



OM/MSB-9000

UNCONTROLLED DOCUMENT

CURRENT AS OF PRINT DATE: 10/26/2018

OPERATING AND MAINTENANCE MANUAL

Model Numbers: *MSB-9000*

Serial Number:

Our products are backed by outstanding technical support, an excellent reputation for reliability, and world wide distribution

ASSEMBLY PROCEDURE FOR GAS PISTON: (USE 86859 ASSEMBLY TOOL)

WITH PISTON ROD HELD SECURELY AND EXTENDING 1/4" BEYOND THE END OF THE GAS BARREL, ASSEMBLE THE PARTS IN THE ORDER SHOWN (DETAIL D) USING THE FLAT END OF THE ASSEMBLY TOOL TO COMPACT THE SEALS. MAKE SURE THAT THE BELLEVILLE SPRINGS ARE ASSEMBLED IN SETS OF TWO, CUPPED ALTERNATIVELY IN OPPOSITE DIRECTIONS. USE THE OTHER END OF THE ASSEMBLY TOOL TO TORQUE THE NUT DOWN UNTIL SNUG AND THEN BACK OFF UNTIL A SLOT IN THE NUT LINES UP WITH THE HOLE IN THE ROD. INSERT AND SECURE THE COTTER PIN.

* CAUTION: MAKE SURE NUT (86789) SURFACE DOES NOT PROTRUDE BEYOND END OF ROD (86788). THIS CAN BE ACHIEVED BY USING FEWER NUMBER OF BELLEVILLE SPRINGS (16719-13) IF NECESSARY.

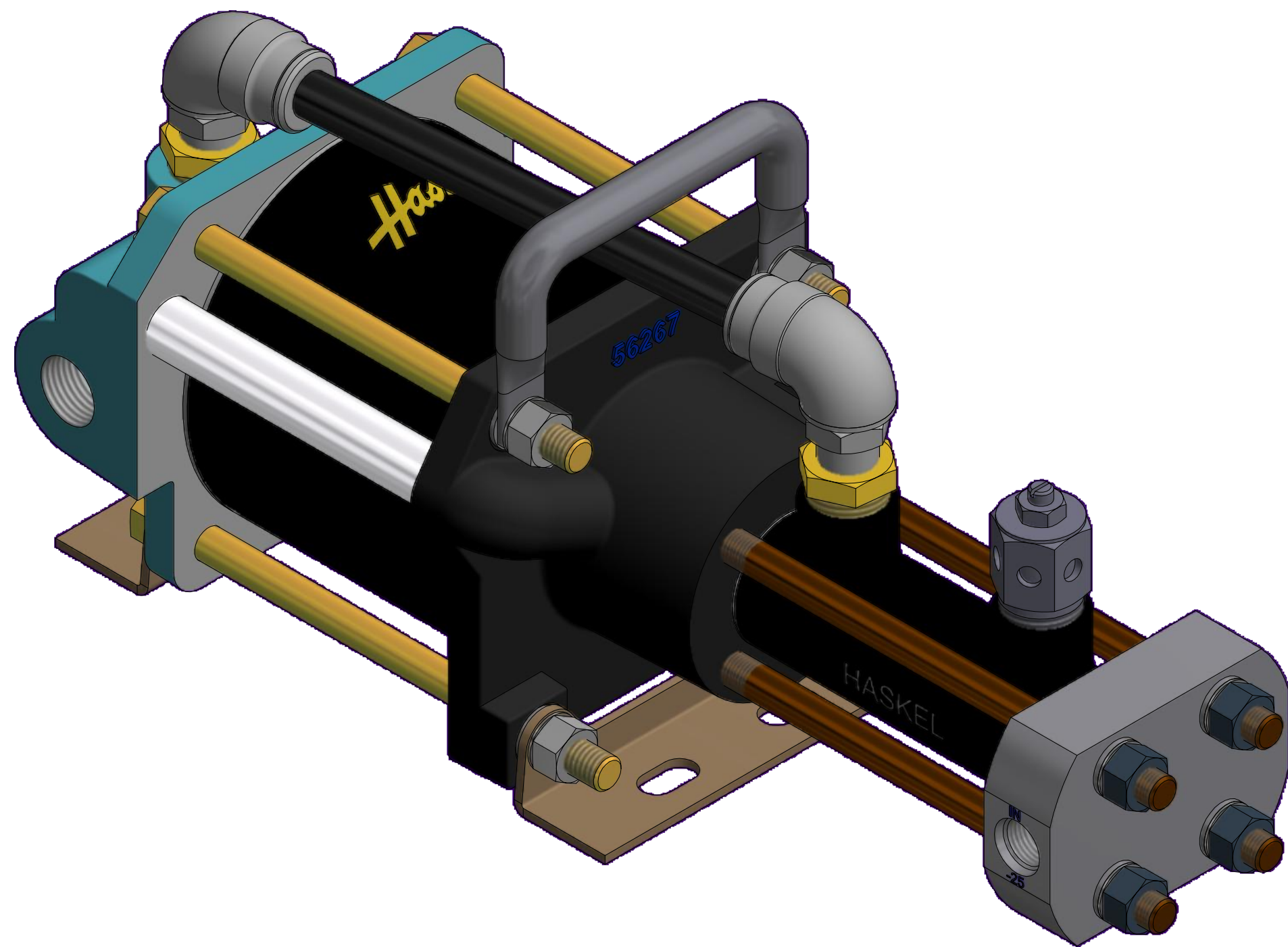
ASSEMBLY PROCEDURE FOR GAS CHECK VALVES: (USE 16675 ASSEMBLY TOOL)

1. PLACE OUTLET PORT IN THE UPRIGHT POSITION. INSERT SEAT, BALL, RING, SMALL SPRING, SHANK, AND LARGE SPRING UNTIL SEATED PROPERLY. IT IS IMPORTANT THAT THESE PARTS ARE IN PROPER POSITION BEFORE CONTINUING. SLIDE ONE SET OF PACKINGS (BRONZE, THIN TFE BACK-UP, O-RING, THICK TFE BACK-UP) IN THE ORDER SHOWN ONTO SEAT FITTING. THE THICK TFE BACK-UP WILL PROVIDE SUFFICIENT GRIP TO RETAIN THE PACKINGS DURING INSERTION. THEN, USING ASSEMBLY TOOL, SCREW SEAT IN UNTIL IT IS SNUG (APPROXIMATELY 5/8" BELOW END CAP FACE). USING A THIN ROD, DEPRESS BALL THROUGH INLET PORT TO VERIFY PROPER MOVEMENT.

2. PLACE INLET PORT IN UPRIGHT POSITION. INSERT LARGE SPRING, SHANK, RING, SMALL SPRING, BALL AND SEAT INTO PORT UNTIL SEATED. IT IS IMPORTANT THAT THE PARTS ARE IN PROPER POSITION BEFORE CONTINUING. SLIDE ONE SET OF PACKINGS (BRONZE, THIN TFE BACK-UP, O-RING, THICK TFE BACK-UP) IN THE ORDER SHOWN ONTO SEAT FITTING. THE THICK TFE BACK-UP WILL PROVIDE SUFFICIENT GRIP TO RETAIN THE PACKINGS DURING INSERTION. THEN, USING THE ASSEMBLY TOOL, SCREW THE SEAT IN UNTIL IT IS SNUG (APPROXIMATELY 5/8" BELOW END FACE). CHECK THAT THE BALL IS FREE TO MOVE BY DEPRESSING IT WITH A THIN ROD FROM THE INLET END.

NOTES:

- 1. GAS PISTON ASSEMBLY, 86784
 - 2. PART OF GAS SECTION SEAL KIT, 86796
 - 3. PART OF AIR SECTION SEAL KIT, 86797
 - 4. PART OF GAS END CAP, 86798
 - 5. PARTS TO BE OXYGEN CLEANED PER HPS-4.11
 - 6. TORQUE TO 15 FT. LBS.
7. THIS IS A STANDARD 4AG-25 BOOSTER WITH THE FOLLOWING MODIFICATIONS:
 *ADDED PRESSURE RELIEF VALVE (ITEM 78) TO CYCLING VALVE
 *THE GAS SECTION TO BE CLEANED FOR OXYGEN SERVICE (SEE NOTE 5)
8. ALL DIMENSIONS SHOWN ARE APPROXIMATE IN INCHES, WITH CENTIMETERS IN PARENTHESES.



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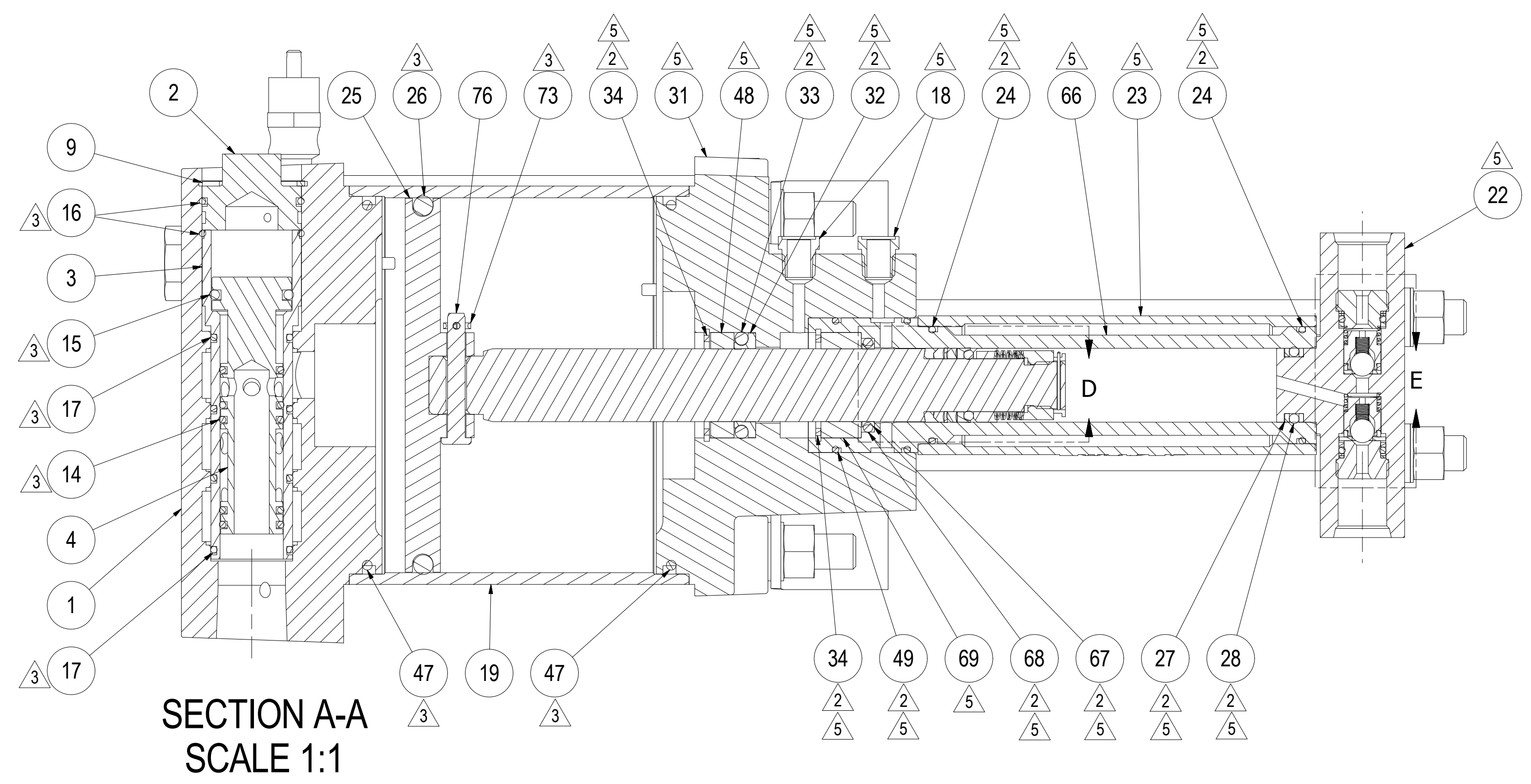
QTY	PART NUMBER	DESCRIPTION	MATERIAL	ITEM	QTY	PART NUMBER	DESCRIPTION	MATERIAL	ITEM
2	124470738	ELBOW,MALE SWVL,1/2TBX3/8NPT	BRASS	80	1	86438-2	BEARING-PISTON	BRONZE, C94300	40
2	61112-8-6B	PIPE THREAD REDUCER	BRASS	79	10	16719-13	SPRING WASHER, BELLEVILLE	17-7PH SS	39
1	KSV10-1-155	RELIEF VALVE, 155 PSI	BRASS	78	1	16704-50	SEAL, TEFLON	PTFE	38
4	17834	NUT, 3/8-24	316 SS	77	1	568113-31	O-RING	VITON	37
1	MS20392-2C37	PIN	ALLOY STEEL	76	1	27065-50	SEAL	CARBON FILLED PTFE	36
1	MS24665-24	COTTER PIN	STAINLESS STEEL	75	2	17225-50	BACKUP	BRONZE, SOFT TIN	35
1	28081-1	SEAT	PTFE, VIRGIN	74	2	5008-112H	RETAINING RING	300 SERIES SS	34
1	MS24665-151	COTTER PIN	C.R. STEEL	73	1	568212-7	O-RING	VITON	33
1	27077-16	PILOT TUBE	304 SS	72	1	86441	ROD SEAL, AG-50	CARBON FILLED PTFE	32
2	5005-31H	RETAINER RING	15-7 PH	71	1	86787	END CAP, VENT 4"	ALUMINUM 356-T6	31
2	55701-8	BOLT,3/8-16X6.00	AISI 1020	70	2	55742	MOUNTING BRACKET	STEEL	30
1	86440	BEARING, AG-50	RYTON 134	69	1	27078-17	FLOW TUBE	304 SS	29
1	568117-7	O-RING	VITON	68	1	568114-7	O-RING	VITON	28
1	51351-5	GLIDER RING	CARBON FILLED PTFE	67	2	17254-50	BACKUP RING	PTFE-GLASS FIBER FILLED	27
1	86790	GAS BARREL, 4AG-25	15-5 SS	66	1	568343-2	O-RING	BUNA-N	26
2	54067	SEAT, CHECK VALVE	15-5 SS	65	1	86786	AIR PISTON, 4"	6061-T6 AL	25
2	17422	BACK-UP	ALUM BRONZE	64	2	568024-7	O-RING	VITON	24
2	17421	BACKUP RING	PTFE	63	1	86791	COOLING BARREL	2024-T4 AL	23
2	568012-31	O-RING	VITON	62	1	86792	GAS END CAP, 4AG-25	304 SS	22
2	56228	BACKUP RING	PTFE	61	2	55701-4	BOLT,3/8-16x5-1/2	AISI 1020	21
2	28082	SPRING	316 SS	60	4	86803	TIE ROD	AISI 4140H	20
2	26685	SPRING	316 SS	59	1	86785	BARREL-AIR, 4"	AEROSLIDE	19
2	26130-8	BALL	316 SS	58	3	29348-2	BREATHER 1/8" NPT	BRASS	18
2	28083-1	RING	316 SS	57	4	568018-2	O-RING	BUNA-N	17
1	28081-3	SEAT	PTFE, VIRGIN	56	2	568021-2	O-RING	BUNA-N	16
2	28083-2	RETAINER CHECK VALVE	316 SS	55	1	568115-2	O-RING	BUNA-N	15
1	86795	HANDLE, 4"	AISI 1018 TB	54	5	568015-21	O-RING	BUNA-N (MOLY FILLED)	14
1	17568-2	PLUG, 1/8 NPT	STEEL	53	4	17563-6	NUT, 3/8-16	STEEL	13
1	86805	TUBING, COOLING	NYLON	52	8	1720	LOCKWASHER, 3/8	STAINLESS STEEL	12
1	86804	MUFFLER	BRASS	51	12	AN960-C616	WASHER	STAINLESS STEEL	11
1	27375-3V	STEM, PILOT VALVE	303 SS	50	2	568906-9	O-RING	BUNA-N	10
2	568027-2	O-RING	BUNA-N	49	1	N5000-106H	RING, RETAINING	ALLOY STEEL	9
1	86440-1	BEARING, AG-50	RYTON 134	48	2	16510	PLUG	AL 2024-T351 OR T4	8
2	568154-2	O-RING	BUNA-N	47	2	16513	SPRING	ASTM-A-228	7
1	27375-5V	STEM	304 SS	46	2	568006-2	O-RING	BUNA-N	6
2	568010-2	O-RING	BUNA-N	45	2	16517	SPACER	BRASS	5
2	568014-2	O-RING	BUNA-N	44	1	55727	SPOOL, 4"	DELTRIN PLASTIC	4
1	86789	NUT, RETAINER	303 S.S.	43	1	56215-2	SLEEVE, AIR VALVE, 4"	7075-T6 AL	3
1	86443	BACK-UP, SEAL	ALUM BRONZE	42	1	56216	PLUG	2024-T4 AL	2
1	86788	PISTON ROD, 4AG-25	15-5 PH (H925)	41	1	56213	CAP, AIR VALVE END	ALUMINUM 356-T6	1

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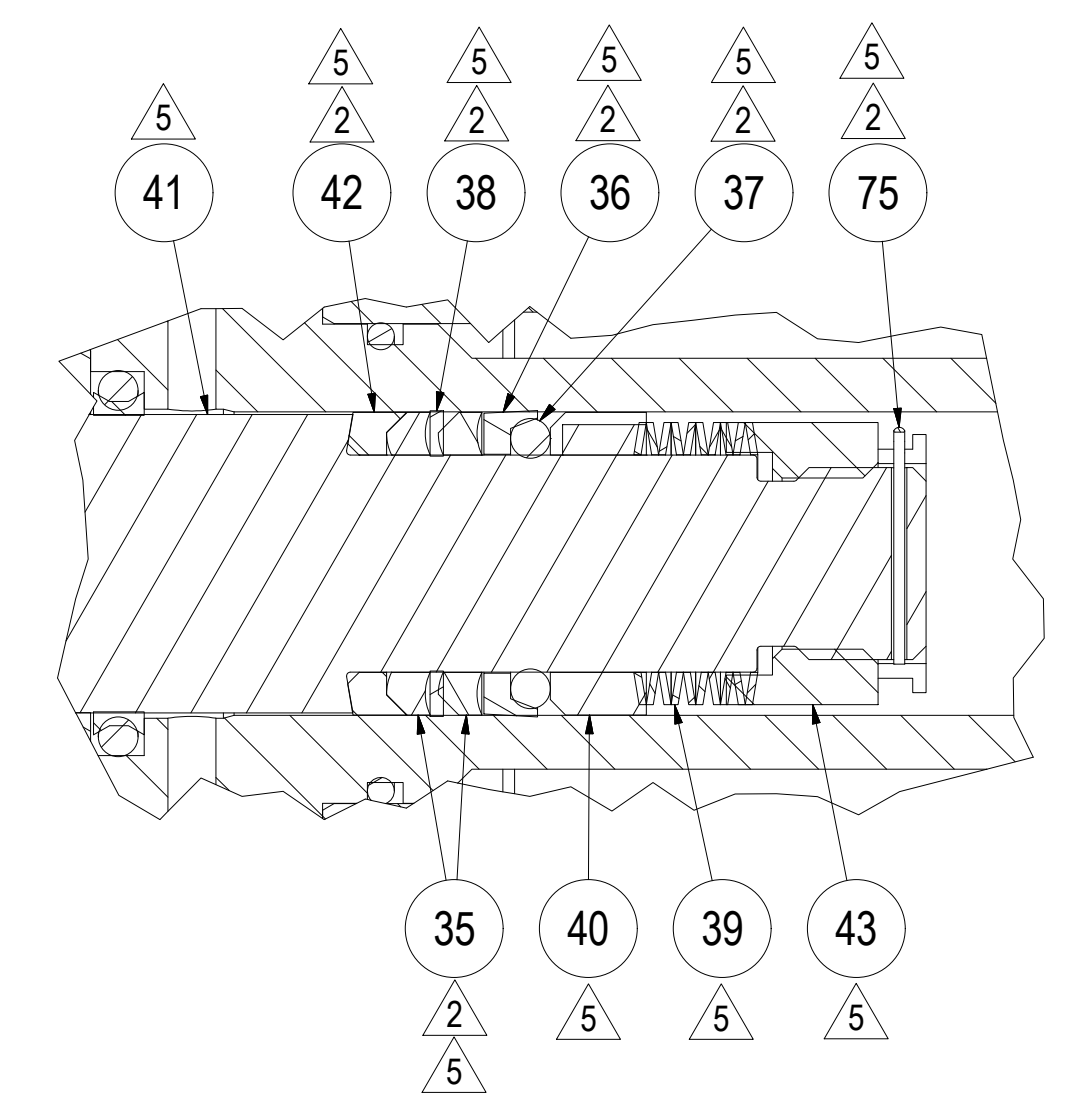
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NEXT ASSY (REF ONLY)		Haskel International, LLC Burbank, California 91502	
APPROVALS	DATE	TITLE	
DRAWN D MACH	8/10/2006	MINI SPORT BOOSTER ASEMBLY (MSB-9000)	
CHECKED PD	11/29/2006	SIZE	CAGE CODE
APPROVED SDQ	11/29/2006	D	81400
CAD FILENAME	86783	DWG NO.	86783
SCALE: NA	INVENTOR DRAWING	SHEET	1 OF 3

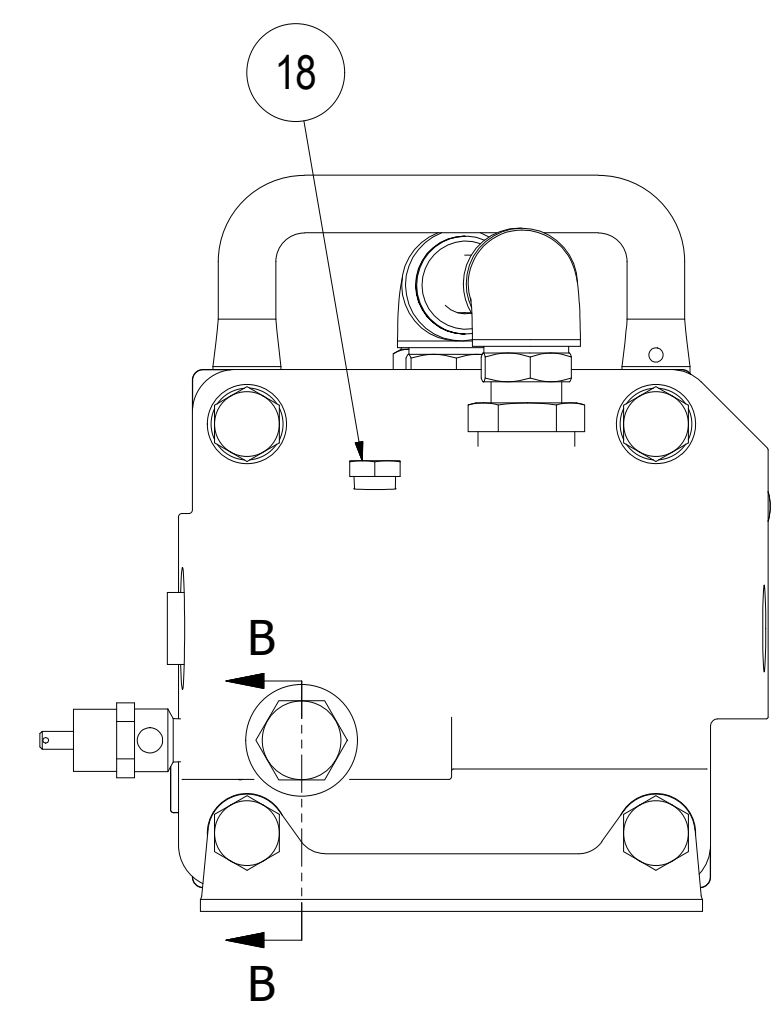
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REV	DESCRIPTION	DATE	CHECKED
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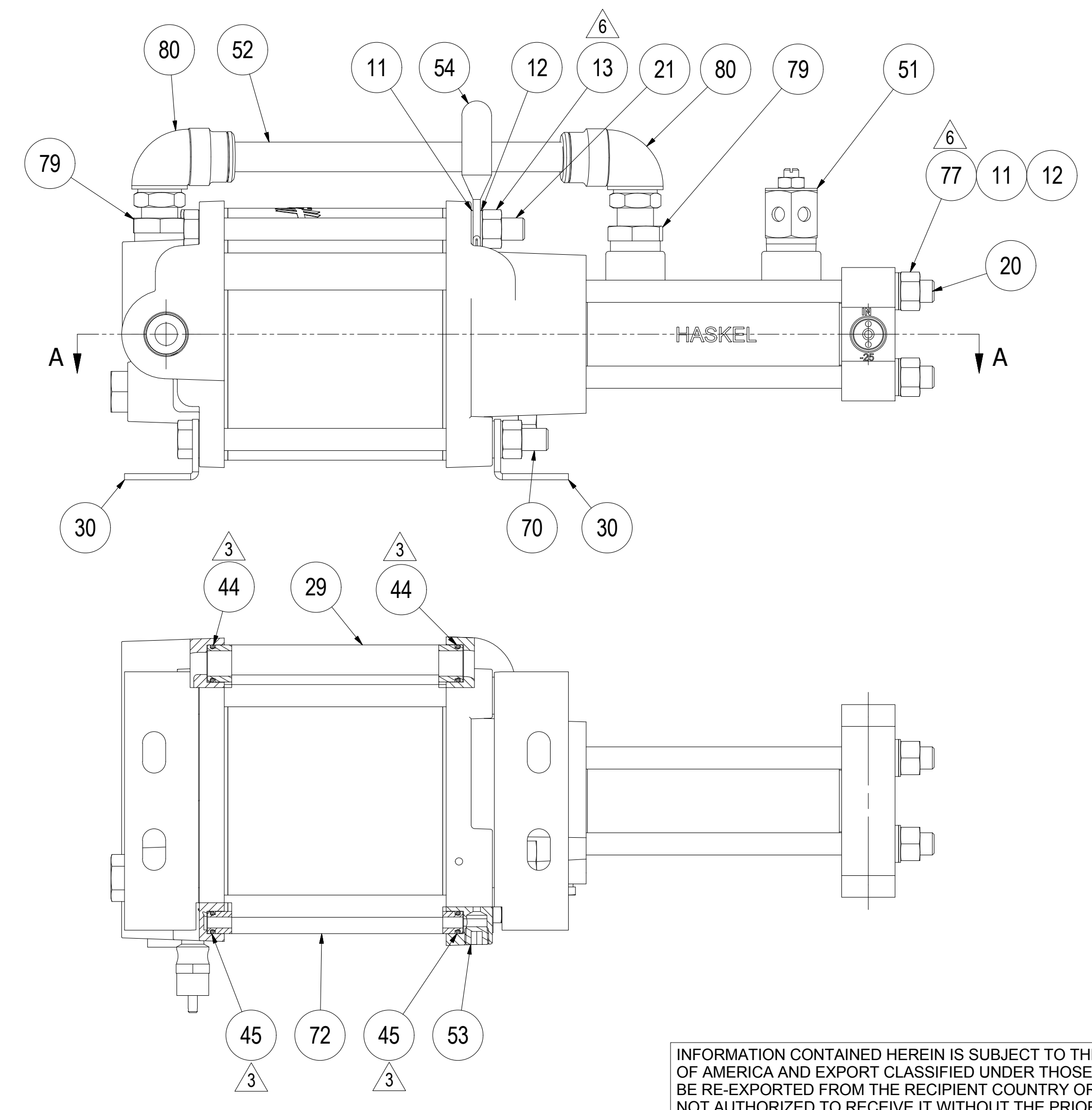
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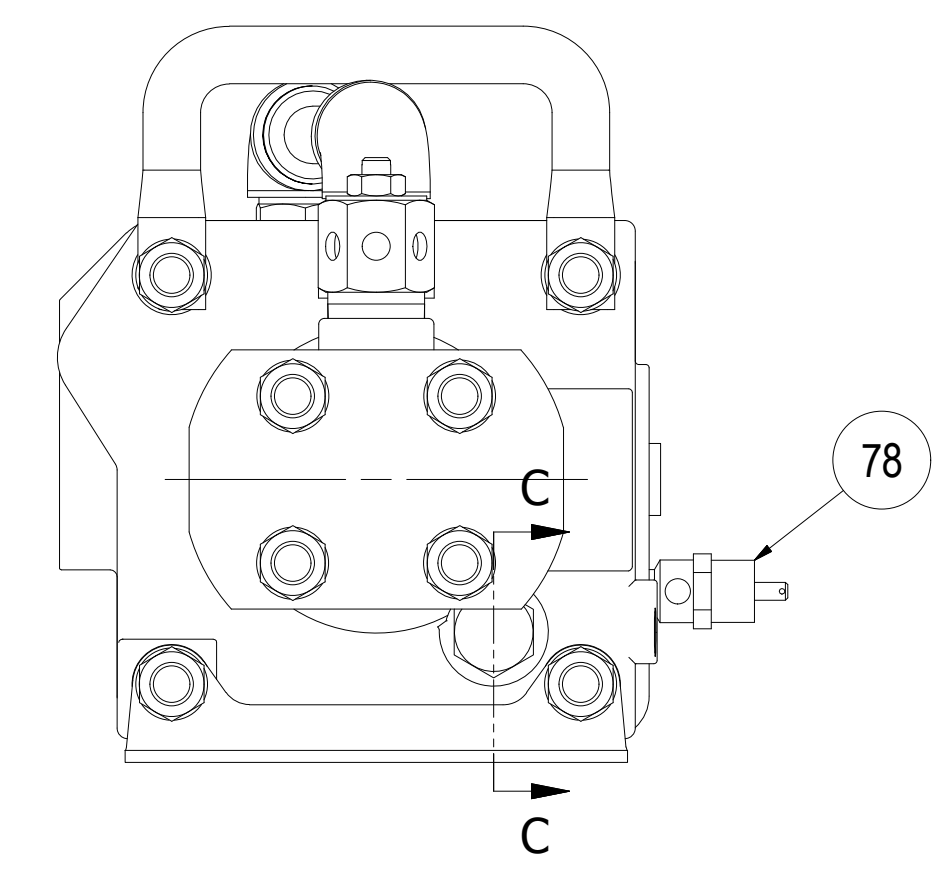
DETAIL D
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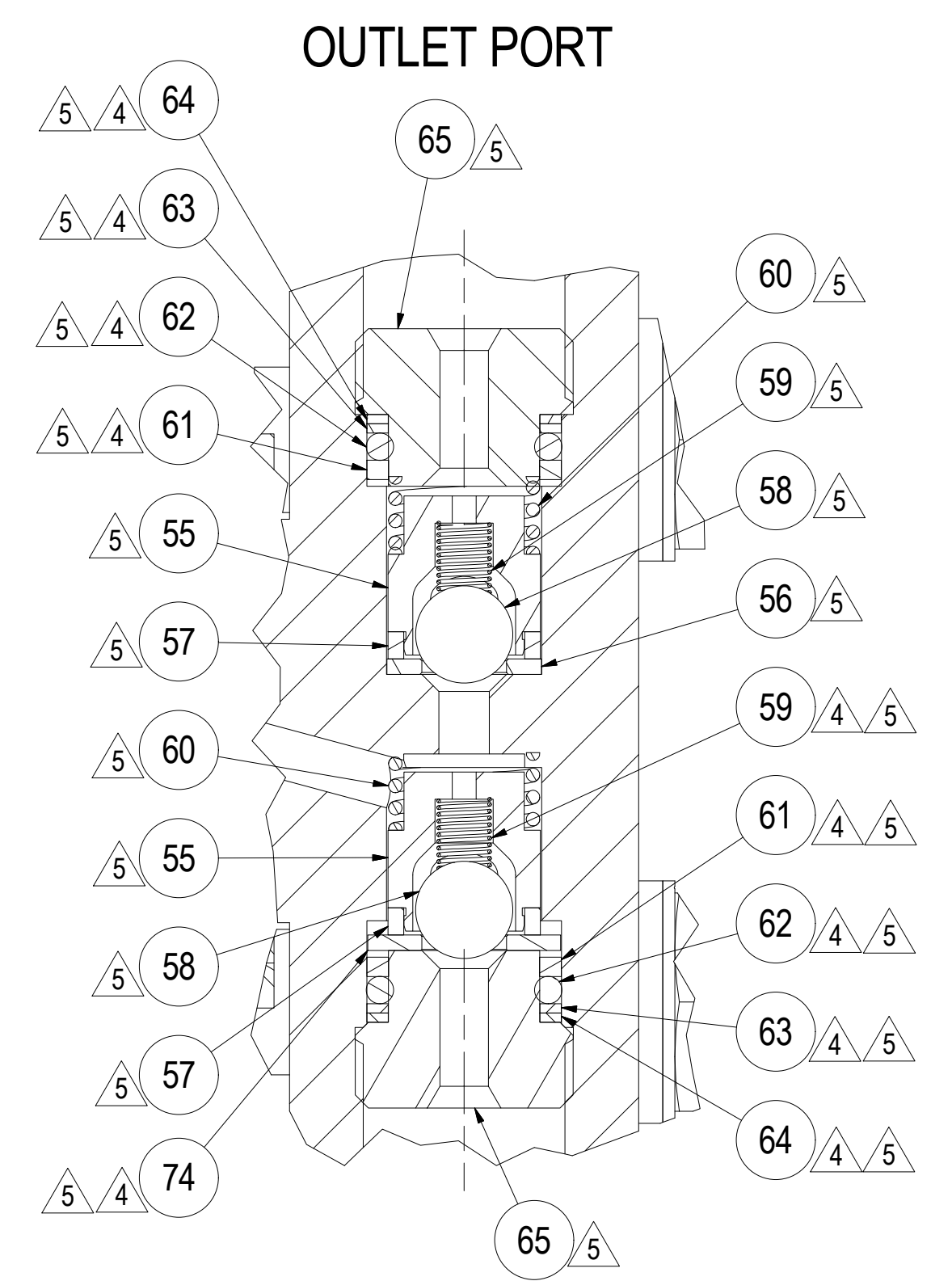
SECTION B-B
SCALE 1:1



SECTION C-C
SCALE 1:1



DETAIL E
SCALE 2.5:1

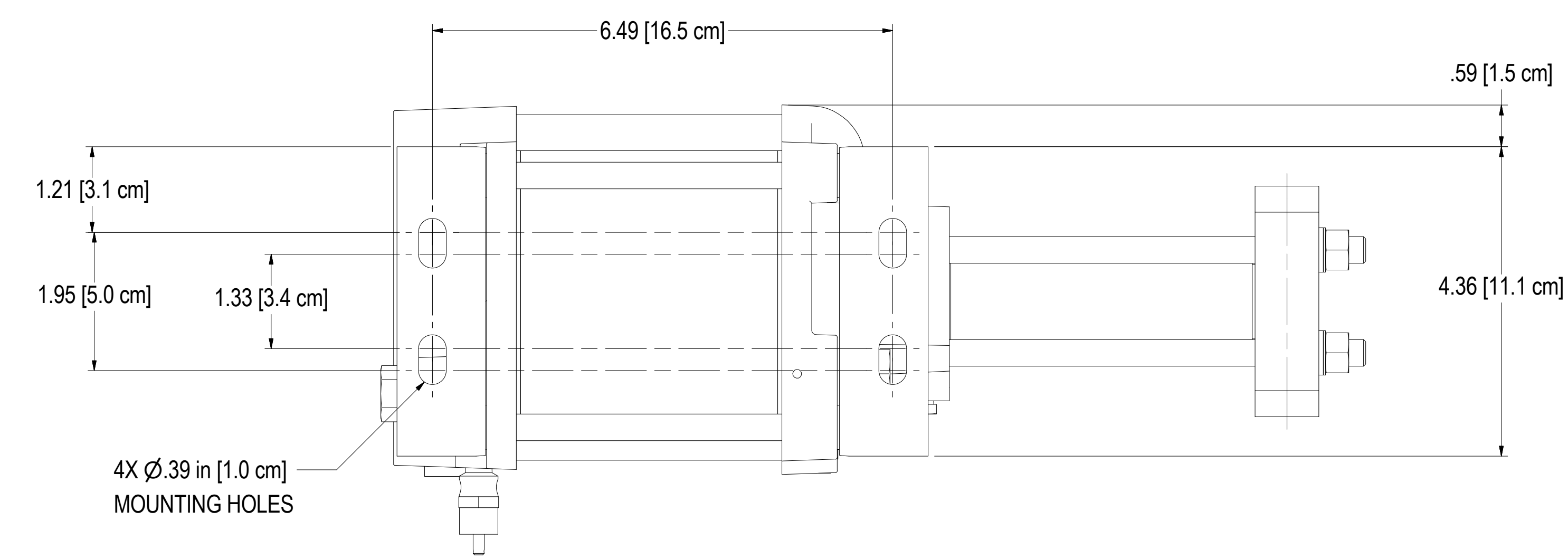
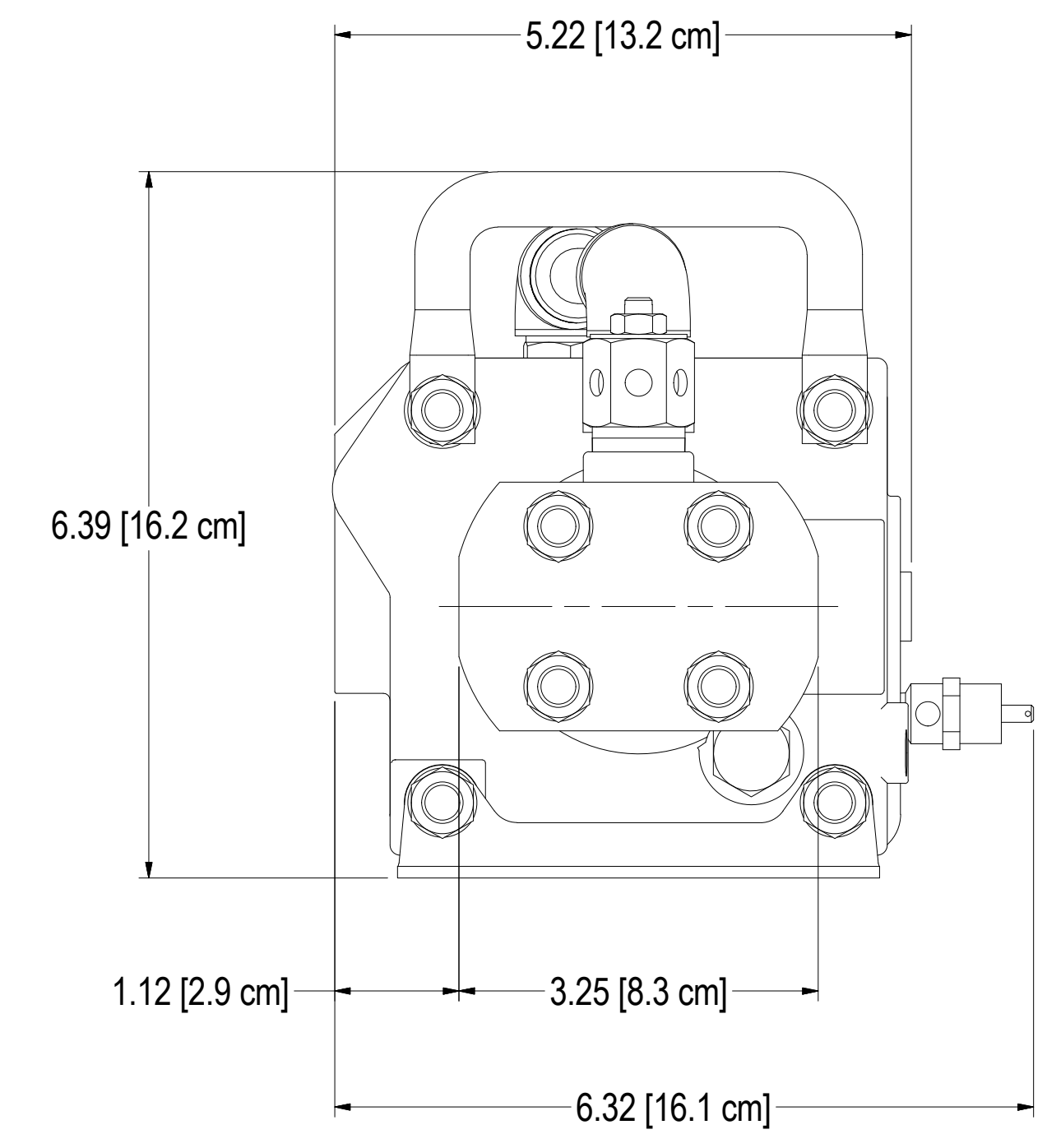
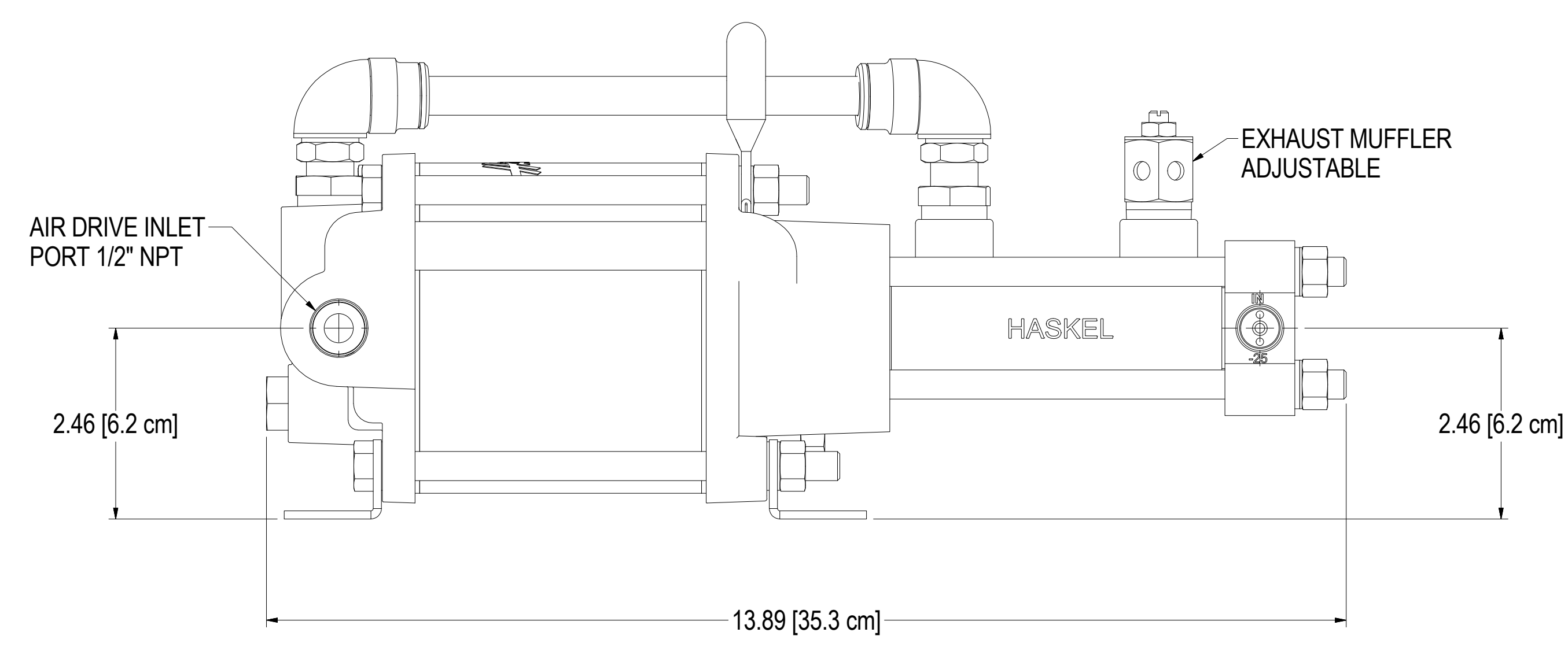
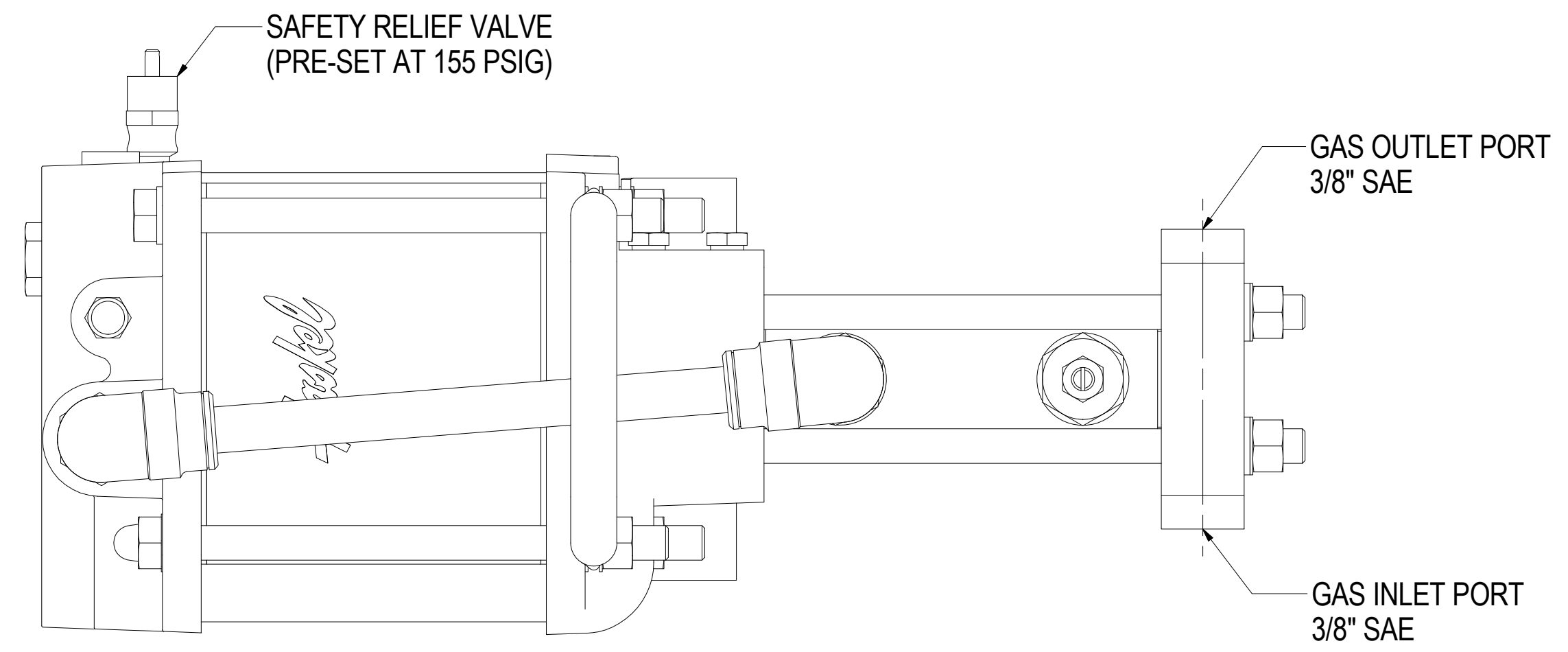


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DRAWN D MACH	CHECKED PD	SIZE D	CAGE CODE 81400	DWG NO. 86783	REV G

86783

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		Haskel International, LLC Burbank, California 91502		SIZE D	CAGE CODE 81400	DWG NO. 86783	REV G
DRAWN D MACH	CHECKED PD	SCALE: NA	INVENTOR DRAWING	SHEET 3 OF 3			

D	<i>Haskel</i>	AIR QUALITY RECOMMENDATIONS				
	100 E. Graham Place	REV	DESCRIPTION	BY	APPD	DATE
	Burbank, CA 91502 U.S.A.	D	REVISED PER ECO 32668	ES	SDQ	1/29/18

Table 1 - Compressed air purity classes for particles

Class	Maximum number of particles per cubic metre as a function of particle size, <i>d</i>		
	0.1 µm < <i>d</i> ≤ 0.5 µm	0.5µm < <i>d</i> ≤ 1.0 µm	1.0 µm < <i>d</i> ≤ 5.0 µm
0	As specified by the equipment user or supplier and more stringent than class 1		
1	≤ 20,000	≤ 400	≤ 10
2	≤ 400,000	≤ 6,000	≤ 100
3	Not specified	≤ 90,000	≤ 1,000
4	Not specified	Not specified	≤ 10,000
5	Not specified	Not specified	≤ 100,000

Table 2 – Compressed air purity for humidity and liquid water

Class	Pressure dewpoint, °C
0	As specified by the equipment user or supplier and more stringent than class 1
1	≤ -70
2	≤ -40
3	≤ -20
4	≤ +3
5	≤ +7
6	≤ +10

Table 3 – Compressed air purity classes for total oil

Class	Concentration of total oil (liquid, aerosol and vapour)
	mg/m ³
0	As specified by the equipment user or supplier and more stringent than class 1
1	≤ 0.01
2	≤ 0.1
3	≤ 1
4	≤ 5
X	> 5

SKIS-100	<i>Haskel</i>	AIR QUALITY RECOMMENDATIONS				
	ISO 8573-1:2010(E)					
	100 E. Graham Place	REV	DESCRIPTION	BY	APPD	DATE
	Burbank, CA 91502 U.S.A.	D	SEE SHEET 1	-	-	-

**Recommended Minimum ISO Quality Air Supply
For Haskel Air Motors is Class 5 or Better**

Class 1 or 2 may be required for heavy duty applications, i.e., high cycle rates (over 40 cpm) to help prevent freezing, high contamination, or higher pressures. The required frequency of re-lubricating the cycling spool may increase with dryer air.

Installation Hints

1. Generally install filters downstream of after-coolers and air receivers at the lowest installation temperature, and as close to the point of application as possible. This ensures that in wet systems as much water & oil vapor has condensed out as possible which can be removed by the coalescing filters. Installing close to the application reduces risk of pipe scale downstream of the filters contaminating the filtered air. Please refer to above installation hints.
2. Filters should not be installed downstream of quick opening valves, and should be protected from possible reverse flow or other shock conditions.
3. It may be necessary to install a combination of main line filtration near the compressor installation before entering the building or shop, and install additional filtration at the critical points. Remember especially in existing installations the contamination already in the pipe system downstream of the filters will take a long time to disappear, and probably never will completely.
4. Purge all lines leading to the filters before installation and connecting to the final application to be protected.
5. Install filters in a vertical position (pipe-work is horizontal) ensuring that there is sufficient room below the filters to facilitate element change.
6. Avoid by-pass lines whenever possible as contamination may leak through valves and by-pass the filters.
7. Provide a facility to drain away collected liquids where applicable from the filter drains via suitable tubing taking care that no restrictions are caused.
8. Install differential pressure gauges to indicate the pressure drop across the filters. This will give an idea of the filter element condition.
9. Care should be taken with larger filters to see that they are properly supported by the pipe-work.
10. If you have a problem on filter selection or installation, please contact your local Haskel distributor, or the Factory.



Oxygen Usage – Best Practice Guide

1. Introduction

Oxygen enriched systems possess a risk of fire and explosion since ignition and combustion hazards are present in all oxygen systems, and oxygen related fire incidents have occurred in many industries. Because ignition and combustion hazards are inherently present in most oxygen systems, a proper guidance for using Haskel oxygen service products is crucial to avoiding accidents and ensuring the safety of personnel and equipment.

2. Oxygen Hazards and Risks

Oxygen is a serious fire hazard. It makes materials easier to ignite and their subsequent combustion more intense, more complete, and more explosive than in air alone.

2.1. Causes of Fires in Oxygen

Many common ignition mechanisms and causes of oxygen system fires are recognized and well understood.

2.1.1. Kindling Chain

Ignition usually begins as a small event and grows into a fire through the kindling chain sequence. Once ignited, the material gives off enough heat to ignite bulk materials with higher ignition temperatures, which generate more heat, until the process is self-sustaining.

2.1.2. Ignition Mechanisms

Oxygen fires require a source of energy to trigger ignition. The most common ignition energy sources are:

2.1.3. Mechanical Impact

When one object impacts another, the absorbed energy appears as heat that can be sufficient to ignite materials at the point of impact.

2.1.4. Particle Impact

Small particles carried by flowing gas in the oxygen system strike surfaces of the system, such as piping intersections or valve seats. The kinetic energy of the particle creates heat at the point of impact, which can ignite either the particle or the target material.

2.1.5. Friction

The rubbing of two solid materials results in the generation of heat.

2.2. Pneumatic Impact or Compression Heating

When oxygen flows from high to low pressure through an orifice, such as when a valve is opened quickly, it often reaches sonic velocity and compresses the oxygen downstream against an obstruction, such as the seat of the next closed valve or regulator (Fig. 1). The gas temperature can reach the autoignition point of plastics, organic contaminants, or small metal particles.

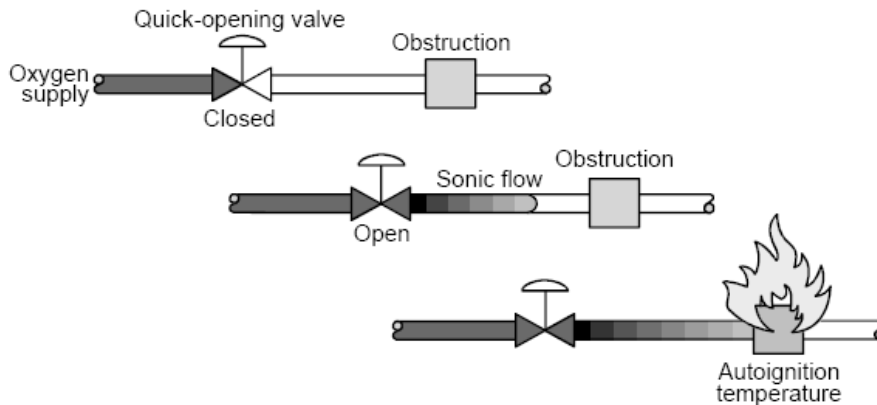


Figure 1

CAUTION: DO NOT USE ¼" quarter turn ball valves on oxygen systems. Use needle valves only (Fig.1).

3. Special Precautions and Operating Parameters

- 3.1. Do not exceed 5000 psig pressure output.
- 3.2. Do not use an oxygen booster for any other gas --even occasionally. Although other gases may be perfectly pure, we do not recommend this practice.
- 3.3. Service of the oxygen containing sections of the booster (or accessories) involves a more stringent procedure to insure cleanliness. It is strongly recommended that oxygen boosters to be returned to Haskel, Burbank for maintenance service. Factory training is available. Contact Haskel service department for details.
- 3.4. Maximum Compression Ratios (maximum output pressure psia, divided by minimum inlet pressure psia). The maximums shown in the following chart must be observed at all times to avoid excessive heat:

	Maximum Compression Ratios	
	O ₂ Inlet < 150 psig	O ₂ Inlet 150 psig or Higher
Single Stage	5 : 1	6 : 1
Two Stage	25 : 1	36 : 1
Three Stage	45 : 1	

For heavy duty, continuously operating applications, we recommend that the above compression ratios be reduced even further, where feasible, with additional staging and/or plenum coolers (now a standard optional Haskel accessory).

- 3.5. Design booster circuit cycling rate no greater than 50 Cycle/Minute (CPM).
- 3.6. Use valves that can be opened gradually to reduce adiabatic compression such as needle valve, **DO NOT use ¼ or 180° ball valves, globe valves or butterfly valves**, which may cause particle impact.
- 3.7. Isolate oxygen containers from booster system with proper distance (12 ~ 15 feet).
- 3.8. When connecting pipe to the system, visually inspect cleanliness at open ports. Use clean lint-free cloth, safe zone spray clean and wipe the opening. Use clean Latex gloves when contacting exposed plumbing. Cap or bag all connection ports when not in use.

4. System Set-up:

- 4.1. Check booster nameplates to confirm that all components, Haskel and other products, are certified for **OXYGEN SERVICE**.
- 4.2. Before operation, make sure **ALL** tubing, hoses, piping, and connections are capable of the specified maximum pressures indicated on the drawing. Make sure **ALL** connections, pipe work, hoses, and other parts that will come in contact with oxygen, have been thoroughly cleaned for oxygen service. Make sure **ALL** openings at cylinder hose connections and piping are clean and free of dust, oil, and grease, visual inspection or/and wipe test are recommended.
- 4.3. Make sure that oxygen supply and fill bottles are separated from oxygen booster section with 12 ~ 15 feet safe distance.
- 4.4. Do not install a valve between the supply cylinders and the booster system, or between outlet of booster and fill cylinders.

Caution: Do not use ¼ ball valves on Oxygen Section.
Needle valves only.

- 4.5. Connect air drive supply to the air inlet filter.
- 4.6. Connect oxygen supply to the oxygen inlet filter.
- 4.7. Connect fill cylinders to be pressurized.

5. Operation Instructions (Refer to Fig. 2 on Page 4)

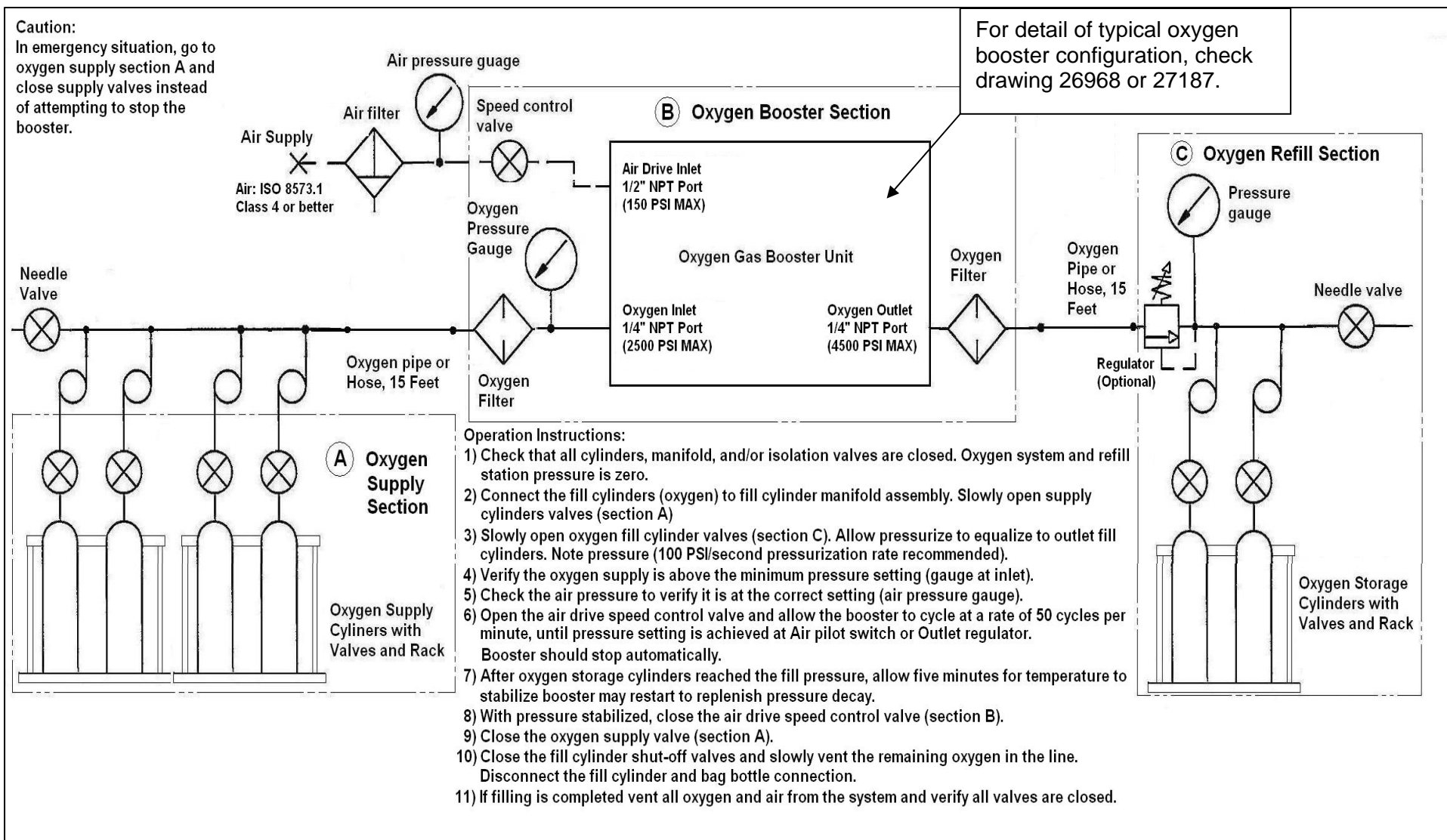


Fig. 2
Typical Configuration of
Haskel Oxygen System and Operation Instructions

6. Suggested Maintenance

Performance Interval	Maintenance Action	
Before/After each use.	a.	Perform overall visual check of system.
	b.	Drain and clean the air filter bowl.
	c.	Clean oxygen cylinder connections, cap connections
Every 20,000 cycles. (Or 3-6 months)	a.	Inspect and re-lubricate air cycling valve o-rings in air drive section. (Replace if necessary)
	b.	Check Booster for oxygen leaking from vents, external leakage, and overall performance.
	c.	Check tie rod bolts, relief valve and air pilot switch, hex nuts for loosing. Re-torque if needed.
Every 6 months.	a.	Test and calibrate all pressure gauges.
	b.	Replace oxygen and air filters.
Every 12 Months.	a.	Inspect piping at full system pressure.
	b.	Test relief valve, reset as needed
Every 500 - 1000 hours of continuous use, or every 18 Months.	a.	Reseal booster – gas section, air drive section as needed

Referenced Documents

- NFPA 53** Recommended Practice on Materials, Equipment and Systems Used in Oxygen-Enriched Atmospheres
- ASTM G128** Standard Guide for Control of Hazards and Risks in Oxygen Enriched Systems
- ASTM G88** Standard Guide for Designing Systems for Oxygen Service
- ASTM G-4** Standards Technology Training course *Controlling Fire Hazards in Oxygen Handling Systems*
- EIGA 8/76/E** Prevention of Accidents Arising from Enrichment or Deficiency of Oxygen in the Atmosphere



SAFETY INFORMATION

PUMPS, GAS BOOSTERS AND AIR PRESSURE AMPLIFIERS (LIQUID, AIR OR GAS DRIVEN)

> CAUTION <

**HIGH PRESSURE GAS OR LIQUID CAN BE DANGEROUS IF IMPROPERLY HANDLED.
EYE PROTECTION, RESPIRATORS AND GLOVES SHOULD BE USED PER MSDS**

1. BEFORE INSTALLATION:

- 1.1 Study the technical data received with the unit. Do not hesitate to call your distributor or Haskel, Inc., on any question.
- 1.2 Determine the maximum system pressure that might be encountered for the drive input, pump input, & pump output.
 - 1.2.1 Be certain that the data confirms the unit is rated for those pressures at all three connections.
 - 1.2.2 Be certain that your connecting piping, fittings, gauges, and accessories are rated properly at all three ports and that relief valve or burst disc protection is provided for any potential over pressure.
- 1.3 Review the compatibility of the gas and/or liquids with all components and piping (particularly oxygen gas where each component exposed to the gas should be specifically cleaned, labeled, and designed for oxygen service).
- 1.4 Do not use oxygen gas boosters to pump any other gas.

2. INSTALLATION:

- 2.1 Inspect all connections for contaminants and clean as needed before tightening. If system is for oxygen gas, follow specific special inspection and cleaning procedures to ensure removal of any hydrocarbon contamination.
- 2.2 Fasten unit securely to mounting surface before tightening piping connections.
- 2.3 Use back up wrench to hold unit fitting while tightening connecting fitting.
- 2.4 Stop and inspect for any indication of cross-threading or galling (particularly stainless steel to stainless steel fittings).
- 2.5 Assure that system isolation valves are installed on the drive input, fluid input and fluid discharge lines. Also make sure that bleed down valves are installed so that pressure can be vented off from all connections to the pump.

3. OPERATION:

- 3.1 Be certain you have an understanding of the complete system before operating. Question anything that is unclear.
- 3.2 Equalize inlet & outlet pressures slowly first. Always open fluid inlet and outlet valves (to and from the pump sections) before opening drive valve. (Inlet gas will free flow through all pumps & boosters when inlet pressure exceeds outlet)
- 3.3 Open all valves slowly. Do not use quick acting valves such as 1/4 turn type - particularly in oxygen gas systems.
- 3.4 Presume that ALL installations will eventually leak due to vibration, wear or accident. Consider ALL fluids (except air & water) to be potentially hazardous if confined in a closed area. Therefore, operate only in a well ventilated area.

4. MAINTENANCE:

- 4.1 Prior to performing any maintenance, close all three isolation valves and vent all pressure to zero. **THIS IS CRITICAL. INJURY MAY RESULT IF MAINTENANCE IS ATTEMPTED WHILE THE UNIT IS PRESSURIZED.**
- 4.2 Perform maintenance in accordance with the Operating & Maintenance Manual. Make sure that replacement seals and O-rings are of fluid compatible material. Do not modify the unit in any way without contacting the factory.

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OXYGEN

Oxygen is a colorless, odorless, and tasteless gas. It makes up about 21 percent of our atmosphere.

WARNING

Oxygen supports and can greatly accelerate combustion.

Oxygen, as a liquid or cold gas, may cause severe frostbite to the eyes or skin. Do not touch frosted pipes or valves. If exposure to liquid oxygen or cold gas occurs, restore tissue to normal body temperature (98.6°F) as rapidly as possible, followed by protection of the injured tissue from further damage and infection. Call a physician immediately. Rapid warming of the affected part is best achieved by using water at 108°F. Under no circumstances should the water temperature be over 112°F, nor should the frozen part be rubbed either before or after rewarming. The patient should not smoke or drink alcohol. Keep warm and at rest.

Use a pressure-reducing regulator when withdrawing gaseous oxygen from a cylinder or other high-pressure source.

Keep Combustibles Away From Oxygen and Eliminate Ignition Sources.

Many substances which do not normally burn in air and other substances which are combustible in air may burn violently when a high percentage of oxygen is present. DO NOT permit smoking or open flame in any area where oxygen is stored, handled, or used. Keep all organic materials and other flammable substances away from possible contact with oxygen, particularly oil, grease, kerosene, cloth, wood, paint, tar, coal, dust, and dirt which may contain oil or grease. Avoid spills of liquid oxygen. Do not walk on or roll equipment over spills.

Keep All Surfaces Which May Come In Contact With Oxygen Clean to Prevent Ignition.

Even normal industrial soot and dirt can constitute a combustion hazard. Do not place liquid oxygen equipment on asphalt, or on any surface which may have oil or grease deposits. Use cleaning agents which will not leave organic deposits on the cleaned surfaces. In handling equipment which may come in contact with oxygen, use only clean gloves or hands washed clean of oil. Do not lubricate oxygen equipment with oil, grease, or unapproved lubricants.

Maintain Adequate Ventilation.

To prevent accumulation of oxygen in areas containing oxygen equipment and to minimize combustion hazards, adequate ventilation must be provided.

Liquid Oxygen Is Extremely Cold.

(297 deg. F. below zero)

COVER EYES AND SKIN.

Accidental contact of liquid oxygen or cold oxygen gas with the eyes or skin may cause severe frostbite. Handle liquid so that it will not splash or spill. Protect your eyes with safety goggles or face shield, and cover the skin to prevent contact with the liquid or cold gas, or with cold pipes and equipment. Clean, protective gloves without gauntlet that can be quickly and easily removed and long sleeves are recommended for arm protection. Cuffless trousers should be worn outside boots or over high-top shoes to shed spilled liquid. If clothing should be splashed with liquid oxygen or otherwise saturated with oxygen gas, air out clothing immediately. Such clothing should not be considered safe to wear for at least 30 minutes, since it will be highly flammable and easily ignited while the concentrated oxygen remains.

Containers, Equipment, and Replacement Parts Must Be Suitable for Oxygen Service.

Use only equipment, cylinders, containers and apparatus designed for use with oxygen. Many materials, especially some non-metallic gaskets and seals, constitute a combustion hazard when in oxygen service, although they may be acceptable for use with other gases. Make no substitutions for recommended equipment, and be sure all replacement parts are compatible with oxygen and cleaned for oxygen service. Keep repair parts in sealed clean plastic bags until ready for use.

Regulators.

Before attaching regulator to cylinder, inspect the regulator very carefully. Make visually certain that the regulator and the inlet filter are free of oil, grease or other hydrocarbon-type contaminants. These contaminants may be ignited when the cylinder valve is opened and would burn violently in an enriched oxygen atmosphere. Replace the inlet filter if broken, missing or found contaminated. When filter is missing or damaged, the regulator should also be reconditioned and the high pressure gauge replaced. Before attaching the regulator to the cylinder valve, crack the cylinder valve momentarily to blow out any dust or dirt that might have accumulated in the cylinder valve outlet. Connect the regulator to the valve, back out the pressure adjusting screw until it turns freely and then open the cylinder valve very slightly and very slowly so the inlet pressure gauge moves slowly to the Cylinder pressure. Then open the cylinder valve all the way. To minimize chance of injury, stand to one side of the regulator when opening the cylinder valve.



EC DECLARATION OF CONFORMITY

We of **Haskel International Inc.**
100 East Graham Place
Burbank, CA 91502, USA

declare that any:

Gas Booster / Air Amplifier / Air Driven Liquid Pump Serial No. 0111-989

Mini Pump Serial No. M111-985

and beyond, Issue after January 27, 2011

conform to the provisions of Council Directive 2006/42/EC on the approximation of the laws of the Member States relating to Safety of Machinery.

Conformity is declared based on the provisions of the Essential Health and Safety Requirements of Annex 1 of the Machinery Directive.

The equipment has been designed and manufactured to comply with the following harmonised standards:

BS EN 13857:2008 Safety of machinery - Safety distances to prevent hazard zones being reached by the upper and lower limbs;

BS EN ISO 12100:2010 - Safety of machinery. General principles for design. Risk assessment and risk reduction

BS EN 13732-1:2008 Thermal environment – Methods for the assessment of human response to contact with surfaces;

(BS EN 1012-1:2010 Compressors and vacuum pumps - Safety requirements Part 1: Compressors) *Not to use until this standard is published in the OJEU*

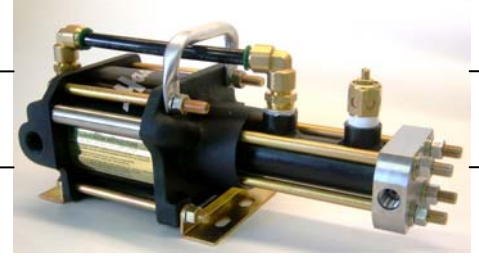
BS EN 809:1998 + A1:2009 Pumps and pump units for liquids- Common safety requirements. (For Air driven liquid Pumps only)

Signed:

A handwritten signature in blue ink, appearing to be "Greg Terterian", written over a horizontal line.

Responsible Person:

Greg Terterian, Director of Engineering
Haskel International Inc.
100 East Graham Place
Burbank, CA 91502 USA



SINGLE AIR HEAD
SINGLE ACTING
SINGLE STAGE

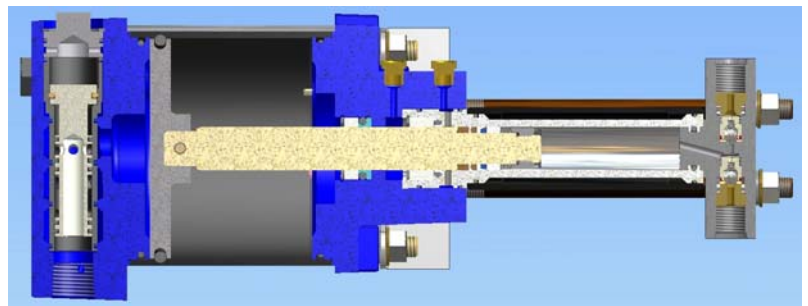
MODEL NO: MSB-9000

SERIAL NO:

DATE:

PLEASE PROVIDE COMPLETE MODEL NO. AND SERIAL NO. WHEN ORDERING PARTS.

Air Driven GAS BOOSTER MSB-9000



Operating and Maintenance Instructions

LIMITED WARRANTY

Haskel manufactured products are warranted free of original defects in material and workmanship for a period of one year from date of shipment to first user.

This warranty does not include packings, seals nor failures caused by lack of proper maintenance; incompatible fluids; foreign materials in the driving media; in the pumped media; or application of pressures beyond catalog ratings. Products believed to be originally defective may be returned, freight prepaid for repair and/or replacement to the distributor, authorized service representative, or to the factory. If upon inspection by the factory or authorized service representative the problem is found to be originally defective material or workmanship, repair or replacement will be made at no charge for labor or materials, F.O.B the point of repair or replacement.

Permission to return under warranty should be requested before shipment and include the following; the original purchase date, purchase order number, serial number, model number, or other pertinent data to establish warranty claim, and to expedite the return or replacement to the owner.

If unit has been disassembled and reassembled in a facility other than Haskel, warranty is void if it has been improperly reassembled or substitute parts have been used in place of factory manufactured parts.

Any modification to any Haskel product which you have made or may make in the future has been and will be at your sole risk and responsibility, and without Haskel's approval or consent. Haskel disclaims any and all liability, obligation, or responsibility for the modified product; and for any claims, demands or causes of action for damage or for personal injuries resulting from the modification and/or use of such a modified Haskel Product.

HASKEL'S OBLIGATION WITH RESPECT TO ITS PRODUCTS SHALL BE LIMITED TO REPLACEMENT, AND IN NO EVENT SHALL HASKEL BE LIABLE FOR ANY LOSS OR DAMAGE CONSEQUENTIAL OR SPECIAL, OF WHATEVER KIND OR NATURE, OR ANY OTHER EXPENSE WHICH MAY ARISE IN CONNECTION WITH OR AS A RESULT OF SUCH PRODUCTS OR THE USE OR INCORPORATION THEREOF IN A JOB. THIS WARRANTY IS EXPRESSLY MADE IN LIEU OF ALL OTHER WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE. NO EXPRESS WARRANTIES AND NO IMPLIED WARRANTIES WHETHER OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR OTHERWISE, OTHER THAN THOSE EXPRESSLY SET FORTH ABOVE, SHALL APPLY TO HASKEL PRODUCTS.

CAUTION: HIGH PRESSURE GAS CAN BE DANGEROUS IF IMPROPERLY HANDED.

INTRODUCTION

The Haskel "Oil-Free" 4 Inch Gas Booster is an air driven, non-lubricated, reciprocating piston type gas booster. This booster is a single stage and single acting type. The approximate ratio of the air drive piston to the gas piston is 25:1.

GENERAL

The air drive piston is automatically cycled by a non-detained, un-balanced air valve spool that is alternately pressurized and vented by the pilot air system. This drive is directly connected to the booster section piston which is designed to run dry without lubrication to supply gas free of hydrocarbon contamination. Exhaust air from the air drive is utilized to cool the gas barrel by directing the exhaust air through a cooling jacket.

AIR DRIVE SECTION

Refer to detailed assembly drawing of the air drive section provided with each unit. The air drive section consists of one air drive piston assembly, an un-balanced spool type cycling control valve and pilot valves (one mounted in the valve end cap and one in the opposite end cap), a flow tube to direct drive air flow from the valve end cap to the opposite end cap, and a pilot tube to connect the two pilot valves, which are in series. The drive control valve operates without springs and is cycled by the pilot valves alternately pressurizing and venting the large area on the inside end of this spool valve.

The control valve, pilot valves and drive cylinder are lubricated with oxygen compatible grease, at assembly. Occasional re-lubrication may be needed depending on the booster's duty cycles. This process will be described in the maintenance sections. Haskel replacement seals are recommended.

If not otherwise installed by the factory, always install a conventional bowl type shop air filter/water separator of the same or larger pipe size on the incoming air drive plumbing and drain and maintain it regularly. ***Do not use an airline lubricator of any kind.***

GAS SECTION

Refer to the detailed assembly drawing on the gas section provided with each unit. These sheets cover the individual parts and their installation for gas section. Note that no ***lubrication of any kind is ever used in the gas pumping sections.*** They are design to run dry supported by the inherent low friction properties of the seal and bearing materials. The life of the gas section depends on the cleanliness of the gas supply, and therefore, a 5 micron filter is suggested at the gas inlet port. If compressed air or other moisture containing gas is to be pumped, the initial dew point should be low enough to prevent saturation at booster output pressure, and if any carry over of oil from the compressed air source is evident, special coalescing type filtration may be necessary.

Over the life of the moving parts, some migration of inert particles into the gas output should be expected. Therefore, a small particle filter on the high pressure line is recommended for critical applications.

For oxygen service: The booster was cleaned and assembled in a clean room environment at the factory. When servicing the gas section, trained personnel with oxygen application experience is necessary. It is recommended that the booster be sent back to the factory for gas section service. **For oxygen service, only oxygen compatible grease should be use per MIL-STD-1330D or HPS-4.11.**

COMPRESSION RATIO – Volumetric Efficiency

The compression ratio is the ratio of output pressure to gas supply pressure (to calculate, use absolute pressure values). The gas pumping section is designed to have minimize un-swept or clearance volume at the end of the compression stroke. On the return (suction) stroke of the piston, output pressure in the un-swept volume expands to inlet pressure. This reduces the amount of potential fresh gas intake on the suction stroke. Volumetric efficiency therefore decreases rapidly with an increase in compression ratio until the volumetric efficiency reaches zero when the un-expelled (expanded) gas completely fills the cylinder at the end of the intake stroke. A cylinder with a 4% un-swept volume will reach zero efficiency at a compression ratio of approximately 25:1. Production of Haskel gas boosters are tested at the factory.

COOLING

Effective cooling of the gas pumping section is of paramount importance as service life of the piston seals, bearings, and static seals are dependent upon proper operating temperatures. Haskel gas boosters use the exhaust air from the driving system to cool the gas barrel. Driving air expands during the work cycle with a significant reduction in temperature. Therefore, the exhaust air is a very efficient source of cooling medium.

In theory, compression ratios above 3:1 with most gases produce temperatures above the allowable limits for the seals. In practice, however, the heat of compression is transferred to the air cooled gas barrel and adjacent metal components during the relatively slow speed of the piston on the compression stroke. Therefore, these components will stay within allowable temperature limits. Laboratory tests indicate that maximum temperature occur between compression ratios of 5:1 and 10:1 and have shown that the exhaust air cooling is adequate even when the booster is running at full speed.

The gas discharge temperature may run as high as approximately 150° F above ambient temperature. Under certain severe operating conditions, it may be necessary to slow down the cycling of the gas booster to prevent overheating. It is very difficult to predict exactly when overheating may occur. To test, install a thermocouple approximately 1 inch from the discharge port of the gas pumping section. Temperature above 300° F at this point will shorten gas piston seal life considerably.

OPERATION SPECIFICATIONS

This booster is design to have a maximum of 150 PSI air drive pressure. ***It is not recommended to exceed 150 PSI air drive pressure at any time.*** The maximum output pressure with 150 PSI air drive inlet is 3,750 PSI. Although the booster is capable of cycling at more than 180 cycles/minute (at zero back pressure), it is ***not recommended to exceed 60 cycles/minute continuously.*** At cycle rate exceeding 60 cycles/minute of operation will damage the gas seals considerably and can result in booster failure. This can be controlled by the adjustable exhaust muffler (P/N: 86804). This can also be controlled by slowly increasing air drive pressure at start up.

1. ROUTINE MAINTENANCE

Normal Maintenance requirements are limited to periodic re-lubrication for the cycling valve as follows (Refers to figure 1 for reference):

1.1 Air Cycling Valve Lubrication and Assembly

Remove the cycling spool from the top cap (9) and check the spool and o-ring as follow:

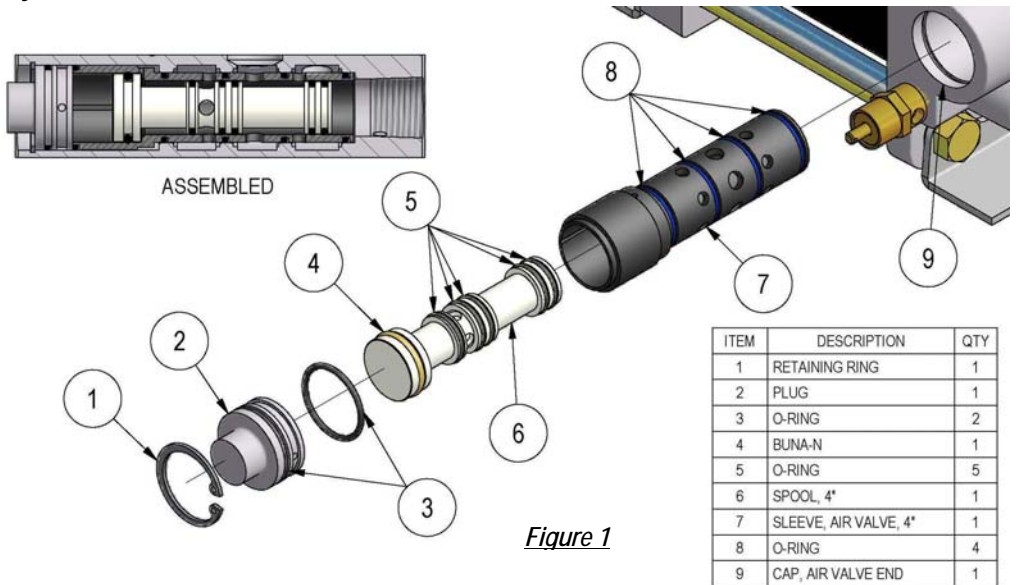


Figure 1

- A. Use Truarc pliers to remove the Truarc ring (1).
- B. Use ordinary pliers to remove the end plug (2) & o-ring (3).
- C. Push the cycling spool out with a probe through the drive inlet port. Inspect all o-rings (4 & 5) on the cycling spool (6), and replace any that are worn or damaged. Re-lubricate with oxygen compatible grease. Reassemble and test.
- D. Use extractor tool (P/N: 28584) to pull out the sleeve (7). If necessary, use a screwdriver in the pry grooves of the tool.
- E. Check for visible damage to the sleeve (7) or the five dynamic o-rings (4 & 5) for scores, scratches, & etc. Replace these parts as needed. Lubricate the four static o-rings (8) on the sleeve's OD.
- F. Push the sleeve (7) back into the air cap (9). Lightly lubricate and insert o-ring (3) on to the end of the sleeve (7), using the plug (2) to push it into position.
- G. Lightly lubricate and install o-ring (3) on to the plug. Push the plug (2) past the snap ring groove in the casting and into contact with the end of the sleeve (7).
- H. Use a new Truarc ring (1) to retain the end plug.

1.2 Pilot Stem Lubrication and Assembly.

There are two pilot stems on each booster; one on the cycling valve and one on the vent cap. (Refer to figures 2 & 3 for reference)

- A. Use wrench to remove plug (10).
- B. Remove spring and use pliers to pull stem (13) out. Inspect the stem and make sure there are no scratches or scores on the smaller OD of the stem. Replace if needed.
- C. Slightly apply lubrication to the smaller OD of the stem and to the rubber bonding of the stem.
- D. Slightly apply lubrication to the o-ring (11) and tighten the plug (10). (Torque to 2 ft-lb max.)

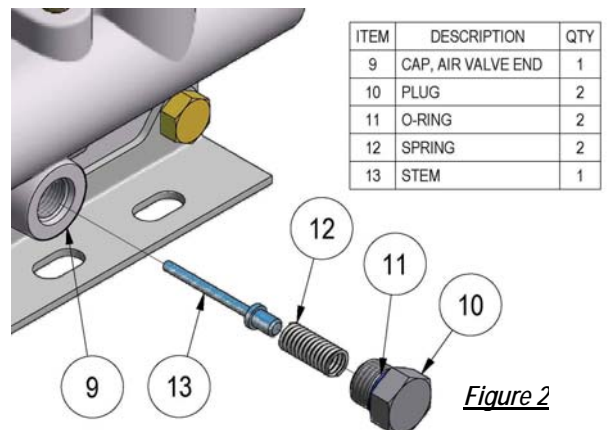


Figure 2

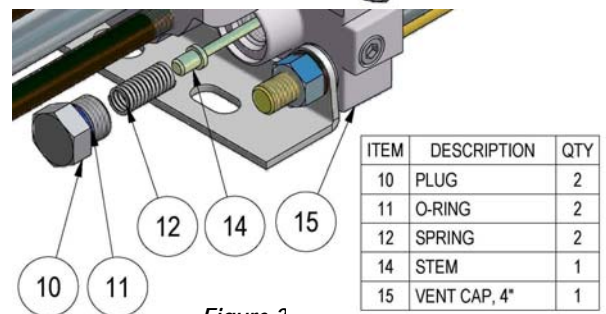


Figure 3

2. DISSASSEMBLY AND INSPECTION

2.1 Air Drive Section

- Use Figure 4 for reference.
- Remove tubing (22) from the two elbows (23)
- Use a wrench to remove 4 nuts (16) as shown in Figure 4.
- Slide 4 bolts (21) and remove brackets (19) & handle (20).
- Disassemble Air Piston as shown in Figure 5. Check for any wear on Piston o-ring (28).
- Check bumpers (30) for damage and replace if necessary. There are six total with 3 on each end cap.

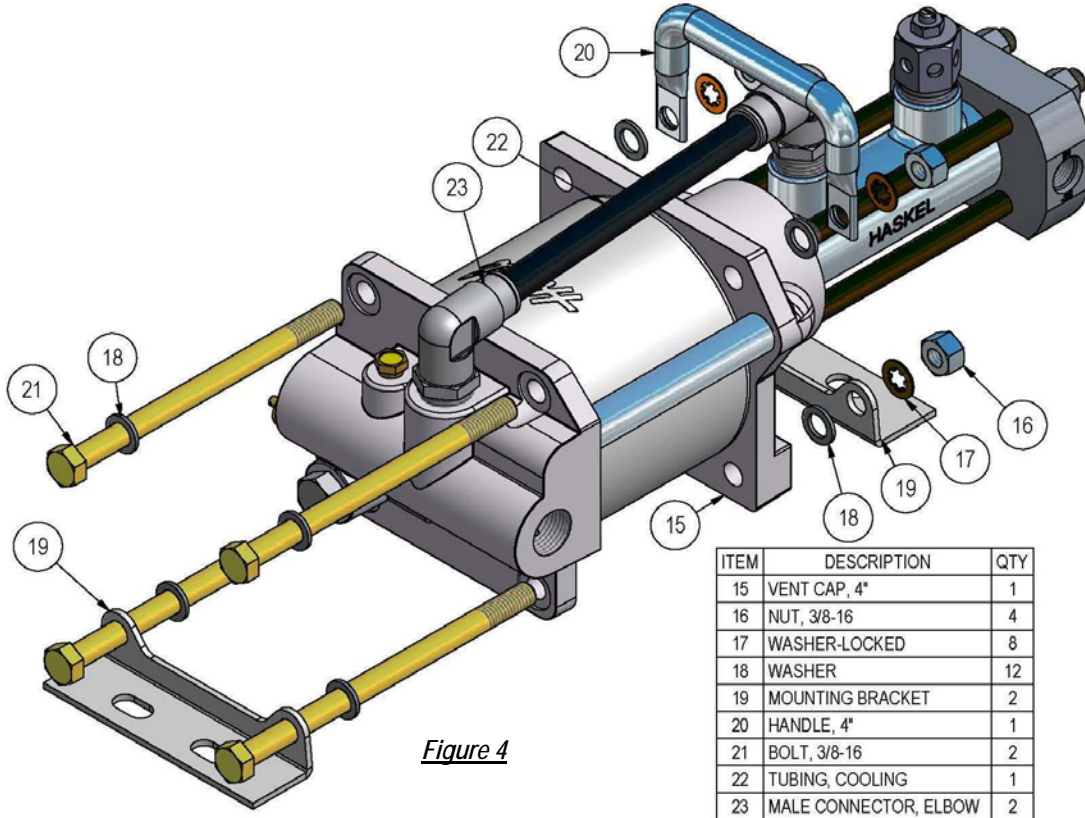


Figure 4

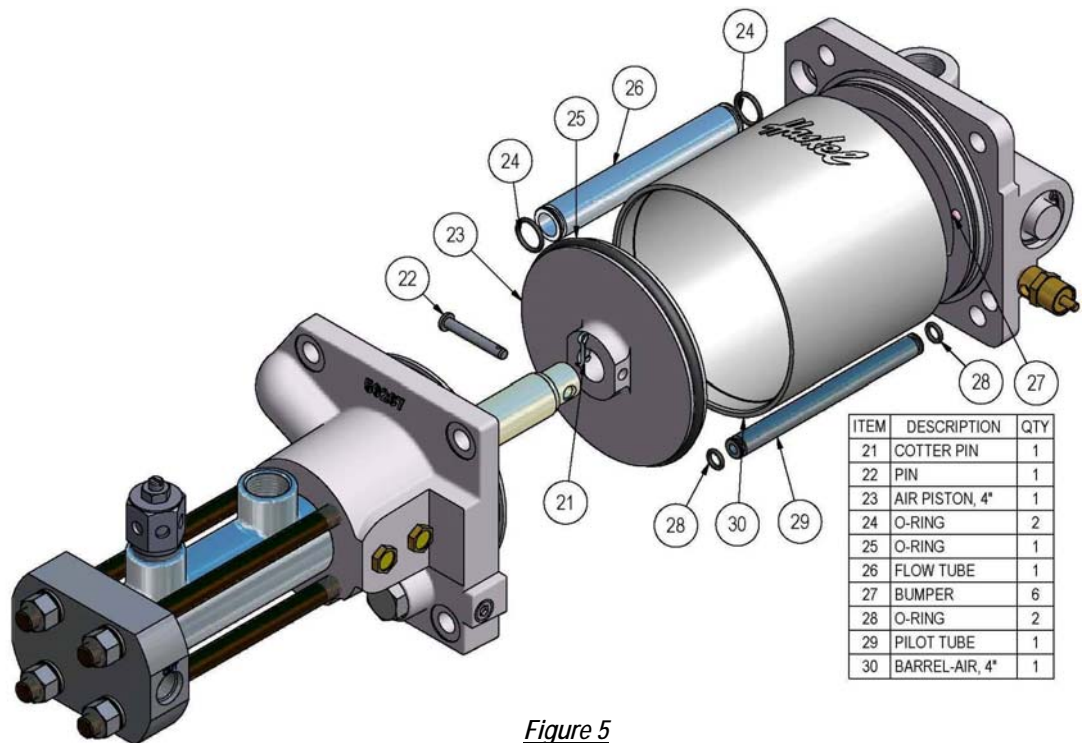


Figure 5

2.2 Gas Section

2.2.1 Gas Barrel (Refer to Figure 6 & 7)

- A. Unscrew the four nuts (37) & remove end cap (34).
- B. Gently remove cooling jacket (32) & gas barrel (31).
- C. To inspect rod bearing, remove retaining ring (38), then slide out the bearing (39) and the glider ring (40) along with the o-ring (41).
- D. From here the gas barrel can then be inspected for any scratches.
- E. There is also another bearing in the gas vent bearing in the gas vent cap (44). Refers to Figure 8 for reference.

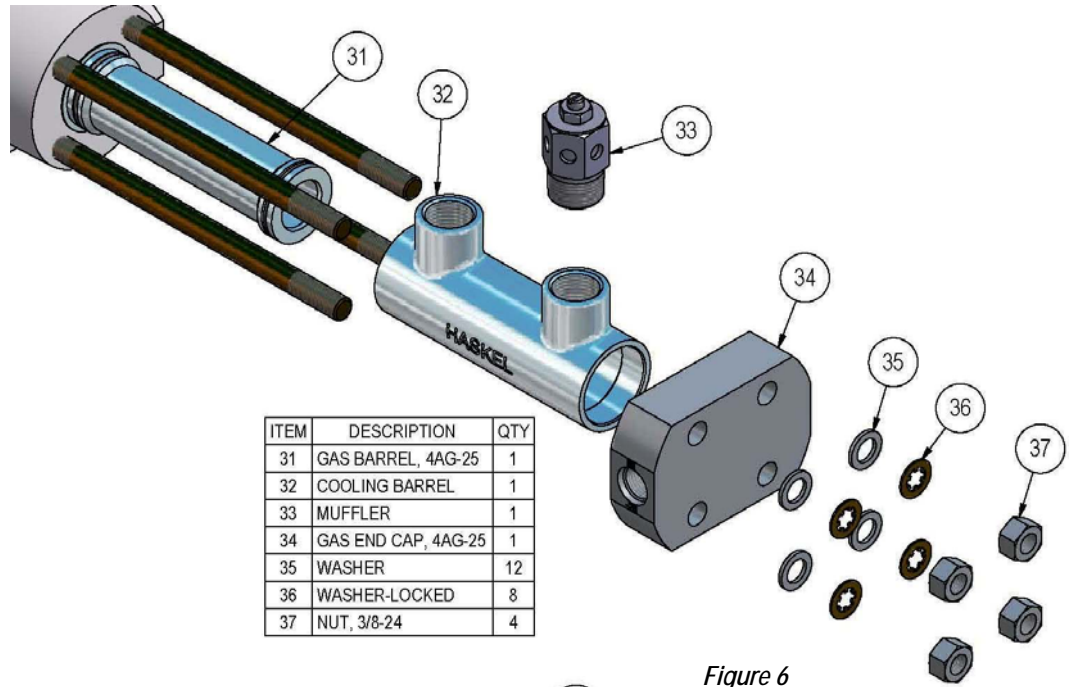


Figure 6

ITEM	DESCRIPTION	QTY
31	GAS BARREL, 4AG-25	1
38	RETAINING RING	2
39	BEARING, AG-50	1
40	GLIDER RING	1
41	O-RING	1
42	O-RING	2
43	O-RING	2

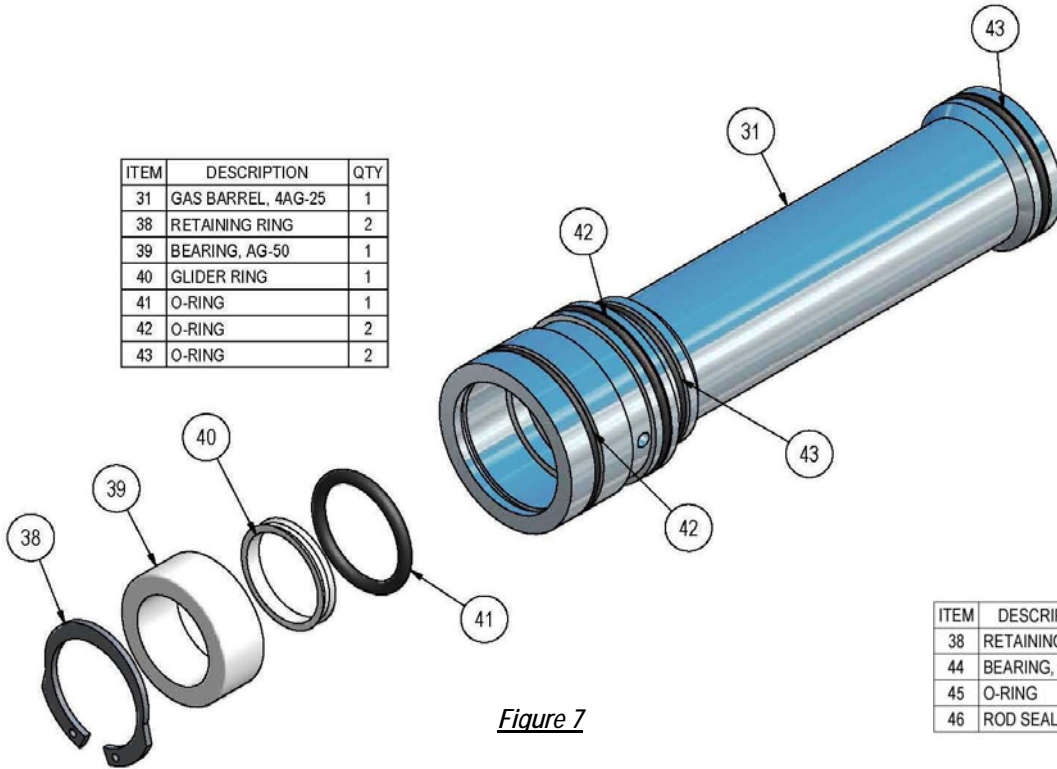


Figure 7

ITEM	DESCRIPTION	QTY
38	RETAINING RING	2
44	BEARING, AG-50	1
45	O-RING	1
46	ROD SEAL, AG-50	1

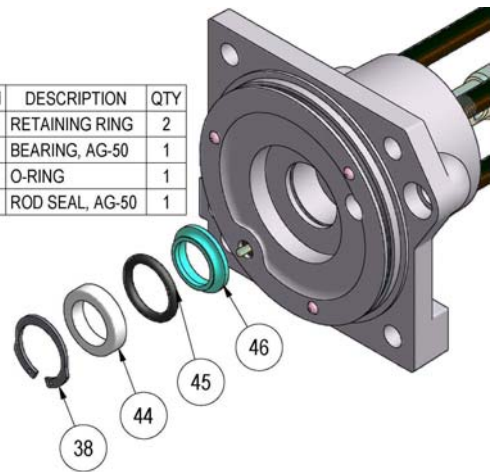


Figure 8

2.2.2 Piston Seal Assembly

- A. Use a needle nose pliers to remove cotter pin (48)
- B. Use tool assembly tool (101) to remove retainer (56). The rest of the assembly (49 to 55) should slide out of the piston rod (47).
- C. The main seal for the gas section is item 51 & 52.

ITEM	DESCRIPTION	QTY
47	PISTON ROD, 4AG-25	1
48	COTTER PIN	1
49	BACK-UP, SEAL	1
50	BACKUP	2
51	SEAL, TEFLON	1
52	SEAL	1
53	O-RING	1
54	BEARING-PISTON	1
55	SPRING WASHER, BELLEVILLE	7
56	NUT, RETAINER	1
101	ASSEMBLY TOOL, 4AG-25 & GS-50	1

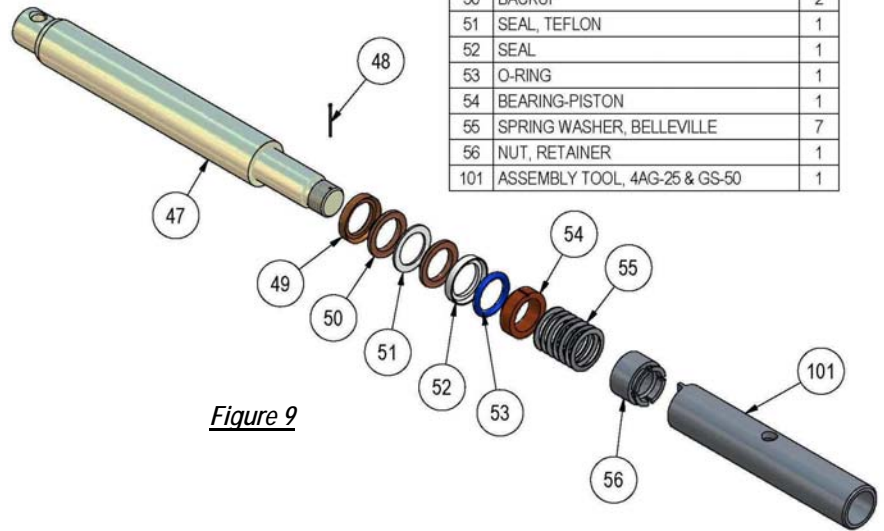


Figure 9

2.2.3 Check Valve Assembly

- A. Use tool (102) to remove retainer (57) and disassemble check valve assemblies as shown in figure 10.

ITEM	DESCRIPTION	QTY
34	GAS END CAP, 4AG-25	1
57	RETAINER	2
58	BACK-UP	2
59	BACKUP RING	2
60	O-RING	2
61	BACKUP RING	2
62	SEAT	1
63	RING	2
64	BALL	2
65	SPRING	2
66	SHANK	2
67	SPRING	2
68	SEAT	1
102	TOOL-CHECK VALVE	2

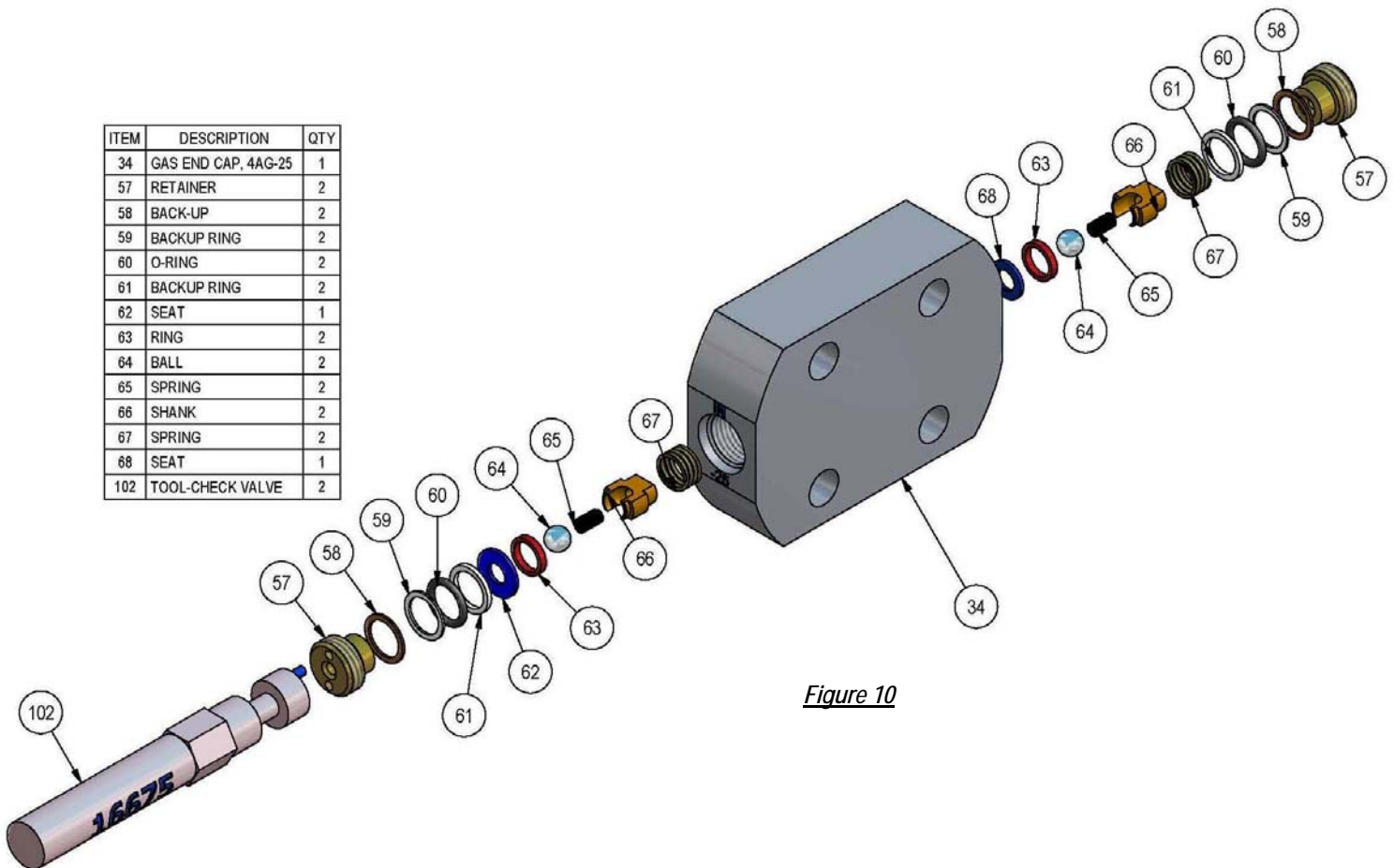


Figure 10

3. ASSEMBLY PROCEDURES

3.1 ASSEMBLY PROCEDURE FOR GAS PISTON: (USE 86859 ASSEMBLY TOOL)

With piston rod held securely and extending 1/4" beyond the end of the gas barrel, assemble the parts in the order shown (figure 9 & 11) using the flat end of the assembly tool to compact the seals. Make sure that the belleville springs are assembled in sets of two, cupped alternatively in opposite directions. Use the other end of the assembly tool to torque the nut down until snug and then back off until a slot in the nut lines up with the hole in the rod. Insert and secure the cotter pin.

*caution: make sure nut (86789) surface does not protrude beyond end of rod (86788) – shown in figure 12. This can be achieved by using fewer number of belleville springs (16719-13) if necessary.

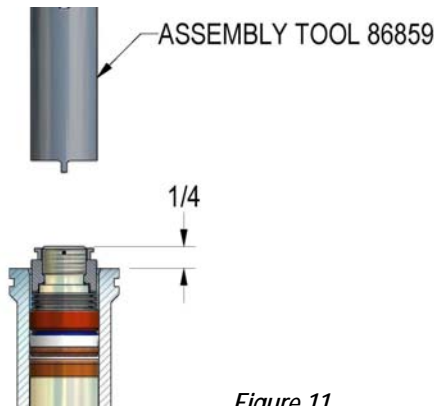


Figure 11

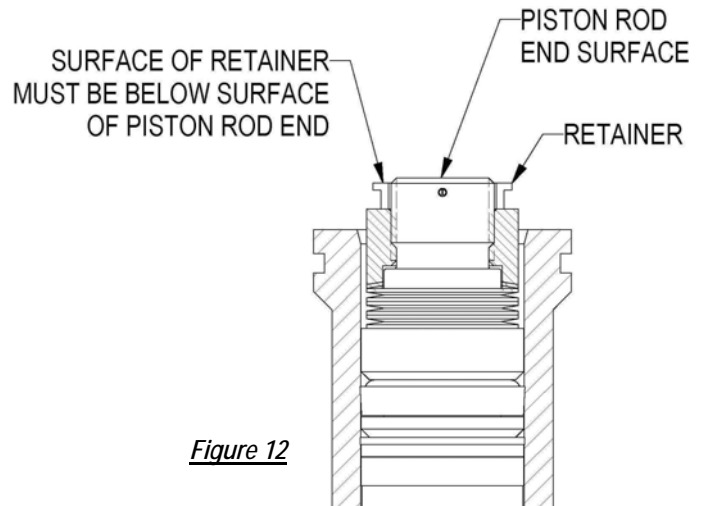


Figure 12

3.2 ASSEMBLY PROCEDURE FOR GAS CHECK VALVES: (USE 16675 ASSEMBLY TOOL)

1. Place outlet port in the upright position. Insert seat, ball, ring, small spring, shank, and large spring until seated properly (See Figure 10 for correct order). It is important that these parts are in proper position before continuing. Slide one set of packing's (bronze, thin tfe back-up, o-ring, thick tfe back-up) in the order shown onto seat fitting. The thick TFE back-up will provide sufficient grip to retain the packing's during insertion. Then, using assembly tool to screw seat in until it is snug (approximately 5/8" below end cap face). Using a thin rod, depress ball through inlet port to verify proper movement.

2. Place inlet port in upright position. Insert large spring, shank, ring, small spring, ball and seat into port until seated. It is important that the parts are in proper position before continuing. Slide one set of packing's (bronze, thin TFE back-up, o-ring, thick TFE back-up) in the order shown onto seat fitting. The thick TFE back-up will provide sufficient grip to retain the packing's during insertion. Then, using the assembly tool, screw the seat in until it is snug (approximately 5/8" below end face). Check that the ball is free to move by depressing it with a thin rod from the inlet end. *REFER TO FIGURE 13 FOR REFERENCE

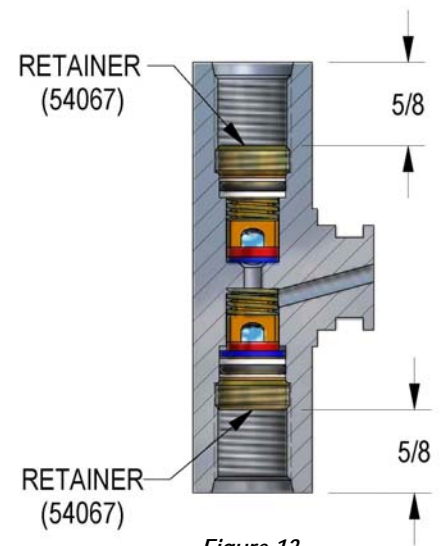


Figure 13

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