Haskel
MILTON ROY

OPERATING AND MAINTENANCE MANUAL

MSB-9000

INDEX

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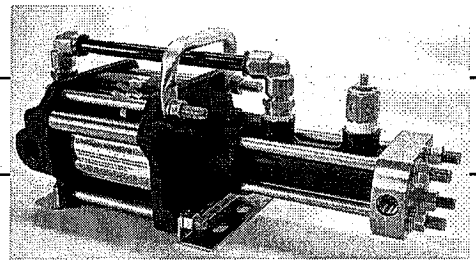
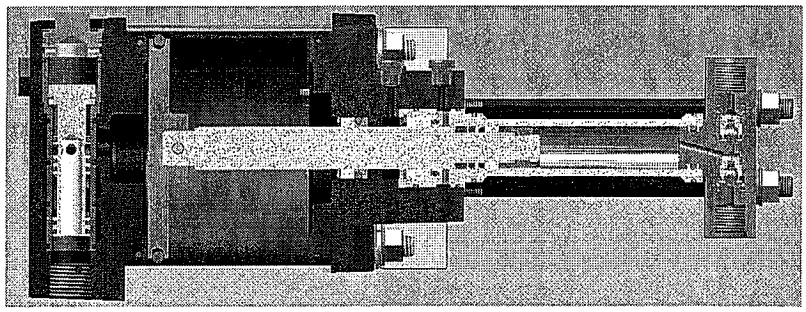


SINGLE AIR HEAD
SINGLE ACTING
SINGLE STAGE

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 WHETHERE OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE OR OTHERSWISE, 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 stoke. 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:

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.

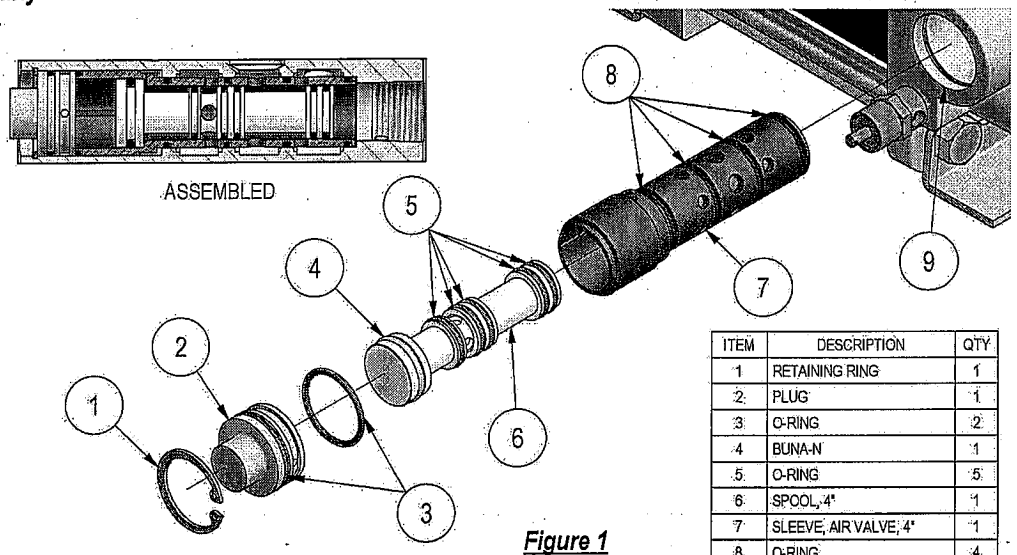


Figure 1

ITEM	DESCRIPTION	QTY
1	RETAINING RING	1
2	PLUG	1
3	O-RING	2
4	BUNA-N	1
5	O-RING	5
6	SPOOL, 4"	1
7	SLEEVE, AIR VALVE, 4"	1
8	O-RING	4
9	CAP, AIR VALVE END	1

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.)

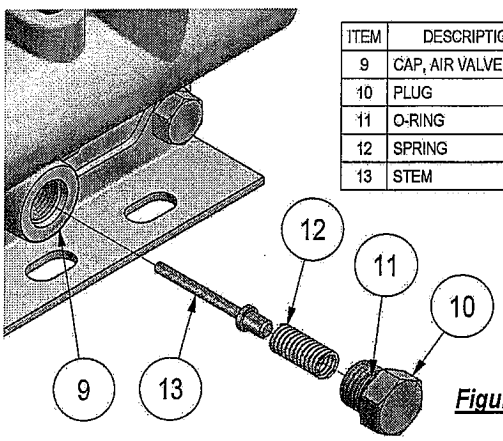


Figure 2

ITEM	DESCRIPTION	QTY
9	CAP, AIR VALVE END	1
10	PLUG	2
11	O-RING	2
12	SPRING	2
13	STEM	1

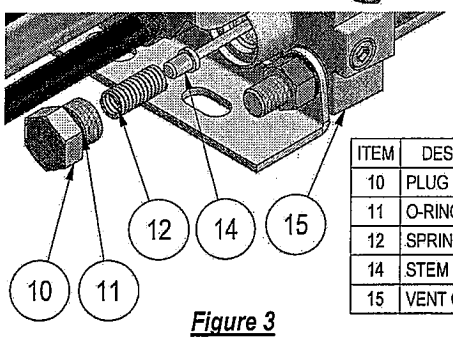


Figure 3

ITEM	DESCRIPTION	QTY
10	PLUG	2
11	O-RING	2
12	SPRING	2
14	STEM	1
15	VENT CAP, 4"	1

2. DISSASSEMBLY AND INSPECTION

2.1 Air Drive Section

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

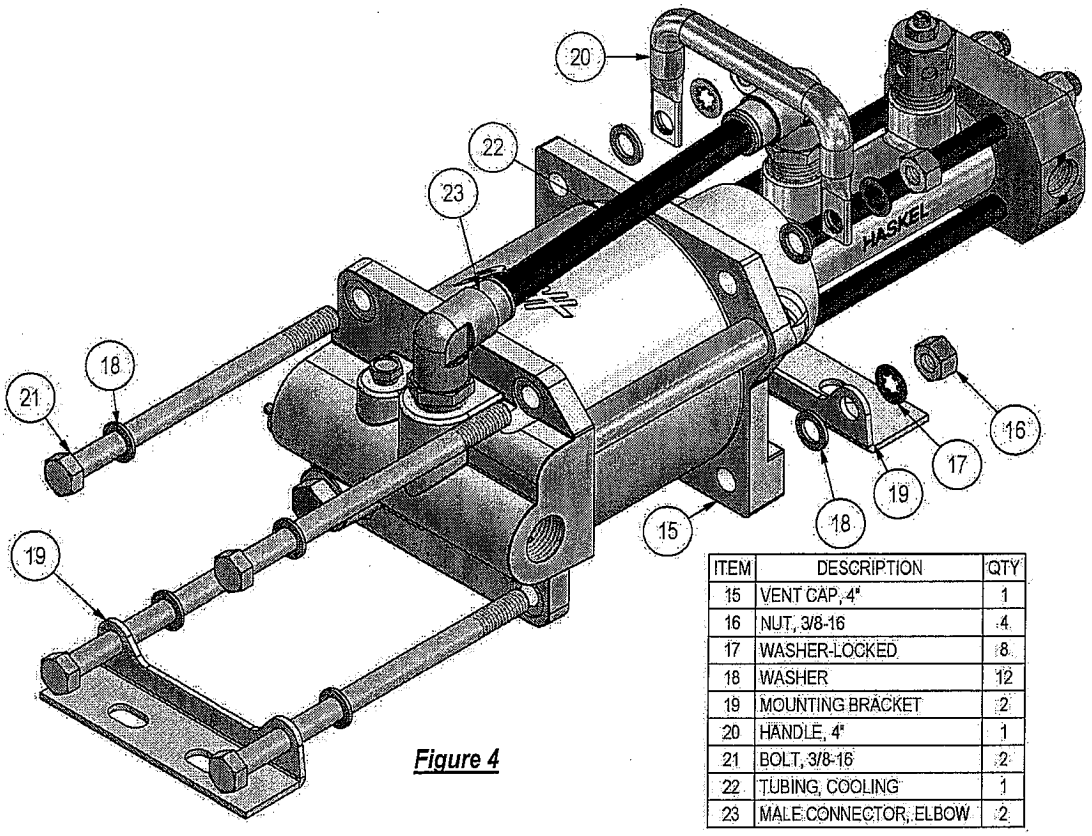
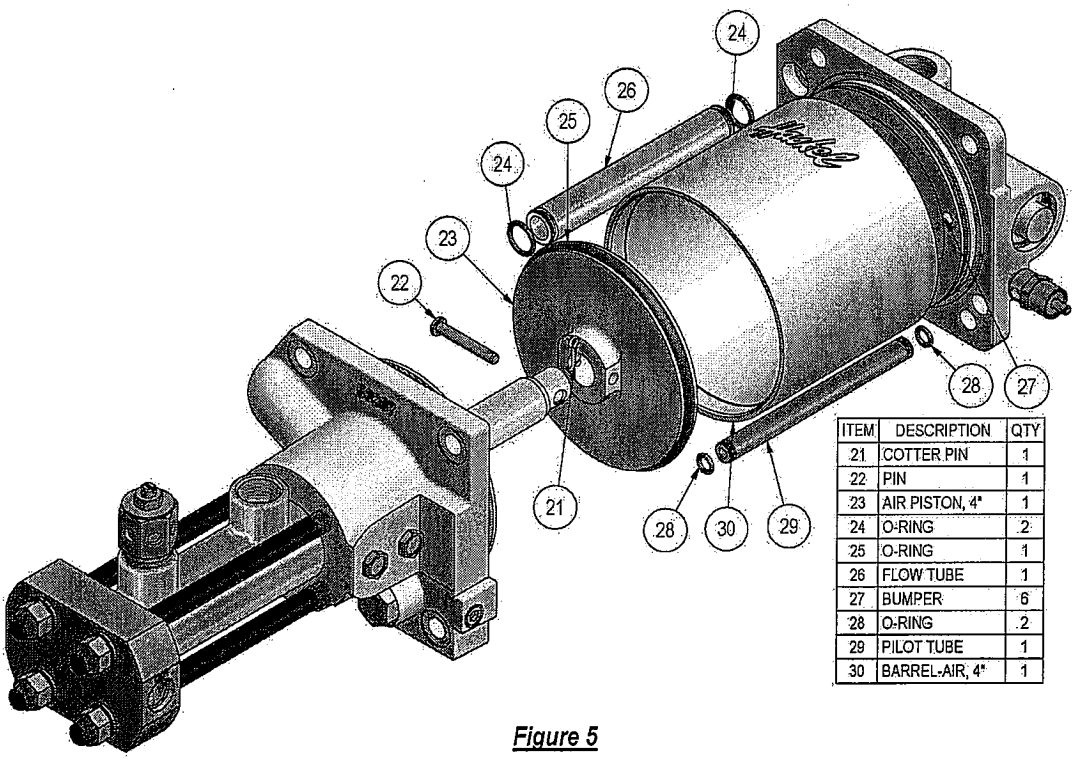


Figure 4

ITEM	DESCRIPTION	QTY
15	VENT CAP, 4"	1
16	NUT, 3/8-16	4
17	WASHER-LOCKED	8
18	WASHER	12
19	MOUNTING BRACKET	2
20	HANDLE, 4"	1
21	BOLT, 3/8-16	2
22	TUBING, COOLING	1
23	MALE CONNECTOR, ELBOW	2



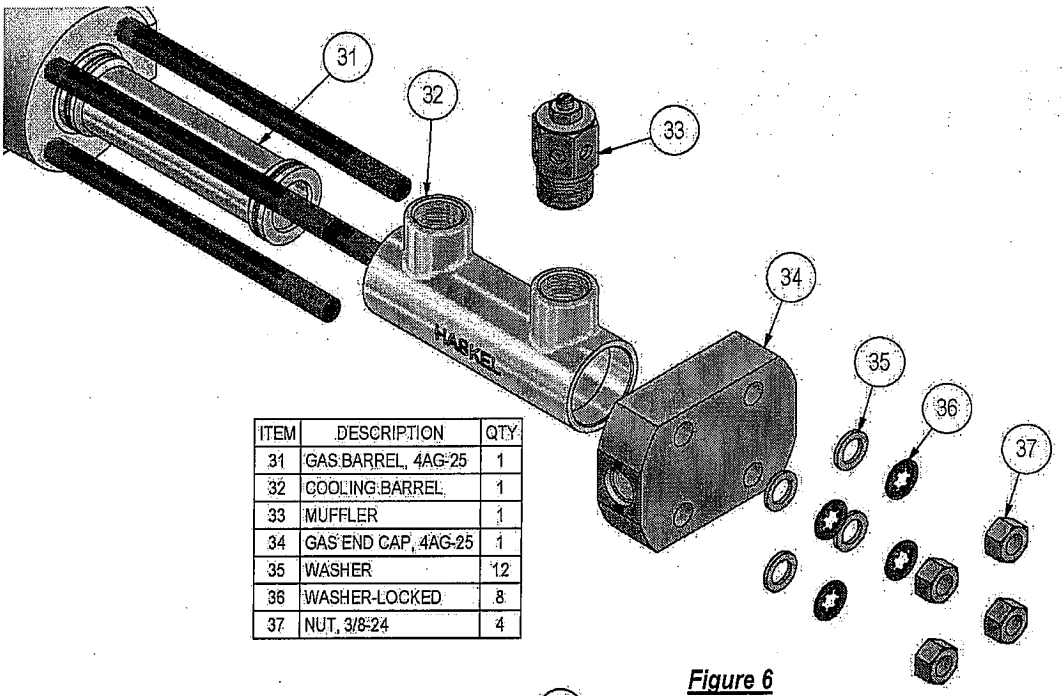
ITEM	DESCRIPTION	QTY
21	COTTER PIN	1
22	PIN	1
23	AIR PISTON, 4"	1
24	O-RING	2
25	O-RING	1
26	FLOW TUBE	1
27	BUMPER	6
28	O-RING	2
29	PILOT TUBE	1
30	BARREL-AIR, 4"	1

Figure 5

2.2 Gas Section

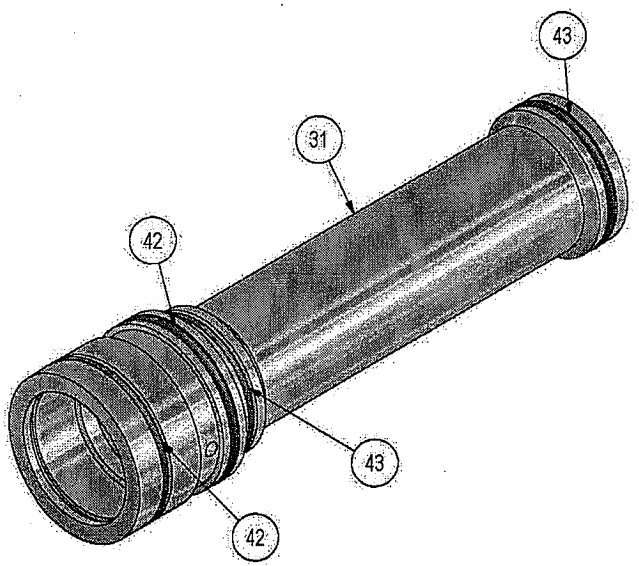
2.2.1 Gas Barrel (Refer to Figure 6 & 7)

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 cap (44). Refers to Figure 8 for reference.



ITEM	DESCRIPTION	QTY
31	GAS BARREL, 4AG-25	1
32	COOLING BARREL	1
33	MUFFLER	1
34	GAS END CAP, 4AG-25	1
35	WASHER	12
36	WASHER-LOCKED	8
37	NUT, 3/8-24	4

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

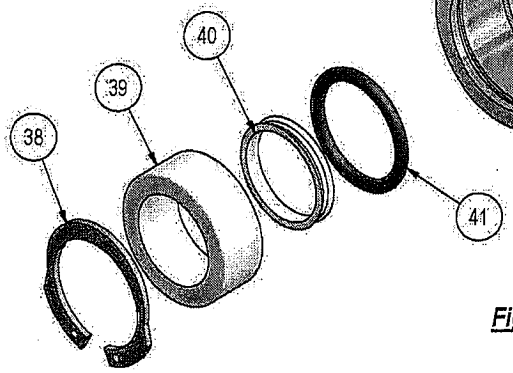
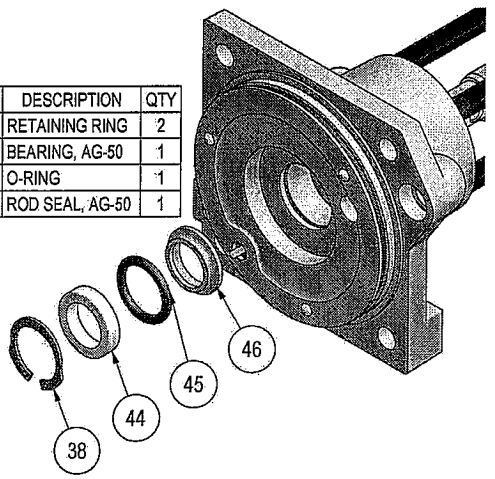


Figure 7



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

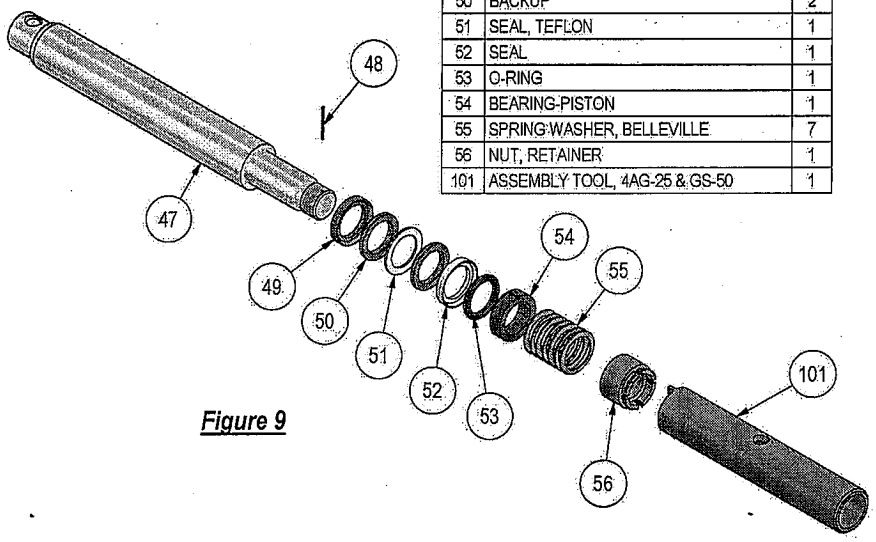


Figure 9

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

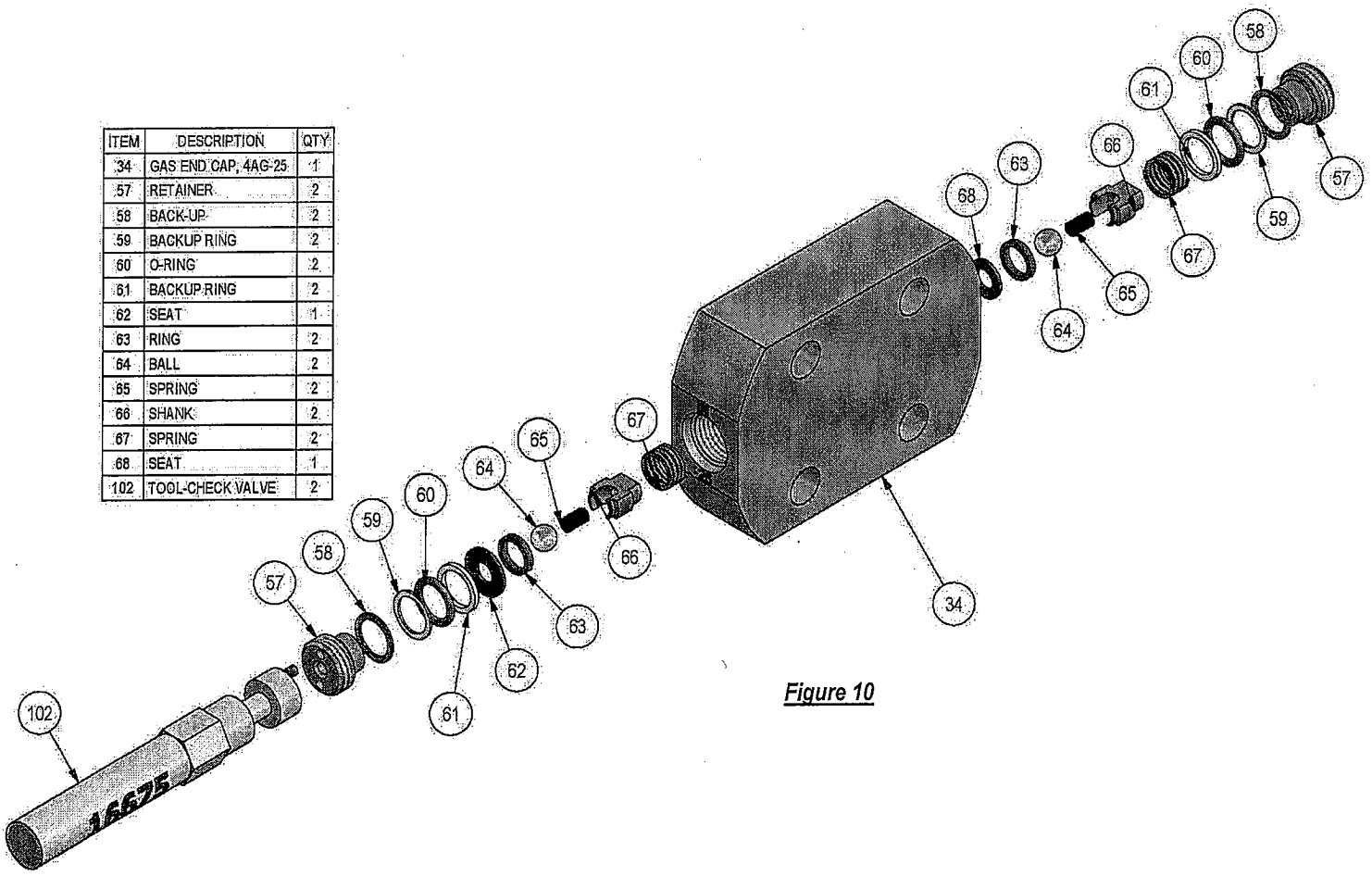


Figure 10

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.

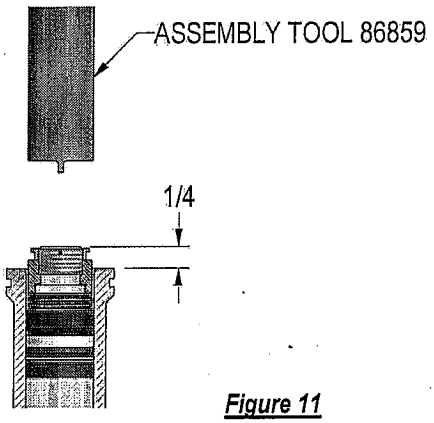


Figure 11

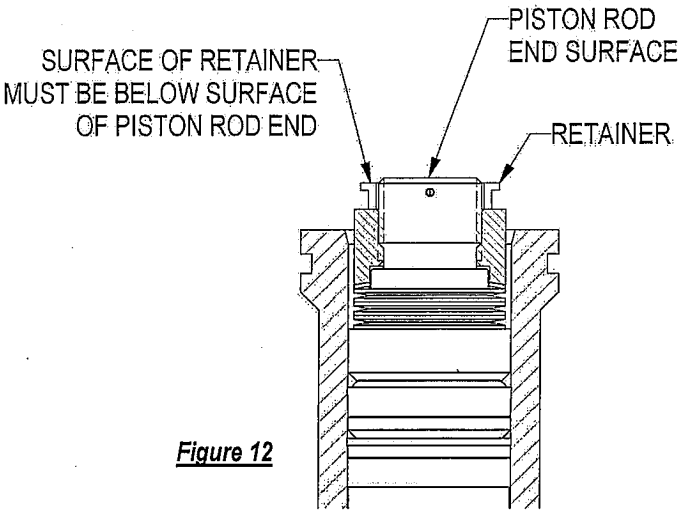


Figure 12

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*

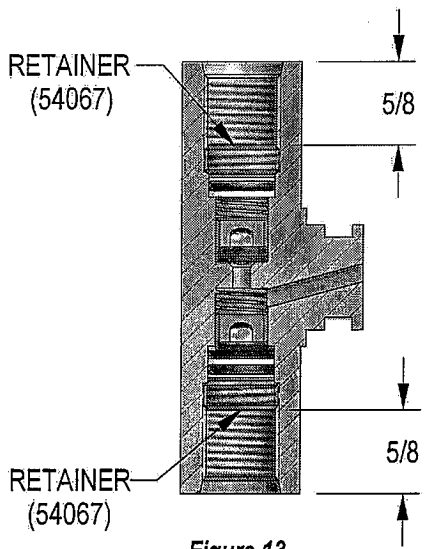


Figure 13

Haskel International, Inc
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Fax: 44-91-549-0911

86783

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 SEAL KIT, 86798
5. PARTS TO BE OXYGEN CLEANED PER HPS-4.11
6. TORQUE TO 15 FT-LBS

REVISION			
REV	DESCRIPTION	DATE	CHECKED
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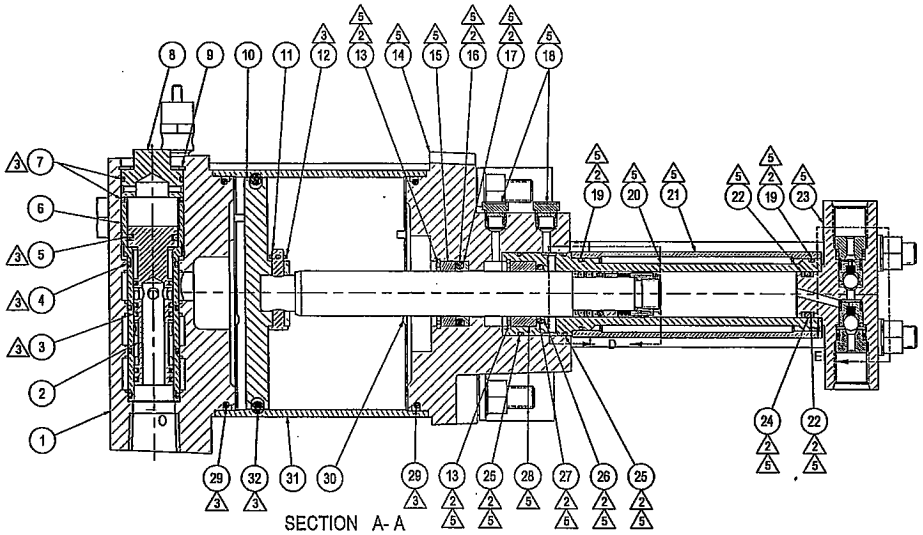
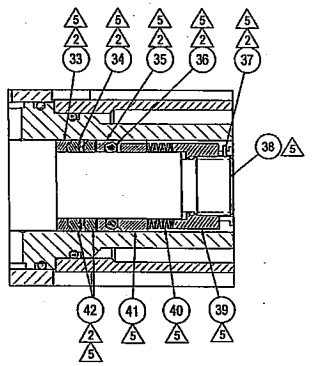
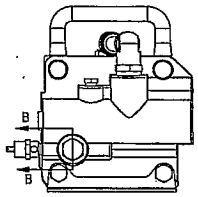
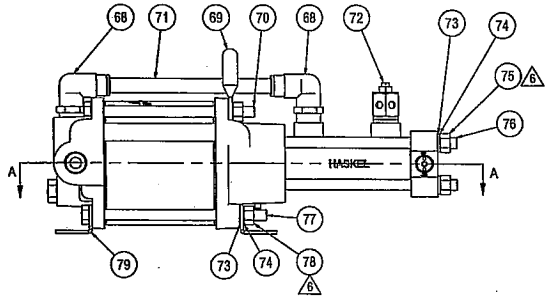
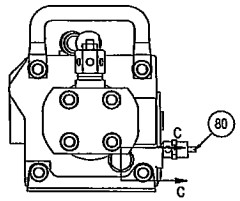
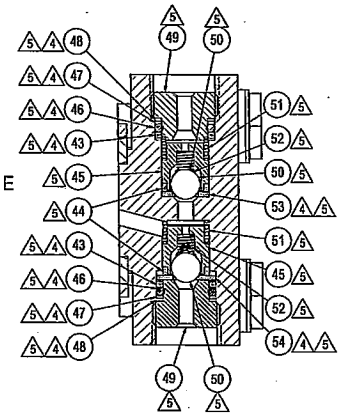


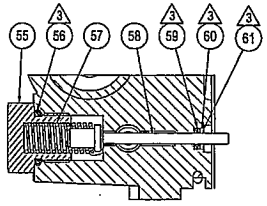


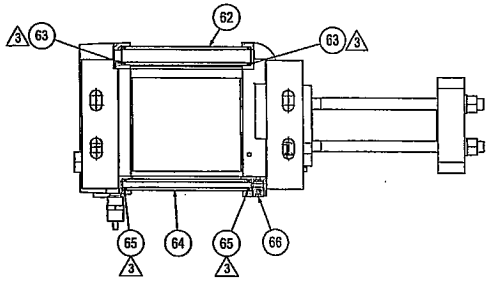


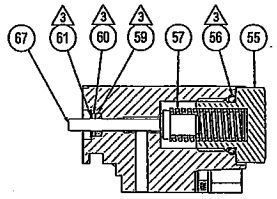












NEXT ASSY (REF ONLY)		Haskel International, Inc. Burbank, California 91502			
APPROVALS	DATE	TITLE: MICRO SPORT BOOSTER ASSEMBLY, MSB-9000			
DRAWN D MACH	09/10/05				
CHECKED	11/29/06				
APPROVED	11/29/06	SIZE: D	CAGE CODE: 81400	DWG NO.: 86783	REV: A
CAD FILENAME: 86783		SCALE: N/A	INVENTOR DRAWING	SHEET 1 OF 2	

REV A 12/14/2004 ECO 28659

86783

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.

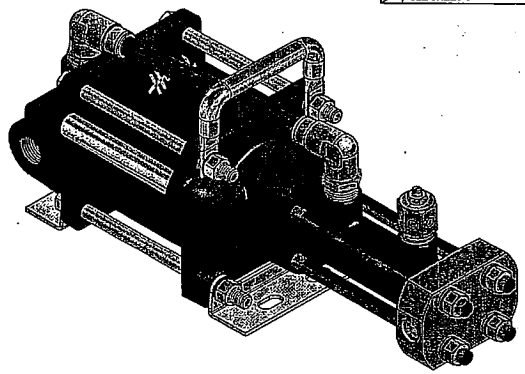
* CAUTION: MAKE SURE NUT (86789) SURFACE DOES NOT PROTRUDE BEYOND END OF ROD (86788). THIS CAN BE ACHEIVED BY USING FEWER NUMBER OF BELLEVILLE SPRINGS (16719-13) IF NECESSARY.

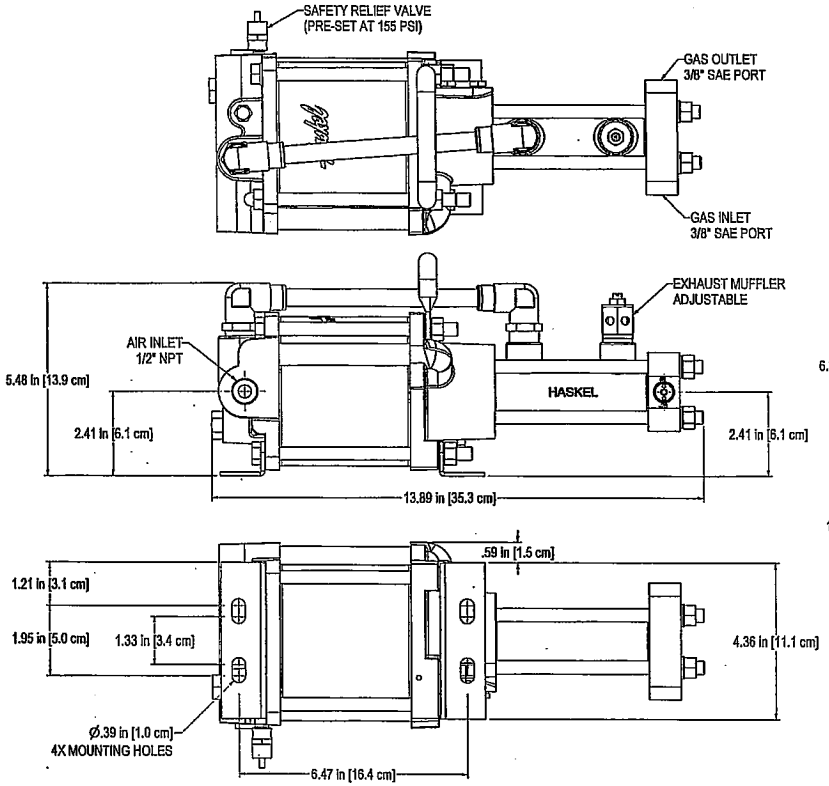
ASSEMBLY PROCEDURE FOR GAS CHECK VALVES: (USE 16675 ASSEMBLY TOOL)

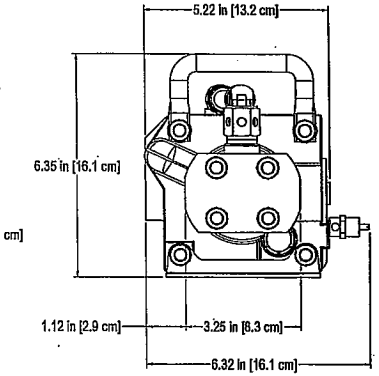
1. PLACE OUTLET PORT IN THE UPRIGHT POSITION. INSERT SEAT, BALL, RING, SMALL SPRING, SHANK, AND LARGE SPRING UNTIL SEATED PROPERLY. IT IS IMPORTANT THAT THESE PARTS ARE IN PROPER POSITION BEFORE CONTINUING. SLIDE ONE SET OF PACKINGS (BRONZE, THIN TFE BACK-UP, O-RING, THICK TFE BACK-UP) IN THE ORDER SHOWN 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.

REVISION			
REV	DESCRIPTION	DATE	CHECKED
	SEE SHEET 1		







Parts List				Parts List			
ITEM	PART NUMBER	DESCRIPTION	QTY	ITEM	PART NUMBER	DESCRIPTION	QTY
1	86867	CAP, AIR VALVE END	1	41	86438-2	BEARING-PISTON	1
2	55727	SPOOL, 4"	1	42	17225-50	BACKUP	2
3	568015-21	O-RING	5	43	56228	BACKUP RING	2
4	568018-2	O-RING	4	44	28083-1	RING	2
5	568115-2	BUNA-N	1	45	28083-2	SHANK	2
6	56215	SLEEVE, AIR VALVE, 4"	1	46	568012-31	O-RING	2
7	568021-2	O-RING	2	47	17421	BACKUP RING	2
8	56216	PLUG	1	48	17422	BACK-UP	2
9	N5000-106H	RETAINING RING	1	49	54057	RETAINER	2
10	86786	AIR PISTON, 4"	1	50	26130-8	BALL	2
11	MS20392-2C37	PIN	1	51	28082	SPRING	2
12	MS24665-151	COTTER PIN	1	52	26685	SPRING	2
13	5008-112H	RETAINING RING	2	53	28081-3	SEAT	1
14	86787	VENT CAP, 4"	1	54	28081-1	SEAT	1
15	86440-1	BEARING, AG-50	1	55	16510	PLUG	2
16	568212-7	O-RING	1	56	568906-9	O-RING	2
17	86441	ROD SEAL, AG-50	1	57	16513	SPRING	2
18	29348-2	BREATHER	3	58	27375-5V	STEM	1
19	568024-7	O-RING	2	59	568006-2	O-RING	2
20	86790	GAS BARREL, 4AG-25	1	60	16517	SPACER	2
21	86791	COOLING BARREL	1	61	5005-31H	RETAINING RING	2
22	17254-50	BACKUP	2	62	27078-17	FLOW TUBE	1
23	86792	GAS END CAP, 4AG-25	1	63	568014-2	O-RING	2
24	568114-7	O-RING	1	64	27077-16	PILOT TUBE	1
25	568027-2	O-RING	2	65	568010-2	O-RING	2
26	51351-5	GLIDER RING	1	66	17568-2	PLUG	1
27	568117-7	O-RING	1	67	27375-3V	STEM	1
28	86440	BEARING, AG-50	1	68	1244707-48	MALE CONNECTOR, ELBOW	2
29	568154-2	O-RING	2	69	86795	HANDLE, 4"	1
30	86794	BUMPER	6	70	55701-4	BOLT, 3/8-16	2
31	86785	BARREL-AIR, 4"	1	71	86805	TUBING, COOLING	1
32	568343-2	O-RING	1	72	86804	MUFFLER	1
33	86443	BACK-UP, SEAL	1	73	AN960-C616	WASHER	12
34	16704-50	SEAL, TEFLON	1	74	1720	WASHER-LOCKED	8
35	27065-50	SEAL	1	75	17834	NUT, 3/8-24	4
36	568113-31	O-RING	1	76	86803	TIE ROD	4
37	MS24665-24	COTTER PIN	1	77	55701-8	BOLT, 3/8-16	2
38	86788	PISTON ROD, 4AG-25	1	78	17563-6	NUT, 3/8-16	4
39	86789	NUT, RETAINER	1	79	55742	MOUNTING BRACKET	2
40	16719-13	SPRING WASHER, BELLEVILLE	7	80	KSV10-1-155	RELIEF VALVE, 155 PSI	1

Haskel Equipment	Haskel International, Inc. Burbank, California 91502	SIZE	CAGE CODE	DWG NO.	REV
DRAWN D MACH		D	81400	86783	A
CHECKED		SCALE: NONE	INVENTOR DRAWING	SHEET 2 OF 2	

REV A 12/14/2004 ECO 2559

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.

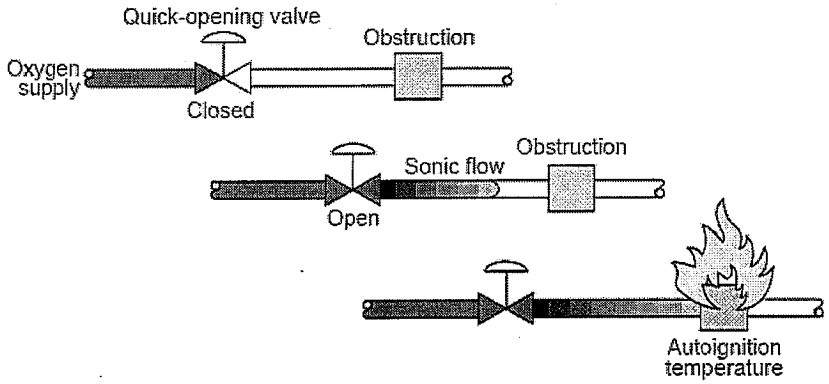


Figure 1

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)

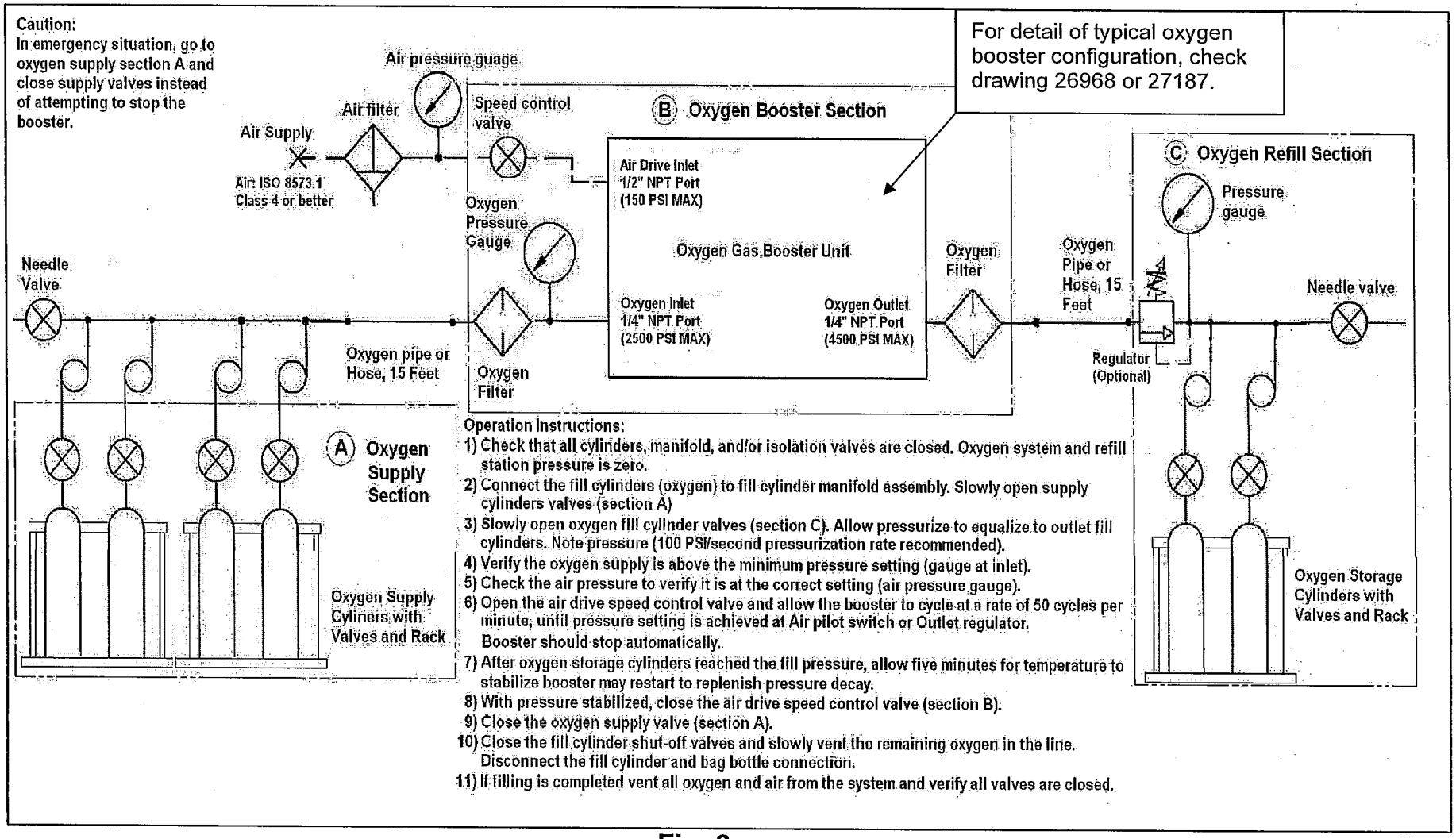


Fig. 2
Typical Configuration of
Haskel Oxygen System and Operation Instructions

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