

WARNING: Do Not Operate Before Reading Manual

Mechanical C-Flange Vacuum Boosters

OPERATOR'S MANUAL

Models

3204	4009	5509	5518	7013	7026
3206	4012	5511	5524	7017	
3210	5507	5514	7010	7021	

91/93 Series - Horizontal Flow

90/92 Series - Vertical Flow



TABLE OF CONTENTS

SECTION	PAGE
1. INTRODUCTION	3
1.1 APPLICABLE DOCUMENTATION	3
1.2 SCOPE OF MANUAL	3
2. CONVENTIONS AND DATA PLATE	4
2.1 GRAPHIC CONVENTIONS IN MANUAL	4
2.2 DATA PLATE	4
3. LIFTING	5
4. DESCRIPTION	5
4.1 FLOW BY DIRECTION AND ROTATION	6
4.2 SPECIFICATIONS	7
5. INSTALLATION	8
5.1 GENERAL	8
5.1.1 LOCATION	10
5.1.2 FOUNDATION	10
5.1.3 BOOSTER AIR INTAKE	10
5.1.4 SOFT FOOT	11
5.2 SAFETY	11
5.3 LUBRICATION	12
5.3.1 FILLING PROCEDURE	13
5.3.2 FREQUENTLY ASKED QUESTIONS REGARDING LUBRICATION	13
5.3.3 HAZARDS ASSOCIATED WITH BREAKDOWN OR IGNITION OF LUBRICATION	14
5.4 PIPING CONNECTIONS	14
5.4.1 BLOCKAGE OR RESTRICTION	15
5.5 WATER COOLING INSTRUCTIONS	15
5.6 COOLING WATER CONNECTIONS	16
5.7 COOLING WATER SPECIFICATIONS	16
5.8 DRIVE COMPONENTS	16
5.9 MOTOR DRIVE	16
5.9.1 DIRECT COUPLED	16
5.10 MOTOR AND ELECTRICAL CONNECTIONS	17
5.11 C-FLANGE COUPLING INSTALLATION	17
5.11.1 WOOD'S COUPLINGS	17
5.11.2 LOVEJOY COUPLINGS	17
6. OPERATION	18
6.1 GENERAL	18
6.2 START-UP CHECKLIST	19
6.3 STARTING	19
6.4 OPERATING	19
6.5 STOPPING	20
6.6 STOPPING	20
6.7 WATER INJECTED VACUUM BOOSTERS	20
6.7.1 OPERATION	21
6.7.2 SHUTDOWN	21
6.8 RECOMMENDED SHUTDOWN PROCEDURE TO MINIMIZE RISK OF FREEZING OR CORROSION	22
7. MAINTENANCE	22
7.1 GENERAL	22
7.2 REGULAR MAINTENANCE	23
7.3 SPARE PARTS	23
7.4 FACTORY SERVICE & REPAIR	24
7.5 LONG TERM STORAGE	24
8. MODEL 3200C SERIES DISASSEMBLY AND REASSEMBLY	25
9. MODEL 4000C AND 5500C SERIES DISASSEMBLY AND REASSEMBLY	30
10. MODEL 7000C SERIES DISASSEMBLY AND REASSEMBLY	35
11. TROUBLESHOOTING	40
12. ASSEMBLY CLEARANCES	41
13. TORQUE CHART	41
14. RECOMMENDED LUBRICANTS	42
15. TOOL DRAWINGS	44
16. PARTS LISTS AND ASSEMBLY DRAWINGS	46
17. DECLARATION OF CONFORMITY	69
18. WARRANTY — BLOWER PRODUCTS	70
19. OPERATING DATA FORM / PRODUCT REGISTRATION	71

1. INTRODUCTION

CONGRATULATIONS on your purchase of a new **C-Flange 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 booster is stored outdoors be sure to protect it from weather and corrosion.

This manual covers the installation, operation and maintenance of 3200, 4000, 5500 and 7000 Series C-Flange mechanical vacuum boosters. The boosters are manufactured for either a vertical flow or a horizontal flow. Most in-field drive conversions can be readily accomplished by changing the location of a few external parts.

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

MODEL	MECHANICAL SEAL	SLINGER SEAL
3200C 4000C 5500C 7000C	(1) 90/91	(2) 92/93

(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.



NOTE

Record the blower model and serial numbers of your machine in the OPERATING DATA form on the inside back cover of this manual. You will save time and expense by including this reference identification on any replacement part orders, or if you require service or application assistance.

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 2: Vacuum Pumps

1.2 SCOPE OF MANUAL

The scope of this manual and the Declaration of Conformity includes the following components offered, as a complete assembly, by Tuthill Vacuum & Blower Systems:

- Vacuum booster with integral C-face flange
- Coupling
- Motor adaptor kit
- Motor (optional)

2. CONVENTIONS AND DATA PLATE

2.1 GRAPHIC CONVENTIONS IN MANUAL

This manual is the result of a risk assessment according the applicable documents referenced in section 1.1. The following are hazard levels are referenced within this manual:

DANGER
Indicates an immediate hazardous situation which, if not avoided, will result in death or serious injury.

WARNING
Indicates that a physical injury or damage to health or property, if not avoided, could occur.

CAUTION
Indicates that a potential hazard may occur which, if not avoided, could result in minor or moderate injury.

NOTE
Indicates a statement of information which, if not avoided, could cause damage to the product.

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



2.2 DATA PLATE

MODEL NUMBER <input style="width: 90%;" type="text"/>	SERIAL NUMBER <input style="width: 90%;" type="text"/>	MAWP <input style="width: 80%;" type="text"/>	YEAR <input style="width: 80%;" type="text"/>
		Tuthill Vacuum & Blower Systems 4840 West Kearney Street Springfield, Missouri USA 65803	
		MAX RPM <input style="width: 80%;" type="text"/>	

READ INSTRUCTION MANUAL BEFORE OPERATION OR BODILY HARM MAY RESULT

WARNING
Keep body & clothing away from machine openings.

WARNING
Do not operate without guards in place.

CAUTION
Hearing protection required.

CAUTION
Do not touch hot surfaces.

<http://www.tuthill.com>

(800) 825-6937

Made in the USA

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.

- MODEL NUMBER:** This identifies the specific model of the booster.
SERIAL NUMBER: Each booster has a unique serial number. This number is to be used with any service issues and with any contact with the manufacturer.
YEAR: This states the year that the booster was manufactured.
RPM: This states the maximum RPM that the booster can be operated.

3. LIFTING



WARNING

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

4. DESCRIPTION



NOTE

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 model 3200, 4000, 5500 and 7000 Series C-Flange mechanical vacuum boosters are positive displacement type units, 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.

Effective sealing of the inlet to the discharge is accomplished through the use of very small operating clearances. The resulting absence of moving contact eliminates the need for any internal lubrication. 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 1 illustrates that the air moves not between the rotors but between the rotors and the side of the housing. Also, the machine is bi-directional, meaning that the direction of rotation of the booster can make either side the inlet or discharge. See also the *Flow Direction by Rotation* section below.

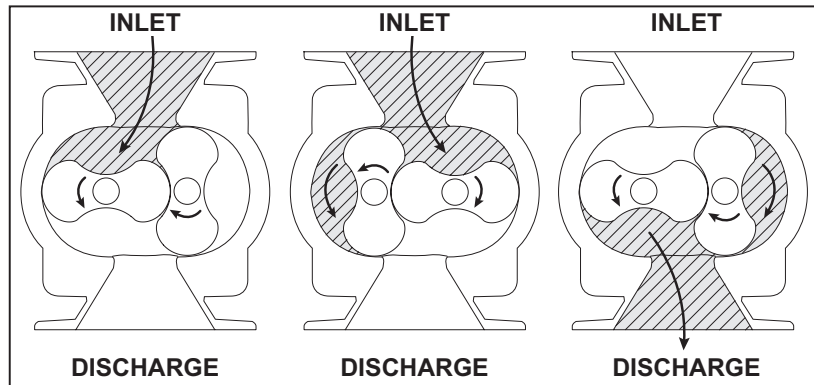


Figure 1 - Illustration of general operation principle

No attempt should ever be made 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, increase operating temperatures, and can overload and/or seriously damage the booster. Likewise, if a possibility exists that flow to the booster inlet may be cut off during normal operation of a process, then an adequate vacuum relief valve must be installed near the booster. 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. Check valves should also be used on every booster when more than one booster is connected to a discharge line. This is for both safety and operating conditions.

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

In a direct coupled arrangement, a variable speed motor or transmission is required, or excess air or gas may be blown off through a manually controlled unloading valve and silencer. Gas units 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.

Consult your Tuthill Vacuum & Blower Systems sales professional if questions arise.



DANGER

As with any equipment with rotating elements, the booster will over time become a source of media leaks and a source of ignition. It is the user's responsibility to assure that proper installation, operation and maintenance is performed to assure that the booster does not become a hazard.

FLOW BY DIRECTION AND ROTATION



WARNING

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

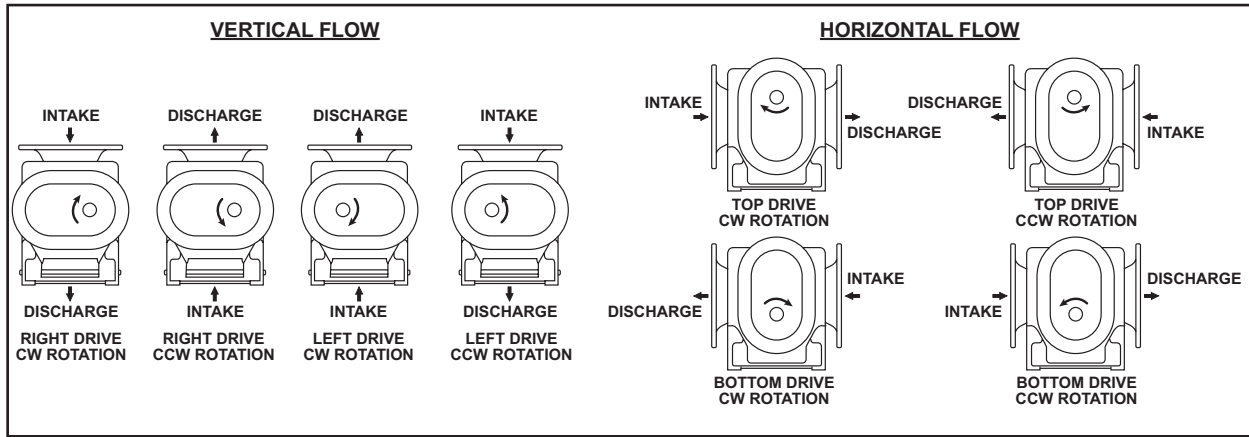


Figure 2 - Flow Direction by Rotation

4.1 SPECIFICATIONS

TABLE 1 — SPECIFICATIONS (SUMP OIL LUBRICATION)

MODEL	APPROXIMATE OIL CAPACITY QUARTS / LITERS		PORT SIZE IN / MM	MAX RPM	APPROXIMATE WEIGHT LBS. / KG	
	90 / 92	91 / 93			90 / 92	91 / 93
3204	1 / 0.95	0.5 / 0.47	2 / 50	3600	145 / 66	130 / 59
3206	1 / 0.95	0.5 / 0.47	3 / 80	3600	160 / 73	145 / 66
3210	1 / 0.95	0.5 / 0.47	4 / 100	3600	195 / 88	180 / 82
4009	1.5 / 1.42	1 / 0.95	4 / 100	3600	260 / 188	240 / 109
4012	1.5 / 1.42	1 / 0.95	4 / 100	3600	300 / 136	280 / 127
5507	4 / 3.79	2.5 / 2.37	6 / 150* 3 / 80**	3600	450 / 204	430 / 195
5509	4 / 3.79	2.5 / 2.37	6 / 150	3600	480 / 218	465 / 210
5511	4 / 3.79	2.5 / 2.37	5 / 127	3600	560 / 254	490 / 222
5514	4 / 3.79	2.5 / 2.37	6 / 150	3600	580 / 263	540 / 245
5518	4 / 3.79	2.5 / 2.37	8 / 200	3600	685 / 310	645 / 293
5524	4 / 3.79	2.5 / 2.37	10 / 250	3600	790 / 358	750 / 340

	90	91			90 / 91
7010		8 / 7.57	6 / 150	3600	1050 / 476
7013		8 / 7.57	8 / 200	3600	1150 / 522
7017		8 / 7.57	10 / 250	3600	1275 / 578
7021		8 / 7.57	12 / 300	3600	1450 / 658
7026		8 / 7.57	12 / 300	3600	1600 / 726

* TOP PORT ** BOTTOM PORT



NOTE
Maximum discharge temperature is 374° F (190° C).



NOTE
Do not exceed maximum RPM or discharge temperature as stated above.

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 here for various booster sizes when operated under the standard atmospheric conditions. Do not exceed any one of these limits.

EXAMPLE: Seldom does the operation of a vacuum booster result 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.



NOTE
Specially ordered blowers with nonstandard construction, or with rotor end clearances greater than shown within the <i>Assembly Clearances</i> table, will not have the operating limits specified here. Contact your Tuthill Vacuum & Blower Systems sales representative for specific information.



NOTE
Special attention must be paid 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), low-deadband cut-in switches and low-mass thermocouples should be utilized and positioned such that 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.

5. INSTALLATION

5.1 GENERAL



DANGER
The booster is not intended to be used with explosive products or in explosive environments. Consult the factory for support.



DANGER
The booster is not intended to be used with hazardous or toxic gases. Consult the manufacturer if the booster is to be used in these applications.



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 1 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.



NOTE

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 a claim must be filed with the carrier immediately; preserve the shipping container for inspection by the carrier.



NOTE

In the event that your unit sustains damage while being shipped to your facility, do not return it to the factory without first obtaining shipping instructions from us.

Protective covers and plugs should not be removed until the connection is being made. Mount the booster on a flat, level surface. We recommend a baseplate that is a 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 feet rest evenly on the mounting surface before fastening down. Twisting or cramping the booster in mounting will cause rotor contact and binding during operation, resulting in a condition called "soft foot". (See the *Soft Foot* section of this manual for further details and preventative measures.)

A unit that is factory mounted on a base, should not require the above adjustments. However, since the assembly can become twisted in shipping or installation, checking for soft foot should be done after installation of the base. Shims may be needed for alignment. Loosen the foot hold-down screws to check foot contact with the mounting surface. The base should be mounted on a solid foundation or heavy flooring, using shims as necessary at bolting points to prevent warping the assembly. (Also refer to the *Foundation* section.)

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

Piping should be accurately squared with the booster and supported independently. Stress imparted from incorrectly 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. Care should be taken to evenly tighten the mounting bolts to not impart undue stress into the booster. Stress can be checked in a free state with feeler stock or verified on a previously installed blower with the aid of a dial indicator. Less than .002" (.05 mm) spring or gap should be found.

A booster may be driven by direct-coupling to the driver or by V-belt drive, to obtain other speeds within approved range. (See the *Motor Drives* section 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 closing plugs and seals are not removed. Protection against chemical 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), please see the *Long Term Storage* section in this manual.)

5.1.1 LOCATION

Install your booster in a room or outdoor area that supplies adequate space and lighting for routine maintenance. Indoor installation areas should be well ventilated and kept as cool as possible, because operating the unit at elevated temperatures can result in nuisance overload or temperature shutdowns. An unprotected outdoor installation is only satisfactory when correct lubrication for expected temperatures is provided, as per the *Recommended Lubricants* section in this manual.

5.1.2 FOUNDATION

Your 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.

5.1.3 BOOSTER AIR INTAKE

To minimize maintenance, supply your booster with the cleanest air possible. It is important that the air does not contain any flammable or toxic gases, as the booster will concentrate these gases. This could result in damage to the unit and surrounding property, lead to personal injury or death. Do not block or restrict the opening or the booster and/or motor may overheat and fail.

Do not use boosters on explosive or hazardous gases. Each size booster has limits on pressure differential, running speed, and discharge temperature. These limits must not be exceeded. Consult Table 1 for details pertaining to the allowable performance criteria.

If it is necessary to take air from a remote source, such as in a vacuum application, the piping should be at least the same diameter of the booster inlet. For distances greater than 20 feet (6 m) the pipe diameter should be enlarged 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. The inlet should be covered to keep out precipitation, insects, and small animals. Vacuum kits are available.

5.1.4 SOFT FOOT

Soft foot is a condition in which one of the booster feet does not sit flat on the base. Usually, this is due to irregularities in the surface to which the booster is mounted. When you tighten the bolt on the foot, the booster will distort slightly, but enough to cause problems with bearing and seal life, and premature internal contact between the rotors and the housing.

1. Place booster on base.
2. Check each foot for gaps between foot and base (soft foot), shim as necessary to fill gap within .002" (.05 mm). Below are shown the two most common types of soft foot conditions. If either type is present, and measures more than .003" (.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 bolt on that foot. Observe indicator travel and add shims as needed to reduce "spring" to less than .002" (.05 mm). Tighten bolt on foot. Repeat steps 4 and 5 on remaining feet.

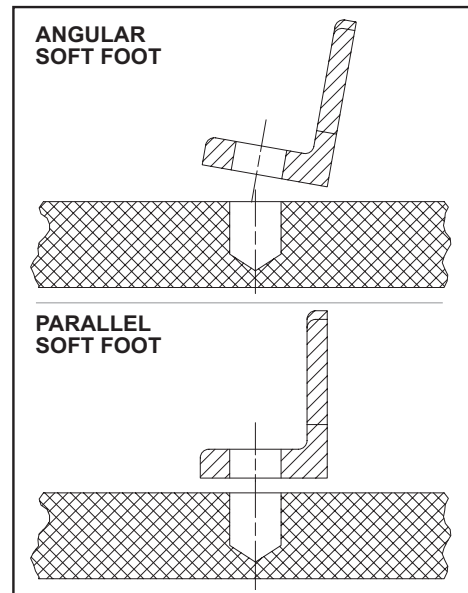


Figure 3 - Illustrations of Soft Foot

5.2 SAFETY

Tuthill Vacuum & Blower Systems recommends the use of relief valves to protect against excessive pressure or vacuum conditions. These valves should be tested 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

Blower 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.

5.3 LUBRICATION

Every booster from Tuthill Vacuum & Blower Systems is factory tested, oil drained and shipped dry to its installation point. Both independent oil reservoirs must be filled to the proper level before operation. Oil reservoirs are under 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 oil sumps as shown below within the *Filling Procedure* section.

Add oil to the booster in the quantity shown within the *Specifications* Table. The oil level must be maintained within the notched area of the sight glass. See Figure 4. Lower drive units have “bull’s eye” type oil level gauges. Maintain oil levels at the center of the glass.



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.



NOTE

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



NOTE

Refer to Table 1 for oil capacities.

5.3.1 FILLING PROCEDURE

See Figure 4. Recommended lubricants are shown on page 42.

1. Remove 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 oil level to center of sight glass.
3. Verify oil level is at proper level in BOTH gear end and drive end sight glasses.
4. Replace fill plugs or breathers that were removed in step 1.

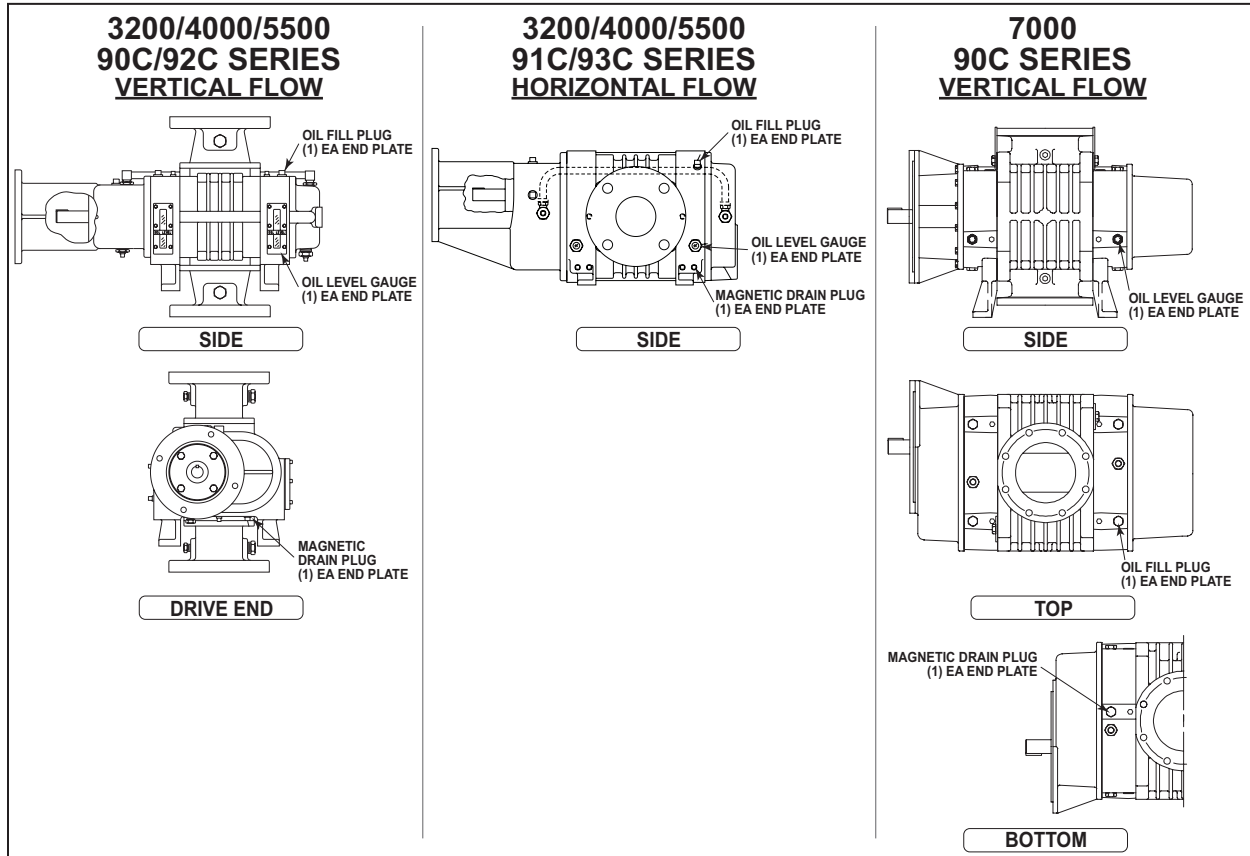


Figure 4 - Location of oil fill, drain plugs, level plugs and level gauges

5.3.2 FREQUENTLY ASKED QUESTIONS REGARDING LUBRICATION

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

The lubricant is selected based on bearing and gear speed, and operating temperature. Too light of a lubricant 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. Since it is thicker, it 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 their toll and the lubricant will thicken, making matters worse. The unit will run hotter and the wear on running surfaces will increase. Generally, the lubricant will appear dirtier, this is actually material rubbed off the unit's components. The discoloration comes from overheating the additive

package. An indicator of the breakdown of a lubricant is the increase in the TAN (Total Acid Number), and a change in the base viscosity of ten percent.

Several things are happening as the lubricant goes through the unit. 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. Our published cycles are based on worst-case conditions.

5.3.3 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 manufacture's applicable instruction for safety precautions.

5.4 PIPING CONNECTIONS



NOTE

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



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.

Manifolding should be 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. The manifolding to and from the booster should be fitted with flexible connections to isolate vibrations, absorb expansion and contraction due to thermal change, and to absorb misalignment differences. If the booster is to be water cooled, connect a clean supply to the 1/4" NPT connection on the seal adapter housing adjacent to the drive shaft. The drain line will be connected on the bottom of the non-drive end reservoir, see Figure 4 for connection locations. Care should be taken to not over tighten or loosen the bushing for the cooling coil connection. The bushing should be held in place as additional fitting and plumbing is performed.

The partly water-cooled versions (92/93) have 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.

The air-cooled configuration requires no cooling water. However, cooling water can be circulated through the seal adapter housing on most models without modification to the booster. Cooling the bearing housing will prolong the life of the mechanical seal therein.

An on-off valve should be provided on the incoming line and a regulating valve located in the drain line. The drain line should terminate at an open drain to enable the operator to better regulate the water flow.

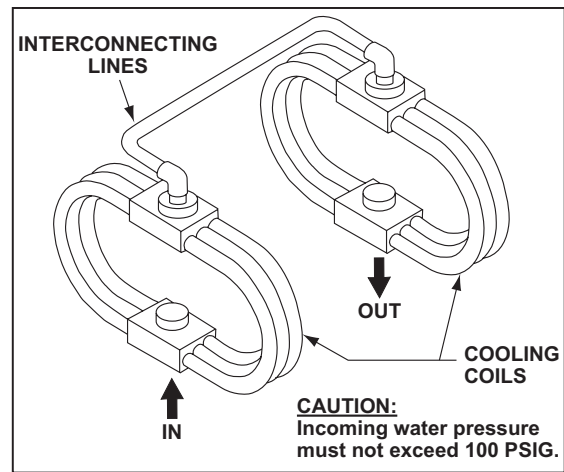


Figure 5 - Cooling Water Piping Harness

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.

5.4.1 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.

5.5 WATER COOLING INSTRUCTIONS



WARNING

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.



NOTE

Units are never shipped from the manufacturer with liquid in the end plates.

5.6 COOLING WATER CONNECTIONS

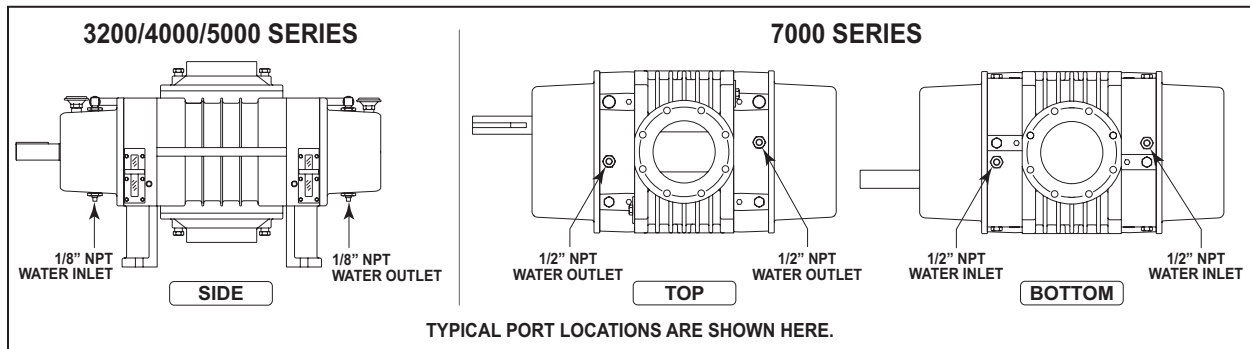


Figure 6 - Water Cooling Connections

5.7 COOLING WATER SPECIFICATIONS



NOTE

FLOW RATE: Less than 2 GPM total both end plates.
MAXIMUM PRESSURE: 100 PSIG

5.8 DRIVE COMPONENTS



NOTE

Refer to the following drawings for applicable drive components – motor adaptor kit and coupling:

SERIES	NEMA DRAWING	IEC DRAWING
3200	32172	32173
4000	40111	40110
5500	55228	55227
7000	77131	77129



NOTE

Only approved drive system components shall be used to maintain CE compliance.

5.9 MOTOR DRIVE

5.9.1 DIRECT COUPLED

When installing the motor directly to the booster, align shafts to coupling in accordance with the coupling manufacturer's instructions. Boosters shipped with motor directly coupled and mounted on a common base have been aligned prior to shipment and normally no further alignment is necessary. However, alignment should be checked and adjustments made if necessary prior to starting the unit.

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 not having more than .005" (.13 mm) T.I.R. (Total Indicator Reading). Face must be aligned within .002"(.05 mm) .

Proper gap between coupling halves must be established according to coupling manufacturers instructions with the motor armature. This will minimize the change for end thrust on the booster shaft. All direct coupled base mounted units must be re-aligned and greased after field installation.

5.10 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.



NOTE

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 performed per IEC 60204-1, this includes over current 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 each component being wired. Turn the booster by hand after wiring is completed to determine that there are no obstructions and if the booster turns freely; then momentarily start the booster to check the direction of rotation. Figure 2 shows direction of air flow in relation to rotor rotation. The air flow direction can be reversed by reversing the appropriate motor leads.

5.11 C-FLANGE COUPLING INSTALLATION

Two types of couplings are used: the Wood's and the Lovejoy L-Type.

5.11.1 WOOD'S COUPLINGS

1. Inspect all coupling components and remove any protective coatings or lubricants from bores, mating surfaces and fasteners. Remove any existing burrs, etc. from the shafts.
2. Slide one coupling flange onto each shaft, using snug-fitting keys where required.
3. Position the flanges on the shafts. It is usually best to have an equal length of shaft extending into each flange.
4. Move one flange to its final position. (Usually the motor shaft.) Torque fasteners to proper value.
5. Slide the other flange far enough away to install the sleeve. With the two piece sleeve, do not move the wire ring to its final position, allow it to hang loosely in the groove adjacent to the teeth. The coupling employs a two-piece sleeve with a wire ring. Force the ring into its groove in the center of the sleeve. It may be necessary to pry the ring into position with a blunt screw driver.



NOTE

Coupling sleeves may be thrown from the coupling assembly with substantial force when the coupling is subjected to a severe shock load or abuse.

5.11.2 LOVEJOY COUPLINGS

1. Type-L sizes L099, L100, L110, L150, and L190 are used.
2. Follow instructions 1 and 2 for Wood's couplings.
3. Shaft sleeves may be used with this type of coupling to prevent the hubs from sliding back on the shafts should they come loose. Slide the locking collars on the shafts first. Do not tighten.
4. Position the hubs on the shafts. It is usually best to have an equal length of shaft extending into each hub. Move one hub to its final position and torque fasteners to proper value.
5. Slide the other hub far enough away to install the spider. Lock the hub in place and slide the locking collars up against the back of each of the hubs and lock in place.



NOTE
Be sure not to compress the rubber sleeves or the spider between the couplings or hub halves. Compression could result in damage or failure. Consult manufacturer's instructions for approximate gaps between coupling or hubs.

6. OPERATION

6.1 GENERAL



DANGER
The booster is not intended to be used with explosive products or in explosive environments. Consult manufacturer if the booster is to be used in these environments.



DANGER
The booster is not intended to be used with hazardous or toxic gases. Consult the manufacturer if the booster is to be used in these applications.



WARNING
Do not operate without guards in place. Assure that the coupling guard is in place and secure prior to operation.



WARNING
Maximum operating speed: Table 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 troubles. Use the following check list 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 that it is connected through suitable electrical overload devices.
6. With electrical power off and locked out to prevent accidental starting, rotate booster shaft several times by hand to make sure booster is rotating freely. Unevenness or tight spots is an indication of a problem that should be corrected before progressing.
7. Check motor rotation by momentarily pushing the start button and check flow direction of the booster. Reverse the motor connections if flow is in the wrong direction.

Initial operation should be carried out under "no load" conditions by opening all valves and venting the discharge to atmosphere, if possible. Then start motor briefly, listen for unusual noises, and check that the booster coasts freely to a stop. If no problem appears, repeat this check, 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, make periodic checks to determine that all conditions remain acceptable and steady. These checks 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 inlet filter. Also, recheck leveling, coupling alignment or belt tension, and mounting bolts for tightness.

6.2 START-UP CHECKLIST

We recommend that these startup procedures be followed in sequence and checked off () in the boxes provided in any of the following cases:

- During initial installation
- After any shutdown period
- After maintenance work has been performed
- After booster has been moved to a new location

DATES CHECKED:

Check the unit for proper lubrication. Proper oil level cannot be over-emphasized. Refer to the *Lubrication* section. Please see *Recommended Lubricants* for information on acceptable lubricants for your product.

Check V-belt drive for proper belt alignment and tension.

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.

“Bump” the unit with the motor to check rotation (counter-clockwise [CCW] when facing shaft) and to be certain it turns freely and smoothly.

Start the unit and operate it for 30 minutes at no load. During this time, feel the cylinder for hot spots. If minor hot spots occur, refer to the *Troubleshooting* chart.

Apply the load and observe the operation of the unit for one hour.

If minor malfunctions occur, discontinue operation and refer to the *Troubleshooting* chart.

6.3 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. 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]).

6.4 OPERATING TEMPERATURE

The upper temperature limits for booster pump operation are between 350° to 375° F (177° 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 booster 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.



NOTE

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

6.5 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. Refer to component instruction manual.

6.6 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. Refer to component instruction manual.

6.7 WATER INJECTED VACUUM BOOSTERS

Water injected into the inlet of a booster operating on vacuum service will cool the booster. The water absorbs the heat of compression as it passes through the unit along with the air/gas being compressed. A booster cooled in this manner can operate safely at higher vacuums or higher inlet temperatures than a normally uncooled unit.

The amount of water required depends on the inlet air/gas temperature, inlet vacuum, water temperature, and the maximum discharge temperature desired. Check with the factory or sales representative for additional guidance.

6.7.1 OPERATION

1. Check oil level in sight glass of booster and assure all fittings are tight.
2. Check the water injection system to assure water is available.
3. Operate the booster dry for a few minutes at no load to check correct rotation and smooth operation.
4. Turn water on and adjust flow as recommended for the individual booster. Assure water discharges freely from the outlet piping.
5. Apply vacuum and observe operation at the desired inlet condition.

6.7.2 SHUTDOWN

1. The booster can be shutdown for brief periods by relieving the inlet vacuum, shutting the water off, and then stopping the unit.
2. Rusting during a slightly longer shutdown period can be avoided by operating the booster under a partial vacuum without the water injection, allowing the booster to heat within safe limits. The heat will tend to drive off residual moisture.
3. For extended shutdown, oil may be injected into the inlet of the heated booster just prior to shutting the booster down. The oil will provide a protective coating on the internals. Insure that the water is completely shut off after shutdown.
4. Special coatings or platings are available to minimize rusting or corrosion in applications where units can remain wet.

Vertical flow units with two-lobed, plugged rotors should always be used. Always orient system such that the booster intake is at the top and discharge at the bottom.



CAUTION

Water injection can cause lime build-up on rotors. Check water supply for hardness. The use of water softeners, other chemicals, or distilled water may be necessary to prevent or remove this build-up. However, due to the wide variations in mineral content, pH, and chemical content of water that can be injected, Tuthill Vacuum & Blower Systems cannot be responsible for damage which may result should this build-up occur. Units should be inspected regularly to determine any problems.

NOTE

For liquid injection other than water, consult the factory.

6.8 RECOMMENDED SHUTDOWN PROCEDURE TO MINIMIZE RISK OF FREEZING OR CORROSION

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

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



NOTE

Care must be taken so as 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, simply allow the booster to run a few (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 prior to 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, exercise care to prevent the applicator tube from getting sucked into the booster. The applicator tube will damage the booster, most likely to the point that repair would be required.
4. If the booster is being taken out of commission for an extended period of time, please also refer to the “Long Term Storage” section of this manual.

7. MAINTENANCE

7.1 GENERAL

Regular inspection of your 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. By use of thermometers and gauges, 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.



DANGER

The booster and connecting piping shall be regularly inspected to assure that process gases are not vented such that a hazard is created. The booster shall also be regularly inspected to assure that the booster and the drive components do not create a source of ignition.



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.



NOTE

When changing oil be sure to reseal the drain and fill plugs. This is especially important on 92/93 series 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.

Particular attention should be paid to lubrication of timing gears and bearings in accordance with comments under the *Lubrication* section.

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 down time. Under atmospheric conditions producing rapid corrosion, the booster should be protected immediately. Refer to the *Long Term Storage* section for more details.

7.2 REGULAR MAINTENANCE

A good maintenance program will add years of service to your booster.

A newly installed booster should be checked frequently during the first month of operation, especially lubrication. With booster at rest, check oil level in both the gear (drive) end and free (non-drive) end of the booster and add oil as needed. Scheduled maintenance consists of changing lubricating oil every 250 to 1500 hours of operation, or more frequently depending on the type of oil and operating temperature. Boosters with mechanical seals on the rotors can generally run the full 1500 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
1. Check and maintain oil level, and add oil as necessary. 2. Check for unusual noise or vibration (See <i>Troubleshooting</i>)	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 relief valve to assure it is operating properly.	1. Inspect the entire system for leaks. 2. Inspect condition of oil and change if necessary. 3. Check drive belt tension and tighten if necessary.



NOTE
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 sampling into a clean container and check for the presence of water or solids. Slight discoloration of the oil should not necessitate an oil change.

7.3 SPARE PARTS

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

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

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

- 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)

Contact Tuthill Vacuum & Blower Systems Service Department for any assistance in selecting spare parts. Telephone: (417) 865-8715 — Toll Free (48 contiguous states): (800) 825-6937 — Fax: (417) 865-2950

7.4 FACTORY SERVICE & 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 authorized service location nearest you. Units which are still under warranty must be returned to the factory, freight prepaid, for service.

Tuthill Vacuum & Blower Systems
 ATTN: Inside Service Manager
 4840 West Kearney Street
 Springfield, MO 65803-8702



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



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

7.5 LONG TERM STORAGE

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

1. Spray the interior (lobes, housing and end plates) with rust preventative. This should be repeated as conditions dictate and at least on a yearly basis.
2. Fill both end covers completely full of oil.
3. Firmly attach a very prominent tag stating that the end covers are full of oil and must be drained and refilled to proper levels prior to startup.
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 unit 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 so attached to the covers that they will be removed before startup of the booster.
9. Store the booster in an air conditioned and heated building if at all possible. At least insure as dry conditions as possible.
10. If possible, rotate the drive shaft by hand at least monthly in order to prevent seals from setting in one position.

8. MODEL 3200C SERIES DISASSEMBLY AND REASSEMBLY

8.1 DISASSEMBLY OF 3200C SERIES BOOSTERS



WARNING

Before performing any repair or replacement, disconnect and lock out power.

With proper maintenance and lubrication, normal life expectancy for gears, bearings, and seals can be achieved. However, over a period of time these parts must be replaced to maintain the efficiency of your booster. This section is written in a way that will allow you to completely disassemble your booster. The inspection of certain repairable or replaceable parts is referred to at the point of disassembly where these parts are exposed. If at any point of inspection, repair or replacement is deemed necessary, appropriate instruction will be given to achieve these repairs or replacements is deemed necessary, appropriate instruction will be given to achieve these repairs or replacements.

1. Disconnect cooling water lines [274 & 181]. Do not disturb cover bushings [120] or it will be necessary to retest cooling coils for leakage as described in the assembly procedure. Covers should be retested if water is detected in drain oil. (90/91 series only).
2. Drain oil from both ends of booster and remove inlet and outlet port fittings [38 or 48].
3. Remove spanner lock nut [83], dust washer [82], screws [93], and seal adapter housing [91]. Tap out seal [76] and discard O-rings [92 & 140]. Remove spacers [77 & 74], adjusting shim [118] and discard O-ring [75].
4. Remove cap screws [26A & 26B] and both end covers [6 & 7]. Two jack screw holes are provided on each cover.
5. Remove lockwire [49], socket head screws [66], and drive shaft [45]. Using puller, remove bearing [50].
6. Remove flat head Allen screws [29] from end of each rotor shaft. Remove washers [25], spacers [57], and oil slinger [21]



NOTE

The flat head screws have nylok in their threads and may be difficult to remove. Strike the head a couple of blows with a flat face hammer for easy removal.

7. Mark housing, end plates, rotors, and gears before proceeding with disassembly. There are two methods which can be used to disassemble the rest of the unit. Method "A" requires an arbor press and method "B" requires the use of bar or yoke pullers. See puller drawing (T29603) on page 44.
8. **Method A:**
 - a. Place two support blocks, 5-1/2 to 6 inches (14 to 15.5 cm) high (hard wood or steel), on the bed of an arbor press. Set the unit, 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.



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

- b. Lift the housing off the rotors and remove the non-drive end plate [4] by tapping the end plate from the inside of the housing. Place the rotor housing back over the rotors.
- c. Set the unit on the support blocks with the gears pointing upward. Do not extend blocks into the rotor bores. The rotors may now be pressed from the gear end plate. Do not damage rotors.

Method B:

- a. Align timing marks on gears (Figure 7). Rotate drive gear clockwise approximately three teeth and mark a matching reference line on each gear as shown in Figure 8. This gear position is necessary so rotors will clear and not jam. Do not allow the gears to move from the

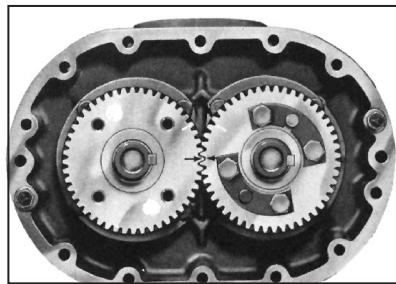


Figure 7 - Position of timing marks
Keyways in line
and timing marks matched

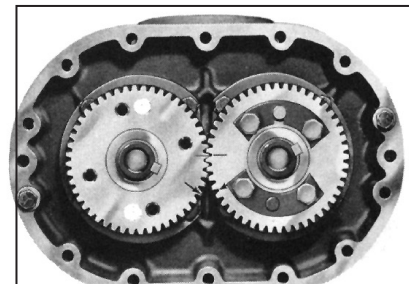


Figure 8 - Position of timing marks
Timing marks advanced 3 teeth and
reference marks aligned.

matched reference line while pulling. Use a light rocking motion to insure that the lobes have not jammed. Remove driven gear first then drive gear.

- b. Remove button head Allen screws [30] and bearing retainer rings [14] from both end plates.
 - c. Attach a pair of bar pullers to the bearing bores of the free end plate. Use 10-32 x 4" long screws (no metric equivalent) Alternately push both rotors from end plate. Separate end plate from housing.
 - d. Turn the unit around and attach a single bar puller to either bore and push rotor from end plate making sure the rotor is vertical in the housing (for support) while removing. Repeat for opposite rotor. Note location of timing shims [16], oil slinger [20], and spacers [17 & 18].
 - e. Tap end plate from housing.
9. **90/91 Series** - Tap out bearings from both end plates. Note location of spacers under bearings and retain for reassembly. To remove seals [54] use a cape chisel or similar tool being careful not to nick or cut the bearing or seal bores. Remove the labyrinth seal [51] in the same manner. The seals will be damaged by removal and must be replaced.

92/93 Series - Carefully tap out seal slinger [238], spacer [123], and bearings. The oil slinger stator [79] should not be removed unless it is damaged or the end plate is to be replaced.



NOTE
On some older units the oil seal slinger is made up of two separate parts, items 238 & 129. The newer design combines these two parts and is identified as item 238.

10. Clean all parts with good grade of clean solvent and replace any worn or damaged parts with factory approved parts. New bearings, seals, and O-rings should be installed at each assembly.

8.2 ASSEMBLY OF 3200C SERIES BOOSTERS

The assembly procedure is generally the same for all series, but where there are differences, notations are made. All vacuum joints, end covers, seal casings, and plugs should be sealed with an RTV Silicone Sealer equal, unless O-rings have been provided.

Gaskets are never used between rotor housing and end plates. Dowel pins are used to locate end plates, housing, and drive end cover in proper location relative to each other. Be sure they are in place.

It is recommended that the gear end rotor shaft bearings be purchased from Tuthill Vacuum and Blower Systems, as they are specially ground to locate the rotors with correct end clearance relative to the gear end plate. Do not use standard bearings which have not been flush ground within .001" (.025 mm) tolerance. Use factory approved parts.

It is suggested that long feeler gauges (12" or 30 cm) be used to check the interlobe timing, preferably (2) .006" (.15 mm), (1) .005" (.13 mm), (1) .004" (.10 mm), and (1) .003 (.08 mm). This will give you all the combinations from .003" (.08 mm) to .021" (.53 mm) and also .024" (.61 mm) which is the total.

8.2.1 PREPARATION OF END PLATES FOR ASSEMBLY

1. Remove all nicks, scratches, etc. from all sealing surfaces. Clean all parts thoroughly. See seal pressing tool drawing (T32018) on page 44.
2. **90/91 Series** - Press in new labyrinth seals [51] into bores of both end plates [4] 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 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.

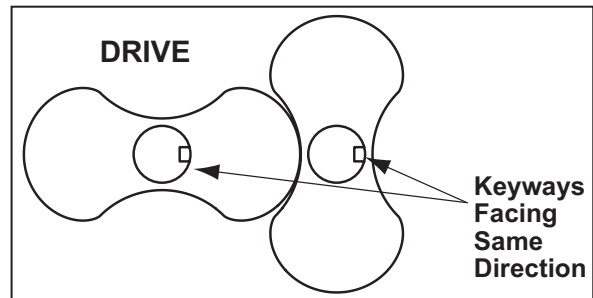


Figure 9 - Keyways position

92/93 Series - Press in new oil slinger stators [79] if required.

8.2.2 GEAR END ASSEMBLY

3. Stand rotors [1] on arbor press table with gear end shafts up. See Figure 9. Two keyways should point in the same direction, to the right.
4. Carefully install gear end plate over rotor shafts.



NOTE

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 unit will have the same drive shaft location as before.

5. **90/91 Series** - Some earlier models used an O-ring [314] 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 insure compression is taking place and ring is not hung up for any reason.

92/93 Series - Slide seal slinger [238] over shaft. Also install spacer [129] if two piece.

- Lubricate shafts and press the double row ball bearings [9] onto rotor shafts and into end plate bores.



NOTE

These bearings have been flush ground at the factory. The inner race will have a black dot etched on the surface. This dot must be up and visible when bearings are installed. Secure with bearing retainers (14) and socket head screws (30).

- Check clearance between the face of the end plate and rotor lobes. See *Assembly Clearances* table on page 41 for correct gear end clearances. If clearances are not within specifications, recheck parts to find cause of improper clearances before proceeding.

8.2.3 INSTALLATION OF TIMING GEARS

- Install spacer [17] (.260" {6.60 mm} thickness) on one shaft and spacer [18] (.200" {5.08 mm} thickness) and oil slinger [20] on the other shaft.



NOTE

The oil slinger and its spacer should always be mounted on lower rotor for horizontal flow units.

It can be mounted on either shaft for vertical flow units. Install timing shim in same location as found in disassembly. This does not necessarily insure the unit will be in proper time. Adjustments can be made later in the assembly process.

- Insert gear keys [24] in their proper location and flush with top of shaft. Use the two keyways facing to the right. A tight fit is required. Coat shafts and keys with lubricant. Install drive gear (right hand helix) on drive rotor (left side). To install driven gear, align reference marks as shown in Fig. 7. Install driven gear carefully to avoid damaging any teeth when engaging opposite gear. Secure with spacers [57], washers [25], and flat head Allen screws [29].



NOTE

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

- Remove assembly from press and stand on work table with gears down. Place blocks under end plate to prevent assembly from falling over. Drive gear should remain on left side.

8.2.4 HOUSING AND FREE END ASSEMBLY

- Place a small bead of sealer around the periphery of the end plate, encircling each bolt hole. Install rotor housing [3] and secure with 4 screws evenly spaced.
- Check clearance between end of lobes and housing using a flat bar and feeler gauges or a depth micrometer. Refer to *Assembly Clearances* table on page 41 for free end clearances.
- 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.
- 90/91** - Install mating rings same as gear end, No. 5.
92/93 - Install seal slinger same as gear end.
- Install bearing spacers [123] on each shaft. Lubricate shafts and install roller bearings [10].



NOTE

Inner race of bearing has a flange on one side only. This flange must face outward. See Figure 14.

- Install oil retainer rings [14] with button head screws [30]. Only two required for each ring.

17. Install spacer [67] on each shaft. Install oil slinger [21] on lower rotor, (either shaft on vertical flow units) spacer [57] on opposite shaft, washers [25], and screws [29]. Lay assembly down with drive on left for timing.

8.2.5 ADJUSTING ROTOR INTERLOBE CLEARANCE:

18. Using feeler gauges take interlobe readings and record on each side of housing as indicated in Figure 10. 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 .006" (.15 mm) will change the rotor lobe clearance .003" (.08 mm) or one-half the amount.

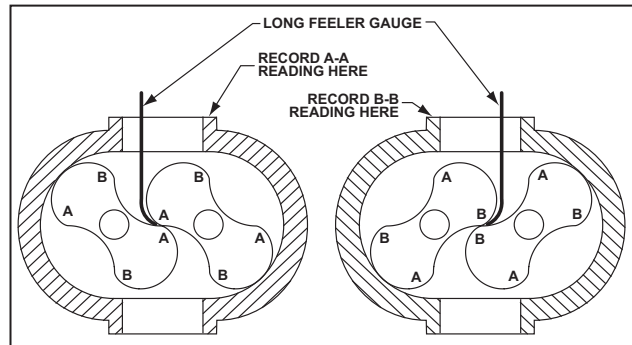


Figure 10 - Checking Rotor Interlobe Clearance

EXAMPLE: Referring to Figure 10 to the right, check the clearance a AA (right hand reading) and BB (left hand reading). If AA reading is .009" (.23 mm) and BB reading .003" (.08 mm) by removing .006" (.15 mm) shims, the readings will change one-half the amount removed or .003" (.08 mm) AA should then read .006" (.15 mm) and BB should read .006" (.15 mm). The final reading should be within .002" (.05 mm) of each other.

To determine the amount of shim to add or remove, subtract the small figure from the larger. If the right side reading is higher than the left side, remove shim. If the right side reading is lower, add shim.

19. Install drive shaft [45] and secure with Allen screws [66]. Check drive shaft runout behind keyway. Do not exceed .002" (.05 mm) T.I.R. Install lockwire [49].
20. Remove temporary cap screws from gear end plate and apply a bead of sealer around end plate (not cover), encircling all holes, and install gear cover [6] and secure with cap screws [26A].



NOTE

If cooling coil or fittings were disturbed or water was detected in drain oil, they should be retested with air pressure to check for leaks and resealed. This applies to mechanical seal series only.

8.2.6 DRIVE SHAFT SEAL ASSEMBLY:

21. Install cover [6].
22. Install new mechanical seal [76] into seal housing [91], and press in lip seal [13].
23. Install mating ring [76] onto drive shaft and install assembled seal housing.
24. Be sure to lubricate seals before final assembly.

8.2.7 COMPLETE BOOSTER ASSEMBLY:

25. Install free end cover [7] following the same procedure used to install the gear cover. Secure with cap screws [26B].
26. Apply sealer and install both port fittings [38 or 48].
27. Install all necessary cooling water lines.
28. Prior to putting booster into operation, follow instructions stated within the *Installation* and *Operation* sections. Observe the oil level frequently during the initial hours of operation. An improperly installed or damaged oil seal will result in oil loss.

9. MODEL 4000C AND 5500C SERIES DISASSEMBLY AND REASSEMBLY



WARNING

Before performing any repair or replacement, disconnect and lock out power.

With proper maintenance and lubrication, normal life expectancy for gears, bearings, and seals can be achieved. However, over a period of time these parts must be replaced to maintain the efficiency of your booster. This section is written in a way that will allow you to completely disassemble your booster. The inspection of certain repairable or replaceable parts is referred to at the point of disassembly where these parts are exposed. If at any point of inspection, repair or replacement is deemed necessary, appropriate instruction will be given to achieve these repairs or replacements is deemed necessary, appropriate instruction will be given to achieve these repairs or replacements.

9.1 DISASSEMBLY OF 4000C AND 5500C SERIES BOOSTERS

1. Disconnect cooling water lines [274 & 181]. Do not disturb the large hex head screw [97]. If it is removed, loosened, or water is detected in drain oil, the coil assembly must be retested as described in the assembly procedure.
2. Drain oil from both ends of booster and remove port fittings [38 or 48].
3. Remove bolts [93] and take off seal housing [91] using jack screws.
4. Remove cover [6], mating ring [76] will come off with cover.
5. Remove drive shaft screws [66] and locks [65]. Tap shaft lightly to remove.
6. Remove gear lock nuts and washers [35 & 36].

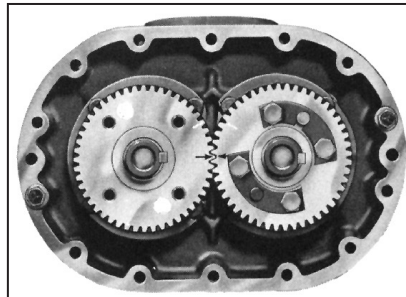


Figure 11 - Position of timing marks
Keyways in line
and timing marks matched

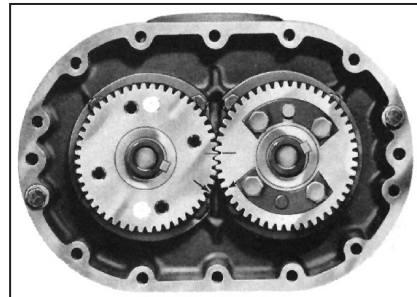


Figure 12 - Position of timing marks
Timing marks advanced 3 teeth and
reference marks aligned.

7. **Model 5500 - 91/93 series** (top drive only). Remove cap screw [396] washers [136 & 80] and oil slinger [20] if furnished.
7. Position the timing gears for pulling by first matching the timing marks on the gears. See Figure 11. Turn the drive gear clockwise five teeth and mark a matching reference line on each gear as shown in Figure 12, above. The rotor lobes are now in their most open position. Using a gear puller, the driven gear (left hand helix) may now be removed without jamming the rotors. This gear is in two parts - the gear rim and hub. It is not necessary to disassemble. Do not allow the gears to move from the matched reference line while pulling. Use a light rocking motion while pulling the gear to insure that the lobes have not jammed.



NOTE

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

8. Remove drive gear. It is not necessary to remove keys from rotor shafts.
9. Remove cap screw [62], locks [61], and bearing lock rings [14].
10. Install two screws temporarily to hold end plate to housing.
11. Remove the free end cover [7], rotor shaft socket screws [26 & 69], washer [25], spacer [57], oil slinger [21] (must be pried off on model 5500), roll or dowel pin [68], socket head screws [30], and oil retainer rings [14 or 15].



NOTE

On model 4000, it is not necessary to remove item 15 unless the end plate is being replaced.

The flat head screws have nylok in their threads and may be difficult to remove. Strike the head a couple of blows with a flat face hammer for easy removal.

- Using two yoke style pullers with pressure screws attached to free end plate bores, pull end plate from housing. Dimensional drawings for the pullers are on page 44 (T29603-1). Tap out the bearings [10].

Series 90/91: Tap out mechanical seal [54], spacers [123], and labyrinth seal [51].

Series 92/93: Tap out seal slinger [238] and spacers [123]. The oil slinger stator [79] should not be removed unless it is damaged or the end plate is to be replaced.



NOTE

On some older units the oil seal slinger is made up of two separate parts - items 238 & 129. The newer design combines these two parts and is identified as item 238.

- Using a single yoke puller with longer screws, push out one rotor at a time making sure the rotor is vertical in the housing (for support) while removing.
- Remove the two temporarily installed screws and tap gear end plate from housing and remove bearings and seals.
- Clean all parts with a good grade of clean solvent and replace any worn or damaged parts with factory approved parts. New bearings, seals, and O-rings should be installed at each assembly.

9.2 ASSEMBLY OF 4000C AND 5500C SERIES BOOSTERS

The assembly procedure is generally the same for all series, but where there are differences, notations are made. All vacuum joints, end covers, seal casings, and plugs should be sealed with an RTV Silicone Sealer equal, unless O-rings have been provided.

Gaskets are never used between rotor housing and end plates. Dowel pins are used to locate end plates, housing, and drive end cover in proper location relative to each other. Be sure they are in place.

It is recommended that the gear end rotor shaft bearings be purchased from Tuthill Vacuum and Blower Systems, as they are specially ground to locate the rotors with correct end clearance relative to the gear end plate. Do not use standard bearings which have not been flush ground within .001" (.025 mm) tolerance. Use factory approved parts.

It is suggested that long feeler gauges (12" or 30 cm) be used to check the interlobe timing, preferably (2) .006" (.15 mm), (1) .005" (.13 mm), (1) .004" (.10 mm), and (1) .003 (.08 mm). This will give you all the combinations from .003" (.08 mm) to .021" (.53 mm) and also .024" (.61 mm) which is the total.

9.2.1 PREPARATION OF END PLATES FOR ASSEMBLY

- Remove all nicks, scratches, etc. from all sealing surfaces. Clean all parts thoroughly. See Page 44 for dimensions of seal pressing tool.
- 90/91 Series** - Press in new labyrinth seals [51] into bores of both end plates [4] 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 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.
92/93 Series - Press in new oil slinger stators [79] if required.

9.2.2 GEAR END ASSEMBLY

- Stand rotors [1] on arbor press table with gear end shafts up. See Figure 13. Two keyways should point in the same direction, to the right.
- Carefully install gear end plate over rotor shafts.

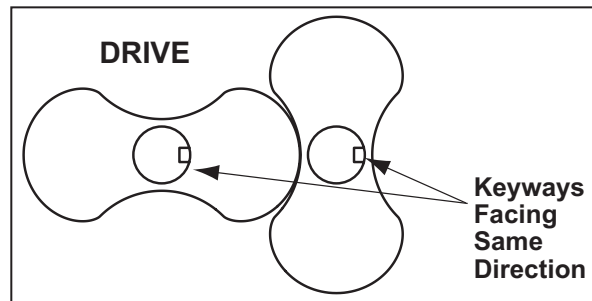


Figure 13 - Keyways position



NOTE

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 unit will have the same drive shaft location as before.

- 90/91 Series** - 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 insure compression is taking place and ring is not hung up for any reason. **92/93 Series** - Slide seal slinger [238] over shaft. Also install spacer [129] if two-piece.
- Lubricate shafts and press the double row ball bearings [9] onto rotor shafts and into end plate bores.



NOTE

These bearings have been flush ground at the factory. The inner race will have a black dot etched on the surface. This dot must be up and visible when bearings are installed. Secure with bearing retainers [14] or [14 & 15] on model 4000, locks, and cap screws [61 & 62].

- Check clearance between the face of the end plate and rotor lobes. See *Assembly Clearances* table for correct gear end clearances. If clearances are not within specifications, recheck parts to find the cause of improper clearances before proceeding.

9.2.3 INSTALLATION OF TIMING GEARS

- Insert gear keys [24] in their proper location. Use the two keyways facing to the right. A tight fit is required. Coat shafts and keys with lubricant.
- Install drive gear (right hand helix) on drive rotor (left side). To install driven gear, align reference marks as shown in Figure 12. Install driven gear carefully to avoid damaging any teeth when engaging opposite gear. Secure with gear lockwasher [36] and lock nut [35].



NOTE

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

- Remove assembly from press and stand on work table with gears down. Place blocks under end plate to prevent assembly from falling over. Drive gear should remain on left side.

9.2.4 HOUSING AND FREE END ASSEMBLY

11. Place a small bead of sealer around the periphery of the end plate, encircling each bolt hole. Install rotor housing [3] and secure with four screws evenly spaced.
12. Check clearance between the end of lobes and the housing using a flat bar and feeler gauges or a depth micrometer. Refer to *Assembly Clearances* table 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 four screws.
14. **90/91 Series** - Install mating rings in the same way as the gear end, No. 5.
92/93 Series - Install seal slinger in the same way as the gear end. Install bearing spacers [123] on each shaft.
15. Lubricate shafts and install roller bearings [10]

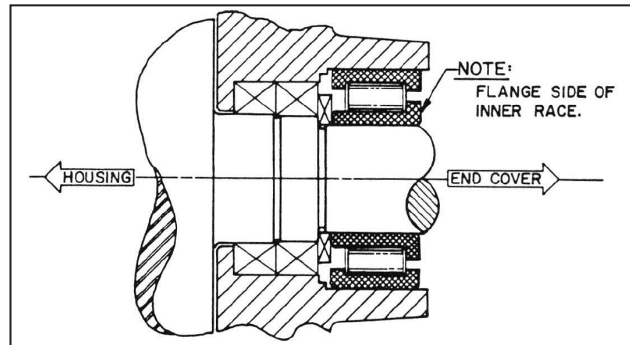


Figure 14 - Roller Bearing Flange



NOTE

Inner race of bearing has a flange on one side only. This flange must face outward. See Figure 14.

16. Install oil retainer rings and screws [14 & 30], spacer [57] (Model 5500 only), washer [25], screw [29], oil slinger and dowel [21 & 68], and screw [69].



NOTE

Oil slinger should always be mounted on lower rotor for horizontal flow units. It can be mounted on either shaft for vertical flow units.

17. Lay booster assembly down and torque timing gear nuts at this time. See Torque table on page 41 for proper torques.

9.2.5 ADJUSTING ROTOR INTERLOBE CLEARANCE

18. Using feeler gauges take interlobe readings and record on each side of housing as indicated in Figure 15. 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 .006" (.15 mm) will change the rotor lobe clearance .003" (.08 mm) or one-half the amount.

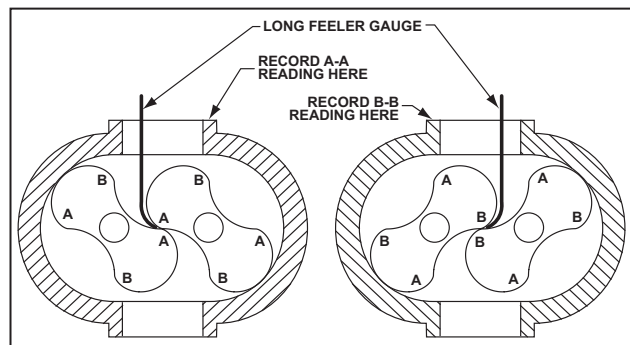


Figure 15 - Checking Rotor Interlobe Clearance

EXAMPLE: Referring to Figure 15 to the right, check the clearance a AA (right hand reading) and BB (left hand reading). If AA reading is .009" (.23 mm) and BB reading .003" (.08 mm) by removing .006" (.15 mm) shims, the readings will change one-half the amount removed or .003" (.08 mm) AA should then read .006" (.15 mm) and BB should read .006" (.15 mm). The final reading should be within .002" (.05 mm) of each other.

To determine the amount of shim to add or remove, subtract the small figure from the larger. If the

right side reading is higher than the left side, remove shim. If the right side reading is lower, add shim. When removing gear shell from driven gear, it is not necessary to remove gear lock nut. Make sure bolt locks are in place because the dowel pins must come off with the gear shell.

19. Bend over lock tabs of gear lockwasher [36] and gear screw locks.
Model 5500 - 91/93 series (top drive only). Reinstall oil slinger [20] to lower rotor and secure with washer [136 & 80] and cap screw [396], if furnished. Not used on older models.
20. Install drive shaft, making sure both surfaces are clean and free of all burrs. Drive shaft runout should not exceed .003 T.I.R. measured behind keyway.
21. Remove temporary cap screws from end plate and apply a bead of sealer around end plate (not cover), encircling all holes, and install gear cover [6] and secure with cap screws [26].



NOTE

If cooling coils or manifold screws have been disturbed, they should be retested with air pressure to check for leaks. If leaks occur, disassemble and replace O-rings [9 & 96]. Mechanical Seal series only

9.2.6 DRIVE SHAFT SEAL ASSEMBLY

22. Install mechanical seal [76] into seal housing [91] and lip seal [13].
23. Install mating ring on shaft.
24. Install assembled seal housing. Be sure to clean and lubricate seals before installing.

9.2.7 COMPLETE BOOSTER ASSEMBLY

25. Install free end cover [7] following the same procedure used to install the gear cover.
26. Apply sealer and install both port fittings (38 & 48).
27. Install all necessary cooling water lines.
28. Prior to putting booster into operation, follow Installation and Operation instructions. Observe the oil level frequently, during the initial hours of operation. An improperly installed or damaged oil seal will result in oil loss.

10. MODEL 7000C SERIES DISASSEMBLY AND REASSEMBLY



WARNING

Before performing any repair or replacement, disconnect and lock out power.

With proper maintenance and lubrication, normal life expectancy for gears, bearings, and seals can be achieved. However, over a period of time these parts must be repaired or replaced to maintain the efficiency of your booster. This section is written in a way that will allow you to completely disassemble your booster. The inspection of certain repairable or replaceable parts is referred to at the point of disassembly where these parts are exposed. If at any point of inspection, repair or replacement is deemed necessary, appropriate instruction will be given to achieve these repairs or replacements is deemed necessary, appropriate instruction will be given to achieve these repairs or replacements.

10.1 DISASSEMBLY OF 7000C SERIES BOOSTERS

1. Remove unit from installation and drain lubricant from both ends by removing magnetic drain plugs (31). Mark end plates, covers and housing so they can be reassembled in their original position.

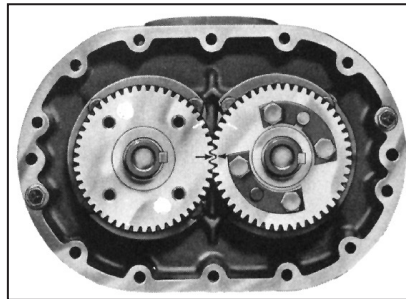


Figure 16 - Position of timing marks
Keyways in line
and timing marks matched

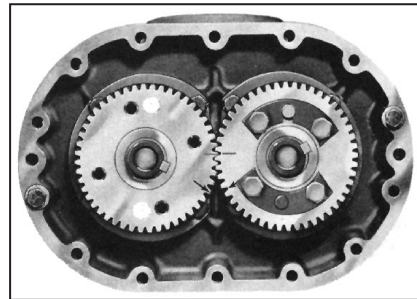


Figure 17 - Position of timing marks
Timing marks advanced 3 teeth and
reference marks aligned.

2. Remove motor, coupling and C-flange adapter.
3. Remove four socket head screws (93). Requires 5/32" hex head (Allen) wrench. Place two of the screws in tapped jacking holes and remove seal housing (91). Tap out seal and discard O-rings.
4. Remove gear cover cap screws (26) and gear cover (6) by placing two of the screws in the tapped jacking holes provided on the cover flange. Support cover with lift straps or other suitable means while removing. The jackscrews will provide the force necessary to break the seal between cover and end plate.
5. Temporarily secure end plate to housing with two screws (26) and some flat washers. Remove four nylok screws (66) from drive shaft (45). A light tap with a mallet will break it loose from the gear. Remove mating ring of mechanical seal [54].
6. Bend back lock tabs and remove cap screws (29), lock (59), washers (25) and spring pins (68).
7. Position timing gears (8) so both timing marks are matched. See Figure 16. Rotate drive gear clockwise approximately three teeth and mark a matching reference line on each gear as shown in Figure 17. This gear position is necessary so rotors will clear and not jam. Using a gear puller with a live center or a centering adapter, large enough so it will not jam into threaded hole, pull driven gear, while keeping matched reference line marks aligned. Use a slight rocking motion to insure rotors have not jammed. Should jamming occur, release pressure and tap gear back on until it rotates freely. Pull mating gear.



NOTE

Never attempt to pull gear when rotors are jammed. Rotor keyway damage will result.

8. Repeat procedure used in No. 4 to remove free end cover (7). Remove rotor shaft screws as was done in No. 6 and also oil slinger (20). Remove cap screws (30) and oil retainer rings (14).
90 Series: Place ½" eye bolt into both sides of end plate on 90 series, in holes provided for lifting.
91 Series: Place ½" eye bolt into top of end plate on 91 series.
9. Make up four pieces of threaded rod ½"-13 UNC approximately 9" long with double nuts or a single welded nut to turn rods. On the opposite ends remove about ½" of threads as this end will mushroom slightly when jacking end plate. This will prevent threads from jamming when removing rods. Run in equally to remove end plate. Tap out roller bearings (10). Note that each bearing on this end has two identical spacers (57), one on each side of bearing. Tap out seals (54) or (12). Also remove the labyrinth seals (51), as they should be replaced with each overhaul.
90/91 Series: discard O-ring (75) and retain O-ring spacers (74) for reassembly.
10. Remove cap screws (30) and bearing retainer rings (14) from drive end of unit. Remove rotors (1). To remove the rotors from the end plate will require either a two-jaw gear puller with jaws inserted in the oil feed slots of the bearing bore, or a bar-type puller using the tapped holes around the bearing bore.



CAUTION

If rotors are side by side, position the lobes vertically when removing. If they are one on top of the other, remove top rotor first in a vertical position. Then position bottom rotor vertically and remove.

11. Support end plate with eyebolts and lift strap. Remove temporary cap screws and tap end plate from housing (3). Remove bearings and seals.
12. Clean and inspect parts for damage and wear. Replace all O-rings, seals and bearings at each overhaul.



NOTE

If end plates, housing or end covers are not being reassembled in their original position or some new parts are being used, it will be necessary to clean all paint or rust build-up from the mating surfaces to insure a good seal. Failure to do so could result in excessive end clearances and air or oil leaks.

10.2 ASSEMBLY OF 7000C SERIES BOOSTERS

The assembly procedure is generally the same for all series, but where there are differences, notations are made. Dowel pins are used to locate end plates, housing and end covers in their proper locations relative to each other. Be sure they are in place. An O-ring lubricant should be used on all O-rings.

It is recommended that the gear end rotor shaft bearings be purchased from Tuthill Vacuum & Blower Systems, as they are specially ground to locate the rotors with correct end clearance relative to the gear end plate.

Make sure all parts are clean and free of any nicks or burrs caused by disassembly. Refer to Special Tool Drawings on page 44-45.



NOTE

When rebuilding the model 7000 blowers and vacuum boosters and depending on the series designation, it may be necessary to reseal the joints between the rotor housing, end plates, and end covers. The sealer, Loctite 515, is recommended and available for purchase from Tuthill Vacuum & Blower Systems.

10.2.1 PREPARATION OF END PLATES FOR ASSEMBLY

1. Press the labyrinth seals (51) into seal bores with the lips toward the oil side. (Note:) For lip seal units put a light coat of silicone in the seal bore of end plate. Install lip seal open side facing up.
2. Install O-ring spacers (74) with grooves up. Install O-rings (75) making sure they are fully seated in their grooves. Apply a thin coat of sealer to O. D. of seal (54) and press into seal bore. Make sure seals are fully seated without deforming. Clean seal carbon with soft tissue and cleaning agent (acetone).

10.2.2 GEAR END ASSEMBLY

3. Place free end plate on suitable blocking with rotor side up. Stand rotors (1) into each bore with gear end shafts up and keyways facing in the direction shown in Figure 18 to the right.
4. Install the gear end plate (4) over the rotor shafts and coming to rest on top of the rotor lobes, being careful not to damage the seals. Recheck the location of the oil sight glass in relation to the drive rotor before proceeding with the assembly. Inspect lapped surface of seal mating ring to be sure it is perfectly clean. Use a soft tissue and cleaning agent if necessary. Place a few drops of lubricating oil on its surface and lubricate the O-ring. Install on rotor shaft with lapped surface down. Slot must line up with pin (300) in rotor shaft. Gently press with fingers to insure compression is taking place and mating ring is not hung up for any reason. Top of mating ring should sit flush with rotor shoulder when fully seated.
5. Coat the rotor shafts with an anti-seize lubricant and press the bearings (9) on the shafts. The bearing manufacturer numbers and/or an acid dot (inner race) should be up or toward the gears. Use the tool shown on page 44 along with a length of 3/4 - 10 x 6" threaded rod, washer (25) and nut. The use of a hydraulic ram with a hollow center is also recommended. In this case the threaded rod will have to be made longer.
6. Install bearing retainer plates (14) and secure with cap screws (30).
7. Check clearance between the face of the end plate and rotor lobes. Refer to *Assembly Clearances* table on page 41 for correct gear end clearances. If clearances are not within specifications, recheck parts to find cause of improper clearances before proceeding. Install keys (24) in rotor shaft keyways.
8. Lubricate shafts and keys and press drive gear (right hand helix) on drive rotor. To install driven gear, align reference marks as shown in Figure 17 on page 35. Tap gear with mallet to start then press the gear until seated.

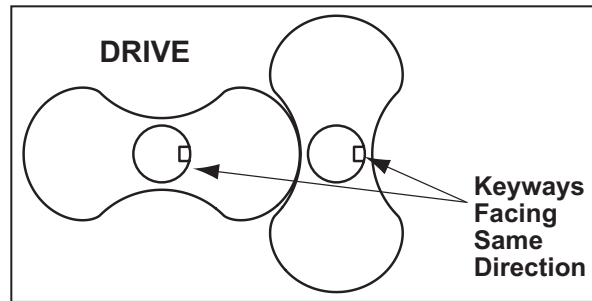


Figure 18 - Keyways position



NOTE

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

9. Install roll pins (68), washers (25), lock tabs (59) and shaft bolts (29). Bend over lock tabs.



NOTE

These bolts are structural bolts, not standard cap screws. Therefore they have a larger body diameter and this centers the washers and slinger. Do not replace with standard cap screws.

10. Remove the gear end assembly from the free end plate and turn over so the gears are facing down on a solid surface. Place some wood blocking on each side for support. Place a small bead of an RTV silicone type sealer around the periphery of the housing [3] bores but inside the bolt pattern. Encircle the dowel pins. Install rotor housing and temporarily secure to end plate with two cap screws [26] and some flat washers. Check clearances between end of lobes and housing using a flat bar and feeler gauges or a depth micrometer. Refer to exploded view for free end clearances.

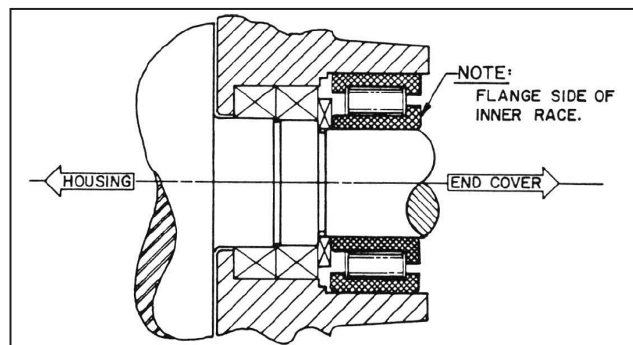


Figure 19 - Roller Bearing Flange

11. Put sealer on rotor housing, same as above. Install free end plate and secure in same manner.
12. Install seal mating rings as was done in Step 4. Install one bearing spacer (57) on each shaft. Lubricate shafts and install roller bearing with inner race flange outward. See Figure 19. Install second bearing spacer (57) on each shaft. Install oil retainer rings (14) and cap screws (30). Install roll pin (68) washers (25), oil slinger (20) (on drive rotor), lock tabs (59) and bolts (29). Bend over tabs.
13. Install mounting feet (304) with machined surface against housing and secure with lockwashers (80) and cap screws (307). Install lifting lugs (195) with cap screws (196).

10.2.3 ADJUSTING ROTOR INTERLOBE CLEARANCE

14. The driven gear is made of two pieces. The outer gear shell is fastened to the inner hub with four cap screws and located with two dowel pins. A laminated shim, made up of .003" (.076 mm) laminations, separates the hub and the shell. By removing or adding shim laminations, the gear shell is moved axially relative to the inner hub. Being a 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 .014" (.36 mm) will change the rotor lobe clearance .005" (.13 mm).

EXAMPLE: Referring to Figure 15, check the clearance at AA (right hand reading) and BB (left hand reading). If AA reading is .017" (.43 mm) and BB reading is .004" (.10 mm), by removing .018" (.46 mm) shims, the readings should then read AA .011" (.28 mm) and BB .010" (.25 mm).

To determine the amount of shim to add or remove, subtract the smaller reading from the larger and multiply the result by 1.4. (.017" [.43 mm] - .004" [.10 mm] = .013" [.33 mm] × 1.4 = .018" [.46 mm]) If the right side reading is higher than the left side, remove shim. If the right side reading is lower, add shim. The final readings should be within .002" (.05 mm) of each other. When removing gear shell from driven gear, it is not necessary to remove gear lock bolt. Make sure bolt locks are in place because the dowel pins must come off with the gear shell.

15. Install oil slingers (395) back to back on drive shaft flange. Make sure both mating surfaces are clean and free of burrs-then mount drive shaft to gear and secure with-nylok cap screws (29). Check drive shaft runout at seal journal. Do not exceed .003" (.08 mm) T.I.R.
16. Remove temporary cap screws from gear end of housing and place bead of silicone around the periphery of the end plate. Encircle the dowel pins. Install cover (6) and cap screws (26). The use of two ½"-13 threaded rods as guide screws is recommended.

10.2.4 DRIVE SHAFT SEAL ASSEMBLY

17. Follow steps as listed below:
 - a. Install O-ring (75) into seal housing (91) and press in stator portions of mechanical seal (54) see special tool drawing. Clean face of carbon and mating ring with soft tissue and acetone. Install O-ring (92).



NOTE

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

- b. Lubricate O-ring in ID of mating ring and carefully slide onto drive shaft with slot up and seat against shoulder. Do not use any tools. Lapped surface should be facing outward.
 - c. Install seal housing (91) into cover bore and secure with four hex head screws (93).
 - d. With set screws (90) in place install mating ring retainer (89) (flange facing outward) while aligning pin (300) with slot in mating ring. Secure to shaft with set screws.
 - e. Install dust washer (82) and secure with three hex head screws (111).
18. Install free end cover (7) same as gear end.

10.3 INSTRUCTIONS FOR CONVERTING DRIVES

10.3.1 BOTTOM DRIVE UNITS

If the sight glasses are on the right side as you face the drive shaft you can make a right drive unit by changing mounting feet, lift lugs, sight glasses and magnetic drain plugs. If the sight glasses are on the left you can make a left drive unit by changing the same items above.

10.3.2 LEFT OR RIGHT DRIVE UNITS

Can be made bottom drives by changing the same items above.



NOTE
When converting to bottom drive it may be necessary to change the location of the oil slinger to the bottom rotor.

11. 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 chart below 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 the <i>Disassembly</i> section.
	Loose drain plug.	Tighten drain plug.
Excessive bearing or gear wear	Improper lubrication.	Correct oil level. Replace dirty oil. See the <i>Lubrication</i> section.
	Excessive belt tension.	Check belt manufacturer's specifications for tension and adjust accordingly.
	Coupling misalignment.	Check carefully, realign 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 the <i>Assembly Clearances</i> section.
	Speed too low.	Increase booster speed within limits.
	Obstruction in piping.	Check system to assure an open flow path.
Knocking	Unit 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 the <i>Disassembly</i> section.
Excessive booster temperature	Too much or too little oil in gear reservoir.	Check oil level. See the <i>Lubrication</i> section.
	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 the <i>Assembly Clearances</i> section.
Rotor end or tip drag	Insufficient assembled clearances.	Correct clearances. See the <i>Assembly Clearances</i> section.
	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, realign if necessary.
	Lobes rubbing.	Check cylinder for hot spots, then check for lobe contact at these points. Correct clearances. See the <i>Assembly Clearances</i> section.
	Worn bearings or gears.	Check condition of gears and bearings; replace if necessary.
	Unbalanced or rubbing lobes.	Possible buildup on casing or lobes, or inside lobes. Remove buildup and restore clearances.
	Driver or booster loose.	Check mounting and tighten if necessary.
	Piping resonance.	Check pipe supports, check resonance of nearby equipment, check foundation.

12. ASSEMBLY CLEARANCES

Values are shown in inches and *millimeters*.

MODEL	GEAR END	FREE END	INTERLOBE	TIP-DOWEL	TIP-PORT
3204	.003 - .005 .08 - .13	.006 - .010 .15 - .25	CENTER TIMED	.003 - .007 .08 - .18	.006 - .010 .15 - .25
3206	.003 - .005 .08 - .13	.012 - .017 .30 - .43		.003 - .007 .08 - .18	.006 - .010 .15 - .25
3210	.003 - .005 .08 - .13	.012 - .017 .30 - .43		.003 - .007 .08 - .18	.006 - .010 .15 - .25
4009	.004 - .007 .10 - .18	.011 - .016 .28 - .41		.017 - .022 .43 - .56	.006 - .011 .15 - .28
4012	.004 - .007 .10 - .18	.011 - .016 .28 - .41		.017 - .022 .43 - .56	.006 - .011 .15 - .28
5507	.004 - .007 .10 - .18	.011 - .016 .28 - .41		.007 - .012 .18 - .30	.011 - .016 .28 - .41
5509	.004 - .007 .10 - .18	.013 - .018 .33 - .46		.007 - .012 .18 - .30	.011 - .016 .28 - .41
5511	.004 - .007 .10 - .18	.014 - .019 .36 - .48		.007 - .012 .18 - .30	.011 - .016 .28 - .41
5514	.004 - .007 .10 - .18	.017 - .022 .43 - .56		.007 - .012 .18 - .30	.011 - .016 .28 - .41
5518	.004 - .007 .10 - .18	.021 - .026 .53 - .66		.007 - .012 .18 - .30	.011 - .016 .28 - .41
5524	.004 - .007 .10 - .18	.025 - .030 .64 - .76		.008 - .013 .20 - .33	.012 - .017 .30 - .43
7010	.006 - .009 .15 - .23	.013 - .019 .33 - .48		.010 - .014 .25 - .36	.008 - .012 .20 - .30
7013	.006 - .009 .15 - .23	.016 - .022 .41 - .56	.010 - .014 .25 - .36	.008 - .012 .20 - .30	.015 - .019 .38 - .48
7017	.006 - .009 .15 - .23	.021 - .027 .53 - .69	.010 - .014 .25 - .36	.008 - .012 .20 - .30	.015 - .019 .38 - .48
7021	.006 - .009 .15 - .23	.026 - .032 .68 - .81	.010 - .014 .25 - .36	.008 - .012 .20 - .30	.015 - .019 .38 - .48
7026	.006 - .009 .15 - .23	.031 - .037 .79 - .94	.010 - .014 .25 - .36	.008 - .012 .20 - .30	.015 - .019 .38 - .48

13. TORQUE CHART

Data shown represents “wet” torque values, in foot-pounds (ft.-lbs) and *Newton-meters (N-m)*.

PART DESCRIPTION	TORQUE
CAP SCREW 10-32UNF	4 5
CAP SCREW 1/4"-20UNC GR5	8 10
CAP SCREW 5/16"-18UNC GR5	15 20
CAP SCREW 3/8"-16UNC GR5	33 45
CAP SCREW 1/2"13UNC GR5	78 106
CAP SCREW 5/8"14UNC GR5	123 167
CAP SCREW 3/4"-10UNC GR5	260 350

14. RECOMMENDED LUBRICANTS

RECOMMENDED MINERAL BASED LUBRICANTS				
AMBIENT TEMPERATURE	SHELL	CITGO	CHEVRON	EXXONMOBIL
0° to 32° F (-18° to 0° C)	TELLUS® S2 M 68 (ISO 68)	A/W 68 (ISO 68)	RANDO HD 68 (ISO 68)	DTE HEAVY MEDIUM (ISO 68)
32° to 90° F (0° to 32° C)	TELLUS® S2 M 100 (ISO 100)	A/W 100 (ISO 100)	RANDO HD 100 (ISO 100)	DTE HEAVY (ISO 100)
90° to 120° F* (32° to 50° C)	—	A/W 150 (ISO 150)	RANDO HD 150 (ISO 150)	DTE EXTRA HEAVY (ISO 150)

RECOMMENDED SYNTHETIC BASED LUBRICANTS**			
AMBIENT TEMPERATURE	TUTHILL	EXXONMOBIL	SHELL
0° to 32° F (-18° to 0° C)	PneuLube™ (ISO 100)	SHC 626 (ISO 68)	MORLINA® S4 B 68 (ISO 68)
32° to 90° F (0° to 32° C)		SHC 627 (ISO 100)	MORLINA® S4 B 100 (ISO 100)
90° to 120° F* (32° to 50° C)		SHC 629 (ISO 150)	MORLINA® S4 B 150 (ISO 150)

RECOMMENDED MINERAL BASED, FOOD GRADE LUBRICANTS		
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	Lubricant meeting U.S. FDA regulations 21 CFR 172.878 and 178.3620(a) for direct and indirect food contact
0° to 32° F (-18° to 0° C)	CITGO CLARION® A/W 68 (ISO 68)	CITGO CLARION® 350 FOOD GRADE (ISO 68)
32° to 90° F (0° to 32° C)	CITGO CLARION® A/W 100 (ISO 100)	CONSULT FACTORY
90° to 120° F* (32° to 50° C)	CONSULT FACTORY	CONSULT FACTORY

RECOMMENDED SYNTHETIC BASED, FOOD GRADE LUBRICANTS		
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	Lubricant meeting U.S. FDA regulations 21 CFR 172.878 and 178.3620(a) for direct and indirect food contact
0° to 32° F (-18° to 0° C)	PneuLube™ FG (ISO 100)	CONSULT FACTORY
32° to 90° F (0° to 32° C)		
90° to 120° F* (32° to 50° C)		

RECOMMENDED LUBRICANTS FOR M-D VACUUM BOOSTERS (90/91, 92/93, 96, 31/33 AND 35/37 SERIES)	
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 COMPETITOR® PLUS BLOWERS:	
TUTHILL	CITGO
Tuthill PneuLube™ NLGI #2 premium grade, petroleum base lithium grease.	For food grade requirements: Use Citgo Clarion® Food Grade HTEP grease, NLGI No. 2 grade. It meets 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.

** Blowers used in oxygen-enriched service should use only Castrol Brayco 1726 Plus 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 and Blower Systems.

15. TOOL DRAWINGS

FIGURE 20 — 3200C SEAL PRESSING TOOL (T32018-1)

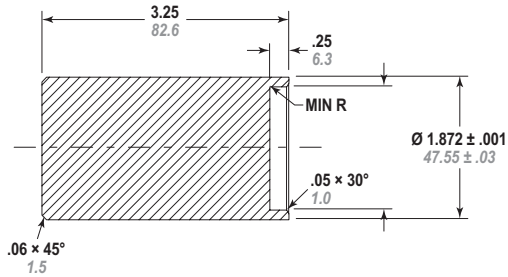
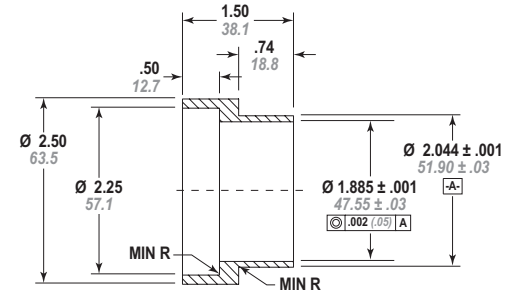


FIGURE 21 — 3200C SEAL PRESSING TOOL (T32018-2)



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

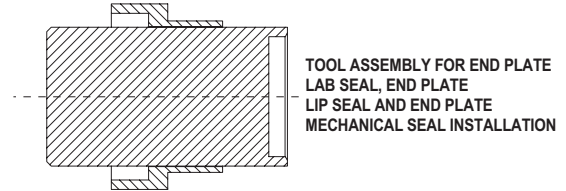
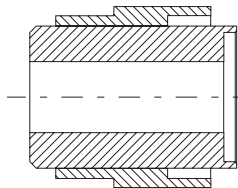
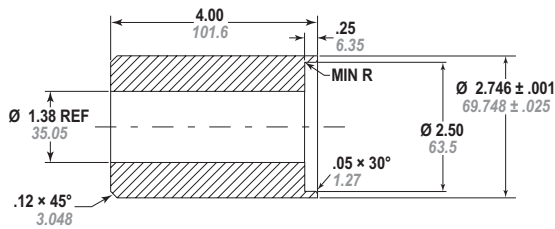


FIGURE 22 — 4000C/5500C SEAL PRESSING TOOL (T11449-1)

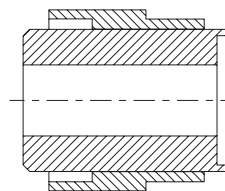
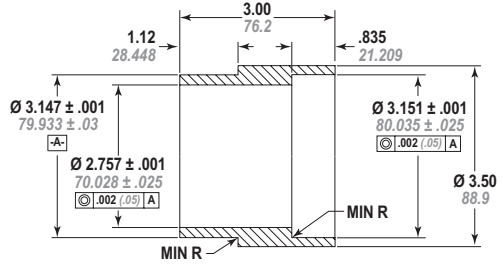


TOOL ASSEMBLY FOR DRIVE SHAFT MECHANICAL SEAL INSTALLATION

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 (0.254)
 .XXX = ± .0005 (0.0127)
 CHAMFERS = ± 2°

FIGURE 23 — 4000C/5500C SEAL PRESSING TOOL (T11449-2)

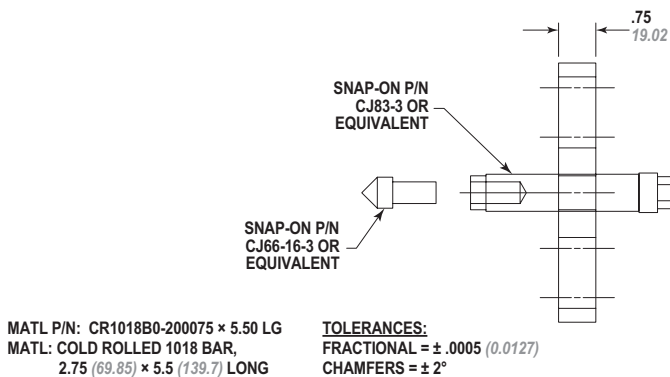


TOOL ASSEMBLY FOR END PLATE LAB SEAL AND END PLATE MECHANICAL SEAL INSTALLATION

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

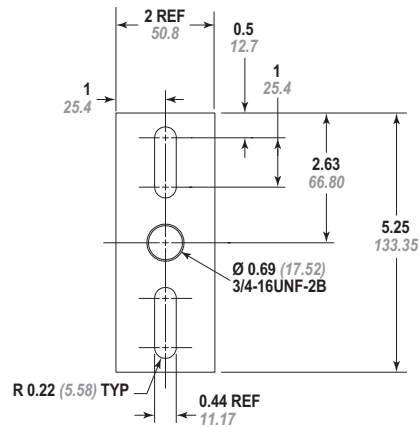
NOTE:
 TOOLS T11449-1 & T11449-2 ARE USED TO INSTALL MECHANICAL SEAL AND LABRYINTH SEAL USED ON MODEL 5500 ROTOR SHAFTS.
 MECHANICAL SEAL USED ON MODEL 5500 DRIVE SHAFTS AND MECHANICAL SEAL USED ON MODEL 4000 VACUUM BOOSTER DRIVE SHAFT.

FIGURE 24 — 3200C/4000C/5500C GEAR AND EP TOOL (T29603)



MATL P/N: CR1018B0-200075 x 5.50 LG
 MATL: COLD ROLLED 1018 BAR,
 2.75 (69.85) x 5.5 (139.7) LONG

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



NOTE: All dimensions are shown in inches and millimeters.

FIGURE 25 — 7000C LAB SEAL PRESSING TOOL

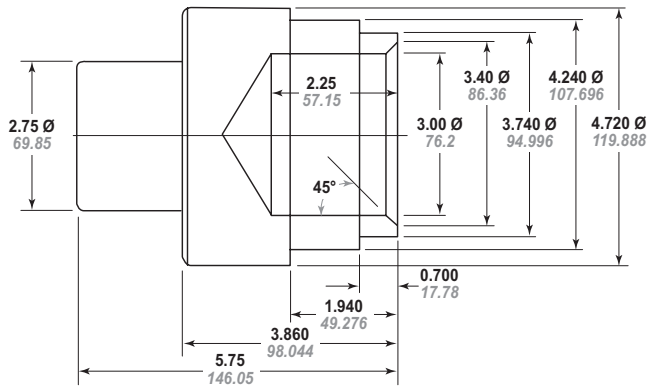


FIGURE 26 — 7000C MECHANICAL & LIP SEAL TOOL

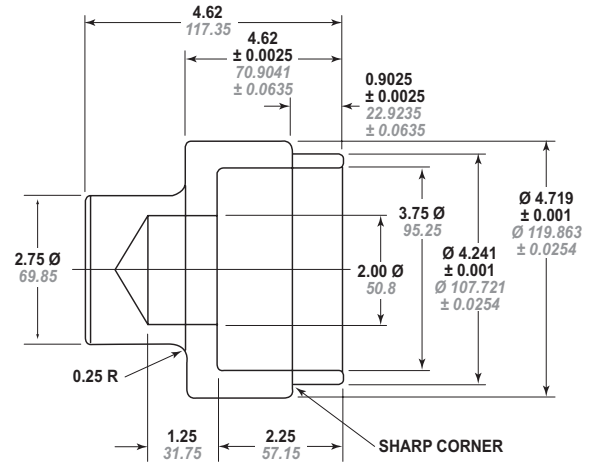


FIGURE 27 — 7000C DRIVE SHAFT MECHANICAL SEAL INSTALLATION TOOL

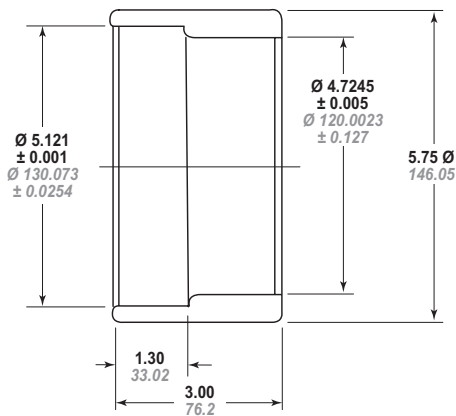


FIGURE 28 — 7000C BEARING PRESSING TOOL

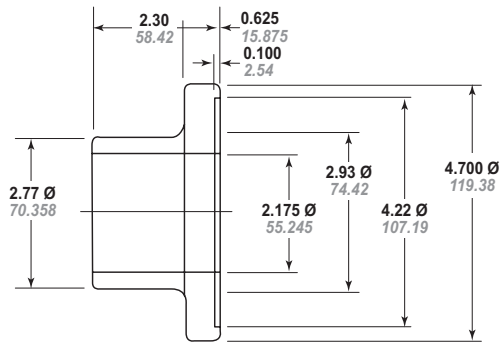
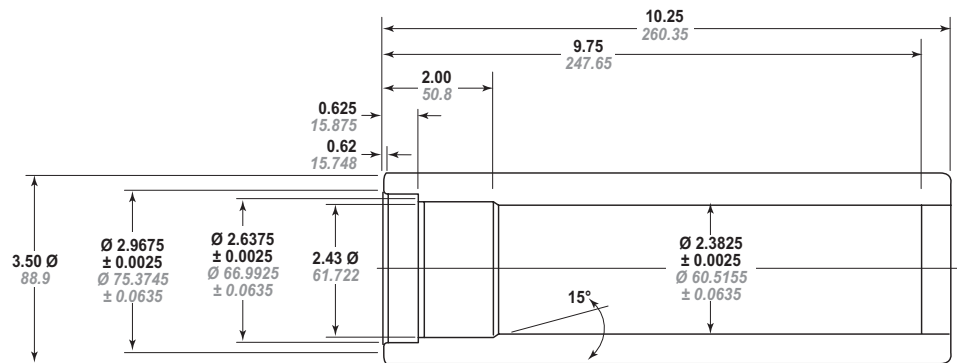


FIGURE 29 — 7000C DRIVE SHAFT BEARING INNER RACE PRESSING TOOL



NOTE: All dimensions are shown in Inches and millimeters.

PARTS LIST FOR MODEL 3200C SERIES

ITEM NO.	DESCRIPTION	90/91	92/93
1	ROTOR	2	2
3	HOUSING	1	1
4	END PLATE	2	2
6	DRIVE END COVER	1	1
7	FREE END COVER	1	1
8	TIMING GEAR SET	1	1
9	BEARING, DRIVE END	2	2
10	BEARING, FREE END	2	2
13	LIP SEAL	1	1
14	BEARING RETAINER	4	4
16	TIMING GEAR SHIM	1	1
17	SPACER	1	1
18	SPACER	1	1
20	OIL SLINGER	1	1
21	OIL SLINGER ASSEMBLY	1	1
22	DOWEL PINS	6	6
23	DRIVE SHAFT KEY	1	1
24	GEAR KEY	2	2
25	ROTOR SHAFT WASHER	4	4
26A	CAP SCREW	12	12
26B	CAP SCREW	12	12
29	FLAT SOCKET SCREW	4	4
30	SOCKET SCREW	12	12
31	MAGNETIC PIPE PLUG	2	2
38	PORT FITTING	2	2
40	HEX HEAD CAP SCREW	24	24
45	DRIVE SHAFT	1	1
49	LOCK WIRE	1	1
51	LABYRINTH SEAL	4	—
54	MECHANICAL SEAL	4	—
57	SPACER	1	1
66	SCREW	2	2

ITEM NO.	DESCRIPTION	90/91	92/93
67	SPACER	2	2
70	SIGHT GLASS	0/1	0/1
76	MECHANICAL SEAL	1	1
79	OIL RETAINER	—	4
85	PIPE PLUG	6	6
91	SEAL ADAPTER HOUSING	1	1
92	O-RING	1	1
93	SCREW	4	4
94	COOLING COILS	2	—
98	PIPE PLUG	10	10
118	SHIM	1	1
120	BUSHING	4	—
121	PIPE PLUG	4	4
123	BEARING SPACER	2	2
137	OIL DEFLECTOR	—	1
165	CONNECTOR	4	—
166	CONNECTOR	2	—
174	PIPE PLUG	2	2
180	ELBOW	2	—
181	HOSE	1	—
238	SLINGER	—	4
241	SOCKET SCREW	12	12
242	SIGHT GLASS FRAME	2	2
243	SIGHT GLASS WINDOW	2	2
244	WINDOW GASKET	2	2
245	FRAME GASKET	2	2
303	COVER PLATE	2	2
309	CAP SCREW	8	8

NOTES:

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

PARTS KITS ARE AVAILABLE, AS FOLLOWS:

90/91 — P/N 32184
92/93 — P/N 32226

PARTS LIST FOR MODEL 4000C SERIES

ITEM NO.	DESCRIPTION	90/91	92/93
1	ROTOR	2	2
3	HOUSING	1	1
4	END PLATE	2	2
6	DRIVE END COVER	1	1
7	FREE END COVER	1	1
8	TIMING GEAR SET	1	1
9	BEARING, DRIVE END	3	3
10	BEARING, FREE END	2	2
13	LIP SEAL	1	1
14	BEARING RETAINER	2	2
15	OIL RETAINER RING	4	4
21	OIL SLINGER ASSEMBLY	1	1
22	DOWEL PINS	6	6
23	DRIVE SHAFT KEY	1	1
24	GEAR KEY	2	2
25	ROTOR SHAFT WASHER	2	2
26	CAP SCREW	28	28
29	FLAT SOCKET SCREW	1	1
30	SOCKET SCREW	4	4
31	MAGNETIC PIPE PLUG	2	2
35	GEAR LOCKNUT	2	2
36	GEAR LOCKWASHER	2	2
38	PORT FITTING	2	2
40	HEX HEAD CAP SCREW	28	28
45	DRIVE SHAFT	1	1
51	LABYRINTH SEAL	4	—
54	MECHANICAL SEAL	4	—
61	LOCKPLATE	2	2
62	CAP SCREW	8	8
65	LOCKPLATE	2	2
66	SCREW	4	4
68	OIL SLINGER PIN	1	1
69	FLAT SOCKET SCREW	1	1

ITEM NO.	DESCRIPTION	90/91	92/93
70	SIGHT GLASS	0 / 1	0 / 1
76	MECHANICAL SEAL	1	1
79	OIL RETAINER	—	4
85	PIPE PLUG	4	4
91	SEAL ADAPTER HOUSING	1	1
92	O-RING	1	1
93	SCREW	4	4
94	COOLING COILS	2	—
95	O-RING	4	—
96	O-RING	4	—
97	MANIFOLD SCREW	4	—
98	PIPE PLUG	10	10
118	SHIM	1	1
121	PIPE PLUG	3	3
123	BEARING SPACER	2	2
137	OIL DEFLECTOR	—	1
166	CONNECTOR	2	—
174	PIPE PLUG	2	2
180	ELBOW	2	—
181	HOSE	1	—
238	SLINGER	—	4
241	SOCKET SCREW	12	12
242	SIGHT GLASS FRAME	2	2
243	SIGHT GLASS WINDOW	2	2
244	WINDOW GASKET	2	2
245	FRAME GASKET	2	2
303	COVER PLATE	2	2
309	CAP SCREW	8	8

NOTES:

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

PARTS KITS ARE AVAILABLE, AS FOLLOWS:

90/91 — P/N 40119

92/93 — P/N 40204

PARTS LIST FOR MODEL 5500C SERIES

ITEM NO.	DESCRIPTION	90/91	92/93
1	ROTOR	2	2
3	HOUSING	1	1
4	END PLATE	2	2
6	DRIVE END COVER	1	1
7	FREE END COVER	1	1
8	TIMING GEAR SET	1	1
9	BEARING, DRIVE END	2	2
10	BEARING, FREE END	2	2
13	LIP SEAL	1	1
14	BEARING RETAINER	4	4
20	OIL SLINGER	0 / 1	0 / 1
21	OIL SLINGER ASSEMBLY	1	1
22	DOWEL PINS	6	6
23	DRIVE SHAFT KEY	1	1
24	GEAR KEY	2	2
25	ROTOR SHAFT WASHER	1	1
26	CAP SCREW	28	28
29	FLAT SOCKET SCREW	1	1
30	SOCKET SCREW	6	6
31	MAGNETIC PIPE PLUG	2	2
35	GEAR LOCKNUT	2	2
38	PORT FITTING	1 / 2	1 / 2
40	HEX HEAD CAP SCREW	28	28
45	DRIVE SHAFT	1	1
48	PORT FITTING (5507)	1 / 0	1 / 0
51	LABYRINTH SEAL	4	—
54	MECHANICAL SEAL	4	—
57	SPACER	1	1
61	LOCKPLATE	6	6
62	CAP SCREW	12	12
65	LOCKPLATE	2	2
66	SCREW	4	4
68	OIL SLINGER PIN	1	1
69	FLAT SOCKET SCREW	1	1

ITEM NO.	DESCRIPTION	90/91	92/93
70	SIGHT GLASS	0 / 1	0 / 1
76	MECHANICAL SEAL	1	1
79	OIL RETAINER	—	4
80	WASHER	0 / 1	0 / 1
85	PIPE PLUG	6	6
91	SEAL ADAPTER HOUSING	1	1
92	O-RING	1	1
93	SCREW	4	4
94	COOLING COILS	2	—
95	O-RING	4	—
96	O-RING	4	—
97	MANIFOLD SCREW	4	—
98	PIPE PLUG	6	6
123	BEARING SPACER	2	2
136	LOCKWASHER	0 / 1	0 / 1
166	CONNECTOR	2	—
174	PIPE PLUG	2	2
180	ELBOW	2	—
181	HOSE	1	—
238	SLINGER	—	4
241	SOCKET SCREW	12	12
242	SIGHT GLASS FRAME	2	2
243	SIGHT GLASS WINDOW	2	2
244	WINDOW GASKET	2	2
245	FRAME GASKET	2	2
303	COVER PLATE	2	2
309	CAP SCREW	8	8

NOTES:

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

PARTS KITS ARE AVAILABLE, AS FOLLOWS:

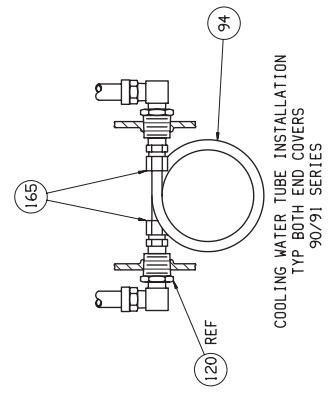
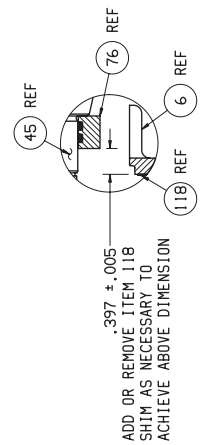
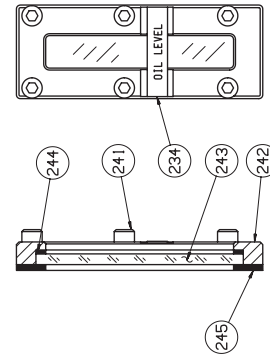
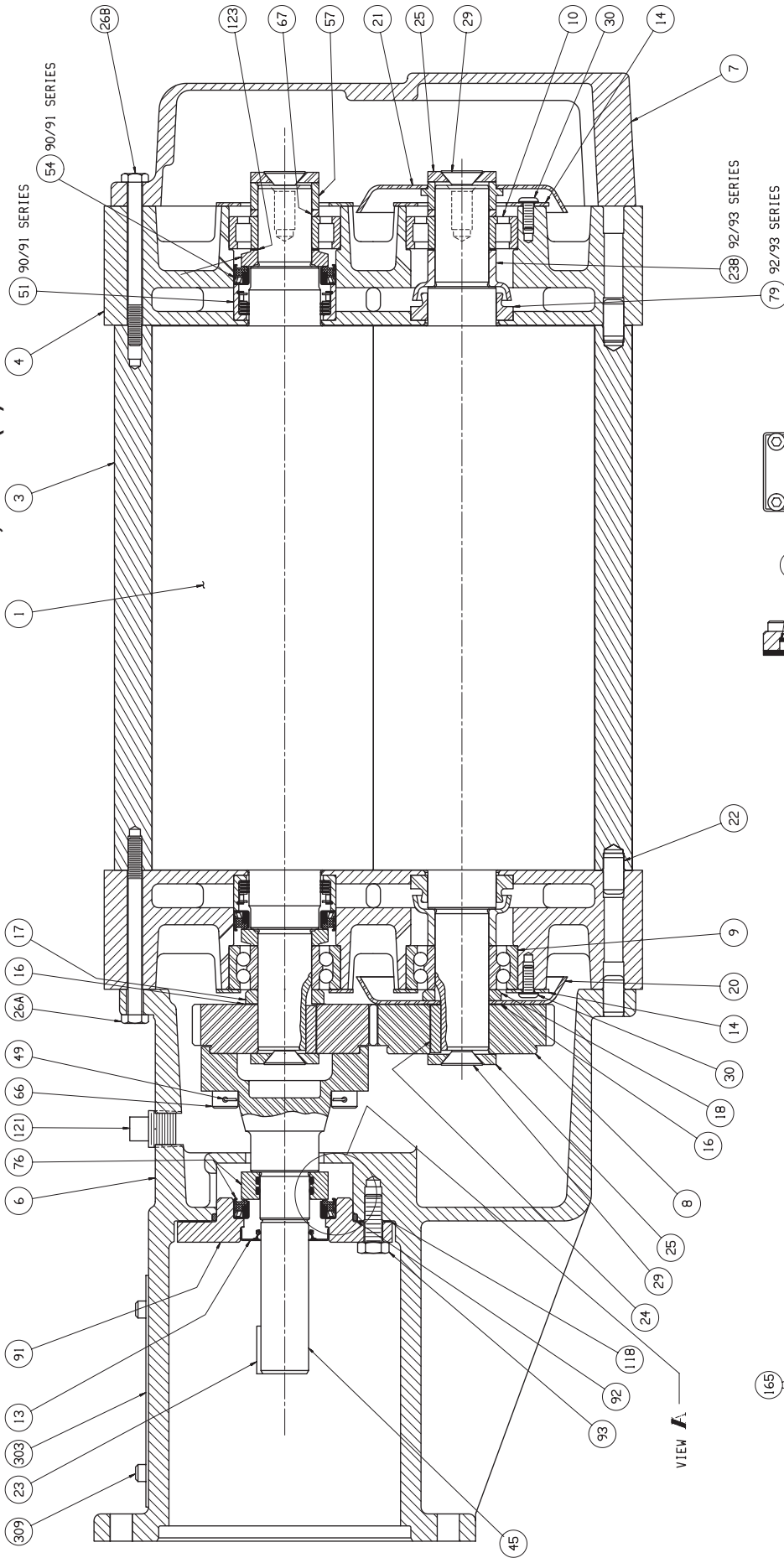
90/91 — P/N 55272

92/93 — P/N 55399

PARTS LIST FOR MODEL 7000C SERIES

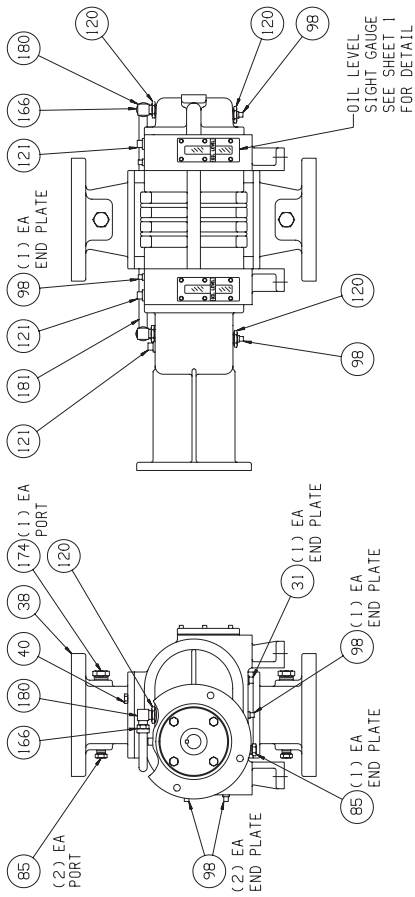
ITEM NO.	DESCRIPTION	90/91	ITEM NO.	DESCRIPTION	90/91
1	ROTOR	2	75	O-RING	5
3	HOUSING	1	80	WASHER	4
4	END PLATE	2	85	PIPE PLUG	14
6	DRIVE END COVER	1	89	LOCKING RING	1
7	FREE END COVER	1	90	SET SCREW	3
8	TIMING GEAR SET	1	91	LIP SEAL	1
9	BEARING, DRIVE END	2	92	O-RING	1
10	BEARING, FREE END	2	93	CAP SCREW	4
13	LIP SEAL	1	94	COOLING COILS	2
14	RETAINER	2	95	O-RING	4
15	RETAINER	2	96	O-RING	4
20	OIL SLINGER	1	97	BUSHING	4
22	DOWEL PIN	8	98	PIPE PLUG	4
23	DRIVE SHAFT KEY	1	174	PIPE PLUG	4
24	GEAR KEY	2	195	LIFTING LUG	2
25	ROTOR SHAFT WASHER	4	196	CAP SCREW	2
26	CAP SCREW	36	199	O-RING	2
29	BOLT	4	300	ROLL PIN	5
30	CAP SCREW	16	304	FOOT	2
31	MAGNETIC PIPE PLUG	2	307	CAP SCREW	4
45	DRIVE SHAFT	1	339	STRAIGHT PLUG	6
51	LABYRINTH SEAL	4	395	OIL SLINGER	2
54	MECHANICAL SEAL	5	499	BUSHING	1
49	LOCKING TAB	4			
66	CAP SCREW	4			
68	ROLL PIN	4			
70	SIGHT GLASS	2			
74	SEALING RING	4			
			<p>NOTES:</p> <ul style="list-style-type: none"> • QUANTITIES SHOWN ARE MAXIMUM VALUES; QUANTITIES MAY VARY BETWEEN BLOWER <p>PARTS KITS ARE AVAILABLE, AS FOLLOWS: 90/91 — P/N 77165</p>		

3200C CUTAWAY DRAWING — 3200-90C/91C/92C/93C, 1 OF 2 (A)

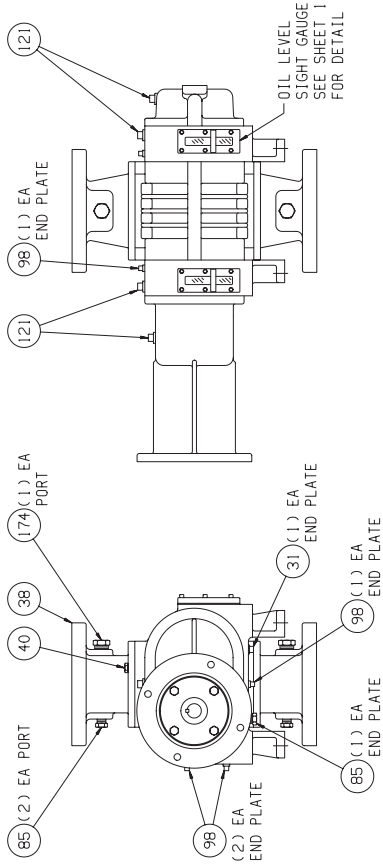


3210 MODEL SHOWN

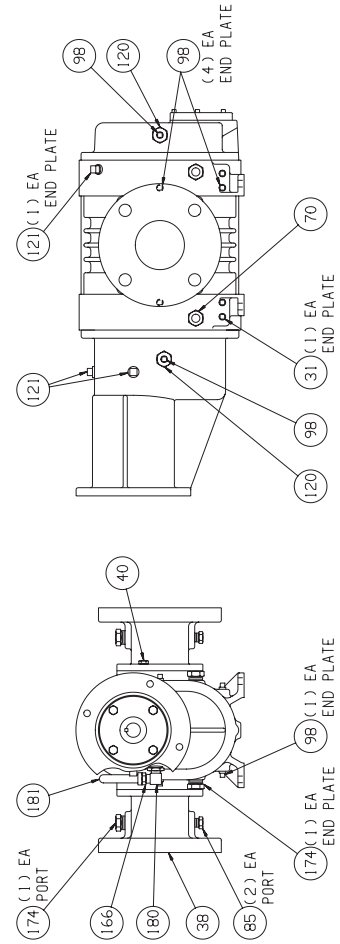
3200C CONFIGURATIONS DRAWINGS — 3200-90C/91C/92C/93C, 2 of 2 (A)



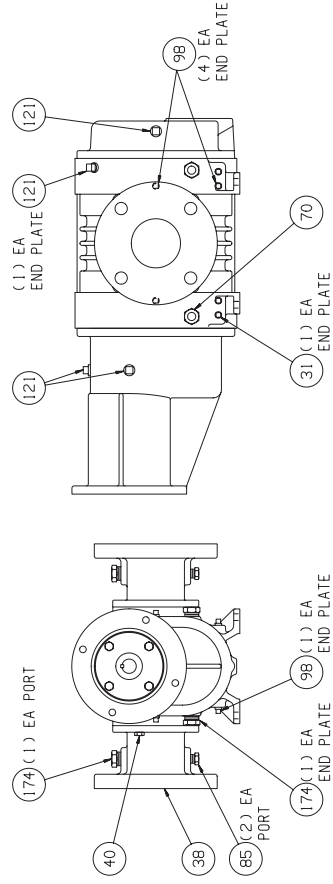
90 SERIES



92 SERIES



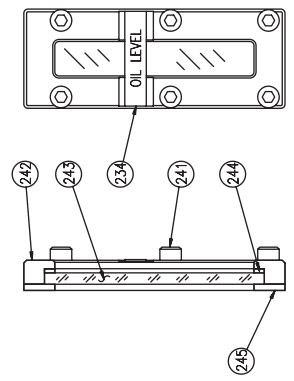
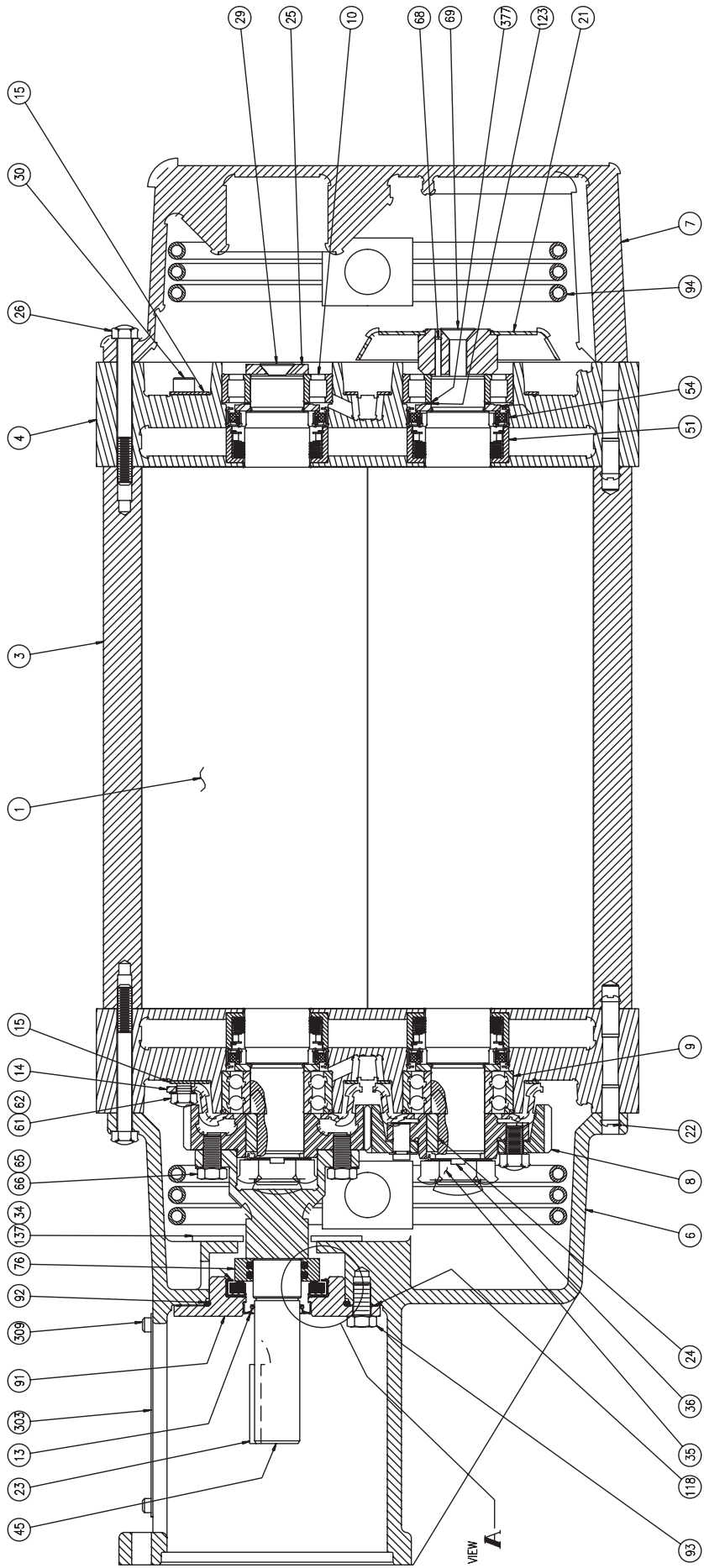
91 SERIES



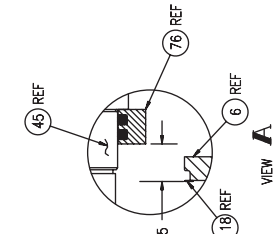
93 SERIES

3206 MODELS SHOWN

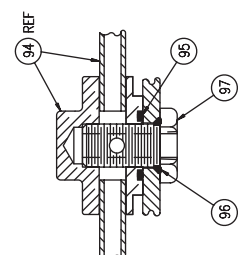
4000C CUTAWAY DRAWING — 4000-90C/91C/92C/93C, 1 OF 2 (D)



OIL LEVEL SIGHT GAUGE DETAIL



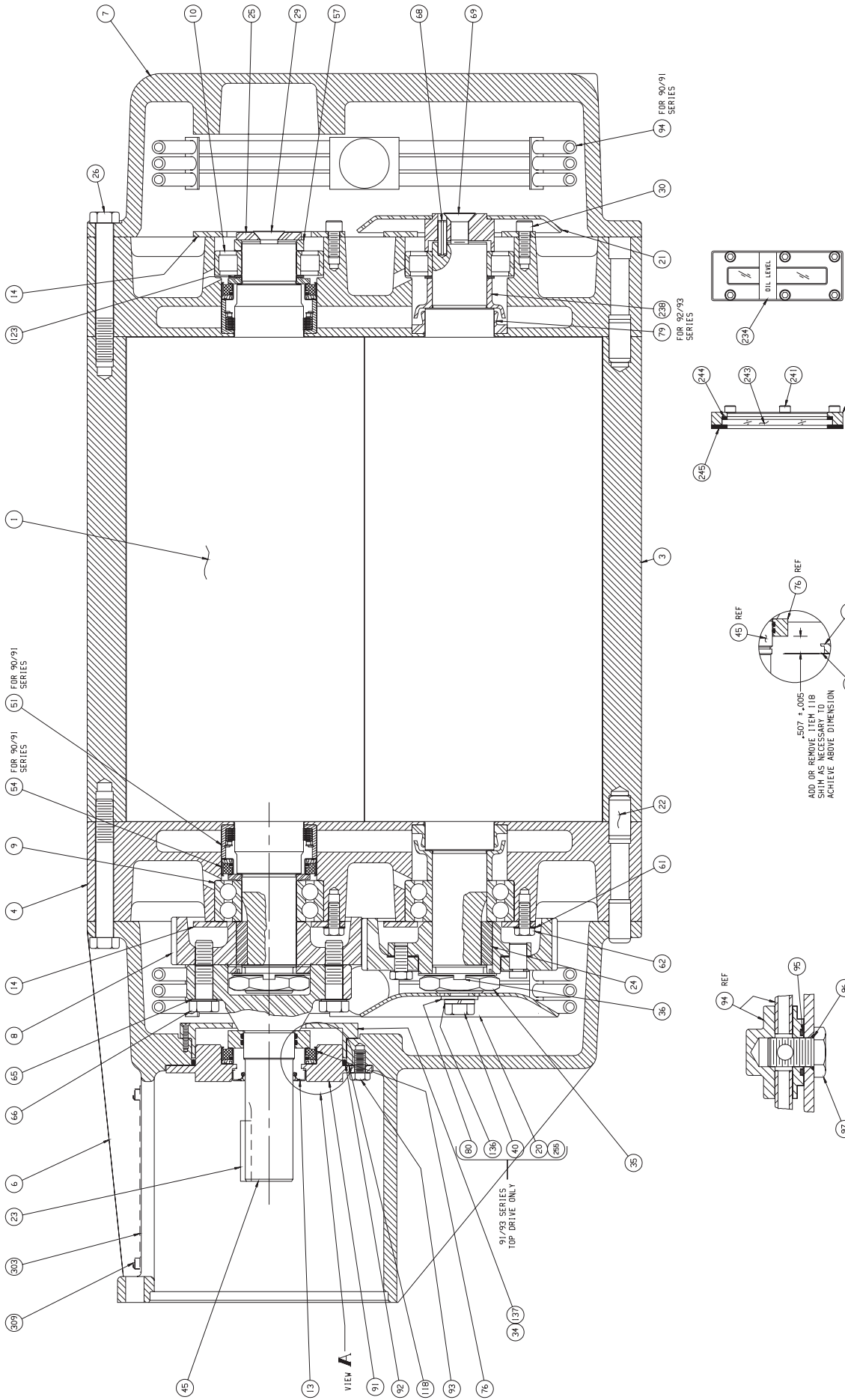
.545 ± .005
ADD OR REMOVE ITEM 118
SHIM AS NECESSARY TO
ACHIEVE ABOVE DIMENSION



COOLING COIL DETAIL
90/91 SERIES ONLY

NOTE: TO BLOWER OUTLINE
REFER FOR MOTOR MOUNTING KIT INFORMATION

5500C CUTAWAY DRAWING — 5500-90C/91C/92C/93C, 1 OF 2 (E)



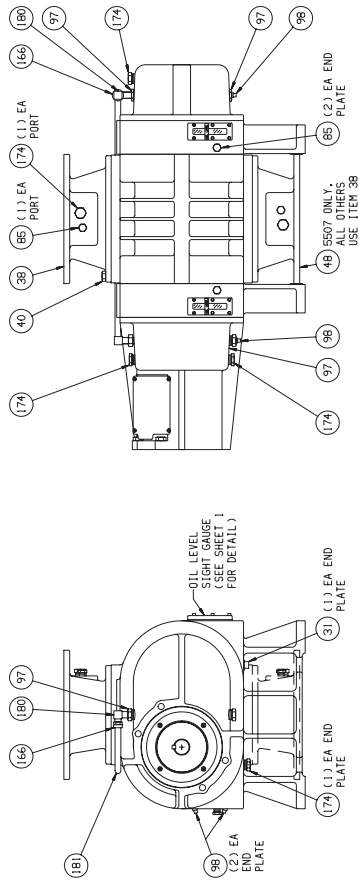
VIEW A

COOLING COIL DETAIL
90/91 SERIES ONLY

507 ±.005—
ADD OR REMOVE ITEM 118
SHIM AS NECESSARY TO
ACHIEVE ABOVE DIMENSION

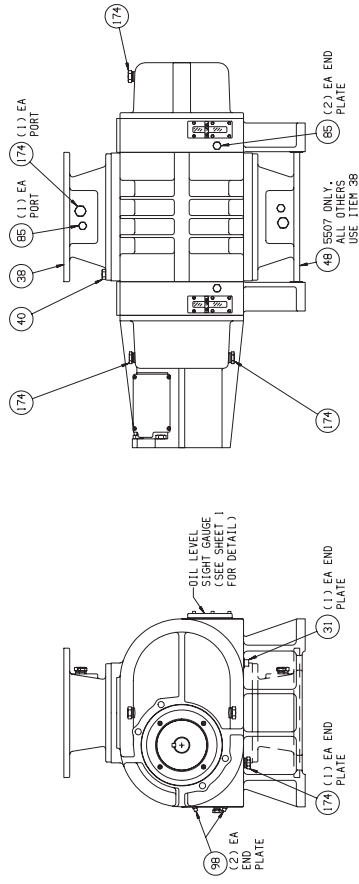
NOTE: REFER TO BLOWER OUTLINE
FOR MOTOR MOUNTING KIT INFORMATION

5500C CONFIGURATIONS DRAWINGS — 5500-90C/91C/92C/93C, 2 of 2 (E)



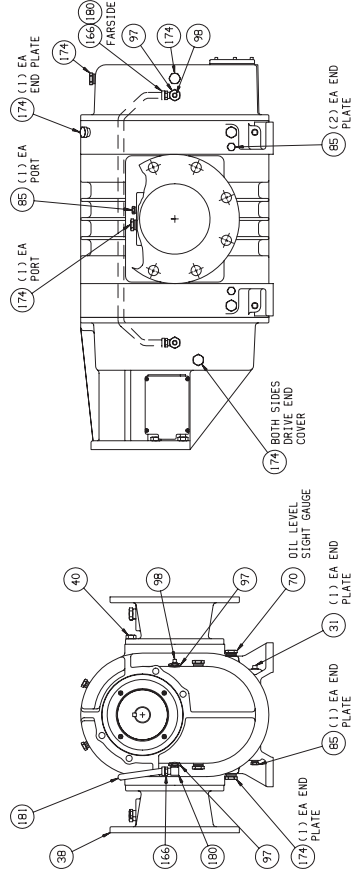
LEFT DRIVE

90 SERIES



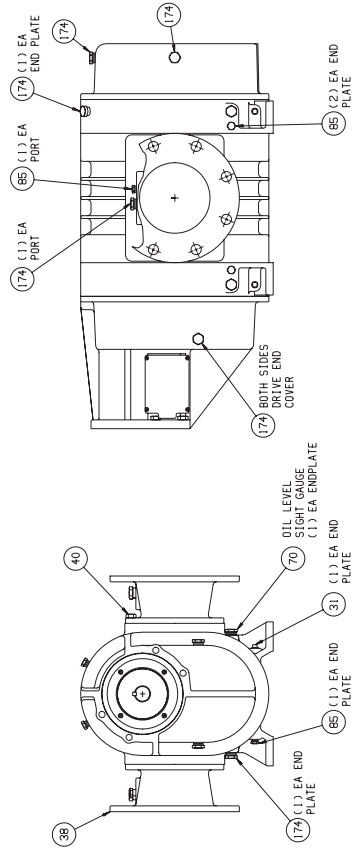
LEFT DRIVE

92 SERIES



TOP DRIVE

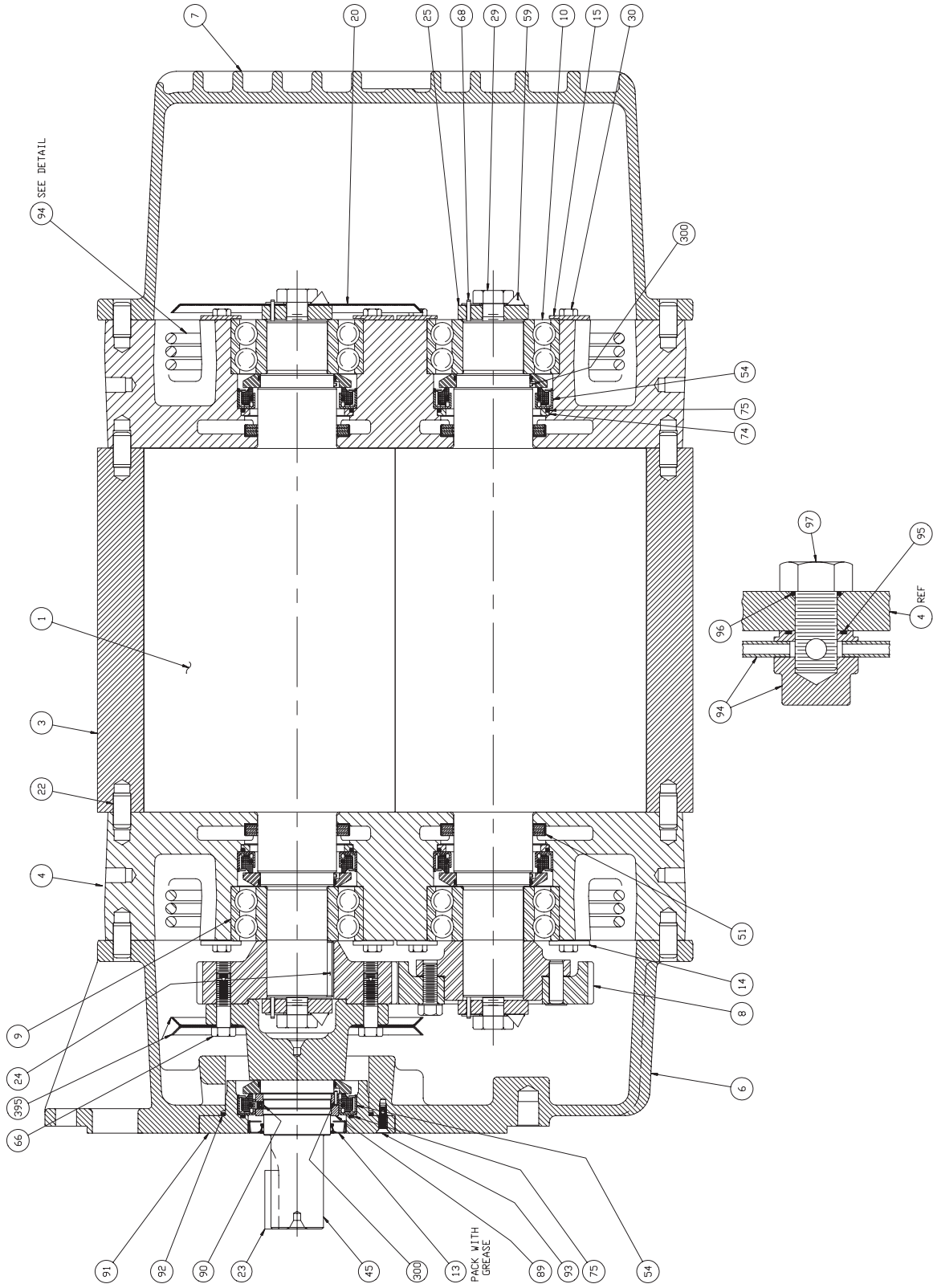
91 SERIES



TOP DRIVE

93 SERIES

7000C CUTAWAY DRAWING — 7000-90C/91C, 1 OF 3 (-)

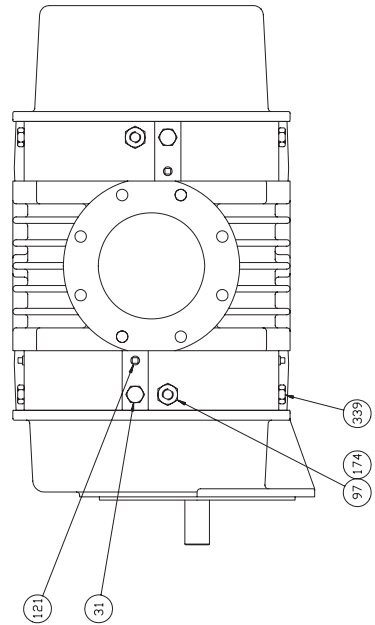
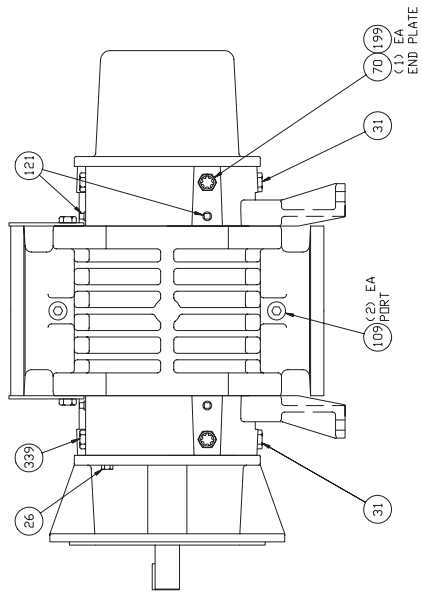
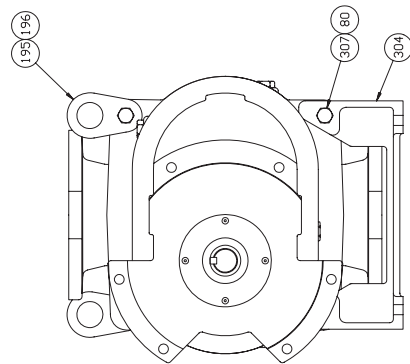
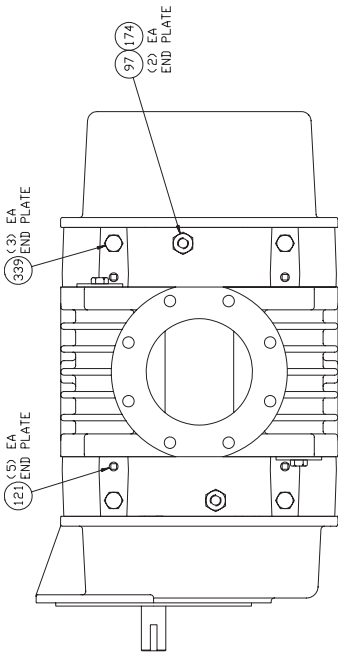


NOTE: USE SEALANT BETWEEN END COVERS, END PLATES & HOUSING

COOLING COIL DETAIL
EACH END PLATE

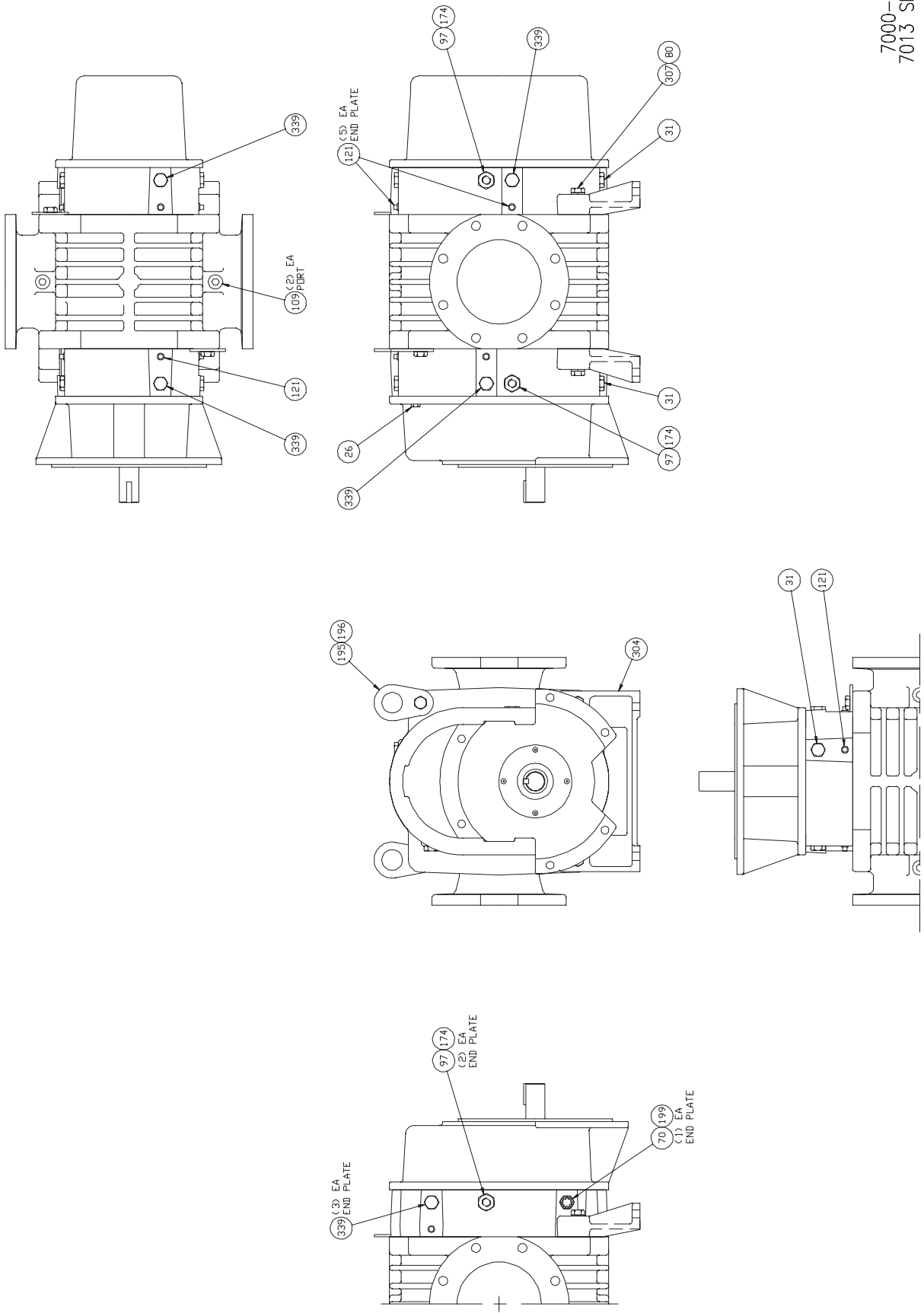
7013 MODEL SHOWN

7000C CONFIGURATIONS DRAWING — 7000-90C, 2 OF 3 (—)



7000-90C
7013 SHOWN

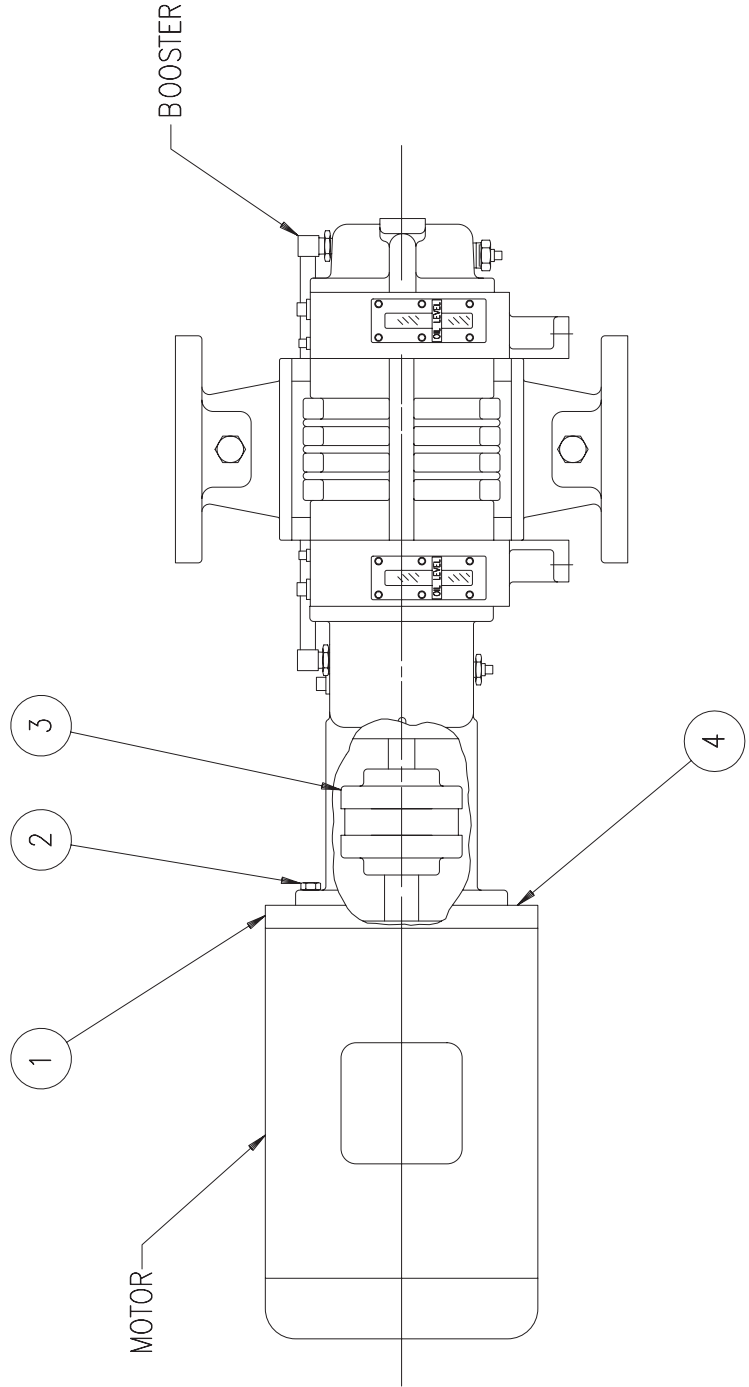
7000C CONFIGURATIONS DRAWING — 7000-91C, 3 OF 3 (—)



7000-91C
7013 SHOWN

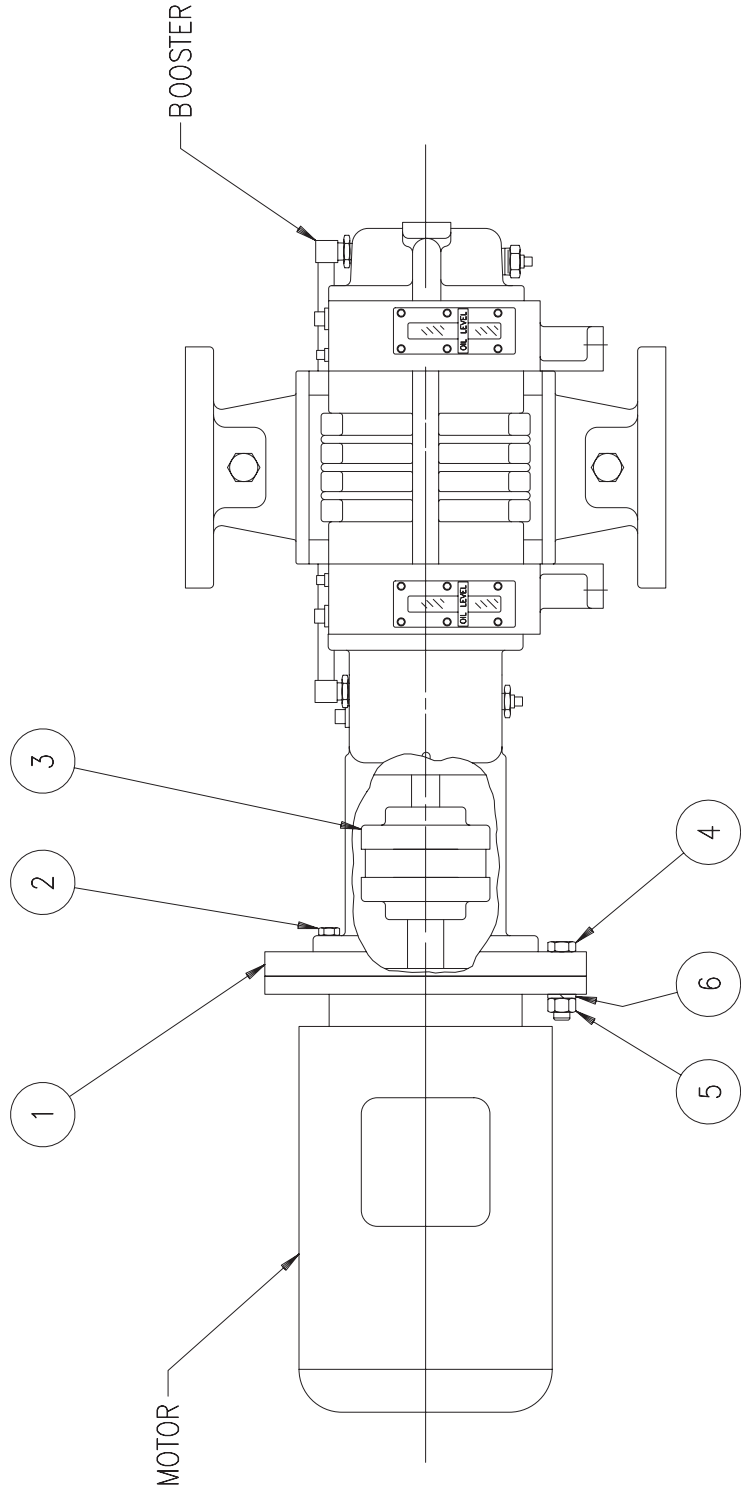
3200C – MOTOR ADAPTER KIT (NEMA) – 32172 (A)

M-D PART NO.	MOTOR FRAME	(ITEM 1) ADAPTER PART NO.	(ITEM 2) ADAPTER MTG SCREWS (QTY 4)	(ITEM 3) COUPLING PART NO.	(ITEM 4) MOTOR MTG SCREWS (QTY 4)
32172-140TC	145TC	32166-145	90032-100	—	90293-100
32172-140TCCP	145TC	32166-145	90032-100	31718-063087087	90293-100
32172-180TC	182TC & 184TC	32166-200	90032-100	—	90295-100
32172-180TCCP	182TC & 184TC	32166-200	90032-100	31718-063087112	90295-100
32172-210TC	213TC & 215TC	32166-200	90032-100	—	90295-100
32172-210TCCP	213TC & 215TC	32166-200	90032-100	31718-063087137	90295-100



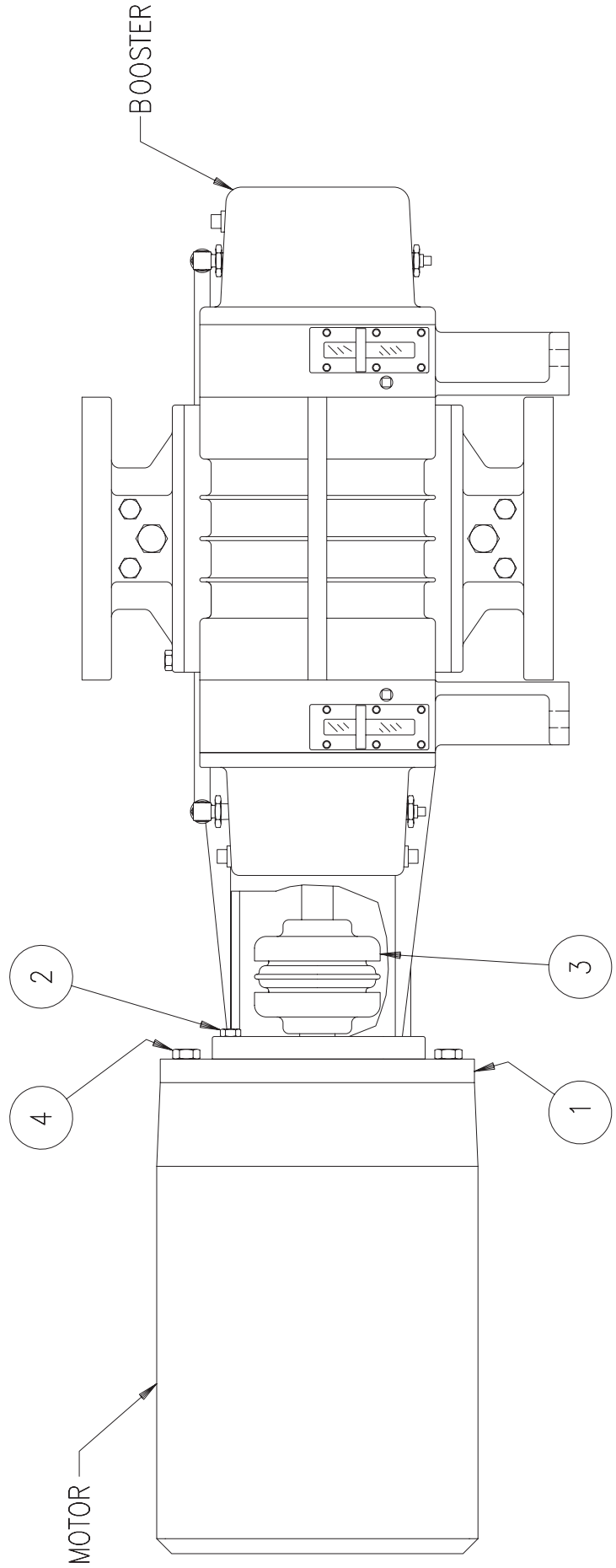
3200C – MOTOR ADAPTER KIT (IEC) – 32173 (B)

M-D PART NO.	MOTOR FRAME	(ITEM 1) ADAPTER PART NO.	(ITEM 2) ADAPTER MTG SCREWS (QTY 4)	(ITEM 3) COUPLING PART NO.	(ITEM 4) MOTOR MTG SCREWS (QTY 4)	(ITEM 5) MOTOR MTG HEX NUTS (QTY 4)	(ITEM 6) MOTOR MTG LOCKWASHER (QTY 4)
32173-90	90	32168-090	90032-100	—	92288-40	80024-10	80040-10
32173-90CP	90	32168-090	90032-100	31790-063022024	92288-40	80024-10	80040-10
32173-112	110/112	32168-112	90032-100	—	80005-45	80024-12	80040-12
32173-112CP	110/112	32168-112	90032-100	31790-063022028	80005-45	80024-12	80040-12
32173-132	132	32168-132	90032-100	—	80005-45	80024-12	80040-12
32173-132CP	132	32168-132	90032-100	31790-063022038	80005-45	80024-12	80040-12



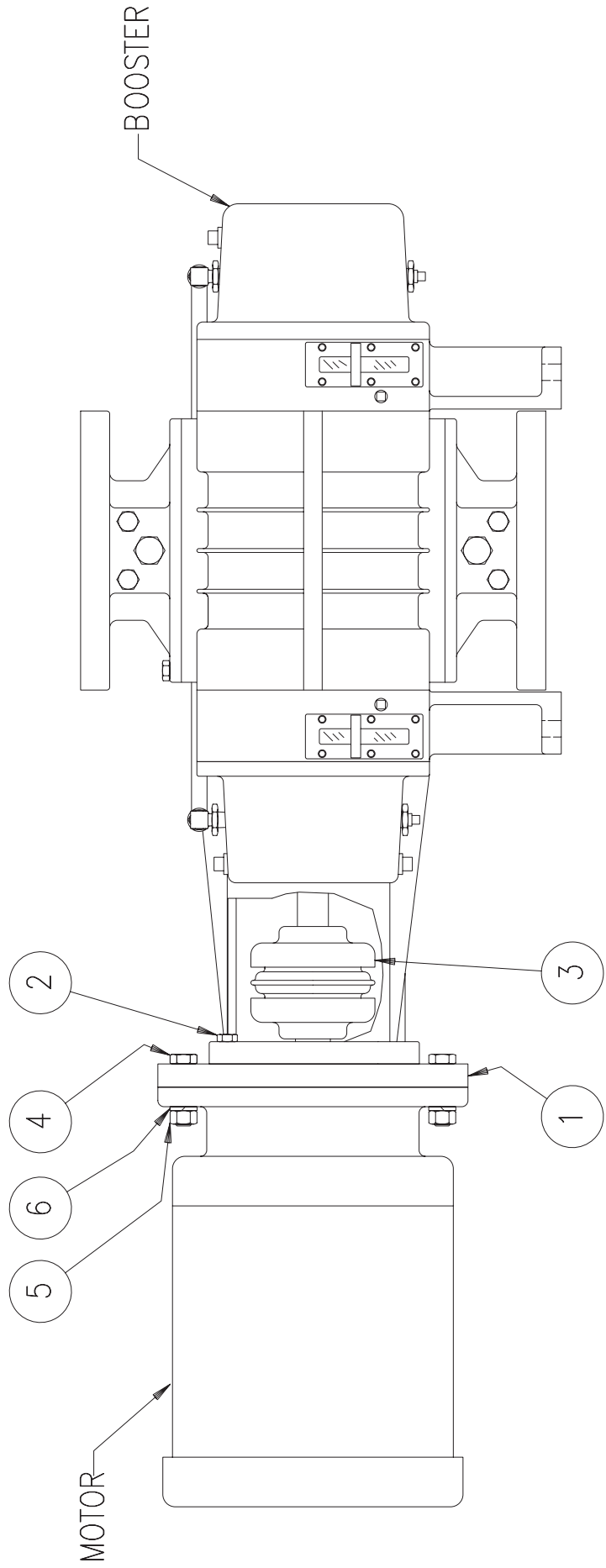
4000C – MOTOR ADAPTER KIT (NEMA) – 40111 (C)

MOTOR FRAME	KIT DASH NUMBER	(ITEM 1) ADAPTER PART NUMBER	(ITEM 2) ADAPTER MOUNTING CAP SCREWS P/N (QTY)	(ITEM 3) COUPLING P/N	(ITEM 4) MOTOR MOUNTING CAP SCREWS P/N (QTY)
184TC	-180TC	40108-200	90032-125 (4)	---	90170-100 (4)
184TC	-180TCCP	40108-200	90032-125 (4)	31718-063100112	90170-100 (4)
213TC/215TC	-210TC	40108-200	90032-125 (4)	---	90170-100 (4)
213TC/215TC	-210TCCP	40108-200	90032-125 (4)	31718-063100137	90170-100 (4)
254TC/256TC	-250TC	40108-250	90032-175 (4)	---	90170-175 (4)
254TC/256TC	-250TCCP	40108-250	90032-175 (4)	31718-063100162	90170-175 (4)



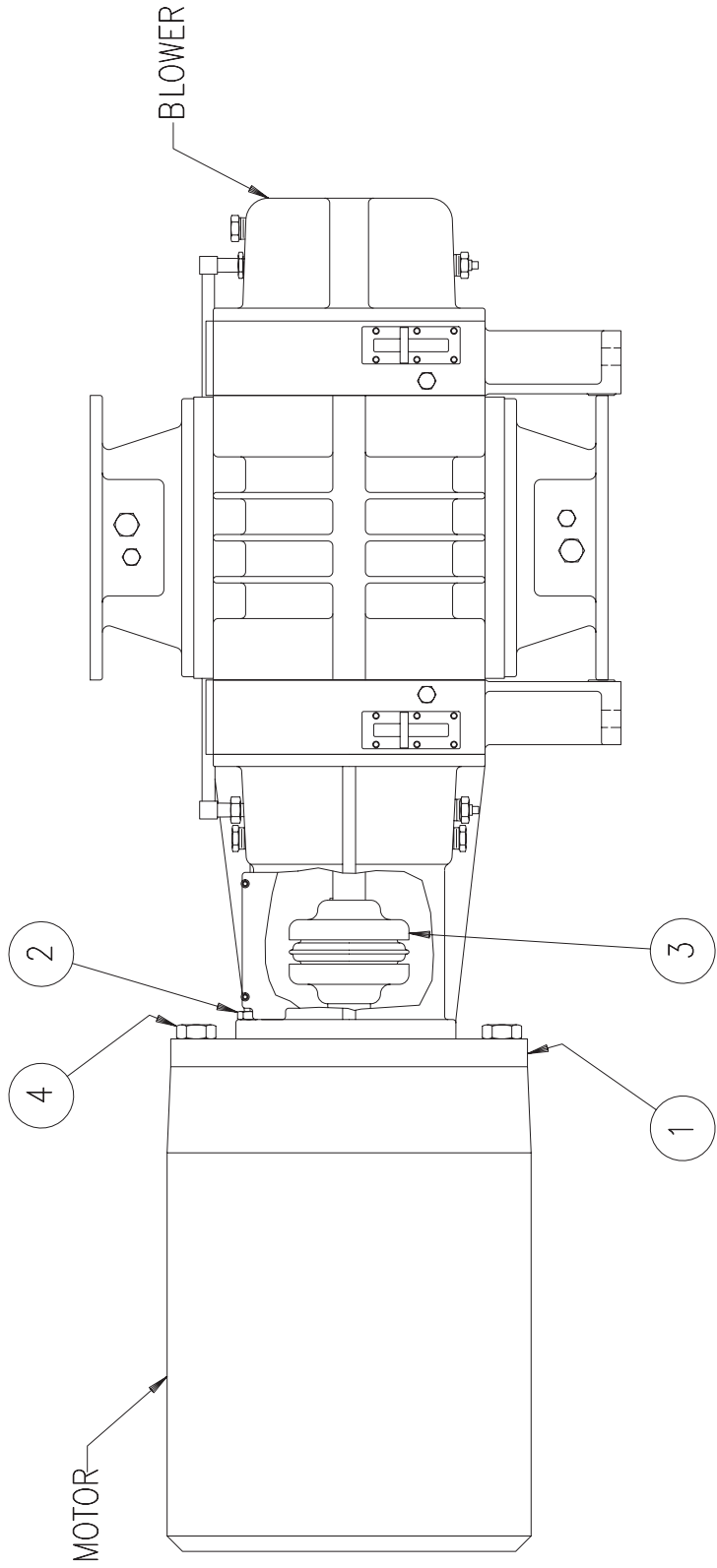
4000C – MOTOR ADAPTER KIT (IEC) – 40110 (B)

MOTOR FRAME	KIT DASH NUMBER	(ITEM 1) ADAPTER PART NUMBER	(ITEM 2)		(ITEM 3) COUPLING P/N	(ITEM 4)		(ITEM 5)		(ITEM 6)	
			ADAPTER MOUNTING CAP SCREWS P/N	QTY		MOTOR MOUNTING CAP SCREWS P/N	QTY	MOTOR MOUNTING NUTS P/N	QTY	MOTOR MOUNTING LOCKWASHER P/N	QTY
110/112	-112	40107-112	90032-100	(4)	---	80006-45	(4)	80024-14	(4)	80040-14	(4)
110/112	-112CP	40107-112	90032-100	(4)	31790-063025028	80006-45	(4)	80024-14	(4)	80040-14	(4)
132	-132	40107-132	90032-125	(4)	---	80006-45	(4)	80024-14	(4)	80040-14	(4)
132	-132CP	40107-132	90032-125	(4)	31790-063025038	80006-45	(4)	80024-14	(4)	80040-14	(4)
160	-160	40107-160	90032-125	(4)	---	80007-80	(4)	80024-16	(4)	80040-16	(4)
160	-160CP	40107-160	90032-125	(4)	31790-063025042	80007-80	(4)	80024-16	(4)	80040-16	(4)



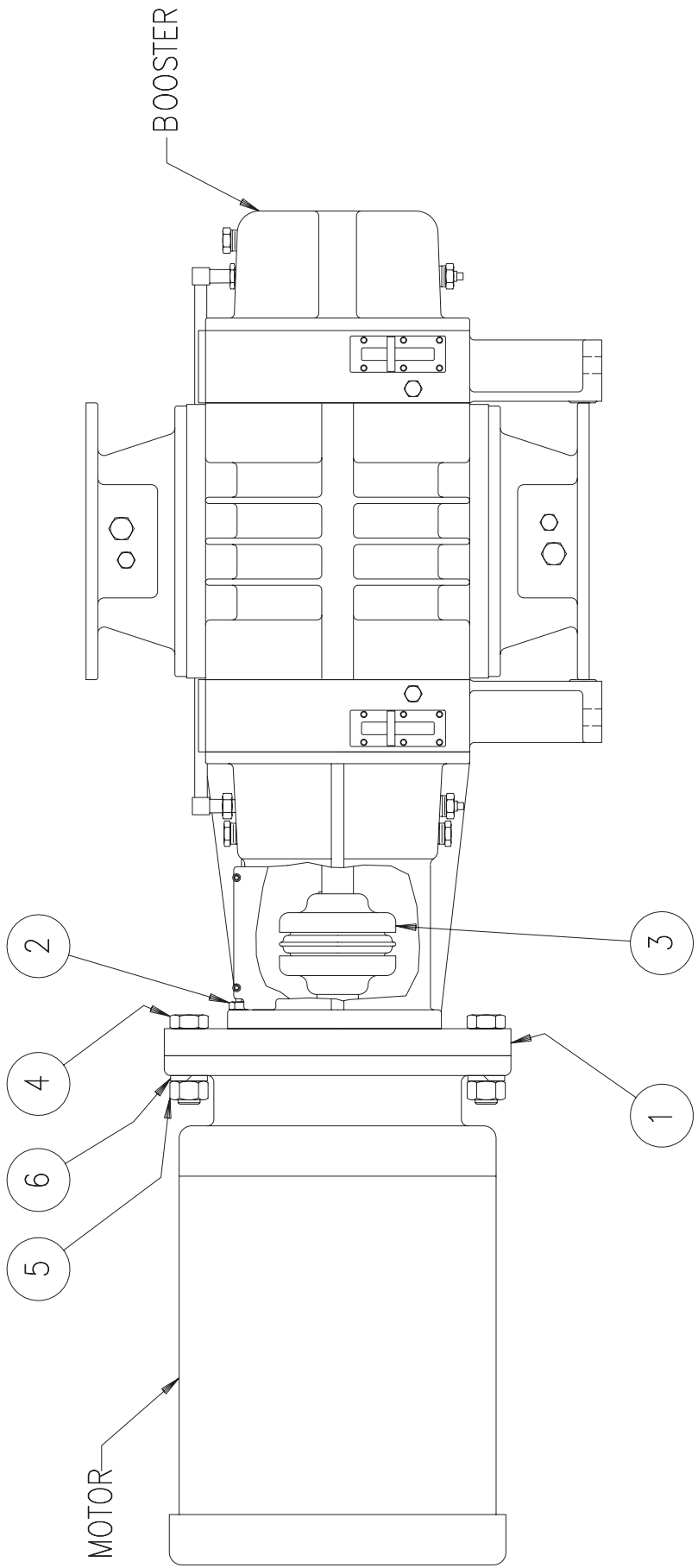
5000C – MOTOR ADAPTER KIT (NEMA) – 55228 (B)

DASH NUMBER	MOTOR FRAME	(ITEM 1) ADAPTER PART NUMBER	(ITEM 2) ADAPTER MOUNTING CAP SCREWS P/N 90170-125	(ITEM 3) COUPLING P/N	(ITEM 4) MOTOR MOUNTING CAP SCREWS P/N 90295-125
-210TC	213TC/215TC	55223-230	4	---	4
-210TCCP	213TC/215TC	55223-230	4	31718-073137137	4
-250TC	254TC/256TC	55223-230	4	---	4
-250TCCP	254TC/256TC	55223-230	4	31718-073137162	4
-280TSC	284TSC/286TSC	55223-280	4	---	4
-280TSCCP	284TSC/286TSC	55223-280	4	31718-073137162	4



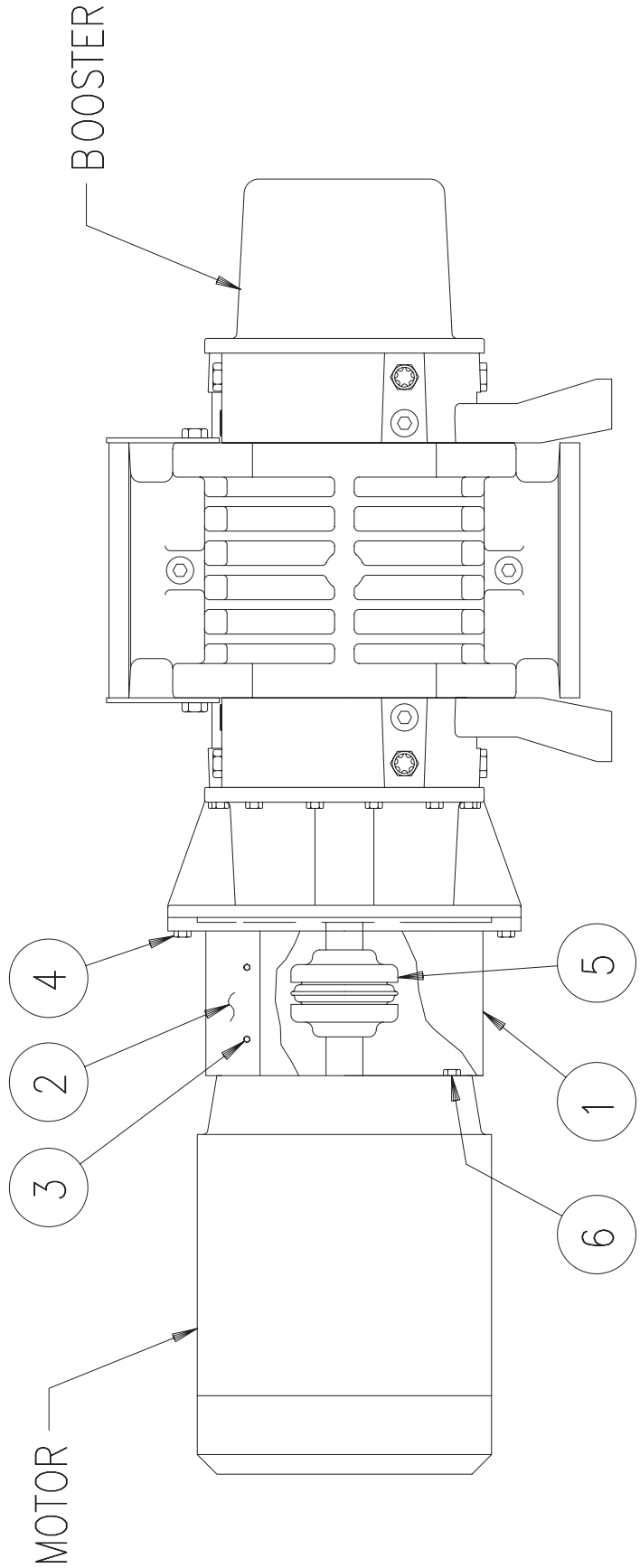
5000C – MOTOR ADAPTER KIT (IEC) – 55227 (B)

DASH NUMBER	MOTOR FRAME	(ITEM 1) ADAPTER PART NUMBER	(ITEM 2) ADAPTER MOUNTING CAP SCREWS P/N 90170-125	(ITEM 3) COUPLING P/N	(ITEM 4) MOTOR MOUNTING CAP SCREWS P/N QTY	(ITEM 5) MOTOR MOUNTING NUTS	(ITEM 6) MOTOR MOUNTING LOCKWASHER
-132	132S	55224-132	4	---	80006-70 (4)	80024-14 (4)	80040-14 (4)
-132CP	132S	55224-132	4	31790-073032038	80006-70 (4)	80024-14 (4)	80040-14 (4)
-160	160L/160M	55224-170	4	---	80007-80 (4)	80024-16 (4)	80040-16 (4)
-160CP	160L/160M	55224-170	4	31790-073032042	80007-80 (4)	80024-16 (4)	80040-16 (4)
-180	180L/180M	55224-170	4	---	80007-80 (4)	80024-16 (4)	80040-16 (4)
-180CP	180L/180M	55224-170	4	31790-073032048	80007-80 (4)	80024-16 (4)	80040-16 (4)



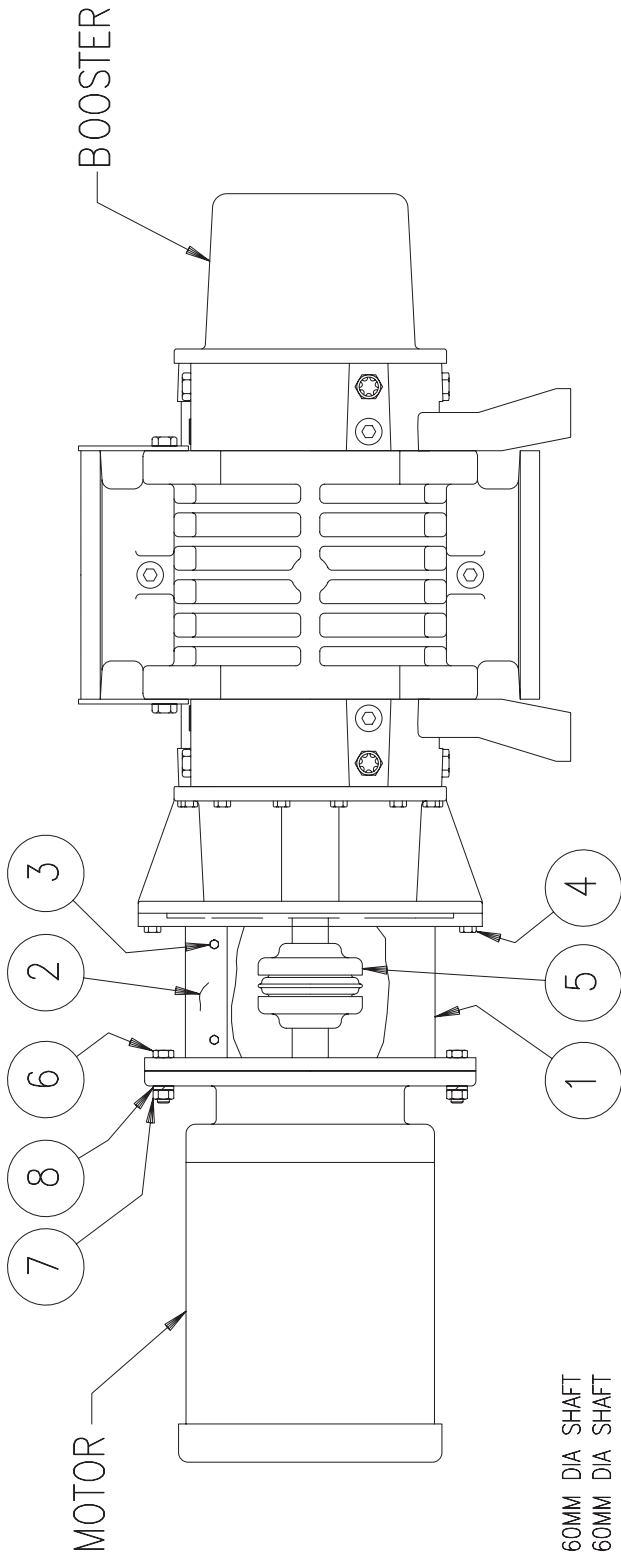
7000C – MOTOR ADAPTER KIT (NEMA) – 77131 (B)

MOTOR FRAME	KIT DASH NUMBER	(ITEM 1) ADAPTER PART NUMBER	(ITEM 2) COVER PLATE P/N	(ITEM 3) COVER PLATE CAP SCREWS P/N 90335-050	(ITEM 4) ADAPTER MTG CAP SCREWS P/N 90464-150	(ITEM 5) COUPLING P/N	(ITEM 6) MOTOR MTG CAP SCREWS P/N (QTY)
254TC/256TC	-250TC	77124-250TC	77127-250TC (2)	8	6	---	90170-125 (4)
254TC/256TC	-250TCCP	77124-250TC	77127-250TC (2)	8	6	31718-083162187	90170-125 (4)
284TC/286TC	-280TC	77124-280TC	77127-280TC (2)	8	6	---	90170-125 (4)
284TC/286TC	-280TCCP	77124-280TC	77127-280TC (2)	8	6	31718-083187187	90170-125 (4)
284TSC/286TSC	-280TSC	77124-280TSC	77127-280TSC (2)	8	6	---	90170-125 (4)
284TSC/286TSC	-280TSCCP	77124-280TSC	77127-280TSC (2)	8	6	31718-083162187	90170-125 (4)
324TSC/326TSC	-320TSC	77124-320TSC	77127-340TSC (2)	8	6	---	90785-150 (8)
324TSC/326TSC	-320TSCCP	77124-320TSC	77127-340TSC (2)	8	6	31718-083187187	90785-150 (8)
364TSC/365TSC	-360TSC	77124-360TSC	77127-340TSC (2)	8	6	---	90785-150 (8)
364TSC/365TSC	-360TSCCP	77124-360TSC	77127-340TSC (2)	8	6	31718-083187187	90785-150 (8)



7000C – MOTOR ADAPTER KIT (IEC) – 77129 (B)

MOTOR FRAME	KIT DASH NUMBER	(ITEM 1) ADAPTER PART NUMBER	(ITEM 2) COVER PLATE P/N	(ITEM 3) COVER PLATE CAP SCREWS P/N 90335-050	(ITEM 4) ADAPTER MOUNTING CAP SCREWS P/N 90464-150	(ITEM 5) COUPLING P/N	(ITEM 6) MOTOR MOUNTING CAP SCREWS P/N 80007-60	(ITEM 7) MOTOR MTG NUTS P/N 80024-16	(ITEM 8) MOTOR MOUNTING LOCKWASHER P/N 80040-16
160L/160M	-160	77122-170	77127-170 (2)	8	6	---	4	4	4
160L/160M	-160CP	77122-170	77127-170 (2)	8	6	31790-083042048	4	4	4
180L/180M	-180	77122-170	77127-170 (2)	8	6	---	4	4	4
180L/180M	-180CP	77122-170	77127-170 (2)	8	6	31790-083048048	4	4	4
200L	-200	77122-200	77127-200 (2)	8	6	---	4	4	4
200L	-200CP	77122-200	77127-200 (2)	8	6	31790-083048055	4	4	4
225M [1]	-225	77122-225	77127-225 (2)	8	6	---	8	8	8
225M [1]	-225CP	77122-225	77127-225 (2)	8	6	31790-083048060	8	8	8
225S/225M [2]	-225X	77122-225X	77127-225X (2)	8	6	---	8	8	8
225S/225M [2]	-225XCP	77122-225X	77127-225X (2)	8	6	31790-083048055	8	8	8



NOTE:
 [1] 110MM X 60MM DIA SHAFT
 [2] 140MM X 60MM DIA SHAFT

DRIVE COUPLING (U.S. CUSTOMARY) – 31718 (–)

SHAFT DIAMETER OVER THRU	KEY
.438 .562	.125 X .125
.562 .875	.188 X .188
.875 1.250	.250 X .250
1.250 1.375	.312 X .312
1.375 1.750	.375 X .375
1.750 2.250	.500 X .500
2.250 2.750	.625 X .625
2.750 3.250	.750 X .750
3.250 3.750	.875 X .875
3.750 4.500	1.000 X 1.000

COUPLING SLEEVE		
THIRD DIGIT OF DASH NO.	TYPE	CONSTRUCTION AND MATERIAL
1	E	2 PIECE EPDM
2	N	2 PIECE NEOPRENE
3	HS	2 PIECE HYTREL
4	H	1 PIECE HYTREL

WOOD'S SURE-FLEX COUPLING TYPE S

DASH NO. EQUALS COUPLING SIZE, TYPE SLEEVE
AND BORE SIZES IN INCHES & HUNDREDTHS

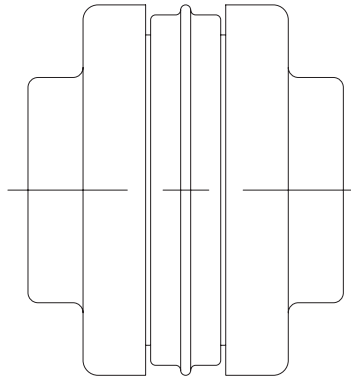
EXAMPLE:
31718-073137162

COUPLING SIZE ———

COUPLING SLEEVE
(SEE TABLE) ———

LARGER (OR EQUAL)
BORE SIZE
162=1.625 ∅ BORE
*SEE NOTE

SMALLER (OR EQUAL)
BORE SIZE
137=1.375 ∅ BORE
*SEE NOTE



*NOTE:
BORE SIZES HAVE STANDARD
SQUARE KEYWAYS. SEE CHART

DRIVE COUPLING (METRIC) – 31790 (–)

SHAFT DIAMETER OVER THRU	KEY
12 17	5 X 5
17 22	6 X 6
22 30	8 X 7
30 38	10 X 8
38 44	12 X 8
44 50	14 X 9
50 58	16 X 10
58 65	18 X 11
65 75	20 X 12
75 85	22 X 14
85 95	25 X 14
95 110	28 X 16

COUPLING SLEEVE		
THIRD DIGIT OF DASH NO.	TYPE	CONSTRUCTION AND MATERIAL
1	E	2 PIECE EPDM
2	N	2 PIECE NEOPRENE
3	HS	2 PIECE HYTREL
4	H	1 PIECE HYTREL

WOOD'S SURE-FLEX COUPLING TYPE S

DASH NO. EQUALS COUPLING SIZE, TYPE SLEEVE
AND BORE SIZES IN MILLIMETERS

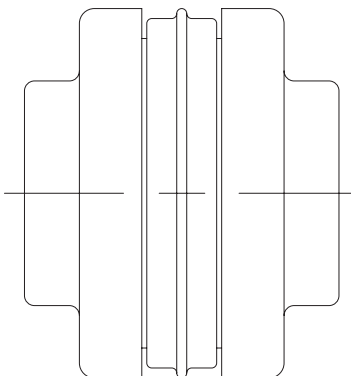
EXAMPLE:
31790-063028038

COUPLING SIZE ———

COUPLING SLEEVE
(SEE TABLE) ———

LARGER (OR EQUAL)
BORE SIZE
038=38MM ∅ BORE
*SEE NOTE

SMALLER (OR EQUAL)
BORE SIZE
028=28 MM ∅ BORE
*SEE NOTE



*NOTE:
BORE SIZES HAVE STANDARD
METRIC SQUARE OR RECTANGULAR
KEYWAYS. SEE CHART



DECLARATION OF INCORPORATION

Herewith we declare that the items detailed below are in conformity with the provisions of the Machinery Directive 2006/42/EC.

Information on the items detailed are compiled per the Machinery Directive 2006/42/EC, Annex VII, part A and are the responsibility of the person listed below.

The items detailed below must not be put into service until the machinery into which it is to be incorporated has been declared in conformity with the provisions of the relevant directive(s).

Other directives and standards that apply to this Declaration of Incorporation:

EN 1012-2:1996 - Compressors and vacuum pumps - Safety requirements -
Part 2: Vacuum Pumps

The scope of the Declaration of Incorporation is for M-D Pneumatics™ C-Flange
Mechanical Vacuum Boosters

MODEL 3200(M)C, 4000(M)C, 5500(M)C AND 7000(M)C

90/92 SERIES – VERTICAL FLOW

91/93 SERIES – HORIZONTAL FLOW

The person authorized to compile the technical file is Xavier Lambert, Tuthill Corporation,
Parc Industriel Wavre Nord-Avenue Vesale 30, B-1300 Wavre Belgium.

David Schardt
VP of Engineering & Product Development



Tuthill Vacuum & Blower Systems
4840 West Kearney Street
P.O. Box 2877
Springfield, MO USA 65801-0877

WARRANTY – BLOWER PRODUCTS

Subject to the terms and conditions hereinafter set forth and set forth in General Terms of Sale, Tuthill Vacuum & Blower Systems (the Seller) warrants products and parts of its manufacture, when shipped, and its work (including installation and start-up) when performed, will be of good quality and will be free from defects in material and workmanship. This warranty applies only to Seller's equipment, under use and service in accordance with seller's written instructions, recommendations and ratings for installation, operating, maintenance and service of products, for a period as stated in the table below. Because of varying conditions of installation and operation, all guarantees of performance are subject to plus or minus 5% variation. (Non-standard materials are subject to a plus or minus 10% variation)

PRODUCT TYPE	TYPE OF APPLICATION	
	ATMOSPHERIC AIR OR PROCESS AIR WITHOUT LIQUIDS PRESENT	PROCESS GASES OTHER THAN AIR, OR ANY LIQUID INJECTED APPLICATION
New <i>(Qx™ models only)</i>	30 months from date of shipment, or 24 months after initial startup date, whichever occurs first.	Consult Factory
New <i>(all other models)</i>	24 months from date of shipment, or 18 months after initial startup date, whichever occurs first	18 months from date of shipment, or 12 months after initial startup date, whichever occurs first
Repair	12 months from date of shipment, or remaining warranty period, whichever is greater	12 months from date of shipment, or remaining warranty period, whichever is greater

THIS WARRANTY EXTENDS ONLY TO BUYER AND/OR ORIGINAL END USER, AND IN NO EVENT SHALL THE SELLER BE LIABLE FOR PROPERTY DAMAGE SUSTAINED BY A PERSON DESIGNATED BY THE LAW OF ANY JURISDICTION AS A THIRD PARTY BENEFICIARY OF THIS WARRANTY OR ANY OTHER WARRANTY HELD TO SURVIVE SELLER'S DISCLAIMER.

All accessories furnished by Seller but manufactured by others bear only that manufacturer's standard warranty.

All claims for defective products, parts, or work under this warranty must be made in writing immediately upon discovery and, in any event within one (1) year from date of shipment of the applicable item and all claims for defective work must be made in writing immediately upon discovery and in any event within one (1) year from date of completion thereof by Seller. Unless done with prior written consent of Seller, any repairs, alterations or disassembly of Seller's equipment shall void warranty. Installation and transportation costs are not included and defective items must be held for Seller's inspection and returned to Seller's Ex-works point upon request.

THERE ARE NO WARRANTIES, EXPRESSED, IMPLIED OR STATUTORY WHICH EXTEND BEYOND THE DESCRIPTION ON THE FACE HEREOF, INCLUDING WITHOUT LIMITATION, THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS OF PURPOSE.

After Buyer's submission of a claim as provided above and its approval, Seller shall at its option either repair or replace its product, part, or work at the original Ex-works point of shipment, or refund an equitable portion of the purchase price.

The products and parts sold hereunder are not warranted for operation with erosive or corrosive material or those which may lead to build up of material within the product supplied, nor those which are incompatible with the materials of construction. The Buyer shall have no claim whatsoever and no product or part shall be deemed to be defective by reason of failure to resist erosive or corrosive action nor for problems resulting from build-up of material within the unit nor for problems due to incompatibility with the materials of construction.

Any improper use, operation beyond capacity, substitution of parts not approved by Seller, or any alteration or repair by others in such manner as in Seller's judgment affects the product materially and adversely shall void this warranty.

No employee or representative of Seller other than an Officer of the Company is authorized to change this warranty in any way or grant any other warranty. Any such change by an Officer of the Company must be in writing.

The foregoing is Seller's only obligation and Buyer's only remedy for breach of warranty, and except for gross negligence, willful misconduct and remedies permitted under the General Terms of Sale in the sections on CONTRACT PERFORMANCE, INSPECTION AND ACCEPTANCE and the PATENTS Clause hereof, the foregoing is BUYER'S ONLY REMEDY HEREUNDER BY WAY OF BREACH OF CONTRACT, TORT OR OTHERWISE, WITHOUT REGARD TO WHETHER ANY DEFECT WAS DISCOVERED OR LATENT AT THE TIME OF DELIVERY OF THE PRODUCT OR WORK. In no event shall Buyer be entitled to incidental or consequential damages. Any action for breach of this agreement must commence within one (1) year after the cause of action has occurred.

OPERATING DATA FORM / PRODUCT REGISTRATION

It is to the user's advantage to have the requested data filled in below and available in the event a problem should develop in the blower or the system. This information is also helpful when ordering spare parts.

Model No.	_____	V-Belt Size	_____	Length	_____
Serial No.	_____	Type of Lubrication	_____		
Startup Date	_____	_____			
Pump RPM	_____	Operating Vacuum	_____		
Pump Sheave Diameter	_____	Any other Special Accessories Supplied or in use:			
Motor Sheave Diameter	_____	_____			
Motor RPM	_____	HP	_____	_____	

NOTES:

IMPORTANT

All blowers manufactured by Tuthill Vacuum & Blower Systems are date coded at time of shipment. In order to assure you of the full benefits of the product warranty, please complete, tear out and return the product registration card, or register online at tuthillvacuumblower.com.



**For Service & Repair, Technical Support,
or Product Sales contact:**

Tuthill Vacuum & Blower Systems

4840 West Kearney Street
Springfield, Missouri USA 65803-8702
O 417.865.8715 800.825.6937 F 417.865.2950
tuthillvacuumblower.com



Manual 2000 0811 ENG