

WARNING: Do Not Operate Before Reading Manual

Mechanical Vacuum Boosters

OPERATOR'S MANUAL

Models

150	540	1200	2700
240	720	1600	
400	850	2000	



Mechanical Splash Lube
Slinger Splash Lube
C-Flange



The employees of Tuthill Vacuum & Blower Systems thank you for your purchase!

Tuthill Vacuum & Blower Systems proudly manufactures Kinney® vacuum pumps and M-D Pneumatics™ blowers and vacuum boosters in Springfield, Missouri, USA. We bring 100+ years of engineering experience and solid, hands-on care to help customers keep their processes running. Your satisfaction is important to us so please take time to provide your Tuthill sales representative with performance feedback. We love to hear from our customers!

Tuthill is a family owned business that was started by James B. Tuthill in 1892. At that time, Tuthill manufactured common brick to Chicago construction companies who were fueling the city's rapid expansion. Fast forward to today and Tuthill now serves sustaining, global markets like agriculture, chemical, construction, energy, food and beverage, pharmaceuticals and medical, transportation, and utilities. While the company has changed in what it manufactures, one thing remains throughout every Tuthill line of business – we are a company with HEART. Our slogan is “Pump Your Heart Into It” and everyday our employees do just that as they represent the Tuthill brand and dare to make better.

Thank you for making Tuthill Vacuum & Blower Systems part of your company's process!

A company with heart right from the start.



FIND OUT MORE AT
TUTHILL.COM

Disclaimer Statement:

All information, illustrations and specifications in this manual are based on the latest information available at the time of publishing. The illustrations used in this manual are intended as representative reference views only. Products are under a continuous improvement policy. Thus, information, illustrations and/or specifications to explain and or exemplify a product, service or maintenance improvement may be changed at any time without notice.

Rights Reserved Statement:

No part of this publication may be reproduced or used in any form by any means - graphic, electronic or mechanical, including photocopying, recording, taping or information storage and retrieval systems - without the written permission of Tuthill Vacuum & Blower Systems.

Copyright © 2017 Tuthill Vacuum & Blower Systems
All rights reserved. Product information and specifications subject to change.

Table of Contents

Introduction	1
Applicable Documentation	1
Scope of Manual.....	1
Conventions and Data Plate	2
Graphic Conventions Used in this Manual.....	2
Data Plate.....	3
Lifting	5
Description	6
Flow by Direction.....	7
Specifications.....	8
Installation	10
General	10
Booster Air Intake	11
Foundation.....	12
Location.....	12
Soft Foot	12
Safety	13
Lubrication	14
Filling Procedure	15
Frequently Asked Questions Regarding Lubrication	16
Hazards Associated With Breakdown or Ignition of Lubrication	16

Piping Connections.....	16
Hazards Associated With Hazardous Process Fluids.....	17
Blockage or Restriction	17
Water-Cooling Instructions.....	17
Cooling Water Connections.....	18
Cooling Water Specifications	18
Motor Drives	18
Direct Coupled	18
V-Belts	18
Setting V-Belt Tension.....	19
V-Belt Troubleshooting	20
Motor and Electrical Connections.....	21
Operation	22
General	22
Start-Up Checklist.....	23
Starting.....	24
Operating	24
Stopping.....	24
Recommended Shutdown Procedure to Minimize Risk of Freezing or Corrosion	25
Maintenance	26
General	26
Regular Maintenance.....	27
Spare Parts	27
Factory Service and Repair	28
Long-Term Storage	28
Models 150 to 400 Disassembly and Reassembly.....	29
Disassembly of 150 to 400 Boosters	29
Assembly of 150 to 400 Boosters.....	30
Preparation of End Plates for Assembly	31

Gear End Assembly	31
Installation of Timing Gears	32
Housing and Free End Assembly.....	32
Adjusting Rotor Interlobe Clearance.....	33
Drive Shaft Seal Assembly	33
Complete Booster Assembly.....	34
Models 540 to 720 and 850 to 2700 Disassembly and Reassembly	35
Disassembly of 540 to 720 and 850 to 2700 Boosters.....	35
Assembly of 540 to 720 and 850 to 2700 Boosters.....	37
General.....	37
Preparation of End Plates for Assembly	37
Gear End Assembly	38
Installation of Timing Gears	38
Housing and Free End Assembly.....	38
Adjusting Rotor Interlobe Clearance.....	39
Drive Shaft Seal Assembly	40
Complete Booster Assembly.....	40
Troubleshooting.....	41
Assembly Clearances.....	43
Torque Chart.....	44
Recommended Lubricants.....	45
Recommended Lubricants for Rotary Blowers and Vacuum Boosters.....	45
Special Tool Drawings.....	47
Parts List	51
Assembly Drawings	57
Declaration of Incorporation.....	65
Warranty – Blower Products.....	66
Operating Data Form / Product Registration.....	67

INTRODUCTION

CONGRATULATIONS on the purchase of a new **Mechanical Vacuum Booster** from Tuthill Vacuum & Blower Systems. Please examine the booster for shipping damage, and if any damage is found, report it immediately to the carrier. If the booster is to be installed at a later date, make sure it is stored in a clean, dry location and rotated regularly. Make sure covers are kept on all openings. If the booster is stored outdoors, be sure to protect it from weather and corrosion.

Mechanical Vacuum Boosters are built to exacting standards and, if properly installed and maintained, will provide many years of reliable service. Tuthill urges you to take time to read and follow every step of these instructions when installing and maintaining your booster. Tuthill has tried to make these instructions as straightforward as possible. Tuthill realizes getting any new piece of equipment up and running in as little time as possible is imperative to production.

NOTE: Record the booster model and serial numbers of the machine in the OPERATING DATA form on the inside back cover of this manual. Use this identification on any replacement part orders, or if service or application assistance is required.

This manual covers the installation, operation, and maintenance of the Tuthill Vacuum & Blower Systems Mechanical Vacuum Boosters listed in **Table 1-1 on page 1**.

MODELS	MECHANICAL SEAL	SLINGER SEAL
150 to 400	(1)	(2)
540 to 720		
850 to 2700		
(1) Interconnecting cooling water between drive shaft bearing housing and the two oil reservoirs. Mechanical seals are used throughout. (2) Water-cooled only at drive shaft bearing housing. Rotor seals are slinger type and a mechanical seal on the drive shaft.		

Table 1-1

APPLICABLE DOCUMENTATION

The applicable documents associated with this manual are:

- 2006/42/CE – Machinery Directive
- EN 1012-2:1996 – Compressors and vacuum pumps – Safety Requirements – Part 1: Compressors

SCOPE OF MANUAL

The scope of this manual and the Declaration of Incorporation includes the bare shaft booster.

02

CONVENTIONS AND DATA PLATE

GRAPHIC CONVENTIONS USED IN THIS MANUAL

This manual is the result of a risk assessment according to the applicable documents referenced in **Applicable Documentation on page 1**.

The following hazard levels are referenced within this manual:

DANGER

Indicates a hazardous situation that, if not avoided, will result in death or serious injury.

WARNING

Indicates a hazardous situation that, if not avoided, could result in death or serious injury.

CAUTION

Indicates a hazardous situation that, if not avoided, could result in minor or moderate injury.

NOTICE

Indicates a situation that can cause damage to the engine, personal property, and/or the environment or cause the equipment to operate improperly.

NOTE: Indicates a procedure, practice, or condition that should be followed in order for the equipment to function in the manner intended.

CAUTION

Read manual before operation or bodily harm may result. Attention should be given to the safety related sections of this manual.

DATA PLATE







MODEL NUMBER	SERIAL NUMBER	MAWP	YEAR
<input type="text"/>	<input type="text"/>	<input type="text"/>	<input type="text"/>
		Tuthill Vacuum & Blower Systems 4840 West Kearney Street Springfield, Missouri USA 65803	
		MAX RPM	
		<input type="text"/>	
READ INSTRUCTION MANUAL BEFORE OPERATION OR BODILY HARM MAY RESULT			
WARNING	WARNING	CAUTION	CAUTION
			
Keep body & clothing away from machine openings.	Do not operate without guards in place.	Hearing protection required.	Do not touch hot surfaces.
http://www.tuthill.com		(800) 825-6937	Made in the USA


Figure 2-1 – General Operation and Symbols on Data Plate


The following information is contained on the data plate:

WARNING

Keep body & clothing away from machine. During operation, keep body and clothing away from inlet and outlet of the booster.

WARNING

Do not operate without guards in place.

CAUTION

Hearing protection is required while the booster is in operation. Noise levels may reach as high as 81 dBA.

CAUTION

Do not touch hot surfaces. The upper limit of the booster operation is 375°F (190°C). Do not touch the booster while it is in operation and assure booster is cool when not in operation.

Conventions and Data Plate

MODEL NUMBER:	The specific model of the booster
SERIAL NUMBER:	Unique to each booster
YEAR:	Year of manufacture
RPM:	The maximum RPM at which the booster can be operated



WARNING

The booster must be handled using an appropriate device such as a fork truck or appropriate lifting device. **See Table 4-1 on page 8** for approximate weights. Care should be taken to assure booster does not over-turn during handling and installation.

04

DESCRIPTION

NOTICE

Refer to specific data sheets for flow capacities and vacuum capacities.

NOTE: Refer to diagrams in this manual for proper rotation and orientation in inlet and discharge.

Tuthill Vacuum & Blower Systems models 150 to 400, 540 to 720, and 850 to 2700 mechanical vacuum boosters are positive displacement type boosters, whose pumping capacity is determined by size, operating speed, and differential pressure conditions. Vacuum boosters employ rotors rotating in opposite directions within a housing closed at the ends by end plates.

The inlet to the discharge is sealed with operating clearances that are very small. Internal lubrication is not needed, as there is no moving contact.

Clearances between the rotors during rotation are maintained by a pair of accurately machined helical timing gears, mounted on the two shafts extended outside the air chamber. The intermeshing rotary lobes are designed to rotate and trap air or gas between each rotor and the housing. As the rotor lobes rotate past the edge of the suction port, the trapped air or gas is essentially at suction pressure and temperature. Since the booster is a constant volume device, the trapped air remains at suction pressure until the leading rotor lobe opens into the discharge port. The close clearances between the rotors inhibit back slippage of the trapped volume from between the rotors and the trapped volume is forced into the discharge piping. Compression occurs not internal to the booster, but by the amount

of restriction, either downstream of the booster discharge port, or upstream of the booster inlet port.

Figure 4-1 illustrates the air movement within the machine. In addition, the machine can operate in either direction.

Never attempt to control capacity by means of a throttle valve in the intake or discharge piping. This will increase the power load on the drive system, which will increase operating temperatures, and can overload and/or seriously damage the booster. Likewise, if the possibility exists that flow to the booster inlet may be cut off during normal operation of a process, install an adequate vacuum relief valve. A pressure-type relief valve in the discharge line near the booster is also strongly recommended for protection against cutoff or blocking in this line. Use check valves on each booster when more than one booster is connected to a discharge line.

Vacuum boosters must be protected by cut-in switches or with bypass valving to limit differential pressure across the booster.

When a belt drive is used, it is possible to adjust booster speed to obtain desired capacity by changing the diameter of one or both sheaves, or by using a vari-speed motor pulley. In a direct coupled arrangement, a variable-speed motor or transmission is required. Gas boosters can use bypasses, but some applications may require additional cooling. If there is a large volume of high-pressure air or gas downstream of the booster, a check valve in the piping downstream of the booster will protect the booster from overspeeding in a backward direction upon shutdown.

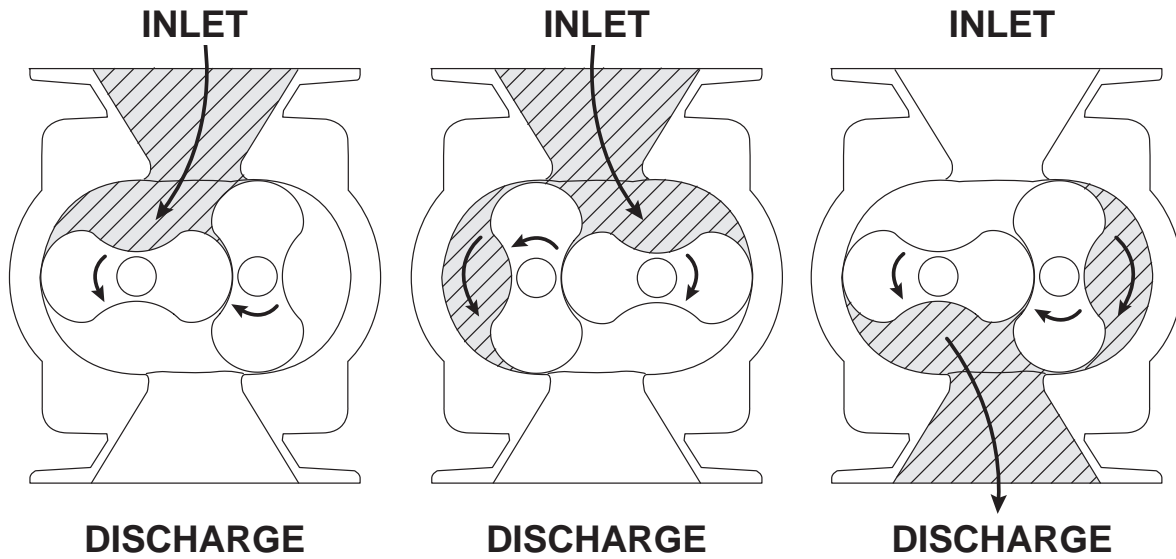


Figure 4-1 – General Operation Principle

FLOW BY DIRECTION

⚠ WARNING

Refer to diagrams in this manual for proper rotation and orientation in inlet and discharge.

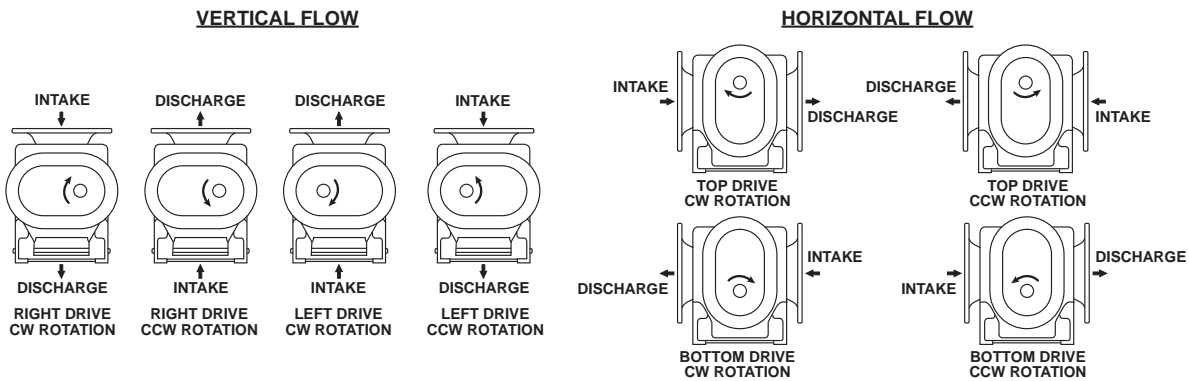


Figure 4-2 – Flow Direction by Rotation

SPECIFICATIONS

MODEL	APPROXIMATE OIL CAPACITY		PORT SIZE	MAXIMUM RPM	APPROXIMATE WEIGHT	
	VERTICAL	HORIZONTAL			VERTICAL	HORIZONTAL
150	1 qt (0.95 L)	0.5 qt (0.47 L)	2 in. (50 mm)	3,600	145 lb (65 kg)	130 lb (59 kg)
240			3 in. (80 mm)		160 lb (73 kg)	145 lb (66 kg)
400			4 in. (100 mm)		195 lb (88 kg)	180 lb (82 kg)
540	1.5 qt (1.42 L)	1 qt (0.95 L)	4 in. (100 mm)	3,600	260 lb (118 kg)	240 lb (109 kg)
720			4 in. (100 mm)		300 lb (136 kg)	280 lb (127 kg)
850	4 qt (3.79 L)	2.5 qt (2.37 L)	6 in. (150 mm)	3,600	450 lb (204 kg)	430 lb (195 kg)
1200			6 in. (150 mm)		520 lb (236 kg)	490 lb (222 kg)
1600			6 in. (150 mm)		580 lb (263 kg)	540 lb (245 kg)
2000			8 in. (200 mm)		685 lb (310 kg)	645 lb (293 kg)
2700			10 in. (250 mm)		790 lb (358 kg)	750 lb (340 kg)

Maximum discharge temperature is 375°F (190°C). Maximum temperature is based on a 70°F (21°C) inlet temperature. For inlet temperatures below 70°F (21°C), maximum allowable temperature rise across the vacuum booster should also never exceed 305°F (170°C).

Table 4-1 – Specifications

To permit continued satisfactory performance, a vacuum booster must be operated within certain approved limiting conditions. The manufacturer's warranty is, of course, also contingent on such operation.

Maximum limits for pressure, temperature, and speed are specified in **Table 4-1 on page 8** for various booster sizes when operated under the standard atmospheric conditions. Do not exceed any of these limits.

EXAMPLE: Operation of a vacuum booster seldom results in pressure differentials large enough to strain the booster drive train (bearings, gears, and seals). Typically in vacuum boosting, the maximum allowable temperature limit (the limit is a function of the temperature rise as well as the inlet temperature) for any particular booster may occur well before the maximum speed or allowable power rating is reached. Temperature rise then becomes the limiting condition. In other words, the operating limit is always to be determined by the maximum rating reached first, and it can be any one of the three: temperature, speed, or horsepower.

NOTICE

*Specially ordered boosters with nonstandard construction, or with rotor end clearances greater than shown within the **Assembly Clearances on page 43**, will not have the operating limits specified here. Contact your Tuthill Vacuum & Blower Systems sales representative for specific information.*

NOTICE

Pay special attention when a vacuum booster has a higher than standard ambient suction temperature. Special recommendations for operating parameters and/or additional cooling may be recommended. Consult the factory or local representative for appropriate information.

Deep vacuum requires instrumentation much more sensitive than standard thermometers and mercury-type pressure or vacuum gauges. At operation pressures less than 100 Torr (mmHg), use low-deadband cut-in switches and low-mass thermocouples, positioned so the sensor is connected to the inlet and discharge connections of the vacuum booster. NPT connections are provided at each of the inlet and discharge ports for this purpose. Standard temperature switches, because of their higher mass, do not have reaction times fast enough to adequately protect the vacuum booster. Likewise, standard vacuum switches are not recommended for cut-in switches, as vacuum boosting typically requires a very accurate cut-in point. A tachometer will enable periodic checks of operating speed.

05

INSTALLATION

GENERAL

DANGER

The booster is not intended to be used with explosive products or in explosive environments. The blower is not intended to be used in applications that include hazardous and toxic gases. Consult the factory for support.

DANGER

It is the responsibility of the installer to assure that proper guarding is in place and compliant with all applicable regulatory requirements.

WARNING



The bare shaft booster can generate excessive noise. Methods to reduce the noise levels by installing inlet and outlet silencers will be required. Even with inlet and outlet silencers, hearing protection will be required.

WARNING

Customers are warned to provide adequate protection, warning and safety equipment necessary to protect personnel against hazards in the installation and operation of this equipment in the system or facility.

WARNING

Table 4-1 on page 8 states the maximum operating speed in RPM (rotations per minute) and maximum temperature. Do not exceed these limits. The installation of the booster shall take these critical operating parameters into account and adequate control features implemented.

WARNING

Upon completion of the installation, and before applying power, rotate the drive shaft by hand. It must move freely. If it does not, look for uneven mounting, piping strain, excessive belt tension or coupling misalignment or any other cause of binding. If booster is removed and still does not move freely, check inside the booster housing for foreign material.

NOTICE

Remove the protective covers from the shaft and inspect for damage.

Carefully check to ensure that no transit damage has been sustained. If damage has occurred from shipment, file a claim with the carrier immediately. Preserve the shipping container for inspection by the carrier.

NOTICE

If booster sustains damage while being shipped to your facility, do not return it to the factory without first obtaining shipping instructions from Tuthill.

Do not remove protective covers and plugs until the connections are complete. Mount the booster on a flat, level surface. Use a baseplate that is rigid, solidly supported, and structurally sound. Shim under the legs where necessary so that each leg of the booster supports an equal share of the booster weight. This is necessary to prevent eventual twisting of the booster. Make sure the feet rest evenly on the mounting surface before fastening down. Twisting or cramping the booster during mounting will cause rotor contact and binding during operation, resulting in a condition called "soft foot". **See Soft Foot on page 12** for further details and preventative measures.

A booster that is factory mounted on a base should not require the above adjustments. However, since the assembly can become twisted in shipping or installation, check for soft foot after installing the base. Shims may be needed for alignment. Loosen the foot hold-down screws to check foot contact with the mounting surface. Mount the base on a solid foundation or heavy flooring, using shims as necessary at bolting points to prevent warping the assembly.

Transmission of small operating vibrations to a support structure may be objectionable in some applications. Use of vibration isolators or vibration absorbing materials can be effective in overcoming this transmission. To avoid causing distortion, apply the treatment under the common motor/booster base or mounting plate rather than directly under the feet alone.

Make sure piping is accurately squared with the booster and supported independently. Stress imparted from improperly aligned piping or mounting will create problems with bearing and seal life, possibly leading to premature internal contact. The booster should sit stress-free and evenly on its supporting surface. Take care to evenly tighten the mounting bolts to avoid imparting undue stress into the booster. Stress can be checked in a free state with feeler stock or verified on a previously installed booster with the aid of a dial indicator. Spring or gap should be less than 0.002 in. (0.05 mm).

A booster may be driven by direct-coupling to the driver or by V-belt drive for the purpose of obtaining other speeds within the approved range. **See Motor Drives on page 18** for more information.

Boosters from Tuthill Vacuum & Blower Systems are internally and externally treated after factory assembly and testing to protect against rusting in normal atmospheric conditions prior to installation. The maximum period of internal protection is considered to be up to 6 months under average conditions, provided breathing plugs and seals are not removed. Protection against brackish or salt-water atmosphere is not provided. Avoid opening the booster until ready to begin installation, as protection will be quickly lost due to evaporation. For recommended preparations for long term storage (longer than 6 months), **see Long-Term Storage on page 28**.

Booster Air Intake

To minimize maintenance, supply the booster with the cleanest air possible. The air must not contain any flammable or toxic gases, as the booster will concentrate these gases. This could result in damage to the booster and surrounding property and lead to personal injury or death. Do not block or restrict the opening of the booster, as the motor could overheat and fail.

Do not use boosters on explosive or hazardous gases. Do not exceed the limits described in **Table 4-1 on page 8** on pressure differential, running speed, and discharge temperature.

If it is necessary to take air from a remote source, such as in a vacuum application, make sure diameter of the piping is at least equal to the diameter of the booster inlet. For distances greater than 20 ft (6 m), enlarge the pipe diameter to reduce inlet restriction. Excessive restriction will reduce the efficiency of the booster and elevate its discharge temperature. The piping used should also be corrosion resistant and free of scale and dirt. Keep the inlet covered to keep out foreign objects and rain. Vacuum kits are available.

Foundation

The booster does not need a special foundation. However, it does require a solid, level floor and adequate frame support. Bolt the booster to the floor and seal any cracks.

Location

Install the booster in a room or outdoor area that supplies adequate space and lighting for routine maintenance. Make sure that indoor installation areas are well ventilated and kept as cool as possible, because operating the booster at elevated temperatures can result in nuisance overload or temperature shutdowns. An unprotected outdoor installation is satisfactory only when correct lubrication for the expected temperatures is provided. **See Recommended Lubricants on page 45.**

Soft Foot

Soft foot is a condition in which one of the booster feet does not sit flat on the base. Soft foot is usually due to irregularities in the surface to which the booster is mounted. When the bolt on the foot gets tightened, a slight distortion occurs that can affect bearing and seal life as well as internal contact between parts.

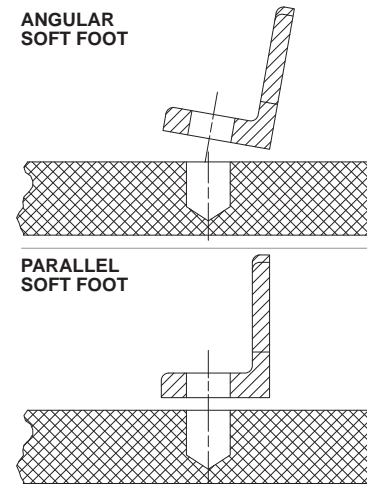


Figure 5-1 – Illustrations of Soft Foot

1. Place the booster on base.
2. Check each foot for gaps between the foot and base (soft foot). Shim as necessary to fill gap within 0.002 in. (0.05 mm). **Figure 5-1** shows the two most common types of soft foot conditions. If either type is present at a measurement of more than 0.003 in. (0.076 mm), the booster may fail prematurely.
3. Tighten all bolts.
4. Mount a dial indicator on base contacting one foot at 12 o'clock position.
5. Loosen the bolt on that foot. Observe indicator travel and add shims as needed to reduce "spring" to less than 0.002 in. (0.05 mm). Repeat steps 4 and 5 on remaining feet.

SAFETY



Tuthill Vacuum & Blower Systems recommends the use of relief valves to protect against excessive pressure or vacuum conditions. Test these valves at initial start-up to be sure they are properly adjusted to relieve at or below the maximum pressure differential rating of the booster.

! DANGER




It is the responsibility of the installer to assure that proper guarding is in place and compliant with all applicable regulatory requirements.

! DANGER





Internal and external rotating parts of the booster and driving equipment can produce serious physical injuries. The booster should never be run with the inlet or discharge piping removed. If it becomes necessary to inspect the rotating parts of the booster or to change V-belts, be absolutely sure that all power to the motor controls has been shut off, the motor controls are locked out, and properly tagged before proceeding.

! DANGER


Assure that properly sized vacuum breaks/relief valves are used on the inlet side of the booster. Also assure that properly sized pressure relief valves are used on the outlet of the booster. The sizing shall be such to assure that the proper flow can be achieved without exceeding the rated vacuum and pressure ratings.

! DANGER




Booster housing and associated piping or accessories may become hot enough to cause major skin burns on contact.

! WARNING



Use lock out/tag out procedures to disable the electrical energy source before any service or work is done on the booster.

! WARNING



Avoid extended exposure in close proximity to machinery with high intensity noise levels. Wear adequate ear protection.

NOTE: Use proper care and good procedures in handling, lifting, installing, operating, and maintaining the equipment.

LUBRICATION

Every booster from Tuthill Vacuum & Blower Systems is factory-tested, oil-drained, and shipped dry to its installation point. Fill both independent oil reservoirs to the proper level before operation. Oil reservoirs are under the vacuum.

Shaft bearings at the gear end of the booster are splash-lubricated by one or both gears dipping into an oil reservoir formed in the gear end plate and cover. Shaft bearings at the drive end of the booster are lubricated by a slinger assembly dipping into an oil reservoir. Before starting the booster, fill the oil sumps as described in **Filling Procedure on page 15**.

Add oil to the booster in the quantity listed in **Table 4-1 on page 8**. Make sure oil level is maintained within the notched area of the sight glass. **See Figure 5-2**. Lower drive boosters have “bull’s eye” type oil level gauges. Maintain oil levels at the center of the glass.

NOTICE

Assure oil is compatible with copper/yellow metals (if equipped with cooling coils).

NOTICE

See Table 4-1 on page 8 for oil capacities.

WARNING

Never attempt to change or add lubrication while the booster is running. Failure to heed this warning could result in damage to the equipment or personal injury. Oil must be checked when the booster is NOT running.

WARNING

Properly dispose of the spent lubricants. Refer to the manufacturer of the lubricant and any regulations to assure proper and safe disposal.

WARNING

Do not start the booster until you are sure oil has been put in the gear housing and rear cover. Operation of the booster without proper lubrication will cause the booster to fail and void the warranty.

Filling Procedure

See **Recommended Lubricants on page 45** for suggested lubricants and grease.

1. Remove the fill plugs or breathers from both gear end and drive end plates.
2. Slowly pour oil through fill until oil appears in the oil sight glass. Bring the oil level to the center of the sight glass.
3. Verify oil level is at proper level in both gear end and drive end sight glasses.
4. Replace the fill plugs or breathers that were removed in step 1.

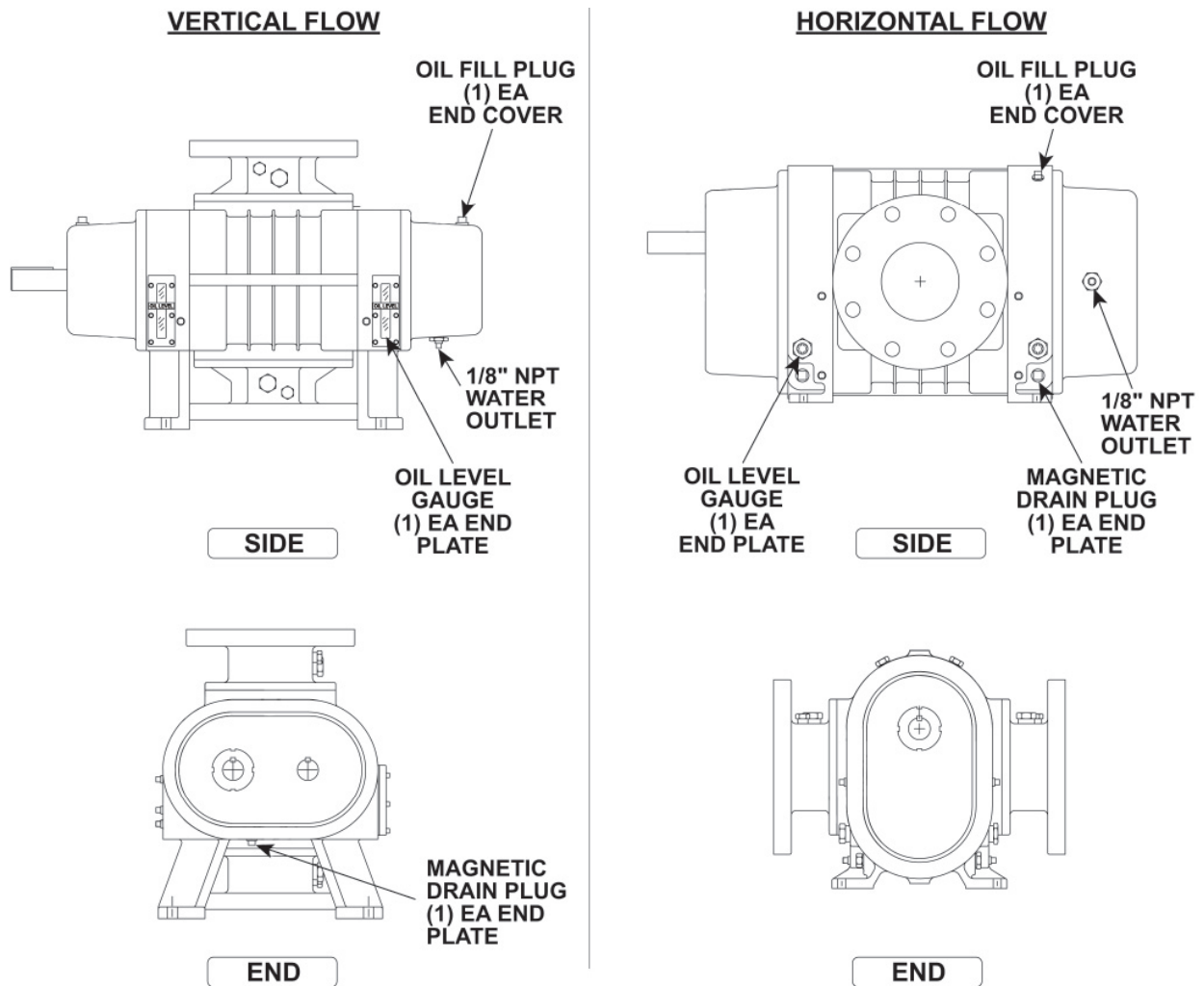


Figure 5-2 – Oil Fill, Drain and Level Plugs, and Level Gauges

Frequently Asked Questions Regarding Lubrication

What is the functional detriment if the “wrong oil” is used?

The lubricant is selected based on bearing speed, gear speed, and operating temperature. If the lubricant is too light, it increases wear by not separating the sliding surfaces and it will not remove the heat adequately. If the lubricant is too thick, the drag in the bearings is increased, causing them to run hotter. Thicker lubricant will not flow as readily into the gears and it will reduce the available backlash. Lubricants at our conditions are incompressible.

What is the functional detriment if the oil is not serviced?

If the lubricant is not serviced at the proper interval, the shearing action in the bearing and the gears will begin to take its toll and the lubricant will thicken. The booster will run hotter and the wear on running surfaces will increase. The lubricant will generally appear dirtier, caused by material rubbing off the components. The lubricant will discolor because of overheating. An indicator of the breakdown of a lubricant is the increase in the Total Acid Number (TAN), and a change of 10 percent in the base viscosity.

Several things are happening as the lubricant goes through the booster. First, it is absorbing frictional energy in the form of heat. This heat has to be dissipated through either surface contact with cooler materials or in a rest volume of lubricant. While reducing the friction, the lubricant is also going through a shearing process and the molecular structure is broken down.

The result is that the lubricant will begin to thicken because of the shorter molecular chains and the drop out of additive packages. The thickened lubricant will cause more drag, increasing the friction and heat, and further degrading the lubricant.

Operation of the booster (environment, run time, speed, and pressure) has a direct effect on duty cycles. The published cycles are based on worst-case conditions.

Hazards Associated With Breakdown or Ignition of Lubrication

DANGER



There is a risk associated with the lubrication media breaking down and resulting in a hazardous fluid or vapor. There may also be a hazard associated with the ignition of the lubrication media. Refer to the lubrication manufacturer's applicable instruction for safety precautions.

PIPING CONNECTIONS

WARNING

Pipe loading on the booster should be negligible as pipe loading can cause distortion of the booster. Use proper supports and pipe hangers to assure that there is no loading.

NOTICE

Remove the protective covers from the inlet and outlet ports and inspect for dirt and foreign material.

Make sure that manifolding is no smaller than the pump connections in order to minimize restrictions to gas flow. Accurately align the mating flanges to the inlet and discharge manifolding to prevent distortion of the booster housing. Temporarily fit a fine-wire mesh filter at the suction port if solid particles are likely to be entrained into the air stream, and remove the filter when particles no longer appear. This is especially desirable on new installations and when manifolds have been welded. Fit the manifolding to and from the booster with flexible connections to isolate vibrations, absorb expansion and contraction due to thermal change, and absorb misalignment differences. If the booster is to be water-cooled, connect a clean

supply to the 1/8 in. NPT connection to the bottom of drive gear end. The drain line will be connected on the bottom of the non-drive end reservoir (see **Figure 5-2** for connection locations). Take care to not overtighten or loosen the bushing for the cooling coil connection. Make sure the bushing is held in place as additional fitting and plumbing is performed.

Hazards Associated With Hazardous Process Fluids

DANGER



It shall be the responsibility of the installer to ensure that piping is adequate, sealing between pipe joints is adequate for the process fluids and proper process and pressure protection devices are in place. It is also the responsibility of the installer to assure that process gasses are not vented in a manner that would be hazardous.

Refer to the manufacturer of the process media to assure that proper safety precautions are in place.

Blockage or Restriction

WARNING

Damage to the booster could occur if there is blockage in the inlet or outlet ports or piping. Care should be taken when installing the booster to assure that there are no foreign objects or restrictions in the ports or piping.

WATER-COOLING INSTRUCTIONS

CAUTION

If the unit is to be located outside or in a building where ambient temperatures can fall below freezing, then care must be taken to ensure the water or liquid used for cooling does not freeze and damage the booster. Cooling coils must be drained of liquid during downtime unless a recirculating unit using a glycol mixture has been installed.

NOTICE

Water cooled end plates are discontinued. See Technical Bulletin 52 for additional details.

NOTICE

Units are never shipped from the manufacturer with liquid in the cooling coils.

Cooling Water Connections

The partially water-cooled version has cooling water to the seal adapter housing only. The cooling coils and interconnecting water line are omitted and the interconnecting line leading from the seal adapter housing is led to the drain.

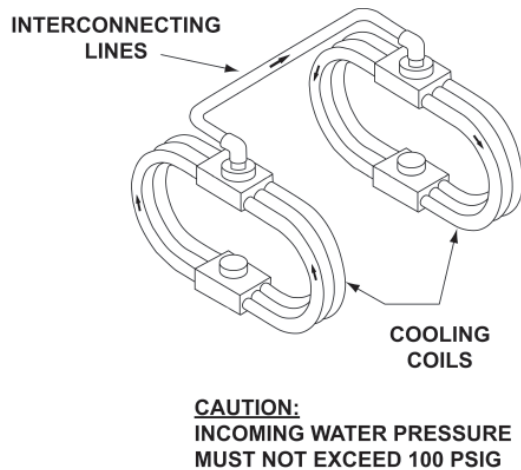


Figure 5-3 – Cooling Water Piping Harness

Cooling the bearing housing will prolong the life of the mechanical seal therein.

Provide an ON-OFF valve on the incoming line and a regulating valve located in the drain line. Terminate the drain line at an open drain for better regulation of the water flow.

COOLING WATER SPECIFICATIONS

Boosters that will operate with continuous discharge gas temperatures of 250°F (121°C) or more must be connected to a water (liquid) supply in order to maintain reasonable oil temperatures. Generally a water flow of 1/2 to 1 GPM (1.9 – 3.8 L/min) is sufficient to maintain oil temperatures below 150°F (65°C).

MOTOR DRIVES

Two drive connections commonly used are direct drive and V-belt drive.

Direct Coupled

When installing the motor directly to the booster, align the shafts to the coupling according to the coupling manufacturer's instructions. Boosters shipped with motor directly coupled and mounted on a common base have been aligned prior to shipment. Further alignment is not normally necessary, but be sure to check the alignment and make adjustments if necessary prior to starting the booster.

Coupling halves must correctly fit the booster and drive shafts so that only light tapping is required to install each half. The two shafts must be accurately aligned. A direct-coupled booster and motor must be aligned with the two shafts.

Establish proper gap between coupling halves according to the coupling manufacturer's instructions with the motor. Proper gap will minimize the change for end thrust on the booster shaft.

V-Belts

If the motor and booster are V-belt connected, the sheaves on both the motor and booster shafts should be as close to the shaft bearings as possible. Booster sheave is not more than 1/4 in. (6.5 mm) from the booster drive end cover. The drive sheave is as close to the driver bearing as possible. Take care should when installing sheaves on the booster and motor shafts. Make sure the face is accurately in line to minimize belt wear.

Adjust the belt tension to the to the manufacturer's specifications using a belt tension tester. Check new belts for proper tension after 24 hours of run time. When manufacturer data is not available, industry guidelines recommend 1/64 in. deflection for each inch of span (0.157 mm deflection per centimeter of span) at 8 to 10 lb (3.6 – 4.5 kg) of force in the center of the belt.

Insufficient tensioning is often indicated by slipping (squealing) at start-up. Do not use belt dressing on V-belts. Keep sheaves and V-belts free of oil and grease. Remove tension from belts if the drive is to be inactive for an extended period of time. For more specific information, consult the drive manufacturer. In a V-belt drive, the booster sheave must fit its shaft accurately, run true, and be mounted as close to the bearing housing as possible to minimize bearing loads.

A tight or driving fit will force the drive shaft out of its normal position and cause internal damage. A loose fit will result in shaft damage or breaking. Make sure the motor sheave fits correctly and is properly aligned with the booster sheave.

Adjust motor position on its sliding base so that belt tension is in accordance with drive manufacturer's instructions. Always avoid excessive belt tension. Recheck tension after the first 10 hours of operation and periodically thereafter to avoid slippage and loss of booster speed.

Check the booster after installation and before applying power by rotating the drive shaft by hand.

If the drive shaft does not rotate freely:

- Look for uneven mounting, piping strain, excessive belt tension, or coupling misalignment.
- Check booster at this time to insure oil was added to the reservoirs.

Setting V-Belt Tension

Proper belt tension is essential to long booster life. **Figure 5-4**, **Figure 5-5**, and the following procedures are provided to aid in field-adjusting V-belts (when the booster is so equipped) for maximum performance. A visual inspection of the V-belt drive should yield the appearance shown in **Figure 5-4**.

Factors outside the control of the belt tensioning system used on an individual booster package assembly, such as environmental factors and quality of the belts installed, may contribute to decreased belt life. Such factors can cause wear of the belts beyond the ability of the tensioning system to compensate.

As such, it is recommended to check belt tension monthly and make any manual adjustments found necessary.

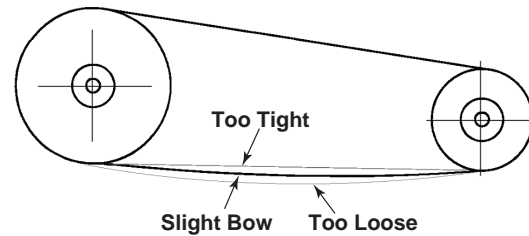


Figure 5-4 – General appearance of a V-belt drive

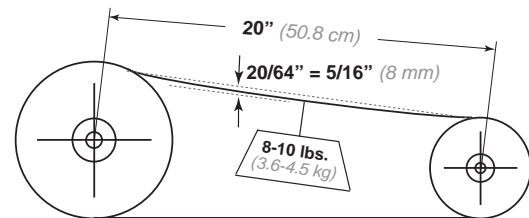


Figure 5-5 – Setting of proper tension for a V-belt drive

1. Turn off and lock out power.
2. Remove the fasteners from the belt guard (if equipped)
3. Remove the belt guard.
4. Check and adjust the belt tension as necessary. Tension should be 1/64 in. deflection per inch of span (0.157 mm deflection per centimeter of span) between sheaves, with 8 – 10 lb (3.6 – 4.5 kg) force applied at the center point of the top section of belt.
5. Install the belt guard, making sure that all drive components are free of contact with the guard.
6. Install the belt guard fasteners that were removed in step 2.
7. Unlock the power and start the booster.
8. Resume normal operation.

V-Belt Troubleshooting

PROBLEM	POSSIBLE CAUSES	SOLUTION
Belts slip (sidewalls glazed)	Not enough tension	Replace belts; apply proper tension.
Drive squeals	Shock load	Apply proper tension.
	Not enough arc of contact	Increase center distance.
	Heavy starting load	Increase belt tension.
Belt(s) turned over	Broken cord caused by prying on sheave	Replace set of belts and install correctly.
	Overloaded drive	Redesign drive.
	Impulse loads	Apply proper tension.
	Misalignment of sheave and shaft	Re-align drive.
	Worn sheave grooves	Replace sheaves.
	Excessive belt vibration	Check drive design. Check equipment for solid mounting. Consider use of banded belts.
Mismatched belts	New belts installed with old belts	Replace belts in matched sets only.
Breakage of belt(s)	Shock loads	Apply proper tension; recheck drive.
	Heavy starting loads	Apply proper tension; recheck drive. Use compensator starting.
	Belt pried over sheaves	Replace set of belts correctly.
	Foreign objects in drives	Provide drive guard.
Rapid belt wear	Sheave grooves worn	Replace sheaves.
	Sheave diameter too small	Redesign drive.
	Mismatched belts	Replace with matched belts.
	Drive overloaded	Redesign drive.
	Belt slips	Increase tension.
	Sheaves misaligned	Align sheaves.
	Oil or heat condition	Eliminate oil. Ventilate drive.

MOTOR AND ELECTRICAL CONNECTIONS

WARNING

The motor and connections shall be protected to assure that product and environmental condensation does not come in contact with the electrical connections.

NOTICE

It is the responsibility of the installer to assure that the motor is in compliance with the latest edition of IEC 60204-1 and all electrical connections are performed per IEC 60204-1, this includes overcurrent protection.

Wire the motor and other electrical devices, such as solenoid valves and temperature switch, to the proper voltage and amperage as indicated on the nameplate of the component being wired. Turn the booster by hand after wiring is completed to determine that there are no obstructions and that the booster turns freely. Then, momentarily start the booster to check the direction of rotation. **Figure 4-2** shows direction of airflow in relation to rotor rotation. The airflow direction can be reversed by reversing the appropriate motor leads.

06

OPERATION

GENERAL

DANGER

The booster is not intended to be used with explosive products or in explosive environments. The blower is not intended to be used in applications that include hazardous and toxic gases. Consult the factory for support.

WARNING



Do not operate without guards in place.



WARNING

Maximum operating speed: *Table 4-1* states the maximum operating speed in RPM (rotations per minute) and maximum temperature. Do not exceed these limits.

Before starting the booster for the first time under power, recheck the installation thoroughly to reduce the likelihood of difficulties. Use the following checklist as a guide, but also consider any other special conditions in your installation.

1. Be certain no bolts, rags, or dirt have been left in booster.
2. Be certain that inlet piping is free of debris. If an open outdoor air intake is used, be sure the opening is clean and protected by an inlet filter. This also applies to indoor use.
3. If installation is not recent, check booster leveling, drive alignment, belt tension, and tightness of all mounting bolts.
4. Be certain the proper volume of oil is in the oil reservoir chambers.
5. Be certain the driving motor is properly lubricated and connected through suitable electrical overload devices.
6. With electrical power off and locked out to prevent accidental starting, rotate the booster shaft several times by hand to make sure the booster is rotating freely. Unevenness or tight spots are indicators of a condition that should be corrected before progressing.
7. Check motor rotation by momentarily pushing the START button and then checking the flow direction of the booster. Reverse the motor connections if flow is in the wrong direction.

Carry out initial operation under “no load” conditions by opening all valves and venting the discharge to atmosphere, if possible. Then, start the motor briefly, listen for unusual noises, and make sure the booster operates freely to a stop. If no problem appears, repeat this block and let the motor run a little longer. If any questions exist, investigate before proceeding further.

Assuming all tests are satisfactory, the booster will now be ready for continuous full load operation. During the first several days, check periodically to make sure all conditions remain acceptable and

steady. These blocks may be particularly important if the booster is part of a process system where conditions may vary. At the first opportunity, stop the booster and clean or remove the inlet filter. Also, recheck leveling, coupling alignment or belt tension, and mounting bolts for tightness.

START-UP CHECKLIST

Tuthill recommends that these start-up procedures be followed in sequence and blocked off () in the boxes provided in any of the following areas.

<ul style="list-style-type: none"> • During initial installation • After any shutdown period 	<ul style="list-style-type: none"> • After maintenance work has been performed • After booster has been moved to a new location
DATES CHECKED:	<input type="text"/> <input type="text"/> <input type="text"/> <input type="text"/>
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Check the unit for proper lubrication. Proper oil level is critical. See Lubrication on page 14. See Recommended Lubricants on page 45 for information on acceptable lubricants for the product.
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Check the V-belt drive for proper belt alignment and tension.
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Carefully turn the rotors by hand to be certain they do not bind.

WARNING

Disconnect power. Make certain power is off and locked out before touching any rotating element of the booster, motor, or drive components.

<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	“Bump” the unit with the motor to block rotation (counter-clockwise when facing the shaft) and to be certain it turns freely and smoothly.
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Start the booster and operate it for 30 minutes at no load. During this time, feel the flywinder for hot spots. If minor hot spots occur, see Troubleshooting on page 41.
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	Apply the load and observe the operation of the booster for 1 hour.
<input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/> <input type="checkbox"/>	If minor malfunctions occur, discontinue operation and see Troubleshooting on page 41.

STARTING

Check the oil for proper level at both ends of the booster. Add or drain oil as necessary to bring the oil to the correct level. **See Figure 4-2.** Too much oil, particularly on the gear end, can result in excessive heat generation. Too little oil will possibly result in failure of the timing gears, bearings, and mechanical seals.

Start the backing pump. When pressure is reduced sufficiently, start booster pump. A pressure switch can be installed to start the booster at a predetermined pressure. If the booster is water-cooled turn on the cooling water when the booster is started. Adjust the water flow so that the discharge water temperature is no more than lukewarm (70° to 80°F [21° to 26°C]).

OPERATING

The upper temperature limits for booster pump operation are between 350° to 375°F (175° to 190°C), measured in the exhaust gas stream with a low mass thermocouple. When this temperature limit switch is installed, as the temperature exceeds the predetermined temperature, the booster motor will stop and cannot be restarted until the temperature drops below the trip setting of the temperature switch.

DANGER

The booster is not intended to be used with explosive products or in explosive environments. The blower is not intended to be used in applications that include hazardous and toxic gases. Consult the factory for support.

WARNING

Physical harm may occur if human body parts are in contact or exposed to the process vacuum. Assure that all connections are protected from human contact.

WARNING

If rated vacuum or pressure levels are exceeded, process fluids will migrate to other parts of the booster and system.

CAUTION



Do not touch hot surfaces.

The upper limit of the booster operation is 375°F (190°C). Do not touch the booster while it is in operation and assure booster is cool when not in operation.

CAUTION

Use of a thermowell insulates the thermocouple. Invalid and delayed readings will result. This can result in ineffective protection devices.

NOTICE

The upper limits are not intended for continuous operation. Consult with factory for detailed information assistance.

STOPPING

CAUTION

Venting the booster to pressures above cut-in while running can damage the pump.

Stop the booster by turning off the motor. Isolate the booster from the vacuum system and vent the booster to atmosphere. Turn off the cooling water if water-cooled. Stop the backing pump. See the component instruction manual.

RECOMMENDED SHUTDOWN PROCEDURE TO MINIMIZE RISK OF FREEZING OR CORROSION

When an air piping system has high humidity or moisture, water condensation can occur after the booster is shut down and it begins to cool. Condensation creates an environment favorable to corrosion of the iron internal surfaces and to ice formation in cold weather. Both conditions can close the operating clearances, causing the booster to fail upon future start-up.

The following shutdown procedure minimizes the risk of moisture condensation, corrosion, and freezing.

NOTICE

Take care not to overload or overheat the booster during this procedure.

1. Isolate the booster from the moist system piping, allowing the booster to intake atmospheric air. Operate the booster under a slight load, allowing the booster to heat within safe limits. The heat generated by the booster will quickly evaporate residual moisture.
2. For carpet cleaning applications, after the work is completed, allow the booster to run 3 – 5 minutes with the suction hose and wand attached. The suction hose and wand will provide enough load to the booster to evaporate the moisture quickly.
3. For extended shutdown, inject a small amount of a light lubricating oil such as 3-in-One® or a spray lubricant such as WD-40® into the inlet of the booster just before shutdown. (*3-in-One and WD-40 are registered trademarks of WD-40 Company.*) The lubricant will provide an excellent protective coating on the internal surfaces. If using a spray lubricant, take care to prevent the applicator tube from getting sucked into the booster. The applicator tube will damage the booster, likely to a degree where repair would be required.
4. If the booster is being taken out of commission for an extended period of time, **see Long-Term Storage on page 28.**

07

MAINTENANCE

GENERAL

Regular inspection of the vacuum booster and its installation, along with complete checks on operating conditions, will pay dividends in added life and usefulness. Also, service the drive per manufacturer's instructions and lubricate the coupling or check belt drive tension. Use thermometers and gauges to make sure that booster operating temperature and pressure remain within allowed limits.

DANGER



The booster and parts may contain hazardous media. Assure that pump and parts are evacuated of hazardous media prior to servicing.

CAUTION

The electrical service must be isolated and de-energized prior to maintenance. Apply appropriate procedures to assure electrical supply is de-energized and cannot be inadvertently energized during maintenance.

Assure piping and product is isolated prior to maintenance of booster. Apply appropriate procedures to assure piping and product is isolated and that inadvertent opening of valves cannot occur during maintenance.

CAUTION

During routine maintenance, inspect and assure that guards are in place and secure.

NOTICE

When changing oil, be sure to reseal the drain and fill plugs. This is especially important on Slinger Splash Lube Series models, which have no mechanical seals on the rotors. Air leaks past these plugs can cause rapid loss of oil from end covers, resulting in booster failure.

Pay special attention to lubrication of timing gears and bearings according to the information in **Lubrication on page 14.**

When a vacuum booster is taken out of service, it may require internal protection against rusting or corrosion. The need for such protection must be a matter of judgment based on existing conditions as well as length of downtime. Under atmospheric conditions producing rapid corrosion, protect the booster immediately. **See Long-Term Storage on page 28.**

REGULAR MAINTENANCE

A well-designed maintenance program will add years of service to the booster.

Check a newly installed booster frequently during the first month of operation, especially lubrication. With the booster at rest, check the oil level in both the gear (drive) end and free (non-drive) end of the booster and add oil as needed. Complete oil

changes are recommended every 1,000 – 1,200 operating hours, or more frequently depending on the type of oil and operating temperature. Boosters with mechanical seals on the rotors can generally run the full 1,500 hours before an oil change is required. Also change the oil more frequently if pumping corrosive vapors or where excessive operating temperatures are encountered. The following is recommended as a minimum maintenance program.

DAILY	WEEKLY	MONTHLY
<ol style="list-style-type: none"> 1. Check and maintain oil level, and add oil as necessary. 2. Check for unusual noise or vibration (See Troubleshooting on page 41). 	<ol style="list-style-type: none"> 1. Clean all air filters. A clogged air filter can seriously affect the efficiency of the booster and cause overheating and oil usage. 2. Check the relief valve to make sure it is operating properly. 	<ol style="list-style-type: none"> 1. Inspect the entire system for leaks. 2. Inspect the condition of the oil and change if necessary. 3. Check drive belt tension and tighten if necessary.

NOTICE

Oil levels should be checked every 24 hours of operation.

Proper oil drain schedules require oil be changed before the contaminant load becomes so great that the lubricating function of the oil is impaired or heavy disposition of suspended contaminants occurs. To check the condition of the oil, drain a sample into a clean container and check for the presence of water or solids. Slight discoloration of the oil should not necessitate an oil change.

SPARE PARTS

Should adjustments or replacement be needed, repairs can often be performed locally as described in this manual after obtaining the required parts. Personnel should have a good background of mechanical experience and be thoroughly familiar with the procedures outlined in this manual. For major repairs not covered in this manual, contact the nearest Tuthill Vacuum & Blower Systems service representative.

When ordering parts, supply the booster nameplate information, as well as the item number and parts description as per the parts lists and assembly drawings. Repair kits are available for all models. These kits contain all the seals, bearings, O-rings, locks, and special retaining screws necessary for an overhaul. For convenience when ordering parts, complete the **Operating Data Form** included on the inside, back cover of this manual.

In developing a stock of spare parts, consider the following factors:

- The degree of importance in maintaining the booster in a “ready” condition
- The time lag in parts procurement
- Cost
- Shelf life (seals and O-rings)

FACTORY SERVICE AND REPAIR

With proper care, Tuthill Vacuum & Blower Systems boosters will give years of reliable service. The parts are machined to very close tolerances and require special tools by mechanics who are skilled at this work. Should major repairs become necessary, contact the factory for the location of the nearest service facility.

NOTICE

Current regulations require Material Safety Data Sheet to be completed and forwarded to Tuthill Corporation on any booster being returned for any reason that has been handling or involved with hazardous gases or materials. This is for the protection of the employees of Tuthill Corporation and the service facilities who are required to perform service on this equipment. Failure to do so will result in service delays.

NOTICE

When returning a booster to the factory for repair under warranty, please note the factory will not accept any booster that arrives without authorization. Contact Customer Service Department for return authorization.

4. Apply a rust-preventative grease to the drive shaft.
5. Spray all exposed surfaces, including the inlet and discharge flanges, with rust preventative.
6. Seal inlet, discharge, and vent openings. It is not recommended that the booster be set in place, piped to the system, and allowed to remain idle for a prolonged amount of time. If any component is left open to the atmosphere, the rust preventative will escape and lose its effectiveness.
7. During storage, ensure that the booster does not experience excessive vibration.
8. Attach a desiccant bag to either of the covers to prevent condensation from occurring inside the booster. Make sure any desiccant bag (or bags) is attached to the covers so that they will be removed before start-up of the booster.
9. Store the booster in an air conditioned and heated building if possible. If air conditioned and heated storage is not possible, make conditions as dry as possible.
10. If possible, rotate the drive shaft by hand at least monthly in order to prevent seals from setting in one position.

LONG-TERM STORAGE

Any time the booster will be stored for an extended period of time, make sure that it is protected from corrosion by following these steps:

1. Spray the interior (lobes, housing, and end plates) with rust preventative. Repeat as conditions dictate and at least on a yearly basis.
2. Fill both end covers completely full of oil.
3. Firmly attach a prominent tag stating that the end covers are full of oil and must be drained and refilled to proper levels before start-up.

MODELS 150 TO 400 DISASSEMBLY AND REASSEMBLY

DISASSEMBLY OF 150 TO 400 BOOSTERS

1. Disconnect the oiling water lines. Do not disturb the oiler bushings. If the oiler bushings are disturbed, it will be necessary to retest the oiling oils for leakage as described in **Assembly of 150 to 400 Boosters on page 30**. Retest the oilers if water is detected in drain oil. (Mechanics I Splash Lube Series only.)
2. Drain oil from both ends of the booster, and remove the inlet and outlet port fittings.
3. Remove spanner lock nut, dust, and washer. Tap out seal. Remove spacers and adjusting shim, and disassemble O-ring.
4. Remove all screws and both end oilers. Two jack screw holes are provided on gear end oiler.
5. Use puller to remove bearing before removing shaft. Remove snapping, bolts, and drive shaft.
6. Remove flat-head Allen screws from end of each rotor shaft. Remove washers, and spacers.
7. Mark the housing, end plates, rotors, and gears before proceeding with disassembly. Two methods can be used to disassemble the rest of the booster. Method A requires an arbor press, and method B requires bar or yoke pullers. **See Figure 14-5.**

Method A

- a. Place two support blocks, 5-1/2 to 6 in. (14 to 15.5 cm) high (hard wood or steel), on the bed of an arbor press. Set the booster, with the gears pointing down, on the two blocks, making sure the blocks support the rotor housing only. Press both rotors out of free end bearings simultaneously.
- b. Lift the housing off the rotors and remove the non-drive end plate by tapping the end plate from the inside of the housing. Place the rotor housing back over the rotors.
- c. Set the booster on the support blocks with the gears pointing upward. Do not embed the blocks into the rotor bores. The rotors may now be pressed from the gear end plate. Do not damage the rotors.

Method B

- a. Align the timing marks on the gears (**Figure 8-1**). Rotate the drive gear clockwise approximately three teeth and mark a matching reference line on each gear as shown in **Figure 8-2**. This gear position is necessary so rotors will bear and not jam. Do not allow the gears to move from the marked reference line while pulling. Use a light rocking motion to ensure that the lobes have not jammed. Remove the driven gear first and then remove the drive gear.

 **WARNING**

Failure to properly pull this gear could result in damage to the rotor keyway or a bent rotor shaft. Never use excessive force.

- b. Remove bolts and bearing retainer rings from end plates.
 - c. Attach a pair of bar pullers to the bearing bores of the free end plate. Use 10-32 x 4 in. long screws (no metric equivalent). Alternately push both rotors from end plate. Separate end plate from housing.
 - d. Turn the booster around and attach a single bar puller to either bore and push the rotor from the end plate, making sure the rotor is vertical in the housing (for support) while removing. Repeat for the opposite rotor. Note the location of the timing shims, oil slinger, and spacers.
 - e. Tap the end plate from the housing.
8. Mechanical Splash Lube Series – Tap out the bearings from both end plates. Note the location of spacers under the bearings and retain for reassembly. To remove seals, use a cape chisel or similar tool, being careful not to nick or cut the bearing or seal bores. Remove the labyrinth seal in the same manner. The seals will be damaged by removal and must be replaced.
- Slinger Splash Lube Series – Carefully tap out the seal slinger, spacer, and bearings. Do not remove the oil slinger stator unless it is damaged or the end plate is to be replaced.
9. Clean all parts with good grade of clean solvent, and replace any worn or damaged parts with factory-approved parts. Install new bearings, seals, and O-rings at each assembly.

ASSEMBLY OF 150 TO 400 BOOSTERS

The assembly procedure is generally the same for all series, but notations are made where there are differences. Seal all vacuum joints, end covers, seal casings, and plugs with an RTV silicone sealer or equivalent, unless O-rings have been provided. Dowel pins are used to locate end plates, housing, and drive end cover in the proper location relative to each other. Be sure they are in place.

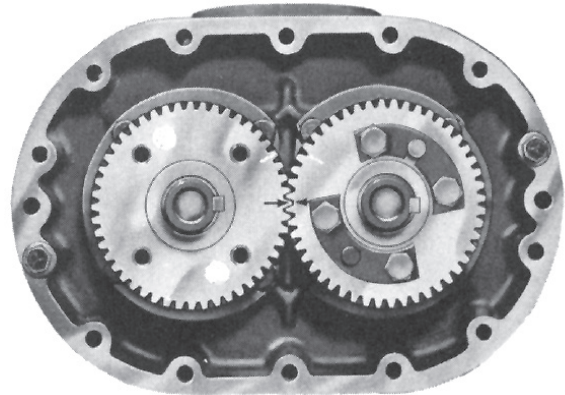


Figure 8-1 – Keyways in line and timing marks matched

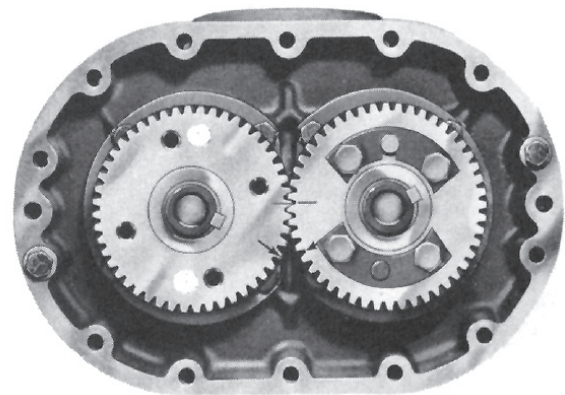


Figure 8-2 – Timing marks advanced 3 teeth (reference marks aligned)

Tuthill Vacuum and Blower Systems recommends that the gear end rotor shaft bearings be purchased from Tuthill, as they are specially ground to locate the rotors with correct end clearance relative to the gear end plate. Do not use standard bearings that have not been flush ground within 0.001 in. (0.025 mm) tolerance. Use factory-approved parts.

Tuthill Vacuum and Blower Systems suggests that long feeler gauges (12 in. [30 cm]) be used to check the interlobe timing, preferably two 0.006 in. (0.15 mm), one 0.005 in. (0.13 mm), one 0.004 in. (0.10 mm), and one 0.003 in. (0.08 mm). This will provide all the combinations from 0.003 in. (0.08 mm) to 0.021 in. (0.53 mm) and also 0.024 in. (0.61 mm), which is the total.

Preparation of End Plates for Assembly

1. Remove all nicks, scratches, etc. from all sealing surfaces. Clean all parts thoroughly. **See Figure 14-1** and **Figure 14-2**.
2. Mechanical Splash Lube Series – Press in new labyrinth seals into bores of both end plates, making sure the scalloped areas of seal case are aligned with openings in vent area of seal bore. Coat O.D. of mechanical seal with sealer and press into seal bore, coming to rest on top of labyrinth seal. Make sure the seals are fully seated without deforming case. Keep sealer from carbon surface. Carefully wipe carbon with soft tissue and cleaning agent (acetone) before continuing assembly.

Slinger Splash Lube Series – Press in new oil slinger stators if required.

Gear End Assembly

3. Stand rotors on arbor press table with the gear end shafts up. **See Figure 8-3**. Two keyways should point in the same direction, to the right.

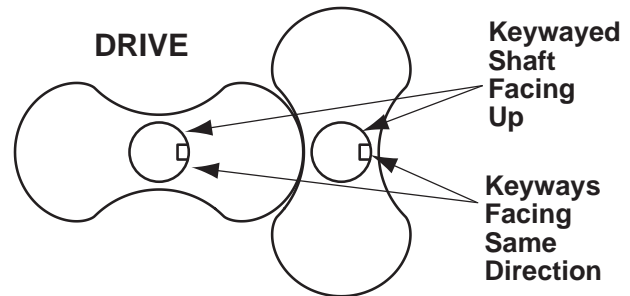


Figure 8-3 – Keyways

4. Carefully install the gear end plate over the rotor shafts.

NOTICE

The drive rotor should always be on the left side. Make sure the end plate feet are facing in the proper direction so the assembled booster will have the same drive shaft location as before.

5. Mechanical Splash Lube Series – Some earlier models used an O-ring under the mating portion of the mechanical seal. This has been discontinued and O-rings should not be used with newly purchased seals. Check lapped surface of seal mating ring to be sure it is perfectly clean. Use soft tissue and cleaning agent if necessary. Place a few drops of lubricating oil on its surface and install on shaft with lapped surface coming to rest on top of carbon. Gently press with fingers to ensure compression is taking place and the ring is not hung up for any reason.

Slinger Splash Lube Series – Slide seal slinger over shaft. Also install spacer if two-piece.

6. Lubricate shafts and press the double-row ball bearings onto the rotor shafts and into the end plate bores.
7. Check clearance between the face of the end plate and rotor lobes. **See Assembly Clearances on page 43** for correct gear end clearances. If clearances are not within specifications, recheck the parts to find the cause of improper clearances before proceeding.

Installation of Timing Gears

8. Install spacer (0.260 in. [6.60 mm] thickness) on one shaft and spacer (0.200 in. [5.08 mm] thickness) and oil slinger on the other shaft. Install timing shim in same location as found in disassembly. This does not necessarily ensure the booster will be in proper time. Adjustments can be made later in the assembly process.

NOTICE

Always mount the oil slinger and its spacer on the lower rotor for horizontal flow boosters. It can be mounted on either shaft for vertical flow boosters.

9. Insert gear keys in their proper location and flush with the top of the shaft. Use the two keyways facing to the right. A tight fit is required. Coat the shafts and keys with lubricant. Install the drive gear (right hand helix) on the drive rotor (left side). To install the driven gear, align the reference marks as shown in **Figure 8-2**. Install the driven gear carefully to avoid damaging any teeth when engaging opposite gear. Secure with spacers, washers, and flat-head Allen screws.

NOTICE

All timing gears must be used in sets, as they are matched and serially numbered.

10. Remove the assembly from the press and stand it on work table with the gears down. Place blocks under the end plate to prevent the assembly from falling over. The drive gear should remain on the left side.

Housing and Free End Assembly

11. Place a small bead of sealer around the periphery of the end plate, encircling each bolt hole. Install the rotor housing and secure with 4 screws evenly spaced.
12. Check the clearance between the end of lobes and housing using a flat bar and feeler gauges or a depth micrometer. **See Assembly Clearances on page 43** for free end clearances.
13. Place a small bead of sealer around the periphery of the housing, encircling each bolt hole. Install free end plate and secure with 4 screws.
14. Mechanical Splash Lube Series – Install mating rings using the same procedure as described in step 5.

Slinger Splash Lube Series – Install seal slinger using the same procedure as described in step 5.
15. Install bearing spacers on each shaft. Lubricate the shafts and install roller bearings.

CAUTION

Inner race of bearing has a flange on one side only. This flange must face outward. **See Figure 8-2.**

16. Install oil retainer rings with button-head screws. Only two are required for each ring.

Adjusting Rotor Interlobe Clearance

17. Install spacer on each shaft. Install oil slinger on lower rotor (either shaft on vertical flow boosters) spacer on opposite shaft, washers, and screws. Lay the assembly down with the drive on the left for timing.

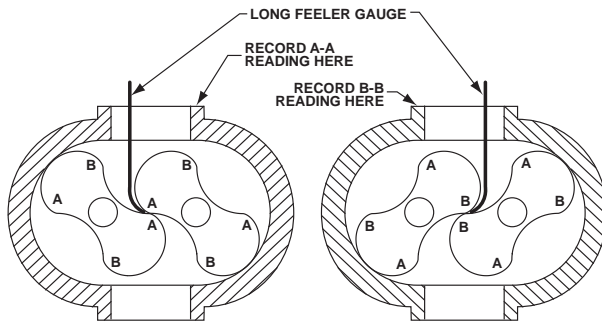


Figure 8-4 – Checking Rotor Interlobe Clearance

18. Using feeler gauges, take interlobe readings and record on each side of housing as indicated in **Figure 8-4**. By removing or adding shim behind the helical gear, it rotates as it is moved in or out and the driven rotor turns with it, thus changing the clearance between rotor lobes. Changing the shim thickness 0.006 in. (0.15 mm) will change the rotor lobe clearance 0.003 in. (0.08 mm) or one-half the amount.

EXAMPLE: Referring to **Figure 8-4**, check the clearance at AA (right-hand reading) and BB (left-hand reading). If AA reading is 0.009 in. (0.23 mm) and BB reading 0.003 in. (0.08 mm), by removing 0.006 in. (0.15 mm) shims, the readings will change one-half the amount removed or 0.003 in. (0.08 mm). AA should then read 0.006 in. (0.15 mm), and BB should read 0.006 in. (0.15 mm). The final readings should be within 0.002 in. (0.05 mm) of each other. To determine the amount of shim to add or remove, subtract the smaller figure from the larger one. If the right side reading is higher than the left side, remove shim. If the right side reading is lower, add shim.

19. Install the drive shaft and secure with Allen screws. Check drive shaft runout behind the keyway. Do not exceed 0.002 in. (0.05 mm) T.I.R. Install lockwire.

20. Install bearing on the drive shaft with shield towards gear and shim pack.
21. Remove temporary cap screws from the gear end plate and apply a bead of sealer around the end plate (not cover), encircling all holes. Install the gear cover and secure with cap screws.

NOTICE

If cooling coil or fittings were disturbed or water was detected in drain oil, retest them with air pressure to check for leaks and reseal. This applies to Mechanical Splash Lube Series only.

Drive Shaft Seal Assembly

22. Grease and install O-ring into groove of seal adapter housing. Press in stator portion (carbon) of mechanical seal.
23. Install O-ring spacer, O-ring, and mating ring portion of mechanical seal, with lapped surface facing outward. Make sure surface is clean and place a few drops of lubricating oil on its surface. Install sleeve with grooved side facing mating ring.
24. Slide seal assembly housing over the drive shaft and against the cover. Slide dust washer against spacer sleeve. Dust washer should be flush to plus 0.005 in. (0.13 mm) with the face of the housing. Adjust with shim pack.
25. Remove the housing and install O-ring. Reinstall the housing (with cutout on the seal housing up when booster is standing on its feet) and dustwasher, and secure with Allen screws and spanner nut.

CAUTION

Do not hammer on wrench or use excessive force as distortion of mating ring may occur causing leakage.

Complete Booster Assembly

26. Install free end cover following the same procedure used to install the gear cover. Secure with cap screws.
27. Apply sealer and install both port fittings.
28. Install all necessary cooling water lines.
29. Before putting the booster into operation, follow the instructions in ***Installation on page 10*** and ***Operation on page 22***. Observe the oil level frequently during the initial hours of operation. An improperly installed or damaged oil seal will result in oil loss.

TROUBLESHOOTING

Although Tuthill Vacuum & Blower Systems boosters are well designed and manufactured, problems may occur due to normal wear and the need for readjustment. The following chart lists symptoms that may occur along with probable causes and remedies.

SYMPTOM	PROBABLE CAUSE	REMEDIES
Loss of oil	Gear housing not tightened properly	Tighten gear housing bolts.
	Lip seal failure	Disassemble and replace lip seal.
	Insufficient sealant	Remove gear housing and replace sealant. See Disassembly of 150 to 400 Boosters on page 29 and Disassembly of 540 to 720 and 850 to 2700 Boosters on page 35.
	Loose drain plug	Tighten drain plug.
Excessive bearing or gear wear	Improper lubrication	Correct oil level. Replace dirty oil. See Lubrication on page 14.
	Excessive belt tension	Check belt manufacturer's specifications for tension and adjust accordingly.
	Coupling misalignment	Check carefully. Re-align if necessary.
Lack of volume	Slipping belts	Check belt manufacturer's specifications for tension and adjust accordingly.
	Worn lobe clearances	Check for proper clearances. See Assembly Clearances on page 43.
	Speed too low	Increase booster speed within limits.
	Obstruction in piping	Check system to ensure an open flow path.

SYMPTOM	PROBABLE CAUSE	REMEDIES
Knocking	Booster out of time	Re-time.
	Distortion due to improper mounting or pipe strains	Check mounting alignment and relieve pipe strains.
	Excessive pressure differential	Reduce to manufacturer's recommended pressure. Examine relief valve and reset if necessary.
	Worn gears	Replace timing gears. See <i>Disassembly of 150 to 400 Boosters on page 29</i> and <i>Disassembly of 540 to 720 and 850 to 2700 Boosters on page 35</i>.
Excessive booster temperature	Too much or too little oil in gear reservoir	Check oil level. See <i>Lubrication on page 14</i>.
	Too low operating speed	Increase booster speed within limits.
	Clogged filter or silencer	Remove cause of obstruction.
	Excessive pressure differential	Reduce pressure differential across the booster.
	Elevated inlet temperature	Reduce inlet temperature.
	Worn lobe clearances	Check for proper clearances. See <i>Assembly Clearances on page 43</i>.
Rotor end or tip drag	Insufficient assembled clearances	Correct clearances. See <i>Assembly Clearances on page 43</i>.
	Case or frame distortion	Check mounting and pipe strain.
	Excessive operating pressure	Reduce pressure differential.
	Excessive operating temperature	Reduce pressure differential or reduce inlet temperature.
Vibration	Belt or coupling misalignment	Check carefully. Re-align if necessary.
	Lobes rubbing	Check cylinder for hot spots, and then check for lobe contact at these points. Correct clearances. See <i>Assembly Clearances on page 43</i>.
	Worn bearings or gears	Check condition of gears and bearings. Replace if necessary.
	Unbalanced or rubbing lobes	Possible build-up on casing or lobes, or inside lobes. Remove build-up and restore clearances.
	Driver or booster loose	Check mounting and tighten if necessary.
	Piping resonance	Check pipe supports, check resonance of nearby equipment, and check foundation.

ASSEMBLY CLEARANCES

MODEL	GEAR END	FREE END	INTERLOBE	TIP-DOWEL	TIP-PORT
150	0.003 – 0.005 in. (0.08 – 0.13 mm)	0.006 – 0.010 in. (0.15 – 0.25 mm)	CENTER TIMED	0.003 – 0.007 in. (0.08 – 0.18 mm)	0.006 – 0.010 in. (0.15 – 0.25 mm)
240	0.003 – 0.005 in. (0.08 – 0.13 mm)	0.012 – 0.017 in. (0.30 – 0.43 mm)		0.003 – 0.007 in. (0.08 – 0.18 mm)	0.006 – 0.010 in. (0.15 – 0.25 mm)
400	0.003 – 0.005 in. (0.08 – 0.13 mm)	0.012 – 0.017 in. (0.30 – 0.43 mm)		0.003 – 0.007 in. (0.08 – 0.18 mm)	0.006 – 0.010 in. (0.15 – 0.25 mm)
540	0.004 – 0.007 in. (0.10 – 0.18 mm)	0.011 – 0.016 in. (0.28 – 0.41 mm)	CENTER TIMED	0.017 – 0.022 in. (0.43 – 0.56 mm)	0.017 – 0.022 in. (0.43 – 0.56 mm)
720	0.004 – 0.007 in. (0.10 – 0.18 mm)	0.011 – 0.016 in. (0.28 – 0.41 mm)		0.017 – 0.022 in. (0.43 – 0.56 mm)	0.017 – 0.022 in. (0.43 – 0.56 mm)
850	0.004 – 0.007 in. (0.10 – 0.18 mm)	0.011 – 0.016 in. (0.28 – 0.41 mm)	CENTER TIMED	0.007 – 0.012 in. (0.18 – 0.30 mm)	0.011 – 0.016 in. (0.28 – 0.41 mm)
1200	0.004 – 0.007 in. (0.10 – 0.18 mm)	0.014 – 0.019 in. (0.36 – 0.48 mm)		0.007 – 0.012 in. (0.18 – 0.30 mm)	0.011 – 0.016 in. (0.28 – 0.41 mm)
1600	0.004 – 0.007 in. (0.10 – 0.18 mm)	0.017 – 0.022 in. (0.43 – 0.56 mm)		0.007 – 0.012 in. (0.18 – 0.30 mm)	0.011 – 0.016 in. (0.28 – 0.41 mm)
2000	0.004 – 0.007 in. (0.10 – 0.18 mm)	0.021 – 0.026 in. (0.53 – 0.66 mm)		0.007 – 0.012 in. (0.18 – 0.30 mm)	0.011 – 0.016 in. (0.28 – 0.41 mm)
2700	0.004 – 0.007 in. (0.10 – 0.18 mm)	0.025 – 0.030 in. (0.64 – 0.76 mm)		0.008 – 0.013 in. (0.20 – 0.33 mm)	0.012 – 0.017 in. (0.30 – 0.43 mm)

12

TORQUE CHART

Data shown represents “wet” torque values.

PART DESCRIPTION	TORQUE
CAP SCREW 10-32UNF	3 ft-lb (4 N-m)
CAP SCREW 1/4"-20UNC GR5	6 ft-lb (8 N-m)
CAP SCREW 5/16"-18UNC GR5	13 ft-lb (17 N-m)
CAP SCREW 3/8"-16UNC GR5	23 ft-lb (31 N-m)
CAP SCREW 1/2"-13UNC GR5	57 ft-lb (77 N-m)
CAP SCREW 5/8"-14UNC GR5	113 ft-lb (153 N-m)
CAP SCREW 3/4"-10UNC GR5	200 ft-lb (271 N-m)

RECOMMENDED LUBRICANTS

RECOMMENDED LUBRICANTS FOR ROTARY BLOWERS AND VACUUM BOOSTERS

RECOMMENDED SYNTHETIC BASED LUBRICANTS FOR BLOWERS				
AMBIENT TEMPERATURE	TUTHILL	VISCOSITY GRADE	ISO 100	ISO 150
0° to 32°F (-18° to 0°C)	PneuLube™ (ISO 100)	Specific Gravity 16° C (62° F)	0.859	0.865
32° to 90°F (0° to 32°C)		Viscosity 40° C (104° F)	91.8 cSt	142.7 cSt
90° to 120°F* (32° to 50°C)		Viscosity 100° C (212° F)	13.1 cSt	18.0 cSt
		Viscosity Index Pour Point Flash Point Copper Corrosion Rating	142 -51° C (-60° F) 246° C (475° F) 1A	140 -51° C (-60° F) 246° C (475° F) 1A

RECOMMENDED SYNTHETIC BASED, FOOD GRADE LUBRICANTS FOR BLOWERS	
AMBIENT TEMPERATURE	LUBRICANT MEETING U.S. FDA REGULATION 21 CFR 178.3570 GOVERNING PETROLEUM PRODUCTS WHICH MAY HAVE INCIDENTAL CONTACT WITH FOOD, AND USDA H1 REQUIREMENTS
0° to 32°F (-18° to 0°C)	PneuLube™ FG (ISO 100)
32° to 90°F (0° to 32°C)	
90° to 120°F* (32° to 50°C)	

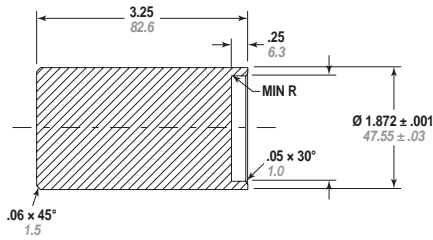
Recommended Lubricants

RECOMMENDED LUBRICANTS FOR M-D VACUUM BOOSTERS	
REQUIREMENTS	
<ul style="list-style-type: none"> • Suitable for high vacuum service • 100 cSt @ 40°C • Vapor pressure of 1 micron or less @ 70°F (21°C) • Straight mineral (no additives) or PAO synthetic oil 	

RECOMMENDED GREASE FOR CP BLOWERS:	
TUTHILL	
Tuthill PneuLube™ NLGI #2 premium grade, petroleum base lithium grease.	Food Grade HTEP grease, NLGI No. 2 grade. Must meet all requirements of FDA Regulation 21 CFR 178.3570 (the former USDA H-1 approval requirements) for lubricants having incidental contact with food.
* For higher ambient temperatures, please consult the factory.	

RECOMMENDED OIL FOR OXYGEN-ENRICHED SERVICE	
Blowers used in oxygen-enriched service should use only non-flammable, PFPE synthetic lubricant. Blowers used in hydrogen service should use only PneuLube synthetic oil. Tuthill Vacuum & Blower Systems cannot accept responsibility for damage to seals, O-rings and gaskets caused by use of synthetic lubricants not recommended by Tuthill Vacuum & Blower Systems.	

SPECIAL TOOL DRAWINGS



MATL P/N: CR1018R0-0200 x 3.50 (88.9) LG
 MATL: COLD ROLLED 1018, 2.00 (50) OD x 3.50 (90) LONG

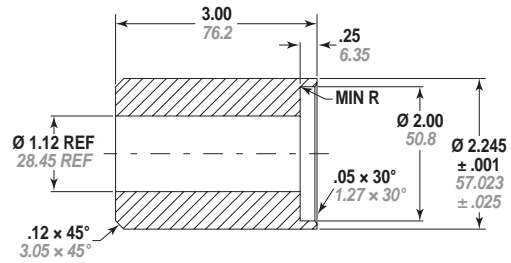
TOLERANCES

.XX = ± .01 (± .03)
 .XXX = ± .005 (± .05)
 ANGULAR = ± .005

NOTE:

TOOLS T32018-1 & T32018-2 ARE USED TO INSTALL MECHANICAL SEAL, LABYRINTH SEAL AND LIP SEAL USED ON MODEL 150 TO 400 ROTOR SHAFTS.

Figure 14-1 – 150 to 400 Seal Pressing Tool (T32018-1)

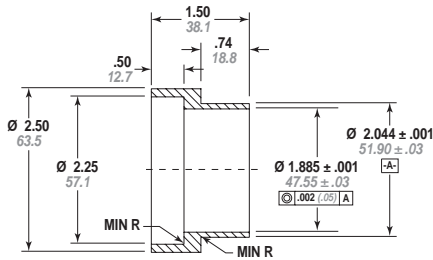


MATL P/N: CR1026T0-237062 x 3.25 (82.55) LG
 MATL: COLD ROLLED 1026 TUBE
 2.38 (60.45) OD x 0.63 (16.002) LG x 3.25 (82.55)

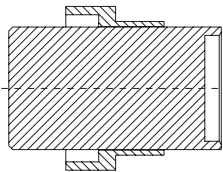
TOLERANCES

.XX = ± .01 (± .03) ANGULAR = ± 2°
 .XXX = ± .005 (± .05) CHAMFERS = ± 2°

Figure 14-3 – 150 to 400 Seal Installation Tool (T27563-1)

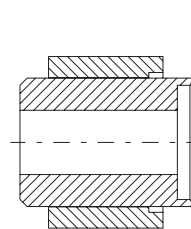


MATL P/N: CR1026T0-250050 x 1.75 (44.5) LG
 MATL: COLD ROLLED 1026 TUBE,
 2.50 (65) OD x .50 (15) WALL x 1.75 (45) LONG

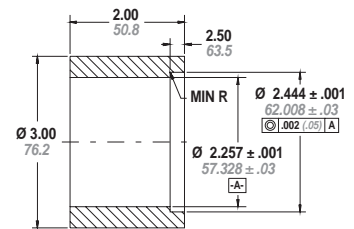


TOOL ASSEMBLY FOR END PLATE
 LAB SEAL, END PLATE
 LIP SEAL AND END PLATE
 MECHANICAL SEAL INSTALLATION

Figure 14-2 – 150 to 400 Seal Pressing Tool (T32018-2)



TOOL ASSEMBLY FOR
 DRIVE SHAFT MECHANICAL
 SEAL INSTALLATION



MATL P/N: CR1026T0-300050 x 2.25 (57.15) LG
 MATL: COLD ROLLED 1026 TUBE
 3 (76.2) OD x 0.5 (12.7) LG x 2.25 (57.15)

NOTE:

TOOLS T27563-1 & T27563-2 ARE USED TO INSTALL MECHANICAL SEAL USED ON MODEL 150 TO 400 DRIVE SHAFTS.

Figure 14-4 – 150 to 400 Seal Installation Tool (T27563-2)

MATL P/N: CR1018B0-200075 x 5.5 (139.7) LG
 MATL: COLD ROLLED 1018 BAR
 2.75 (69.85) x 5.5 (139.7) LONG

TOLERANCES
 FRACTIONAL = ± .0005 (± 0.0127)
 CHAMFERS = ± 2°

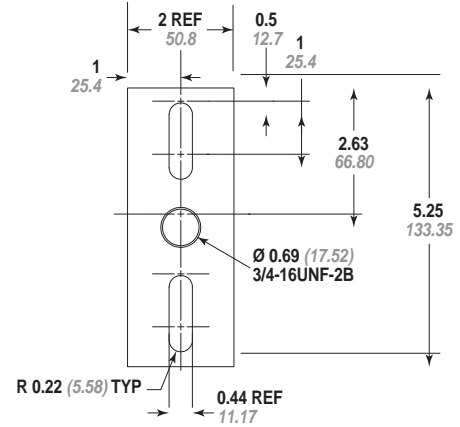
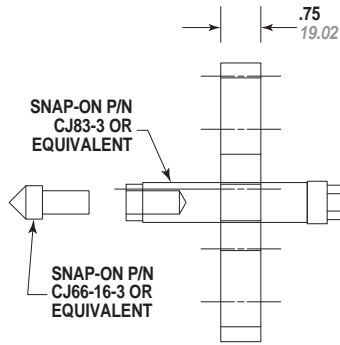
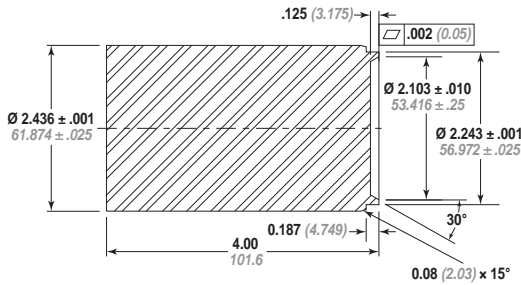
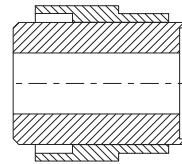
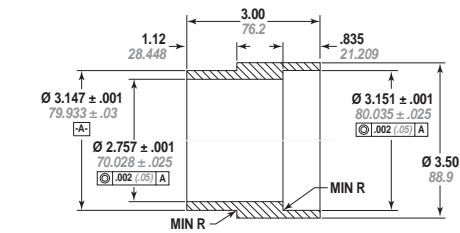


Figure 14-5 – 150 to 400/540 to 720/850 to 2700 Gear and EP Tool (T29603)



MATL P/N: CR1215R0-0250 x 4.25 (88.9) LG
 MATL: COLD ROLLED STEEL BAR
 Ø 2.50 (63.5) OD x 4.25 (107.95) LG

TOLERANCES
 .XX = ± .01 (± .03)
 .XXX = ± .005 (± .05)
 CHAMFERS = ± 2°

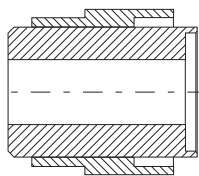
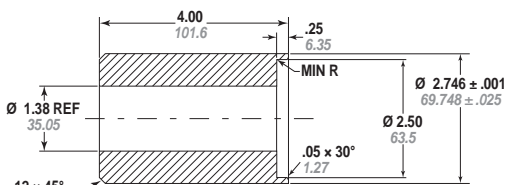


TOOL ASSEMBLY FOR END PLATE LAB SEAL & END PLATE MECHANICAL SEAL INSTALLATION

MATL P/N: CR1026T0-350050 x 3.25 (82.55) LG
 MATL: COLD ROLLED 1026 TUBE
 3.50 (88.9) OD x .50 (12.7) WALL
 x 3.25 (82.55) LONG

NOTE:
 TOOLS T11449-1 & T11449-2 ARE USED TO INSTALL MECHANICAL SEAL AND LABRYNTH SEAL USED ON MODEL 850 TO 2700 ROTOR SHAFTS.
 MECHANICAL SEAL USED ON MODEL 850 TO 2700 DRIVE SHAFTS AND MECHANICAL SEAL USED ON MODEL 540 TO 720 VACUUM BOOSTER DRIVE SHAFTS.

Figure 14-6 – 540 to 720 Mechanical Seal Tool (T11549)



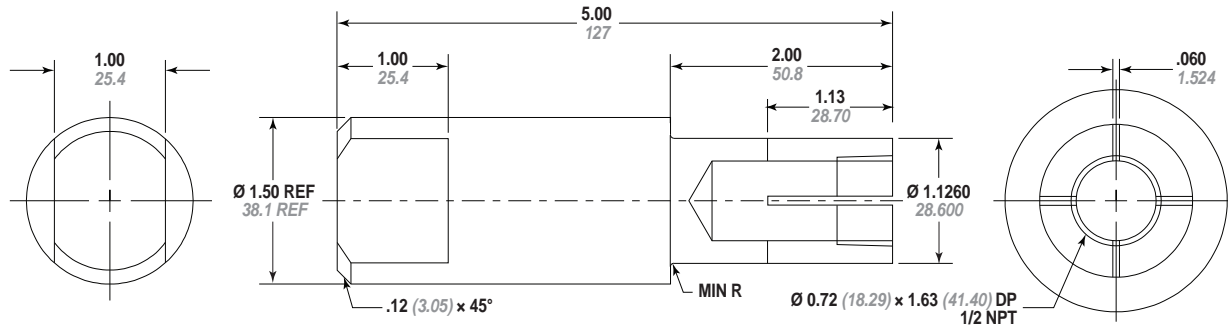
TOOL ASSEMBLY FOR DRIVE SHAFT MECHANICAL SEAL INSTALLATION

MATL P/N: CR1026T0-287075 x 4.25 (107.95) LG
 MATL: COLD ROLLED 1026 TUBE
 2.875 (73.025) OD x 4.25 (107.95) LONG

TOLERANCES:
 .XX = ± .01 (0.3)
 .XXX = ± .0005 (0.05)
 CHAMFERS = ± 2°

Figure 14-8 – 540 to 720/850 to 2700 Seal Pressing Tool (T11449-2)

Figure 14-7 – 540 to 720/850 to 2700 Seal Pressing Tool (T11449-1)

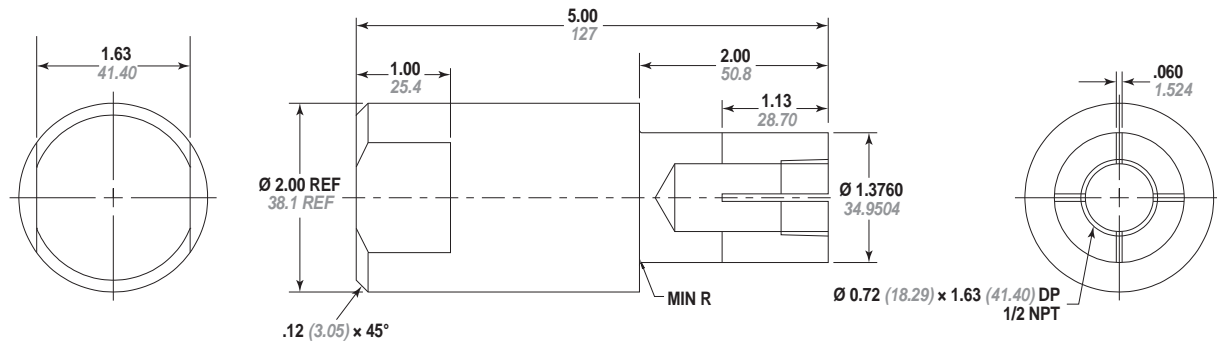


MATL P/N: CR1215R0-0150 x 5.25 (133.35) LG
 MATL: COLD ROLLED STEEL BAR
 Ø 1.50 (38.10) OD x 5.25 (133.35) LG

FURNISH ONE M-D P/N 90094-050
 1/2 NPT SOCKET HEAD PIPE PLUG

TOLERANCES
 .XX = ± .01 (± .03)
 .XXX = ± .005 (± .05)
 .XXXX = ± .0005 (± .013)
 CHAMFERS = ± 2°

Figure 14-9 – 540 to 720 Drive Shaft Seal Assembly Fixture (T22179)



MATL P/N: CR1215R0-0150 x 5.25 (133.35) LG
 MATL: COLD ROLLED STEEL BAR
 Ø 2.00 (50.8) OD x 5.25 (133.35) LG

FURNISH ONE M-D P/N 90094-050
 1/2 NPT SOCKET HEAD PIPE PLUG

TOLERANCES
 .XX = ± .01 (± .03)
 .XXX = ± .005 (± .05)
 .XXXX = ± .0005 (± .013)
 CHAMFERS = ± 2°

Figure 14-10 – 850 to 2700 Drive Shaft Seal Assembly Fixture (T22180)

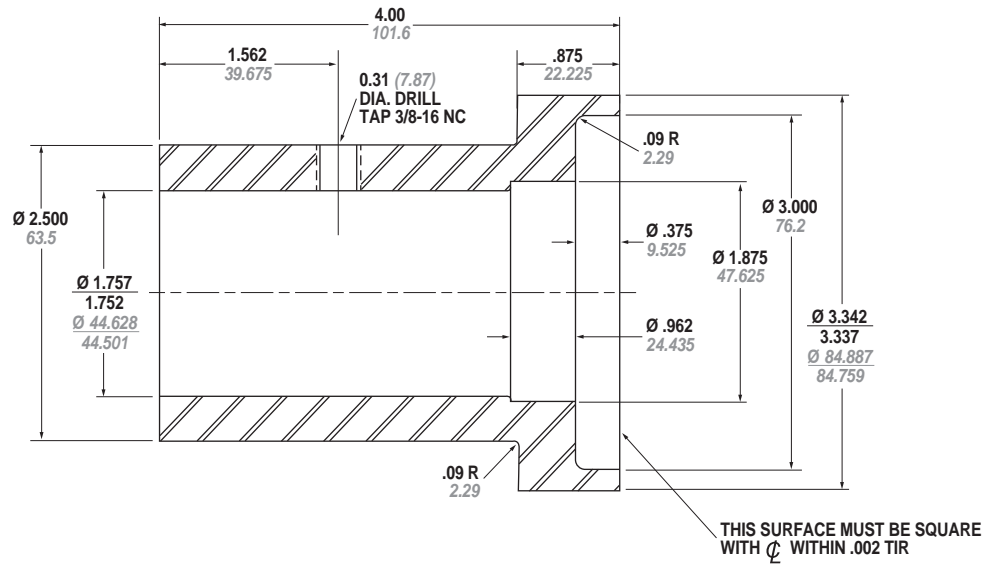


Figure 14-11 – 540 to 720 Pressing Tool for Mechanical Seals

NOTE: All dimensions are shown in inches and millimeters.

PARTS LIST

Parts List for Model 150 to 400 Series – Mechanical Splash Lube

ITEM NO.	PART DESCRIPTION	QTY
1	Rotor	2
3	Housing	1
4	End Plate	2
6	Drive End Cover	1
7	Free End Cover	1
8	Timing Gear Set	1
9	Bearing, Drive End	2
10	Bearing, Free End	2
14	Retainer	4
16	Shim	2
16	Shim	6
16	Shim	2
17	Spacer	1
18	Spacer	1
20	Oil Slinger	1
21	Oil Slinger	1
23	Drive Shaft Key	1
24	Gear Key	2
25	Rotor Shaft Washer	4
26	Cap Screw, Hex HD	12
26	Cap Screw, Hex HD	12
29	Cap Screw, Hex HD	4
30	Cap Screw, Socket HD	16
31	Magnetic Pipe Plug	2
38	Port Fitting	2
40	Cap Screw, Hex HD	24
42	Nameplate	1
45	Drive Shaft	1
50	Bearing	1
51	Lab Seal	4
54	Mechanical Seal	4
57	Spacer	1
66	Cap Screw, Socket HD	2
67	Spacer	2
74	Spacer	1
75	O-ring	1
76	Mechanical Seal	1
77	Spacer	1
82	Washer	1

ITEM NO.	PART DESCRIPTION	QTY
83	Locknut	1
85	Pipe Plug	9
91	Drive Shaft Adapter Seal	1
92	O-ring	1
93	Cap Screw, Socket HD	4
94	Cooling Coils	2
98	Pipe Plug	9
118	Shim	1
118	Shim	1
120	Reducing Bushing	4
121	Pipe Plug	2
123	Bearing Spacer	2
140	O-ring	1
152	Elbow	1
165	Tube Connector	4
166	Tube Connector	3
174	Pipe Plug	2
180	Elbow	2 / 3
181	Hose	1
234	Oil Level Tag	2 / 4
241	Cap Screw	12
242	Sight Gauge Frame	2
243	Sight Gauge Glass Frame	2
244	Window Gasket	2
245	Frame Gasket	2
271	Pipe Plug	1 / -
272	Tee	1 / -
273	Hose Connector	1
274	Hose	1
500	Thermoswitch	1

NOTES:

- QUANTITIES SHOWN ARE MAXIMUM VALUES. QUANTITIES MAY VARY BETWEEN BLOWER.

PARTS KITS ARE AVAILABLE. CONSULT AUTHORIZED REPRESENTATIVE FOR PART NUMBERS.

Parts List for Model 150 to 400 Series – Slinger Splash Lube

ITEM NO.	PART DESCRIPTION	QTY
1	Rotor	2
3	Housing	1
4	End Plate	2
6	Drive End Cover	1
7	Free End Cover	1
8	Timing Gear Set	1
9	Bearing, Drive End	2
10	Bearing, Free End	2
14	Retainer	4
16	Shim	2
16	Shim	6
16	Shim	2
17	Spacer	1
18	Spacer	1
20	Oil Slinger	1
21	Oil Slinger	1
23	Drive Shaft Key	1
24	Gear Key	2
25	Rotor Shaft Washer	4
26	Cap Screw, Hex HD	12
26	Cap Screw, Hex HD	12
29	Cap Screw, Hex HD	4
30	Cap Screw, Socket HD	16
31	Magnetic Pipe Plug	2
38	Port Fitting	2
40	Cap Screw, Hex HD	24
42	Warning Tag	1
42	Nameplate	1
45	Drive Shaft	1
50	Bearing	1
57	Spacer	1
66	Cap Screw, Socket HD	2
67	Spacer	2
74	Spacer	1
75	O-ring	1

ITEM NO.	PART DESCRIPTION	QTY
76	Mechanical Seal	1
77	Spacer	1
79	Slinger Seal Stat.	4
82	Washer	1
83	Locknut	1
85	Pipe Plug	8
91	Drive Shaft Adapter Seal	1
92	O-ring	1
93	Cap Screw, Socket HD	4
98	Pipe Plug	6
118	Shim	1
118	Shim	1
121	Pipe Plug	1 / -
123	Bearing Spacer	2
140	O-ring	1
174	Pipe Plug	2 / 6
175	Straight Plug	2 / -
176	Straight Plug	2 / -
234	Oil Level Tag	4
238	Rotor Slinger Seal	4
241	Cap Screw	12
242	Sight Gauge Frame	2
243	Sight Gauge Glass Frame	2
244	Window Gasket	2
245	Frame Gasket	2
344	Straight Plug	- / 2
373	Straight Plug	- / 2
500	Thermoswitch	1

NOTES:

- QUANTITIES SHOWN ARE MAXIMUM VALUES. QUANTITIES MAY VARY BETWEEN BLOWER.

PARTS KITS ARE AVAILABLE. CONSULT AUTHORIZED REPRESENTATIVE FOR PART NUMBERS.

ASSEMBLY DRAWINGS

Models 150 to 400 – Cutaway View

