:

1. **DO NOT use on LOW PRESSURE aircraft systems.**
2. **DO NOT use with ANY GAS OTHER THAN OXYGEN.**
3. **DO NOT exceed 2250 PSIG inlet oxygen bottle pressure into booster.**
4. **All components used in the oxygen system shall be clean, dry and free of all contamination per SAE SPEC. AIR 1176.**
5. **Servicing and/or maintenance of oxygen systems shall be done by trained and qualified personnel using approved procedures per SAE SPEC. ARP 1532.**

1.2 MODEL & SERIAL NUMBER

Reference nameplate on unit

1.3 MANUFACTURER

TRONAIR, Inc.
1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
Fax: (419) 867-0634
E-mail: sales@tronair.com
Website: www.tronair.com

1.4 SPECIFICATIONS/FEATURES

Dimensions:

- Height: 46 11/16 in (118.58 cm)
- Length: 92 13/16 in (235.74 cm)
- Width: 35 13/16 in (90.96 cm)
- Weight: 970 lbs (440 kg)

Rotating Cylinder Loader/Un-Loader:

- Stable and efficient rotational motion guidance under variable weights, speeds and high load conditions keeping the cylinders in the correct location
- Struts control the rotating of the cylinders from the vertical and horizontal positions
- Accommodates cylinders 9 diameter, 56” tall and weighing less than 150 lbs
- Manufactured of high strength materials to ensure the cylinders are secure
- Locks into horizontal or vertical position by a spring loaded plunger
- Makes unloading, transporting, servicing and moving the cylinders a one person operation

Cart:

- CE Marked
- Easy, one person loading/unloading
- Use with 9 diameter, 56” tall and weighing less than 150 lbs oxygen cylinders; CGA 540 connection with check valves, 3000 psi max
- Cylinders fully captured
- Pneumatic tires/tapered wheel bearings
- Narrow width
- Very low profile, fits under most aircraft wings
- Parking brake
- Hose compartment storage tray
- Instrument Panel
- Powder coated heavy duty steel construction
- compact frame allows for a tight turning radius

Booster:

- Output Hose: 15 ft (4.6 m) long with #4 37ºJIC female flare swivel fitting at aircraft hook-up end
- Output Rating: 2250 psi (155 bar) maximum
- Minimum Supply Bottle Pressure: 250 psi (17 bar)
- Input to Booster Pump: 80 SCFM at 150 psi (10.3 bar) maximum
- Booster High Pressure Air Pilot: 2500 psi (172 bar)
- Booster High Pressure Relief: 2750 psi (189.6 bar)
- All plumbing, fittings, and components are oxygen cleaned. The unit and hoses are cleaned and packaged to avoid possible system contamination.

Temperature Range:

- 0º to 200ºF (17.7º to 93.3º C)

2.0 SAFETY INFORMATION

CAUTION!

It is mandatory that this instruction manual be read and understood by all persons operating this High Pressure Oxygen Booster.

2.1 USAGE AND SAFETY INFORMATION

Information presented in this manual and on various labels, tags, and plates on the unit pertains to equipment design, installation, operation, maintenance and trouble shooting which should be read, understood, and followed for the safe and effective use of this equipment.

2.2 SAFETY

The operation, maintenance, and trouble shooting of this high pressure oxygen booster requires practices and procedures which ensure personal operator safety and the safety of others. Therefore, this equipment is to be operated and maintained only by qualified persons in accordance with this manual and all applicable local codes.

NOTE: Safety instructions specifically pertaining to this unit appear throughout this manual highlighted by the signal words WARNING, CAUTION, DANGER which identify different levels of hazard.

WARNING! — Warning is used to indicate the presence of a hazard that ***can cause severe personal injury, death, or substantial property damage*** if the warning notice is ignored.

CAUTION! — Caution is used to indicate the presence of a hazard that ***will or can cause minor personal injury or property damage*** if the caution notice is ignored.

WARNING!

TO AVOID SERIOUS INJURY OR DEATH OBSERVE THE FOLLOWING:

1. **All components used in the oxygen system must be clean, dry, and free of all contamination per SAE SPEC AIR 1176.**
2. **DO NOT use this equipment with nitrogen or gas other than oxygen.**
3. **DO NOT exceed 2250 PSIG bottle inlet pressure into booster.**
4. **Servicing and maintenance of the system should only be done by trained and qualified personnel using approved procedures.**
5. **It is mandatory that this instruction manual be read and understood by all persons operating this oxygen manifold.**

Pressures: Gases under pressure are a potential hazard in the form of stored energy. Accidents can occur when this energy is improperly handled. Be sure that all equipment used is compatible and designed to control the pressures encountered.

Oxygen: Oxygen is an oxidizing gas and is chemically stable and nonflammable. However oxygen does support combustion. High concentrations can accelerate the combustion of flammable materials up to and including an explosion. It is important to understand that spontaneous combustion of organic materials can occur in oxygen rich atmospheres.

Handling: Oxygen handling must be done with care to avoid any association with hydro-carbons. Especially where fuels and lubricants are present in aircraft service areas. It is imperative that oxygen systems be handled properly. Be sure to keep all protective caps in position on equipment as long as possible, and replace them as soon as possible.

Velocity: Oxygen flowing at a high velocity in a piping system can propel any foreign material particles with such force that the impact friction can raise the particles temperature to a possible ignition point. It is, therefore, imperative that a high degree of cleanliness be maintained in the oxygen system at all times.

Oxygen Servicing: The following list contains additional general safety precautions that should be adhered to during the servicing process. However, always refer to the manufacturer's procedure for the airplane being serviced.

1. Always ground the system to be serviced and the servicing equipment before connecting the filler adapter.
2. Close the oxygen bottle manual shutoff valve.
3. Ensure that all aircraft electrical power is off. Do not operate electrical switches, or connect or disconnect ground power generators during the oxygen charging operation.
4. Do not service the oxygen system if fueling or other flammable fluid servicing is in process.
5. Do not charge the system too fast. Rapid charging can create a dangerous overheating condition.

SAE AIRCRAFT OXYGEN SPECIFICATION INFORMATION
For more information concerning specific SAE aircraft oxygen equipment specifications, contact:
Society of Automotive Engineers
400 Commonwealth Drive, Warrendale, PA 15096-0001

3.0 PREPARATION FOR USE

CAUTION!

Only use cylinders for which this unit was designed: 9 – 9 ¾ inch diameter, 2250 psig (155 bar) maximum pressure with CGA 540 connection.

CAUTION!

Maximum towing speed is 10 mph (16 km/h).

3.1 LOADING/UNLOADING CYLINDERS

3.1.1 Loading Cylinders

WARNING!

This cart is designed to carry 4 cylinders simultaneously. Failure to install all 4 cylinders will create an unstable condition. Cart must be fully loaded/unloaded before transporting.

CAUTION!

Do NOT transport cart with cradles in upright position. Always store cradles in horizontal position.

1. Place cart on flat, level surface
2. Ensure Towbar is in upright position
3. Rotate both cylinder cradles to upright position (empty cradles will require assistance to move into position), ensure locking mechanism is engaged
4. Lower bottom ramp
5. Remove bottom clamping handle assembly
6. Loosen only one top clamping knob and rotate strap away from cradle
7. Walk cylinder up ramp and into cradle, position cylinder valve outlet port to face directly forward, toward towbar
8. Rotate strap against cylinder and tighten top clamping knob
9. Repeat steps 6-8 for second cylinder
10. Install bottom clamping handle assembly and tighten
11. Raise bottom ramp into upright position and click into place
12. Repeat steps 6-11 for cylinders on opposite side
13. Once all four cylinders are secure rotate cradles to horizontal position. Ensure locking mechanism is engaged
14. Attach 4 input hosed to cylinders

3.1.2 Unloading Cylinders

WARNING!

This cart is designed to carry 4 cylinders simultaneously. Failure to install all 4 cylinders will create an unstable condition. Cart must be fully loaded/unloaded before transporting.

CAUTION!

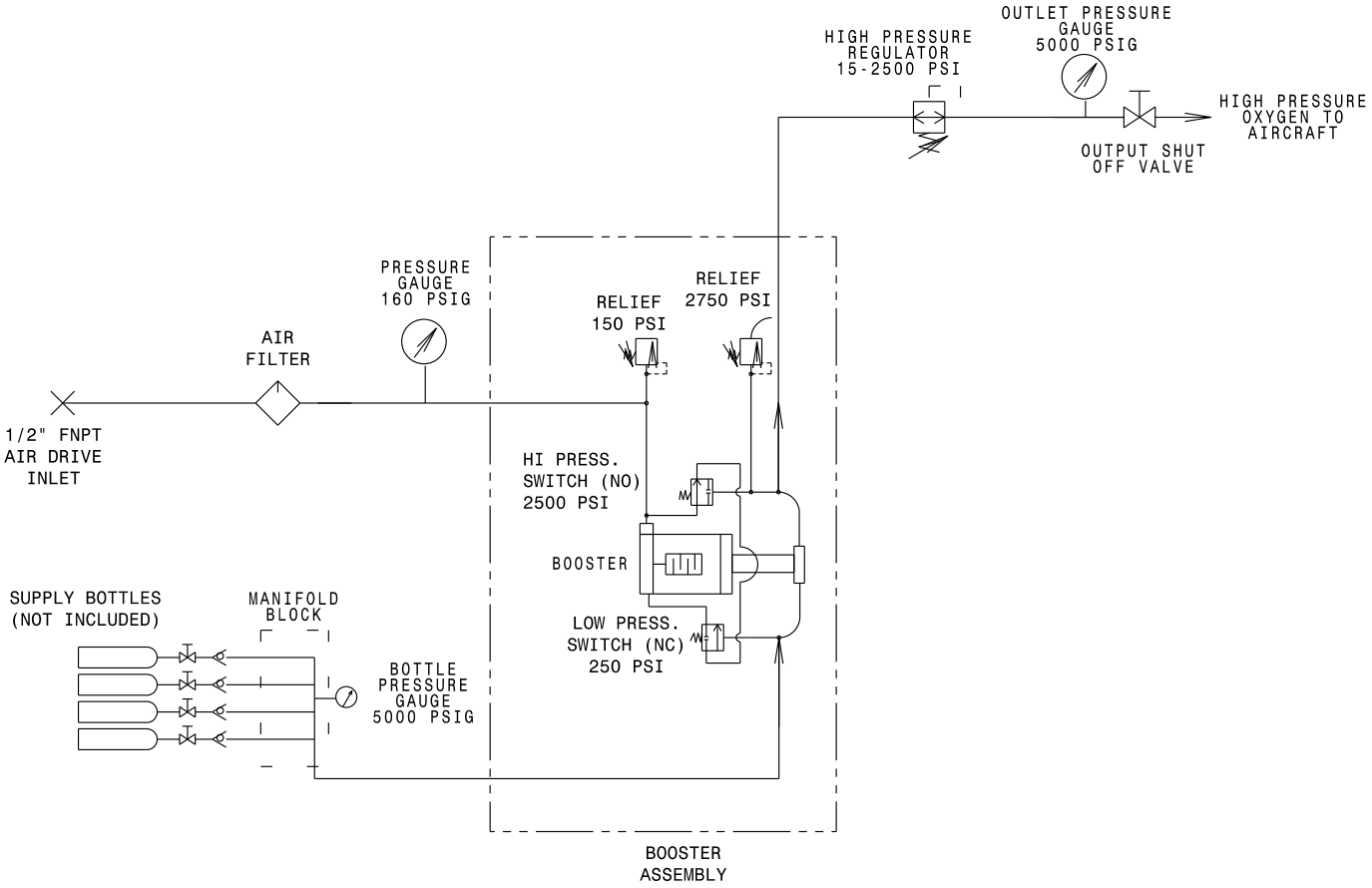
Do NOT transport cart with cradles in upright position. Always store cradles in horizontal position.

1. Place cart on flat, level surface
2. Ensure Towbar is in upright position
3. Close cylinder valves and disconnect input hoses
4. Rotate both cylinder cradles to upright position, ensure locking mechanism is engaged
5. Lower bottom ramp
6. Remove bottom clamping handle assembly
7. Loosen only one top clamping knob and rotate strap away from cradle
8. Walk cylinder down ramp
9. Repeat steps 7 & 8 for second cylinder
10. Repeat steps 5-8 for cylinders on opposite side

3.0 Preparation for use continued on following page.

3.0 PREPARATION FOR USE *(continued)*

3.2 SCHEMATIC



4.0 TRAINING

4.1 TRAINING REQUIREMENTS

The employer of the operator is responsible for providing a training program sufficient for the safe operation of the unit.

4.2 TRAINING PROGRAM

The employer provided operator training program should cover safety procedures concerning use of the unit in and around the intended aircraft at the intended aircraft servicing location.

4.3 OPERATOR TRAINING

The operator training should provide the required training for safe operation of the unit.

NOTE: Maintenance and Trouble Shooting are to be performed by a skilled and trained technician.

5.0 OPERATION OF OXYGEN BOOSTER

WARNING!

If there are any differences between the following instructions and the aircraft maintenance manual, the aircraft maintenance manual will take precedence.

1. Attach one static discharge cable clamp to aircraft static ground. (See aircraft maintenance manual if any questions.)
2. Attach other static discharge cable clamp to earth static ground. (See aircraft maintenance manual if any questions.)
3. Be sure all valves and controls are in the closed or "OFF" position.

WARNING!

Be sure fill line is secured prior to purging the unit. This will prevent the hose from "whipping" if too much oxygen is allowed to flow through the unit.

5.1 FILL PROCEDURE

1. Connect shop air supply (see Figure 3)
2. Close high pressure oxygen gas output valve
3. Reduce output pressure regulator to minimum pressure (counter clockwise)
4. Remove cap from output hose and immediately loosely connect hose to aircraft component
5. **SLOWLY** open shut off valve on the oxygen bottle
6. Adjust output pressure regulator for 50 – 100 psig on output pressure gauge
7. Open high pressure oxygen gas output valve slightly to purge output hose
8. Close high pressure oxygen gas output valve
9. Tighten output hose to aircraft component
10. Read aircraft system oxygen pressure required
11. Adjust output pressure regulator to required pressure
12. Slowly open high pressure oxygen gas output valve to fill aircraft component
13. Close high pressure oxygen gas output valve
14. Allow system to cool and recheck aircraft oxygen pressure prior to disconnecting. Repeat stems 12 & 13 if necessary

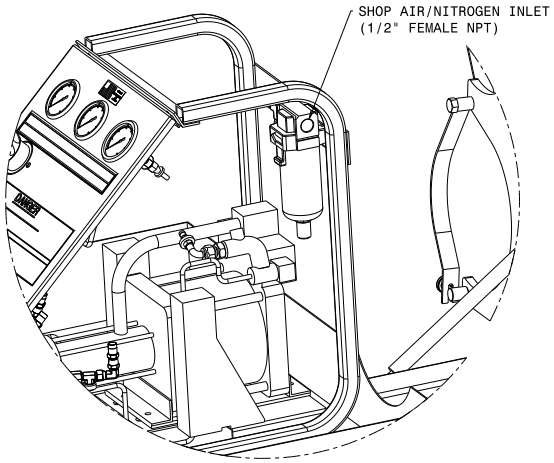


FIGURE 3 – Shop Air

If non-standard ambient temperatures are present at the time of oxygen system recharging, refer to Table 1 to determine the proper filling pressure for oxygen cylinders.

TABLE 1

At Temperature Degrees F	Fill to Working Pressure Multiplied by Figure Below
110	1.10
105	1.0875
100	1.075
95	1.0625
90	1.05
85	1.0375
80	1.025
75	1.0125
70	1.000
65	0.9875
60	0.975
55	0.9625
50	0.95
45	0.9375
40	0.925

EXAMPLE: Ambient Temperature = 90° F, Working pressure is 1800 PSIG:
Charge Pressure = (1800) x (1.05) = 1890 PSIG

5.0 Operation of oxygen booster continued on following page.

5.0 OPERATION OF OXYGEN BOOSTER *(continued)*

5.2 DISCONNECT PROCEDURE

WARNING!

When the aircraft fill line is pressurized or when oxygen is flowing through the system, the fill line hose will "whip" if not secured.

1. Close the shut off valves on the oxygen bottle
2. Open high pressure oxygen gas output valve
3. Reduce high pressure output regulator to minimum pressure
4. SLOWLY disconnect the output hose from the aircraft to bleed remaining pressure within the system
5. Immediately reinstall the cap on the output hose
6. Close high pressure oxygen gas output valve
7. Disconnect shop air supply and close shop air shut off valve

5.3 TO READ INDIVIDUAL BOTTLE PRESSURE

1. Close high pressure oxygen gas output valve
2. **SLOWLY** open a bottle shutoff valve
3. Read pressure on bottle supply pressure gauge
4. Close bottle shutoff valve
5. Open high pressure oxygen gas output valve and slightly adjust pressure regulator to bleed off system pressure
6. Repeat procedure for other bottles

5.4 EFFICIENT USE OF SYSTEM

Maximum oxygen may be removed from supply bottles if aircraft are serviced from the lowest pressure bottle first. In this manner, the most oxygen may be removed from each bottle. Even bottles with relatively low pressures may be used to service aircraft if the aircraft has a depleted system (250 psi minimum).

6.0 PACKAGING AND STORAGE

6.1 STORAGE

- Store the unit in a clean, dry area when not in use.
- Be sure that all hoses are capped and the unit is covered with lint free covering for the duration of unit storage to ensure complete oxygen system cleanliness for future aircraft system recharging.

7.0 TROUBLESHOOTING

Refer to Appendix I and Appendix II

8.0 MAINTENANCE

The operation, maintenance, and trouble shooting of this unit require practices and procedures, which ensure personal operator safety and the safety of others. Therefore, this equipment is to be operated and maintained only by qualified persons in accordance with this manual and all applicable local codes. Maintenance is only to be done by qualified persons.

All maintenance personnel must be familiar with the cautions and warnings associated with high pressure oxygen and high pressure oxygen systems as outlined in *Section 3 - Safety* of this manual prior to performing any maintenance on the unit.

8.1 TRAILER

- The inlet shop air filter should be inspected every 300 - 600 hours of service or every two years, whichever comes first. The sintered bronze filter element can be cleaned using soap and water. The element should be dried with shop air blown from the inside out. The element may be cleaned multiple times before replacing, depending on cleanliness of operating environment. The replacement air filter element is available from Tronair, part number PC-1145.
- Maintain pressure listed on tires.
- Grease wheel bearings quarterly.
- Generally keep the entire unit clean and free from contaminants. Visually inspect for any system leaks or damage. Correction of any problems prior to unit operation is imperative for safe operation.

8.2 OXYGEN COMPONENTS

WARNING!

OXYGEN EQUIPMENT IS NOT FIELD OR CUSTOMER SERVICEABLE!

OEM repair or replacement is recommended.

- The gauges on this unit should be inspected and calibrated annually to ANSI grade A accuracy, to maintain and ensure accuracy.
- Manifold inlet hoses should be inspected weekly for signs of cracking or kinking, replace as necessary.
- Inspect oxygen manifold output hose prior to each use for signs of cracking or kinking, replace as necessary.
- Replace inlet and output filters after 2000 hours of use (Z-7011).

9.0 PROVISION OF SPARES

9.1 SOURCE OF SPARE PARTS

Spare parts may be obtained from the manufacturer:

TRONAIR, Inc.
1 Air Cargo Pkwy East
Swanton, Ohio 43558 USA

Telephone: (419) 866-6301 or 800-426-6301
Fax: (419) 867-0634
E-mail: sales@tronair.com
Website: www.tronair.com

9.2 RECOMMENDED SPARE PARTS LISTS

Reference the following page(s) for Replacement Parts and Kits available.

10.0 IN SERVICE SUPPORT

Contact Tronair, Inc. for technical services and information. See Section 1.3 – Manufacturer.

11.0 GUARANTEES/LIMITATION OF LIABILITY

Tronair products are warranted to be free of manufacturing or material defects for a period of one year after shipment to the original customer. This is solely limited to the repair or replacement of defective components. This warranty does not cover the following items:

a) Parts required for normal maintenance
b) Parts covered by a component manufacturers warranty
c) Replacement parts have a 90-day warranty from date of shipment

If you have a problem that may require service, contact Tronair immediately. Do not attempt to repair or disassemble a product without first contacting Tronair, any action may affect warranty coverage. When you contact Tronair be prepared to provide the following information:

a) Product Model Number
b) Product Serial Number
c) Description of the problem

If warranty coverage is approved, either replacement parts will be sent or the product will have to be returned to Tronair for repairs. If the product is to be returned, a Return Material Authorization (RMA) number will be issued for reference purposes on any shipping documents. Failure to obtain a RMA in advance of returning an item will result in a service fee. A decision on the extent of warranty coverage on returned products is reserved pending inspection at Tronair. Any shipments to Tronair must be shipped freight prepaid. Freight costs on shipments to customers will be paid by Tronair on any warranty claims only. Any unauthorized modification of the Tronair products or use of the Tronair products in violation of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately void any warranty, express or implied.

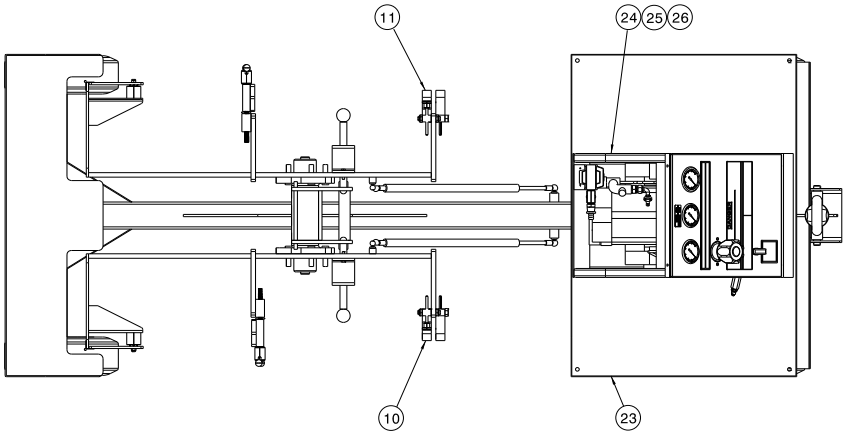
The obligations of Tronair expressly stated herein are in lieu of all other warranties or conditions expressed or implied. **Any unauthorized modification of the Tronair products or use of the Tronair products in violations of cautions and warnings in any manual (including updates) or safety bulletins published or delivered by Tronair will immediately *void any warranty, express or implied* and Tronair *disclaims any and all liability for injury (WITHOUT LIMITATION and including DEATH), loss or damage arising from or relating to such misuse*.**

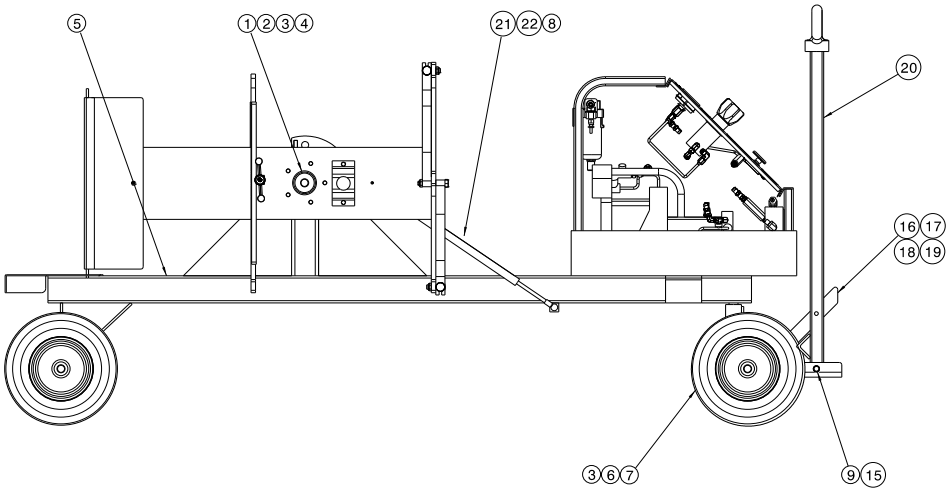
12.0 APPENDICES

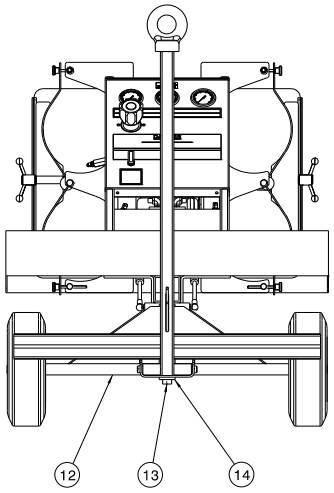
APPENDIX I	Maxpro Operating & Maintenance Instructions & Drawing.
APPENDIX II	Tescom (44-1100 Series) Regulator Operation & Service Instructions, Piston Sensed Pressure Reducing Regulators Operation & Service Manual, Safety, Installation, & Operation Precautions, Cleaning Notice
APPENDIX III	Haskel Gas Booster
APPENDIX IV	Instrument Certification Notice
APPENDIX V	Declaration of Conformity

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.







Item	Part Number	Description	Qty
1	H-3424	Hub, Bearing	2
2	G-1230-01	Nut, Axle 1 ¼	2
3	G-1283	Washer, Spindle 1”	6
4	G-1301-11	Pin, Cotter 3/16 x 1 ½	2
5	Z-8095-01	Weldment, 4-Cylinder Cart	1
6	U-1144	Assembly, Wheel w/Seal	4
7	G-1203-1120	Elastic Jamnut, 1 ¼	4
8	H-3668	Clips, Retaining	4
9	G-1301-02	Pin, Cotter 3/16 x 1 ½	2
10	Z-8237	Assembly, Left Cylinder Support	1
11	Z-8236	Assembly, Right Cylinder Support	1
12	Z-8099-01	Weldment, Front Truck	1
13	G-1301-03	Pin, Cotter ⅛ x 1 ½	1
14	H-2019-76	Bearing, Flange	2
15	R-2096	Pin, Towbar	1
16	J-5501	Lever	1
17	G-1503-1090N	Flatwasher, ½ Narrow, SST	2
18	G-1112-109500	Bolt, HH SST, ½ - 20 X 2 ½ Long	1

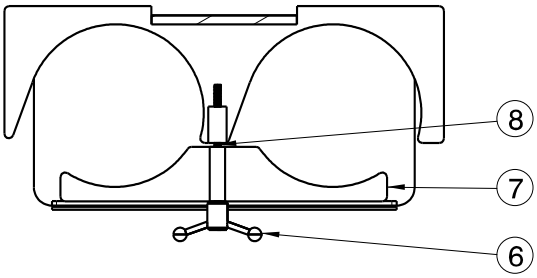
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

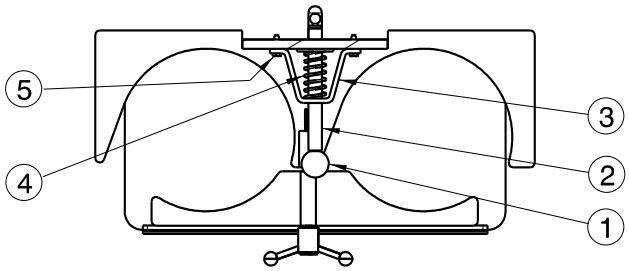
Item	Part Number	Description	Qty
19	G-1203-1095	Elastic Jamnut, ½ - 20	1
20	Z-8173-01	Weldment, Towbar	1
21	H-3687	Dampner	2
22	H-3666	Stud, Ball 5/16 – 18	2
23	S-2625-01	Hose Tray	1
24	Z-8242	Assembly, Oxygen Booster	1
25	G-1112-105022	Bolt, HH SST, ¼ - 20 x 2 ¼ Long	2
26	G-1501-1050	ESN, SST, ¼ - 20	2

Parts List

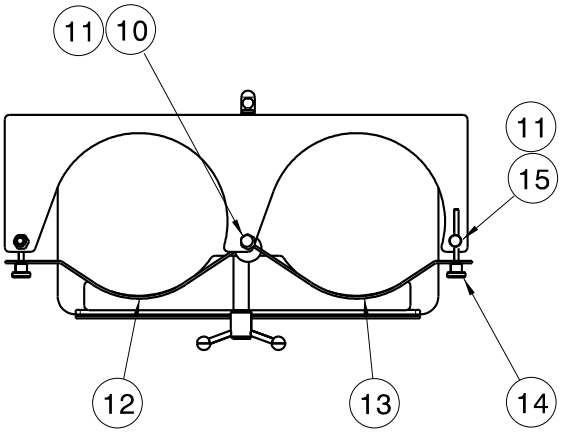
When ordering replacement parts/kits, please specify model, serial number and color of your unit.

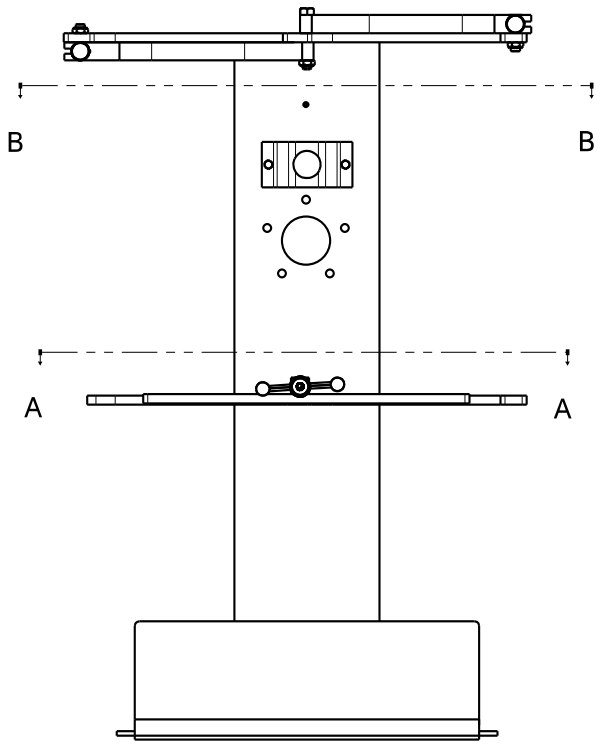


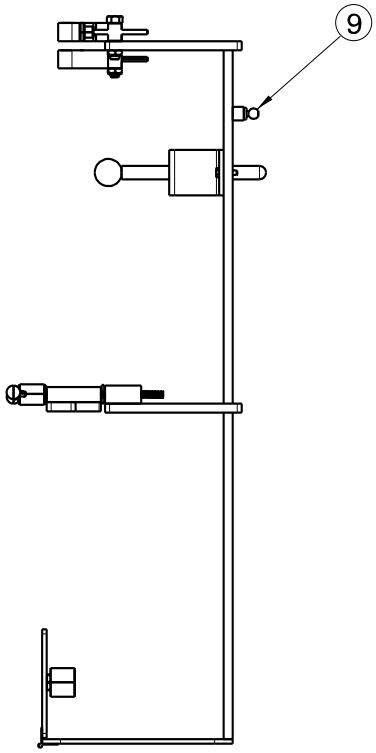
Section view A-A



Section view B-B







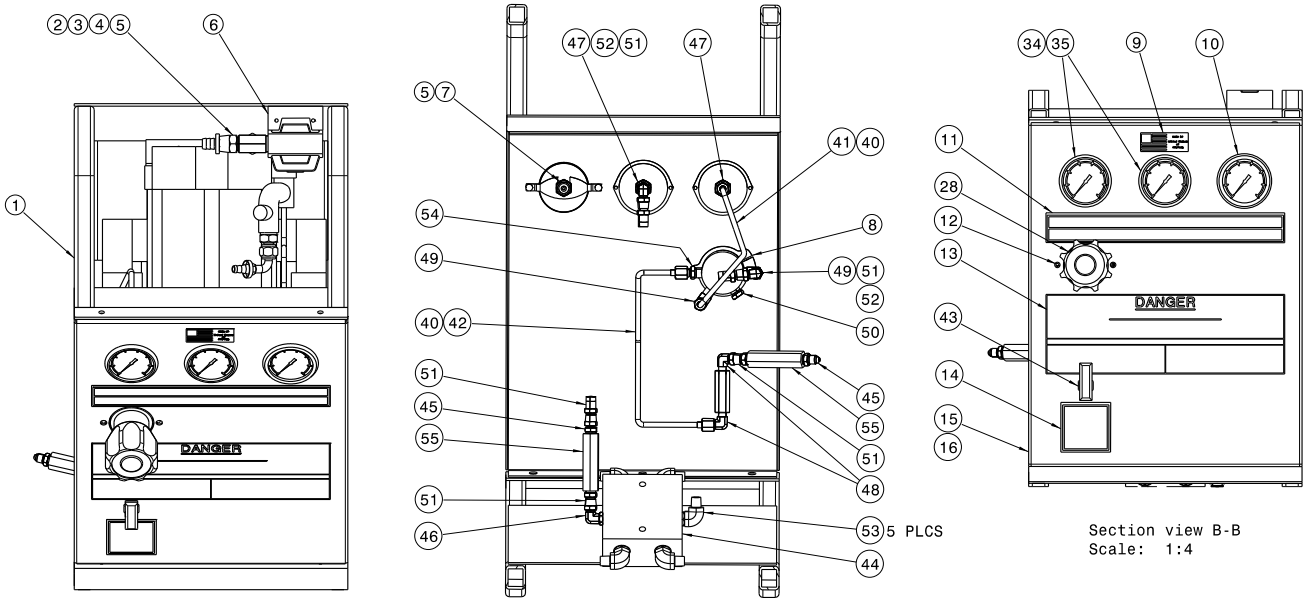
Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	H-3673	Knob, Ball	1
2	Z-8171-01	Weldment, Pin	1
3	S-2626-01	Bracket, Cradle Stop	1
4	H-3674	Spring	1
5	G-1112-105010	Bolt, HH SST, ¼ - 20 x 1 Long	2
6	Z-8188-01	Machining, Clamping Handle	1
7	Z-8103-01	Weldment, Cylinder Support Handle	1
8	G-1303-13100	Pin, Roll SST, ⅛ x 1 Long	1
9	H-3666	Stud, Ball 5/16 – 18	2
10	G-1112-109030	Bolt, HH SST, ½ - 13 X 3 Long	1
11	G-1203-1090	Elastic Jamnut, ½ - 13	3
12	S-2629-01	Strap	1
13	S-2628-01	Srap	1
14	H-2677-08	Assembly, Knurled Knob, SST	2
15	R-2800	Threaded Pivot	2

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.



Section view A-A
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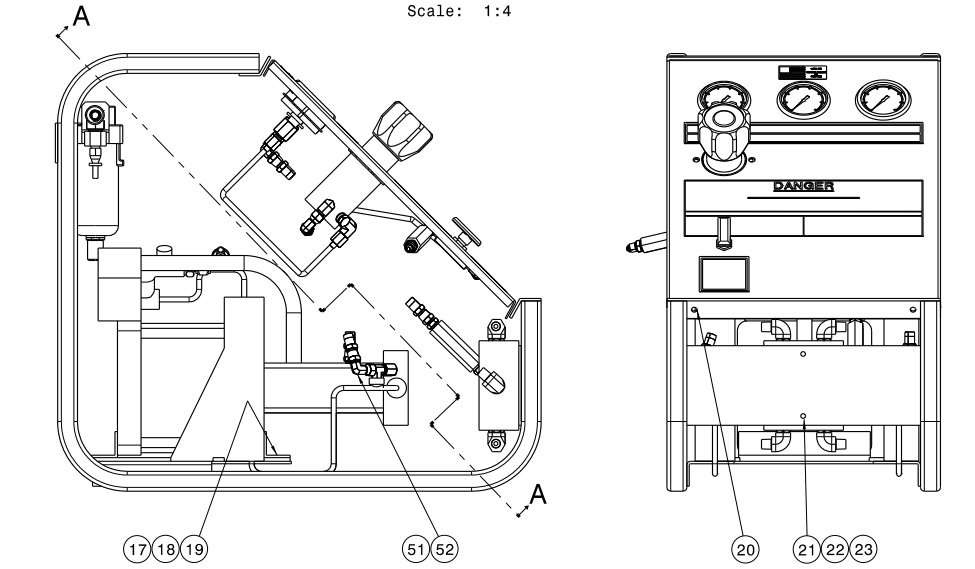
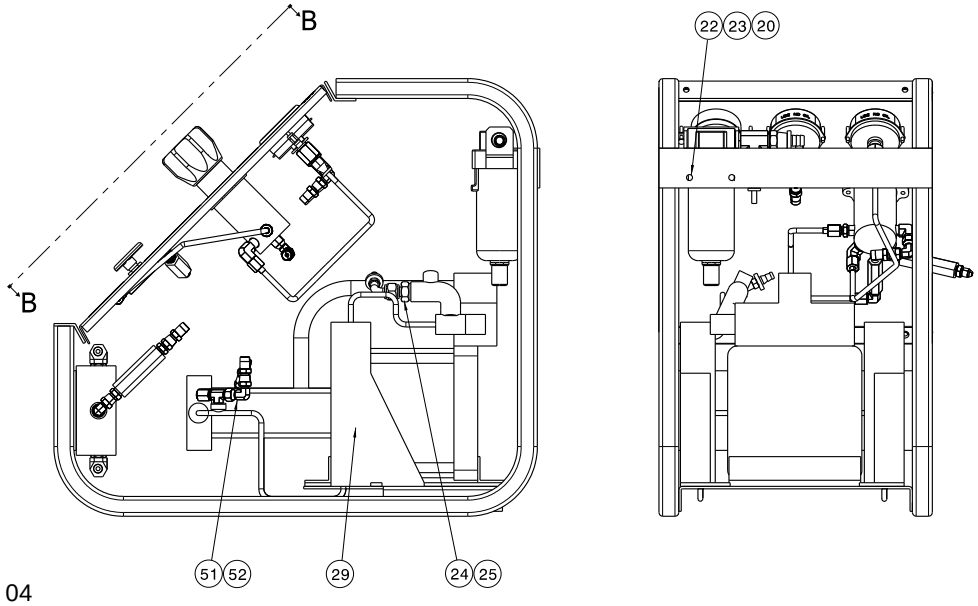
Section view B-B
Scale: 1:4





Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
1	Z-7654-01	Weldment, Frame	1
2	N-2017-14-S	Tee, Male Run	1
3	N-2055-03-S	Reducer, Tube (8-4)	1
4	N-2026-05-B	Swivel, Hose Fitting (-8)	1
5	N-2026-01-B	Swivel, Hose Fitting (-4)	2
6	PC-1032	Filter	1
7	N-2010-04-SS	Connector, Female (1/4 NPT x -4 JIC)	1
8	PC-1103	Clamp, Regulator Mounting	1
9	V-1001	Label, Made in the USA	1
10	HC-2278	Gauge, Pressure 160 psi	1
11	V-2045	Label, Operator	1
12	G-1154-105204	Screw, BHCS ¼ - 20 x ½ Long	2
13	V-2044	Label, Oxygen	1
14	V-2064	Label, Output Valve	1
15	S-1908-01	Panel, Instrument	1
16	G-1439-1050-S	Nutsert, ¼ - 20	5
17	G-1100-106510	Bolt, 5/16 – 24 x ¾ Long	4
18	G-1250-1060N	Flatwasher, 5/16 Narrow	8
19	G-1202-1065	Elastic Stopnut, 5/16 - 24	4
20	G-1157-105006	Screw, PAN HD CRS REC, ¼ - 20 x ¾ Long	6
21	G-1100-105026	Bolt, ¼ - 20 x 2 ¾ Long	2
22	G-1250-1050N	Flatwasher, ¼ narrow	4
23	G-1202-1050	Elastic Stopnut, ¼ - 20	4
24	N-2009-05-S	Connector, Male (04 Tube ½ NPT)	1
25	N-2500-03	Elbow, 90º Barbed	1
28	PC-1062-02	Regulator, High Pressure (Cleaned)	1
29	PC-1196	Booster, Oxygen (Cleaned)	1
34	V-1556	Label, Use No Oil	2
35	HC-2289	Gauge, Pressure 5000 psi (Cleaned)	2
40	HC-2285-04	Seal, Conical	4
41	TF-1249	Assembly, Hose	1
42	TF-1250	Assembly, Hose	1
43	HC-2397	Valve, Ball	1
44	J-3717	Manifold, Oxygen	1
46	N-2755-03-SS-B	Elbow, Straight Thread	1
47	N-2098-04-SS	Connector, Female	2
48	N-2518-03-SS	Elbow, Male	2
49	N-2518-04-SS	Elbow, Male	2
50	N-2522-03-SS	Plug, Hex Head	1
52	N-2753-03-SS	Elbow, Swivel Nut	4
53	N-2754-02-SS-B	Elbow, Male Pipe	5
54	N-2756-04-SS	Connector, Male	1

Parts List

When ordering replacement parts/kits, please specify model, serial number and color of your unit.

Item	Part Number	Description	Qty
N/S	TF-1047-05*15.0	Hose, ½" Push On (Air Filter Outlet – Booster Drive)	1
N/S	TF-1047-01-15.0	Hose, ¼" Push On (Air Filter Outlet – Booster Pressure Gauge)	1
N/S	TF-1079-06	Pigtail, 12” Long (Cleaned) (Booster Inlet – Inlet Filter)	1
N/S	TF-1079-06	Pigtail, 12” Long (Cleaned) (Booster Outlet – Regulator Inlet)	1
N/S	TF-1079-01	Pigtail, 18” Long (Cleaned) (Supply Pressure Gauge – Side/Manifold)	1
N/S	Z-8272	Assembly, Inlet Hose (Cleaned) (Top/Bottom of Manifold)	4
N/S	Z-5997	Assembly, Output Hose (Cleaned) (Output Filter)	1
	Z-7011	**Assembly, Filter;** *consist of:*	
45	N-2009-04-SS	Connector, Male (-04)	2
51	N-2752-01-SS	Swivel, 37º	7
55	PC-1136	Filter, In-Line	2

TRONAIR®

APPENDIX I

Maxpro
Operating & Maintenance Instructions & Drawing

MAXPRO TECHNOLOGIES, INC.
Installation and Maintenance Manual

MAXIMATOR
"DLA", "MPLV2", "SPLV2", "GPLV2" AIR AMPLIFIERS

When ordering spare parts please specify model, serial and order numbers.

INTRODUCTION

The Maximator Air Amplifiers and Gas Boosters are driven by compressed air and controlled by a floating control valve and pilot valves. Styles are single and double acting with single and two stage versions

INSTALLATION

The Amplifier and Gas Booster can be installed in any position.

Mounting brackets are provided at each end of the air cylinder, which uses 3/8" bolts.

Recommended Schematic:

1. Air Filter
2. Air Regulator
3. Manual Shut-off Valve
4. Connection for unregulated pilot valve (1/8" FNPT)
5. Main Air Drive Inlet
6. Tee

MAXPRO TECHNOLOGIES, INC.
7728 KLIER DR. FAIRVIEW, PA. 16415
PHONE: 814-474-9191 FAX: 814-474-9391

COMPRESSED AIR SUPPLY

Do not use an air lubricator because the Amplifier was lubricated with a silicon free grease when built. (Kluber Lube).

A compressed air filter is required and if the air is not dry, a water separator must be used.

Air control packages including a filter, regulator, gauge and shut-off valve are available as an option.

The air pressure connection is a 1/2" FNPT on DLE and DLA units, and 3/8" FNPT on SPLV and GPLV Amplifiers, and is located at the spool valve housing.

A second 1/8" FNPT air connection is provided and must be plumbed from an unregulated air source. This connection bypasses the pressure reducer and is connected directly to the pilot valve to provide low pressure differential start-up and re-start for better pressure contro.

HIGH PRESSURE AIR/GAS SECTION

When connection the Amplifier or Booster, **never** loosen the suction or discharge nozzles.

A suction filter with a maximum of 40 mesh should be installed in the suction line.

VENTILATION AND LEAKAGE PORTS

The two air section end caps each contain two 1/8" FNPT connections, located opposite each other.

One of these is fitted with a filter and ensures that the rear of the high pressure piston is adequately ventilated and the seals are protected on the suction stroke from external particles entering the high pressure section. Any high pressure gas leak would come out of these ports.

When using hazardous gas, these ports **must** be plumbed to a safe vent area along with the main air exhaust in event of seal failure.

The other 1/8" FNPT connection is for venting the air drive side in event of air seal failure.

START UP

The Suction and Discharge valves are marked with arrows indicating the direction of flow and must be fitted with the proper size and style of tubing.
Unload the pressure regulator on the compressed air side and open the manual shut-off valve on the air side. Open the suction line with the appropriate supply pressure gas. The Amplifier or Booster will automatically shut down once the preset operating pressure has been obtained. With multistage Boosters, the first stage discharge valve is already connected to the second stage suction valve.

COOLING

The exhaust air from the compressed air drive is used in boosters with a relatively high compression ratio for cooling the high pressure cylinders. Under certain extreme operating conditions or with constant operation, it is necessary to reduce the Maximator Amplifier or Booster's stroke rate in order to avoid overheating. If thermal monitoring is required, install a thermocouple with temperature indicator as near as possible to the high pressure connection. Tests have shown that temperatures in excess of 100C measured at this point considerably reduce the service life of the piston seals.

MAINTENANCE
USE ONLY ORIGINAL MAXIMATOR SPARE PARTS

The air drives of all Air Amplifiers and Gas Boosters are factory pre-treated with silicon free grease (Kluber Lube) and require no further lubrication except during routine maintenance.

Amplifiers/Boosters can be repaired at your local authorized service center or returned directly to Maxpro Technologies for quick turn-around service.
Amplifiers/Boosters returned for repair should be accompanied with the model, serial and order numbers as well as mfg. date and description of the problem / symptom.

TROUBLESHOOTING - PNEUMATIC SECTION

Symptom: Amplifier/Booster will not run at low air pressure (7-15)
Cause: Excessive friction of O-rings on spool valve
Remedy: Re-lubricate or replace the O-rings

Symptom: Amplifier/Booster will not run at low air pressure (7-15 psi)
Cause: Continuous escape of air from the exhaust
Remedy: Replace O-Rings on the spool valve

Symptom: Leaking seal between leakage port and air drive section
Cause: O-Rings and slide rings in the bearing bushings are defective.
Remedy: Replace O-Rings and slide rings

Symptom: Amplifier/Booster will not start
Cause: Two low air pressure at the unregulated pilot port.
Remedy: Increase pressure

Symptom: Stroke rate falls.
Cause: Exhaust pipe is iced up.
Remedy: Stop for short time and remove water from drive air line.

Symptom: Amplifier/Booster operates at a high frequency and short strokes.
Cause: Pilot valve defective.
Remedy: Clean, check and lubricate pilot valve parts or replace if necessary.

TROUBLESHOOTING - HIGH PRESSURE SECTION

Symptom: Amplifier/Booster will not run
Cause: Too low air pressure
Remedy: Regulate the air drive pressure according to the pressure ratio

Symptom: Bad leak at the leakage port with filter
Cause: Worn high pressure seal
Remedy: Replace high pressure seals.

Symptom: Amplifier/Booster runs but does not deliver compressed gas.
Cause: a: Too low inlet gas pressure
b: Outlet check valves not working.
Remedy: a: O-rings may need replacement; regulate the inlet gas pressure.
b: Clean check valves and if necessary replace O-rings.

Symptom: Amplifier/Booster overheats
Cause: a: Defective check valves
b: Stroke frequency too high.
Remedy: a: Inspect check valves
b: Throttle down the air feed rate.

SERVICE

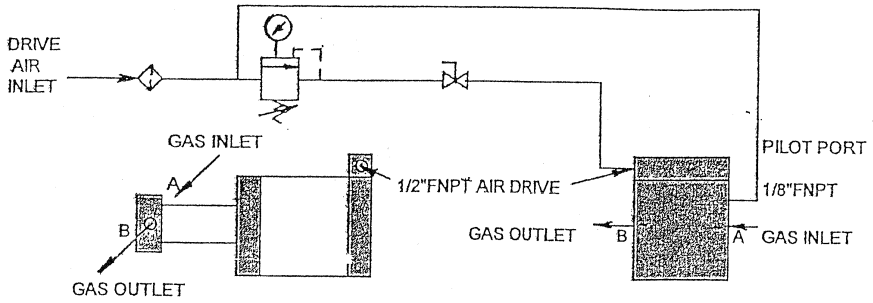
For factory authorized service, contact Maxpro Technologies, Inc. or your local Distributor. Maxpro Technologies fax number is 814-838-2730.

MAXPRO TECHNOLOGIES, INC.

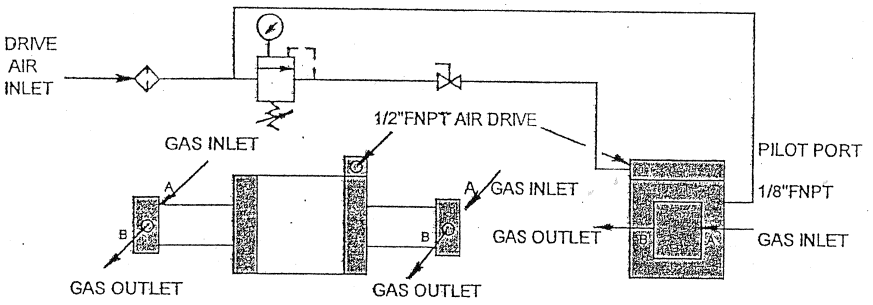
MAXIMATOR INSTALLATION DIAGRAMS

GAS BOOSTERS
DLA AIR AMPLIFIERS

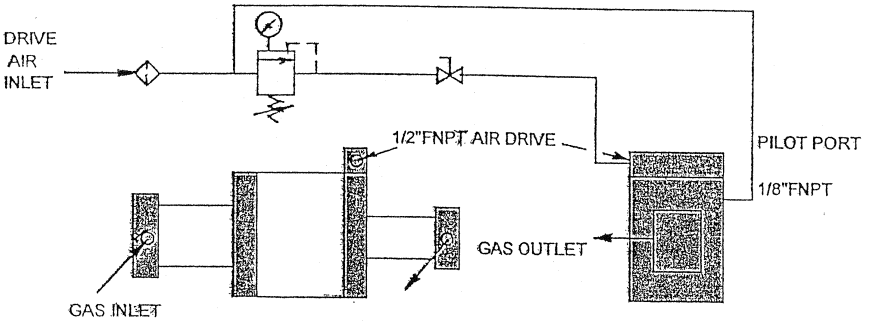
SINGLE ACTING, SINGLE STAGE



DOUBLE ACTING, SINGLE STAGE



DOUBLE ACTING, 2-STAGE



MAXPRO TECHNOLOGIES, INC.
7728 KLIER DRIVE SOUTH
FAIRVIEW, PA 16415

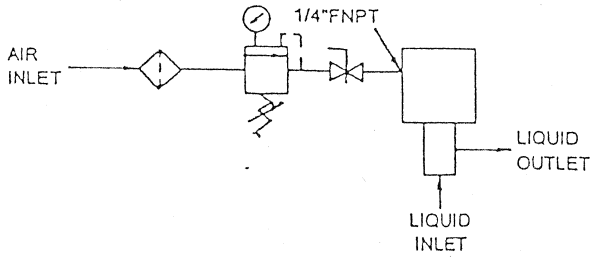
PH: 814-474-9191
FAX: 814-474-9391

MAXPRO TECHNOLOGIES, INC.

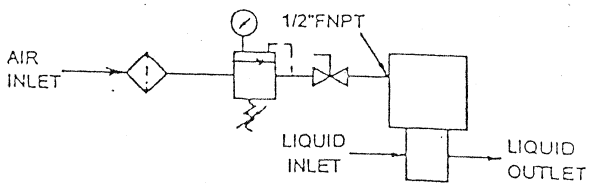
MAXIMATOR INSTALLATION DIAGRAMS

LIQUID PUMPS
AIR AMPLIFIERS

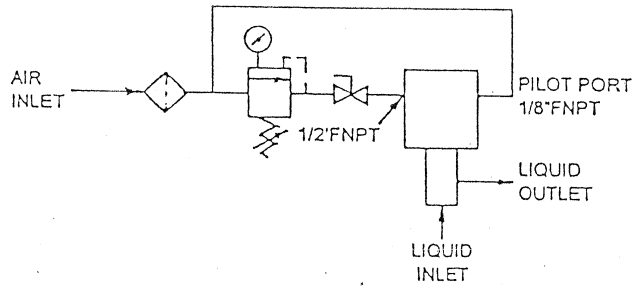
ALL CPO, PPO, PP AND PPSF PUMPS



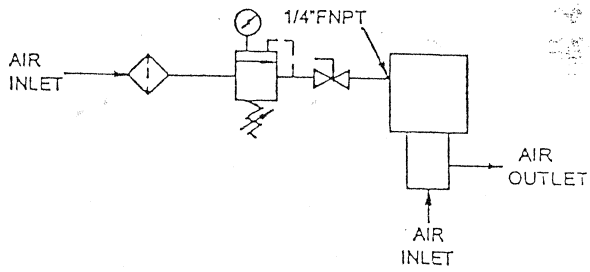
ALL S PUMPS



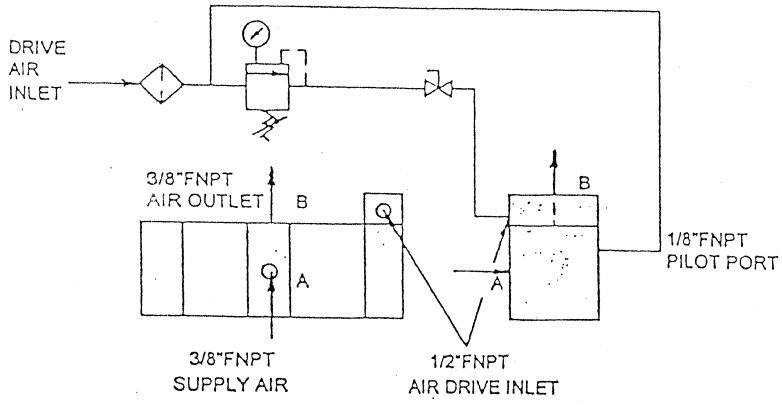
ALL LO, L AND LSF PUMPS



MPLV4-1 AIR AMPLIFIER

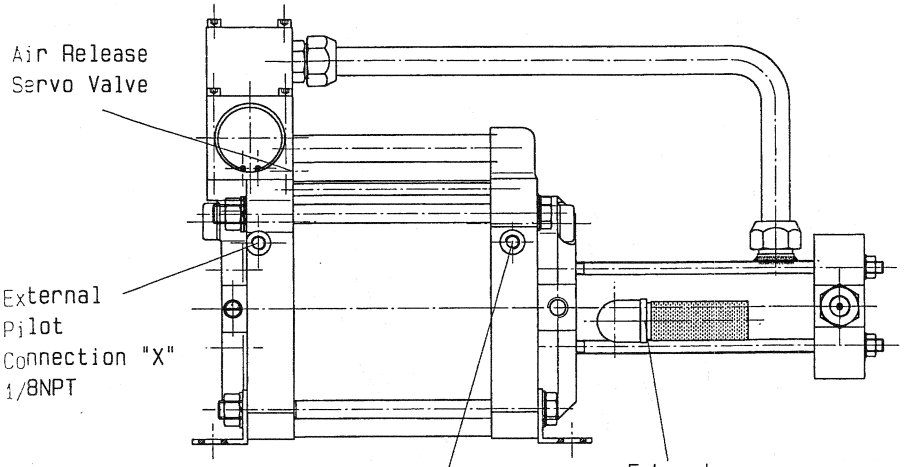


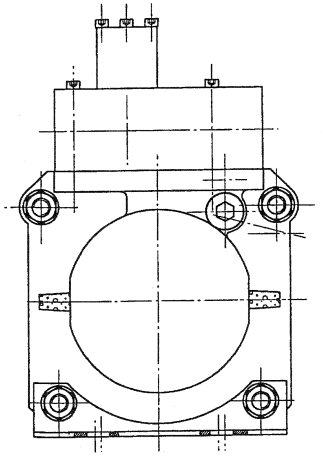
GPLV2 AND SPLV2 AIR AMPLIFIERS



US - representative:
MAXPRO TECHNOLOGIES, INC.
7728 Klier Drive
FAIRVIEW, PA 16415
PHONE: 814-474-9191
FAX: 814-474-9391

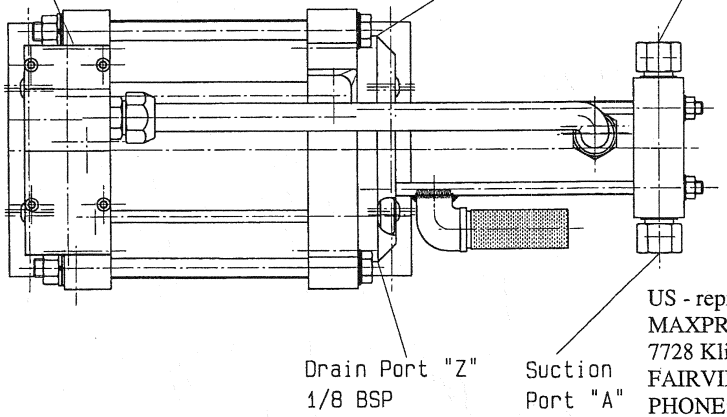
MAXIMATOR Booster - Type: DLE ... - 1





High Pressure
Drain Port
Z1

Air Drive
Drain Port
Z2



ATTENTION !
Dimension of suction-/discharge port sets to the pump model.

US - representative:
MAXPRO TECHNOLOGIES, INC.
7728 Klier Drive
FAIRVIEW, PA 16415
PHONE: 814-474-9191
FAX: 814-474-9391

Maße ohne Toleranzangaben nach DIN 7168 mittel

	Über 6 bis 30 ± 0,1	Über 30 bis 120 ± 0,2	Über 120 bis 315 ± 0,3	Über 315 bis 1000 ± 0,5	Über 1000 bis 2000 ± 0,8	Über 2000 bis 4000 ± 1,2	Über 4000 ± 2

MAXIMATOR®
Schmidt, Kranz & Co GmbH
D-37449 Zorge / Südharz

Kunde:

Maßstab: 1:2 | Gewicht:

No Dimension Drawing !

	Datum	Name
Erstr.	09.02.1997	Sch
Gepr.	12.3.98	
Bearb.	02.03.1998	

(Benennung)
MAXIMATOR
Booster - Type: DLE ... - 1

Halbzeug:
Werkstoff:

(Zeichnungsnummer) VP 16.00.153.05
(Artikel-Nr.) 3250.XXXX

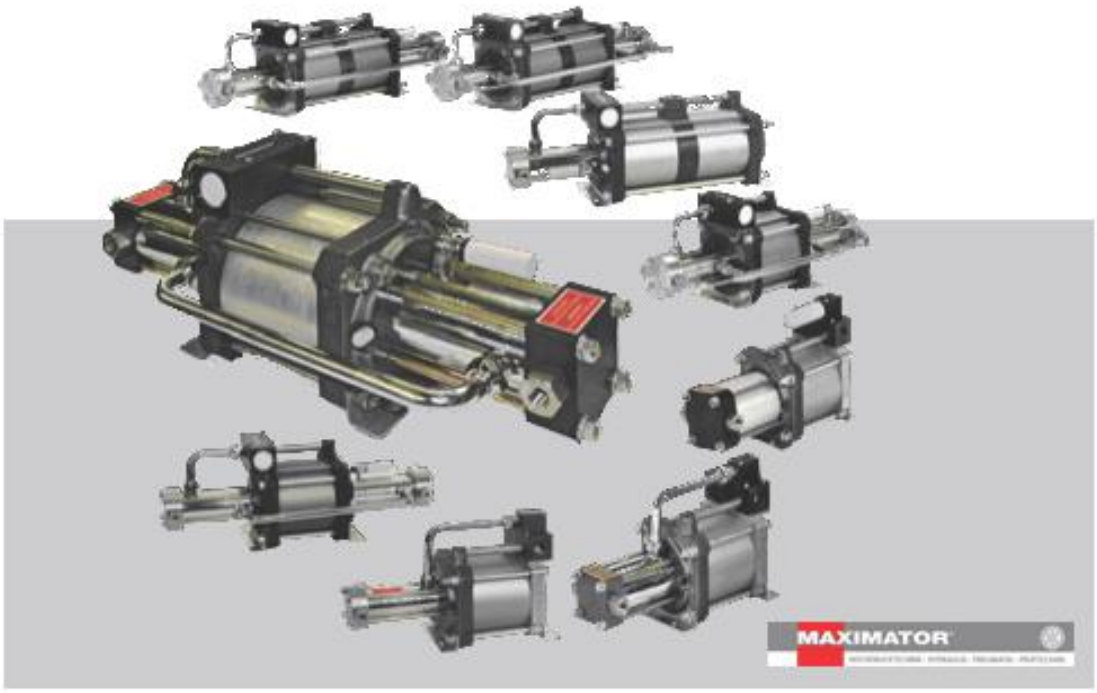
Zust. | Änderung | Datum
Ursor.: (VP 16.00.153)
Ersatz für | Ersetzt durch

15015305

Operating instructions

Boosters

DLE 2 (-1, -2) – DLE 75 (-1, -2)



Read the instructions prior to performing any task!

Maximator GmbH
Lange Straße 6
D-99734 Nordhausen
Telephone: +49 (0) 3631/9533-0
Fax: +49 (0) 3631/9533-5065
email: info@maximator.de
Internet: www.maximator.de
Translation of the original operating instructions
Maxi-14315-DE, 1, en_US

This operating manual was created by:
Kothes!
Technische Kommunikation GmbH & Co. KG
Internet: www.kothes.de

⚠ This operating manual enables the safe and efficient handling of boosters DLE 2 (-1), (-2) – DLE 75 (-1), (-2). The operating manual is a component of the booster and must be kept in the immediate vicinity of the booster where it is available to personnel at all times. Personnel must have carefully read and understood this manual before performing any tasks. The basic prerequisite for safe work is compliance with all specified safety instructions and handling instructions. In addition, the applicable local accident prevention regulations and general safety regulations must be complied with for the booster's area of implementation. The illustrations in this manual are provided for purposes of basic understanding and can deviate from the actual version. No claims whatsoever may be derived from any deviations.

Copyright

Customer service

Our customer service organization is available for technical information and repairs:

Address	Maximator GmbH Ullrichstrasse 3 99734 Nordhausen
Telephone - customer service Mon - Fri: 7:00 AM - 5:00 PM CET	+49 (0) 3631-9533-5026 (Service Manager)
Telephone - customer hotline Mon - Fri: 8:00 AM - 10:00 PM CET Sat - Sun and holidays: 8:00 AM - 8:00 PM CET	+49 (0) 1805-629 462 867
Fax	+49 (0) 3631 / 9533-5065
email	service@maximator.de
Internet	www.maximator.de

In addition, we are always interested in new information and experiences associated with the application which could prove valuable in improving our products.

Table of contents

1 Overview

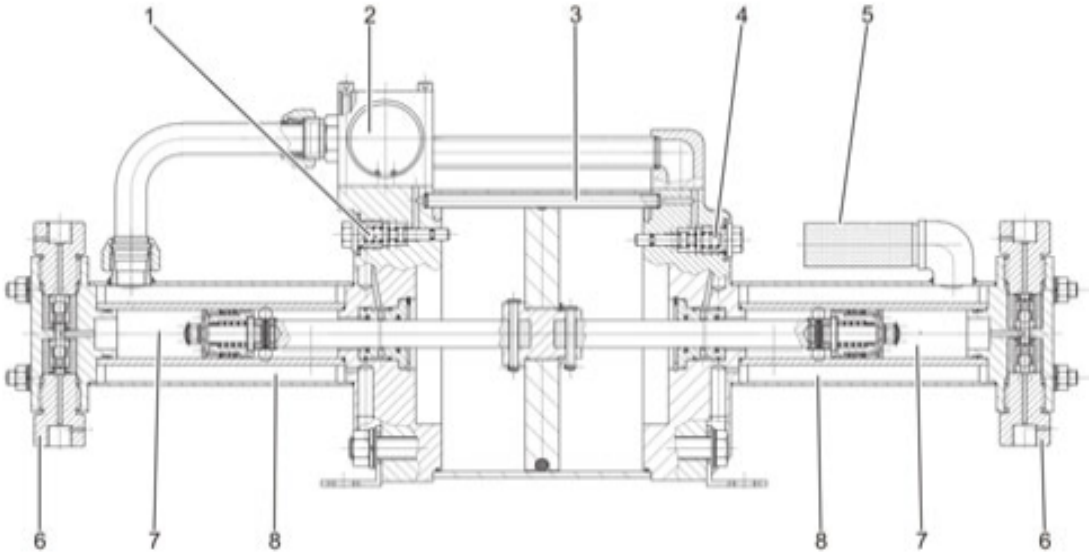


Fig. 1: Booster Overview

1 Pilot valve 1
2 Spool valve (4/2 directional control valve)
3 Air cylinder
4 Pilot valve 2
5 Exhaust air silencer
6 Booster head with suction and pressure valve
7 Pressure cylinder
8 Cooling cylinder

1.1 Brief description

The compressed air-driven boosters of model series DLE 2 (-1, -2) – DLE 75 (-1, -2) are incomplete machines and designed to be installed in plants or systems. The boosters are used exclusively for the oil-free compression of combustible, non-combustible, toxic and non-toxic gases, and compressed air.

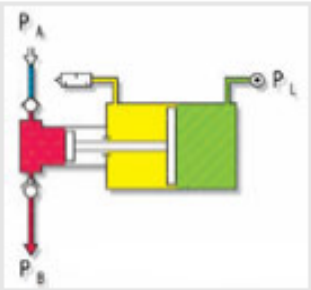
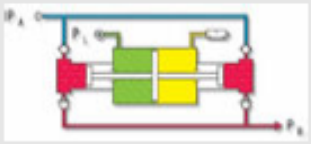
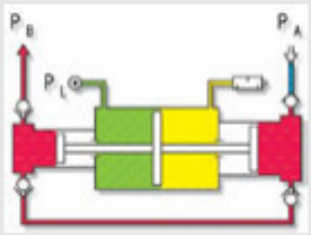
1.2 Versions

The individual booster type versions are listed in the following.

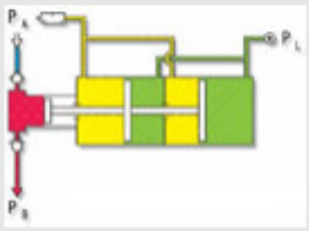
Boosters with one drive piston

Legend:

- P_L = Air drive
- P_A = Gas admission pressure
- P_B = Operating pressure
- = outlet air

Version	Graphic representation
Single-stage, single-acting Types: ■ DLE 2–1 ■ DLE 5–1 ■ DLE 15–1 ■ DLE 30–1 ■ DLE 75–1	
Single-stage, dual-acting Types: ■ DLE 2 ■ DLE 5 ■ DLE15 ■ DLE 30 ■ DLE 75	
Dual-stage, dual-acting Types: ■ DLE 2-5 ■ DLE 5-15 ■ DLE 5-30 ■ DLE 15-30 ■ DLE 15-75 ■ DLE 30-75	

Boosters with two drive pistons

Version	Graphic representation
Single-stage, single-acting with two air pistons Types: ■ DLE 2–1–2 ■ DLE 5–1–2 ■ DLE 15–1–2 ■ DLE 30–1–2 ■ DLE 75–1–2	
Single-stage, dual-acting with two air pistons Types: ■ DLE 2-2 ■ DLE 5-2 ■ DLE 15-2 ■ DLE 30-2 ■ DLE 75-2	
Dual-stage, dual-acting with two air pistons Types: ■ DLE 2-5–2 ■ DLE 5-15–2 ■ DLE 5-30–2 ■ DLE 15-30–2 ■ DLE 15-75–2 ■ DLE 30-75–2	

2 Safety

This section provides an overview of all important aspects that are essential for the protection of personnel as well as safe and trouble-free operation. Additional task-specific safety instructions will be provided in the sections that refer to the individual life stages of the plant.

2.1 Intended use

The compressed air-driven boosters of model series DLE 2 (-1, -2) – DLE 75 (-1, -2) are incomplete machines and designed to be installed in plants or systems. The boosters are used exclusively for the oil-free compression of combustible, toxic and non-toxic gases, and compressed air. Only displacement media that is permitted for use in boosters may be compressed (*Chapter 2.2 "Permissible displacement media (gases)" on page 15*). The boosters are driven by compressed air with a maximum driving pressure of 145 psi.

The boosters can be used, if they are marked accordingly, in explosion-protected areas.

Intended use also includes compliance with all the instructions in this manual.

Any use that extends beyond the intended use, or any other use of the system is considered to be misuse.

Foreseeable misuse

⚠ WARNING

Danger in the event of misuse!

- **Never use any displacement media other than those listed in *Chapter 2.2 "Permissible displacement media (gases)" on page 15*.**
- **Never operate the boosters in closed containers.**
- **Never make unauthorized conversions or modifications to the boosters.**
- **Compressed air must never be used for respiration purposes.**
- **Never use the boosters in any manner other than that described in this operating manual.**
- **Never exceed the technical limits or pressures specified in this operating manual.**
- **Only operate the booster if it is in faultless technical condition.**
- **The boosters must not be used directly for pharmaceutical or sanitary purposes involving food.**
- **Always comply with all instructions concerning installation, maintenance, and fault correction specified in this manual.**

Misuse of the boosters of model series DLE 2 (-1, -2) – DLE 75 (-1, -2) can lead to dangerous situations.

Compression of hydrogen

To prevent potentially explosive atmospheres in areas around hydrogen systems from developing, always observe the following:

- Always set up hydrogen systems in a well ventilated room.
- Always keep hydrogen systems leak-tight.
- Blow-out lines of safety valves and leakage lines must always be routed outside into the open.
- Blow-out lines must not be installed under eaves, openings in buildings, or in the vicinity of air intake openings.
- For hydrogen systems in rooms or buildings, it must be possible to safely and quickly shut off the gas supply coming from the outside at a safe point.
- Pipe connections on hydrogen systems must always be created ensuring that the connection will be tight for a long time.

2.2 Permissible displacement media (gases)

Displacement media (gases)

Displacement media that is permitted for compression with the boosters is listed in the following.

⚠ WARNING

Risk of accident if the permissible displacement media is not observed!

- **Only compress displacement media permissible for the particular booster models. For this purpose, compare the type information on the type plate with those from the following table.**
- **Always observe the special instructions for the particular displacement media.**

If the permissible displacement media and the special instructions are not observed, this can lead to severe accidents.

Displacement medium (gases)	Symbol	Booster types	Special instructions for the compression of the displacement media
Argon	Ar	All models	
N-butane	C_4H_{10}	All models	Lay pipes and rinse SFP (special flushing port) and leak bores; high pressure seal not 100% leak-tight.
Compressed air		All models	
Carbon monoxide	CO	DLE xxx-C	Lay pipes and rinse SFP (special flushing port) and leak bores; high pressure seal not 100% leak-tight.
Carbon dioxide	CO_2	DLE xxx-C	
Ethane	C_2H_6	All models	Lay pipes and rinse SFP (special flushing port) and leak bores; high pressure seal not 100% leak-tight.
Ethylene	C_2H_4	All models	Lay pipes and rinse SFP (special flushing port) and leak bores; high pressure seal not 100% leak-tight.
Freon (F-12)	CCL_2F_2	DLE xx-CR	Lay pipes and rinse SFP (special flushing port) and leak bores; high pressure seal not 100% leak-tight.

Displacement medium (gases)	Symbol	Booster types	Special instructions for the compression of the displacement media
Helium	He	All models	
Hydrogen	H_2	DLExxx-(H2)	Lay pipes and rinse SFP (special flushing port) and leak bores; high pressure seal not 100% leak-tight.
Methane	CH_4	All models	Lay pipes and rinse SFP (special flushing port) and leak bores; high pressure seal not 100% leak-tight.
Acid gas (natural gas with portions of hydrogen sulfide)		DLE xxx-NACE	Lay pipes and rinse SFP (special flushing port) and leak bores; high pressure seal not 100% leak-tight.
Propane	C_3H_8	All models	Lay pipes and rinse SFP (special flushing port) and leak bores; high pressure seal not 100% leak-tight.
Nitrogen	N_2	All models	
Laughing gas	N_2O	All models	
Oxygen	O_2	DLE xxx-S	Lay pipes for leak bores, lubrication with halocarbon grease (oxygen scavenging), max. compression ratio 1:6 Max. pressure 5076.33 psi
Sulfur hexafluoride	SF_6	DLExxx-CR	Lay pipes and rinse SFP (special flushing port) and leak bores; high pressure seal not 100% leak-tight.
Xenon	XE	All models	

Contact the manufacturer for special instructions on the use of further media. See the contact information on Page 2 of these operating instructions.

Remove plug on SFP (special flushing port) for hazardous gases and lay pipes. To do this, see ↳ *Appendix A "Hydrogen compression with Maximator boosters" on page 117 in these operating instructions.*

2.3 Basic dangers

The following section lists remaining risks from boosters that exist even if they are used as intended.

To reduce the risk of personal injury and property damage and to avoid dangerous situations, observe the safety messages listed here as well as the safety instructions in the additional sections of this operating manual.

2.3.1 General dangers at the workstation

Noise

⚠ WARNING

Risk of injury caused by noise!

- **Always wear personal protective equipment when working on running boosters.**
- **Only be in the danger zone to the extent required.**

The noise level that occurs in the work area can cause severe hearing loss depending on the type of installation and expanding air.

2.3.2 Dangers due to gases under pressure

Pressurized components

⚠ WARNING

Danger of injury due to pressurized components!

- **Always establish de-pressurized status before mounting or dismounting hoses, lines, threaded unions, or quick-release couplings. Completely de-pressurize the pressure accumulator.**
- **Always wear personal protective equipment.**
- **Have defective components that are pressurized in operation replaced immediately by qualified personnel (mechanical and plant engineer).**

Compressed air or gas can escape from compressed air lines, threaded unions, or pressurized components if these components are not handled properly. This compressed air or gases can harm the eyes, whirl up dust, can cause uncontrolled movements of the lines, and can cause severe injuries. Defective pressurized components can also cause uncontrolled movements that can result in severe injuries.

2.3.3 Dangers due to low temperatures

Cold surfaces

⚠ CAUTION

Risk of injury due to cold and iced up surfaces!

- **Always wear protective clothing and protective gloves during all work in the vicinity of cold or iced up surfaces.**
- **Make sure prior to all work that all surfaces have warmed up to ambient temperature.**

Components such as the exhaust air silencer can cool down severely and ice up due to expanding air or gas. Skin contact with cold surfaces can cause skin irritations.

Flying ice crystals and accumulated liquids

⚠ WARNING

Risk of injury caused by flying ice crystals and accumulated fluids!

- **Always wear protective eye wear during all work.**
- **Immediately pick up any accumulated fluid using appropriate means.**
- **Always wear non-slip safety shoes.**
- **Place warnings and mandatory action signs on or near the area where liquids can collect on the floor or where there can be flying ice crystals.**

Icing can develop on the exhaust air silencer of the booster during operation that is freed up by expanding outlet air and tossed around. The pushed off ice crystals can lead to eye injury and accumulated fluids on the floor.

2.3.4 Dangers due to fire

Fire control

⚠ WARNING

Risk of injury from insufficient or improper fire suppression!

- **Ensure that fire extinguishers suitable for the corresponding class of fire are readily available.**
- **Check fire extinguishers for proper operation every 2 years.**
- **Refill fire extinguishers after each use.**
- **Use only fire-extinguishing propellants and spare parts that correspond to the approved design specified on the fire extinguisher.**
- **Follow the safety and operating instructions specified on the fire extinguisher when deploying it.**
- **Observe its functional temperature range when deploying the fire extinguisher.**

Using a fire extinguisher in the event of fire that is not ready for operation or unsuitable for the corresponding class of fire may lead to severe injuries, including death, and significant material damage.

2.3.5 Dangers due to explosion

Explosion protection

⚠ WARNING

Risk of explosion!

- **Prior to starting work in the Ex area, obtain a written work approval.**
- **Perform tasks only when a potentially explosive atmosphere can be ruled out.**
- **Prior to all fault elimination work, flush booster with nitrogen to prevent oxyhydrogen gas from developing from previously compressed toxic or combustible gases.**
- **Use only those tools that are permissible for use in the Ex area.**
- **Never smoke in the explosive area.**

Bringing in ignition sources such as sparks, open flames, and hot surfaces can lead to explosion in the Ex area. Non-compliance with these instructions will lead to loss of explosion protection.

2.3.6 Dangers due to chemical substances

Displacement media

⚠ WARNING

Risk of injury due to improper handling of displacement media!

- **Always observe the manufacturer's safety data sheet.**
- **When working with gas, always ensure adequate ventilation.**
- **Do not smoke within the danger zone and in the immediate vicinity. Do not use open flames, fire, and ignition sources of any kind.**
- **Keep a breathing apparatus that does not depend on circulating air on hand for emergencies.**
- **If there are signs of suffocation, immediately provide the affected person with the breathing apparatus that does not depend on circulating air, move to fresh air into recovery position, and keep warm. If no longer breathing, provide first aid measures and start artificial respiration. Seek medial attention immediately.**

Improper handling of displacement media can lead to severe poisoning or even death by suffocation.

Occurring vapors

⚠ WARNING

Risk of injury due to occurring vapors!

- **Do not stay in the immediate vicinity while the boosters are operated.**
- **Do not eat or drink in the vicinity of the boosters.**
- **In case of doubt, wear light respiratory protection.**

During the work process, exhaust gas of the drive air can develop on the drive component of the booster that can lead to poisoning when inhaled or upon contact with skin.

2.4 Responsibility of the owner

Owner

The owner is the person who is personally operating the boosters for industrial or commercial purposes or who is leaving the use/application to a third party and who has the legal product responsibility during the operation for the protection of the user, the personnel, or third parties.

Owner's obligations

The booster is used commercially. The owner of the booster is therefore subject to legal occupational health and safety obligations.

In addition to the safety instructions in this operating manual, general occupational health and safety, accident prevention, and environmental protection regulations must be complied with for the area of implementation of the booster.

In this regard the following particularly applies:

- The owner must inform himself of applicable occupational health and safety regulations, and in a hazard analysis identify additional hazards that may exist at the installation site of the booster due to the special work conditions. The owner must convert this information into operating instructions for operation of the booster.
- The owner must ensure during the entire implementation period of the booster that the operating instructions drawn up by the owner correspond to the current state of legislation, and if necessary the owner must adapt these operating instructions.
- The owner must clearly regulate and specify responsibilities for installation, operation, fault correction, maintenance and cleaning.
- The owner must ensure that all personnel who handle the booster have read and understood this operating manual. In addition, the owner must train personnel and inform them of hazards at regular intervals.
- The owner must provide the required protective equipment for personnel and instruct personnel that the wearing of the required protective equipment is a binding obligation.

The owner is also responsible for keeping the booster in faultless technical condition at all times. For this reason the following applies:

- The owner must ensure that the booster is integrated in the emergency stop devices or in the safety chain of the system in which the booster will be installed.
- When aggressive displacement media and/or toxic gases are used, the owner must ensure that lines will be installed that will capture the leaking aggressive media and/or toxic gases in corresponding containers and that the aggressive and toxic media will be disposed of properly.

- When aggressive, combustible, dangerous, or toxic gases are compressed, the owner must ensure that the booster is flushed with nitrogen before any fault elimination work is performed.
- The owner must ensure that only permissible displacement media (*Chapter 2.2 "Permissible displacement media (gases)" on page 15*) will be compressed with the booster.
- The owner must ensure that the operating media (compressed air, gases) are pre-installed and stored as prescribed.
- The owner must ensure that all pressure hoses, pressure lines, couplings, and threaded unions are configured and dimensioned for the pressure ranges of the booster.
- The owner must ensure that suitable media connections are present and that these connections can be safeguarded via a separate shut-off valve.
- The owner must ensure that the connections of the operating media (compressed air, gases) function properly.
- The owner must ensure that the booster is kept and operated exclusively in technically faultless condition.
- The owner must ensure adequate lighting is always provided in the work area of the booster.
- The owner must ensure that all fault correction and repair tasks are executed exclusively by specialized personnel, who have the qualifications cited in the fault table.
- The owner must ensure that all warnings, instructions and safety signs attached on the booster are always complete and maintained in legible condition.
- The owner must ensure that the system is checked for damage and proper condition prior to each booster start up.

Obligations of the mechanical engineer and plant engineer

The mechanical engineer and plant engineer must has additional obligations resulting from the installation of the booster into a plant or system:

- The mechanical engineer and system engineer must ensure that, when installing the boosters in a plant or in a system, that an overall risk assessment is produced and that required steps to minimize hazards are initiated.
- The mechanical engineer and plant engineer must ensure that the boosters are integrated in the emergency stop concept of the plant/system.
- The mechanical engineer and plant engineer must ensure that all pressure hoses, pressure lines, couplings, and threaded unions are configured and dimensioned for the pressure ranges of the boosters.

Additional explosion protection obligations of the owner

The owner has additional obligations according to the EU directive to improve the health protection and safety of employees who may be endangered by explosive atmospheres.

They include the following organizational steps:

- Marking of Ex areas
- Placing clear signs of all prohibitions
- Preparing explosion protection documentation for every zone
- Prohibiting access to unauthorized persons

2.5 Personnel requirements

2.5.1 Qualifications

⚠ WARNING

Risk of injury in the event of inadequate qualification of the personnel!

- **Always have all work performed by personnel qualified for the particular work only.**
- **Keep unqualified personnel away from the danger zone.**

If unqualified work performs work on the booster or stays in the danger zone of the boosters, dangers arise that can cause severe injury and considerable property damage.

The qualifications of the personnel for the various areas of activity are listed in the following in this operating manual:

Mechanical and plant engineers
Mechanical and plant engineers are personnel, who due to their specialized training, skills, and experience, as well as knowledge of the applicable regulations, are capable of executing the tasks assigned to them. In addition mechanical and plant engineers are familiar with the installation, assembly, and the bringing together of machines and are capable of recognizing and avoiding possible hazards on their own.

Operator
The operator has been trained in a training session by the owner about the tasks conferred upon him and possible dangers in case of improper behavior. The operator may only perform tasks that exceed operation in normal mode if this is specified in the instructions and if the owner has expressly permitted him to do this.

Specialist for potentially explosive areas
The specialists for potentially explosive areas, due to their specialized training, skills, and experience, as well as knowledge of the applicable standards and regulations, are able to perform tasks on systems or sub-components in potentially explosive areas. The specialists for potentially explosive areas can independently recognize potential hazards and prevent dangers.

Only those persons of whom it can be expected that they will perform their work reliably are permissible as personnel. Persons with a reduced ability to respond, e.g., due to drugs, alcohol, or mediation, are not permissible.

When selecting personnel, observe the age and job-specific regulations that apply to the work site.

2.5.2 Instruction

The operator must instruct the personnel regularly. To improve tracking measures, an instruction protocol must be created with the following minimum information:

- Date of instruction
- Name of the instructed person
- Content of instruction

- Name of the instructor
- Signatures of the instructed person and the instructor

2.6 Personal protective equipment

Personal protective equipment is used to protect personnel from impairments to occupational health and safety.

During the various tasks performed on and with the booster, personnel must wear personal protective equipment, to which special reference is made in the individual sections of this manual.

Description of the personal protective equipment

The personal protective equipment is explained below:

Protective gloves
Protective gloves are used to protect the hands from friction, abrasions, puncture wounds or deeper wounds as well as coming into contact with hot surfaces.

Protective work clothing
Protective work clothing is close-fitting work clothing with low tear resistance, with close sleeves and without protruding parts.

Safety goggles
Safety goggles are intended to protect your eyes from flying components and splashes of liquid.

Safety shoes
Safety shoes protect the feet against being crushed, falling objects and slipping on slippery surfaces.

2.7 Safety devices

Integration into an emergency stop concept is required

The boosters are incomplete machines and have no own control and no autonomous emergency stop function.

Before the boosters are started up, emergency stop equipment to the machine must be installed and integrated into the plant control safety chain.

Connect the emergency stop equipment such as to rule out dangerous situations for persons and damage to property when the power supply is interrupted or reactivated after an interruption.

The emergency stop equipment must always bee freely accessible.

2.8 Signage

The following symbols and information signs are located in the work area. They relate to the direct environment where they have been put up.

⚠ WARNING

Risk in conjunction with illegible signage!

- **Always keep safety, warning and operating notices in good legible condition.**
- **Immediately replace damaged signs or stickers.**

Over time, stickers and signs can get dirty or become illegible for other reasons, so that risks can no longer be recognized and necessary operating instructions can no longer be adhered to. This presents a risk of injury.

Signage at the booster

The signs attached on the booster are presented and explained in the following illustrations.

Depending on the version of the booster, the information on the signs can vary.

Fig. 2: Signage

Illustration	Description
	CAUTION! Not suitable for oxygen.
	CAUTION! Keep grease-free, suitable for OPERATION WITH OXYGEN.

2.9 Behavior in case of fire and accidents

Preventative measures

- Always be prepared for fire and accidents!
- Keep first aid equipment (bandage boxes, covers, etc.) and fire extinguishers so that they are functional and close at hand.
- Familiarize personnel with accident reporting, first aid, and rescue equipment.
- Keep access routes free for rescue vehicles.

Measures in case of fire and accidents

- Trigger an emergency off with the emergency off equipment right away.
- If there is no danger to your own health, rescue people in the danger zone.
- If required, initiate first aid measures.
- Call the fire department and/or ambulance.
- In case of fire: if there is no danger to your health, fight the fire with fire extinguishing equipment and continue firefighting until the fire department arrives.
- Inform the responsible person in the affected area.
- Free access routes free for rescue vehicles.
- Inform rescue vehicles.

2.10 Spare parts

Explosion protection

⚠ WARNING

Danger of explosion if the wrong spare parts are used!

- **Only use the manufacturer's genuine spare parts or spare parts that are expressly approved by the manufacturer.**
- **Always contact with the manufacturer if there are questions.**

Using incorrect or faulty spares can lead to explosion in the Ex area. This can lead to sever injury or even death as well as considerable property damage. Non-compliance with these instructions will lead to loss of explosion protection.

2.11 Environmental protection

NOTICE

Danger to the environment due to incorrect handling of materials that can harm the environment!

- **Always heed the notes below about the handling of materials that can harm the environment and their disposal.**
- **If materials that can harm the environment accidentally escape into the environment, take suitable measures immediately. In case of doubt, inform the responsible local authority about the damage and ask what suitable measures to take might be.**

In case of incorrect handling of materials that can harm the environment, especially improper disposal, there can be significant damage to the environment.

The following materials that might harm the environment are used:

Cleaning products

Cleaning products that contain solvents contain poisonous substances. They may not be allowed to escape into the environment. Disposal must be handled by a professional disposal company.

Lubricants

Lubricants may contain poisonous and environmentally hazardous substances. They are water polluting and must not be released into the environment. Disposal must only be performed by licensed specialists. Always follow the instructions of the Material Safety Data Sheet (MSDS). The operating company should make sure that personnel is regularly instructed how to safely handle and dispose of lubricants.

Displacement media

Displacement media such as gases can contain toxic substances. They must not be released into the environment. Potentially leaking displacement media must be disposed of by a specialized company.

3 Structure and function

3.1 Overview

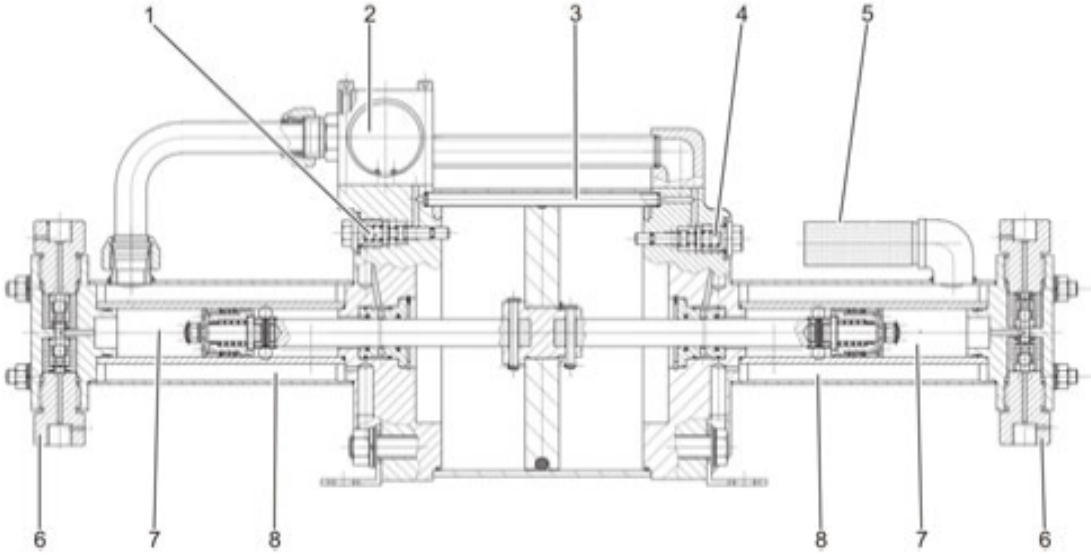


Fig. 3: Overview

1 Pilot valve 1
2 Spool valve (4/2 directional control valve)
3 Air cylinder
4 Pilot valve 2
5 Exhaust air silencer
6 Booster head with suction and pressure valve
7 Pressure cylinder
8 Cooling cylinder

3.2 Brief description

The boosters work on the principle of a pressure intensifier. They are used to compress gas and compressed air to a higher pressure; they are operated with a pneumatic admission pressure of a maximum of 10 bar compressed air. This admission pressure is required to compress the particular delivery medium to a higher operating pressure. In the process, large areas are driven by means of low pressure by the air piston thus generating a high pressure level on small areas of the booster via the high pressure piston.

The following are fields of application for the boosters:

- Pressure test with gas
- Transferring gases from transport containers with a low pressure level to a high pressure level
- Filling pressure accumulators with nitrogen

- Gas recovery
- Nitrogen reservoir filling
- Supply of seal gas plants
- Gas assisted injection molding
- CO_2 foaming
- Filling clean air cylinders
- Leakage tests

3.3 Assembly description

3.3.1 Booster head with intake and outlet valve

The booster head closes the compression chamber and separates it spatially from the surrounding pressure. The booster head contains the intake and outlet valves. The displacement medium flows into the compression chamber through these intake and outlet valves and back out again.

3.3.2 High pressure component

The high pressure component is used to compress the particular displacement medium. The high pressure component consists of the pressure cylinder, booster head with intake and outlet valves, and the high pressure piston with the sealing and guide elements.

3.3.3 Pilot valve

The pilot valves are used by the air piston as a limit switch. The pilot valves are actuated by the air piston in the end positions, they forward air pulses to the control valve. As a result, the pilot valves ventilate the actuation chamber of the control valve. This moves the control valve from one end position to the other.

3.3.4 Control valve

The control valve is used to alternately apply compressed air to the upper and underside of the air piston. The control valve is actuated via the pilot valves; it ensures that the drive air is directed to the left and/or right side of the air piston.

3.3.5 Drive component

The drive component is used to accommodate the drive air (compressed air); it actuates the high pressure component of the booster via a piston rod thus compressing the particular displacement medium to a higher pressure.

3.3.6 Exhaust air silencer

The exhaust air silencer is used to discharge expanding air from the booster with reduced noise. The drive air escapes from the booster after the operation has been performed via the exhaust air silencer. The exhaust air silencer is made of plastic or aluminum depending on the booster model.

3.3.7 Cooling cylinder

The cooling cylinder is used for insulating and cooling the high pressure component of the booster. The cooling cylinder encloses the high pressure cylinder. The expanding (very cold) drive air is directed into the space between the two cylinders in order to cool the high pressure cylinder during operation.

3.3.8 Compressed air control unit

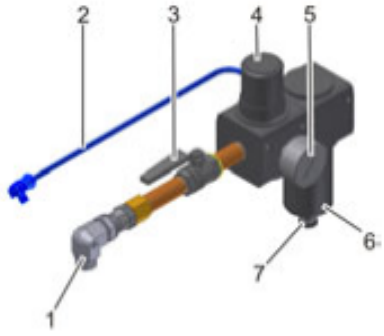


Fig. 4: Compressed air control unit

The compressed air control unit (Fig. 4) is a frequently installed sub-assembly; however, it is not part of the standard equipment. The manufacturer recommends the use of a compressed air control unit.

The compressed air control unit is used to manually adjust and control the operating pressure directly at the booster. It is pre-assembled at the drive air connection of the control valve (Fig. 4/1). Via the pressure regulator (Fig. 4/4), the particular operating pressure can be adjusted and controlled on the pressure gage (Fig. 4/5). Furthermore, the drive air can be warmed up via the water trap (Fig. 4/6) and the bleeder valve (Fig. 4/7). The ball valve (Fig. 4/3) manually shuts off the drive air from the compressed air network to the booster. The control line (Fig. 4/2) supplies the pilot valve air connection with direct pilot valve air.

3.4 Mode of operation of the boosters

The piping and instrumentation (P + I) flow chart of the boosters is illustrated in the graphic below.

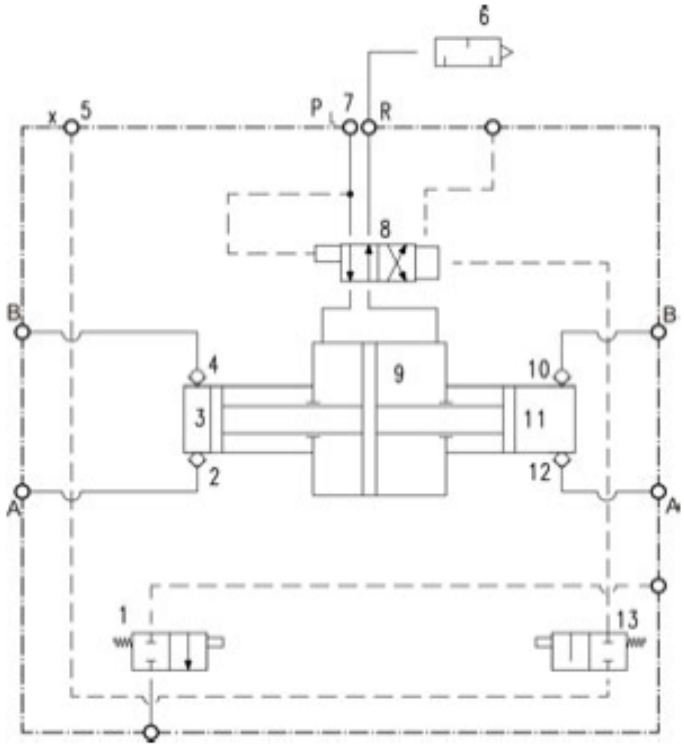


Fig. 5: P + I flow chart of the boosters

1 Pilot valve lower cap
2 Intake valve
3 High pressure piston
4 Outlet valve
5 Pilot valve air connection (X)
6 Exhaust air silencer
7 Air connection (P_L)
8 Control valve
9 Air piston
10 Outlet valve (B)
11 High pressure piston
12 Intake valve (A)
13 Pilot valve upper cap

Explanation of the mode of operation

The drive air flows from the air connection (Fig. 5/7) through the control valve (Fig. 5/8) to the underside of the air piston (Fig. 5/9). The air piston moves to the right in the drive component thus performing a suction cycle on the left side of the high pressure component. The intake valve (Fig. 5/2) opens up and the gas to be compressed flows through the connection (Fig. 5/A) into the compression chamber of the high pressure component. A pressure cycle is performed on the right side of the high pressure component.

The intake valve (Fig. 5/12) closes, the outlet valve (Fig. 5/10) opens up, and the compressed gas flows out of the connection (Fig. 5/B). When the air piston (Fig. 5/9) has moved to the right end position of the drive component, it opens up the pilot valve (Fig. 5/13). The control air flows from the connection through the open pilot valve (Fig. 5/13) to the large control valve side of the booster.

The control valve (Fig. 5/8) switches to the other switch position and the drive air flows to the right side of the air piston (Fig. 5/9). The air piston moves to the left side of the drive component. As a result, a pressure cycle is generated on the left side of the high pressure component and a suction cycle on the right side. The expanding drive air now escapes from the working chamber via the exhaust air silencer (Fig. 5/6).

In the booster variants with a transmission ratio of > 5, the air is directed through the cooling cylinder and therefore used to cool down the high pressure components.

3.5 Connections

The booster is delivered without any piping or threaded unions. The connected load information (↳ "Connected loads, mechanical" on page 105) must be observed for all interface connections. A connection drawing of all connections to be installed can be found in ↳ Appendix B "Connection drawing" on page 127.

The boosters have the following interfaces:

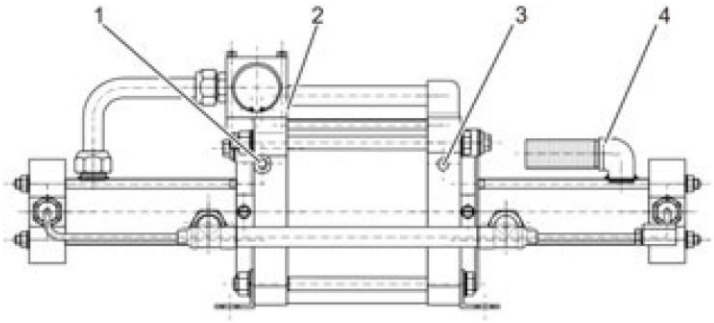


Fig. 6: Interfaces (side view)

Item no.	Designation	Connection	Function
1	Control air connection"X"	G 1/8"	Connection for direct pilot valve air (uncontrolled and filtered) control air ≥ drive air
2	Ventilation connection for spool valve "Y"	Bore	Ventilation and bleeding of the spool valve (pulse-type air discharge)
3	Air connection for pilot valve "X"	M5	Bleeding of the pilot valve. This connection can be used to connect a stroke counter. The air escapes in pulses here. The connection must therefore not be closed.
4	Exhaust air silencer connection	G1/2"	Outlet of the expanding drive air

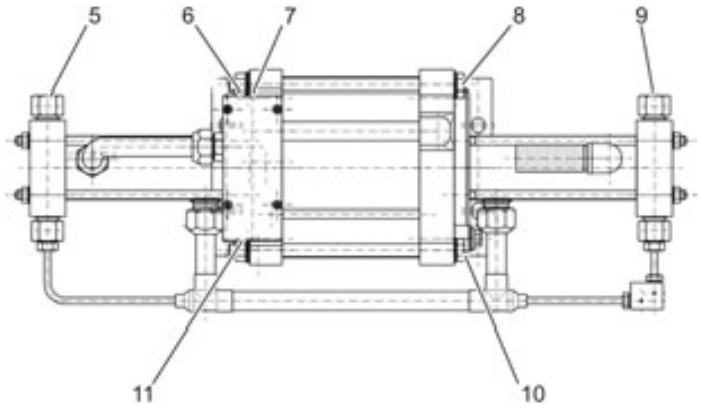


Fig. 7: Interfaces (top view)

Item no.	Designation	Connection	Function
5	Outlet connection "B"	Depends on model	Outlet for operating pressure
6	Leakage connection for high pressure sides "Z_1" and "Z_3"	G 1/8"	Ventilation of the high pressure cylinder behind the piston. Alternate admission and expulsion (alternately fitted with silencer).
7	Operation connection "PL"	G 1/8"	Inlet for the compressed drive air
8	Leakage connection for high pressure sides "Z_1" and "Z_3"	G 1/8"	Ventilation of the high pressure cylinder behind the piston. Alternate admission and expulsion (alternately fitted with silencer).
9	Inlet connection "A"	Depends on model	Inlet for the admission pressure
10	Leakage connection for air sides "Z_2" and "Z_4"	G 1/8"	Deduction of the leakage at the drive component
11	Leakage connection for air sides "Z_2" and "Z_4"	G 1/8"	Deduction of the leakage at the drive component

3.6 Working areas and danger zones

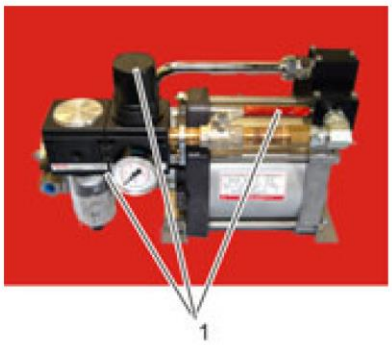


Fig. 8: Working areas and danger zones

The danger zone (Fig. 8/marked in red) is the entire zone surrounding the entire booster. If the booster has an optional compressed air control unit (Fig. 8/1), the working area is located within the danger zone.

3.7 Scope of delivery

The booster is delivered without piping or threaded unions.

The following components are part of the scope of delivery:

Designation	Quantity
Booster	1
Retaining bracket for mounting	2
Operating instructions for boosters DLE 2 (-1, -2) – DLE 75 (-1, -2)	1
Installation explanations	1
Conformity declaration according to ATEX Category IIB and/or IIC	1

3.8 Accessories

The following accessories are available for the boosters.

Compressed air control unit

The compressed air control unit is used to manually adjust the drive air directly at the booster. The compressed air control unit consists of a pressure filter, a water separator, a shut-off valve, a pressure regulator, a hose line, and a manometer. A safety valve for the compressed air control unit is available additionally.

Air lubricator

The air lubricator is used to increase the oil content in the drive air. The manufacturer recommends the use of an air lubricator if the drive air is extremely dry.

Gasket sets

The individual gasket sets of the booster components are available from the manufacturer as complete sealing kits. These sealing kits are used during all fault correction work. See *Appendix D "Cross-sectional drawings and bills of materials" on page 131.*

4 Transport, packaging, and storage

4.1 Safety instructions for transport

Improper transport

NOTICE

Material damage due to improper transport!

- **When unloading transport items at delivery, as well as for inner-company transport, proceed carefully and pay attention to the symbols and instructions on the packaging.**
- **Only remove the packaging just before installation.**

Transport items can fall or tip over if transported improperly. This can cause considerable material damage.

4.2 Transport inspection

Check the delivery immediately upon receipt to ensure that it is complete, and to identify any transport damage.

Proceed as follows if there is apparent external damage:

- Do not accept the delivery, or only accept it with reservation.
- Note the extent of transport damage on the transport documents or on the transport company's delivery ticket.
- Submit a complaint.

Report any defect as soon as it is detected. Claims for damage compensation can only be enforced during the applicable periods for giving notice of lack of conformity.

4.3 Packaging

Information concerning packaging

The individual packaged pieces have been packaged appropriately according to the expected transport conditions. Only environmentally-friendly materials were used for the packaging.

The packaging is supposed to protect the individual components from transport damage, corrosion and other damage prior to installation. Therefore, do not destroy the packaging and only remove it shortly prior to the installation.

Handling packaging materials

Dispose of packaging materials in accordance with the respectively valid statutory regulations and local guidelines.

NOTICE

Improper disposal poses an environmental hazard!

- **Dispose of packaging materials in an environmentally responsible manner.**
- **Comply with locally applicable disposal guidelines. If necessary commission a specialized company to dispose of packaging.**

Packaging materials are valuable raw materials and in many cases they can be reused, or they can be effectively treated and recycled. Improper disposal of packaging materials causes environmental hazards.

4.4 Storage

Storage of packages

Only store packages under the following conditions:

- Do not store outdoors.
- Store in a dry and dust-free environment.
- Do not expose to any aggressive media.
- Protect from direct sunlight.
- Avoid mechanical vibration.
- Storage temperature: - 4 to 140 °F.
- Relative humidity: Max. 60%.
- When storing for longer than three months, check the general condition of all parts and the packaging on a regular basis. Touch up or reapply anti-corrosion agents as needed.

It may be the case that storage instructions are affixed to the packages that extend beyond the requirements cited here. Comply with these instructions accordingly.

5 Installation and commissioning

5.1 Safety instructions for installation and commissioning

Improper installation and commissioning

⚠ WARNING

There is an injury hazard if the device is not installed and commissioned properly!

- **Allow only mechanical engineers and plant engineers to install and commission the device.**
- **Ensure order and cleanliness at the installation location! Parts and tools that are lying loose or on top of each other are accident hazards.**
- **Properly mount lines and hoses. Maintain the prescribed bolt-tightening torque.**
- **Only remove sealing plugs directly prior to mounting the connecting lines.**
- **Comply with the following before commissioning:**
  - **Ensure that all installation tasks have been properly executed and concluded in accordance with the instructions in this manual.**
  - **Ensure that a leak test of all line connections has been executed.**
  - **Ensure that no one is in the danger zone.**

Improper installation and commissioning can cause serious injury or material damage.

Explosion protection

⚠ WARNING

Danger of explosion during installation!

- **Prior to installation, obtain a written work approval.**
- **Perform installation only when a potentially explosive atmosphere can be ruled out.**
- **Use only those tools that are permissible for use in the Ex area.**

Bringing in ignition sources such as sparks, open flames, and hot surfaces can lead to explosion in the Ex area. Non-compliance with these instructions will lead to loss of explosion protection.

5.2 Prerequisites for installation

The prerequisites that must be in place for installation of the booster are described below.

The booster is an incomplete machine and is designed to be installed in a plant or system.

Set up the booster in such a manner that the following conditions are satisfied:

- The installation site must be level.
- The booster must be stable and secure, or firmly and securely seated.
- The booster must not be exposed to any vibration or oscillation.
- The booster must be easily accessible from all sides.
- The booster must be installed in such a manner that it is not exposed to any external heat sources.
- The booster must be installed in a dust-free environment.

Installation specifications

⚠ WARNING

Danger of explosion if the installation specifications are not observed!

- **Always set up boosters in a well ventilated room.**
- **Always keep hydrogen systems leak-tight.**
- **Blow-out lines of safety valves and leakage lines must always be routed outside into the open.**
- **Blow-out lines must not be installed under eaves, openings in buildings, or in the vicinity of air intake openings.**
- **For hydrogen systems in rooms or buildings, it must be possible to safely and quickly shut off the gas supply coming from the outside at a safe point.**
- **Pipe connections on hydrogen systems must always be created ensuring that the connection will be tight for a long time.**

If the installation specifications for boosters designed for the compression of toxic and combustible gases are not observed, this can lead to the development of a potentially explosive atmosphere.

5.3 Mounting the booster

⚠ CAUTION

Danger of material damage!

- **Keep all connections sealed with sealing plugs during installation.**
- **Only remove the sealing plugs directly prior to mounting the connection piping.**

Fouling or drilling dust that gets into the connections of the booster during installation can result in booster damage.

Personnel:	■ Mechanical and plant engineers
Protective equipment:	■ Protective work clothing ■ Safety goggles ■ Safety shoes
Special tool:	■ Power drill ■ Vacuum cleaner

1. Set up booster with pre-assemble angle brackets at installation site.

   i To do this, observe the installation plan
   ↳ Appendix C "Installation plan" on page 129.

2. Set up booster, draw bore holes, and remove booster again.
3. Drill installation holes.
4. Vacuum up drilling dust.
5. Set up booster and use attachment screws and spring washers with a torque of 85 Nm to fasten to foundation.

5.4 Installing the connecting lines

A description of how the booster is connected to the compressed air network and to a transport gas container is provided below.

The booster is delivered without any threaded unions or piping. Please observe the corresponding information in
↳ "Connected loads, mechanical" on page 105 and
↳ Appendix B "Connection drawing" on page 127.

Personnel:	■ Mechanical and plant engineers
Protective equipment:	■ Protective work clothing ■ Safety shoes ■ Safety goggles
Special tool:	■ Wrench

Unforeseeable movements

⚠ WARNING

Danger of injury due to unforeseeable movements of compressed air lines!

- **De-pressurize the connecting line prior to all mounting tasks.**
- **All piping must be securely anchored to the floor or to walls.**
- **All piping must be routed in such a manner that they will not cause any tripping hazard.**
- **Always wear personal protective equipment.**

Lines of the in-house compressed air network can move in an unforeseeable manner and can cause injuries if there is a load change.

Use of incorrect connecting lines

⚠ CAUTION

Danger of material damage if the wrong connecting lines are used!

- **The piping and lines must be matched to the maximum output pressure of the booster.**
- **The tightening torque of the respective threaded unions must be complied with.**
- **The cross-section of the high-pressure pipes and lines may not be less than the cross-section of the connections.**

The use of incorrectly dimensioned piping in threaded unions can cause malfunctions and material damage to the booster.

The prerequisites that must be in place for proper installation is the presence of a professionally planned, installed, and maintained compressed air network and a shut-off valve additionally installed on the inlet of the compressed air network.

5.4.1 Connecting the drive air

Depending on the version, the connection of the drive air on the booster must be either installed on the air drive connection (PL) of the spool valve housing or, if a compressed air control unit is available, at the air drive connection of the compressed air control unit. Please observe the information in ↳ "Connected loads, mechanical" on page 105 and ↳ Appendix B "Connection drawing" on page 127 on how to use drive air lines, hose connections, or threaded unions.

A description of how the drive air is installed on the compressed air control unit is provided below.

Fig. 9: Unscrewing sealing plug

1. Unscrew sealing plug from drive air connection (Fig. 9/1) of spool valve housing or from compressed air control unit (Fig. 9/2).

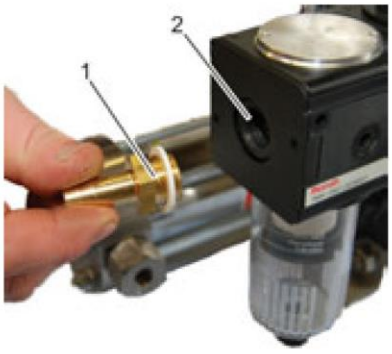


Fig. 10: Drive air connection (compressed air control unit)

2. Insert connecting piece (G 3/4 ") (Fig. 10/1) into drive air connection (PL) of compressed air control unit (Fig. 10/2) together with seal and tighten using a torque of 440 lbf in.

5.4.2 Connecting the inlet line for admission pressure and outlet line for operating pressure

Please observe the information in ↳ "Connected loads, mechanical" on page 105 and ↳ Appendix B "Connection drawing" on page 127 on how to use drive air lines, hose connections, or threaded unions.

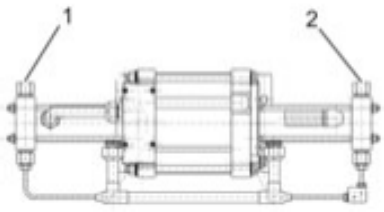


Fig. 11: Connecting inlet and outlet connections

1. Detach sealing plugs from inlet and outlet connections (Fig. 11/1 and 2).
2. Install piping for inlet and outlet lines according to *Appendix B "Connection drawing" on page 127*.

5.4.3 Installing a separate leakage line

When compressing combustible or toxic gases, an additional leakage line must be installed on the booster.

Fig. 12: Removing breather silencer

1. Unscrew the breather silencer (Fig. 12/1) out of leakage connections Z1 and Z3.

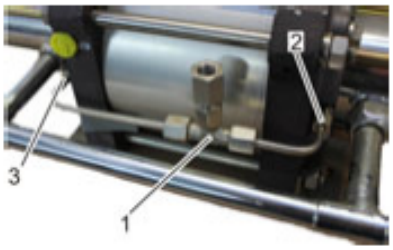


Fig. 13: Piping for leakage line

2. Connect leakage piping (Fig. 13/1) to leakage connections Z1 (Fig. 13/2) and Z3 (Fig. 13/3).
3. Install separate leakage line according to (*Appendix B "Connection drawing" on page 127*) on leakage piping.

5.5 Installing exhaust air silencer

A description of how the exhaust air silencer is installed is provided below.

Depending on the booster version, the exhaust air silencer can be made of plastic or aluminum. The installation of the Die exhaust air silencer is always identical.

Personnel:
- Mechanical and plant engineers

Protective equipment:
- Protective work clothing
- Safety shoes
- Safety goggles

Fig. 14: Exhaust air silencer

1. Keep exhaust air silencer ready.

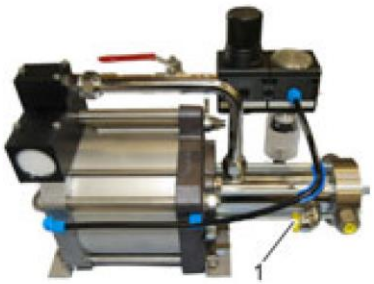


Fig. 15: Sealing plug

2. Unscrew sealing plug from exhaust air connection.

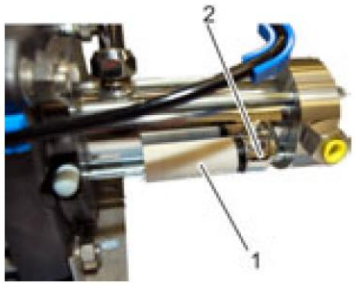


Fig. 16: Installing exhaust air silencer

3. Position exhaust air silencer (Fig. 16/1) at exhaust air connection (Fig. 16/2) and tighten hand-tight.

5.6 Commissioning

A description of how the booster is commissioned is provided below.

Personnel:	■ Mechanical and plant engineers
Protective equipment:	■ Protective work clothing ■ Safety goggles ■ Safety shoes
Special tool:	■ Leak detector spray

Checks prior to commissioning

1. Check all media connections for correct installation.
2. Check all piping and threaded unions for mechanical damage.
3. Open displacement medium (gases) on transport gas container.
   ⇨ The displacement medium flows in.
4. Open compressed air line of compressed air network to booster.
   ⇨ The booster starts delivering.

   When a compressed air control unit is used, the drive air is connected to the manometer of the compressed air control unit when the compressed air network is opened. In this case, the manometer must be additionally checked for function ("Checking the manometer for function" on page 50).
5. Perform a leak test with leak detector spray on all connections.

Checking the manometer for function

During the commissioning process the manometer of the compressed air control unit must be checked for function. Proceed as follows to do this:

Fig. 17: Compressed air control unit

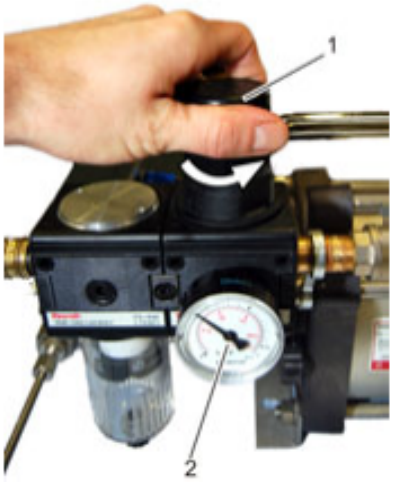


Fig. 18: Opening pressure regulator

1. Keep the ball valve of the compressed air control unit (Fig. 17/1) closed.

   The ball valve is closed, if its position is perpendicular (Fig. 17/1) to the center axis.

2. Pull the pressure regulator (Fig. 17/2) of the manometer upward.

   ⇨ The pressure regulator will audibly detach from the arrest.

3. Open the pressure regulator (Fig. 18/1) by turning it to the right.

   ⇨ The drive air is applied.

4. On the manometer (Fig. 18/2), check whether the applied pressure is displayed.

Fig. 19: Bleeding

5. Open the vent screw (Fig. 19/1) of the water separator (Fig. 19/2) and dissipate the pressure.
   ⇨ Pressure escapes from the vent valve and the pressure drop is displayed on the manometer.
6. Close the vent screw (Fig. 19/1).
7. Close the pressure regulator through left rotation.
8. Press the pressure regulator downward.
   ⇨ The pressure regulator audibly clicks into place.
9. Perform a leak test with leak detector spray on all connections.

6 Operation

6.1 Safety instructions for operation

Improper operation

⚠ WARNING

Danger of injury due to improper operation!

- **Execute all operating steps in accordance with the information and the instructions in this manual.**
- **Comply with the following prior to starting the tasks:**
  - **Ensure that all piping, threaded unions, displacement media and safety devices are installed correctly and that they function properly.**
  - **Ensure that no one is in the danger zone.**
- **Never render safety devices inoperable during operation or bypass them.**

Improper operation can cause severe injury and significant material damage.

6.2 Daily inspections

The inspections listed below must be performed daily prior to and during operation.

Personnel:
- Operator

Protective equipment:
- Protective work clothing
- Safety shoes
- Safety goggles

Execute the following inspections prior to operation:

- Check all threaded unions and piping for damage.
- If no compressed air control unit is used, check the quality of the compressed air ☞ *"Pneumatic" on page 104*.
- If a compressed air control unit is used, check the function of the manometers ☞ *"Checking the manometer for function" on page 50*.

Execute the following inspections prior to operation:

- Drain condensation via the vent screw of the compressed air control unit (☞ *Chapter 6.5 "Draining the condensate on the water separator" on page 58*).

6.3 Calculating the operating pressure

Before the booster is commissioned, the operating pressure must be calculated. The static end pressure of the booster is calculated for the particular booster type using the following formulas.

A list of booster types can be found in Chapter 1.2 “Versions” on page 9.

A legend for the calculation of the operating pressure can be found below the table.

Booster type	Calculation of the static operating pressure
Single-stage, single-acting	PB = PL * i
Single-stage, dual-acting	PB = i * PL + PA
Dual-stage	PB = i2 * PL + i2 / i1 * PA
Single-stage, single-acting with two drive components	PB = PL * i
Single-stage, dual-acting with two drive components	PB = i * PL + PA
Dual-stage with two drive components	PB = i2 * PL + i2 / i1 * PA

Legend:

PL = Drive pressure

PB = Operating pressure

PA = Gas admission pressure

i = Transmission ratio

i1 = Transmission ratio stage 1

i2 = Transmission ratio stage 2

6.4 Switching on

A description of how the booster is installed is provided below.

The boosters have no main switch. The booster starts to operate as soon as the displacement medium is present and the drive air is applied at the booster. The switch-in process using the compressed air control unit differs from the switch-in process without the use of the compressed air control unit. The two processes are described below.

Personnel:
- Operator

Protective equipment:
- Protective work clothing
- Safety shoes
- Safety goggles

Switching the booster on

In a booster without compressed air control unit, the booster starts delivering as soon as the displacement medium is present and the drive air of the in-house compressed air network is applied.

1. Calculate the required operating pressure (*Chapter 6.3 "Calculating the operating pressure" on page 54*).
2. Adjust drive pressure on pressure regulator of in-house compressed air network and check pressure on manometer.
3. Open displacement medium (gas) on transport gas container.
   ⇨ The displacement medium flows in.
4. Open compressed air line of compressed air network to booster.
   ⇨ The booster starts delivering as soon as the drive air pressure is applied.

Switching the booster on with a compressed air control unit present

1. Calculate the required operating pressure (*Chapter 6.3 "Calculating the operating pressure" on page 54*).

Fig. 20: Ball valve of the compressed air control unit

2. Make sure that the ball valve (Fig. 20/1) of the compressed air control unit is closed.

Fig. 21: Vent valve

3. Make sure that the vent valve (Fig. 21/1) of the compressed air control unit is closed.
4. Open valve of displacement medium (gas) on transport gas container.
   ⇨ The displacement medium flows in.
5. Open compressed air line of compressed air network to booster.
   ⇨ Drive air is applied to the compressed air control unit.

Fig. 22: Releasing pressure regulator from arrest

6. Pull the pressure regulator (Fig. 22/1) upward.
   ⇨ The pressure regulator will audibly detach from the arrest.

Fig. 23: Adjusting the operating pressure

7. Slowly adjust the previously calculated drive pressure by turning the pressure regulator (Fig. 23/1) and check required drive pressure on manometer (Fig. 23/2).
   ⇨ Turning it to the right will increase the drive pressure; turning it to the left reduces the driver pressure.
8. Once the drive pressure has been adjusted, press the pressure regulator downward.
   ⇨ The pressure regulator audibly clicks into place.

Fig. 24: Opening the ball valve

9. Open the ball valve (Fig. 24/1) of the compressed air control unit (Fig. 24/arrow).
   ⇨ The booster starts delivering as soon as the operating pressure is released via the ball valve.

6.5 Draining the condensate on the water separator

A description of how the condensation is drained on the vent valve of the water separator is provided below.

The booster must be checked daily during operation for the presence of condensation. If condensate is present in the water separator, it must be drained.

Personnel:
- Operator

Protective equipment:
- Protective work clothing
- Safety shoes
- Safety goggles

Special tool:
- Accumulator

1. Check water separator of compressed air control unit (Fig. 25/2) for the presence of condensate.
   ⇨ If condensate is present, it must be drained.
2. Position accumulator under vent screw.
3. **⚠ CAUTION! Danger from condensate splashing out!**
   Slowly open vent screw (Fig. 25/1) and let condensate drain.
4. Close the vent screw (Fig. 25/1).

Fig. 25: Checking the water separator

6.6 Switching off

A description of how the booster is switched off is provided below.

The boosters have no main switch. The booster stops operating as soon as the drive air is shut off. The switch-off process using the compressed air control unit differs from the switch-off process without the use of the compressed air control unit. The two processes are described below.

Personnel:
- Operator

Protective equipment:
- Protective work clothing
- Safety shoes
- Safety goggles

Switching the booster off

In a booster without compressed air control unit, the booster stops as soon as the drive air from the in-house compressed air network is shut off.

1. Shut off compressed air line of in-house compressed air network.
2. Shut off displacement medium on valve of gas transport container.

   ⇨ The booster stops delivering.

To this end, see the operating instructions for the in-house compressed air network.

Switching the booster off with a compressed air control unit present

Fig. 26: Close ball valve

1. Close the ball valve (Fig. 26/1) of the compressed air control unit (Fig. 26/arrow).
2. Shut off displacement medium on valve of gas transport container.
3. Shut off compressed air line of in-house compressed air network.

   ⇨ The booster stops delivering.

6.7 Shut-down in an emergency situation

In dangerous situations, movements of components must be stopped as quickly as possible and the energy supply must be switched off.

Shut-down in an emergency situation

Proceed as follows in an emergency:

1. Immediately trigger an emergency stop with the emergency stop device.
2. Immediately shut off the displacement medium and compressed air lines.
3. If there is no danger for your own health, get people out of the danger zone.
4. If required initiate first-aid measures.
5. Alert the fire department and/or rescue service.
6. Inform the responsible parties at the implementation site.
7. Switch off the booster and safeguard it from being switched on again.

7 Faults

Possible causes for faults and fault correction tasks are described in the following chapter.

In the events of faults that cannot be corrected with the help of the notes below, contact the manufacturer; see contact information in Chapter 1.4 of these operating instructions.

7.1 Safety instructions for fault correction

Nitrogen

⚠ WARNING

Danger of suffocation due to improper handling of nitrogen!

- **Always observe the manufacturer's safety data sheet.**
- **Always ensure adequate ventilation.**
- **Keep a breathing apparatus that does not depend on circulating air on hand for emergencies.**
- **If there are signs of suffocation, immediately provide the affected person with the breathing apparatus that does not depend on circulating air, move to fresh air into recovery position, and keep warm. If no longer breathing, provide first aid measures and start artificial respiration. Seek medial attention immediately.**

Improper handling of nitrogen while purging the booster can lead to poisoning or even death by suffocation.

Safeguarding against restart

⚠ WARNING

Life-threatening danger due to unauthorized restart!

- **Prior to starting the tasks, shut off all media, depressurize the booster, and safeguard it from being switched on again.**

Through unauthorized restart or opening of the compressed air supply, or the displacement media, during troubleshooting and fault correction there is danger of severe or fatal injuries for persons in the danger zone.

Improperly executed fault correction tasks

⚠ WARNING

Danger of injury due to improper fault correction!

- Before starting the tasks purge the compressor with nitrogen.
- Ensure order and cleanliness at the installation location! Parts and tools that are lying loose or on top of each other are accident hazards.
- If components have been removed, ensure that they are properly reinstalled, that all fastening elements are reinstalled, and that all threaded connections are tightened with the specified screw-tightening torque.
- Comply with the following before restarting the system:
  - Ensure that all fault correction tasks have been properly executed and concluded in accordance with the instructions in this manual.
  - Ensure that no one is in the danger zone.

Improperly executed fault correction tasks can cause severe injury and significant material damage.

Compressed air and gases

⚠ WARNING

Danger of injury due to compressed air and gases!

- Always establish de-pressurized status before mounting or dismounting hoses, lines, threaded unions, or quick-release couplings. Completely de-pressurize the pressure accumulator.
- Always wear personal protective equipment.
- Have defective components that are pressurized in operation replaced immediately by qualified personnel (mechanical and plant engineer).

In the event of a fault or a defect, compressed air or gas can escape from compressed air lines, hoses, or pressurized components of the booster. This compressed air or gases can whirl up dust, can cause uncontrolled movements of the lines, and can cause severe injuries.

Cold surfaces

⚠ CAUTION

Risk of injury due to cold and iced up surfaces!

- **Always wear protective clothing and protective gloves during all work in the vicinity of cold or iced up surfaces.**
- **Make sure prior to all work that all surfaces have warmed up to ambient temperature.**

Components such as the exhaust air silencer can cool down severely and ice up due to expanding air or gas. Skin contact with cold surfaces can cause skin irritations.

Behavior if there is a fault

The following always applies:

1. For faults that pose an imminent danger to personnel or material assets, immediately trigger the emergency-stop function, shut off all lines, and depressurize the machine.
2. Determine the cause of the fault.
3. If correction of the fault requires work in the danger zone, switch off the machine and safeguard it against being restarted.

   Immediately inform the responsible parties at the installation site of the fault.
4. Depending on the type of fault have it corrected by the required personnel specified below.

The fault table provided below lists personnel who are authorized to correct the fault.

7.2 Fault table

Fault description	Cause	Remedy	Personnel
Booster does not work at low air pressure.	Excessive friction on the spool valve.	Replace and re-lubricate the O-rings on the spool valve (↬ *Chapter 7.3.2 “Replacing the O-rings on the spool valve” on page 66*).	Specialist for potentially explosive areas

Fault description	Cause	Remedy	Personnel
	O-rings of the spool valve swell when the wrong oil or lubricating grease is used.	Replace O-rings and use acid-free and silicone-free lubricant (↳ *Chapter 7.3.2 "Replacing the O-rings on the spool valve" on page 66*).	Specialist for potentially explosive areas
Booster does not work or it works too slowly.	Exhaust or spool valve iced up.	Dewater compressed air through water separator (↳ *Chapter 6.5 "Draining the condensate on the water separator" on page 58*).	Operator
	Formation of a residue in the exhaust air silencer .	Clean silencer; replace if necessary (↳ *Chapter 7.3.4 "Cleaning the exhaust air silencer and replacing it if necessary" on page 73*).	Operator
Booster does not work. Air escapes via the exhaust air silencer.	O-ring on spool valve is defective.	Replace and re-grease O-rings on spool valve (↳ *Chapter 7.3.2 "Replacing the O-rings on the spool valve" on page 66*).	Specialist for potentially explosive areas
	O-ring on the air piston is defective or worn.	Replace and re-grease O-ring on air piston (↳ *Chapter 7.3.6 "Replacing O-ring on air piston" on page 78*).	Specialist for potentially explosive areas
Booster does not work. Air escapes via a small bore on the spool valve housing.	Spool valve is blocked.	Clean sleeve of spool valve (↳ *Chapter 7.3.3 "Cleaning and greasing the sleeve of the spool valve" on page 71*).	Specialist for potentially explosive areas
	Spool valve is blocked.	Check O-rings on spool valve and sleeve and replace and grease if necessary (↳ *Chapter 7.3.3 "Cleaning and greasing the sleeve of the spool valve" on page 71* and ↳ *Chapter 7.3.2 "Replacing the O-rings on the spool valve" on page 66*).	Specialist for potentially explosive areas
Booster does not work. Air escapes via the plunger guide in the upper cap.	Pilot valve in the upper cap or lower cap is blocked.	Clean and grease the pilot valve (↳ *Chapter 7.3.5 "Cleaning and greasing the pilot valve" on page 75*).	Specialist for potentially explosive areas
	Pilot valve in the upper cap or lower cap is blocked.	Check pilot valve for wear and replace if necessary (↳ *Chapter 7.3.5 "Cleaning and greasing the pilot valve" on page 75*).	Specialist for potentially explosive areas

Fault description	Cause	Remedy	Personnel
Booster operates at high frequency and with short strokes.	Pilot valve in the upper cap or lower cap is defective.	Clean and grease the pilot valve or replace if necessary (↪ *Chapter 7.3.5 "Cleaning and greasing the pilot valve" on page 75*).	Specialist for potentially explosive areas
Leaks on silencers of bores Z1 and Z3.	High pressure seal or high pressure cylinder is worn.	Check high pressure seal or high pressure cylinder for wear and replace if necessary (↪ *Chapter 7.3.9 "Checking high pressure seals and high pressure cylinder for signs of damage" on page 94*).	Specialist for potentially explosive areas
Leaks on silencers of bores Z1 and Z3 (**only for DLE 15, 30, and 75**).	High pressure piston with pressure cylinder is worn.	Replace high pressure piston with pressure cylinder as a complete component (↪ *Chapter 7.3.8 "Replacing the high pressure cylinder with high pressure piston as a complete component" on page 93*).	Specialist for potentially explosive areas
Booster does not work, but exhaust air silencer blows out air.	O-ring on the air piston is worn.	Check O-ring on air piston for wear and replace if necessary (↪ *Chapter 7.3.6 "Replacing O-ring on air piston" on page 78*).	Specialist for potentially explosive areas
Leaks on inlet and/or outlet valve of booster head/booster does not reach operating pressure.	Inlet and/or outlet valve soiled or defective.	Check inlet and/or outlet valve of booster head; clean or replace if necessary (↪ *Chapter 7.3.7 "Cleaning the inlet and outlet valve of the booster head" on page 92*).	Specialist for potentially explosive areas

7.3 Fault correction tasks

7.3.1 Purging the high pressure component with nitrogen

Boosters that are used to compress combustible or toxic gases must be purged with nitrogen prior to starting the tasks for fault correction purposes in order to purge any remaining combustible or toxic gases and to thus prevent the development of oxyhydrogen gas

and toxic gas mixtures. In the following chapters on fault correction, references are made to Supplement "Hydrogen compression with Maximator boosters" in the Appendix. To purge the booster, proceed as described in the supplement.

DANGER

Danger of explosion caused by toxic and combustible gas residues on the inside of the booster!

– **Purge the high pressure component of the booster with nitrogen before any fault correction task.**

Failing to purge the booster with nitrogen following previously compressed toxic or combustible gases prior to starting fault correction tasks can lead to an explosion caused by the development of oxyhydrogen gas and to severe injury or even death.

Personnel:	■ Specialist for potentially explosive areas
Protective equipment:	■ Safety shoes ■ Safety goggles

1. Bring the booster to a standstill and let the stored pressure completely dissipate.
2. Purge the booster. Proceed as described in Appendix A "Hydrogen compression with Maximator boosters" to do this.

7.3.2 Replacing the O-rings on the spool valve

A description of how the O-rings on the spool valve are replaced is provided below.

Personnel:	■ Specialist for potentially explosive areas
Protective equipment:	■ Safety goggles ■ Protective work clothing ■ Safety shoes
Special tool:	■ Circlip pliers ■ Wrench ■ Lubricating grease ■ Screwdriver

The fault correction tasks below are described on a booster with an optionally installed compressed air control unit. The fault correction tasks for boosters without compressed air control unit are identical. In that case, steps 3 – 4 are merely eliminated. This will be pointed out at the appropriate point.

1. Bring the booster to a standstill, de-pressurize it, and let the stored pressure completely dissipate.

   Carry out steps 3 – 4 and 14 – 15 only if a compressed air control unit is present. If no compressed air control unit is installed, the drive air line must be removed from the spool valve housing instead of the elbow union.

2. Purge booster with nitrogen. Proceed as described in *Appendix A "Hydrogen compression with Maximator boosters" on page 117* to do this.

3. Release threaded union (Fig. 27/1) of compressed air control unit on spool valve housing (Fig. 27/2).

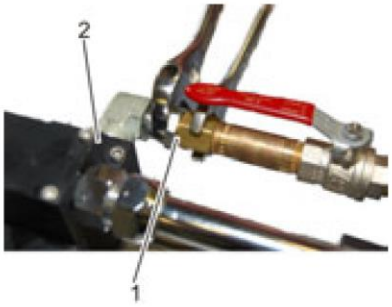


Fig. 27: Releasing the threaded union

Fig. 28: Releasing the elbow union

4. Release and remove elbow union (Fig. 28/1) of compressed air control unit or on drive air connection of spool valve housing (Fig. 28/2).

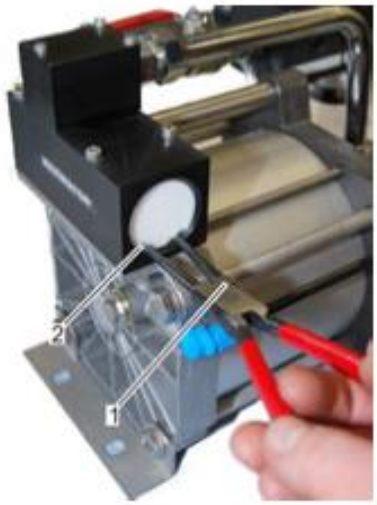


Fig. 29: Removing the circlip

5. Position circlip pliers (Fig. 29/1) on circlip of spool valve housing (Fig. 29/2) and carefully remove circlip and secure to prevent it from getting lost.

Fig. 30: Detaching spool valve and cap

6. Insert screwdriver into drive air connection (Fig. 30/ arrow) of spool valve housing (Fig. 30/1) and carefully press out cap (Fig. 30/2) and spool valve (Fig. 30/3).

7. Remove all O-rings from spool valve and caps.

Fig. 31: Greasing O-rings

8. Grease new O-rings (Fig. 31).

Fig. 32: Sliding on new O-rings

9. Slide new O-rings (Fig. 32/1) onto spool valve and cap.
10. Lightly lubricate spool valve and cap with grease.

Fig. 33: Inserting spool valve

11. Insert spool valve (Fig. 33/1) into spool valve housing and push in up to the stop (Fig. 33/arrow).

Fig. 34: Inserting the cap

12. Insert cap (Fig. 34/1) into spool valve housing (Fig. 34/2).

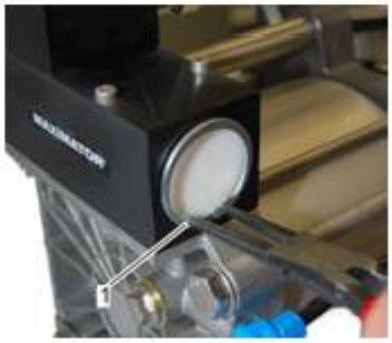


Fig. 35: Securing the cap

13. Secure cap in spool valve housing using circlip (Fig. 35/1).

Fig. 36: Removing the elbow union

14. Position and fasten elbow union (Fig. 36/1) of compressed air control unit to drive air connection of spool valve housing.

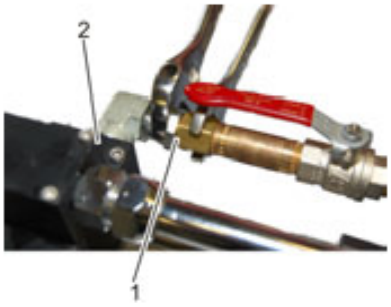


Fig. 37: Installing compressed air control unit

15. Fasten piping (Fig. 37/1) of compressed air control unit to elbow union (Fig. 37/2).

7.3.3 Cleaning and greasing the sleeve of the spool valve

A description of how the sleeve of the spool valve is cleaned and greased is provided below.

Personnel:	■ Specialist for potentially explosive areas
Protective equipment:	■ Safety goggles ■ Safety shoes ■ Protective work clothing
Special tool:	■ Circlip pliers ■ Wrench ■ Screwdriver ■ Lubricating grease ■ Punching drift ■ Hammer

Removing the sleeve of spool valve

To clean the sleeve of the spool valve, it must be removed.

1. Bring the booster to a standstill, de-pressurize it, and let the stored pressure completely dissipate.

   The sleeve of the spool valve is located in the spool valve housing. To remove the sleeve of the spool valve, the spool valve must first be removed. To do this, proceed as described in
   Chapter 7.3.2 "Replacing the O-rings on the spool valve" on page 66, steps 3 – 6.

2. Purge booster with nitrogen. Proceed as described in *Appendix A "Hydrogen compression with Maximator boosters" on page 117* to do this.

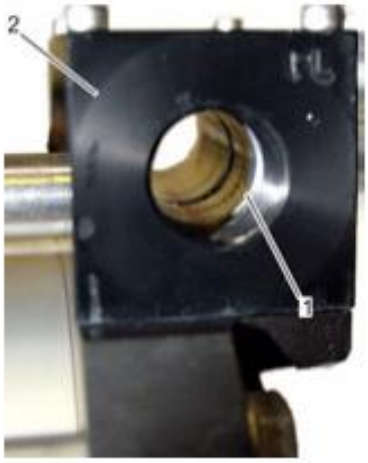


Fig. 38: Positioning the drift

3. Carefully position punching drift at edge of sleeve (Fig. 38/1) in spool valve housing (Fig. 38/2).

Fig. 39: Punching out the sleeve

4. ***NOTICE!*** **Risk of damaging the female thread!**

   Carefully punch out sleeve (Fig. 39) making sure that the female thread in the spool valve housing is not damaged.

Fig. 40: Removing the sleeve

5. Remove sleeve (Fig. 40/1) out on other side of spool valve housing.
6. Check inside of sleeve for score marks and other signs of damage.

   If the sleeve is damaged, it must be replaced.

   Make sure not to slide any O-ring onto the groove (Fig. 41/3) of the control sleeve, since there is a cross bore in this groove.

Fig. 41: Detaching the O-rings

7. Detach O-rings (Fig. 41/1) from the sleeve (Fig. 41/2).
8. Clean inside and outside of sleeve with a paper towel.
9. Grease new O-rings and carefully slide onto sleeve.
10. Clean inside and outside of sleeve with a finger.
11. Grease the inside of the spool valve housing.

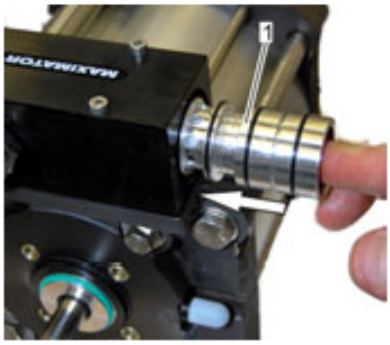


Fig. 42: Inserting the sleeve

12. Carefully insert sleeve into spool valve housing and push in up to the stop.
13. Insert spool valve. To do this, proceed as described in *Chapter 7.3.2 "Replacing the O-rings on the spool valve" on page 66*, steps 11 – 14.

7.3.4 Cleaning the exhaust air silencer and replacing it if necessary

A description of how the exhaust air silencer is cleaned and replaced if necessary is provided below.

Cold components

⚠ CAUTION

Danger of injury due to cold components!

- **Prior to starting the tasks, let the exhaust air silencer thaw adequately.**
- **Wipe off any dew that might be present.**

The exhaust air silencer cools down severely and ices up.

Personnel:
- Operator

Protective equipment:
- Safety goggles
- Protective work clothing
- Safety shoes
- Protective gloves

Depending on the version, the exhaust air silencers of the individual booster models can differ. However, the tasks described below are always identical.

1. Bring the booster to a standstill and let the stored pressure completely dissipate.
2. Let the iced up exhaust air silencer thaw adequately; wipe off any water that might have thawed.
3. Unscrew silencer (Fig. 43/1) from exhaust air connection (Fig. 43/2).
4. Adequately purge exhaust air residues in the exhaust air silencer with water and detergent.

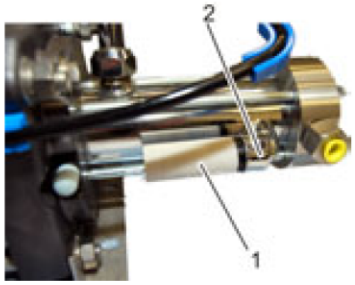


Fig. 43: Exhaust air silencer

Fig. 44: Blowing out the exhaust air silencer

5. Blow out exhaust air silencer with a compressed air gun in the opposite direction of the exhaust air (Fig. 44/arrow).

   If the deposits cannot be removed or if the booster does not reach the required stroke frequency or power after it has been cleaned, the exhaust air silencer must be replaced.
6. Screw exhaust air silencer into exhaust air connection and tighten hand-tight.

7.3.5 Cleaning and greasing the pilot valve

A description of how the pilot valves are cleaned and greased or - if necessary - replaced is provided below.

Personnel:
- Specialist for potentially explosive areas

Protective equipment:
- Safety goggles
- Safety shoes
- Protective work clothing

Special tool:
- Wrench, width across flats 13 mm/0.51 in
- Long nose pliers
- Lubricating grease

It is always necessary to clean, grease, or - if necessary - replace both pilot valves.

1. Bring the booster to a standstill and let the stored pressure completely dissipate.
2. Purge booster with nitrogen. Proceed as described in ↳ *Appendix A "Hydrogen compression with Maximator boosters" on page 117* to do this.
3. Position wrench (Fig. 45/1) at threaded union of pilot valve (Fig. 45/2).

Fig. 45: Pilot valve

Fig. 46: Removing the threaded union

4. Remove threaded union with sealing ring (Fig. 46/1) and pilot valve spring (Fig. 46/2) and secure to prevent it from getting lost.

Fig. 47: Pilot valve tappet

⇨ The pilot valve tappet (Fig. 47/1) is located in the pilot valve opening.

Fig. 48: Removing the pilot tappet

5. Carefully insert long nose pliers (Fig. 48/1) into pilot valve opening and pull out pilot valve tappet (Fig. 48/2).
6. Check pilot valve tappet and O-ring for signs of damage.

   A damaged pilot valve plunger must be replaced.

Fig. 49: Pilot valve tappet

7. Clean and grease pilot valve tappet with a paper towel.

Fig. 50: Inserting the pilot valve tappet

8. Carefully insert pilot valve tappet (Fig. 50/2) with the long nose pliers (Fig. 50/1).

Fig. 51: Fastening the pilot valve

9. Position and tighten pilot valve spring (Fig. 51/2) and threaded union with sealing ring (Fig. 51/1).

To clean and grease the second pilot valve, proceed as described in steps 1 – 9.

7.3.6 Replacing O-ring on air piston

A description of how the O-ring on the air piston is replaced is provided below.

Many of the steps described below must be carried out in the exact same manner for other fault correction tasks. In the corresponding chapters, references are made to the respective steps in this chapter.

Personnel:	■ Specialist for potentially explosive areas
Protective equipment:	■ Safety goggles ■ Safety shoes ■ Protective work clothing
Special tool:	■ Wrench

7.3.6.1 Removing the high pressure component

1. Bring the booster to a standstill and let the stored pressure completely dissipate.
2. Purge booster with nitrogen. Proceed as described in *Appendix A "Hydrogen compression with Maximator boosters" on page 117* to do this.

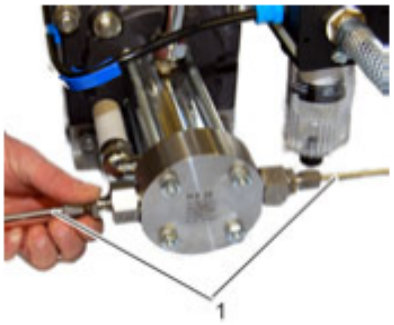


Fig. 52: Inlet and outlet line

3. Unscrew inlet and outlet line (Fig. 52/1) from inlet and outlet connection of booster head.
4. Close openings of removed inlet and outlet line with sealing plug to prevent it from soiling.
5. Release attachment screws of booster from foundation and secure to prevent them from getting lost.
6. Remove line from drive air connection.

   Depending on the version, drive air connection PL is connected to the compressed air control unit or to the spool valve housing.

In a dual-acting booster, the cooling pipe must be removed from the high pressure components and the inlet connections.

Fig. 53: Removing the cooling pipe

7. Release threaded union of cooling pipe from both high pressure components (Fig. 53/2) and from inlet connections (Fig. 53/1) and remove cooling pipe.

Fig. 54: Releasing the booster head

8. Release the four nuts of the stay bolts on the booster head (Fig. 54/marked in red) with a wrench. Secure nuts and square taper washer for U-sections to prevent them from getting lost.

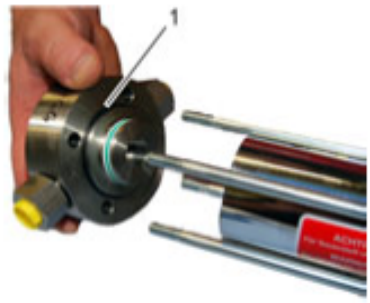


Fig. 55: Detaching the booster head

9. Carefully detach booster head (Fig. 55/1) from stay bolts.

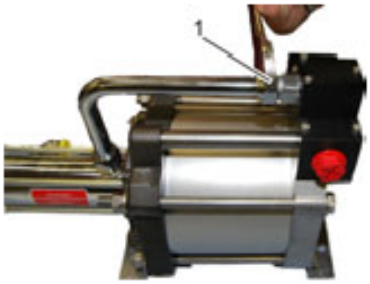


Fig. 56: Removing the cooling pipe

10. Release threaded union of cooling pipe from spool valve housing (Fig. 56/1).

Fig. 57: Removing the cooling pipe

11. Carefully pull off cooling pipe and cooling cylinder (Fig. 57/1) from pressure cylinder (Fig. 57/2).

Fig. 58: Prying off the high pressure cylinder

12. ***NOTICE!*** **Danger of material damage!**

Carefully pry off high pressure cylinder (Fig. 58/1) with a screwdriver (Fig. 58/2) from lower cap of drive component (Fig. 58/3).

13. Slowly pull back high pressure cylinder on piston rod.

Fig. 59: O-ring

14. Release O-ring (Fig. 59/1) from groove of piston rod and slide in direction of drive component (Fig. 59/arrow).

Fig. 60: Safety sleeve

15. Slide safety sleeve (Fig. 60/1) of piston rod in direction of drive component (Fig. 60/arrow).
    - ⇨ A dowel pin (Fig. 60/2) is located below the safety sleeve, which connects the piston rod to the high pressure piston.
16. Push out dowel pin (Fig. 60/2) with a screwdriver and secure to prevent it from getting lost.

Fig. 61: Detaching the high pressure cylinder

17. Detach high pressure cylinder (Fig. 61/1) from piston rod (Fig. 61/2).

7.3.6.2 Removing drive component and replacing O-ring of air piston

Fig. 62: Stay bolt

1. Release threaded union of 4 stay bolts (Fig. 62/ marked in red) and secure to prevent it from getting lost.

   ℹ The upper stay bolts are mounted with a nut, a spring lock washer, and a square taper washer for U-sections. The lower stay bolts are merely mounted with a nut and a spring lock washer.
2. Pull out stay bolt.
3. Remove fastening angle (Fig. 62/1).

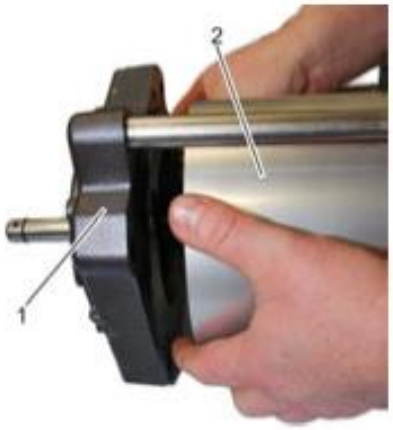


Fig. 63: Lower cap

4. Push lower cap (Fig. 63/1) of drive component from air cylinder (Fig. 63/2).
   ⇨ The 2 air pipes are now hanging free.

Fig. 64: Air pipes

5. Detach air pipes (Fig. 64/1).

Fig. 65: Control tube

6. Remove control tube (Fig. 65/1).

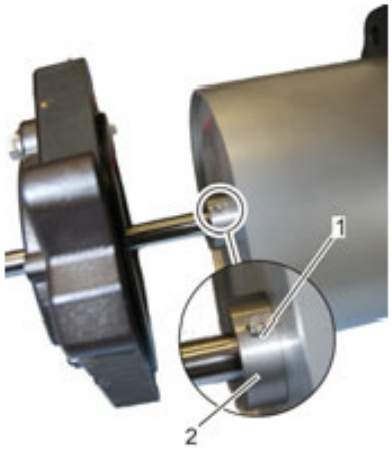


Fig. 66: Cotter pin

7. Remove cotter pin (Fig. 66/1) of socket pin from piston mount (Fig. 66/2).

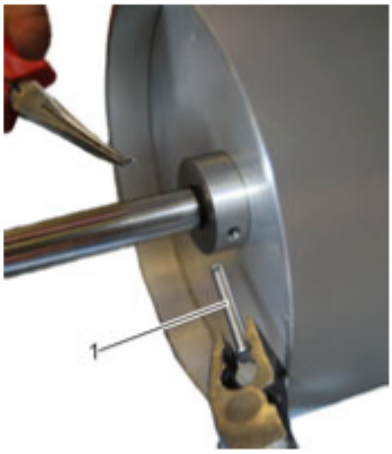


Fig. 67: Pulling out the socket pin

8. Pull out socket pin (Fig. 67/1) with pliers from the piston mount.
9. Detach lower cap of drive component and piston rod.

Fig. 68: Air piston

10. Push air piston (Fig. 68/1) in direction of upper cap (Fig. 68/2) of drive component.

Fig. 69: Detaching the air cylinder

11. Carefully detach air cylinder (Fig. 69/1) from air piston (Fig. 69/2).
12. Check seal of upper cap (Fig. 69/3) and replace if necessary.

Fig. 70: Detaching the seal

13. Detach seal from air piston (Fig. 70).
14. Grease new seal and slide onto air piston.

   The seal on the air piston is a floating seal and appears to be too big for the air piston. However, that is done on purpose.

15. Push back air piston in direction of lower cap (Fig. 70/arrow).

Fig. 71: Putting on the air cylinder

16. ***NOTICE!*** **Risk of damaging the piston seal!**
Position air cylinder (Fig. 71/1) at an incline to the air piston (Fig. 71/2) and carefully slide over air piston.

Fig. 72: Seal of lower cap

17. Check seals of lower cap (Fig. 72/1) and replace if necessary.

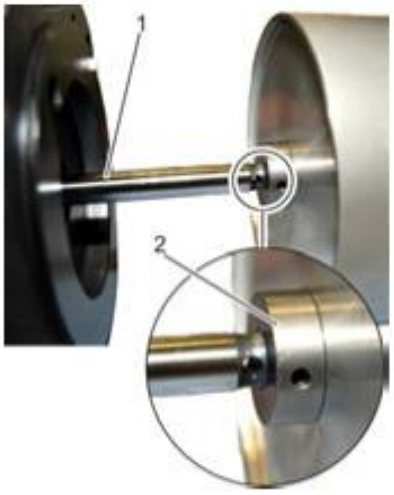


Fig. 73: Position piston rod

18. Position lower cap with piston rod (Fig. 73/1) on piston mount (Fig. 73/2) and make sure that holes are aligned.

Fig. 74: Inserting the socket pin

19. Insert socket pin (Fig. 74/1) into piston mount (Fig. 74/2) and secure with cotter pin.

Fig. 75: Air pipe

20. Detach O-rings (Fig. 75/1) from air pipes.

21. Grease new O-rings and slide onto air pipes.

Fig. 76: O-rings of control tube

22. Remove O-rings (Fig. 76/1) from control bore (Fig. 76/2) of upper and lower cap with a sharp object (scriber).

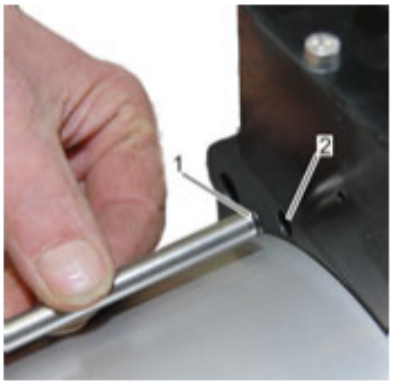


Fig. 77: Inserting the control tube

23. Place new greased O-rings onto ends of control tube (Fig. 77/1) and insert control tube into control bore (Fig. 77/2) of upper cap.

⇨ Because of the grease on the O-ring, the seal adheres to the control tube (Fig. 77).

24. Insert stay bolt through upper cap.

Fig. 78: Installing air pipes and lower cap

25. Insert two air pipes (Fig. 78/1) with new and greased O-rings into air pipe bores of upper cap.

26. Position lower cap (Fig. 78/2) on air cylinder and thread in air pipes (Fig. 78/1) and control tube.

27. *The upper stay bolts must be mounted with a nut, a spring lock washer, and a square taper washer for U-sections. The lower stay bolts must only be mounted with a nut, a spring lock washer, and the assembly brackets.*

Position stay bolts with nuts, spring lock washers, and square taper washer for U-sections and tighten with a torque of 485 lbf in.

7.3.6.3 Installing the high pressure component

Fig. 79: Installing the high pressure cylinder

1. Position high pressure cylinder with high pressure piston (Fig. 79/1) on piston rod (Fig. 79/2) and make sure that holes are aligned.

Fig. 80: Securing the dowel pin

2. Insert dowel pin (Fig. 80/2) into bore and slide safety sleeve (Fig. 80/1) over dowel pin connection.

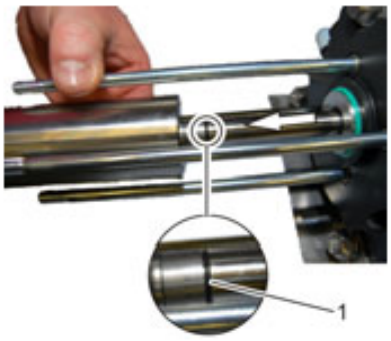


Fig. 81: O-ring

3. Slide O-ring (Fig. 81/1) on piston rod into groove in front of safety sleeve.
   ⇨ The safety sleeve is fixed in place by the O-ring.
4. Slide high pressure cylinder in direction of lower cap.

Fig. 82: Cooling pipe and high pressure pipe

5. Carefully slide cooling pipe and high pressure pipe (Fig. 82/1) over high pressure cylinder (Fig. 82/2).

Fig. 83: Fastening the cooling pipe

6. Fasten cooling pipe (Fig. 83/1) to threaded piece of spool valve housing.

Fig. 84: Booster head seal

7. Detach seal from booster head (Fig. 84/1).
8. Grease new seal and carefully slide onto booster head.

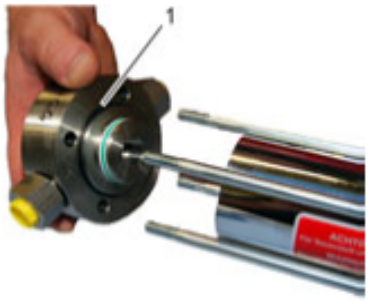


Fig. 85: Slipping on booster head

9. Carefully slip booster head (Fig. 85/1) onto stay bolts.
10. Fasten booster head with nuts, spring lock washers, and square taper washer for U-sections and tighten with a torque of 350 lbf in.
11. Install booster at installation location and tighten foundation screws with a torque of 750 lbf in.

7.3.7 Cleaning the inlet and outlet valve of the booster head

A description of how the inlet and outlet valve of the booster head is checked for soiling and cleaned is provided below.

Personnel:
- Specialist for potentially explosive areas

Protective equipment:
- Protective work clothing
- Safety shoes
- Safety goggles

Special tool:
- Wrench
- Torque wrench

In single-stage, dual-acting boosters, inlet and outlet valves must be removed and cleaned on both booster heads.

The inlet and outlet valves of booster models DLE 2 and DLE 5 differ in design from the one's described below. However, the fault correction procedure is identical.

1. Bring the booster to a standstill, de-pressurize it, and let the stored pressure completely dissipate.
2. Purge booster with nitrogen. Proceed as described in *Appendix A "Hydrogen compression with Maximator boosters" on page 117* to do this.
3. Remove inlet and outlet valves on the booster head and protect the open lines from soiling.
4. Release inlet and outlet connections (Fig. 86/1) on booster head with a wrench (Fig. 86/2).

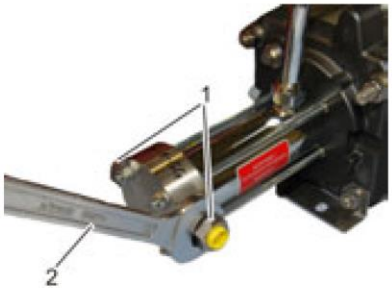


Fig. 86: Releasing the valves

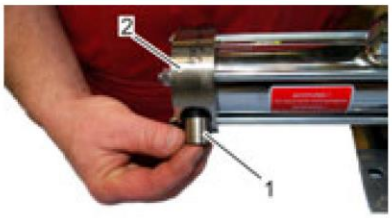


Fig. 87: Removing the valve

5. Remove inlet and outlet valve from booster head.

Fig. 88: Disassembled valve

6. Carefully disassemble valve on a clean working surface.

   The valves consist of two O-rings (Fig. 88/1), valve seat (Fig. 88/2), ball (Fig. 88/3), compression spring (Fig. 88/4), and valve body (Fig. 88/5).

7. Clean all components of the valve, check for signs of damage, and replace if necessary.

8. ***NOTICE!* Danger of material damage due to incorrect installation!**

   Install valve in identical sequence.

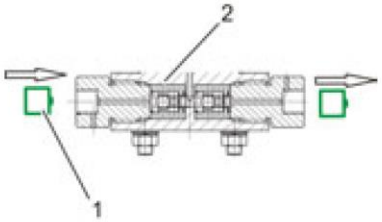


Fig. 89: Installation direction

9. Make sure when installing the valves that the conical valve seat (Fig. 89/1) of the valve is always inserted in the flow direction (Fig. 89/arrows) into the booster head (Fig. 89/2).

10. Fasten inlet and outlet connections and tighten with a torque of 1060 lbf in.

11. Install piping of inlet and outlet lines according to *Appendix B "Connection drawing" on page 127*.

7.3.8 Replacing the high pressure cylinder with high pressure piston as a complete component

A description of how the high pressure cylinder with the high pressure piston is replaced as a complete component is provided below. The high pressure piston is located on the inside of the high pressure cylinder.

These fault correction tasks only apply to booster models DLE 15, 30, and 75.

Personnel:	■ Specialist for potentially explosive areas
Protective equipment:	■ Protective work clothing ■ Safety shoes ■ Safety goggles
Special tool:	■ Wrench

7.3.8.1 Removing the high pressure cylinder with high pressure piston

To remove the high pressure cylinder with high pressure piston, proceed as described in ↳ Chapter 7.3.6.1 “Removing the high pressure component” on page 79.

7.3.8.2 Installing a new high pressure cylinder with high pressure piston

To install a new high pressure cylinder with high pressure piston, proceed as described in ↳ Chapter 7.3.6.3 “Installing the high pressure component” on page 89.

7.3.9 Checking high pressure seals and high pressure cylinder for signs of damage

An explanation of how the high pressure seal and the high pressure cylinder are checked for signs of damage and replaced if necessary is provided below.

Personnel:	■ Specialist for potentially explosive areas
Protective equipment:	■ Protective work clothing ■ Safety shoes ■ Safety goggles
Special tool:	■ Wrench

Checking the high pressure seals and replacing them if necessary

To check the high pressure seals for signs of damage, the high pressure component must be removed. Proceed as described in ↳ Chapter 7.3.6.1 “Removing the high pressure component” on page 79 to do this.

Fig. 90: High pressure seal (on high pressure side)

1. Check high pressure seal (Fig. 90/1) on booster head (Fig. 90/2) for signs of wear and replace if necessary.

Fig. 91: High pressure seal (on air side)

2. Check high pressure seal (Fig. 91/1) on lower cap of drive component (Fig. 91/2) for signs of wear and replace if necessary.

Fig. 92: High pressure cylinder

3. Check inside of removed high pressure cylinder (Fig. 92) for score marks and other signs of damage.

   If the high pressure cylinder is damaged, it must be replaced as a complete component.

   In booster model DLE 15–30–75, the high pressure piston is located in the high pressure cylinder. In the event of damage, the high pressure cylinder with the integrated high pressure piston must be replaced as a complete component.

Reinstalling the high pressure component

To reinstall the high pressure components, proceed as described in Chapter 7.3.6.3 “Installing the high pressure component” on page 89.

7.4 Start up after a corrected fault

After correcting the fault execute the following steps to start up again:

1. Properly reconnect all high pressure lines.
2. Check connections for signs of leaks with a leak detection spray.
3. Ensure that no one is in the danger zone.
4. Start in accordance with the notes in Chapter "Operation".

8 Maintenance

No maintenance work is planned for the boosters.

9 Dismantling and disposal

After the end of the useful life has been reached, the booster must be dismantled and disposed of in an environmentally responsible manner.

9.1 Safety instructions for dismantling and disposal

Explosion protection

⚠ WARNING

Danger of explosion during dismantling!

- **Prior to dismantling, obtain a written work approval.**
- **Prior to dismantling, purge the booster with nitrogen to flush any remaining toxic and combustible gas out of the booster.**
- **Perform dismantling task only when a potentially explosive atmosphere can be ruled out.**
- **Use only those tools that are permissible for use in the Ex area.**

Bringing in ignition sources such as sparks, open flames, and hot surfaces can lead to explosion in the Ex area. Non-compliance with these instructions will lead to loss of explosion protection.

Improper dismantling

⚠ WARNING

Danger of injury due to improper dismantling!

- **Prior to starting the tasks ensure that there is adequate free space.**
- **Shut off all operating media of the machine.**
- **Ensure order and cleanliness at the workstation! Parts and tools that are lying loose or on top of each other are accident hazards.**
- **Consult with the manufacturer if there are questions.**

Stored residual energy, sharp-edged components, points and corners on or in the machine, or on the required tools can cause serious injury.

9.2 Dismantling

Personnel:	■ Specialist for potentially explosive areas
Protective equipment:	■ Protective work clothing ■ Safety shoes ■ Safety goggles

1. Bring the booster to a standstill and let the stored pressure completely dissipate.
2. Purge booster with nitrogen. Proceed as described in *Appendix A "Hydrogen compression with Maximator boosters" on page 117* to do this.
3. Dismount all piping and threaded unions.
4. Release foundation screws.

Then properly clean assemblies and components and take them apart in compliance with the applicable occupational health and safety and environmental protection regulations.

9.3 Disposal

If no there is no take-back or disposal agreement, submit disassembled components for recycling:

- Scrap metals.
- Give plastic elements to recycling.
- Dispose of other components sorted according to their material properties.

NOTICE

Danger to the environment due to incorrect disposal!

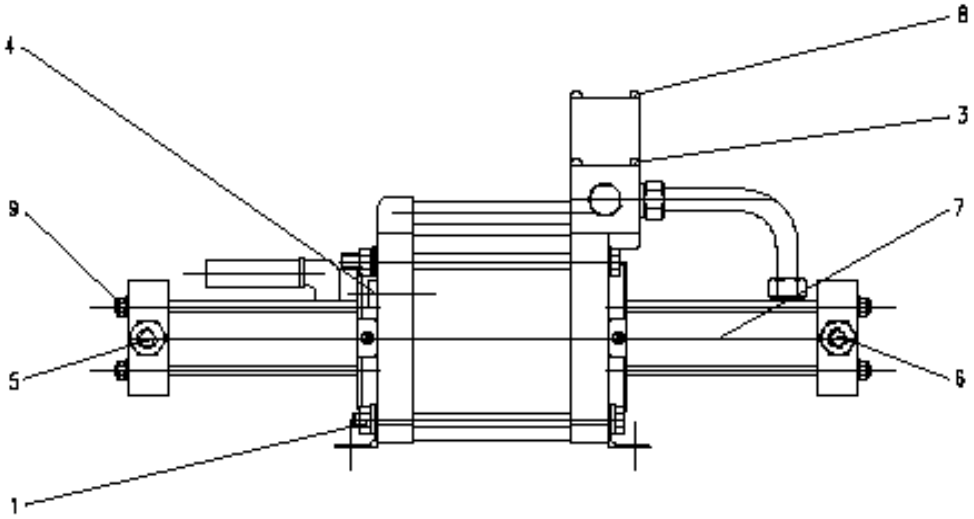
- **Have electrical scrap, electronic components, lubricants and other auxiliary materials disposed of by an approved operation.**
- **In case of doubt, obtain information about environmentally-friendly disposal from the local municipal authorities or a special disposal operation.**

Improper disposal can present a danger to the environment.

9.4 Tightening torques

MAXIMATOR®
HYDRAULIK PNEUMATIK HOCHDRUCKTECHNIK PRÜFSTÄNDE
Geschäftsbereich der Schefdt, Kress & Co GmbH

Technical Information:
Torques for screw connections
Type: DLE - Booster



1: Tie rod air drive section
2: Union nut HP-seal
3: Spool valve housing
4: Pilot valve screw
5: Inlet gland
6: Outlet gland
7: Piston attachment
8: Exhaust-connection
9: Tie rod HP-section

Pumps Type	1 a)		2		3 b)		4 a)		5 a)		6 a)		7 a)		8 b)		9 a)	
	SW	Nm	SW	Nm	SW	Nm	SW	Nm	SW	Nm	SW	Nm	SW	Nm	SW	Nm	SW	Nm
DLE 2(-1), DLE 5(-1)	19	55	--	--	4	5	13	2	32	120	32	120	13	25	3	5	17	40
DLE 15/30/75(-1)	19	55	--	--	4	5	13	2	27	120	27	120	10	20	3	5	13	40

SW ... wrench opening

a) Open end- resp. box wrench
b) Hex key

10 Technical data

10.1 Dimensions and weights

The dimensions and weights of all booster types are listed below.

The values listed below are approximate values and can vary slightly.

Type	Width	Height	Depth	Weight
	inches	inches	inches	lbs
DLE 2–1	17.32	10.83	7.09	33.07
DLE 5–1	17.32	10.83	7.09	33.07
DLE 15–1	17.72	10.83	7.09	28.66
DLE 30–1	17.72	10.83	7.09	28.66
DLE 75–1	17.72	10.83	7.09	28.66
DLE 2	23.62	10.83	7.09	44.09
DLE 5	23.62	9.25	7.09	44.09
DLE 15	24.41	9.25	7.09	39.68
DLE 30	24.41	9.25	7.09	39.68
DLE 75	24.41	9.25	7.09	39.68
DLE 2-5	23.62	9.25	7.09	44.09
DLE 5-15	24.02	9.25	7.09	41.89
DLE 5-30	24.02	9.25	7.09	41.89
DLE 15-30	24.41	9.25	7.09	41.89
DLE 15-75	24.41	9.25	7.09	41.89
DLE 30-75	24.41	9.25	7.09	41.89
DLE 2–1–2	24.02	10.83	7.09	48.50
DLE 5–1–2	24.02	9.25	7.09	48.50
DLE 15–1–2	24.21	9.25	7.09	44.09
DLE 30–1–2	24.21	9.25	7.09	44.09
DLE 75–1–2	24.21	9.25	7.09	44.09
DLE 2-2	30.71	10.83	7.09	55.11
DLE 5-2	30.71	9.25	7.09	55.11

Type	Width	Height	Depth	Weight
	inches	inches	inches	lbs
DLE 15-2	31.50	9.25	7.09	50.71
DLE 30-2	31.50	9.25	7.09	50.71
DLE 75-2	31.50	9.25	7.09	50.71
DLE 2-5–2	30.71	9.25	7.09	55.11
DLE 5-15–2	31.10	9.25	7.09	52.91
DLE 5-30–2	31.10	9.25	7.09	52.91
DLE 15-30–2	31.50	9.25	7.09	52.91
DLE 15-75–2	31.50	9.25	7.09	52.91
DLE 30-75–2	31.50	9.25	7.09	52.91
8 DLE 3	38.98	13.78	8.66	121.25
8 DLE 6	38.98	13.78	8.66	121.25
8 DLE 1.65	31.89	13.78	8.66	88.18

10.2 Connected loads

Pneumatic

Data	Value	Unit
Compressed air quality	Oil-free possible	
Solids, max. particle size	5	µm
Solids, max. particle concentration	$2.19 * 10^{-3}$	grain/ft³
Dew point up to + 10 °C water content	4.1	grain/ft³
Dew point up to + 2 °C water content	2.5	grain/ft³

* Once a lubricator has been used, the air must always be lubricated, since oil in air will wash out the pneumatic pump grease!

Connected loads, mechanical

Type	Inlet connection*	Outlet connection **	Recommended internal tube diameter in inches		
			Drive air	Admission pressure	Operating pressure
DLE 2–1	G 1/2	G 1/2	0.75	0.51	0.51
DLE 5–1	G 1/2	G 1/2	0.75	0.51	0.51
DLE 15–1	G 1/4	G 1/4	0.75	0.24	0.16
DLE 30–1	G 1/4	G 1/4	0.75	0.24	0.16
DLE 75–1	G 1/4	G 1/4	0.75	0.24	0.16
DLE 2	G 1/2	G 1/2	0.75	0.51	0.51
DLE 5	G 1/2	G 1/2	0.75	0.51	0.51
DLE 15	G 1/4	G 1/4	0.75	0.24	0.16
DLE 30	G 1/4	G 1/4	0.75	0.24	0.16
DLE 75	G 1/4	G 1/4	0.75	0.24	0.16
DLE 2-5	G 1/2	G 1/2	0.75	0.51	0.51
DLE 5-15	G 1/2	G 1/4	0.75	0.51	0.16
DLE 5-30	G 1/2	G 1/4	0.75	0.51	0.16
DLE 15-30	G 1/4	G 1/4	0.75	0.24	0.16
DLE 15-75	G 1/4	G 1/4	0.75	0.24	0.16
DLE 30-75	G 1/4	G 1/4	0.75	0.24	0.16
DLE 2–1–2	G 1/2	G 1/2	0.75	0.51	0.51
DLE 5–1–2	G 1/2	G 1/2	0.75	0.51	0.51
DLE 15–1–2	G 1/4	G 1/4	0.75	0.24	0.16
DLE 30–1–2	G 1/4	G 1/4	0.75	0.24	0.16
DLE 75–1–2	G 1/4	G 1/4	0.75	0.24	0.16
DLE 2-2	G 1/2	G 1/2	0.75	0.51	0.51
DLE 5-2	G 1/2	G 1/2	0.75	0.51	0.51
DLE 15-2	G 1/4	G 1/4	0.75	0.24	0.16
DLE 30-2	G 1/4	G 1/4	0.75	0.24	0.16
DLE 75-2	G 1/4	G 1/4	0.75	0.24	0.16
DLE 2-5–2	G 1/2	G 1/2	0.75	0.51	0.51

Type	Inlet connection*	Outlet connection **	Recommended internal tube diameter in inches		
			Drive air	Admission pressure	Operating pressure
DLE 5-15–2	G 1/2	G 1/4	0.75	0.51	0.16
DLE 5-30–2	G 1/2	G 1/4	0.75	0.51	0.16
DLE 15-30–2	G 1/4	G 1/4	0.75	0.24	0.16
DLE 15-75–2	G 1/4	G 1/4	0.75	0.24	0.16
DLE 30-75–2	G 1/4	G 1/4	0.75	0.24	0.16
8 DLE 3	G1/2	G 1/2	0.75	0.51	0.51
8 DLE 6	G1/2	G1/2	0.75	0.51	0.51
8 DLE 1.65	G1/2	G1/2	0.75	0.51	0.51

When the recommended internal tube diameters are observed, the boosters reach the maximum delivery output.

Additional connections

The above inlet and outlet connections are standard connections. Additional connections options for inlet and outlet are provided below. These additional connection options must correspond to the type key information on the type plate. To this end, see
Chapter 10.9 “Type key” on page 112 in these operating instructions.

* Inlet connection (Table "Connected loads, mechanical")

Connection designation of inlet connection	Dimension	Booster types
N	NPT G1/2"	DLE 2, DLE 5
	NPT G1/4"	DLE 15 – 75
U	9/16 – 18 UNF for G1/4" high pressure pipe, connection H4 downstream of Maximator	DLE 15 – 75

** Outlet connection (Table "Connected loads, mechanical")

Connection designation of outlet connection	Dimension	Booster types
N	NPT G1/2"	DLE 2, DLE 5
	NPT G1/4"	DLE 15 – 75
U	9/16 – 18 UNF for G1/4" high pressure pipe, connection H4 downstream of Maximator	DLE 15 – 75

*The following combinations of threaded inlet and outlet unions are possible **GG**, **GU**, **UU**, **NU**, and **NN**.*

10.3 Performance characteristics

Type	Displacement in cu.in.	Max. operating pressure pB (static) psi	Max. compression ratio	Transmission ratio (i1/i2)	Max. operating temperature in °F	Admission pressure	
						min. psi	max. psi *
DLE 2–1	56.26	290	1:10	1:2	140	0	230.1
DLE 5–1	22.76	725	1:15	1:5	140	29.0	725.2
DLE 15–1	7.45	2175	1:20	1:15	212	101.5	2175
DLE 30–1	3.66	4350	1:20	1:30	212	217.6	4350
DLE 75–1	1.53	10875	1:20	1:75	212	507.6	10875
DLE 2	112.53	580	1:10	1:2	140	0	580.1
DLE 5	45.52	1450	1:15	1:5	140	29.0	1450
DLE 15	14.89	4350	1:20	1:15	212	101.5	4350
DLE 30	7.32	8700	1:20	1:30	212	217.6	8700
DLE 75	3.05	21750	1:20	1:75	212	507.6	21750
DLE 2-5	56.26	1450	1:25	1:2/1:5	140	0	0.8 *PL
DLE 5-15	22.76	4350	1:45	1:5/1:15	212	29.0	6 *PL
DLE 5-30	22.76	8700	1:90	1:5/1:30	212	29.0	2 *PL
DLE 15-30	7.45	8700	1:40	1:15/1:30	212	101.5	15 *PL
DLE 15-75	7.45	21750	1:100	1:15/1:75	212	101.5	3.5 *PL
DLE 30-75	3.66	15225	1:50	1:30/1:75	212	217.6	20 *PL
DLE 2–1–2	56.26	580	1:10	1:4	140	0	580.1
DLE 5–1–2	22.76	1450	1:15	1:10	140	58.0	1450
DLE 15–1–2	7.45	4350	1:20	1:30	212	145.0	8700
DLE 30–1–2	3.66	8700	1:20	1:60	212	230.1	8700
DLE 75–1–2	1.53	21750	1:20	1:150	212	652.7	21750
DLE 2-2	112.53	580	1:10	1:4	140	0	580.1
DLE 5-2	45.52	1450	1:15	1:10	140	58.0	1450
DLE 15-2	14.89	4350	1:20	1:30	212	145.0	4350
DLE 30-2	7.32	8700	1:20	1:60	212	230.1	8700

Type	Displacement in cu.in.	Max. operating pressure pB (static) psi	Max. compression ratio	Transmission ratio (i1/i2)	Max. operating temperature in °F	Admission pressure	
						min. psi	max. psi *
DLE 75-2	3.05	21750	1:20	1:150	212	652.7	21750
DLE 2-5–2	56.26	1450	1:25	1:4/1:10	140	0	1.6 *PL
DLE 5-15–2	22.76	4350	1:45	1:10/1:30	212	29.0	12 *PL
DLE 5-30–2	22.76	8700	1:90	1:10/1:60	212	29.0	4 *PL
DLE 15-30–2	7.45	8700	1:40	1:30/1:60	212	101.5	30 *PL
DLE 15-75–2	7.45	21750	1:100	1:30/1:150	212	101.5	7 *PL
DLE 30-75–2	3.66	21750	1:50	1:60/1:150	212	217.6	40 *PL

** = Maximum permissible pressure load that may be used for the high pressure component of the booster. Compression ratio = operating pressure/admission pressure*

10.4 Operating conditions

Environment

Data	Value	Unit
Temperature range	- 4 – + 140	°F
Relative humidity, maximum	60	%
Ambient pressure range	min. 14.5 psi less than drive pressure, max. 145 psi	
Altitude, max.	unlimited	ft above sea level

Duration

Data	Value
Switch-on time	Switch-on time 50% with a stroke frequency of > 60 strokes per minute
Switch-on time	Switch-on time 100% with a stroke frequency of < 30 strokes per minute

10.5 Operating materials

Lubricant

Operating material	Manufacturer	Designation
Lubricating grease	Klüber Lubrication	ISOFLEX TOPAS NB 52

10.6 Emissions

The noise emission measurement was executed at a height of 5 feet and at a distance of 3.3 feet to the test stand. The determined noise emission was measured during full-load operation with a counterpressure of 145 psi.

Data	Value	Unit
Noise emission	81	dB(A)

10.7 Ex marking

Fig. 93: Ex marking explosion group IIB

The Ex marking is located on the drive component of the boosters in immediate vicinity of the type plate.

Fig. 94: Ex marking explosion group IIC

Marking	Designation	Meaning
CE	CE sign	Conformity sign in accordance with Appendix X of directive 94/9/EC. The manufacturer attaches it before the device is put into circulation.
II	Device group	The booster may be used in potentially explosive areas with the exception of mining.
2GD	Device category	With device category 2GD, a potentially explosive atmosphere may develop occasionally involving gas (G) and dust (D). The device ensures a high level of safety and can be used in zone 1 and zone 2.
IIB	Explosion group	Can be used for substances with a Maximum Experimental Safe Gap of 0.02 inches ≤ MESG ≤ 0.04 inches (IEC 60079-1).
IIC	Explosion group	Can be used for substances with a Maximum Experimental Safe Gap of < 0.02 inches (IEC 60079-1).
c	Ignition protection type	Constructive safety for non-electronic devices in potentially explosive areas as per DIN EN 13463-5.
X	Additional marking	Indicates the necessity to observe special operating conditions, in this case environmental temperatures (☞ *"Environment" on page 109*).

10.8 Type plate

Fig. 95: Type plate

The type place is centrally located on the drive component of the booster and contains the following information:

- Manufacturer
- Type (information from type key)
- Year of manufacture
- Gas pressure, min. inlet
- Gas pressure, max. outlet
- Maximum air drive
- Transmission ratio
- Max. compression ratio

10.9 Type key

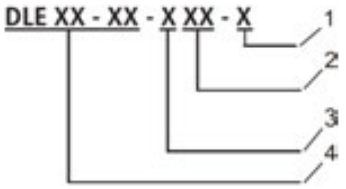


Fig. 96: Type key

The type key for the corresponding booster models is structured as follows:

1 Version for C = CO_2, S = oxygen
2 Thread of gas inlet and outlet G = pipe thread (standard), U = high pressure connection , N = NPT
3 1 = 1 high pressure piston, 2 = 2 drive piston
4 Design (e.g. DEL 15–75)

11 Index

Appendix

A Hydrogen compression with Maximator boosters

Achtung!

Wichtige Informationen für die MAXIMATOR Kompressoren der DLE - Baureihe. Werden die Kompressoren zur Verdichtung von aggressiven, brennbaren, gefährlichen oder giftigen Gasen eingesetzt, sind die Hinweise, wie im Fallbeispiel „Wasserstoff“ unbedingt zu beachten.

Weiterhin müssen natürlich die dem entsprechenden Gas geltenden Vorschriften und Richtlinien eingehallten werden. Für den sicheren Betrieb der Kompressoren, ist der Betreiber verantwortlich.

Caution!

Important information for MAXIMATOR DLE Series Booster:
If the boosters are used to compress aggressive, flammable, hazardous or toxic gases, the instructions as mentioned in the document: “Best Practice Hydrogen Compression” need to be observed.

Furthermore the current regulations and directives for the specific gas need to be complied. The operator is responsible for the safe operation of the booster.

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MAXIMATOR
GLOBAL PRESSURE SOLUTIONS

Best Practice
Hydrogen compression

Safety, explosion protection, systems engineering

What you need to know

Hydrogen is a colourless, odourless and flavourless gas and therefore cannot be detected with our human sensory organs.

Hydrogen burns with invisible flame and radiates only little heat in this process.

When mixing with air in a ratio of 4 to 76 percent by volume (vol. %) of hydrogen a detonating gas develops that already can be brought to explosion by a low-energy spark.

Oxygen-hydrogen mixtures with a fraction of below 10.5 percent by volume are heavier than air and sink to the floor.

Physical and chemical properties

Appearance:	colourless gas
Odour:	odourless
Molar mass:	30,8 grain/mol
Melting point:	-434 °F
Boiling point:	-423 °F
Critical temperature:	-400 °F
Ignition temperature:	1040 °F
Explosion limits (vol. % in air):	4 %(V) - 75 %(V)
Relative density, gaseous (air=1):	0,07
Solubility in water (mg/l):	0,699 grain/ft³

Safety during compression of hydrogen

Avoiding explosive atmospheres in confined spaces and outdoors

The formation of an explosive atmosphere in adjacent areas near the hydrogen equipment is prevented by observing the following requirements:

- Hydrogen equipment shall be installed in well-ventilated areas (if possible, outdoors).
- Hydrogen equipment has to be leak-proof and remain so.
- Venting lines from safety valves, leakage lines and similar lines shall be directed into the open.
- Discharge units must not terminate below eaves, openings in buildings or placed near air intake ports.
- In case hydrogen equipment is installed in confined spaces, the gas supply coming from the outside must be provided with a reliable shut-off device placed at a safe point.
- Pipe connections on hydrogen equipment shall be fitted such that they ensure a long-term tightness of the joint.

Explosive mixture

Avoiding explosive mixtures in hydrogen equipment

Explosive mixtures cannot be tolerated in hydrogen equipment with regard to safety aspects. Such mixtures are easily ignited by e.g. the friction heat generated in activating a valve or by the friction generated by rust particles dragged through. Even the heating of the gas caused by a pressure surge during rapid inflow of hydrogen into a equipment component filled with air can induce ignition.

Prior to commissioning, the air has to be removed from the hydrogen equipment, e.g. by evacuation or flushing. The safest method is by flushing with hydrogen, when an oxygen content of below 1 percent by volume is achieved inside the plant.

When decommissioning hydrogen equipment it is necessary to render the equipment free of gas by evacuation or flushing. To achieve this, the hydrogen content must be below 1 percent by volume, before the equipment can be opened.

Please observe in all flushing procedures that flush gas always takes the path of lowest resistance. Therefore, the flush gas flow must be directed such that „dead pockets“ are avoided.

Hydrogen compression with MAXIMATOR booster

MAXIMATOR hydrogen booster design

MAXIMATOR booster are especially modified for the compression of hydrogen in the following areas:

- Material suited for pressurised components
- Sealing geometry
- Flushing Connection
- Air drive section suitable for Atex

These modifications are available for the following high-pressure sections:

- DLE 2
- DLE 5
- DLE 15
- DLE 30
- DLE 75

MAXIMATOR hydrogen boosters are marked with the suffix H2-ExIIC and are generally suited for applications in explosion class IIC.

Materials

Hydrogen places significant demand on material choice. In this area, the phenomenon of hydrogen embrittlement must be especially mentioned.

Hydrogen embrittlement describes the change in the ductility of metals. Atomic hydrogen penetrates the microstructure of metallic material. At voids or grain boundaries, the atomic hydrogen recombines to form molecular hydrogen, thus increasing the pressure inside the structure.

This process causes internal stresses and leads to material embrittlement. Material failure becomes apparent in cracks that spread outside (hydrogen-induced crack formation).

In practical tests, austenitic steel has proven to be especially successful. After high performance tests, the MAXIMATOR hydrogen booster showed no sign of hydrogen embrittlement.

Piston compressors with dynamically loaded seals are not absolutely gas-tight. To increase the performance of the piston seal for hydrogen compression purposes, both sealing geometry and material were adapted to the special requirements.

Flushing Connection

From a technical point of view, the most important part in the compression of hydrogen is to avoid the formation of explosive atmospheres. As gas leakages cannot be ruled out, MAXIMATOR hydrogen boosters have to be flushed with inert gas (preferably nitrogen) prior, during and after use.

An explosive mixture can form inside the compressor chamber, but also in the rear piston chamber due to a little leakage at the high-pressure seals.

To provide safe flushing of these areas, the MAXIMATOR hydrogen boosters are also fitted with an additional flushing connection. In accordance with the boosters operating principle, different flushing processes shall be carried out to ensure safe operation.

If no flushing is carried out, these areas are characterised by zone zero. In this case, MAXIMATOR boosters would belong in category 1 (which requires type approval test). In the current version, the boosters do not meet the requirements of category 1. Therefore, operation without flushing is expressly prohibited.

Flushing plans for MAXIMATOR hydrogen boosters

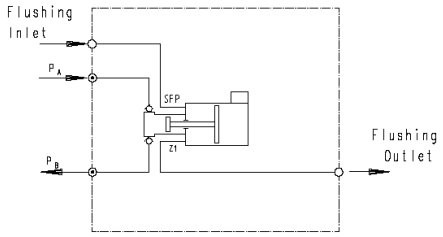
To be able to effectively flush the rear piston chamber of the booster, please observe the following installation scheme when fitting the flushing line.

It is important that there is a continuous flow of flushing gas through the flushing lines during the complete duty cycle. Make sure in particular that flushing lines are not pressurised. Otherwise this might result in damage of the high-pressure section.

Prior and after operation of the booster or equipment, the booster chamber and associated lines shall be flushed with copious amounts of nitrogen (or another inert gas). Through the flushing process it must be ensured that the oxygen content inside the booster or equipment falls below 1 percent by volume.

Flushing plan for single-stage, single-acting booster:

(With SFP flushing connection and Z1 leakage connection on the high-pressure side).

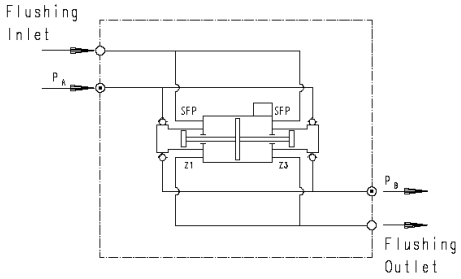


Flushing procedure:

1. Prior to booster start-up, connect the nitrogen supply to the inlet pressure connection (PA) and to the flushing connection (SFP).
2. Switch on the booster for approx. 1 min. (depending on the volume to be flushed).
3. Switch off the booster after completion of the flushing process.
4. Afterwards, the inlet pressure line (PA) can be connected to the hydrogen supply. During hydrogen compression, the flushing connection shall be continuously flushed with nitrogen.
5. After completion of hydrogen compression, the booster chamber shall again be flushed as described under item 2.

Flushing plan for single-stage, double-acting boosters:

(With SFP flushing connection and Z1 and Z3 leakage connection on the high-pressure side)

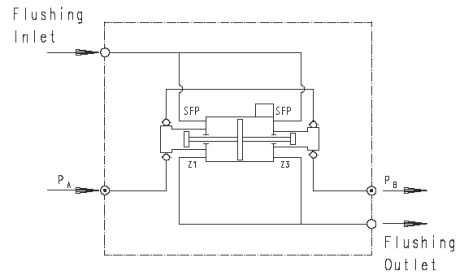


Flushing procedure:

1. Prior to booster start-up, connect the nitrogen supply to the inlet pressure port (PA) and to the flushing connections (SFP).
2. Switch on the booster for approx. 1 min. (depending on the volume to be flushed).
3. Switch off the booster after completion of the flushing process.
4. Afterwards, the inlet pressure line (PA) can be connected to the hydrogen supply. During hydrogen compression, the flushing connection do not neet to be continuously flushed with nitrogen, because in single-stage, double-acting compressors no ambient air is sucked in via the leakage ports.
5. After completion of hydrogen compression, the booster chamber shall again be flushed as described under item 2.

Flushing plan for two-stage booster:

(With SFP flushing connections and Z1 and Z3 leakage connections on the high-pressure side)



Flushing procedure:

1. Prior to booster start-up, connect the nitrogen supply to the inlet-pressure port (PA) and to the flushing connection (SFP).
2. Switch on the booster for approx. 1 min. (depending on the volume to be flushed).
3. Switch off the booster after completion of the flushing process.
4. Afterwards, the inlet pressure line (PA) can be connected to the hydrogen supply. During hydrogen compression, the flushing connection shall be continuously flushed with nitrogen.
5. After completion of hydrogen compression, the booster chamber shall again be flushed as described under item 2.

Volume flow for gas flushing

Depending on the type of booster, different volume flows must be ensured to provide for sufficient flushing performance. The table below shows the minimum required volume flow.

Boosters marked in red only require volume flow during start-up and decommissioning, whereas no volume flow is required during operation.

Apart from flushing gas volume flow, the cross sections of flushing lines are also significant. We recommend not to fall below an inner diameter of 0.157 in (4 mm). If the diameter is smaller, this involves the hazard of gas pressure accumulating inside the flushing line. Under certain circumstances, the high-pressure component of the booster might be damaged. Also make sure the flushing line exit remains unobstructed.

Type	Volume Flow scfm
DLE 2-1	6.71
DLE 5-1	3.17
DLE 15-1	1.41
DLE 30-1	0.71
DLE 75-1	0.35
DLE 2	6.00
DLE 5	3.17
DLE 15	1.06
DLE 30	0.71
DLE 75	0.35
DLE 2-5	3.88
DLE 5-15	2.12
DLE 5-30	2.47
DLE 15-30	0.71
DLE 15-75	1.06
DLE 30-75	0.35
DLE 2-1-2	6.71
DLE 5-1-2	3.17
DLE 15-1-2	1.06
DLE 30-1-2	0.71
DLE 75-1-2	0.35
DLE 2-2	6.00
DLE 5-2	2.83
DLE 15-2	1.06
DLE 30-2	0.71
DLE 75-2	0.35
DLE 2-5-2	3.53
DLE 5-15-2	2.12
DLE 5-30-2	2.47
DLE 15-30-2	0.71
DLE 15-75-2	0.71
DLE 30-75-2	0.35

Temperature

Booster temperature is dependent of the medium temperature, the degree of compression and other operating conditions.

A prerequisite for safe operation is that the booster is correctly connected to earth potential.

For ideal gases, the temperature to be expected can be calculated by the following formula:

$$T_2 = \left(\frac{P_2}{P_1}\right)^{\frac{\chi-1}{\chi}} \cdot T_1$$

with
T_2 = Temperature after compression (in K)
T_1 = Temperature prior to compression (in K)
P_2 = Pressure after compression (in bar)
P_1 = Pressure prior to compression (in bar)
χ = Isentropic exponent
The isentropic exponent for hydrogen is 1.41.

Due to the fact that compression cannot take place without a heat exchange with the environment, the actual temperature will always remain below the calculated temperature. If the temperature of the compressed gas exceeds the maximum admissible temperature, compression has to be performed in several steps, with a cooling phase in between the individual compression steps.

If the temperature of the compressed gas lies below the maximum admissible temperature, you have to ensure that - in dependence with the respective explosion zone - that operating conditions do not change. A slightly less inlet pressure would result in a higher temperature!

High-pressure screw connections and hydrogen

As a rule, high-pressure screw connections (cone and thread) are suitable for hydrogen operation.
The operator of hydrogen equipment with high-pressure screw connections has to be advised that there might be possible leakage from leakage bores in fittings (t-pieces, elbows, crosspieces etc.).

If required, suitable monitoring measures shall ensure that equipment using this type of screw connection is only used when tightness of the connection is assured. The requirements are stipulated by the classification into explosion zones.

MAXIMATOR hydrogen stations

ATEX for housing and electrical cabinets

Suitability of the housing or electrical cabinets for ATEX IIC shall be separately examined for the relevant application.

As a rule, the following criteria should be met:
- Stainless steel
- no potential source of ignition
- Ventilation ports on top and at the bottom

All accessory parts have to be electrically conductive. Varnished surfaces or sight glasses normally do not meet these requirements.

In case this is required, the availability of such components (with the corresponding manufacturer's confirmation) must be checked.

Due to the material's non-conductive properties, noise insulation of the housing is also inadmissible.

ATEX for power packs

The standard MAXIMATOR power packs are not admissible for ATEX IIC. The reason here is the labelling foil. The foil with a printed flow diagram on instrumentation is approximately 0.039 in (1 mm) thick. However, the ATEX 94/9/EC Directive limits maximum thickness of foil suitable for category IIC to 0.0079 in (0.2 mm).

In case ATEX IIC is required, the stations are also available with plates as an alternative to foil. The frame itself remains unchanged.

Special features in project planning of hydrogen stations

Generally, the compression of hydrogen does not place special demands on safety installations. For example, the installation of additional temperature and pressure monitoring devices is normally not necessary.

In the selection of the various components (regulators, valves, filters etc.) special emphasis must be placed on their suitability for hydrogen.

In general it must be ensured that only such components are used, which do not have a potential source of ignition. The material also has to be resistant against hydrogen embrittlement. Therefore, medium-carrying lines should be of stainless steel grade 1.4404, 1.4571 or similar.

Hose lines are unsuitable for hydrogen stations according to ATEX IIC because of their lack of conductivity.

MATERIAL SAFETY DATA SHEET

Print date: 14-Dec-2010 *Revision Number: 2* *Revision date: 14-Dec-2010*

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND THE COMPANY/UNDERTAKING

Product Name: ISOFLEX TOPAS NB 52
Article Code: 004131
Synonyms: No information available
Chemical characterisation: Not applicable..

Supplier:
Klüber Lubrication North America L.P.
32 Industrial Drive
Londonderry, NH 03053
(603) 647-4104
Fax (603) 647-4106

Emergency telephone number CHEMTREC: 1-800-424-9300 International: (703) 527-3887

2. COMPOSITION/INFORMATION ON INGREDIENTS

Components	CAS-No	ACGIH (TWA mg/m³):	OSHA (TWA mg/m³):
Synthetic hydrocarbon oil		None	None
Barium complex soap		None	None

3. HAZARDS IDENTIFICATION

Properties affecting health: Harmful if swallowed

Principle routes of exposure: Skin.

Skin contact: Substance may cause slight skin irritation.

Eye contact: Contact with eyes may cause irritation.

Inhalation: Vapors and/or aerosols which may be formed at elevated temperatures may be irritating to eyes and respiratory tract.

Ingestion: Harmful if swallowed. Ingestion may cause gastrointestinal irritation, nausea, vomiting and diarrhoea

4. FIRST AID MEASURES

General advice: If symptoms persist, call a physician.

Skin contact: Rinse with plenty of water. If skin irritation persists, call a physician.

Inhalation: Move to fresh air in case of accidental inhalation of fumes from overheating or combustion. If symptoms persist, call a physician.

Eye contact:	Flush eye with water for 15 minutes. If symptoms persist, call a physician.
Ingestion:	Do not induce vomiting. Consult a physician.
Notes to physician:	Treat symptomatically.

5. FIRE-FIGHTING MEASURES

Suitable extinguishing media:
Carbon dioxide (CO2), Dry chemical, Dry sand, Water spray mist or foam

Extinguishing media which must not be used for safety reasons:
Do not use a solid water stream as it may scatter and spread fire.

Special protective equipment for firefighters:
In the event of fire and/or explosion do not breathe fumes. In the event of fire, wear self-contained breathing apparatus. Standard procedure for chemical fires.

Specific hazards:	Burning produces irritant fumes In the event of fire and/or explosion do not breathe fumes
Unusual hazards:	No hazards resulting from the material as supplied
Specific methods:	Water mist may be used to cool closed containers. Standard procedure for chemical fires.
Flash point:	Not applicable.
Autoignition temperature:	Not determined..
Flammability Limits in Air:	
Lower	No information available
Upper	No information available

6. ACCIDENTAL RELEASE MEASURES

Personal precautions:	Contaminated surfaces will be extremely slippery. Avoid contact with skin, eyes and clothing. Wear personal protective equipment.
Environmental precautions:	Prevent further leakage or spillage if safe to do so. Do not allow material to contaminate ground water system. Prevent product from entering drains.
Methods for cleaning up:	Scrape-up. Pick up and transfer to properly labelled containers. Clean contaminated surface thoroughly.

7. HANDLING AND STORAGE

Handling

Technical measures/precautions:	No special technical protective measures required.
Safe handling advice:	Spilling onto the container`s outside will make container slippery. Avoid contact with skin, eyes and clothing. Handle in accordance with good industrial hygiene and safety practice.

Storage

Technical measures/storage conditions:	Keep containers tightly closed in a dry, cool and well-ventilated place. Keep away from open flames, hot surfaces and sources of ignition. Keep in properly labelled containers. Keep out of reach of children.
Incompatible products:	Oxidising and spontaneously flammable products.

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

8. EXPOSURE CONTROLS / PERSONAL PROTECTION

Engineering measures to reduce exposure:
Ensure adequate ventilation, especially in confined areas..

Personal Protective Equipment

Respiratory protection:	No personal respiratory protective equipment normally required.
Hand protection:	Preventive skin protection
Skin and body protection:	Usual safety precautions while handling the product will provide adequate protection against this potential effect..
Eye protection:	Avoid contact with eyes..
Hygiene measures:	Avoid contact with skin, eyes and clothing.

9. PHYSICAL AND CHEMICAL PROPERTIES

Physical State:	Grease	**Appearance:**	Paste
Color:	Beige	**Odor:**	Not significant
Specific gravity:	~ 0.96	**Boiling point/range**	No information available
Evaporation rate:	Not determined	**Vapor density:**	Not determined
Vapor pressure:	Not determined	**Solubility:**	Insoluble.

10. STABILITY AND REACTIVITY

Stability:	No hazards to be especially mentioned
Polymerization:	Hazardous polymerisation does not occur.
Hazardous decomposition products:	None under normal use
Materials to avoid:	Strong oxidising agents.
Conditions to avoid:	Heat, flames and sparks..

11. TOXICOLOGICAL INFORMATION

Acute toxicity: No data available

12. ECOLOGICAL INFORMATION

Mobility: No information available.

Bioaccumulative potential: No information available.

Ecotoxicity effects: No data available.

Aquatic toxicity: No information available

13. DISPOSAL CONSIDERATIONS

Waste from residues / unused products: In accordance with local and national regulations.

Contaminated packaging: Empty containers should be taken for local recycling, recovery or waste disposal

14. TRANSPORT INFORMATION

DOT

Proper shipping name: Not regulated by DOT

TDG (Canada)

14. TRANSPORT INFORMATION

IMO / IMDG

ICAO

IATA

15. REGULATORY INFORMATION

TSCA

TSCA: Listed in TSCA

U.S. Regulations:

Barium complex soap
SARA 313 Threshold: Barium compound (25 - 35%)

Sara (311, 312) hazard class:

Canada
WHMIS hazard class:
Non-controlled

16. OTHER INFORMATION

NFPA	**Health:**	1	**Flammability:**	1	**Instability:**	0
HMIS	**Health:**	1	**Flammability:**	1	**Physical Hazard:**	0

Reason for revision: Not applicable
Prepared by: Health & Safety

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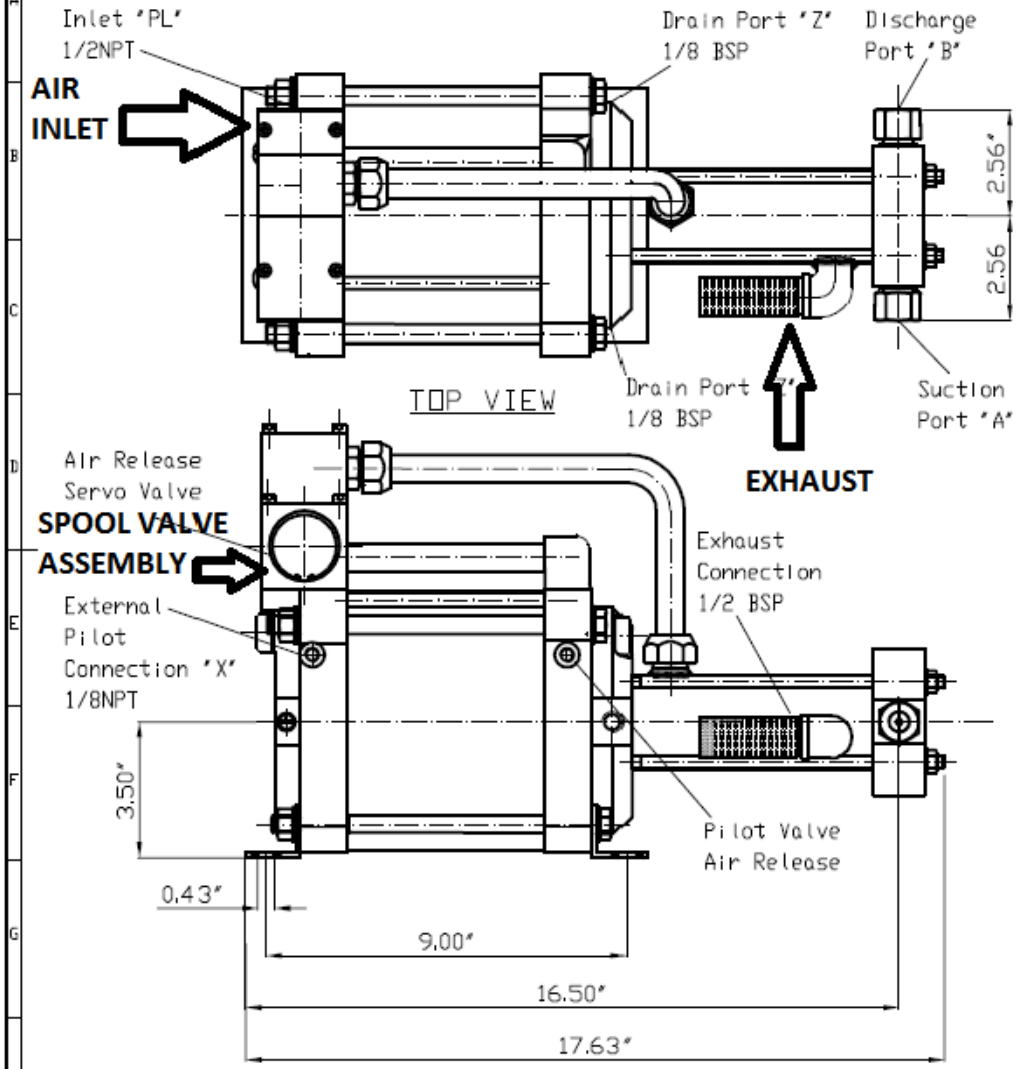
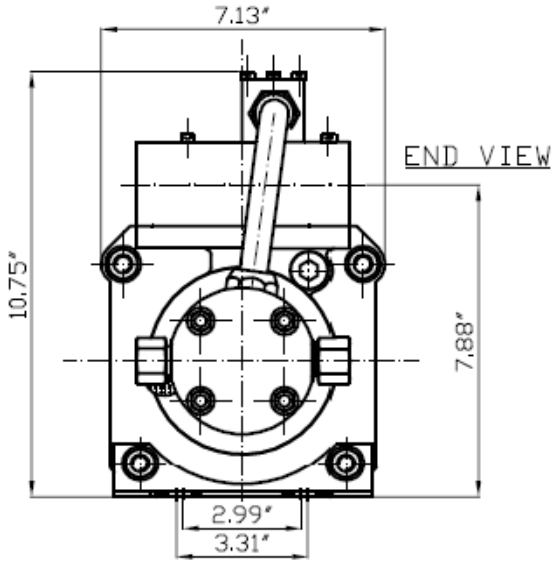
MAXIMATOR Booster - Type: DLE 15 - 1, DLE 30 - 1 & DLE 75 - 1



High Pressure
Drain Port
Z1

Air Drive
Drain Port
Z2

ATTENTION !
Dimension of suction-/discharge port sets to the pump model.



US - representative:
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Tel (814) 838 - 1416
Fax (814) 838 - 2730

MAXIMATOR®
Schlick, Kranz & Co GmbH
D-37449 Zorge / Südharz

Maßstab 1:2 | Gewicht

Arrangement Drawing !

(Benennung)
MAXIMATOR - Booster
Type: DLE 15 (30; 75) - 1

(Zeichnungsnummer)
VP 16.00.153.05

(Artikel-Nr.)
3250.XXXX

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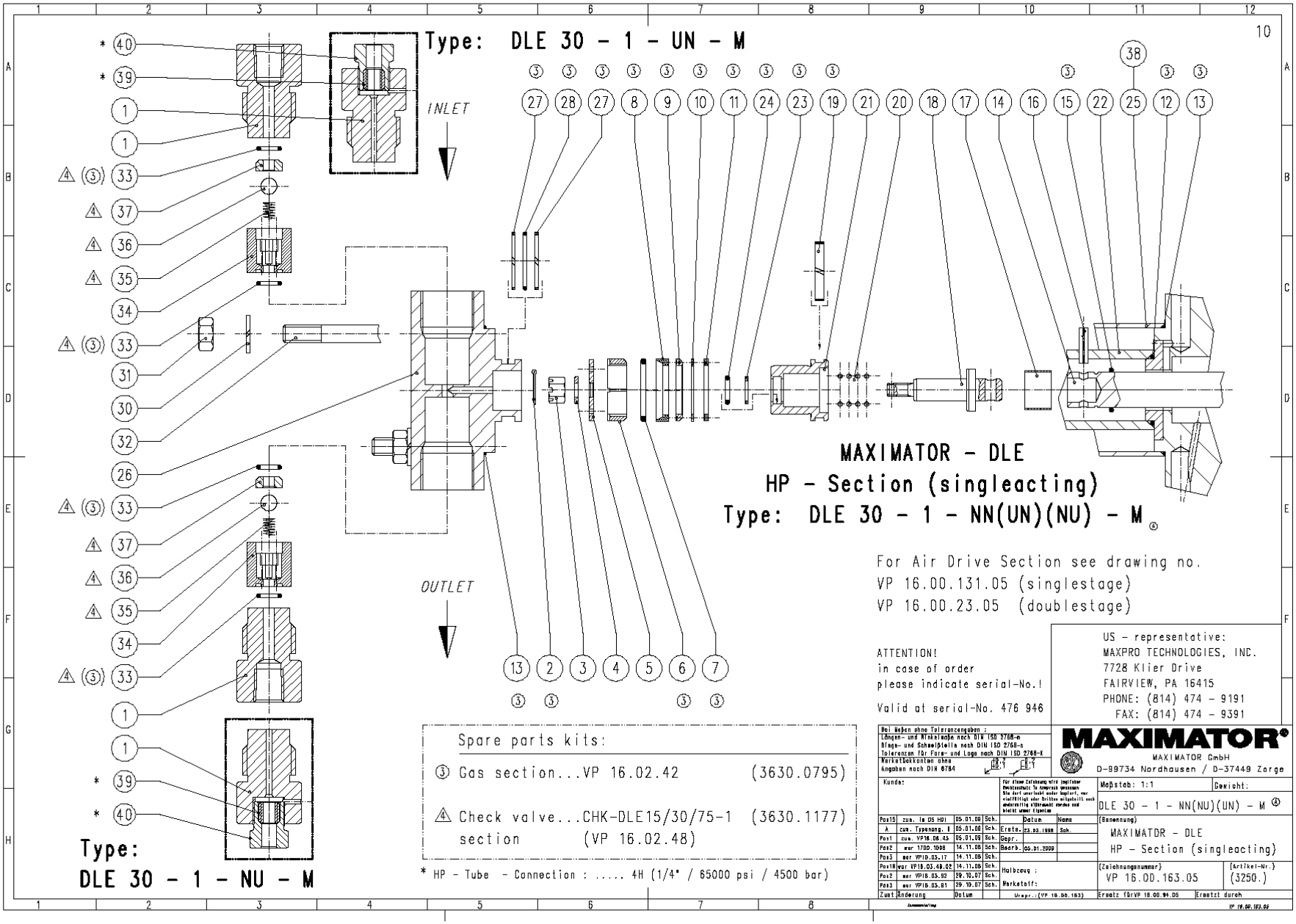

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Technische Änderungen vorbehalten

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MAXIMATOR. GmbH
05.01.2009 VP 16.00.163.05 Seite: 1 / 3

:Pos	:Anz:	Benennung : Artikel-Nr	:Zeichnungs-Nr	: Bemerkung
:1	: 2	:Retaining gland :3630.0824	:VP 16.06.38	:9/16-18UNF
:1	: 2	:Retaining gland :3630.0944	:VP 16.06.43	:1/4NPT
:2	: 1	:Cotter pin :3630.0271	:VP 16.03.92	:
:3	: 1	:Castle nut :3630.0270	:VP 16.03.91	:
:4	: 1	:Washer :3630.0268	:VP 16.03.89	:
:5	: 1	:Washer :3630.0232	:VP 16.03.54	:DLE 30
:6	: 1	:Spacer :3630.0230	:VP 16.03.52	:DLE 30
:7	: 1	:O-ring :3660.0535	:OR 90.23.99.03	:
:8	: 1	:Seal :3630.0231	:VP 16.03.53	:DLE 30
:9	: 1	:Back up :3630.0238	:VP 16.03.60	:DLE 30
:10	: 1	:Seal :3630.0240	:VP 16.03.62	:DLE 30
:11	: 1	:Back up :3630.0239	:VP 16.03.61	:DLE 30
:12	: 1	:O-ring :3660.0268	:OR 75.02.32.03	:
:13	: 2	:O-ring :3660.0217	:OR 70.55.15.01	:
:14	: 1	:Plunger :3630.0244	:VP 16.03.66	:
:15	: 1	:O-ring :3660.0109	:OR 70.01.42.01	:
:16	: 1	:Roll pin :3630.0272	:VP 16.03.93	:
:17	: 1	:Sleeve :3630.0233	:VP 16.03.55	:

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:Pos	:Anz:	Benennung : Artikel-Nr	:Zeichnungs-Nr	: Bemerkung
:18	: 1	:Center plunger :3630.0227	:VP 16.03.49	:DLE 15. DLE 30
:19	: 1	:Bushing :3630.0196	:VP 16.03.20	:
:20	: 1	:Spring :3630.0237	:VP 16.03.59	:
:21	: 1	:Piston head :3630.0228	:VP 16.03.50	:DLE 30
:22	: 1	:Gas cylinder :3630.0618	:VP 16.05.10.01	:DLE 30
:23	: 1	:Back up :3630.0195	:VP 16.03.19	:DLE ...
:24	: 1	:O-ring :3660.0401	:OR 75.21.25.03	:
:25	: 1	:Cooling barrel cplt. :3630.0334	:VP 16.05.02	:DLE 15(30)(75) - 1
:26	: 1	:Check body :3630.0799	:VP 16.05.71	:DLE 30
:27	: 2	:Back up :3630.0350	:VP 16.05.14	:DLE 30
:28	: 1	:O-ring :3660.0339	:OR 75.11.92.03	:
:30	: 4	:Spring washer :3630.0298	:VP 16.04.09	:
:31	: 4	:Nut :3630.0299	:VP 16.04.10	:
:32	: 4	:Tie rod :3630.0294	:VP 16.04.05	:
:33	: 4	:O-ring :3660.0616	:OR 75.08.39.03	:
:34	: 2	:Spacer :3630.0801	:VP 16.06.37	:
:35	: 2	:Spring :3610.1186	:VP 10.17.35	:
:36	: 2	:Ball :3630.0872	:VP 16.06.35.01	:

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:Pos	:Anz	: Benennung : Artikel-Nr	:Zeichnungs-Nr	: Bemerkung
:37	: 2	:Seat :3610.1188	:VP 10.17.37	:
:38	: 1	:Muffler :3630.0878	:VP 16.01.04.01	:
:39	: 2	:Collar 65C4H :3780.0306	:HP 007.01.E.01	:65000 psi / 4500 bar
:40	: 2	:Gland 65G4H :3780.0312	:HP 001.01.E.01	:65000 psi / 4500 bar

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MAXPRO Änderungsprotokoll
MAXPRO Record of changes

Typ: **Type:**	DLE 30-1-NN(UN)(NU)-M (HP – section)
Zeichnungs-Nr.: **Drawing-No.**	VP 16.00.163.05
Artikel-Nr.: **Ident-No.**	(3250.)
Änderungsdatum: **Date of change**	05.01.2009
Änderungshinweise: **Change directions**	- Pos1 zus. Einlaßverschraubung 1/4NPT VP16.06.43 (3630.0944) **> Neuer MAXPRO-Standard für DLE 30 - Anschlüsse !** - Index A zus. Typenangabe DLE 30-1-NN(UN)(NU)-M - Pos15 O-Ring OR70.01.42.01 (3660.0109) Zus. Im Dichtsatz HD-Teil VP16.02.42 (3630.0795). - Item1 Additional Retaining gland 1/4NPT VP16.06.43 (3630.0944) **> New MAXPRO – Standard for DLE 30 – connections !** - Rev. A additional Booster types DLE 30-1-NN(UN)(NU)-M - Item 15 O-Ring OR70.01.42.01 (3660.0109). additional in the seal kit Gas Sec. VP16.02.42 (3630.0795)

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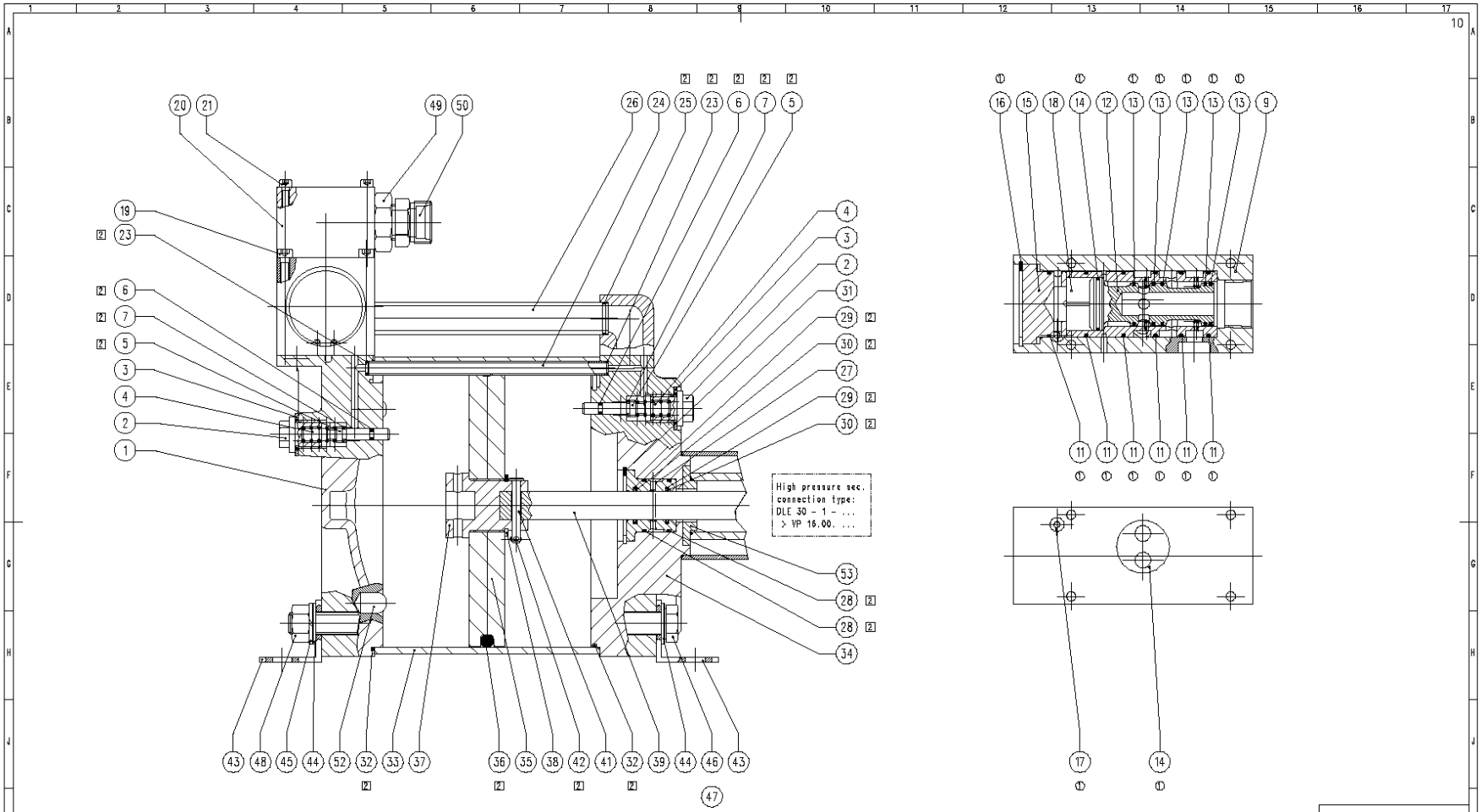

Spare parts kits:

①	Spool.....VP 15.01.00.02	(3620.1523)
②	Air drive section...VP 16.08.00	(3630.0447)

MAXIMATOR
Air drive section
(singleacting / singlestage)
Type: DLE 30 - 1

in case of order please indicate serial-No. !

Valid at serial-No. 278 961

US - representative:
MAXPRO TECHNOLOGIES, INC.
7728 klier Drive
FAIRVIEW, PA 16415
PHONE: (814) 474 - 9191
FAX: (814) 474 - 9391

MAXIMATOR
MAXIMATOR GmbH
D-98734 Nordhausen / D-37449 Zorge

Maßstab: 1:1 | Gewicht:

DLE 30 - 1

(Benennung)
MAXIMATOR Gas - Booster
(singleacting / singlestage)

(Zeichnungsnummer) VP 16.00.131.05 | (Artikel-Nr.) (3250.)

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Technische Änderungen vorbehalten

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MAXIMATOR. GmbH
17.03.2005 VP 16.00.131.05 Seite: 1 / 3

:Pos	:Anz:	Benennung : Artikel-Nr	:Zeichnungs-Nr	: Bemerkung
:1	: 1	:Top cap :3620.4118	:VP 15.13.112.01	:w. 1/8NPT - leak con.
:2	: 2	:Pilot screw :3620.0129	:VP 15.02.03	:
:3	: 2	:Gasket :3620.0131	:VP 15.02.04	:
:4	: 2	:Spring :3620.0132	:VP 15.02.05	:
:5	: 2	:Pilot tappet :3620.4087	:VP 15.02.52	:
:6	: 2	:O-ring :3660.1006	:	:
:7	: 2	:Seal :3610.3181	:VP 10.02.48	:
:9	: 1	:Spool housing :3620.1527	:VP 15.01.03.06	:1/2NPT
:11	: 6	:O-ring :3660.0122	:OR 70.02.62.01	:
:12	: 1	:Spool :3620.0104	:VP 15.01.02	:
:13	: 5	:O-ring :3660.0519	:OR 80.22.29.01	:
:14	: 2	:O-ring :3660.0119	:OR 70.02.32.01	:
:15	: 1	:Spool plug :3620.0108	:VP 15.01.04	:
:16	: 1	:Snap ring :3620.0113	:VP 15.01.09	:
:17	: 1	:O-ring :3660.0103	:OR 70.00.82.01	:
:18	: 1	:Spool sleeve :3620.0103	:VP 15.01.01	:
:19	: 4	:Head socket screw :3620.0111	:VP 15.01.07	:
:20	: 1	:Muffler block :3620.0114	:VP 15.01.10	:

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:Pos	:Anz: Benennung : Artikel-Nr	:Zeichnungs-Nr	: Bemerkung
:21	: 3	:Head socket screw :3620.0117	: :VP 15.01.11
:23	: 2	:O-ring :3660.0104	: :OR 70.00.92.01
:24	: 1	:Pressure tube :3630.0291	: :VP 16.04.03
:25	: 2	:O-ring :3660.0184	: :OR 70.16.125.01
:26	: 1	:Air tube :3630.0290	: :VP 16.04.02
:27	: 1	:Separation sleeve :3630.0395	: :VP 16.06.01
:28	: 2	:O-ring :3660.0118	: :OR 70.02.22.01
:29	: 2	:O-ring :3660.0112	: :OR 70.01.72.01
:30	: 2	:Gasket :3630.0406	: :VP 16.06.07
:31	: 1	:Snap ring :3630.0407	: :VP 16.06.08
:32	: 2	:O-ring :3660.0181	: :OR 70.155.20.01
:33	: 1	:Air cylinder :3630.0666	: :VP 16.03.105.01
:34	: 1	:Bottom cap :3630.1550	:DLE ... w. 1/8NPT leak con. ! :VP 16.04.116.05
:35	: 1	:Air piston :3630.0167	:only w. item 37 ! :VP 16.03.01
:36	: 1	:O-ring :3660.0216	: :OR 70.43.72.01
:37	: 1	:Plunger gland :3630.0173	:only w. item 35 ! :VP 16.03.04
:38	: 1	:Snap ring :3630.0190	: :VP 16.03.14
:39	: 1	:Piston rod :CON. HIGH PRESSURE SEC. DRAWING	:

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Pos	Anz	Benennung / Artikel-Nr	Zeichnungs-Nr	Bemerkung
41	1	Pin 3630.0191	VP 16.03.15	
42	1	Cotter pin 3630.0193	VP 16.03.17	
43	2	Mounting bracket 3620.0289	VP 15.04.18	
44	4	U-Washer 3620.0275	VP 15.04.05	
45	4	Spring washer 3620.0276	VP 15.04.05.01	
46	3	Hex head screw 3630.0292	VP 16.04.04	
47	1	Hex head screw 3630.0293	VP 16.04.04.01	
48	4	Nut 3620.0274	VP 15.04.04	
49	1	Reducer 3630.0372	VP 16.05.38	
50	1	Adapter 3630.0371	VP 16.05.37	
52	3	Damper 3610.0499	VP 10.07.01	
53	1	Distance washer 3620.1443	VP 16.07.14	DLE 30

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MAXPRO Änderungsprotokoll
MAXPRO Record of changes

Typ: **Type:**	DLE 30 – 1 (Air drive section)
Zeichnungs-Nr.: **Drawing-No.**	VP 16.00.131.05
Artikel-Nr.: **Ident-No.**	(3250.)
Änderungsdatum: **Date of change**	17.03.2005
Änderungshinweise: **Change directions**	- Pos42 Splint VP 16.03.17 (3630.0193) 1Stk. In Dichtsatz Luftantrieb VP 16.08.00 (3630.0447) eingepflegt. - Item42 Cotter pin VP 16.03.17 (3630.0193) 1pc. additional contained in the air drive section seal kit VP 16.08.00 (3630.0447).

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TRONAIR®

APPENDIX II

Tescom
44-100 Series Regulator Operator & Service Instructions

Piston Sensed Pressure Reducing Regulators
Operator & Service Manual

Safety, Installation & Operation Precautions

Cleaning Notice

OPERATION AND SERVICE INSTRUCTIONS FOR

TESCOM CORPORATION

REGULATOR 44-1100 SERIES

GENERAL

The TESCOM 44-1100 SERIES REGULATOR is a self-contained direct-acting, spring loaded pressure reducing regulator. This unit incorporates a piston sensor with integral, adjustable vent valve. The regulator utilizes a soft-seated main valve to provide bubble tight service for dead end applications. The adjusting mechanism is designed with high-load needle bearings to produce excellent setting sensitivity while maintaining a low-operating torque of approximately 40 in.-lbs. (.46 cm-kg.).

MATERIALS

Standard materials of contruction are as follows:

BODY and BONNET . BRASS or 303 SST

MAIN VALVE TRIM and SENSOR ASSEMBLY ..... 300 SERIES STAINLESS STEEL

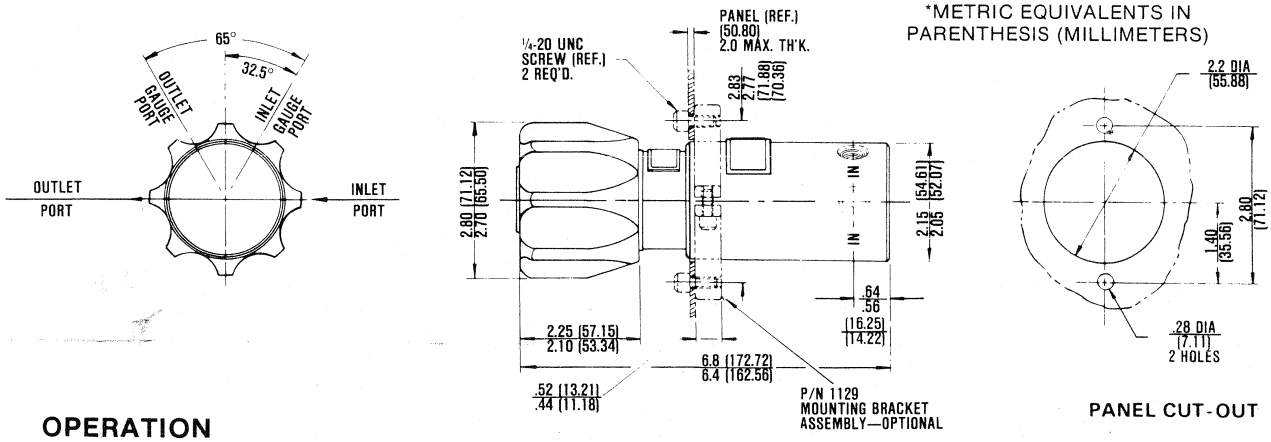
SEALS & BACK-UP RINGS ..... BUNA-N & TEFLON®

SEAT VENT VALVE ..... KEL-F-81®

SEAT MAIN VALVE ..... VESPEL®

ENVELOPE DIMENSIONS

*METRIC EQUIVALENTS IN PARENTHESIS (MILLIMETERS)



OPERATION

Control pressure settings are obtained in the TESCOM 44-1100 SERIES REGULATOR by adjusting the control knob. Pressure INCREASES are made by a CLOCKWISE rotation while a DECREASE is obtained by a COUNTERCLOCKWISE adjustment. All final adjustments should be made in the "INCREASE" direction in order to insure the most accurate set point. The venting action of the regulator can be accomplished by approximately one-half turn in the "DECREASE" direction from the set point, if venting does not occur within the half turn see VENT VALVE ADJUSTMENT procedure in the MAINTENANCE SECTION.

These regulators will operate using any media which is compatible with the wetted parts. The units are equipped with an internal filter; however, if excessive dirt is a problem, a larger filter should be provided on the supply side of the regulator. When using a gaseous media, it is necessary that all moisture be removed since "icing" will occur at the high expansion ratios during the regulation process.

UNDER NO CIRCUMSTANCE SHOULD THESE REGULATORS BE USED WITH OXYGEN, WITHOUT BOTH THE REGULATOR AND THE ASSOCIATED SYSTEM, BEING PROPERLY CLEANED FOR OXYGEN SERVICE.

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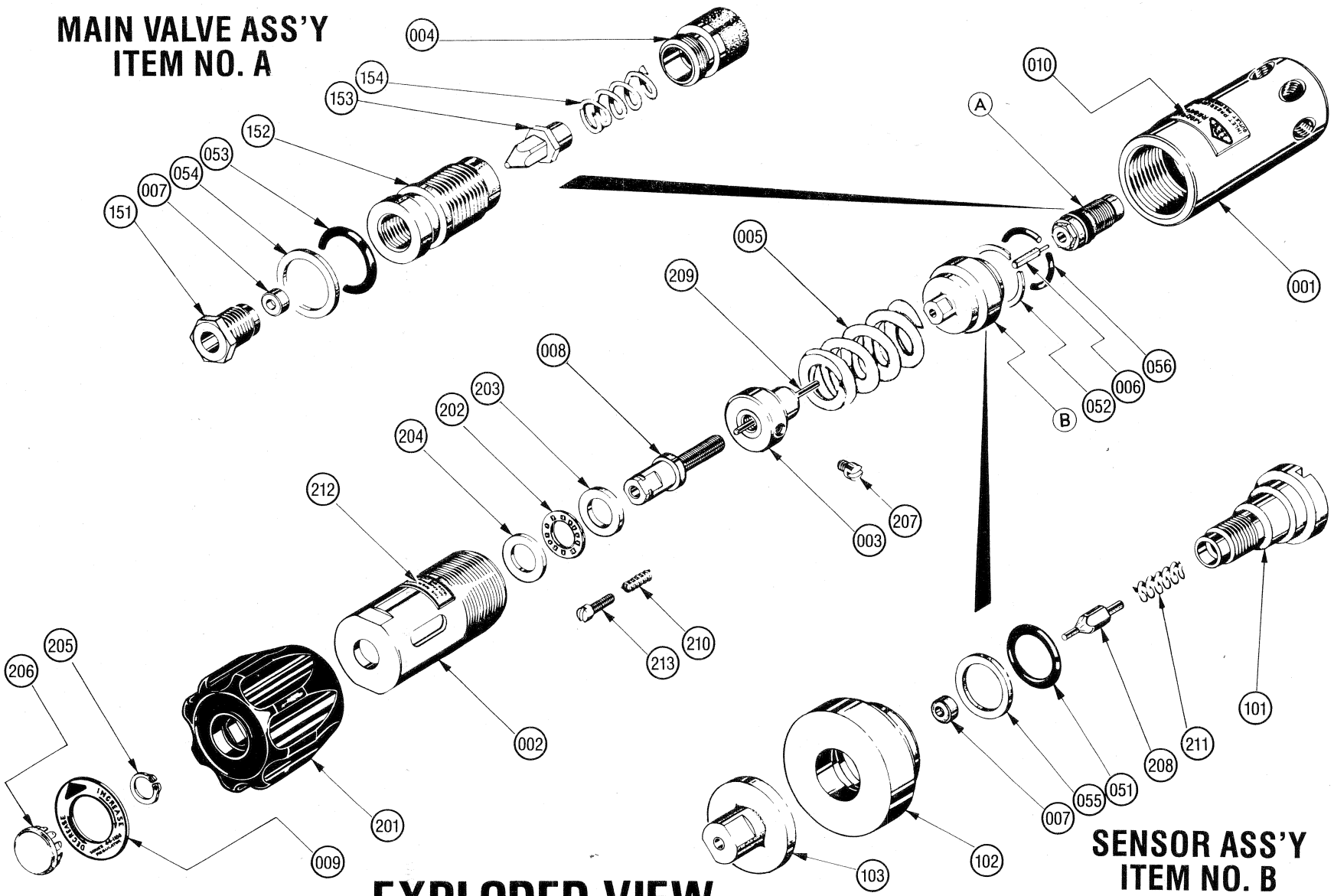
Kel-F-81 is a registered trademark of 3M



EXPLODED VIEW
44- 1100 SERIES

MAINTENANCE

REPAIR KITS: Basic Models only.

Standard Repair Kit ..... P/N 389-1449
(metallic & non-metallic parts)

Non-Metallic Spare Parts Kit . P/N 389-1275

RECOMMENDED TOOLS

Tools necessary for complete Regulator disassembly are listed below. All are standard.

Screwdriver, 3/16" blade
Screwdriver, 1/2" blade
Wrench, 1-5/8" open end
Wrench 1/2" open end
Wrench, 1/2" socket
Pliers, snap ring
Pliers

VENT VALVE ADJUSTMENT

The Vent Valve is set at the factory during assembly and usually will not need adjustment. If adjustment becomes necessary, it may be done in the following manner:

Remove Hole Plug (206); turn some pressure on the outlet of the Regulator; turn Screw (213) clockwise until gas can be heard escaping through Relief Valve; back Screw off until gas flow stops.

SERVICE PROCEDURE

The Regulator may be serviced for O-Ring, Seat and Seal replacement without removal from the line. The following steps outline the basic disassembly operations necessary to repair the majority of all malfunctions.:

1. Remove Plug (206) with screwdriver.
2. Using external snap-ring pliers, remove Snap Ring (205) and Control Knob (201).
3. With 1-5/8 open-end wrench, remove Bonnet by turning counterclockwise. (Note: Spring (005) and Vent Rod (209) are free and may fall if care is not taken.)
4. Remove Sensor Assembly (B) with pliers if necessary.
5. Remove Main Valve Assembly (A) with 1/2" socket wrench.

The following paragraphs describe the procedures for the servicing of the individual subassemblies.

SENSOR DISASSEMBLY

Step 1: Unscrew Spring Pad (103) from Sensor (101) using a 1/2" open-end wrench or a vise jaw to hold Spring Pad (103) and a 1/2" wide screwdriver (or a 1" open-end wrench, depending upon Sensor) to loosen Sensor (101). Sensor and Sensor back-up are then merely pushed apart.

Step 2: To expose Relief Valve (208) and Relief Valve Spring (211) it is necessary to forcefully remove Relief Valve Seat (007) which quite possibly will cause permanent damage to this Seat and require its replacement. The removal can be made with any sharp-pointed instrument.

SENSOR REASSEMBLY

Step 1: If Sensor O-Ring requires lubricant apply Krytox 240 AC or other suitable non-hydrocarbon grease.

Step 2: Reassemble O-Ring (051), Back-up Ring (055), Sensor Back-up (102) and Sensor (101).

Step 3: If Seat (007) has been removed, put Spring (211) and Valve (208) into Sensor. Place new Seat—with chamfer toward Valve Stem into Sensor.

Step 4: Hold both members in a vertical position carefully thread Spring Pad (103) onto Sensor (101) and tighten. Recommended maximum torque is 75-90 in. lbs.

MAIN VALVE DISASSEMBLY

Step 1: Clamp Valve Body (152) in smooth jawed vise or hold with pliers. Clamping is dfone on shoulders that hold O-Ring (053) and Back-up Ring (054). If pliers are used, a protecting cover should be placed over jaws. Remove Seat Retainer (151) with 1/2" wrench—left hand thread.

Step 2: To remove Spring (154) and Main Valve (153), unscrew Filter Assembly (004) from Body (152). This is a finger-tight engagement.

Step 3: Remove Seat (007) with a sharp-pointed tool.

MAIN VALVE REASSEMBLY

Step 1: Install new Seat (007) in Retainer (151) with chamfer of Seat toward Valve (153).

Step 2: Seat Retainer (151) is replaced and tightened to a recommended 100-110 in.-lbs.

Step 3: Replace Valve Spring (154) and Filter Assembly (004).

ADJUSTING SCREW (008) SERVICING

If the Adjusting Screw (008) or Spring Cap (003) should need lubrication or replacement, the following procedure may be followed:

Step 1: Refer to SERVICE PROCEDURE steps 1 through 4.

Step 2: Remove Screw (207) and the Adjusting Screw Assembly and Thrust Bearing (202) will drop out.

Step 3: Lubricate and reassemble, paying attention to Step 4 of the REASSEMBLY OF MAJOR SUBASSEMBLIES SECTION.

PARTS LIST

ITEM NO.	DESCRIPTION	NO. REQ'D.	BASIC MODEL NUMBERS					
			44-1111-24 44-1121-24	44-1112-24 44-1122-24	44-1113-24 44-1123-24	44-1114-24 44-1124-24	44-1115-24 44-1125-24	44-1116-24 44-1126-24
206	PLUG, BUTTON	1	5432	5432	5432	5432	5432	5432
205	RING, RETAINING	1	5427	5427	5427	5427	5427	5427
212	LABEL, VENT	1	5153	5153	5153	5153	5153	5153
204	WASHER, THRUST	1	5426	5426	5426	5426	5426	5426
202	BEARING, THRUST	1	5424	5424	5424	5424	5424	5424
203	WASHER, THRUST	1	5425	5425	5425	5425	5425	5425
008	SCREW, ADJUSTING	1	5947-1	5947-1	5947-1	5947-1	5947-1	5947-1
209	ROD, VENT VALVE	1	5948-2	5948-2	5948-2	5948-2	5948-2	5948-2
005	SPRING, LOAD	1	1049	1050	1051	1051	1050	1051
A	ASS'Y., MAIN VALVE	1	1010-100	1010-100	1010-100	1010-100	1010-100	1010-100
	Consists of:	1	1010-200	1010-200	1010-200	1010-200	1010-200	1010-200
151	RETAINER, SEAT	1	1035-2	1035-2	1035-2	1035-2	1035-2	1035-2
007	SEAT, MAIN VALVE	1	1036-7	1036-7	1036-7	1036-7	1036-7	1036-7
054	RING, BACK-UP	1	5475-113	5475-113	5475-113	5475-113	5475-113	5475-113
053	O-RING	1	5200-001137	5200-001137	5200-001137	5200-001137	5200-001137	5200-001137
152	BODY, MAIN VALVE	1	1038-2	1038-2	1038-2	1038-2	1038-2	1038-2
153	VALVE, MAIN	1	1037-2	1037-2	1037-2	1037-2	1037-2	1037-2
154	SPRING	1	1437	1437	1437	1437	1437	1437
004	ASS'Y., FILTER	1	1011	1011	1011	1011	1011	1011
004	ASS'Y., FILTER	1	6666	6666	6666	6666	6666	6666

010	PLATE, DATA	Brass	1	5728-4	5728-5	5728-6	5728-7	5728-8	5728-9
		SST.		5728-11	5728-12	5728-13	5728-14	5728-15	5728-16
001	BODY, REGULATOR								
		Brass	1	5950-2411	5950-2411	5950-2411	5950-2411	5950-2411	5950-2411
		SST.		5950-2421	5950-2421	5950-2421	5950-2421	5950-2421	5950-2421
056	O—RING		1	5200-001227	5200-001227	5200-001227	5200-001227	5200-001227	5200-001227
006	CONNECTOR		1	1034-2	1034-2	1034-2	1034-2	1034-2	1034-2
052	RING, BACK-UP		1	NONE	NONE	NONE	5476-11220	5476-11220	5476-11220
B	ASS'Y., SENSOR		1	1009-20	1009-20	1009-20	1008-20	1007-20	1007-20
	Consists of:								
103	Pad, Spring		1	1021-1	1021-1	1021-1	1021-1	1021-1	1021-1
102	BACK-UP, SENSOR		1	1033-2	1033-2	1033-2	1032-2	1031-2	1031-2
007	SEAT, VENT VALVE		1	1036	1036	1036	1036	1036	1036
055	RING, BACK-UP		1	NONE	NONE	NONE	5475-116	5475-014	5475-014
051	O-RING		1	5200-001209	5200-001209	5200-001209	5200-001167	5200-000147	5200-000147
208	VALVE, VENT		1	1023-2	1023-2	1023-2	1023-2	1023-2	1023-2
211	SPRING		1	1022	1022	1022	1022	1022	1022
101	SENSOR		1	1027-2	1027-2	1027-2	1026-2	1025-2	1025-2
207	SCREW, LIMIT		1	5401-21088	5401-21088	5401-21088	5401-21088	5401-21088	5401-21088
003	ASS'Y., SPRING CAP		1	1130-3	1130-3	1130-3	1130-3	1130-3	1130-3
210	SPRING		1	2776	2776	2776	2776	2776	2776
213	SCREW		1	5401-14288	5401-14288	5401-14288	5401-14288	5401-14288	5401-14288
002	BONNET	Brass	1	5945-1	5945-1	5945-1	5945-1	5945-1	5945-1
		SST.		5945-0	5945-0	5945-0	5945-0	5945-0	5945-0
201	HANDKNOB		1	5397-6	5397-6	5397-6	5397-6	5397-6	5397-6
009	PLATE, DATA		1	5435-2	5435-2	5435-2	5435-2	5435-2	5435-2

NOTE: Operation & Service Instructions are applicable for all Basic Models (8 digits) and most Modified Models (11 digits).
The complete Parts List, however, may not be applicable for all Modified Models.
See attached Engineering Modification Drawings for appropriate part numbers.

REASSEMBLY OF MAJOR SUBASSEMBLIES

Reassembly of the major subassemblies if the reverse of steps 1 through 5 of the SERVICE PROCEDURE. The following precautions are to be observed:

Step 1: Sensor O-Ring (052) and Back-up Ring (056) should be on Sensor Assembly.

NOTE: The Back-up Ring is necessary only if regulated pressure is to be in excess of 1500 PSI. (100 bar).

Step 2: If any O-Rings appear dry, lubricate lightly with Krytox 240 AC or other suitable non-hydrocarbon.

Step 3: Screw in Valve Assembly (A) until it bottoms. Hand tighten.

Step 4: When assembling Bonnet to Body, put Load Spring (005) into Bonnet (002).

Relief Valve Rod (209) partially into hole in Adjusting Screw (008). Tighten bonnet to 50 ft.-lbs. torque.

TROUBLE SHOOTING

When performing necessary corrective action in the following operations, refer to the MAINTENANCE section for the necessary procedure.

PROBLEM

The regulated pressure continues to increase after lock-up and without change in Control Knob position.

Possible Cause

1. Valve Seat (007) needs replacement.
2. Sensor Assembly needs cleaning and Seal replacement.

PROBLEM

Continuous leakage through Bonnet with outlet pressure on the Regulator.

Possible Cause

1. Vent Valve needs adjustment.
2. Vent Valve Seat (007) needs replacement.
3. Sensor O-Ring (051) worn and leaking.

PROBLEM

Regulated pressure drops off sharply when flow is within Regulator capabilities.

1. Check inlet Filter (004) and clean if necessary.
2. Main Valve Seat (007) needs replacement.

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PRESSURE CONTROLS DIVISION

(Rev. 4/86) Form No. 1119

OPERATION AND SERVICE MANUAL for TESCOM CORPORATION

Piston Sensed Pressure Reducing Regulators

General
Tescom's piston sensed pressure reducing regulators are specifically engineered for applications requiring dependable pressure regulation. These regulators are especially appropriate for installations where high system pressures (up to 20,000 psi) must be reduced to levels suitable for actuating low pressure (0 to 20,000 psi) instruments and related equipment.

Pressure Activation Methods
Tescom uses three basic types of activation methods. The activation method provides the means by which the operator can set the force that determines the outlet pressure of a regulator

Control Knob: Delivery pressure is increased by turning the control knob. The control knob applies a load through a spring to the piston.

Dome Load: Delivery pressure is increased by applying pressurized gas or liquid to the dome of a regulator at a pressure equal to the outlet pressure desired. This dome pressure is normally provided by a second regulator called the pilot regulator.

Combination Spring and Dome: Delivery pressure is increased by applying a spring force as well as the introduction of pressurized gas or liquid.

Materials of Construction
Standard materials of construction contacting the fluid media can be any of the following:

Regulator Body: 300 Series SST, Brass, Hastelloy®, Monel®, Aluminum
Seats: Teflon®, PCTFE, Vespel®, Peek®, Soft Goods (O-rings & back-up Rings) Teflon®, BUNA-N, Viton A®

Trim: 300 Series SST, Brass, Hastelloy, Monel, Aluminum

The official material of construction and pressure activation method for your pressure reducing regulator depends on series number and modification ordered.

Operation (Control Knob Adjustment)
Controlled outlet pressure settings are obtained using Tescom pressure reducing regulators by adjusting the control knob. Rotating the knob clockwise raises the outlet pressure while a counterclockwise rotation, coupled with venting of the downstream side of the regulator plumbing, lowers the outlet pressure. Final adjustments should be made in the direction of increasing pressure to obtain the most accurate set point.

Tescom regulators will operate with any liquid or gaseous media compatible with the wetted materials. Some series/modifications come with an internal filter that only are designed to stop random contamination resulting from the installation of the regulator. An auxiliary upstream filter is recommended for use in all but the cleanest media. Gaseous media should be free of excessive moisture to prevent icing of the regulator at high flow rates.

WARNING *A REGULATOR IS NOT INTENDED TO BE USED AS A SHUTOFF DEVICE. WHEN THE REGULATOR IS NOT IN USE, THE INLET SUPPLY SHOULD BE TURNED OFF. AS A SAFETY PRECAUTION, A PRESSURE RELIEF DEVICE SHOULD BE INSTALLED DOWNSTREAM OF THE REGULATOR.*

Maintenance

The following procedures are provided to enable the customer to perform all normal maintenance and repair operations. These operations are more easily performed with the regulator removed from the line. However, in some cases repair may be accomplished without removal of the regulator body as long as the inlet and outlet pressure have been vented.

The following steps outline the disassembly of pressure reducing regulators for maintenance and repair. Up-to-date assembly drawings and bills of material are available from the factory.

1. Clamp the regulator in a vise by the flats on the bottom and/or side of the regulator body.

2. Turn control knob and/or spring adjustment mechanism counterclockwise to insure removal of all spring force on the diaphragm.

   NOTE (Dome loaded regulators): All pressurized gas or liquid must be vented from dome before disassembly.

3. Remove upper portion of regulator (bonnet and/or dome). Some models require the mounting bracket to be removed first.

   NOTE: Upper portion of regulator may also include spring button, load spring back-up plate, and piston sensor, etc. Review correct drawing to ensure that all parts have been disassembled.

   NOTE: (Two-Stage Regulator) Tescom Model Series BB-5 is a two-stage regulator that has portions on both ends of the regulator body that must be removed. It is Tescom's recommendation that two-stage regulators be returned to the factory for repair.

Maintenance (continued)

4. The valve parts can now be removed from the regulator body by turning the seat retainer and/or back cap counter-clockwise until it is free of the regulator body.

   

   WARNING *TESCOM MODELS 26-1000 AND 44-1100 VALVE PARTS ARE HELD IN PLACE BY THE USE OF LEFT-HANDED THREADS.*

   NOTE: If necessary, valve seat may be removed from the seat retainer using a sharp instrument.

   CAUTION: When removing valve parts from a regulator that has a back cap, care must be taken to insure the main valve stem remains vertical. If the main valve stem is not removed correctly, parts may remain in the regulator.

5. To disassemble main valve assembly and/or valve, clamp valve in smoothed jaw vice or hold with pliers. Clamping should be done on flats.

   CAUTION: Care must be used to not damage valve. A special fixture may be ordered from the factory to aid in the disassembly of the main valve assembly found in Tescom Regulator Models 26-1000 and 44-1100.

   NOTE: Several of Tescom's regulators are supplied with internal filters. They will be located either in the inlet port or in the main valve area of the regulator. In each case, they should be removed and replaced before reassembly.

Reassembly

The regulator is reassembled in the reverse order of disassembly, observing the following precautions. Please reference the Bill of Material and assembly drawing for the correct location of replacement parts and correct torque specifications.

Reassembly (continued)

1. Inspect all parts and replace those worn or damaged with Tescom replacement parts.

2. All parts should be cleaned to the cleanliness level required for safe operation with the media and system they will be used in. All parts in the flow stream must be free of particles which could prevent proper seating of the main valve.

3. Apply a thin uniform coating of fluorocarbon grease to any or all of the following parts: indentation of spring bottom, threaded portion of adjusting screen, entire threaded area of the bonnet, all O-rings, all threaded parts internal to regulator.

   NOTE: Do NOT apply fluorocarbon grease to any of the inlet or outlet connections.

4. Valve seats must be installed with the chamfered side towards the main valve.

5. Standard Regulator with Control Knobs - The body and bonnet are best joined by holding the bonnet assembly open end up and dropping all required items into place one at a time. The last item to be placed in the body of most all of Tescom regulators is the piston sensor. Place all O-rings and back-up rings that are external to the piston sensor in the body before placing the sensor in place. O-rings should always be installed before back-up rings. The bonnet and body may now be attached. This is best done by holding the body in one hand and the bonnet in the other. Tilt the body at a 45° angle and then attach the bonnet by screwing it into the body firmly, hand tight. Regulator should then be placed in vise and bonnet retorqued to correct specifications. See print.

Reassembly (continued)

6. Dome/Spring Combination and Dome Loaded Regulators are more easily reassembled by holding regulator firmly in vise and reinstalling dome.

7. Self-Venting Regulator - If your regulator has an adjustable relief valve mechanism, it is set on final assembly at the factory and usually will not require further adjustment. If adjustment becomes necessary, use the following procedure after regulator has been installed:

   Step 1. Remove hole plug.
   Step 2. Using control knob, apply 10 to 15 psi on downstream side.
   Step 3. Turn in vent adjusting screw (located under hole plug) until media can be heard escaping through relief valve.
   Step 4. Back off screw until media flow stops, usually 1/2 turn. Replace hole plug.

8. Reinstalling wire mesh inlet filter - Insert filter into primary inlet port. It must then be expanded to fit correctly. This can be accomplished by inserting a metal tool the same size as the port and then lightly tapping it with a hammer.

WARNING *AFTER REGULATOR HAS BEEN REASSEMBLED, IT SHOULD BE CONNECTED TO A PRESSURE SOURCE WITH MEDIA COMPATIBLE WITH THE USE OF THE REGULATOR AND PRESSURIZED TO CHECK FOR INTERNAL AND EXTERNAL LEAKAGE AND OPERATING CHARACTERISTICS.*

PRODUCT WARRANTY

Tescom Corporation ("Tescom") warrants to the initial purchaser ("Initial Purchaser", as defined below) of products manufactured and sold by its Industrial Controls Division ("ICD") and Electronic Controls Division ("ECD") that such products are free from defects in materials and workmanship under normal use and service for a period of 180 days from the date of initial purchase or one year from the date of delivery of the products, whichever comes first ("Warranty Period"). This warranty applies only to the Initial Purchaser, that is someone who purchases products for initial use directly from Tescom, its affiliates or authorized distributors or representatives. This warranty is not transferable to subsequent purchasers or users of the products.

During the Warranty Period, Tescom will, in its sole discretion, repair or replace, free of charge at its factory in Minnesota, any product or part thereof that is found by Tescom, after reasonable notification by the Initial Purchaser, to have been defective in materials or workmanship. The Initial Purchaser must pay all shipping costs for warranty service and is responsible for risk of loss or damage of products during shipment. Tescom does not warrant, and will not pay for, any repairs or replacement made during the Warranty Period by anyone other than personnel authorized by Tescom, ICD or ECD to make such repairs or replacement.

THE ABOVE WARRANTY IS IN LIEU OF ALL OTHER WARRANTIES. TESCOM, ICD AND ECD MAKE NO OTHER EXPRESS OR IMPLIED WARRANTY, AND IN PARTICULAR AND WITHOUT LIMITATION MAKE NO IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR PARTICULAR PURPOSE. The Initial Purchaser's only remedy under this warranty is repair or replacement of the products during the Warranty Period. This warranty does not apply to any product which has been damaged by accident, abuse, misuse, modification or lack of proper maintenance. NEITHER TESCOM, ICD NOR ECD WILL BE LIABLE FOR ANY CONSEQUENTIAL, SPECIAL, INCIDENTAL OR INDIRECT DAMAGES, INCLUDING WITHOUT LIMITATION, LOST PROFITS.

TESCOM
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Safety, Installation, & Operation Precautions

TESCOM
CORPORATION

INDUSTRIAL CONTROLS DIVISION

DO NOT ATTEMPT TO SELECT, INSTALL, USE, OR MAINTAIN THIS REGULATOR, VALVE, OR ACCESSORY UNTIL YOU HAVE READ AND FULLY UNDERSTAND THESE INSTRUCTIONS.

BE SURE THIS INFORMATION REACHES THE OPERATOR AND STAYS WITH THE PRODUCT AFTER INSTALLATION.

DO NOT PERMIT UNTRAINED PERSONS TO INSTALL, USE, OR MAINTAIN THIS REGULATOR, VALVE, OR ACCESSORY.


WARNING

IMPROPER SELECTION, IMPROPER INSTALLATION, IMPROPER MAINTENANCE, MISUSE, OR ABUSE OF REGULATORS, VALVES, OR RELATED ACCESSORIES CAN CAUSE DEATH, SERIOUS INJURY, AND/OR PROPERTY DAMAGE.

Possible consequences include but are not limited to:

- High velocity fluid (gas or liquid) discharge
- Parts ejected at high speed
- Contact with fluids that may be hot, cold, toxic, or otherwise injurious
- Explosion or burning of the fluid
- Lines/hoses whipping dangerously
- Damage or destruction to other components or equipment in the system


WARNING

SAFETY PRECAUTIONS:

1. Inspect the regulator, valve, and accessories before each use.
2. Never connect regulators, valves, or accessories to a supply source having a pressure greater than the maximum rated pressure of the regulator, valve, or accessory.
3. Refer to product label (modification specific) for maximum inlet pressures. If this rated pressure cannot be found, contact your local Tescom representative for the rated pressure prior to installation and use. Verify the designed pressure rating of all equipment (e.g., supply lines, fittings, connections, filters, valves, gauges, etc.) in your system. All must be capable of handling the supply and operating pressure.
4. Clearly establish flow direction of the fluid before installation of regulators, valves, and accessories. It is the responsibility of the user to install the equipment in the correct direction.
5. Do not tighten fittings, gages, or components in pressurized systems.
6. Never turn regulator or valve body. Instead hold regulator or valve body and turn fitting nut.
7. If a regulator or valve leaks or malfunctions, take it out of service immediately.
8. Do not modify equipment or add attachments not approved by the manufacturer.
9. Apply pressure to the system gradually, avoiding a sudden surge of fluid or pressure shock to the equipment in the system.

WARNING SAFETY PRECAUTIONS (Continued):

10. Regulators are not shut-off devices. Install a pressure relief device downstream of the regulator to protect the process equipment from operating pressure increases. Shut off the supply pressure when the regulator is not in use.
11. Periodic inspection and scheduled maintenance of your equipment is required for continued safe operation.
12. The frequency of servicing is the responsibility of the user based on the application.
13. Never allow problems or lack of maintenance to go unreported.
14. Read and follow precautions on compressed gas cylinder labels.
15. It is important that you analyze all aspects of your application and review all available information concerning the product or system. Obtain, read, and understand the Material Safety Data Sheet (MSDS) for each fluid used in your system.
16. Oxygen service requires special expertise and knowledge of system design and material compatibility in order to minimize the potential for death, serious injury, and/or property damage.
17. Never use materials for regulators, valves, or accessories that are not compatible with the fluids being used.
18. Users must test under normal operating conditions to determine suitability of materials in an application.
19. Vent fluids to a safe environment, and in an area away from employees. Be sure that venting and disposal methods are in accordance with Federal, State, and Local requirements. Locate and

WARNING SAFETY PRECAUTIONS (Continued):

construct vent lines to prevent condensation or gas accumulation. Make sure the vent outlet is not obstructed by rain, snow, ice, vegetation, insects, birds, etc. Do not interconnect vent lines; use separate lines if more than one vent is needed.

20. Do not locate regulators, valves, or accessories using flammable fluids near open flames or any other source of ignition.
21. Some fluids when burning do not exhibit a visible flame. Use extreme caution when inspecting and/or servicing systems using flammable fluids to avoid death or serious injury to employees. Provide a device to warn employees of these dangerous conditions.
22. Many gases can cause suffocation. Make certain the area is well ventilated. Provide a device to warn employees of lack of oxygen.
23. Never use oil or grease on these regulators, valves, or accessories. Oil and grease are easily ignited and may combine violently with some fluids under pressure.
24. Have emergency equipment in the area if toxic or flammable fluids are used.
25. Upstream filters are recommended for use with all fluids.
26. Do not bleed system by loosening fittings.
27. Prevent icing of the equipment by removing excess moisture from the gas.
28. Always use proper thread lubricants and sealants on tapered pipe threads.

INSTALLATION

Inspect the regulator, valve, and accessories for physical damage and contamination. Do not connect the regulator, valve, or accessory if you detect oil, grease, or damaged parts. If the regulator, valve, or accessory is damaged, contact your local Tescom representative to have the regulator cleaned or repaired.

WARNING

Make sure that the components and materials used in the fluid handling system are compatible with the fluid and have the proper pressure rating.

REPAIR SERVICE

If a regulator or valve leaks or malfunctions, take it out of service immediately. You must have instructions before doing any maintenance. Do not make any repairs you do not understand. Have qualified personnel make repairs. Return any equipment in need of service to your equipment supplier for evaluation and prompt service. Equipment is restored to the original factory performance specifications, if repairable. There are flat fee repair charges for each standard model. The original equipment warranty applies after a complete overhaul.

WARNING

Safe Component Selection

1. Consider the total system design when selecting a component to ensure safe, trouble-free performance.
2. The user is responsible for assuring all safety and warning requirements of the application are met through his/her own analysis and testing.

WARNING

Safe Component Selection (continued)

3. Tescom may suggest material for use with specific media upon request. Suggestions are based on technical compatibility resources through associations and manufacturers. Tescom does NOT guarantee materials to be compatible with specific media -- THIS IS THE RESPONSIBILITY OF THE USER!
4. Component function, adequate ratings, proper installation, operation, and maintenance are the responsibilities of the system user.

WARNING

Do not modify equipment or add attachments not approved by the manufacturer.

ASSEMBLY/INSTALLATION DRAWINGS & BILLS OF MATERIAL Drawings and parts lists for your product may be obtained by calling the number below. Tescom will provide these by fax or mail. Your local Tescom representative can provide additional assistance.

Call (800) 447 - 1250 for assembly/installation drawings & bills of material. Be sure to have your complete model number ready.

TESCOM
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12616 Industrial Boulevard
Elk River, MN 55330

Form No. 1891 Printed 5/00 40M

FORM 1329

TESCOM
CORPORATION
INDUSTRIAL CONTROLS DIVISION
12616 Industrial Boulevard
Elk River, Minnesota 55330-2491

CAUTION

CLEANING NOTICE

This equipment has been cleaned to a high commercial standard. When installing, care must be taken to prevent unit from becoming contaminated with particles in excess of 50 micron size. Such contamination may cause malfunctioning of the unit.

---Open in a clean area.

---Install in a properly cleaned system.

10M REV. 8/93 PRINTED IN U S A

TRONAIR®

APPENDIX III

Haskel Gas Boosters
excerpt

Haskel®

an Accudyne Industries brand

Pressure on Demand

Pneumatic and Hydraulic Driven Gas Boosters

Why Use a Haskel Gas Booster

Haskel pneumatic and hydraulic driven gas boosters offer a flexible and efficient source for delivering high pressure gases.

Oxygen or High Purity Cleaning: Haskel boosters are noted for their cleanliness and can handle pure gases such as oxygen without risk of any contamination. (Special cleaning required – advise factory.) Haskel's oxygen cleaned products are certified per Mil Spec 1330. Refer to the Knowledge Library Link on the Haskel website, www.haskel.com, for the Oxygen Usage - Best Practice Guide.

Multi-Staging Capability: For higher flow rates and pressures, beyond the capability of a single gas booster, one or more boosters of the same ratio may be plumbed in parallel and then in series with one or more boosters of the same ratio.

High Flow Rates at High Pressures: When high flow rates at high pressures are needed, the booster can charge a receiver to an even higher pressure level, thus storing a volume of gas available for rapid release at a constant pressure through a pressure reducing valve.

Cost Savings: Most industrial gases are commonly delivered at pressures of 2,000 – 2,600 psi in steel cylinders. If the gas is to be used well below the supply pressure, the pressurized supply is easily piped and controlled to the point of use with simple valving. However, if the end use requires the gas to be used at higher pressures than the supply it will have to be boosted. Gas Boosters can utilize all the gas from a supply source such as cylinders, and boost the gas to whatever pressures (and flows) are required by the application; thus utilizing all the gas volume from the supply source.

If the application requires a pressure greater than common supply cylinder pressures, a booster can often be justified not only because of utilization of the gas, but also because it will eliminate the need to purchase the gas in special higher pressure more costly supply cylinders such as 3,600 or 6,000 psi.

Pneumatic Driven Gas Booster Features

- Reliable, easy to maintain, compact and robust
- No heat, flame or spark risk
- Infinitely variable cycling speed and output
- Pneumatic driven models do not require electrical connection
- Easy to apply automatic controls
- No limit or adverse affect to continuous stop/start applications
- Seal systems designed for long working life
- No airline lubricator required
- Hydrocarbon free – separation between air and gas sections
- Pressures to 39,000 psi (2690 bar)
- Built-in cooling (most models)
- Standard & custom systems available
- Suitable for most gases
- Single, double acting, and two-stage models
- Ability to stall at any predetermined pressure and hold the fixed pressure without consuming power or generating heat

Introduction to Pneumatic Driven Gas Boosters

Theory of Operation

Haskel Gas Boosters consist of a large area reciprocating air drive piston directly coupled by a connecting rod to a small area gas piston. The gas piston operates in a high pressure gas barrel section. Each gas barrel end cap contains high pressure inlet and outlet check valves. Varying applications require many different booster and horse power (HP) combinations. Haskel can assist with HP and Cooling requirements and provide circuitry assistance on the following issues: PID Control - review and advisement, electrical control, and heat exchanger recommendations. General HPU recommendations and guidelines are available from Haskel drawing 87100-TAB. The air drive section includes a cycling spool and pilot valves that provide continuous reciprocating action when air is supplied to the air drive inlet. The ratio between the area of the air drive piston and the gas driven piston is indicated by the number in the model description and approximates the maximum pressure the gas booster is capable of generating.

Isolation of the gas compression chambers from the air drive section is provided by three sets of dynamic seals. The intervening two chambers are vented to atmosphere. This design prevents air drive contamination from entering the gas stream.

Cooling is provided by routing the cold exhausted drive air through an individual jacket surrounding the gas barrel.

Check valves also allow for the equalization of upstream and downstream pressure prior to boosting, therefore the gas booster only needs to "raise" the upstream pressure to the required pressure and does not have to raise it from atmospheric pressure.

Operating temperatures for Gas Booster

There are two distinct sections: the air drive section and the gas barrel section.

Air Drive Section- Standard Air Drive Seals should perform reliably within a temperature range of (25°F to 150°F) (-4°C to 65°C). Lower temperatures will cause air/gas leakage; higher temperatures reduce seal life. Haskel recommends a minimum Class 4 air quality per ISO 8573.1 standards. For operation at extremely low temperatures, consult factory.

Gas Barrel Section- Low temperatures normally have little effect on the operation of standard parts and seals. The heat from the compressing gas helps to balance out an acceptable temperature.

Maximum average acceptable temperature 115°C (240°F).

Haskel gas boosters are used for boosting most all commonly available industrial gases. However, the gas should be "Dry Gas", (no moisture content.) Some gases cannot be pumped with standard boosters, e.g. pure Oxygen or Hydrogen. Depending on the gas and application, e.g. Dry Gas Seal applications, some boosters will require special seals, materials of construction, venting, special cleaning and other considerations. Knowing the specific gas is also necessary to determine gas compressibility at the desired pressure. Compressibility is a factor used in calculating flow rates at different pressures or filling times into a vessel.

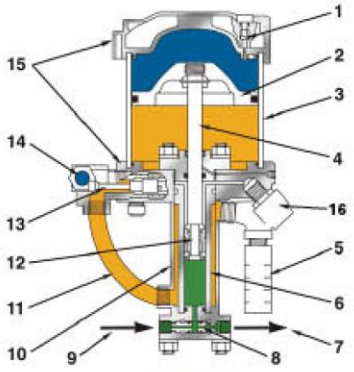


Figure 1

Figure 1: Example of Single Stage, Single acting Booster

1. Pilot Valve
2. Air Piston
3. Air Drive Barrel
4. Connecting Rod
5. Exhaust Muffler
6. High Pressure Barrel
7. Booster Outlet
8. Check Valves
9. Booster Inlet
10. Cooling Jacket
11. Air Exhaust Tube
12. Gas Piston
13. Air Cycling Valve
14. Air Drive Inlet Port
15. Upper & Lower Caps
16. Vent Port Breather

Gas booster compressors are suitable for transfer and pressurization of:

1. Nitrogen (N_2)
2. Helium (He)
3. Breathing Air (N_2O_2)
4. Nitrous Oxide (N_2O)
5. Carbon Dioxide (CO_2)
6. Neon (Ne)
7. Argon (Ar)
8. Sulphur Hexafluoride (SF_6)
9. Oxygen (O_2)*
10. Carbon Monoxide (C)**
11. Hydrogen (H_2)**
12. Methane (CH_4)**
13. Ethylene (C_2H_4)**
14. Deuterium (D_2)**
15. Natural Gas (CH_4)** *(often contains high proportion of CO_2 & N_2)*

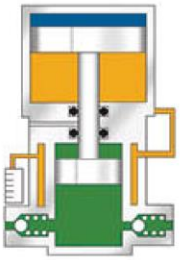
Note: Liquefied gases (propane, CO_2, nitrous oxide, halons, etc.) can be boosted as a liquid or gas in controlled applications.

** Oxygen (O_2)- maximum safe working pressure 345 bar (5000 psi).*

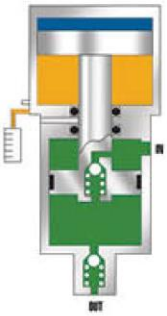
*** For these gases (10-15), the gas booster must be operated in a safe and well ventilated area and vent(s) piped to controlled environment.*

Pneumatic Driven Gas Booster Configurations

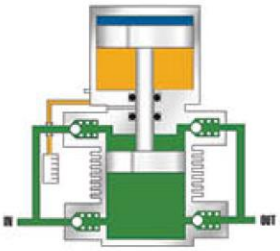
Single acting, single stage boosters are the smallest and lightest with pressures to 39,000 psi.
Double acting, single stage provides twice the delivery of a single acting single stage booster.
Two stage models are used for high gas compression ratios.



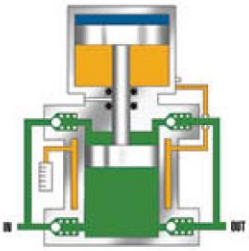
Model AG
Single Stage, Single Acting



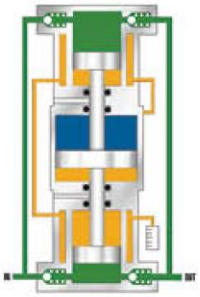
Model AG
Single Stage, Single Acting, Flow Thru Piston



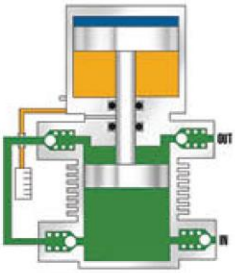
Model AGD
Single Stage, Double Acting, Cooling Fins



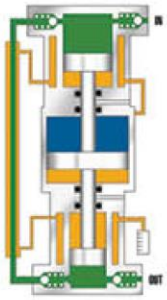
Model AGD-4 (only)
Single Stage, Double Acting, Cooling Jacket



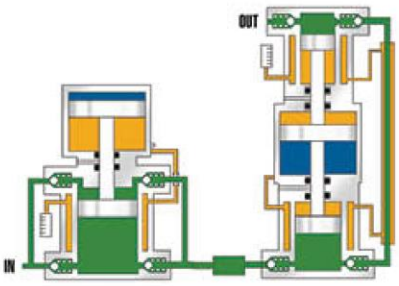
Model AGD
Single Stage, Double Acting, Cooling Jackets



Model AGT
Two Stage, Cooling Fins



Model AGT
Two Stage, Cooling Jackets



Model AGD-4 feeding into Model AGT-x/x

Multi stage - Two boosters. More than one booster of the same ratio may be used for each stage.

Blue=Compressed Air *Yellow=Exhaust Drive Air* *Green=Gas Media*

AG-50 High-ratio gas booster, single stage, single acting

AGD-30 - Medium-ratio gas booster, single stage double acting, single air head

AGT-30/75- Two stage gas booster single air head, cooling jacket

Metric Conversion Table

Multiply	By	To Obtain
PSI	0.0703	Kg/Cm2
SCFM	0.0283	Cu. Meters/min.
Inches	25.4	Millimeters
Pounds	0.453	Kilograms

Selecting a Pneumatic Driven Gas Booster

Air driven gas boosters have seven significant operating parameters that determine their selection for any application. These are as follows:

1. Maximum discharge pressure?
2. Flowrate
   a. Is it constant?
      i. What is flowrate required?
   b. Is it filling a vessel?
      i. What is vessel size (water volume)?
      ii. What is fill time required?
3. Supply
   a. Is it at constant pressure?
   b. Is it decreasing?
      i. What is initial pressure?
      ii. What is the minimum pressure?
4. Air drive pressure available?
5. Air drive volume available?
6. What is the gas?
7. What is the application?

The selection of the proper booster for any application starts with determining which booster "series" will provide the amount of flow and pressure required. The ability of the booster to *generate pressure* is a function of the drive pressure, multiplied by the nominal booster ratio. The ability to *generate flow* is a function of the quantity of air available to drive it, the displacement per cycle of the booster, and volumetric efficiency.

Within each booster series, there are standard materials of construction available. For applications involving aggressive gases, such as Hydrogen, Helium and CO2, some material substitutions are required.

Single Acting Single Stage "AG" boosters provide economical means of boosting pressure for testing or small components and similar applications where volume is small and efficiency is not important. Control of maximum outlet pressure is accomplished with the use of an air drive pressure regulator. Maximum outlet pressure is drive area ratio multiplied by air pressure.

Double Acting Single Stage "AGD" boosters not only pump twice the volume of a Single Acting, Single Stage Booster per cycle, but also require less air drive since the inlet gas pressure is assisting the air drive in each direction, providing a substantial portion of the required driving force. These models provide efficient means of boosting large volumes of gas at low to medium compression ratios. Maximum outlet pressure is drive area ratio times air drive pressure PLUS gas supply pressure.

Two-Stage "AGT" boosters provide efficient means of boosting to a high gas compression ratio since the ratio per stage is low. Maximum outlet pressure with these models is drive area ratio multiplied by air drive pressure plus supply pressure multiplied by the area ratio of the two gas pistons.

Since these models have interconnected gas pistons, they multiply supply pressure during the "interstage" stroke by the area ratio of the two gas pistons. If supply pressure is too high, the booster may have "interstage stall" at an outlet pressure substantially less than that obtainable on the "output" stroke. This limitation does not apply if outlet pressure is less than the "maximum supply" times the area ratio of the two gas pistons. Remember, this condition only applies to two stage models.

Specific performance information for your application may be obtained by referring to the **Sample Performance Chart** on page 8 of this catalog, or from a Haskel distributor. To locate a Haskel distributor near you, view the Distribution link on our website at www.haskel.com, or contact Haskel direct.

Model Number Configuration

8 - AGT - 15/75 - C - 28881

- **8** — Nominal Diameter of Air "Driven" Piston (Inches). Used if diameter is other than 5-3/4" (standard).
- **AGT** — Base Model: AG=Single Stage, Single Acting; AGD=Single Stage, Double Acting; AGT=Two Stage
- **15/75** — Area Ratio – Nominal XXX/XXX (on AGT models) shows nominal area ratio for both first and second stages
- **C** — Air controls Installed: 1. Air Drive Filter 2. Regulator w/gage 3. Shut off/speed control valve
- **28881** — Special Features:

C	Controls: airline filter, reg w/gauge and manual start/stop
C8	On 5-3/4" drive 1/2 NPT
C13	On 8" or 14" drive 3/4 NPT
17800	Electrical stroke counter provision (includes BZE0-2RQ) micro switch
25721	Mechanical stroke counter-installed (6 digit)
28881	External pilot modification - for 5-3/4" series
29125	External pilot modification - for 8" or 14" series
29370	Three way cycling spool for 5-3/4" series and 14" series
29702	Single stroke modification for 5-3/4" series and 14" series pump
50341	5-3/4" low permeability seals for CO2 gas service
50600	8" low permeability seals for CO2 gas service
51050	Extreme service cycling modification for 5-3/4" series pump
54312	Extreme service cycling modification for 8" or 14" series
56011	Vent purge with 15 psi relief - single end models
56011-2	Vent purge with 15 psi relief for 5-3/4", 8" or 14" series
57875	Panel with regulator for mounting remote APS
54827	Level II cleaning and certification of gas sections.
59888	Cycle Timer
80802	Viton air drive
80337	Extended life air drive seals
82500	ATEX Modification

Sample Gas Booster Flow Rate Performance (SCFM)

Flow and Pressure Performance:

Sample performance shown below is used for general reference only; consult Haskel Technical Sales or your Haskel Representative for specific performance information.

Cubic Meters Per Minute = SCFM x 0.0283

Catalog Number	PA=90 psi			
	Qa	Ps	Po	Q
AG-4	25	200	300	6.2
	25	120	300	3.6
	25	80	300	2.3
	25	40	300	1
AG-7	21	240	600	3.4
	21	180	600	2.5
	21	120	600	1.6
	21	60	600	0.7
AG-15	30	600	1200	6.2
	30	500	1200	5.1
	30	400	1200	4
	30	300	1200	3
AG-30	40	1300	2000	9.4
	40	1000	2000	7.2
	40	700	2000	4.9
	40	400	2000	2.6
AG-50	35	1700	4000	6
	35	1300	4000	4.5
	35	900	4000	3
	35	500	4000	1.7
AG-62	25	2000	5000	5.2
	25	1500	5000	3.9
	25	1000	5000	2.5
	25	500	5000	1.1
AG-75	30	2000	6000	3.8
	30	1500	6000	2.9
	30	1000	6000	1.8
	30	500	6000	0.8
AG-102	32	4000	8000	8.5
	32	3000	8000	8
	32	2000	8000	4
	32	1000	8000	2
AG-152	20	6500	13000	3.6
	20	5000	13000	3
	20	3500	13000	2.3
	20	2000	13000	1.3
AG-233	20	10000	20000	3.2
	20	8000	20000	2.8
	20	6000	20000	2.4
	20	4000	20000	1.8
AG-303	40	12500	24000	6
	40	10000	24000	5
	40	7500	24000	3.5
	40	5000	24000	2.5
AGD-1.5	30	100	200	18.2
	30	75	160	15.1
	30	50	140	10
	30	25	100	6.2
AGD-4	30	500	800	33
	30	350	600	25.4
	30	200	400	16
	30	50	200	4.5
AGD-7	30	700	1300	16
	30	500	1000	18.8
	30	300	800	11.2
	30	100	500	4
AGD-14	48	2100	3000	80
	40	1500	2500	48.4
	32	900	2000	22.5
	40	300	1000	10.4
AGD-15	40	2100	3000	50.3
	40	1500	2400	36.1
	40	900	1800	21.5
	40	300	1200	6.7
AGD-30	40	2850	4200	35.6
	40	2250	4200	25.5
	40	1550	3200	19
	40	850	2800	9.6
AGD-32	50	2950	4400	57.7
	40	2250	4400	33.2
	28	1550	4000	15.4
	33	850	3200	9.7
AGD-50	50	3000	6000	24
	50	2300	6000	12
	45	1600	5000	10
	30	900	5000	4

Catalog Number	PA=90 psi			
	Qa	Ps	Po	Q
AGD-62	50	4000	7500	35.6
	41	3250	7500	23.6
	25	2500	7500	11
	45	1000	5000	8
AGD-75	45	5000	10000	21.5
	45	3000	8000	14.3
	50	2000	6000	11.3
	50	1000	5000	5.5
AGD-102	52	8000	12000	26
	52	6000	12000	20
	52	4000	10000	16
	35	2000	10000	6
AGD-152	40	11000	22000	19.1
	25	7000	20000	6.6
	40	5000	16000	12.1
	52	3000	12000	10.7
AGD-152H	30	12000	24000	15.5
	40	10000	21000	18.3
	40	7000	18000	15
	40	5000	16000	12.1
AGT-4	20	100	400	2.7
	20	75	400	2
	20	25	200	1.2
	20	5	200	0.55
AGT-7/15	35	200	1500	4.4
	25	120	1500	1.8
	35	80	1000	2.1
	35	40	1000	1.1
AGT-7/30	32	150	3000	2.6
	40	100	2500	2.3
	40	75	2000	1.9
	40	50	2000	1.2
AGT-14/32	54	400	3000	5.8
	56	240	3000	3.7
	54	200	2400	3
	58	160	2000	2.6
AGT-14/62	54	350	6000	5.0
	56	275	5000	4.2
	54	175	4000	2.6
	58	125	4000	2.4
AGT-15/30	40	900	4000	9.7
	40	500	3000	5.8
	40	300	2000	3.9
	40	100	2000	1.2
AGT-15/50	42	400	5000	3.7
	42	250	5000	2.3
	55	150	4000	2
	55	100	4000	1.2
AGT-15/75	48	230	6000	2.7
	42	150	6000	1.4
	55	110	4000	1.5
	55	70	4000	0.8
AGT-30/50	50	850	5000	6
	50	600	5000	3.5
	62	350	4000	2
	62	100	4000	0.8
AGT-30/75	48	1300	8000	8.4
	25	700	8000	2.3
	45	400	6000	2.4
	55	100	4000	0.69
AGT-32/62	45	1700	7500	14.3
	28	1300	7500	6.7
	56	900	5000	9.8
	45	500	5000	4.3
AGT-32/102	35	1200	9500	5.1
	45	600	9500	3.3
	48	550	6500	3.3
	56	375	6500	2.6
AGT-32/152	23	450	15000	1.6
	52	250	10000	2.1
	50	150	10000	1
	55	50	3000	0.46
AGT-62/102	55	1600	10000	6
	55	1200	10000	4.5
	50	800	10000	3
	60	400	9000	1.5

Catalog Number	PA=90 psi			
	Qa	Ps	Po	Q
AGT-62/152	30	2400	18000	6.6
	35	1400	15000	4.6
	47	900	12000	4
	51	400	10000	1.8
AGT-62/152H	23	2500	19000	4.8
	25	1800	17000	4.1
	20	1200	16000	2
	20	800	15000	1.3
8AGD-1	75	130	180	128
	75	110	180	91
	75	90	160	76
	75	70	140	60
8AGD-2	75	130	250	56
	75	110	200	55
	75	90	200	41
	75	70	200	29
8AGD-2.8	70	500	700	109
	70	300	500	65
	90	200	400	55
	90	100	300	28
8AGD2-2.8	100	500	700	215
	100	300	500	131
	125	200	400	106
	125	100	300	54
8AGD-5	70	600	900	96
	70	450	800	66
	65	300	700	37
	65	100	500	12
8AGD-14	75	1000	2000	55
	75	800	1800	44
	75	500	1200	33
	75	200	1000	11
8AGD-30	75	2500	4000	76
	75	1800	3500	52
	75	1200	2800	36
	65	600	1800	18
8AGD-60	75	4000	7500	53
	75	2800	6800	36
	75	1800	5200	26
	65	1000	3800	14
8AGD-150	75	10000	18000	38
	75	8000	16000	33
	75	6000	14000	28
	65	4000	12000	20
8AGT-5/14	75	150	1200	12
	70	90	1000	8
	50	60	600	6
	40	30	400	3
8AGT-5/30	60	60	2800	1.4
	75	40	2400	0.7
	75	30	1800	0.9
	75	20	1500	0.5
8AGT-14/30	75	700	3500	19.7
	75	400	3000	10.4
	75	250	2500	6.6
	75	100	1800	2.7
8AGT-14/60	57	250	6000	3.7
	75	200	5500	3.5
	75	100	4500	1.2
	75	50	3000	0.31
8AGT-30/60	75	1700	7500	23
	75	1300	6800	17
	75	900	5000	13.8
	75	500	4000	7.8
8AGT-60/150	71	2500	18000	14.2
	75	1500	15000	9.4
	75	1000	12000	7
	75	500	8000	4
14AGD-315	150	16000	32000	25.3
	150	13000	28000	23
	150	9000	24000	18.1
	150	5000	18000	10.2
14AGT-125/315	115	4100	32000	14.9
	133	3100	28000	13
	150	2200	24000	10
	150	1000	18000	4.2
4AG-25	2	2000	2250	0.75
	2	1500	2250	0.6
	2	1000	2250	0.5
	2	500	2250	0.2

LEGEND

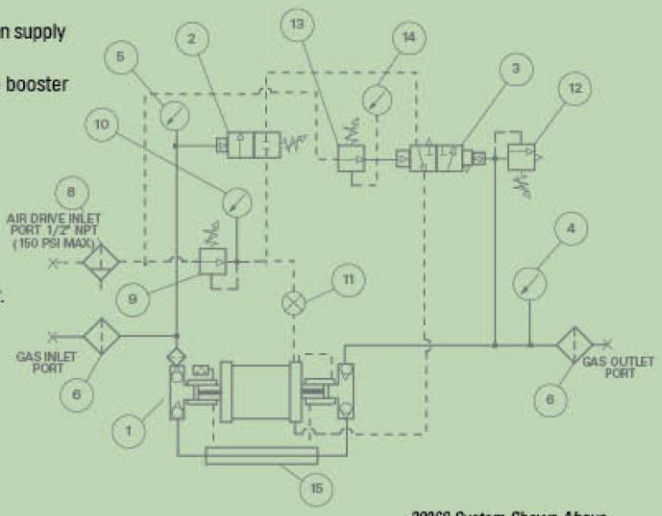
Pa = Air Drive Pressure
Ps = Gas Supply Pressure
Qa = Air Drive Quantity
Po = Gas Outlet Pressure
Q = Gas Outlet Flow Rate

Inert Gas Booster Systems

Haskel's ability to incorporate and interface electronic controls into systems provides precise compression and control of gases.

Standard system components are:

1. Booster with External Pilot Modification to enable use of external components to start/stop the booster.
2. Adjustable Air Pilot Switch (inlet) – used to stop the booster when supply pressure falls to adjusted set point.
3. Adjustable Remoteset Air Pilot Switch (outlet) – used to stop the booster when outlet pressure reaches adjusted set point.
4. Pressure Gauge indicates outlet boosted pressure.
5. Pressure Gauge indicates inlet gas pressure supply
6. Gas Filter used to stop any ingested contamination from entering the booster (e.g. while changing out a gas supply bottle)
7. Roll Bar Frame (not shown) used for mounting booster and other components.
8. Air Filter - inline filter (20-40 micron) for maintaining air drive quality.
9. Adjustable Air Regulator used to set the Air Drive Pressure (0 - 150 psi max)
10. Air Pressure Gauge indicates the Air Drive Pressure
11. Manual On/Off Valve and Speed Control Valve used to adjust cycling speed that the booster cycles
12. Relief Valve used to protect the booster & other components from over pressurization
13. Adjustable Remoteset Pilot Regulator used to adjust the set point for the Remoteset Air Pilot Switch
14. Pressure Gauge used to indicate the Adjustable Remoteset Regulator adjusted pressure
15. Interstage Cooler – a tube & shell cooler used to reduce the boosted gas temperature (part of the booster)



29068 System Shown Above

Charging Systems

Charging systems provide a fast, efficient and economical method of charging, or "topping up" gas pressures. Charging units ensure that the optimum use is made of commercially bottled gases down to as low as 150 psi or vaporized liquid (cryogenic) supplies while producing pressures as high as 39,000 psi depending on gas type. Units are standard or custom-built in a variety of configurations, samples of which are illustrated here.

26968 Oxygen Booster System

Oxygen booster systems for filling oxygen cylinders. An efficient, safe and economical system for oxygen handling.

(A) Outlet stall (max gas outlet pressure is: Air drive psi x 30 Plus 2x gas inlet psi)
(B) Interstage stall (Max gas inlet pressure is air drive psi x 15 if outlet exceeds air drive psi x 30. If it does not, max gas inlet is air drive psi x 30)
(C) If less air flow is available, outlet gas rates will decrease about in proportion

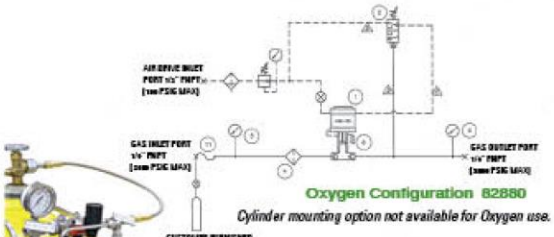
26968 Sample Performance

Oxygen Gas Pressure - PSI		Oxygen Outlet Gas Flow - SCFM		
		Air Drive PSI		
Inlet	Outlet (B)	60	80	100
250	1500	3.5	4.0	4.0
250	2000	2.1	2.1	3.6
250	3000	(A)	(A)	2.5
1000	1500	8.7	14.7	15.0
1000	2500	(B)	9.7	13.7
1000	3500	(B)	9.6	13.6
1500	2000	(B)	14.7	20.7
1500	2500	(B)	(B)	16.1
1500	3000	(B)	(B)	(B)
2000	2500	(B)	(B)	21.6

Performance based on indicated Air Drive PSI @ 50 SCFM (C)

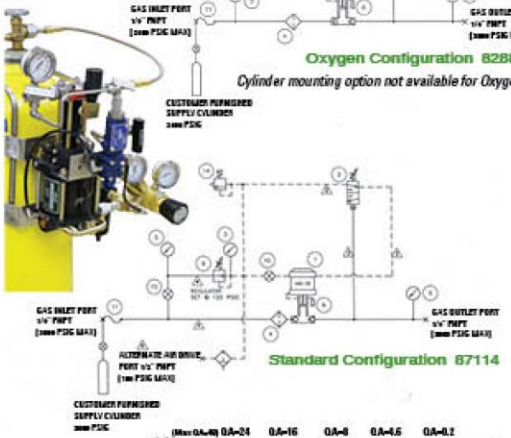
Mini Charging Booster

Designed and Manufactured to achieve an affordable and effective gas transfer and charging unit. Standard configuration includes cylinder mounting bracket.

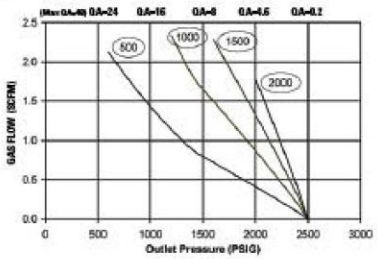


Oxygen Configuration 82880

Cylinder mounting option not available for Oxygen use.



Standard Configuration 87114



ScubAmp

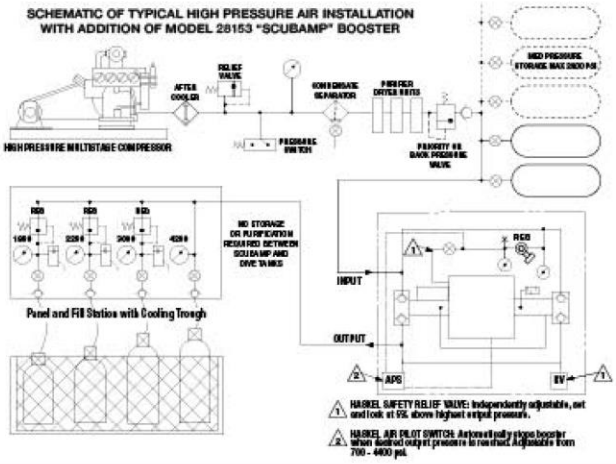
Used by Dive Shops to boost medium pressure breathing air from storage air direct to dive tanks to reach maximum fill pressure rapidly. With the use of a ScubAmp, existing air compressor systems can stay within their 200-2500 psi normal operating range.

TYPICAL FILL TIMES

From Pressure in Storage (After Equalizing in Dive Tank)	To Nominal Tank Size and Pressure			
	83 cu. Ft. to 3000 psi	71.2 cu. Ft. to 2475 psi	71.2 cu. Ft. to 2250 psi	80 cu. Ft. to 4400 psi
2500 psi	12 sec.			60 sec.
2250 psi	28 sec.	14 sec.		90 sec.
2000 psi	39 sec.	22 sec.	12 sec.	
1500 psi	75 sec.	50 sec.	35 sec.	

Performance based on 100 psi air drive @ 50 SCFM.

SCHEMATIC OF TYPICAL HIGH PRESSURE AIR INSTALLATION WITH ADDITION OF MODEL 28153 "SCUBAMP" BOOSTER



Gas Transfer, Test & Charging Carts

Typical gases used are O2, N2, He, Ar & Air used for transfer, charging, testing, calibration or tool operation.

Console Controlled Test Systems

Test console housing pneumatic Gas Booster selected to meet test parameters of the customers specification. Gas pressures can be produced up to 39,000 psig.

Natural Gas Vehicle Fueling Systems

Natural Gas Boosting System with Storage eliminates the need for mechanical compressors where high pressure and low pressure Natural Gas sources are available.

Gas Cylinder Test Rigs

Hydrostatic and cylinder stretch test rigs for inspection and testing of all gas cylinder and pressure vessels, including oxygen, nitrogen, carbon dioxide and halon bottles.

Hydraulic Driven Gas Boosters

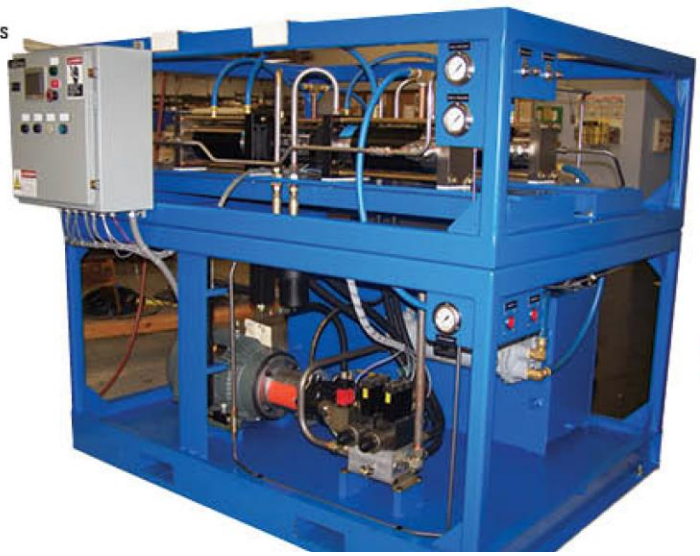
For flow rates that typically go beyond the capability of pnematic driven boosters.

Haskel's gas booster product line began with hydraulic driven gas boosters. Their gas compression technology has been proven in critical applications such as Fuel Cell / Hydrogen, Photovoltaic, Semiconductor, Specialty Gases, and more.

Capable of boosting a variety of gases, Haskel's broad range of Hydraulic Driven Gas Boosters offer complete flexibility for your gas compression and transfer needs. The key design elements incorporated in this range are based on the Haskel technology that has been combined with cutting edge hydraulic drive control to provide a complete solution, from plug-in electrical supply to reliable gas output pressure and flow.

Applications

- Hydrogen Filling Stations
- Charging high-pressure gas cylinders and receivers
- Gas assisted plastic injection molding
- Hydraulic accumulator charging
- Charging air bag storage vessels
- Missile and satellite launch and guidance systems
- Component testing
- Laser cutting and welding
- Oilfield high volume gas testing
- Automotive hoses and component gas testing
- Hot isostatic pressing
- Inert/specialty gas transfer
- Biogas charging
- Extending pressure
- Gas blanketing



Designs

Single-Stage Double Acting Models

- Available in 7 models with flow rates to **400 scfm** and maximum supply and outlet pressures to **16,000 psig**
- Designed for high flow and low-to medium compression ratios

Two-Stage Models

- Available in 8 models with flow rates to 45 scfm. Maximum supply pressure 6000 psig. Maximum outlet pressure to 16,000 psig
- Modular construction for easy gas section maintenance
- Adapts to multiple units in parallel or in series driven by one power source

Hydraulic Driven Gas Booster Model Number Configuration

100	HGT	6	-	85/50	-	EX
Design Series	Design Type	Stroke Length		Ratio		Switch
100 120	HGT = 2 Stage HGD = Double Acting	6 10		xx / xx		-NP (No Proximity Switch) -PS (Proximity Switch; Inert Gas Service) -EX (Explosion Proof Switch)

Optional Features (normally provided by Haskel distributor or system integrator)

- Motor starter
- Inlet pressure control loop
- Temperature control loop
- Water chiller - Cooling loop
- Remote operator station
- Heater hydraulic reservoir
- Noise attenuating panels

Varying applications require many different booster and horse power (HP) combinations. Haskel can assist with HP and Cooling requirements and provide circuitry assistance on the following issues: PID Control - review and advisement, electrical control, and heat exchanger recommendations. General HPU recommendations and guidelines are available from Haskel drawing 87100-TAB.

Features

- Stainless Steel/Monel gas barrel construction
- Oil Free, gas section non-lubricated operation
- Integrated cooling barrels on each gas section
- Isolation between hydraulic and gas sections to prevent contamination.
- 6in. and 10in. stroke models
- Proximity switch control to automate cycling
- Able to accept high supply pressures

Benefits

- Capable of flow rates up to 8 x higher than air driven models
- Modular construction for easy gas section maintenance
- Will not rust like other carbon steel manufactured units
- Non-contaminating gas compression
- Minimizes gas temperature rise from compression
- Suitable for ultra pure gas compression
- Broad range of flows and pressures
- Smooth stroke direction changeover and cycle rate control
- Multiple gas boosters can be driven by one power source
- Steady state cycle control to maximize seal life
- High efficiency for continuous operation

LEGEND
HP = Horsepower Input based on Max. Hyd. Pressure 2500 psig
Ps= Gas Supply Pressure (PSI)
Po= Gas Outlet Pressure(PSI)
CPM= Cycles Per Min. (18 max 120 series, 25 max. 100 series)
Q=Gas Outlet Flow Rate (SCFM)

Part Number	Hydraulic Driven Gas Booster Specifications										Sample Performance				
	Supply Pressure Minimum		Supply Pressure Maximum		Outlet Pressure Maximum		Maximum Compression Ratio	Displacement Cycle		Cycles Per Minute	Hydraulic Pressure : 2500 PSI				
	PSIG	BAR	PSIG	BAR	PSIG	BAR		Cubic Inches	Milliliters		HP Input	Ps	Po	CPM	Q
100HGD6-145	50	3.5	1850	127	1850	127	6	312	5106	25	22.4	150	900	25	39.0
											27.0	250	1200	25	64.5
											28.2	500	1500	25	131.2
											27.2	1050	2000	25	280
100HGD6-115	50	3.5	2750	189	2750	189	6	191	3128	25	22.0	200	1400	25	30.5
											26.6	275	1800	25	41.7
											27.3	725	2300	25	115
											27.7	1200	2800	25	193
100HGD6-85	100	7	6000	413	6500	448	6	107	1760	25	16.9	500	2000	25	44.1
											27.4	690	3500	25	59.0
											28.5	1800	4750	25	159
											27.2	3200	6000	25	272
100HGD6-50	100	7	9000	620	13500	930	6	40	657	25	19.3	1200	6000	25	37.4
											24.0	1600	8000	25	49.4
											27.2	2500	10000	25	78.3
											27.2	4500	12000	25	129
120HGD10-165	50	3.5	1850	127	1850	127	6	716	11728	18	25.1	75	550	18	36.0
											43.4	175	1100	18	77.7
											44.4	250	1200	18	111
											42.4	300	1200	18	133
120HGD10-85	100	7	6000	413	6500	448	6	179	2931	18	24.2	800	2500	18	87.6
											27.0	1200	3200	18	131
											40.4	1300	4600	18	129
											39.5	2500	5800	18	265
120HGD10-50	100	7	9000	620	13500	930	6	68	1111	18	29.6	1400	7000	18	55.3
											35.4	1800	9000	18	70.5
											41.2	2200	11000	18	85.4
											48.0	2800	13500	18	107
100HGT6-145/85	50	3.5	1850	127	6500	448	104	156	2556	25	16.8	250	2200	25	33.6
											20.4	300	2800	25	40.0
											23.7	400	3500	25	52.8
											27.3	500	4000	25	65.7
100HGT6-145/50	50	3.5	1850	127	6500	448	280	156	2556	25	27.1	150	3200	25	18.9
											28.0	150	3800	25	18.9
											28.4	150	4950	25	18.8
											28.6	150	5500	25	18.8
100HGT6-115/85	50	3.5	2750	189	6500	448	64	95	1556	25	19.0	250	2200	25	21.1
											23.1	300	2800	25	25.1
											25.7	400	3500	25	33.2
											29.8	500	4000	25	41.3
100HGT6-115/50	50	3.5	2750	189	13500	930	171	95	1556	25	14.6	175	3500	25	14.1
											14.7	175	4000	25	14.1
											17.4	175	5000	25	14.0
											20.8	250	6000	25	11.5
100HGT6-85/50	100	7	6000	413	13500	930	96	53	868	25	17.5	300	5000	25	13.8
											22.6	400	7000	25	31.0
											24.8	500	8000	25	22.6
											28.7	750	10000	25	33.7
120HGT10-165/85	50	3.5	1850	127	6500	448	144	358	5866	18	28.8	175	2800	18	39.8
											33.8	200	3500	18	45.2
											43.4	200	4500	18	45.1
											46.3	250	5000	18	55.8
120HGT10-165/50	50	3.5	1850	127	13500	930	386	90	1474	18	47.2	100	4000	18	22.2
											47.1	100	5000	18	22.1
											51.8	110	7000	18	24.1
											52.2	110	8000	18	24.6
120HGT10-85/50	100	7	6000	413	13500	930	96	34	557	18	31.4	300	7000	18	16.9
											32.4	600	8000	18	33.2
											38.3	700	10000	18	38.6
											48.4	900	13500	18	49.4

REFER TO PAGES 33 - 35 FOR DIMENSIONAL DRAWINGS OF ALL MODELS

Applications for Pneumatic and Hydraulic Driven Gas Boosters and Gas Booster Systems

General Applications

- Condenser Leak Detection
- Gas Transfer Circuit Breakers
- Aircraft Jacking
- Helicopter Pop Floats
- Autoclaving - Low Pressure
- Hot Isostatic Presses
- Automotive Air Bag Vessel Filling
- Helium Leak Pressure Testing
- Blow Molding
- Boost Pressures from N2/O2 Generators
- Breathing Air Systems
- Laser Cutting (Ar, N2,O2, He)
- CFC Recovery
- Leak Detection Systems
- Charging Gas Suspensions
- Missile Test Systems
- Cooling with Helium in Pilot Plants
- Nitrogen Injection for Molding Machines
- Cryostat Testing (Nitrogen and Argon)
- Nitrogen Accumulator Charging
- Die Cushion Cylinder Charging
- Oxygen Life Support Bottles
- Escape Chute Charging – Co2 Charging
- Oxygen Boosting
- Fuel Cells; Mobile, Portable and Stationary
- Power Valve Actuation/Hold Dump Valves Closed
- Gas Assisted Injection Molding (GAIN)
- Gas Charging for Aircraft Tire Inflation
- Pressure Testing of Hydraulic Systems – Skydrol
- Gas Pressure and Leak Testing
- Super Critical Fluid Extraction
- Gas Reclaim - Low Pressure
- Testing Brake Calipers
- Cylinder Hydro Test

Hydrogen Applications

Haskel Manufactures the most extensive range of gas handling solutions for gas transfer or boosting applications, including **Hydrogen**. **Hydrogen** use products include Pneumatic or Hydraulic Driven Gas Boosters, Diaphragm Compressors, and BuTech High Pressure Valves and Fittings, that are Hydrogen rated to over 20,000 psig.

- Hydrogen Infrastructure
- Hydrogen Fueling & Filling Stations
- Hydrogen Compression, Storage & Transfer
- Fuel cell: Mobile, Portable & Stationary
- Boosting H2 Generator Outlet Pressure
- Hydrogen Purification
- Hydrogen Generation
- Hydrogenation
- PTA manufacture
- Polysilicon manufacture
- Petroleum recovery and refining
- Hydrogenation reactions
- Cylinder filling for storage from H2 generation
- R&D lab gas distribution
- Power generation (used as a coolant)
- Semiconductor manufacturing

Pneumatic Driven Gas Boosters for Hydrogen Applications

Booster Model	Supply Pressure	Flow SCFM @ psi*	Pressure Limit (psi)	Hydrogen System Model #
AG-62	1000	4.21 @ 4800	9,000	86979
AG-75	1500	3.81 @ 6000	12,000	86980
AG-152	2000	3.02 @ 12000	15,000	86981
AGD-7	150	6.85 @ 710	2,500	86982
AGD-15	500	10.68 @ 1700	4,000	86983
AGD-30	750	8.12 @ 3150	9,000	86984
AGD-32	750	10.75 @ 3150	4,000	86985
AGD-62	1000	6.97 @ 5800	9,000	86986
AGD-75	1500	6.18 @ 7500	12,000	86987
AGD-152	2000	5.07 @ 14000	15,000	86988
AGT-7/15	100	2.63 @ 1410	2,500/4,000	86989
AGT-7/30	100	2.30 @ 2820	2,500/9,000	86990
AGT-14/62	250	5.8 @ 4000	2,500/9,000	86991
AGT-15/30	500	5.88 @ 3400	4,000/9,000	86992
AGT-15/75	250	2.34 @ 7250	4,000/12,000	86993
AGT-30/75	500	2.70 @ 7250	9,000/12,000	86994
AGT-32/62	1000	8.08 @ 6800	4,000/9,000	86995
AGT-32/152	350	1.93 @ 13750	4,000/15,000	86996
AGT-62/152	1000	3.80 @ 14500	9,000/15,000	86997

Based on 100 psi Drive Pressure and 48 SCFM (Pa-100, Qa=48)

Booster Model	Supply Pressure	Flow SCFM @ psi*	Pressure Limit (psi)	Hydrogen System Model #
8AGD-14	150	9.20 @ 980	5,000	87219
8AGD-30	750	14.26 @ 3150	5,000	87201
8AGD-60	1000	9.47 @ 5800	9,000	87185
8AGT-14/30	500	10.73 @ 3400	5,000	87226
8AGT-14/60	250	3.87 @ 6000	9,000	87225
8AGT-30/60	1000	10.4 @ 6800	9,000	87224

Based on 100 psi Drive Pressure and 95 SCFM (Pa-100, Qa=95)

Selecting Your Accessories

Haskel can either provide accessories separately or supply them fitted to form a complete package suited to your application. Additionally, Haskel can fit customer nominated accessories. Our accessories catalog is available and our technical support team is always ready to advise you on the most suitable choice of accessories for your application.

A full range of high-pressure regulators, valves, switches and ancillary equipment is available to suit all our gas boosters.

- Air pilot switches
- Air pilot valves
- Regulating relief valves
- Directional control and release valves
- Hydraulic accumulators, gas receivers and storage cylinders
- High pressure valves, fittings and tubing
- Plenum chambers
- Port adapters
- Pressure Regulators
- Gauge snubbers
- Filters
- Stainless steel check valves
- Intensifiers with integral checks for cycling
- Capillary type gauge snubbers

Please ask for your copy of our latest accessories brochure.

Regulating Relief and Back Pressure Control Valves

Provide over pressure protection on any high pressure low flow gas or liquid system. (See system accessory catalog.)

Air Pilot Switches

These pressure switches produce a pneumatic signal up to 150 psi at any sensing pressure within their adjustment range.

Gas Receivers

Gas receivers in 10,000 and 20,000 psi series. Eleven models from 20 to 897 cu. in. displacements. (See system accessory catalog.)

Filters

- 5 Microns
- 6000 psi, 30,000 psi 2 models 1/4' NPT and 1/4" S.P. tube
- S.S. or paper elements

Stainless Steel Check Valves

- Constructed throughout of 316 series stainless steel for high corrosion resistance.

- A PTFE semi soft seat for higher contamination tolerance without leakage. The PTFE initially deflects a slight amount then the ball or poppet to come to rest against the metal seat so the PTFE does not have to absorb the full load of the high pressure.

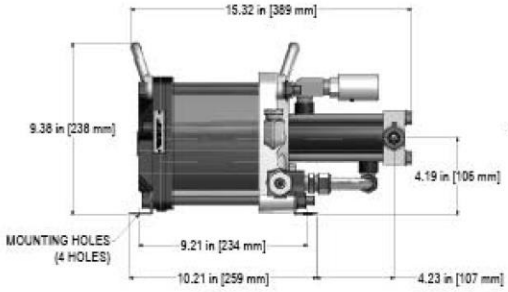
Directional Control and Release Valves

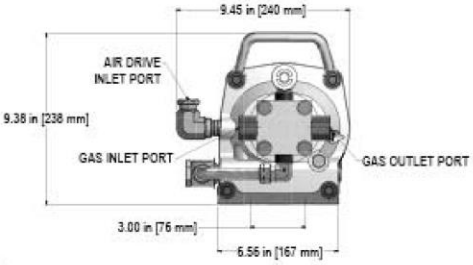
Directional Control valves are basically a family with common characteristics and benefits. They are seated poppet or ball design for virtually zero leakage at high pressures with low viscosity fluids.

Intensifiers

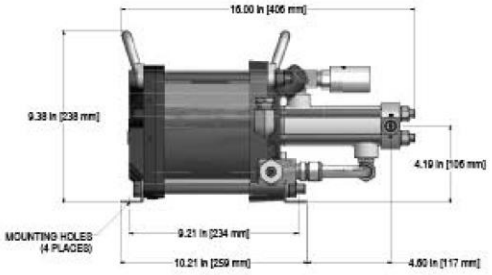
Intensifers with integral checks for cycling. All stainless steel in high pressure wetted section.

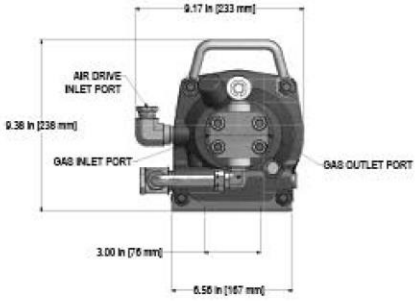
Gas Booster Model: AG-7



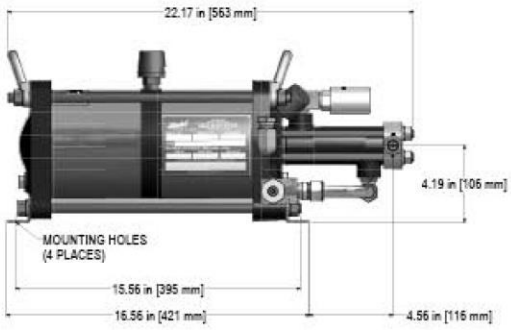


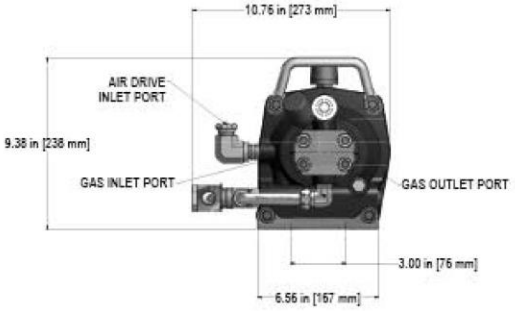
Gas Booster Models: AG-15, AG-30, AG-50, AG-75





Gas Booster Models: AG-62, AG-102, AG-152





Notes

For more information on our high-pressure products, visit Haskel.com or contact your local Haskel representative.

Haskel is a brand of Accudyne Industries, a leading global provider of precision-engineered, process-critical and technologically advanced flow control systems and industrial compressors that deliver consistently high performance and give confidence to the mission of our customers in the most important industries and harshest environments around the world. The company is powered by more than 3,000 employees at 18 manufacturing facilities, supporting a broad range of industries in more than 150 countries.

Accudyne INDUSTRIES

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APPENDIX IV

Instrument Certification Notice

Instrument Certification Notice

The gauge Certificates of Calibration supplied for the gauge(s) on this unit contain the calibration data for the actual instrument calibrated, along with the calibration date of the **STANDARD** used to perform the calibration check.

The due date for re-calibration of the instrument should be based upon the date the instrument was placed in service in your facility. Re-calibration should be done on a periodic basis as dictated by the end user's quality system or other overriding requirements.

Note that Tronair, Inc. does not supply certificates of calibration on flow meters or pyrometers unless requested at the time of placed order. These instruments are considered reference indicators only and are not critical to the test(s) being performed on the aircraft.

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TRONAIR®

APPENDIX V

Declaration of Conformity

DECLARATION of CONFORMITY

The design, development and manufacture is in accordance with European Community guidelines

20-4523-0000

Relevant provisions complied with by the machinery:
2006/42/EC

Relevant standards complied with by the machinery:
EN ISO 12100-1

Identification of person empowered to sign on behalf of the Manufacturer:

Patrick Finch

Quality Assurance Representative

Tronair, Inc.
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