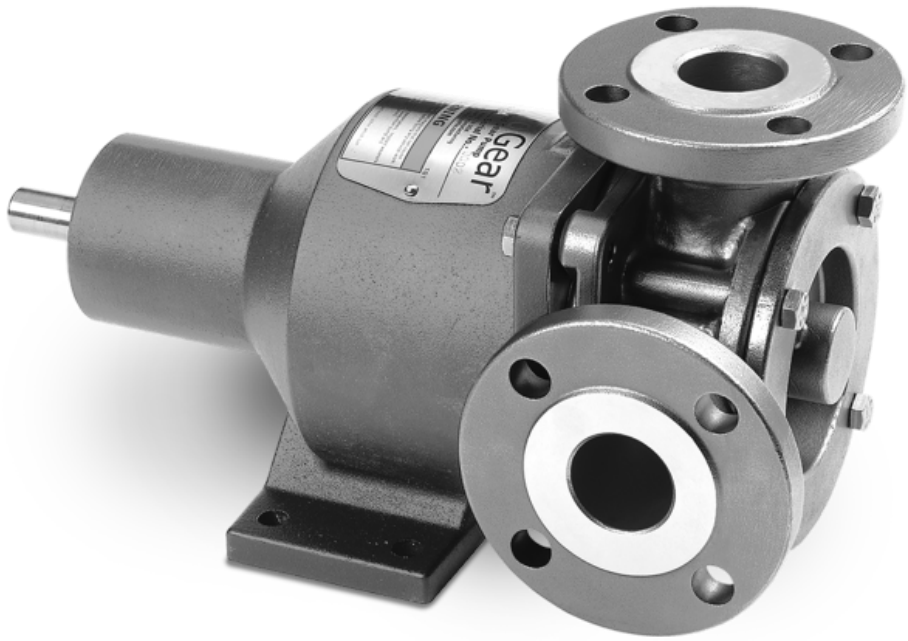
E Series
Seal-less Internal Gear Pumps



PSG a DOVER company

Where Innovation Flows

Blackmer®

Always read the most current version of this manual before performing any work on or around this pump. The most current version of this manual is freely available on the web at www.blackmer.com

Blackmer pumps are specifically configured for your unique application conditions. Those application conditions and the details of the pump configuration were documented during the ordering process. Keep that information available in a safe place, as it may be needed when troubleshooting pump problems or when ordering spare parts or repairs.

Blackmer Gear Pumps are covered by one or more of the following patents: U.S. Patent Nos. 7549205, 7137793, 7183683, 8,608,465B2 Australian Patent No. AU2005233534B2; Korean Patent No. 10-2006-7023162; Mexican Patent No. PA/2006/011436, Russian Patent No. 2006138540(041952); China Patent No. ZL 201280031563.6; and other patents pending.

About EnviroGear®

The information contained in this manual applies to both Blackmer® and EnviroGear E Series Internal Gear Pump models. For more information visit the psgdover.com/blackmer website.

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Cautions—Read First!

WARNING: In any positive-displacement pump system, a reliable pressure-protection device must be used in the discharge piping to avoid a dangerous pressure increase, which could cause the pump or any component in the discharge piping to burst and can lead to serious injury. A pump-mounted integral relief valve is not intended to be used in this manner.

WARNING: This pump contains powerful permanent magnets that can cause serious injury. Read the appropriate section of this IOM before doing any service work.

WARNING: Magnetic field can disrupt medical implants such as pacemakers. Implant wearers should remain a minimum of 0.3 m (1 ft) away from pump and 1 m (3 ft) away from disassembled magnets.

WARNING: Magnets inside the pump can damage electronic equipment or magnetic media.

WARNING: This pump is designed to rotate only in the direction indicated. Do not run the pump in the opposite direction for long periods because internal passageways that control axial thrust will not work correctly, causing premature wear and reduced pumping efficiency.

WARNING: The inner magnets on the back of the rotor assembly are strongly attracted to the outer magnets in the outer-drive assembly. During the separation process, there will be a strong force of up to 136 kg (300 lbs) trying to pull them back together, which can create a powerful pinch point.
To safely separate the rotor assembly from the outer-drive assembly, follow the instructions below and use the following equipment:

- Crane, hoist or other suitable lifting device capable of lifting at least 182 kg (400 lbs)
- Sturdy workbench that is positioned beneath the lifting device and is firmly anchored to the floor, or if unanchored, the workbench must weigh at least 182 kg (400 lbs), and be strong enough to resist a lifting force of up to 182 kg (400 lbs)
- Pump Disassembly Tool F-00096 or F-00097

WARNING: Failure to have each magnet segment in opposite polarity with adjacent magnets will cause a significant reduction of coupling torque.

WARNING: During operation the pump surface temperature can exceed 140° F (60°C). Allow for proper cooling before any handling.

WARNING: Maximum temperature limits are based upon mechanical stress only. Certain chemicals will significantly reduce maximum safe operating temperatures. Consult Chemical Resistance Guide for chemical compatibility and temperature limits.

WARNING: Prevent static sparking. If static sparking occurs, fire or explosion could result. Pump, valves and containers must be grounded to a proper grounding point when handling flammable fluids and whenever discharge of static electricity is a hazard.

WARNING: For applications requiring CE or Atex, refer to the E Series Safety Supplement for addition cautions and warnings.

CAUTION: Only personnel who are familiar with the operation and repair of mechanical products should perform the necessary maintenance. You must familiarize yourself with the entire contents of this manual prior to operating and/or performing any maintenance.

CAUTION: When selecting a E Series pump for an application, you must first ensure that the pump components are compatible with the process media.

CAUTION: Do not operate this pump in excess of its rated capacity, pressure, speed and temperature.

CAUTION: Before any maintenance and repair is attempted, disconnect the drive.

CAUTION: Before any maintenance or repair is attempted, bleed all pressure from the pump through the suction or discharge lines.

CAUTION: Do not remove any pressure-containing components during pump operation.

CAUTION: All E Series pumps contain residual hydraulic oil from the factory production test. Hypar-FG 15 food-grade oil is the standard production test fluid, but any certified performance testing may be done on a non-food grade oil, such as Unilube 32 (ISO 32) or Unilube 100 (ISO 100). Determine if this is compatible with the fluid you are pumping. If the fluid is incompatible, then the pump must be fully flushed prior to use.

CAUTION: When pumping fluids at elevated temperatures, care should be taken to gradually increase temperature. Rapid temperature increase can damage internal components.

CAUTION: Ensure that the pump has cooled to a safe temperature before any maintenance or repair is attemped.

CAUTION: When pumping fluids at elevated temperatures the piping may expand, resulting in excessive stress on the pump. This can cause pump failure. Care must be taken when considering pipe design to avoid damage from thermal expansion.

CAUTION: All inlet and discharge plumbing should be clean and free from foreign material prior to startup of pump.

CAUTION: When connecting to an electric motor, follow all safety recommendations provided by the motor manufacturer.

CAUTION: Never remove safety guards from shafts, couplings, V-belts or pulleys during operation. Doing so could result in injury.

CAUTION: Do not wear loose or dangling clothing or jewelry near the equipment. These items could become caught in the equipment and cause injury.

CAUTION: Before any maintenance or repair is attemped, ensure that the pump has been thoroughly flushed of any hazardous fluids. Review the Material Safety Data Sheet (MSDS) applicable to the fluid for proper handling.

Pump Designation System

EXAMPLE:

E1-32SSE/3ART/TC6H/10/S/000

E1.	MODEL	EXTERNAL MATERIAL	INTERNAL MATERIAL	CLEARANCE	/	PORTS	ORIENTATION	/	O-RINGS	BUSHINGS	MAGNETS	/	RELIEF VALVE	/	SHAFT	/	SPECIALTY CODE
	2	C	C	A		1.5A	RT		V	B	6L		N		S		000
	4	D	D	B		1.5B	LT		T	C	6M		05		V		
	24	S	S	C		1.5D	TR		S	H	6H		07		14		
	32	W	W	D		1.5N	TL		K6	R	7L		08		18		
	55			E		2A	RL		K7	T	7M		10		21		
	69			F		2B	LR			I	7H		12		25		
	82					2D	LB						13				
	133					2N	BR						15				
	222					3A	BL						17				
						3D	RB						20				
						4A											

MATERIAL CODES

MODELS

E1-2 =2 in³/rev
E1-4 =4 in³/rev
E1-24 =24 in³/rev
E1-32 =32 in³/rev
E1-55 =55 in³/rev
E1-69 =69 in³/rev
E1-82 =82 in³/rev
E1-133=133 in³/rev
E1-222=222 in³/rev

MATERIALS

C = CARBON STEEL
D = DUCTILE IRON
S = STAINLESS STEEL
W = CAST IRON

CLEARANCES (E12/4/24/32/55/69/82/133/222)

A = A [<100 cSt, (<149C) <300F]
B = B [100-5000 cSt, (<149C) <300F]
C = C [>5000 cSt, (<149C) <300F]
D = D [<100 cSt, (>149C) >300F]
E = E [100-5000 cSt, (>149C) >300F]
F = F [>5000 cSt,(>149C) >300F]

PORTS

1.5A = 1.5" ANSI
1.5B = 1.5" BSPT
1.5D = DN40 (1.5") PN16
1.5N = 1.5" NPT
2A = 2" ANSI
2B = 2" BSPT
2D = DN50 (2") PN16
2N = 2" NPT
3A = 3" ANSI
3D = DN80 (3") PN16
4A = 4" ANSI
6A = 6" ANSI

ORIENTATION

RT = Right suction, Top discharge
LT = Left suction, Top discharge
TR = Top suction, Right discharge
TL = Top suction, Left discharge
RL = Right suction, Left discharge
LR = Left suction, Right discharge
LB = Left suction, Bottom discharge
BR = Bottom suction, Right discharge
BL = Bottom suction, Left discharge
RB = Right suction, Bottom discharge

O-RINGS

V = FKM, Type "A"
T = FEP-encapsulated FKM
S = PFA-encapsulated silicone
K6 = FFKM 6375
K7 = FFKM 7075

BUSHINGS

B =Bronze bushings, Standard Spindle
C =Carbon-graphite bushings, Standard Spindle
H =Carbon-graphite bushings, Hardened 17-4PH Spindle
R =Resin Impregnated Carbon-graphite bushings, Standard Spindle
T =Tungsten carbide bushings, Hardened Spindle
I =Hardened cast iron bushings, Hardened Spindle

MAGNETS

6L = M6L standard-strength / standard-temp. [(<135C) <275 F]
6M = M6M standard-strength / medium-temp. [(<190C) <375F]
6H = M6H standard-strength / high-temp. [(<260C) <500F]
7L = M7L high-strength / standard-temp. [(<135C) <275 F]
7M = M7M high-strength / medium-temp. [(<190C) <375F]
7H = M7H high-strength / high-temp. [(<260C <500F)]

RELIEF VALVE (E1-2/4/24/32/55/69/82)

N = NO RELIEF VALVE
05 = Cracks at 50 +/-10 psi delta P
07 = Cracks at 75 +/-10 psi delta P
10 = Cracks at 100 +/-10 psi delta P
12 = Cracks at 125 +/-10 psi delta P
15 = Cracks at 150 +/-10 psi delta P
17 = Cracks at 175 +/-10 psi delta P
20 = Cracks at 200 +/-10 psi delta P

RELIEF VALVE (E1-133/222): CAST IRON/CARBON STEEL

N = NO RELIEF VALVE
05 = Full bypass at 20 to 50 psi
08 = Full bypass at 51 to 80 psi
13 = Full bypass at 81 to 130 psi
20 = Full bypass at 131 to 200 psi

RELIEF VALVE (E1-133/222): STAINLESS STEEL

N = NO RELIEF VALVE
05 = Full bypass at 20 to 50 psi
08 = Full bypass at 51 to 80 psi
15 = Full bypass at 81 to 150 psi

SHAFT

S = Standard shaft (no optional shaft selected)
V = Smaller shaft (matches mtg dims of Viking L/LQ/LL)
14 = Close Coupled 143/5TC NEMA
18 = Close Coupled 182/4TC NEMA
21 = Close Coupled 213/5TC NEMA
25 = Close Coupled 254/6TC NEMA

SPECIALTY CODE

Contact Factory

EXAMPLE:

E1-32SSE/3ART/TC6H/10/S/000_CXXXX_BSDCSXXX_GYYYYRZZ_MXXXZHPYYYY_ZZZV XXHz_AAA/B/WEG

	CERT					BASEPLATE																
_C	CERTIFIED HYDRO TEST	MATERIAL CERT	PMI CERT	PERFORMANCE TESTS	_	BASEPLATE SELECTED	BASEPLATE LENGTH REF	_	GEAR REDUCER AND RATIO	GEARBOX FRAME REF	_	MOTOR FRAME SIZE	MOTOR HP	MOTOR SPEED (RPM)	_	MOTOR VOLTAGE	MOTOR FREQ. (HZ)	_	MOTOR ENCLOSURE RATING	/	INVERTER DUTY	/	MOTOR MFG CODE
	X	X	X	X		BSDCS	XXX		GYYYY	RZZ		MXXX	ZHP	YYYY		ZZZ	XX		BLANK		Y		XXX
	N	A	N	P															EXP		N		
	W	B		N															TEFC		BLANK		
		C		W																			
		D																					

CERT CODES

C = DENOTES CERTIFICATION(S) SELECTED

CERTIFIED HYDRO TEST (WITNESS / NON-WITNESS)

X = Not Required
N = Certified Hydrostat Non-Witness
W = Certified Hydrostat Witness

MATERIAL CERTIFICATION (NOT REQUIRED / 3.1 MAT'L CERTS FOR WETTED COMPONENTS)

X = Not Required
A = 3.1 Material Certs for Wetted Components
B = 3.1 Material Certs (Pressure Containing) w/Photo – MCM
C = 2.2 Material Report (Pressure Containing) - MR
D = 2.2 Material Report (Pressure Containing) w/Photo - MPT

PMI CERTIFICATION (NOT REQUIRED / WETTED COMPONENTS NON-WITNESS / WETTED COMPONENTS WITNESS)

X = Not Required
N = Non-Witness

PERFORMANCE TESTS

X = Not Required
P = Production Test Report (PTR)
N = Certified Performance Test (Non-Witness)
W = Certified Performance Test (Witness)

BASEPLATE CODES

BSDCS = DESIGNATES BASEPLATE SELECTED
XXX = BASEPLATE LENGTH REFERENCE
GYYYY = GEAR REDUCER SELECTED AND RATIO
RZZ = GEARBOX FRAME REFERENCE
MXXX = MOTOR FRAME SIZE
ZHP = MOTOR HORSEPOWER

YYYY_ZZZVXXHZ

YYYY = Motor Speed in RPM
ZZZ = Motor Voltage
XX = Motor frequency in Hz

MOTOR ENCLOSURE RATING

Blank = no rating
EXP = Explosion Proof
TEFC = Totally Enclosed Fan Cooled

B – INVERTER DUTY

Y = Yes
N = No
Blank = Not specified

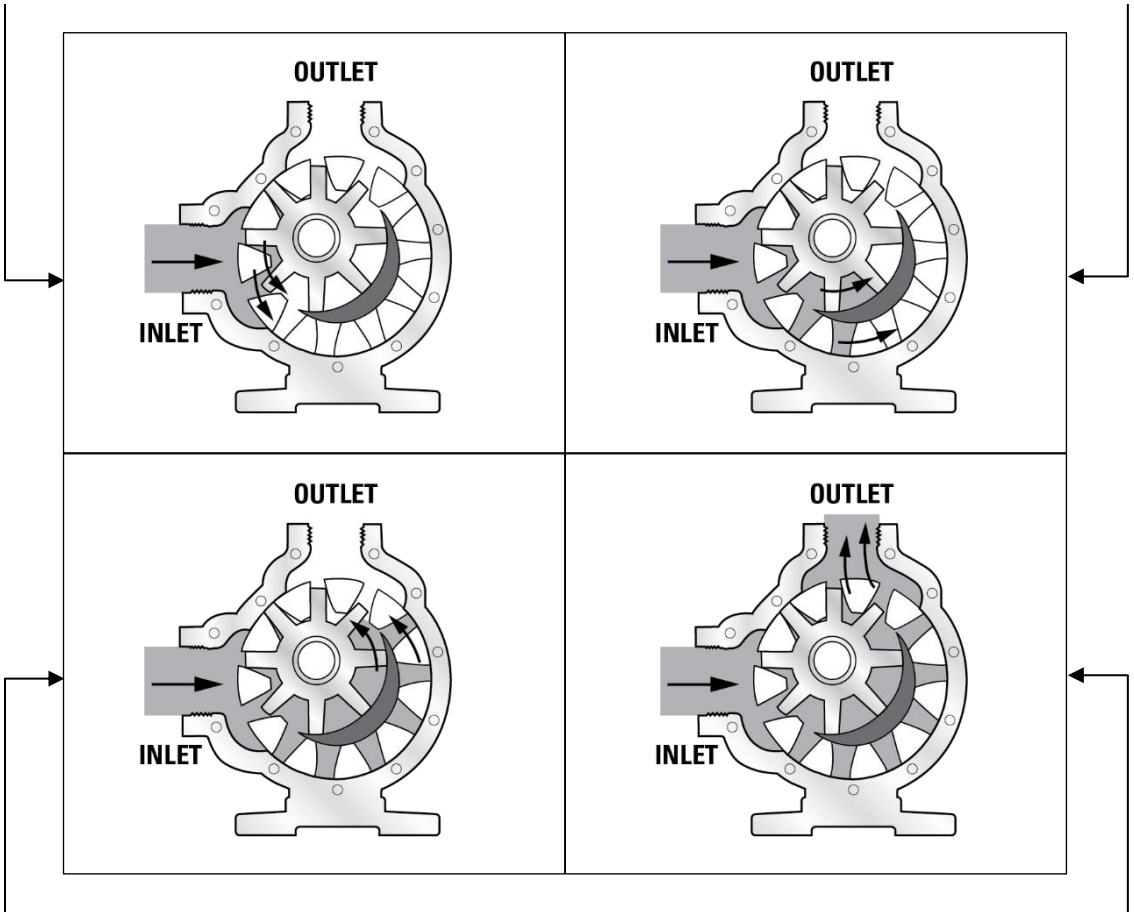
XXX – MOTOR MANUFACTURER CODE

How It Works—Internal Gear Technology

The E SERIES GEAR PUMP is a rotating, positive displacement pump. These drawings show the flow pattern through the pump upon its initial rotation. It is assumed that the pump has no fluid in it prior to its initial rotation.

1 The shaded area indicates the liquid as it is drawn into the liquid inlet port of the pump. As the rotor turns, atmospheric pressure forces the liquid between the rotor teeth and idler teeth. The two arrows indicate the rotational direction of the pump.

2 As the rotor continues to turn, the liquid is forced through the crescent-shaped area of the wetted path. The crescent-shaped area divides the liquid and acts as a barrier between the inlet and discharge ports.



3 As the rotor continues to turn, the liquid is forced past the crescent-shaped area and moves toward the discharge port.

4 As the rotor completes one complete rotation, the rotor and idler teeth interlock, forcing the liquid through the discharge of the pump. The pump may take several rotations to completely prime depending on the conditions of the application.

SIZES AVAILABLE

Model	Cast Iron/ Ductile Iron Port Sizes	Carbon Steel Port Sizes[1]	Stainless Steel Port Sizes[1]	Pump Weight
E1-2	N/A	1-1/2" NPT/ANSI/BSPT	1-1/2" NPT/ANSI/BSPT	24 kg (53 lb)
E1-4	N/A	1-1/2" NPT/ANSI/BSPT	1-1/2" NPT/ANSI/BSPT	24 kg (53 lb)
E1-24	2" NPT/ANSI[1]/BSPT	2" NPT/ANSI/BSPT - 3" ANSI	2" NPT/ANSI/BSPT - 3" ANSI	69 kg (152 lb)
E1-32	2" NPT/ANSI[1]/BSPT	2" NPT/ANSI/BSPT - 3" ANSI	2" NPT/ANSI/BSPT - 3" ANSI	69 kg (152 lb)
E1-55	3" ANSI[1] - 4" ANSI[1]	3" ANSI - 4" ANSI	3" ANSI - 4" ANSI	139 kg (307 lb)
E1-69	3" ANSI[1] - 4" ANSI[1]	3" ANSI - 4" ANSI	3" ANSI - 4" ANSI	139 kg (307 lb)
E1-82	3" ANSI[1] - 4" ANSI[1]	3" ANSI - 4" ANSI	3" ANSI - 4" ANSI	139 kg (307 lb)
E1-133	4" ANSI[2]	4" ANSI	4" ANSI	250 kg (552 lb)
E1-222	6" ANSI[2]	6" ANSI	6" ANSI	270 kg (596 lb)

[1] Flanged connections meet Class 150# ANSI

[2] Flanged connections meet Class 125# ANSI

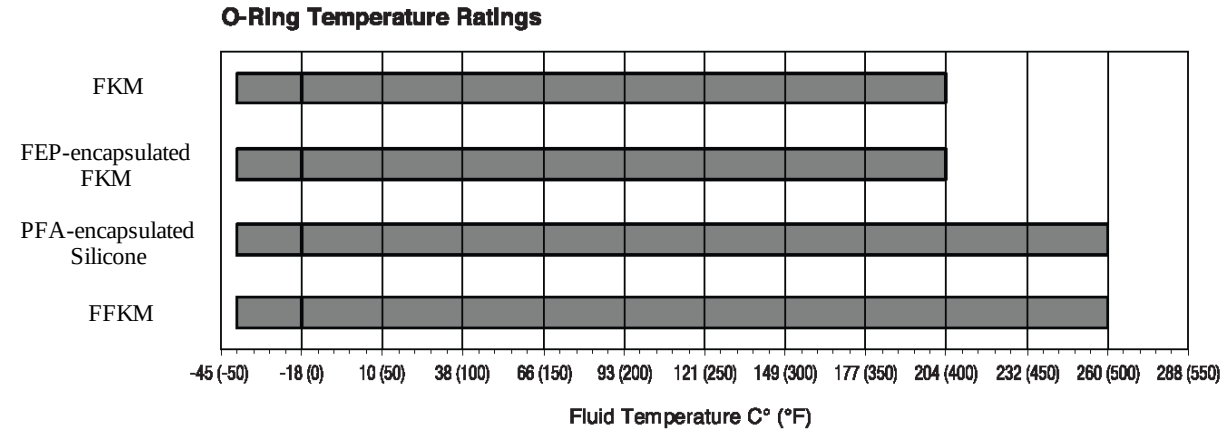
PUMP SELECTION PERFORMANCE CRITERIA

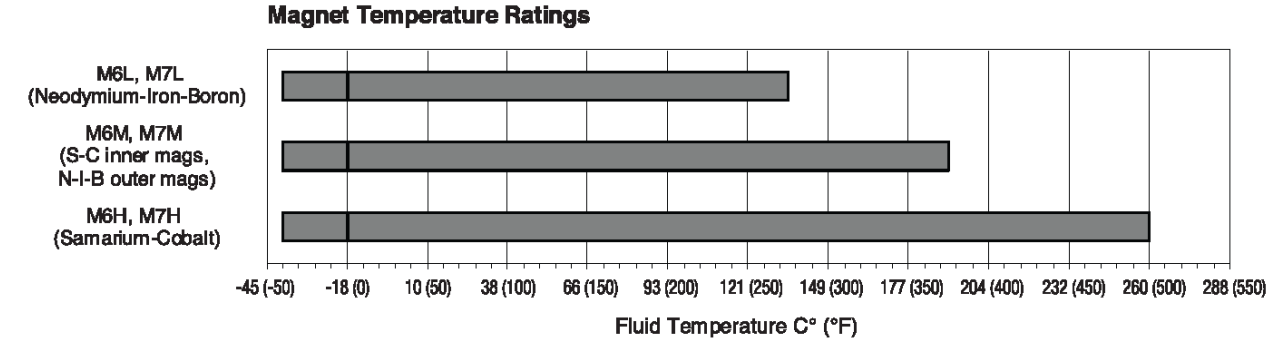
	Nominal Pump Rating		[1,2]Max. Discharge Pressure	Max. Temperature	Nominal Pump Rating		[1,2]Max. Discharge Pressure	Max. Temperature
	CAST IRON / DUCTILE IRON / CARBON STEEL				STAINLESS STEEL			
Model	rpm	m^3/h (gpm)	bar (psig)	Celsius (Fahrenheit)	rpm	m^3/h (gpm)	bar (psig)	Celsius (Fahrenheit)
E1-2	1,750	3.4 (15)	13.8 (200)	260° (500°)	1,150	2.3 (10)	10.3 (150)	260° (500°)
E1-4	1,750	6.8 (30)	13.8 (200)	260° (500°)	1,150	4.5 (20)	10.3 (150)	260° (500°)
E1-24	780	17.0 (75)	13.8 (200)	260° (500°)	640	12.5 (55)	10.3 (150)	260° (500°)
E1-32	780	22.7 (100)	13.8 (200)	260° (500°)	640	18.2 (80)	10.3 (150)	260° (500°)
E1-55	640	30.7 (135)	13.8 (200)	260° (500°)	520	25.0 (110)	10.3 (150)	260° (500°)
E1-69	640	38.6 (170)	13.8 (200)	260° (500°)	520	31.8 (140)	10.3 (150)	260° (500°)
E1-82	640	45.4 (200)	13.8 (200)	260° (500°)	520	36.3 (160)	10.3 (150)	260° (500°)
E1-133	520	68.1 (300)	13.8 (200)	260° (500°)	520	68.1 (300)	10.3 (150)	260° (500°)
E1-222	520	113.6 (500)	13.8 (200)	260° (500°)	520	113.6 (500)	10.3 (150)	260° (500°)

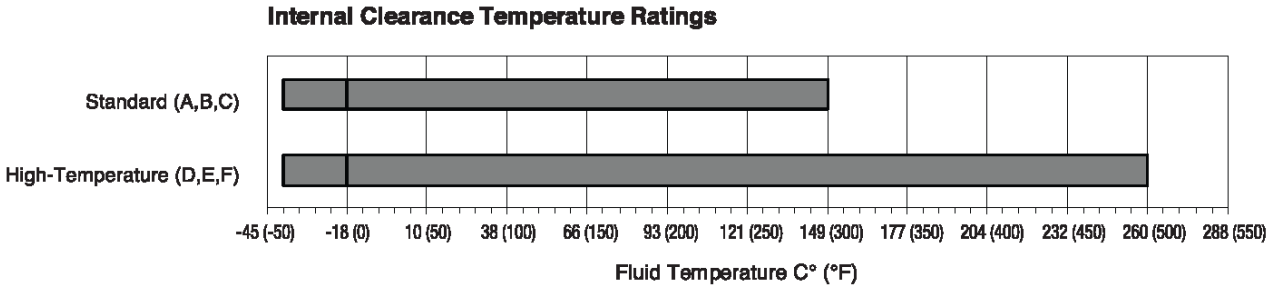
[1] Maximum pressure listed reflects maximum differential pressure and maximum allowable working pressure

[2] Consult factory for differential pressures below 1.4 bar (20 psig)

TEMPERATURE RATINGS

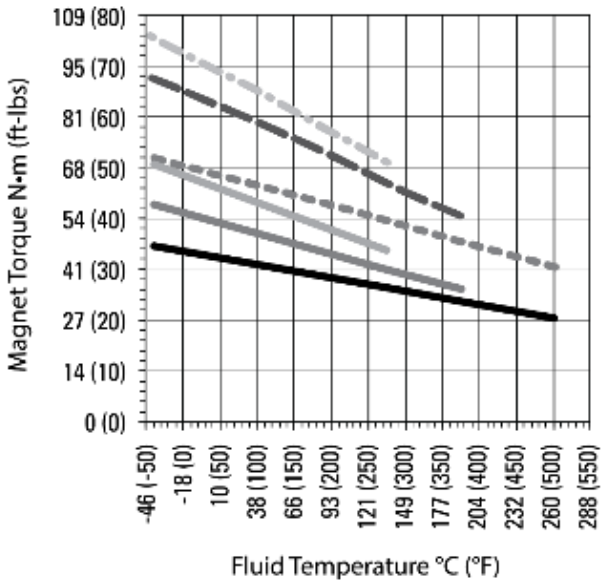




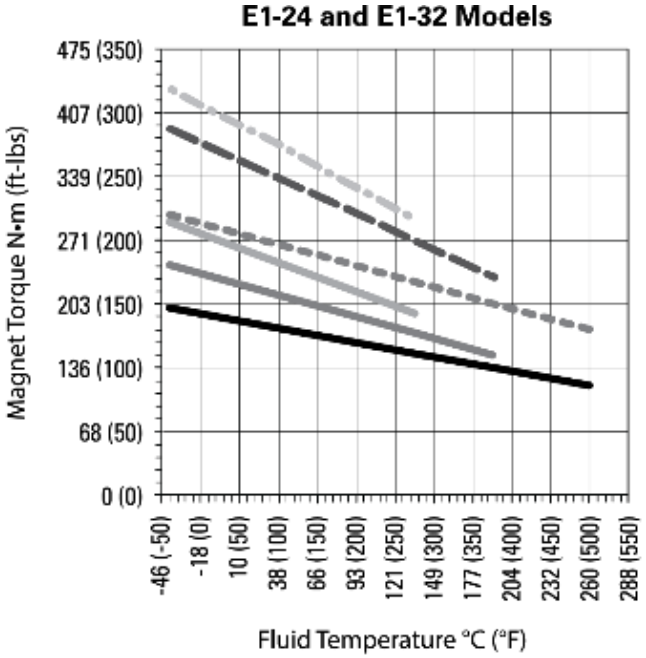


MAGNETIC-COUPLING STRENGTHS

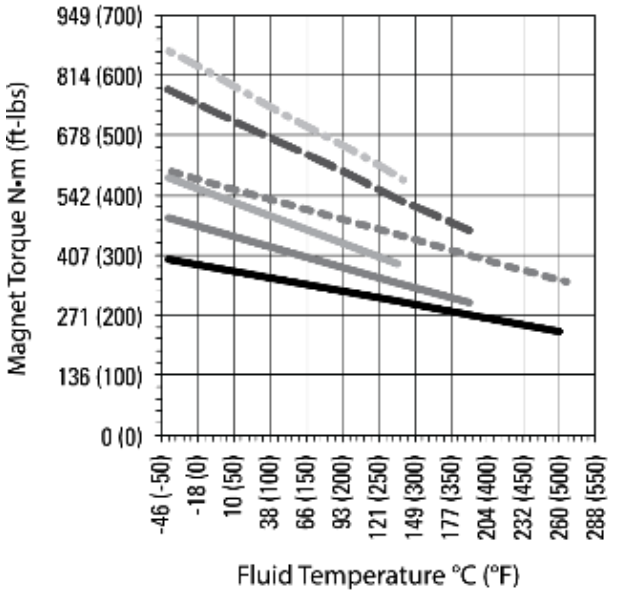
E1-2 and E1-4 Models



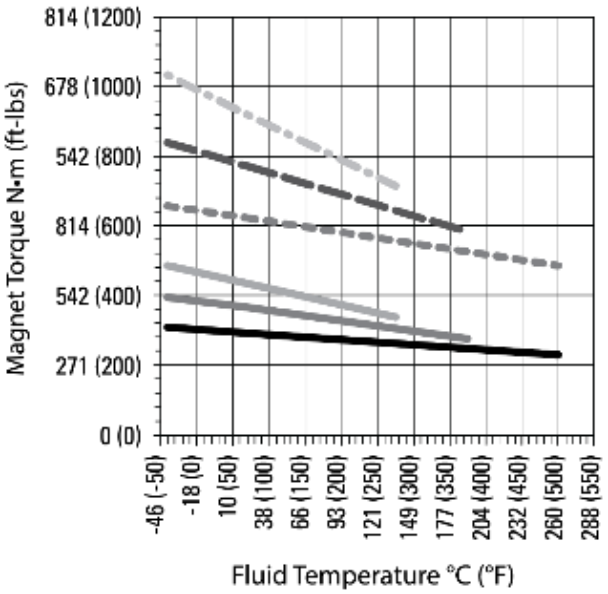
E1-24 and E1-32 Models

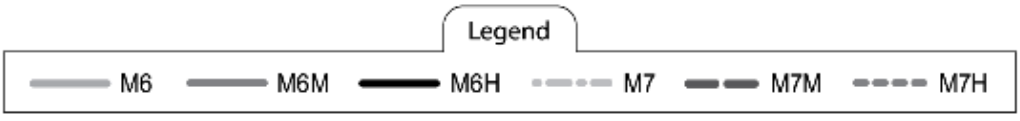


E1-55, E1-69 and E1-82 Models



E1-133 and E1-222 Models

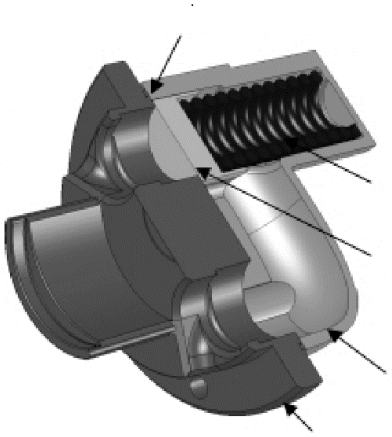




RELIEF VALVE PERFORMANCE

Optional integral relief valves provide pump protection from over-pressure conditions. While not intended for continuous use, internal relief valves protect the pump from closed discharge valves or other intermittent over-pressurization of the system.

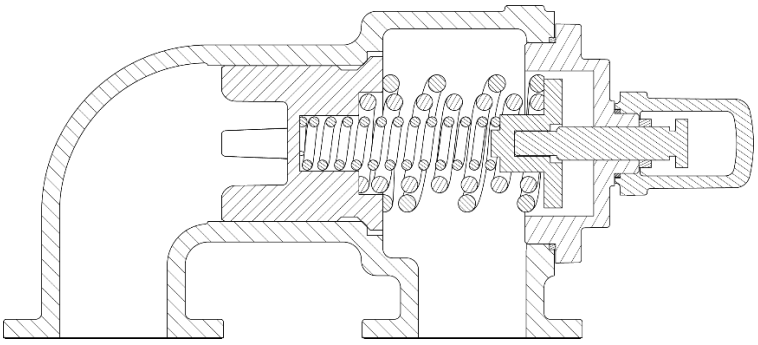
Depending on the size of the pump, you will get one of two relief valve designs, a non-externally adjustable or an externally adjustable relief valve. The design of the E1-2 thru E1-82 are spring-loaded and contain only three (3) parts. This design addresses the problem of over-pressurization by "cracking" (where the poppet lifts off the seat) at the nominal pressure-relief setting, allowing pumped fluid to recirculate internally from the discharge side back to the suction side.



RELIEF VALVE – E1-2 THRU E1-82 MODELS

In order to maintain the integrity of the relief valve setting, the E1-2 thru E1-82 relief valves are not adjusted by means of an external jack screw. Rather, seven (7) relief valve settings are fixed at the factory and adjusted by changing the poppet and spring combinations. See the pump designation system section for details on available E1-2 thru E1-82 relief valve settings.

The design of E1-133 and E1-222 is spring-loaded and externally adjustable. It addresses the problem of over-pressurization by initially cracking, and eventually full-bypassing at the nominal pressure-relief setting, allowing pump fluid to recirculate internally from the discharge side back to the suction side.



RELIEF VALVE – E1-133 AND E1-222 MODELS

To properly size the integral relief valve, it is important to understand the difference between ***crack pressure*** and ***full bypass pressure***.

Crack pressure is the pressure at which the poppet just begins to lift off the seat. This pressure is not affected by variations in fluid viscosity or pump speed. The pump will provide full flow rate at all pressures below the cracking pressure. E1-2 through E-82 pressure relief valves are sized based on cracking pressure.

Full bypass pressure is the pressure that occurs when 100% of the pump's flow rate is bypassing internally through the valve and no flow is exiting the pump. E1-133 and E-222 pressure relief valves are sized based a full bypass pressure.

INTERNAL COOLING CIRCUIT

This pump has an internal cooling circuit that circulates some of the pumped fluid through the magnet chamber. The circuit starts at the discharge port and ends at the suction port. This circuit has three functions:

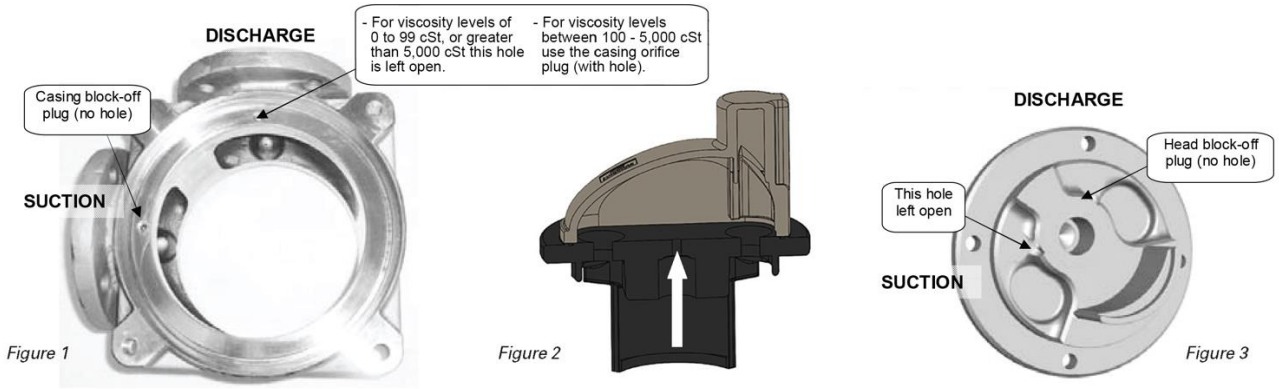
- Cool the inner magnets
- Keep fluid in the magnet area from becoming stagnant
- Lubricate and cool the rotor and idler bushings

NOTE: Consult factory at low differential pressures to ensure proper cooling-path circulation.

There are special plugs in the casing and head that must be in the correct position to complete the circuit:

1. The casing needs to be vented on the DISCHARGE side. In some cases, this is done with an orifice plug that has a hole in it, positioned in the casing hole behind the DISCHARGE port. In other cases, this is done by leaving the casing hole behind the DISCHARGE port open.
2. The casing block-off plug is solid (no hole). It belongs in the casing hole behind the SUCTION port.
3. The head block-off plug is solid (no hole). It is only used in pumps that have no relief valve, and it belongs in the head hole on the DISCHARGE side.
4. On pumps with an integral relief valve, the orifice plug hole is located at the bottom of the pilot hole for the spindle in the head plate. This applies for pump sizes E1-2 to E1-82 only. There are no "head block-off" holes or ports needing to be changed when switching the rotation (Figure 2), only the casing. The orientation of the relief valve must be rotated 180 degrees so that the spring/poppet portion of the valve is closest to the discharge port.

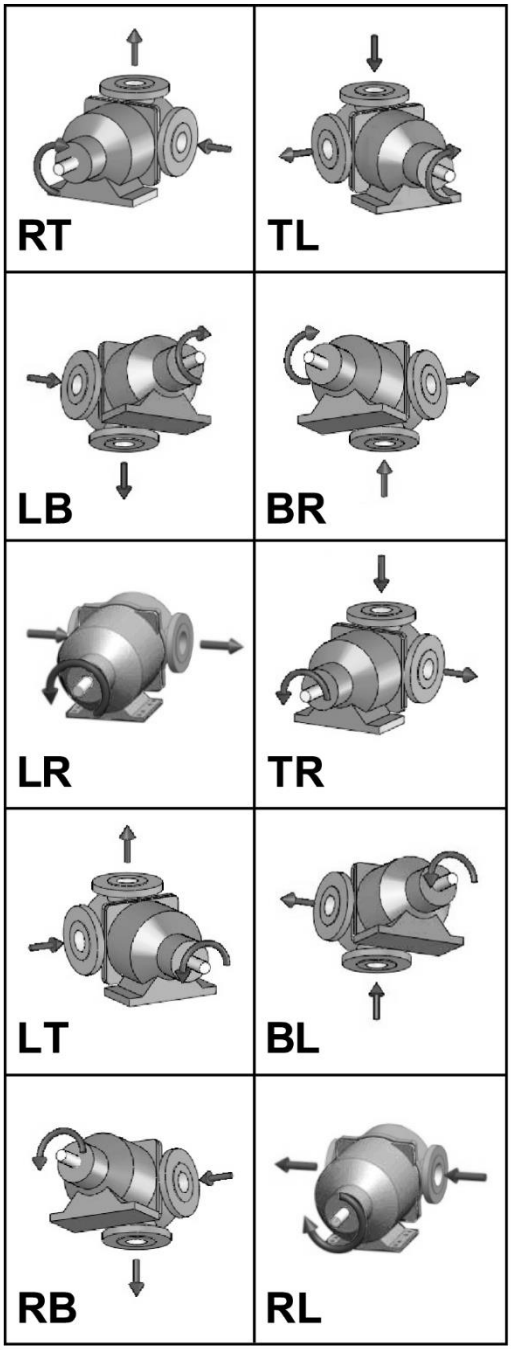
Special Cooling Circuit Plugs in Correct Positions



Cooling Path Port for a PRV Head.

ROTATION AND PORT ORIENTATION

The pump is configured in one of the ten (10) possible orientations shown in the table below and it has labels on it that indicates direction of rotation, suction port and discharge port.



Suggested Installation and Operation

E Series gear pumps are designed to meet the performance requirements of even the most demanding pumping applications. They have been designed and manufactured to the highest standards and are available in a number of different sizes to meet your pumping needs. Refer to the performance section of this manual for an in-depth analysis of the performance characteristics of your pump.

INSTALLATION

Months of careful planning, study and selection efforts can result in unsatisfactory pump performance if installation details are left to chance.

Premature failure and long-term dissatisfaction can be avoided if reasonable care is exercised throughout the installation process.

LOCATION

Noise, safety and other logistical factors usually dictate where equipment will be situated on the production floor. Multiple installations with conflicting requirements can result in congestion of utility areas, leaving few choices for additional pumps.

Within the framework of these and other existing conditions, every pump should be located in such a way that key factors are balanced against each other to maximum advantage.

ACCESS

The location of the pumping unit should be accessible. If it's easy to reach the pump for maintenance, personnel will have an easier time carrying out routine inspections and adjustments. Should major repairs become necessary, ease of access can play a key role in speeding the repair process and reducing total downtime.

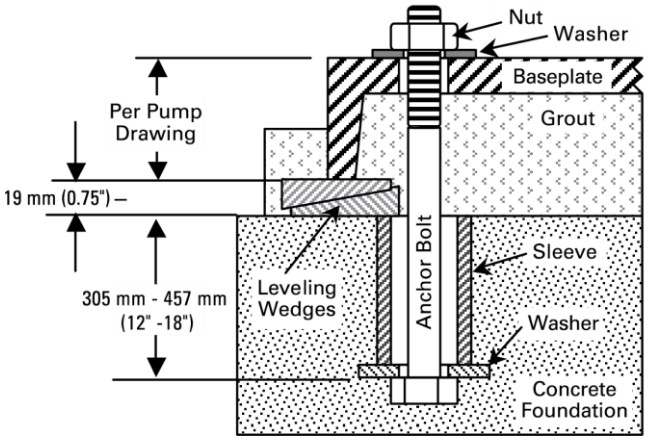
FOUNDATION

BASEPLATES AND ANCHORS

The preferred mounting for a baseplate is on a concrete pad with grouting. No matter how robust the design, there is always some flexibility in the baseplate itself. If there is insufficient support under the baseplate it can distort, causing alignment difficulties and normal vibrations can be amplified to unacceptable levels through resonance in the pump support and/or piping. A properly grouted baseplate will resist distortion and will provide sufficient mass to dampen any vibration.

NOTE: When pumps and motors are assembled on a baseplate at the factory, a preliminary alignment is done to ensure that the pump and motor can be aligned at its installation. This alignment is not to be considered as a final alignment. The factory alignment can, and does, change during shipment and when the pumping unit is installed. Actually, several alignments are necessary as will be described later.

Anchor (foundation) bolts are used to hold the baseplate to its support structure, whatever that may be. In the preferred case of mounting the pump unit on a concrete pad, the anchor bolts are set into the pad as indicated in the following illustration. When pouring the pad, it's helpful to have a wooden template attached to the foundation form to position the anchor bolts at their locations as indicated on the pump unit assembly drawing.



TYPICAL ANCHOR BOLT (SLEEVE TYPE)

Anchor bolts are usually sized smaller than the anchor bolt hole size in the base. Calculate bolt length as indicated in Figure A on the left.

The ID of the sleeve should be two (2) bolt sizes larger than the anchor bolt.

Allow approx. 19 mm - 38 mm (3/4" - 1-1/2") space between the bottom edge of the baseplate and the foundation for grouting.

A "Sleeve" type anchor bolt is shown here. Alternatively, a "hook" or "J" type anchor bolt may be used.

Pack the space between the anchor bolt and sleeve to prevent concrete and/or grout from entering this area.

BASE INSTALLATION AND GROUTING

NOTE: Before the baseplate is installed, it is advisable to thoroughly clean the underside to enable the grouting to adhere to it. Do not use oil-based cleaners since grout will not bond to it.

Once the concrete pad has cured, the baseplate can be carefully lowered over the anchor bolts.

Place shims or tapered wedges under the baseplate at each of the anchor bolt positions to provide about 19 mm - 38 mm (0.75" - 1.50") clearance between the base and the foundation. Adjust shims/wedges to level the baseplate. **Since there may be some flexibility in the baseplate, we must perform an initial alignment prior to grouting to ensure that a final alignment can be achieved. See section covering Alignment of Pump/Driver Shafts**. Potential problems here include bowing and/or twisting of the baseplate. If gross misalignment is observed, shims/wedges may have to be added under the mid-point of the base or the shims/wedges at the corners may have to be adjusted to eliminate any twist. If the driver feet are bolt-bound for horizontal alignment, it may be necessary to loosen the pump hold-down bolts and shift the pump and driver to attain horizontal alignment. When alignment has been achieved, lightly tighten the anchor bolts. The anchor bolts should not be fully tightened until the grout has set.

Grouting furnishes support for the pump unit baseplate providing rigidity, helping to dampen any vibration and serves to distribute the weight of the pump unit over the foundation. To be effective, grouting must completely fill all voids under the baseplate. For proper adhesion or bonding, all areas of the baseplate that will be in contact with the grout should be thoroughly cleaned. See note above. The grout must be non-shrinking. Follow the directions of the grout manufacturer for mixing. Proceed with grouting as follows:

NOTE: If the size of the equipment or the layout of the installation requires it, grouting can be done in two steps as long as the first step is allowed to cure completely before the second step is applied

1. Build a sturdy form on the foundation around the baseplate to contain the grout.
2. Soak the top of the concrete foundation pad thoroughly. Remove surface water before pouring.
3. Pour the grout through the hole(s) in the top and/or through the open ends of the channel steel baseplate, eliminating air bubbles by tapping, using a vibrator or pumping the grout into place. If necessary, drill vent holes into the top of the base to evacuate air.
4. Allow grout to set completely, usually a minimum of 48 hours.
5. Tighten foundation anchor bolts.
6. Recheck alignment to ensure that there have been no changes.
7. After the grout has dried thoroughly, apply an oil base paint to shield the grout from air and moisture.

PIPING

Final determination of the pump site should not be made until the piping challenges of each possible location have been evaluated. The impact of current and future installations should be considered ahead of time to make sure that inadvertent restrictions are not created for any remaining sites.

The best choice possible will be a site involving the shortest and straightest hookup of suction and discharge piping. Unnecessary elbows, bends and fittings should be avoided. Pipe sizes should be selected to keep friction losses within practical limits.

All piping should be supported independently of the pump. In addition, the piping should be aligned to avoid placing stress on the pump fittings. To eliminate possible closing of the line when performing pump maintenance, a gate valve should be installed at the suction line.

E Series gear pumps are positive displacement pumps; as such, care must be used in protecting piping and components used in your system. Pumps equipped with an internal relief valve are designed to protect the pump only. A system relief valve should be installed along with the pump's internal relief valve.

When placing the pump, choose a location as close to the product source as possible. Care should be taken in your supply line to avoid cavitation due to viscosity and suction lift. **NOTE:** Some liquids may become thicker with temperature changes. Please refer to your supplier of product being pumped for information on viscosity changes due to temperature. Avoid air pockets on suction side of pump when designing piping layout. This will also reduce the possibility of cavitation. The weight of the piping should not be supported or absorbed by the pump. Suction and discharge piping should be supported by pipe hangers or another suitable means.

E SERIES GEAR PUMPS ARE NOT SUITED FOR PUMPING DIRTY, SOLID-LADEN LIQUIDS. A strainer should be used on the suction side of the pump. The strainer should consist of an adequate size mesh screen as to not cause excessive friction loss. It is suggested that a maintenance program is created to assure that the inlet strainer remains free of obstructions and blockage.

ALIGNMENT OF PUMP/DRIVER SHAFTS

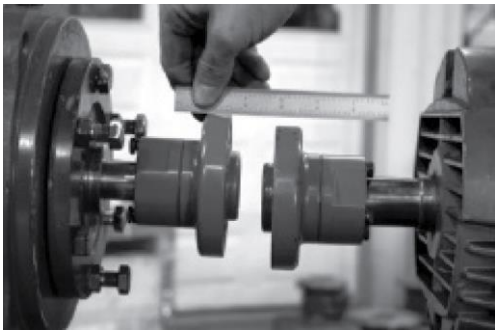
WARNING!

NOTE: Driver power must be locked out before beginning any alignment procedure. Failure to lock out driver power may result in serious physical injury.

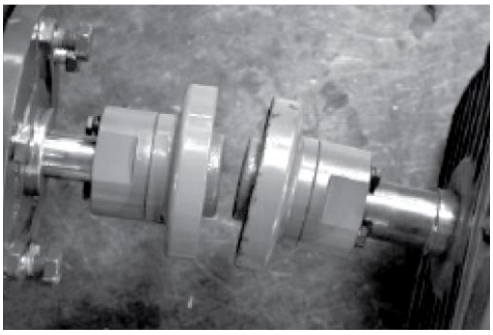
NOTE: Proper alignment is the responsibility of the installer and user of the equipment.

NOTE: Check alignment if process temperature changes, piping changes and/or pump service is performed.

Pump and driver shafts need to be aligned for both parallel and angular alignment. If there is a misalignment of the shafts, it will place a mechanical load on the pump and driver shaft/bearing assemblies, as well as the coupling. This will result in vibration, noise and premature failures.



PARALLEL MISALIGNMENT



ANGULAR MISALIGNMENT

Furthermore, due to the magnetic coupling design of the E Series pump, misalignment can cause deflection of the outer ring in to the stationary magnet housing and containment canister. This can cause bearing failure which, if left undiagnosed, could lead to the outer ring contacting and potentially breaching the containment canister.

NOTE: There are design provisions that cause the outer ring to contact the magnet housing prior to contacting the canister, but this is meant for short-term bearing failure containment, not long-term prevention of outer ring-to-canister contact.

To bring shafts into alignment, we first need to determine the amount and direction of both parallel and angular misalignments. We can then shim and reposition to correct.

It's preferable to shim ONLY under the driver feet since good contact between the pump foot and the base is necessary to resist any pump flange loading that might be imposed by the suction and/or discharge piping.

There are three methods commonly used to determine misalignment:

1. Straight edge and calipers or inside micrometer (least accurate)
2. Dial indicator (reasonably accurate)
3. Laser alignment equipment; see manufacturer's instructions for use

Since any misalignment will impose loads on the pump and driver shafts, the objective is to minimize any misalignment in order to protect the pump and driver, and minimize any tendency for vibration. Suggested misalignment limits are:

MISALIGNMENT LIMITS		
PUMP FRAME GROUP	MAX. PARALLEL	MAX. ANGULAR
2/4, 24/32, 55/69, 82	0.005"	0.005"
133/222	0.010"	0.010"

For optimum performance and Mean Time Between Pump Maintenance (MTBPM), use alignment limits half of those shown above.

NOTE: In any case, disregard the coupling manufacturer's published misalignment limits, as these will impose unacceptable loads on the pump and motor shafts, and bearings.

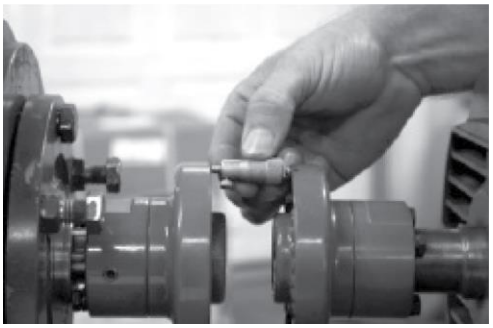
Alignment must be done at several different times:

1. Prior to grouting baseplate during installation
2. After grouting baseplate and tightening anchor bolts
3. After attaching suction and discharge piping prior to initial operation
4. Hot alignment after equipment temperatures have stabilized
5. After pump maintenance bearing housing is removed

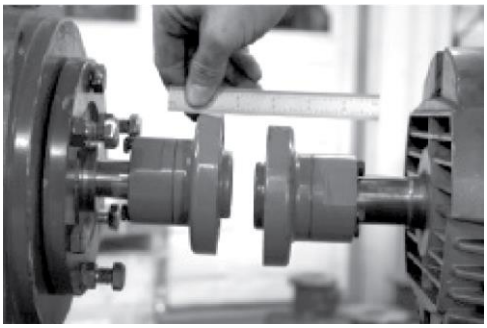
Since the E Series pump is foot-mounted, its shaft centerline will rise when handling pumpage at elevated temperatures. Similarly, the motor shaft centerline will rise as it reaches its operating temperature. Therefore, we will often purposely misalign shafts vertically during cold alignment to allow for thermal growth, thus bringing the shafts into alignment at operating temperature. This is shown in the “COLD SETTING OF PARALLEL VERTICAL ALIGNMENT” table.

The most simple alignment check is with a straight edge and calipers or inside micrometer. This method is the least accurate, but it will serve if a dial indicator or laser is not available.

ALIGNMENT WITH STRAIGHT EDGE AND MICROMETER



ANGULAR ALIGNMENT

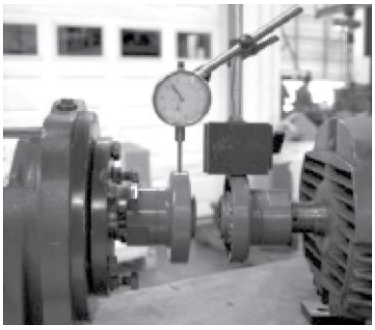


PARALLEL MISALIGNMENT

With coupling hubs stationary, use inside micrometer or calipers to measure the gap between the coupling hubs at 90° intervals. Adjust and/or shim equipment until the gap difference at all points around the hub(s) is less than the value shown in the “MISALIGNMENT LIMITS” table.

With coupling hubs stationary, lay straight edge flat against rim of coupling hub to determine vertical and horizontal alignment offsets. Adjust and/or shim equipment until the straight edge lies flat against both hub rims, vertical and horizontal.

DIAL INDICATOR METHOD



DIAL INDICATOR SETUP

The dial indicator method is preferred for checking alignment.

1. Scribe or mark index lines on both coupling hubs to indicate where the dial indicator point rests.
2. Set dial indicator to zero.
3. Slowly turn BOTH coupling hubs so that the index lines match or the indicator point is always on the mark.
4. Observe dial reading to determine required adjustments.
5. Acceptable parallel and angular alignment occurs when the total indicator reading (TIR) for a complete turn does not exceed the values shown in the “MISALIGNMENT LIMITS” table.

LASER ALIGNMENT METHOD

The laser alignment method is preferred for checking alignment.

Laser alignment is usually the most accurate method. Follow the laser alignment equipment manufacturer's instructions for this method.

As previously mentioned, pump and motor shafts need to be in alignment while they are at their intended operating temperature. When the shafts are aligned "cold" (at ambient temperature), we will intentionally position the motor shaft up or down in vertical parallel alignment to allow for thermal growth. Then, when the alignment is checked "hot" (at stable operating temperature), the shafts should be confirmed to be in alignment. Use the values in the following table as a starting point for cold alignment settings. The actual cold alignment setting will be determined after the hot alignment is performed.

COLD SETTING OF PARALLEL VERTICAL ALIGNMENT	
PUMPAGE TEMPERATURE	SET DRIVER SHAFT
10°C (50°F)	0.051 mm (0.002") LOW
66°C (150°F)	0.025 mm (0.001") HIGH
121°C (250°F)	0.127 mm (0.005") HIGH
177°C (350°F)	0.229 mm (0.009") HIGH
232°C (450°F)	0.330 mm (0.013") HIGH
260°C (500°F)	0.432 mm (0.017") HIGH

PRESSURE RELIEF VALVES

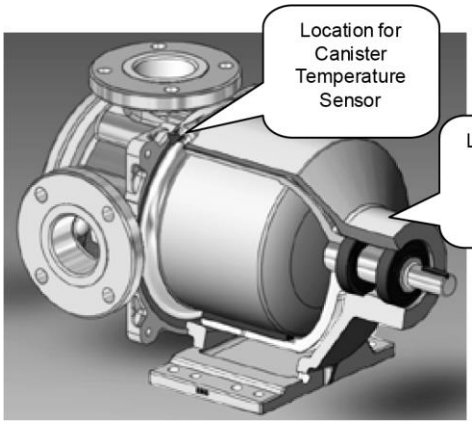
- E Series pumps are positive displacement pumps, which means the system must have provisions for pressure relief protection, such as a relief valve mounted directly on the pump or in-line with the system. Alternatively, the system can be installed with a torque-limiting device or a rupture disk.

  If the system requires the pump to operate in both directions, pressure relief protection is required on both sides of pump.
- When using an integral relief valve, the adjusting screw cap must always point towards the suction side of pump. If shaft rotation has to be reversed, simply remove the pressure relief valve and reinstall it in the proper configuration to avoid over-pressurization of the system.
- Pressure relief valves are not intended to control pump flow or regulate discharge pressure.
- The pump-mounted integral relief valve should never be relied upon for system protection.

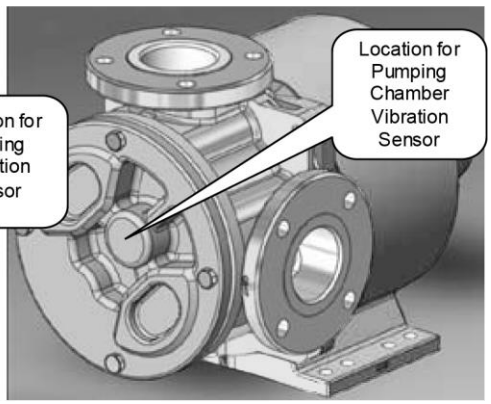
PUMP CONDITION MONITORING

There are several pump conditions that can be monitored.

- **Canister Temperature:** Heat is generated in the canister when the pump is running because of moving magnetic fields that pass through it. The pump has an internal cooling path that pulls heat away from the canister. If this cooling path is obstructed, the canister and magnet could become very hot, which could damage the magnets and/or canister O-ring.
- The canister temperature can be monitored with a temperature probe attached to the access port in the magnet housing near the casing.
- **Bearing Vibration:** The pump shaft is supported by rolling-element bearings. The condition of the bearings can be monitored with a vibration sensor attached to the magnet housing near the bearings.
- **Pumping Chamber Vibration:** The pumping gears rotate with the casing and are supported by journal bushings. The condition of gears and bushings can be monitored with a sensor attached to the pump head.



OPTIONAL SENSOR LOCATIONS



OPTIONAL SENSOR LOCATIONS

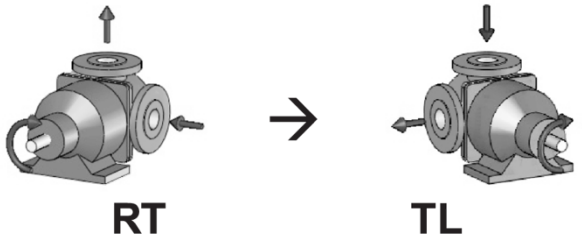
START UP

- Check to ensure that the pressure/vacuum gauges are installed on inlet and discharge side of the pump.
- Check to ensure that installation and piping are correctly fastened and supported.
- Check to ensure that the pump and driver are properly aligned. Refer to **Alignment** section.
- Verify that the motor is wired correctly. Check to ensure that the thermal overload relays are properly sized and set for operation.
- With motor/driver locked out, check that the pump rotates by hand.
- Jog motor to validate correct rotation.
- Check to ensure that the coupling guard and all other safety-related devices and instrumentation are in place and in working order.
- Check to ensure that the pressure relief valve is installed correctly.
- Open suction, discharge and any auxiliary valves, such as in-line PRV loops, to ensure proper flow into and out of pump.
- Prime pumping chamber if possible.
- If pump handles pumpage at temperature greater than 93°C (200°F), the pump should be gradually warmed until its temperature is within 38°C (100°F) of intended operating temperature.
- Start pump. If flow is not achieved in 30 seconds shut off immediately. “Dry” running a pump for extended periods of time will damage the pump. If fluid does not start to flow in 30 seconds, revisit the previous steps. If every step has been followed, manually fill the pump with the process fluid or a lubricating fluid compatible with the process and restart the pump. If no fluid is flowing within 30 seconds shut the pump down and proceed to troubleshooting section of this document.
- Once pump is operational, listen for any untoward noise, check for any significant vibration or indications of binding. If any of these are observed, the pump should be stopped immediately and a thorough check of the installation should be made to determine the cause. Correct any fault(s) prior to re-starting the pump.

CHANGING PORT ORIENTATION ONLY

(Shaft Rotation Unchanged)

The following instructions apply for changes when the direction of shaft rotation will not change, such as changing from RT to TL. Since the shaft rotation is unchanged, the discharge and suction positions relative to the casing and head will not change and, therefore, the cooling circuit plugs will not be moved. See ***Internal Cooling Circuit*** in Section 4.



PORT ORIENTATION CHANGE WHEN SHAFT ROTATION DOES NOT CHANGE

If the pump is equipped with a relief valve, disassemble the relief valve per the instructions in Section 7, Pump Disassembly & Repair Processes. For E1-24, E1-32, E1-55, E1-69, E1-82, E1-133 and E1-222 models, the relief valve does not need to be disassembled; leave the relief valve attached to the head.

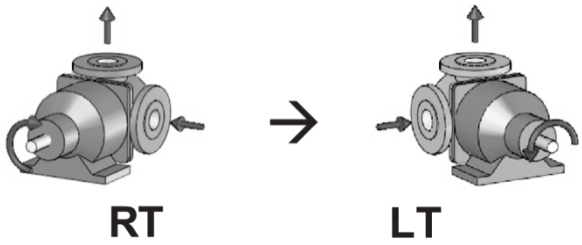
Disassemble the pumping chamber per the instructions in Section 7, **Pump Disassembly & Repair Processes**.

Assemble pumping chamber in the new orientation per the instructions in Section 7, **Pump Disassembly & Repair Processes**.

If the pump is equipped with a relief valve, assemble relief valve per the instructions in Section 7, **Pump Disassembly & Repair Processes**.

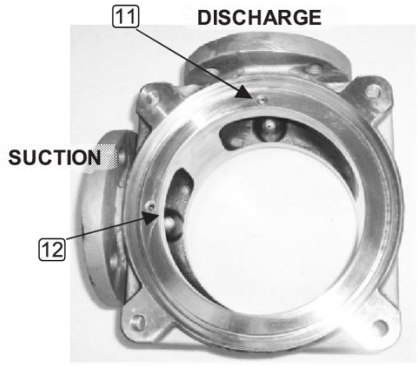
CHANGING PORT ORIENTATION AND SHAFT ROTATION

The following instructions apply for changes when the direction of shaft rotation will change, such as changing from RT to LT. Since the shaft rotation will change, the discharge and suction positions relative to the casing and head will also change and, therefore, the cooling circuit plugs will be moved. See **Internal Cooling Circuit** in Section 4.

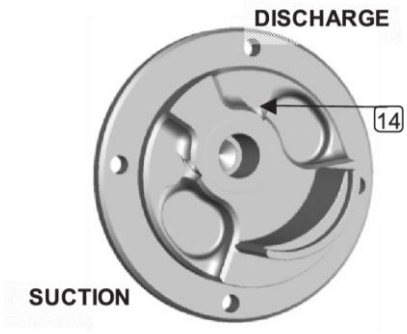


PORT ORIENTATION CHANGE WHEN SHAFT ROTATION CHANGE

1. If the pump is equipped with a relief valve, disassemble the relief valve per the instructions in Section 7, **Pump Disassembly & Repair Processes**.
2. Disassemble pumping chamber per the instructions in Section 7, **Pump Disassembly & Repair Processes**.
3. Remove the casing orifice plug (not found on all configurations) and casing block-off plug.
4. Install the casing orifice plug (if required) behind the DISCHARGE port.
5. If the pump is equipped with a head block-off plug, move it to the DISCHARGE side.
6. Assemble pumping chamber in the new orientation per the instructions in Section 7, **Pump Disassembly & Repair Processes**.
7. If the pump is equipped with a relief valve, assemble relief valve in the new orientation per instructions in Section 7, **Pump Disassembly & Repair Processes**.



CASING PLUGS



HEAD BLOCK-OFF PLUG

CHANGING RELIEF VALVE PRESSURE SETTING

(E1-2 thru E1-82 Models)

In order to maintain the integrity of the relief valve setting, the E1-2 thru E1-82 E Series relief valves are not externally adjustable. Instead, the setting is adjusted by changing the poppet and spring.

1. Obtain a new poppet and spring for the desired relief-valve setting.
2. Disassemble relief valve per the instructions in Section 7, **Pump Disassembly & Repair Processes**.
3. Reassemble the relief valve using the new poppet and spring per the instructions in Section 7, **Pump Disassembly & Repair Processes**.

CHANGING RELIEF VALVE PRESSURE SETTING

(E1-133 and E1-222 Models)

1. Carefully remove the valve cap covering the adjusting screw.
2. Loosen the adjusting screw lock nut.
3. Install a pressure gauge in the discharge line.
4. Turn the adjusting screw inward (clockwise) to increase pressure and outward (counter-clockwise) to decrease pressure.
5. With the discharge line valve closed (at a point beyond the pressure gauge), the gauge will show the maximum pressure (that the pressure relief valve will allow) while the pump is in operation.

RELIEF VALVE DISASSEMBLY

(E1-2 thru-E1-82 Models)

1. Remove the screws that hold the valve body to the head. It is normal for the valve spring to push the valve body away from the head during this step; spring must be fully relaxed before the screws are fully removed.
2. Remove the valve body, spring, poppet and O-ring.

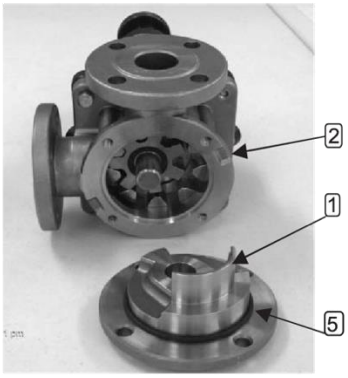
RELIEF VALVE DISASSEMBLY

(E1-133 and E1-222 Models)

1. Place a mark on the valve and head prior to disassembly in order to ensure proper reassembly.
2. Remove the pressure relief valve cap.
3. Measure and record the extension length of the adjusting screw.
4. Loosen the pressure relief valve lock nut and then back out pressure relief valve bonnet and adjusting screw until the spring pressure is released.
5. Remove, clean and inspect all parts (i.e., bonnet, spring guide, spring and poppet) for wear or damage and replace as needed.

PUMPING CHAMBER DISASSEMBLY

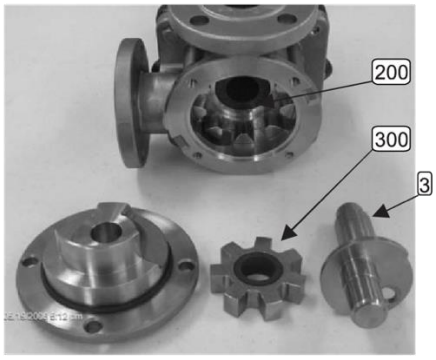
1. Remove the screws that hold the head to the casing.
2. Remove the head.



REMOVE HEAD

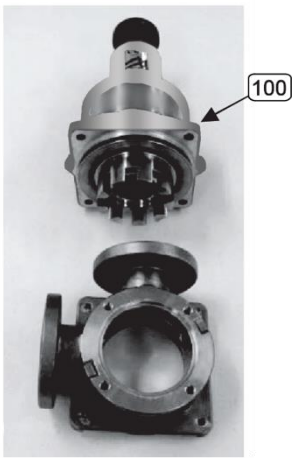
NOTE: When the head or spindle is removed, the pump will be difficult to turn by hand.

3. Remove the head O-ring from the head.
4. Remove the idler assembly by sliding it off the spindle.



REMOVE IDLER AND SPINDLE

5. Pull the spindle out of the rotor assembly.
6. Remove the screws that hold the outer drive assembly to the casing.
7. Separate the casing and outer drive assembly.



REMOVE CASING

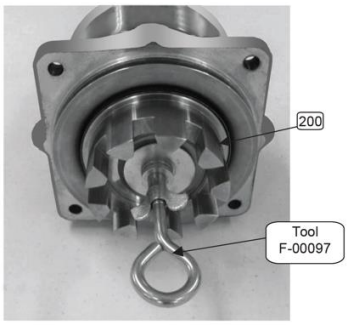
8. Remove the canister O-ring from its groove in the casing.

REMOVE ROTOR ASSEMBLY FROM OUTER DRIVE ASSEMBLY

(E1-2 and E1-4 Models)

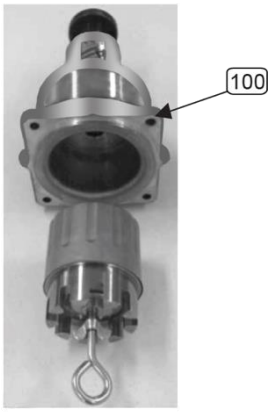
1. Use tool F-00097 to firmly grab the rotor assembly in the bushing bore area.

PUMP DISASSEMBLY TOOL F-00097



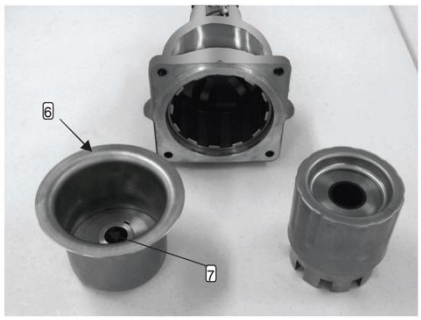
TOOL INSERTED IN ROTOR ASSEMBLY

2. Pull the rotor assembly out of the outer drive assembly using moderate force of 18 to 27 kg (40 to 60 lb).



DRIVE ASSEMBLY

3. Remove the tool and set the rotor assembly aside, away from any magnetic material (e.g., steel, iron).
4. Remove the canister that contains the support plate from the outer drive assembly.

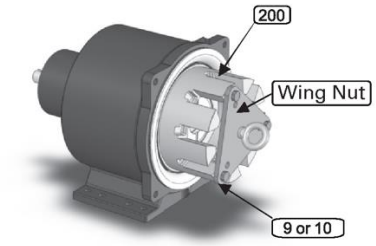


CANISTER REMOVED

REMOVE ROTOR ASSEMBLY FROM OUTER DRIVE ASSEMBLY

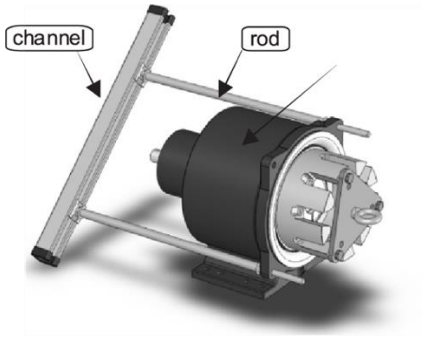
(E1-24, E1-32, E1-55, E1-69 and E1-82 Models)

1. Attach the puller plate to the rotor assembly using three (3) of the pump's 12.7 mm (1/2") screws.



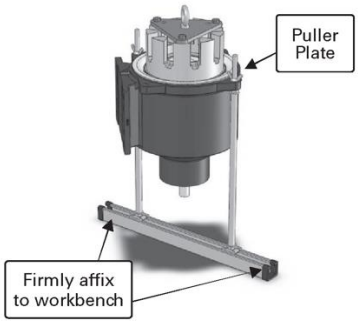
ATTACH PULLER PLATE

2. Loosely fit the two (2) rods into opposite holes on the outer drive assembly.
3. Loosely position the two rod ends into the channel.
4. Twist the two rods to tighten the channel nuts that lock the rods to the channel.



ATTACH RODS AND CHANNEL

5. Assemble the two (2) wing nuts onto the two (2) rods to hold them to the outer drive assembly.
6. Carefully lift the outer drive assembly (with the tool kit attached) and set it on a suitable workbench vertically with the rotor teeth facing up.
7. Firmly affix the channel to the workbench surface so it can safely resist a lifting force of up to 182 kg (400 lb).

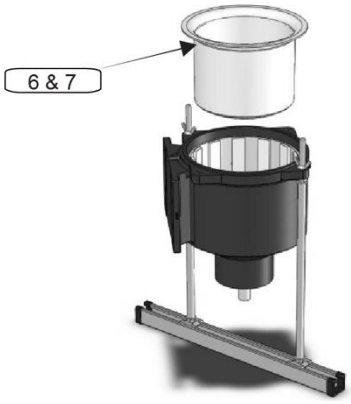


TOOL FULLY ASSEMBLED

8. Slowly pull the rotor assembly up and away from the drive assembly using a crane, hoist or other suitable lifting device.

PULL ROTOR ASSEMBLY UP

9. Remove the puller plate and set the rotor assembly aside, away from any magnetic material (e.g., steel, iron).
10. Remove the canister containing the support plate from the outer drive assembly.

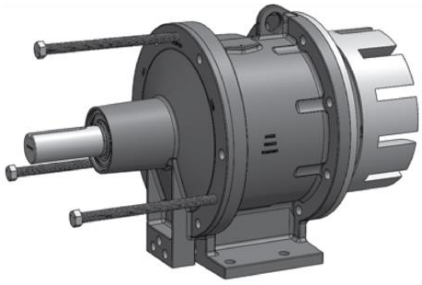


REMOVE CANISTER

REMOVE ROTOR ASSEMBLY FROM OUTER DRIVE ASSEMBLY

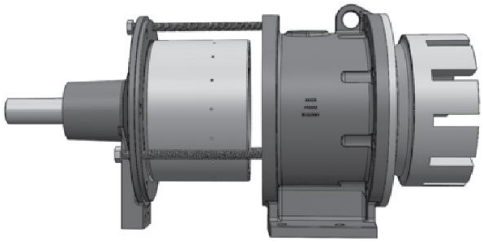
(E1-133 and E1-222 Models)

1. Remove six (6) screws holding the bearing housing to the magnet housing.
2. Remove three (3) jack screws from their storage location in the bearing housing foot.
3. Loosely install jack screws into the bearing housing.



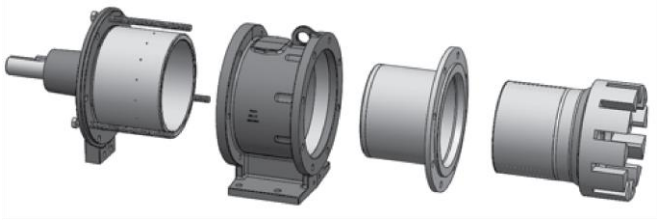
INSTALL JACK SCREWS

4. Slowly and evenly thread the jack screws into the magnet housing, which will separate the bearing housing and the magnet housing.
5. Continue until the coupling has separated.



SEPARATE COUPLING WITH JACK SCREWS

6. Remove the rotor assembly from the front of the mag housing and set aside, away from any magnetic material (e.g., steel, iron). Use the three (3) threaded holes on the ends of the rotor teeth as needed.
7. Remove the canister from the magnet housing.

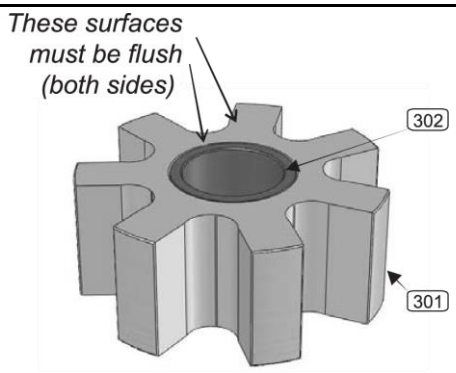


REMOVE ROTOR AND CANISTER

REPLACE IDLER BUSHINGS

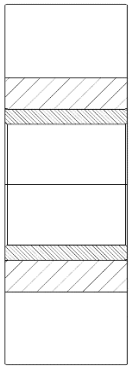
Carbon-Graphite and Bronze (Consult Factory for Other Bushing Materials)

1. Remove the old bushing by pressing it out of the idler. It is not unusual for carbon graphite bushings to crack or break apart during removal.
2. Inspect the idler bore for any damage. Any small scratches or nicks must be filed smooth before installing the new bushing.
3. Press the new idler bushing into the idler leading with the tapered edge.
   a. For models E1-2 thru E1-82 (Figure 1), the bushing is in its proper location when both ends of the bushing are flush or slightly recessed from the idler face.
   b. For models E1-133 and E1-222 (Figure 2), the bushings should protrude per the sketch.

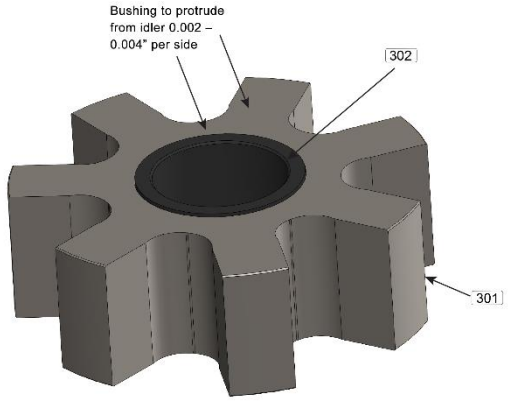


ASSEMBLE IDLER

Figure 1: (E1-2 through E1-82)

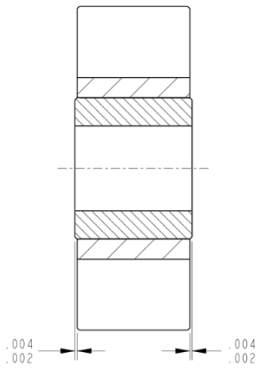


*IDLER BUSHING **Flush***



ASSEMBLE IDLER

Figure 2: (E1-133 through E1-222)

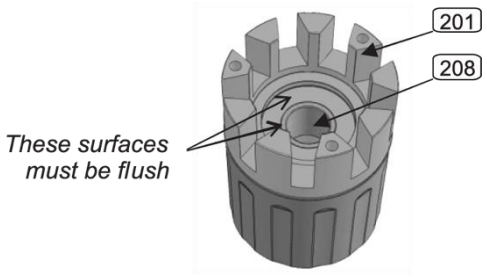


IDLER BUSHING PROTRUSION

REPLACE ROTOR BUSHINGS

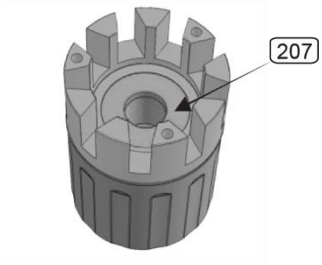
Carbon-Graphite and Bronze (E1-2 thru E1-82 Models)

1. Remove the old bushings by pressing them out of the rotor. It is not unusual for the bushings to crack or break apart during removal.
2. Inspect the rotor bore for any damage. Any small scratches or nicks must be filed smooth before installing the new bushings.
3. Press the front radial bushing into the rotor, leading with the tapered edge. The bushing is in its proper location when the front face of the bushing is flush with the nearest rotor face.



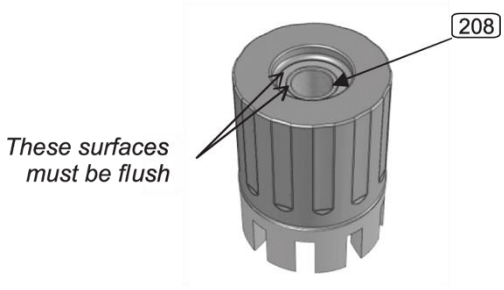
INSTALL FRONT RADIAL BUSHING

4. Press the thrust bushing into the rotor, leading with the tapered edge, until it bottoms out.



INSTALL THRUST BUSHING

5. Press the rear radial bushing into the rotor, leading with the tapered edge. The bushing is in its proper location when the rear face of the bushing is flush with the nearest rotor face.



INSTALL REAR RADIAL BUSHING

REPLACE ROTOR BUSHINGS

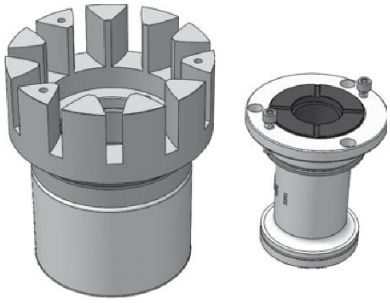
Carbon-Graphite and Bronze (E1-133 and E1-222 Models)

NOTE: The bushing carrier and rotor head are fitted together with a light interference fit.

1. Remove the three bushing carrier bolts.
2. Loosely install the bushing carrier bolts into the two (2) jacking screw holes in the bushing carrier.

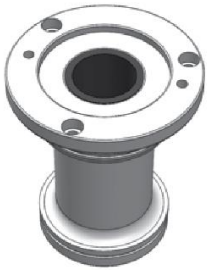
INSTALL JACK SREWS

3. Slowly and evenly thread the bushing carrier bolts into the bushing carrier, which will separate the bushing carrier from the rotor head.
4. Continue until the bushing carrier is free of the interference fit.
5. Separate the bushing carrier from the rotor. **WARNING:** By removing the bushing carrier, the inner ring and rotor head are no longer fastened together. Do not attempt to lift the rotor assembly (inner ring and rotor head) by way of the rotor head when the bushing carrier is not securely fastened in place. If an attempt is made to lift the rotor assembly without the bushing carrier installed, the inner ring will separate from the rotor head and potentially cause injury.



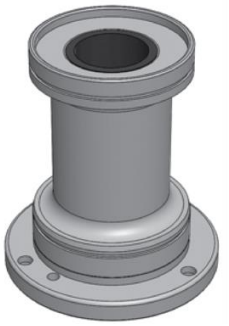
REMOVE BUSHING CARRIER

6. Remove the old bushings by pressing them out of the bushing carrier. It is not unusual for carbon graphite bushings to crack or break apart during removal.
7. Inspect the bushing carrier bore and rotor assembly bore for any damage. Any small scratches or nicks must be filed smooth before installing the new bushings and reassembling the rotor.
8. Press the front radial bushing into the bushing carrier, leading with the tapered edge. The bushing is in its proper location when the front face of the bushing is flush with the nearest bushing carrier face.



INSTALL FRONT RADIAL BUSHING

9. Press the front thrust bushing into the bushing carrier, leading with the tapered edge, until it bottoms out.
10. Press the rear radial bushing into the bushing carrier, leading with the tapered edge. The bushing is in its proper location when the rear face of the bushing is flush with the nearest bushing carrier face.

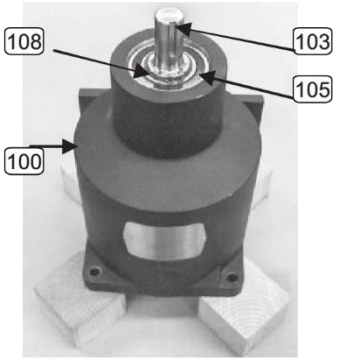


INSTALL REAR RADIAL BUSHING

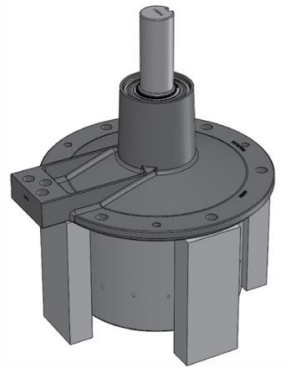
11. Press the rear thrust bushing into the bushing carrier, leading with the tapered edge, until it bottoms out.
12. Loosely install bushing carrier back into the rotor assembly.
13. The connection between the bushing carrier and the rotor head is a slight interference fit. Insert the three (3) bushing carrier bolts and evenly tighten them in small increments to pull the bushing carrier into the rotor head. Extreme caution must be taken to ensure the bushing carrier is properly aligned in the rotor assembly before tightening the bushing carrier bolts.
14. Torque bushing carrier bolts to 58 N•m (43 ft-lb) for cast iron and carbon steel pumps, and 50 N•m (37 ft-lb) for stainless steel pumps.

REPLACE OUTER BALL BEARING

1. Position the outer drive assembly on blocks in a suitable press with the shaft facing upward.
2. Remove the snap ring from its groove in the shaft.
3. Press the shaft downward until the outer bearing disengages from the shaft.

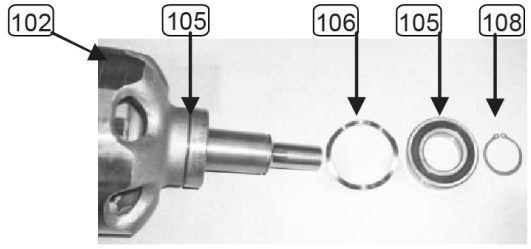


OUTER DRIVE ASSEMBLY ON BLOCKS
(E1-2 THRU E1-82 MODELS)



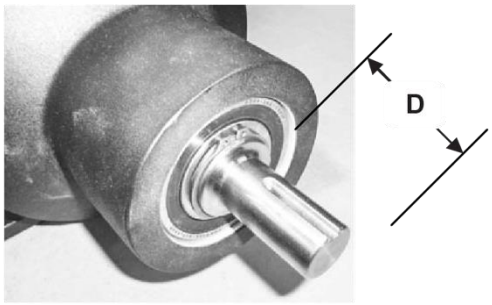
OUTER DRIVE ASSEMBLY ON BLOCKS
(E1-133 AND E1-222 MODELS)

4. Remove the outer ring assembly with shaft and inner bearing attached, wave spring and outer bearing.



BEARING AREA COMPONENTS

5. Remove the inner bearing from the shaft with a suitable gear puller.
6. Apply a light oil to the shaft and press the new inner bearing into the shaft. The new bearing inner race should be flush with the outer ring. Be careful to avoid disrupting the shaft position relative to the outer ring.
7. Insert the wave spring into the inner bearing counter-bore of the magnet housing /bearing housing.
8. Insert the outer ring/shaft/inner bearing assembly into the magnet housing/bearing housing.
9. Press the outer bearing onto the shaft until the distance from the end of the shaft to the face of the bearing meets the following specifications:



OUTER BEARING LOCATION

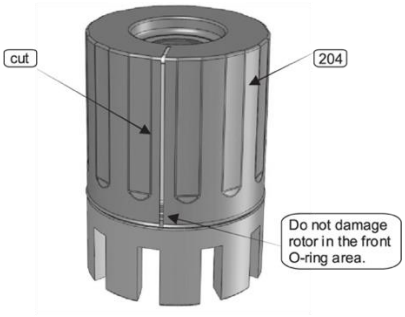
Model	Distance (D)
E1-2, E1-4	48.2 mm (1.9")
E1-24, E1-32, E1-55, E1-69, E1-82 [1.125" Shaft]	64.4 mm (2.5")
E1-24, E1-32, E1-55, E1-69, E1-82 [1.437" Shaft]	99.3 mm (3.9")
E1-133, E1-222	124.5 mm (4.9")

10. Install the snap ring in its groove in the shaft.

REPLACE INNER MAGNETS

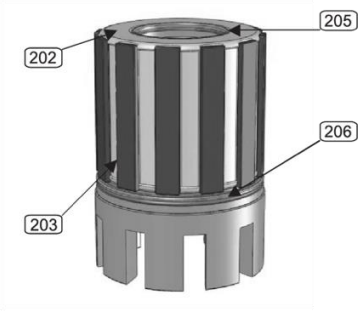
(E1-2 thru-E1-82 Models)

1. Carefully cut the sleeve. Be careful to avoid damaging the rotor in the area around the front O-ring.



CUT SLEEVE

2. Pull sleeve off of the rotor assembly.



REMOVE SLEEVE

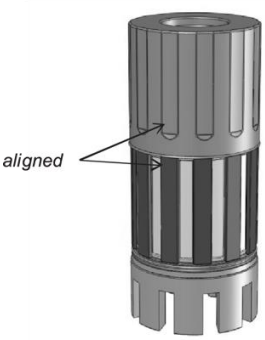
3. Remove the old magnet segments from the inner ring.
4. Remove the front and rear sleeve O-rings from the grooves in the rotor.
5. Install new O-rings in the grooves of the rotor.
6. Slowly bring one end of the new magnet segment into contact with the end of one (1) flat on the inner ring, such that only a short length of the magnet is in contact with the inner ring.

ASSEMBLE MAGNET SEGMENTS

7. Slide the magnet segment along the length of the inner ring until it touches the small stop at the end of the inner ring. Refer to the **Inner Magnet Polarity** figure on page 31.

PROPER MAGNET POSITION

8. Repeat steps 6 and 7 for the other magnet segments, making sure that each magnet is in opposite polarity with adjacent magnets.
9. Align the new sleeve over the back of the rotor such that the sleeve indentations are lined up with the magnets.
10. Press the sleeve over the magnets and O-rings until it contacts the rear of the inner ring.



PROPER SLEEVE ALIGNMENT

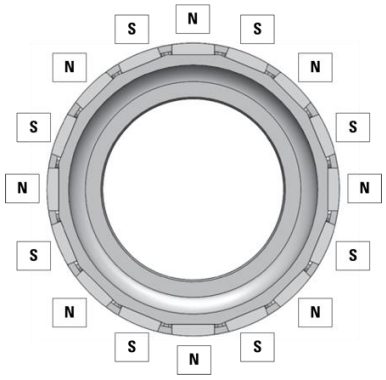
11. Visually inspect the front and rear of the sleeve to verify that the O-rings were not damaged by the sleeve.

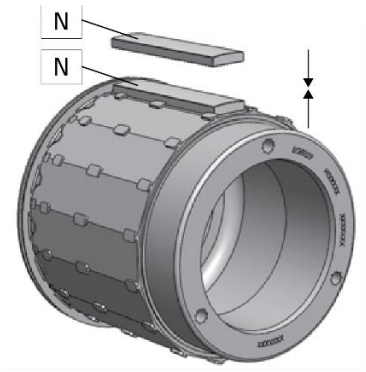
ROTOR ASSEMBLY

REPLACE INNER MAGNETS

(E1-133 and E1-222 Models)

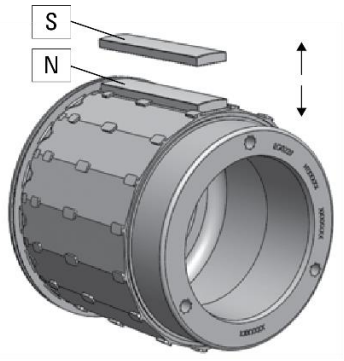
1. Carefully cut the sleeve. Be careful to avoid damaging the rotor in the area around the front and rear O-rings.
2. If bushing carrier is installed, remove it per the instructions in Section 7, **Replace Rotor Bushings**.
3. Remove the rotor head. If it doesn't come off freely, then thread the bushing carrier bolts into the jacking screw holes on the rotor crown and slowly remove the rotor crown from the inner ring by evenly tightening the jacking screws.
4. Pull sleeve off of the rotor assembly.
5. Remove the old magnet segments from the vinner ring.
6. Remove the front and rear sleeve O-rings from the grooves in the inner ring.
7. Slowly bring one (1) end of the new magnet segment into contact with the end of one (1) flat on the inner ring, such that only a short length of the magnet is in contact with the inner ring.
8. Slide the magnet segment along the length of the inner ring until it touches the small stop at the end of the inner ring.





Note: E1-133/222 inner ring shown

Check orientation: same polarity = attraction force



Note: E1-133/222 inner ring shown

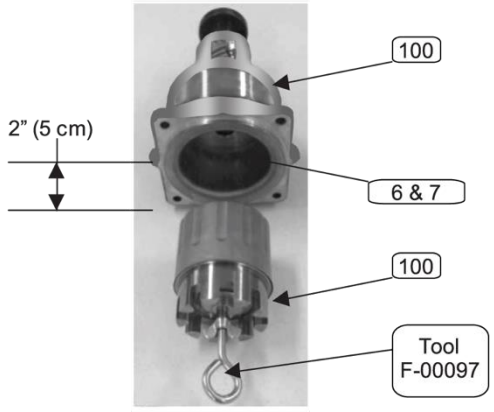
Check orientation: opposite polarity = repulsion force

9. Repeat steps 7 and 8 for the other magnet segments, making sure that each magnet is in opposite polarity with adjacent magnets. Refer to the **Inner Magnet Polarity** figure.
10. Install new O-rings in the grooves of the inner ring.
11. Align the new sleeve over the front of the inner ring and press the sleeve over the magnets and O-rings until it contacts the front of the inner ring.
12. Visually inspect the front and rear of the sleeve to verify that the O-rings were not damaged by the sleeve.
13. Install rotor crown onto inner ring.
14. Install bushing carrier into rotor assembly per the instructions in Section 7, **Replace Rotor Bushings**.

INSTALL ROTOR ASSEMBLY INTO OUTER DRIVE ASSEMBLY

(E1-2 and E1-4 Models)

1. Insert the canister and support plate into the outer drive assembly. The support plate has no “top” and “bottom.” Therefore, its orientation is irrelevant.
2. Use Tool F-00097 to firmly grab the rotor assembly in the bushing bore area.



TOOL IN ROTOR ASSEMBLY

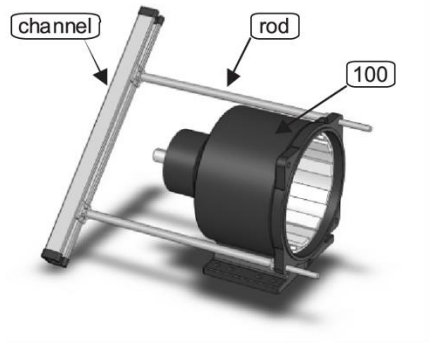
3. Bring the rotor assembly toward the canister until the back of the rotor is about 5 cm (2”) from the front of the outer drive assembly.
4. Slowly let the outer magnets pull the rotor into the canister while using moderate resisting force of about 18 to 27 kg (40 to 60 lb).
5. Remove the puller tool.

ROTOR ASSEMBLY IN PLACE

INSTALL ROTOR ASSEMBLY INTO OUTER DRIVE ASSEMBLY

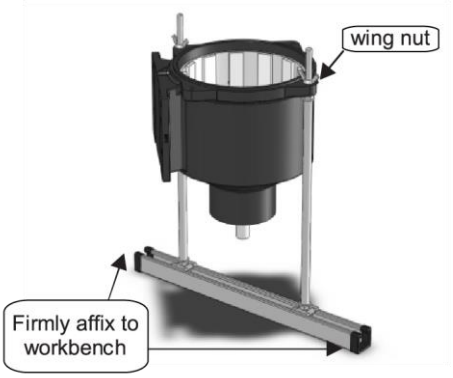
(E1-24, E1-32, E1-55, E1-69 and E1-82 Models)

1. Loosely fit the two (2) rods into opposite holes on the outer drive assembly.
2. Loosely position the two (2) rod ends into the channel.



ASSEMBLE RODS AND CHANNEL

3. Twist the two (2) rods to tighten the channel nuts and clamp the rods to the channel.
4. Assemble the two (2) wing nuts onto the two (2) rods to hold them to the outer drive assembly.
5. Carefully lift the outer drive assembly (with tool kit attached) and set it vertically on a suitable workbench with the rotating teeth facing upwards.
6. Firmly affix the channel to the workbench surface, so that it can safely resist a lifting force of up to 182 kg (400 lb).

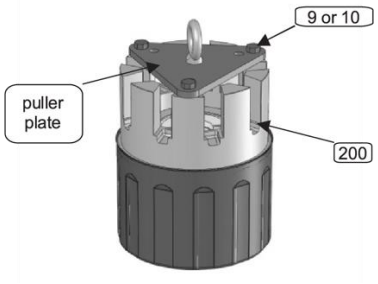


OUTER DRIVE ASSEMBLY MOUNTED TO TOOL

7. Insert the canister containing the support plate into the outer drive assembly. The support plate has no “top” or “bottom.” Therefore, the orientation is irrelevant.

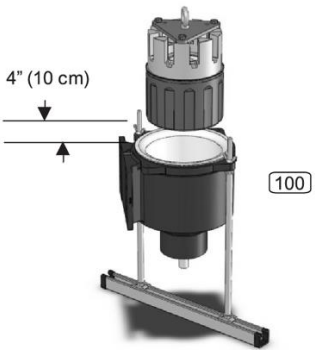
INSERT CANISTER AND SUPPORT PLATE

8. Attach the puller plate to the rotor assembly using three (3) of the pump's 13 mm (1/2") screws.



PULLER PLATE ON ROTOR ASSEMBLY

9. Support the rotor assembly using a crane, hoist or other suitable lifting device, and position it above the canister 10 cm (4") from the front of the outer drive assembly.

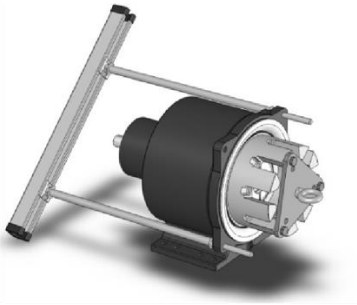


ROTOR ASSEMBLY READY FOR LOWERING

10. Slowly lower the rotor assembly into the canister. **NOTE:** During this process, the inner magnets on the rotor assembly will be strongly attracted to the outer magnets in the outer drive assembly.

ROTOR ASSEMBLY IN PLACE

11. Carefully lift the outer drive assembly (with the tool kit attached) and set it on a workbench, resting on the pump's foot.
12. Remove the tool rods and puller plate.

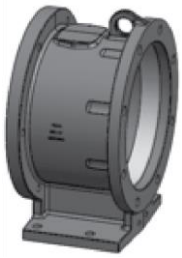


REMOVE TOOL

INSTALL ROTOR ASSEMBLY INTO OUTER DRIVE ASSEMBLY

(E1-133 and E1-222 Models)

1. Secure the magnet housing firmly to a level surface.

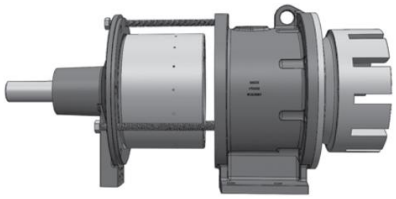


MAG HOUSING ON LEVEL SURFACE

2. Install the canister into the magnet housing aligning the bolt holes. Orientation is irrelevant.
3. Install the rotor assembly into the canister, ensuring it is all the way seated into the rear of the canister. A block may be required under the rotor head to ensure it stays parallel with the build surface during the following steps.

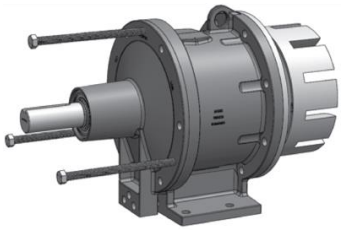
ROTOR INSTALLED INTO CANISTER

4. Thread the three (3) bearing housing jack screws into the bearing housing until the head bottoms out.
5. Orient the outer drive assembly to be in line with the back side of the magnet housing , ensuring the ends of the jack bolts rest against the magnet housing. A block may be required under the outer ring to ensure it stays parallel with the build surface during the following steps.



BEARING HOUSING IN POSITION

6. Slowly and evenly remove the jack screws from the bearing housing, which will allow the outer drive to slowly pull in to the magnet housing.
7. Continue until the coupling has fully re-engaged.

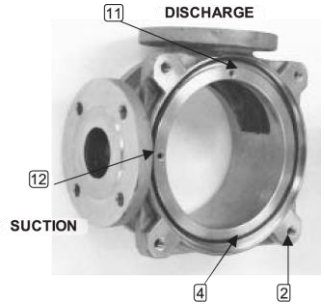


COUPLING FULLY RE-ENGAGED

8. Install six (6) screws holding the bearing housing to the magnet housing.
9. Remove jack screws from the bearing housing.
10. Install jack screws into their storage location in the bearing housing foot.

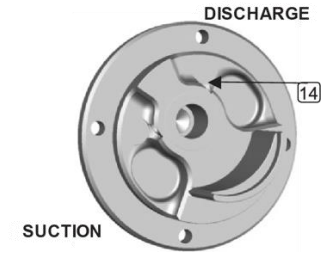
PUMPING CHAMBER ASSEMBLY

1. Make sure the casing orifice plug and casing block-off plug are in the correct locations:
   - Install the casing orifice plug behind the DISCHARGE port, if required.
   - Install the casing block-off plug behind the SUCTION port.
2. Position the canister O-ring in its groove in the casing. If necessary, use a small amount of light adhesive to keep the O-ring properly positioned. For E1-133 and E1-222 models, it is recommended to install the canister O-ring onto the canister.



CASING PLUGS AND O-RINGS

3. Slide the casing over the rotor, the lip of the canister and magnet housing. It may take some wiggling of the casing to get the canister and magnet housing positioned within the casing's alignment counter-bore.
4. If necessary, rotate the casing to get the ports in the preferred position.
5. Insert the screw that holds the outer drive assembly to the casing.
   a. First, torque 7 to 14 N•m (5 to 10 ft-lb) in an alternating pattern
   b. Next, torque 27 N•m (20 ft-lb) in an alternating pattern
   c. Finally, torque final values in an alternating pattern:
      i 10 mm (3/8") screws: 54 N•m (40 ft-lb)
      ii 13 mm (1/2") screws: 88 N•m (65 ft-lb)
      iii 16 mm (5/8") screws: 61 N•m (45 ft-lb)
6. If the pump is not equipped with a relief valve, ensure the head block-off plug is in the correct location on the DISCHARGE side of the head.

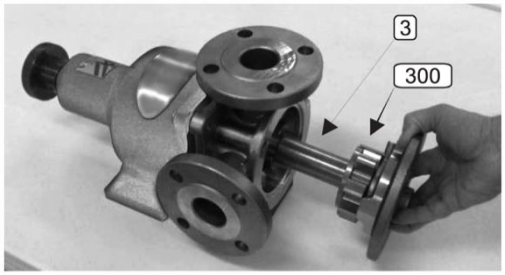


HEAD BLOCK-OFF PLUG

7. Slide the head O-ring onto the head. Take care to avoid scratching the O-ring.

HEAD O-RING

8. Position the head with the crescent facing upward and set idler assembly and spindle in place.



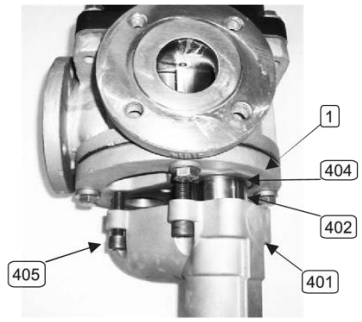
Head/Idler/Spindle Unit

9. Carefully insert the head/idler/spindle unit into the rotor. Take care to avoid cracking or chipping the carbon bushings.
10. Rotate the head so that the rotor and idler mesh are between the ports.
11. Insert the screws that hold the head to the casing and torque them to their final values:
    a. 10 mm (3/8”) screws: 54 N•m (40 ft-lb)
    b. 13 mm (1/2”) screws: 88 N•m (65 ft-lb)
    c. 16 mm (5/8") screws: 61 N•m (45 ft-lb)

RELIEF VALVE ASSEMBLY

(E1-2 thru E1-82 Models)

1. Check the valve body O-ring for damage or wear and replace, if necessary.
2. Position the valve body O-ring in its groove in the valve body. If necessary, use a small amount of light adhesive to keep the O-ring properly positioned.
3. Position the spring and poppet inside the valve body.
4. Determine which pocket in the head is aligned with the discharge port. The relief -valve poppet must be positioned on the discharge pocket for the valve to function correctly.
5. Position the valve body/spring/poppet onto the pump head with the poppet over the discharge pocket and loosely assemble the valve-body screws.
6. Tighten the screws in an alternating pattern until the valve body is fully contacting the head. Torque the screw to their fin al values:
   a. 10 mm (3/8”) screws: 54 N•m (40 ft-lb)
   b. 13 mm (1/2”) screws: 88 N•m (65 ft-lb)



RELIEF VALVE ASSEMBLY

RELIEF VALVE ASSEMBLY

(E1-133 and E1-222 Models)

1. Clean all parts thoroughly.
2. Install the poppet.
3. Insert the required springs.
4. Insert the spring guide.
5. Install the bonnet with O-ring. Securely tighten the bonnet.
6. Install adjusting screw and lock nut.
7. Tighten the adjustment screw to original setting.
8. Install the cap and O-ring. Securely tighten the cap.
9. Attach the pressure relief valve to the head using O-rings.

SYMPTOM OR PROBLEM: PUMP IS EXCESSIVELY NOISY

Problem Cause(s):

- Air in the inlet fluid stream
- Relief valve is opening
- Pump has decoupled
- Pump components are damaged or worn
- Pump is cavitating
- Discharge line is too restrictive
- Cooling path is plugged
- Ball bearings are worn or damaged

SYMPTOM OR PROBLEM: PUMP DOES NOT PRIME

Problem Cause(s):

- Discharge line is too restrictive
- Suction lift is too great
- Pump is not wetted
- Air leak in the suction line
- Pump is running in the wrong direction
- Head is positioned incorrectly
- Cooling-path plugs are not installed
- Pump is locked up with hardened fluid or foreign items
- Pump components are damaged or worn
- Pump has decoupled
- Inner magnets have weakened
- Cooling path is plugged
- Relief valve is stuck open

SYMPTOM OR PROBLEM: FLOW RATE IS TOO LOW

Problem Cause(s):

- Head is positioned incorrectly
- Cooling-path plugs are not installed
- Discharge line is too restrictive
- Viscosity is lower than expected
- Air in the inlet fluid stream
- Pump is cavitating
- Relief valve is opening
- Pump components are damaged or worn
- Bypass or auxiliary line in the discharge piping is open
- Cooling path is plugged
- Relief valve is stuck open

SYMPTOM OR PROBLEM: PUMP DOES NOT DEVELOP ENOUGH PRESSURE

Problem Cause(s):

- Viscosity is lower than expected
- Air in the inlet fluid stream
- Pump is cavitating
- Relief valve is opening
- Pump components are damaged or worn
- Bypass or auxiliary line in the discharge piping is open
- Head is positioned incorrectly
- Cooling-path plugs are not installed
- Cooling path is plugged
- Relief valve is stuck open

SYMPTOM OR PROBLEM: RELIEF VALVE DOES NOT OPEN

Problem Cause(s):

- Pump is running in the wrong direction
- Relief valve is stuck closed

SYMPTOM OR PROBLEM: LEAKAGE FROM HEAD/CASING AREA

Problem Cause(s):

- O-ring material is not compatible with pumped fluid
- Sealing surfaces for the O-rings are damaged
- Bolt(s) are loose or missing
- O-ring is damaged or missing

SYMPTOM OR PROBLEM: LEAKAGE FROM CASING/MAGNET-HOUSING AREA

Problem Cause(s):

- O-ring material is not compatible with pumped fluid
- Sealing surfaces for the O-rings are damaged
- Casing or magnet-housing mounting flanges are cracked
- Bolt(s) are loose or missing
- O-ring is damaged or missing

SYMPTOM OR PROBLEM: LEAKAGE FROM HEAD/VALVE-BODY AREA

Problem Cause(s):

- O-ring material is not compatible with pumped fluid
- Sealing surfaces for the O-rings are damaged
- Bolt(s) are loose or missing
- O-ring is damaged or missing

SYMPTOM OR PROBLEM: LEAKAGE FROM DRIVE-SHAFT AREA

Problem Cause(s):

- Canister is damaged or leaking

SYMPTOM OR PROBLEM: EXCESSIVE VIBRATION

Problem Cause(s):

- Air in the inlet fluid stream
- Relief valve is opening
- Pump has decoupled
- Pump components are damaged or worn
- Pump is cavitating
- Ball bearings are worn or damaged
- Inner magnets have weakened
- Cooling-path is plugged

SYMPTOM OR PROBLEM: PUMP DRAWS TOO MUCH POWER

Problem Cause(s):

- Pump components are damaged or worn
- Relief valve is stuck closed
- Ball bearings are worn or damaged
- Viscosity is higher than expected

Warranty

Each and every product manufactured by Blackmer® is built to meet the highest standards of quality. Every pump is functionally tested to insure integrity of operation.

Blackmer warrants that internal gear pumps, accessories and parts manufactured or supplied by it to be free from defects in material and workmanship for a period of five (5) years from date of installation or six (6) years from date of manufacture, whichever comes first. Failure due to normal wear, misapplication, or abuse is, of course, excluded from this warranty.

Since the use of Blackmer equipment is beyond our control, we cannot guarantee the suitability of any pump or part for a particular application and Blackmer shall not be liable for any consequential damage or expense arising from the use or misuse of its products on any application. Responsibility is limited solely to replacement or repair of defective Blackmer products.

All decisions as to the cause of failure are the sole determination of Blackmer.

Prior approval must be obtained from Blackmer for return of any items for warranty consideration and must be accompanied by the appropriate MSDS for the product(s) involved. A Return Goods Tag, obtained from an authorized Blackmer distributor, must be included with the items which must be shipped freight prepaid.

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Company Where Purchased _____

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Company Name _____

Industry _____

Name _____ Title _____

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Number of pumps in facility? _____ Number of Blackmer pumps? _____

Types of pumps in facility (check all that apply): ☐ Diaphragm ☐ Centrifugal ☐ Gear ☐ Submersible ☐ Lobe

☐ Other _____

Media being pumped? _____

How did you hear of Blackmer? ☐ Trade Journal ☐ Trade Show ☐ Internet/Email ☐ Distributor

☐ Other _____

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