



**04561858**  
Edition 2  
December 2007

# Gas Turbine Starter

Series ST400G

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## Operation and Maintenance Information

**EN** Operation and Maintenance Information

**ZH** 操作和维护信息



Save These Instructions

 **IR** Ingersoll Rand

**WARNING****General Product Safety Information**

- Read and understand this manual before operating this starter.
- It is your responsibility to make this safety information available to others that will operate this starter.
- Failure to observe the following warnings could result in injury.

**WARNING**

- For safety, maximum performance, and maximum durability of parts, do not operate this starter at air pressures over the pressure rating stamped on the nameplate. Use supply lines of adequate size as directed in the installation instructions in this manual.
- Always turn off the air or gas supply and disconnect the air or gas supply hose before installing, removing or adjusting any accessory on this starter, or before performing any maintenance on this starter.
- These Starters are designed for gas operation. They are not totally sealed in dynamic operation since the exhaust must be vented or piped away and there is a possibility of leakage around the output shaft when rotating.
- Caution should be taken when operating these starters on gas because of the danger of fire, explosion, or inhalation.
- After assembling a starter, always test in accordance with the procedures outlined in this manual. Never install a reassembled starter that has not been tested in accordance with the procedures in this manual.
- Operate this starter only when properly installed on the engine.
- Do not lubricate starters with flammable or volatile liquids such as kerosene or jet fuel.
- For personal protection, do not remove any labels. Replace any damaged label.
- Do not use damaged, frayed or deteriorated air hoses and fittings.
- Always wear eye protection when operation or performing maintenance on this starter.
- Always wear hearing protection when operating this starter.
- Use only recommended **Ingersoll Rand** accessories.

**Safety Symbol Identification**

Wear Respiratory Protection



Wear Eye Protection



Wear Hearing Protection



Read Manuals Before Operating Product

(Dwg. MHP2598)

**Safety Information - Explanation of Safety Signal Words****DANGER**

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

**WARNING**

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

**CAUTION**

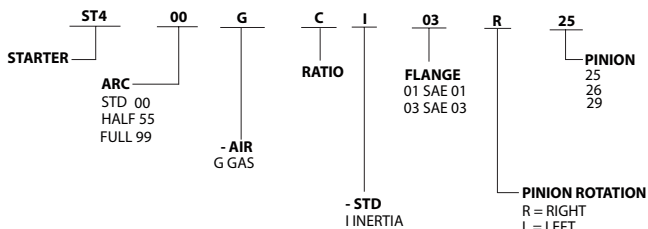
Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damage.

**NOTICE**

Indicates information or a company policy that relates directly or indirectly to the safety of personnel or protection of property.

## Placing Starter in Service

### How to Order a Starter



When ordering a Starter, refer to table below for correct pinion data.

#### Pinion Data

Teeth	Blank	D.P.	P.A.	Rotation	Pinion No.
11	12	6/8	20°	Right	25
12	13	8/10	20°	Right	29
11	13	6/8	20°	Left	26

For different models or special applications, contact your nearest Ingersoll Rand Distributor or Ingersoll Rand, Engine Starting Systems, Box 8000, Southern Pines, NC 28387 (910) 692-8700

### Installation

#### NOTICE

For maximum performance, read this manual prior to installation or operation of Series ST400G Starters.

#### General Information

- This starter is designed for flange mounting at the inlet. The Flange Mounting Kit is required for installation. All piping, hoses and valving must be clean prior to installation. Make sure that the starter inlet is free of dirt and foreign material during installation.
- Engine design often requires mounting the starter underneath in extremely close quarters, and even though two of the mounting bolt holes are easy to reach, the third one is less accessible. To install a starter, the following tools are required: regular ratchet wrench, sockets, universal joint, socket extension and single or double-end box wrench.
- Improper hook-up impairs the efficiency of a Starter. Pressure Lines smaller than those recommended will reduce the volume of air to the motor and the use of reducers for piped-away applications in the exhaust port will restrict the exhaust causing back pressure to the motor resulting in reduced performance. Keep the number of tees and elbows, and the length of the supply line to a minimum. Use 1-1/4" hose or pipe for supply lines up to 15 feet long; use 2" hose or pipe if the supply line is over 15 feet long.
- Install a 300 mesh strainer in the inlet line for each starter. These 300 mesh strainers provide 50 micron filtration and offer significant protection against supply line contaminants which could damage the turbine components. **Ingersoll Rand** offers 3 sizes: ST900-267-24 for 1-1/4 inch lines, ST900-267-32 for 2 inch lines and ST900-267-64 for 4 inch lines. Replacement elements are: ST900-266-24 for 1-1/4 inch, ST900-266-32 for 2 inch and ST900-266-64 for 4 inch lines.
- Make your connections bubble tight to avoid unnecessary costs and delays. On all threaded connections throughout the system, use **Ingersoll Rand** No. SMB-441 Sealant, non-hardening No. 2 Permatex or always run the air supply line from the side or top

of the receiver, never at or near the bottom. Moisture in the air collects at the bottom of the receiver resulting in damage which could cause the valves to become inoperative. Periodically, open the petcock at the bottom of the tank to drain the water.

- Whenever using a hazardous gas to operate the starter, there must be no leaks in inlet or exhaust piping or from any other starter joints. Pipe away all discharges to a safe area.
- We recommend installation of a "glad hand" in vehicular applications for emergency repressurizing of the system. To keep the "glad hand" clean and free of dirt and to protect it from damage, a second "glad hand" closed by a pipe plug can be mated to it, or a "glad hand" protector bracket can be used.

#### Orientation of the Starter

If the factory orientation will not fit your engine due to radial location of the Drive Housing or location of the inlet and/or exhaust ports, re-orient the starter as follows:

- Refer to the dimension illustration and note that the drive housing can be located in any one of eighteen radial positions relative to the air inlet (motor housing). The exhaust port (motor housing) can be located in an infinite number of radial positions relative to the air inlet (motor housing).
- Study the engine mounting requirements, and determine the required orientation of the Drive Housing relative to the Gear Case. If the Drive Housing has to be reoriented, remove the six Drive Housing Cap Screws and rotate the Drive Housing to its required position.

#### Mounting the Air Starter

- Study the piping diagram on TPE\_1026.
- The air receiver tank for a starter installation must meet SAE J10B specifications or conform to ASME specifications. It must have a working pressure capability equal to or greater than the maximum pressure at which the starter will be operated.
- When connecting the starter to a receiver tank that is already in service, bleed off the air pressure by opening the drain valve.

**WARNING**

**Bleed off the air pressure through a valve or petcock. Do not remove a plug from the tank while the tank is still pressurized. Drain off any water that has accumulated in the bottom of the tank.**

- Using a 1-1/4" short nipple, install the SRV125 Starter Relay Valve on the end of the receiver tank as shown in the piping diagram.

**NOTICE**

**Make certain the connection is made to the inlet side of the Relay Valve indicated by the word "IN" cast on the valve body.**

- Install the No. SMB-G618 Starter Control Valve on the dash panel (for vehicular installations) or some other appropriate panel (for stationary installations).
- Mount the No. 150BMP-1064 Air Pressure Gauge on or adjacent to the control panel. It should be located where it is readily visible to the operator of the Control Valve.
- Connect the Starter Control Valve to the Relay Valve with 1/4" hose. Install a Tee in this line with a short feeder hose to the Pressure Gauge.

**NOTICE**

**Make certain the hose is connected to the "SUPPLY" side of the Starter Control Valve.**

**Gas-Operated Starters**

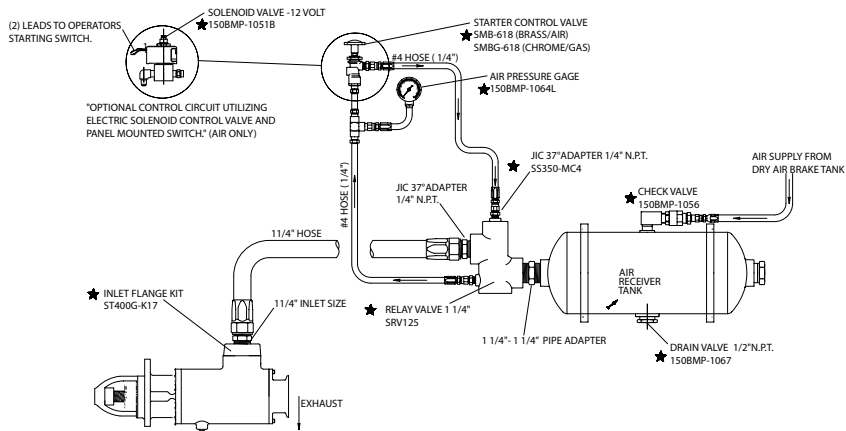
- Apply a thin film of sealant to the Housing Cover End Plug and the Lubricator Port Plug as they are assembled.
- Plug the exhaust. Connect air line to the inlet, regulate the air pressure to 40 psig (2.8 bar/280 kPa) and immerse the unit

- To determine the exact length of 1-1/4" air hose required, run a piece of heavy-duty hose or some other flexible tubing of the same diameter from the Relay Valve on the receiver to the Starter location on the engine.
- Attach the 1-1/4" air hose to the outlet side of the Relay Valve, and run the hose through the frame to its final position at the starter location.
- At this point, determine if it is feasible or practical to attach the hose to the starter before or after the starter is actually mounted. In many cases, it may be necessary to attach the hose to the starter before mounting.
- If possible, liberally grease the teeth on the ring gear with a good, sticky gear grease or motorcycle chain lube. This will help promote the life of the ring gear and the Starter Pinion.
- Place the starter into position, and mount it on the flywheel bell housing. Tighten the mounting bolts to 100 ft-lb (136 Nm) of torque.
- Pressurize the complete starting system and check every connection with a soap bubble test. There must be no leaks.

for 30 seconds in light oil, or non-flammable solvent. If there are any bubbles, the unit is unfit for gas operation. Tighten where necessary and/or apply sealant to area showing leak. Retest.

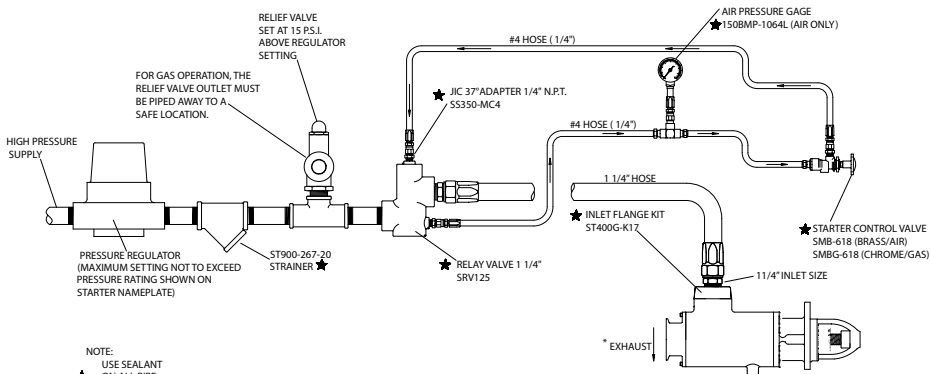
Piping Diagram

Piping Diagram for a Typical Vehicular Installation-Inertia



NOTE:  
USE SEALANT  
★ ON ALL PIPE  
CONNECTIONS.  
SMB-441

Piping Diagram for a Typical Stationary Installation-Inertia



NOTE:  
USE SEALANT  
★ ON ALL PIPE  
CONNECTIONS.  
SMB-441  
★ INGERSOLL RAND PART NUMBER

\*FOR NATURAL GAS OPERATION, STARTER  
MAIN EXHAUST MUST BE PIPED AWAY.

\* 2" NPT or  
ST400G-K350  
ELBOW KIT

(Dwg. TPE\_1026)



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## Parts and Maintenance

### **NOTICE**

**The use of other than genuine Ingersoll Rand replacement parts may result in safety hazards, decreased motor performance, and increased maintenance, and may invalidate all warranties.**

**Ingersoll Rand is not responsible for customer modification of Starters for applications on which Ingersoll Rand was not consulted. Repairs should be made only by authorized trained personnel. Consult your nearest Ingersoll Rand Authorized Service center.**

When the life of the Starters has expired, it is recommended that the Starters be disassembled, degreased and parts be separated by material so that they can be recycled.

Manuals can be downloaded from [www.irtools.com](http://www.irtools.com).

Refer all communications to the nearest **Ingersoll Rand** Office or Distributor.

**警告****通用产品安全信息**

- 在操作该起动机之前，请阅读并理解本手册。
- 您有责任为其他准备操作本起动机的人员提供此安全信息。
- 不按照以下警告进行操作将可能导致人员受伤。

**警告**

- 为使零件保持安全、高性能和耐用性，切勿在气压大于铭牌上所印的压力定数值时操作该起动机。使用本手册安装说明所述型号的供应管线。
- 在安装、拆卸或调整本起动机上的任何附件之前，或者在对本起动机进行任何维护之前，请务必关闭空气供应，并断开供气管道。
- 这些起动机供气操作之用。它们在动态运行期间没有完全密封，因为排气口必须进行排气，输出轴旋转时其周围可能存在漏气现象。
- 当通过气体操作这些起动机时应该十分小心，因为可能发生火灾、爆炸或气熏的危险。
- 在装配好起动机后，务必根据本手册中列出的步骤进行测试。如果重新组装的起动机未根据本手册程序进行测试，请勿对其进行安装。
- 只有起动机正确安装到发动机上后，才能运行。
- 不要使用煤油或喷气机燃油等易燃、易挥发的液体来润滑起动机。
- 为保护个人安全起见，切勿撕下任何标签。请更换任何受损的标签。
- 切勿使用已损坏、磨损或老化的空气软管及其它连接装置。
- 在对该起动机进行操作或维护时，务必佩戴防护眼镜。
- 操作本起动机时，请务必佩戴听力保护装置。
- 请只使用推荐的 **Ingersoll Rand** 附件。

**安全标识识别。**

戴呼吸保护器  
保护。



戴眼镜  
保护。



戴听力保护器  
保护。



先阅读手册  
操作产品

(图 MHP2598)

**安全信息：安全信号文字解释****危险**

表示：如果不避免，可能出现紧急危险情况导致死亡或重伤。

**警告**

表示：如果不避免，可能出现紧急危险情况，可能导致死亡或重伤。

**小心**

表示：如果不避免，可能出现紧急危险情况，可能导致人员轻度或重度受伤或财产损失。

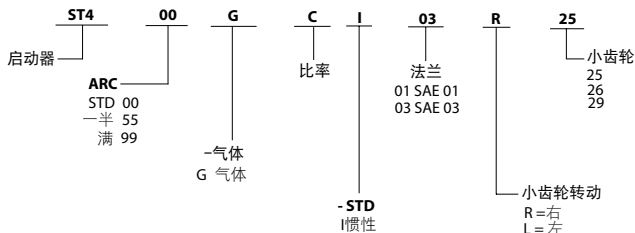
**注意**

表示直接或间接与人身安全和财产保护有关的信息或公司政策。



## 使启动器处于使用状态

### 如何订购启动器



订购启动器时，请参阅以下表格选择正确的小齿轮数据。

#### 小齿轮数据

齿牙	空白	D.P.	P.A.	旋转	小齿轮号码
11	12	6/8	20°	右	25
12	13	8/10	20°	右	29
11	13	6/8	20°	左	26

如果需要不同型号或特殊应用，请联系最近的 **Ingersoll Rand** 经销商，或 **Ingersoll Rand** 发动机启动系统部，地址：**Box 8000, Southern Pines, NC 28387 (910) 692-8700**。

## 安装

### 注 意

为保持高性能，请在安装或使用 **ST400G** 系列启动器之前阅读本手册。

#### 一般信息

- 该启动器供在进口处的法兰装置之用。安装法兰时需要使用成套安装工具。在安装前，必须清洁所有管道、软管和装设阀门。在安装期间，请确保启动器进口没有污物和异物。
- 发动机设计经常要求将启动器安装在极靠下的位置。这样，有两个安装螺丝容易够到，但第二个不容易够到。要安装启动器，需要以下工具：常用的棘轮扳手套筒、万向接头、伸缩套筒和单头或双头套筒扳手。
- 不适当的联结将降低启动器的效率。使用小于所建议尺寸的软管会将气体量压缩到电动机中，而且使用在排气管端口内的排放装置（即渐缩管）将会限制排放量（对导致性能降低的发动机造成反压力）。尽量减少供应管线中的T形管和弯管，及供应管线的长度。使用1-1/4"软管或管线做供应管线，最长15英尺：如果供应管线长度超过15英尺，使用2"软管或管线。
- 在每台新启动器的进口管道上安装300网滤水器。该300网滤水器具有50微米滤芯，可有效保护供应管线免受污染（可能会损坏涡轮增压件）。**Ingersoll Rand** 提供3种尺寸：ST900-267-24（1-1/4英寸管线），ST900-267-32（2英寸管线）和ST900-267-64（4英寸管线）更换元件有：ST900-266-24（1-1/4英寸）、ST900-266-32（2英寸）和ST900-266-64（4英寸管线）。
- 使连接气泡紧密以避免不必要的费用和延迟。在整个系统的所有螺纹连接中，使用**Ingersoll Rand**的SMB-441号密封胶和非硬化2号Permatex，或始终在接收器的侧面或顶部布置空气供应管线，切忌在底部或靠近底部的位置。空气中的水分聚集在接收器的底部，便可能导致阀门损坏以致无法使用。定时打开箱底部的小龙头以排出水份。
- 当使用有害气体操作启动器时，在进气口、排气管线或其它连接处决不能有泄露。用管线将所有排放物排到安全地点。
- 我们建议在车辆应用中安装“glad hand”用作系统的紧急增压。要保持“glad hand”干净和没有污物，并保护其免受损坏，可将其连接到由管道塞子密封的第二个“glad hand”，可使用“glad hand”保护器托架。

#### 启动器的定向

如果工厂定向因传动箱的径向位置或进气口和/或排气管端口而无法安装发动机，请按如下方式重新定向启动机：

- 参见尺寸图并注意传动箱可以位于相对进气口（电动机箱）18个径向位置的任一位置。排气口（电动机箱）可以位于相对进气口（电动机箱）无数个径向位置的任一位置。
- 学习发动机安装要求，并确定与齿轮箱相对的传动箱的所需定向。如果传动箱必须重新定位，可卸下8个传动箱有头螺丝，然后将传动箱旋转至所需位置。

#### 安装气动启动器

- 学习图TPE\_1026上的管线布置图。
- 在安装启动器时，空气接收器箱必须符合SAE J10B规格或ASME规格。工作压力必须等于或大于启动器运行的最大压力。
- 当启动器与在用的接收器箱连接时，打开溢流阀以释放空气压力。

### 警告

通过阀或旋塞排出气压。当油箱仍处于增压状态时，切勿从箱上拔出塞子。排出积聚在箱底部的水份。

- 使用1-1/4"的短螺纹接管将SRV125启动器继动阀安装在接收箱末端，如管道布置图所示。

### 注 意

确保连接到继动阀的进口侧（在阀座上标注为字母“IN”）。

- 请在仪表板上（车载装置）或某些其他相应面板上（固定装置）安装No. SMB-618启动器控制阀。
- 将No. 150BMP-1064气压计安装在控制面板上或邻近控制面板处。它应位于控制阀操作者容易看到的地方。
- 将启动器控制阀连接到具有1/4"软管的继动阀上。使用短进料软管将此管道中的T形管安装到压力计上。

### 注 意

确保将软管连接到启动器控制阀的“SUP”侧。

- 要确定所需的1-1/4"进气软管的确切长度，可运行大功率软管设备或直径相同的某些其他弹性软管（从接收器的继动阀到发动机的启动器位置）。

- 将 1-1/4" 进气软管连接到继动阀的出口侧，并使软管从机架旁穿过起动器处的最终位置。
- 在此，可在实际安装起动器之前或之后，确定将软管连接到起动器是否可行或实用。在多数情况下，可能需要在安装之前将软管连接到起动器。
- 如果可能，在环型齿轮的齿牙上涂抹高质量粘性齿轮油脂或摩托车链条润滑油。这将有助于延长环形齿轮和起动器小齿轮的使用寿命。
- 将起动器各就其位，然后将其安装在飞轮外壳上。旋紧安装螺栓至 100 英寸-磅（136 牛米）扭矩。
- 加压整个起动系统，并使用皂气泡测试检查各个连接。确保不会出现渗漏状况。

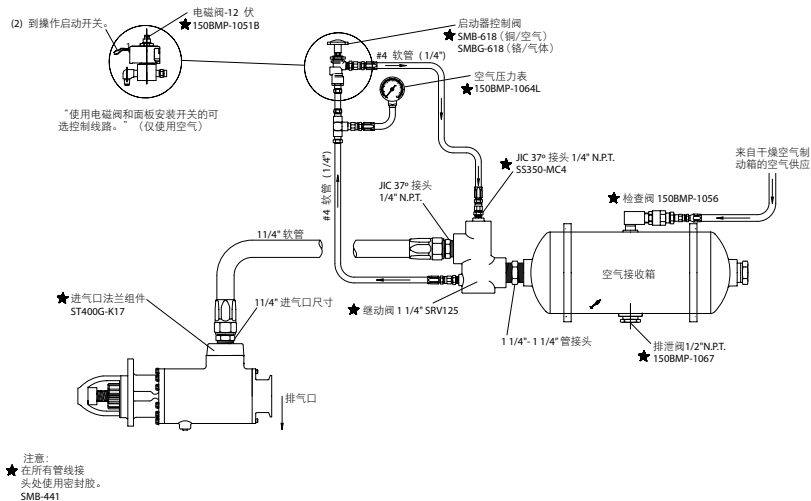
## 气动启动器

- 在安装外壳端盖塞和润滑器端口塞时，使用密封胶。
- 插上排气管。将空气管与进气口连接，调节气压到 40 psig (2.8 bar/280 kPa)，浸入该装置在轻油内或可燃溶剂内 30 钟。

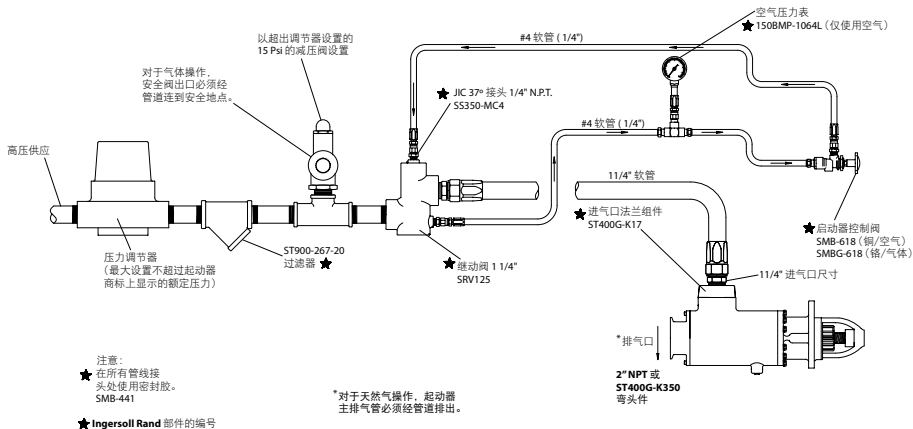
如果有气泡，该装置不适合气体操作。将漏气的地方紧固和/或涂上密封胶。再试。

## 管道布置图

典型车辆安装-惯性管道布置图



典型固定安装-惯性管道布置图



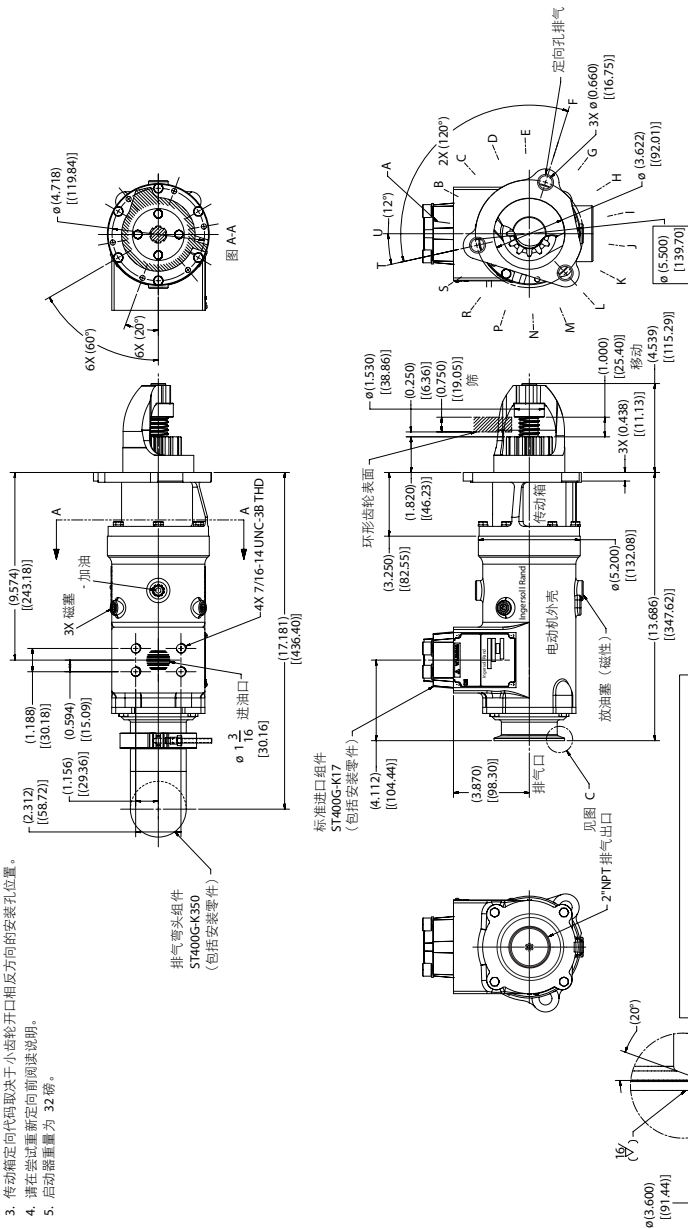
(图 TPE\_1026)

尺寸图

注意:

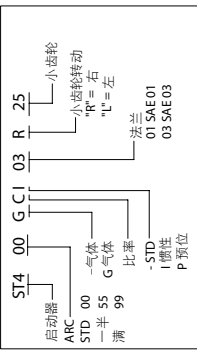
1. 如果可能, 启动器应使排气口朝下安装在内微机上。
2. 这些型号没有批准用于启动器暴露在变速器油中的情况。
3. 传动箱定向代码取决于小齿轮开口相反方向的安装孔位置。
4. 请在安装重新定向前阅读说明。
5. 启动器重量为 32 磅。

(图 TPE\_1023)



小齿轮数据			
齿牙	空白	DP, PA	小齿轮号码
11	12	6/8 20°	25
12	13	8/10 20°	29
11	12	6/8 20°	25

定向选项		英寸	毫米
空白	定向选项	双	英寸
18@20°	传动箱	英寸	毫米



ST400GCI03R25 惰性气体 PHOENIX

**注 意**

如果使用非 **Ingersoll Rand** 配件, 可导致安全危害、降低电动机性能、增加维修和取消所有保证。

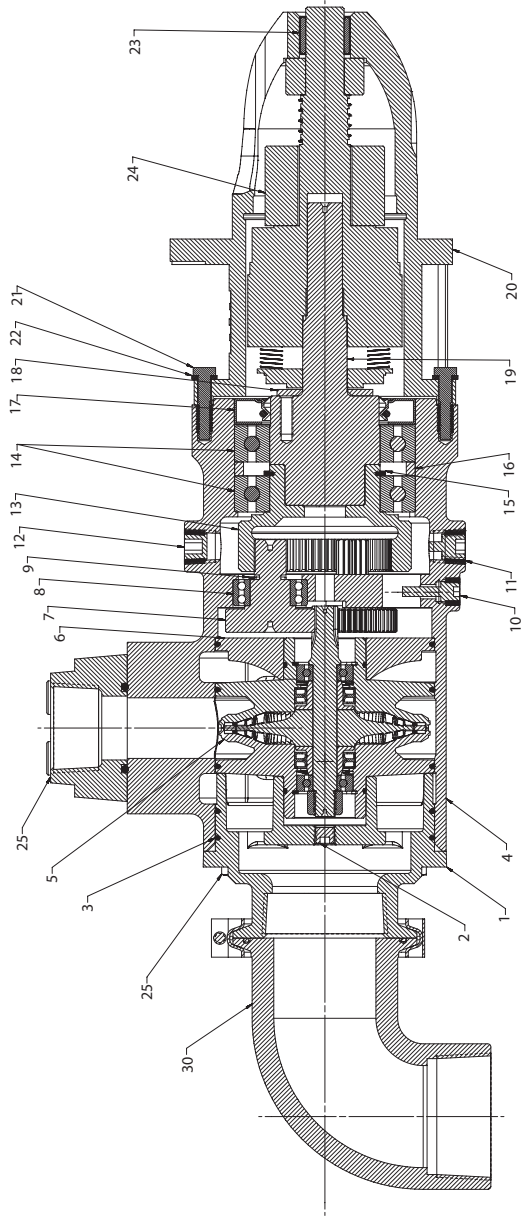
**Ingersoll Rand** 对客户将启动器修改用于非 **Ingersoll Rand** 指定场合概不负责。维修应由授权专业人员进行。咨询您最近的 **Ingersoll Rand** 授权维修中心。

当启动器的寿命到期时, 应将启动器拆卸和去脂, 零件按材料分开以进行回收。

手册可从 [www.irtools.com](http://www.irtools.com) 下载。

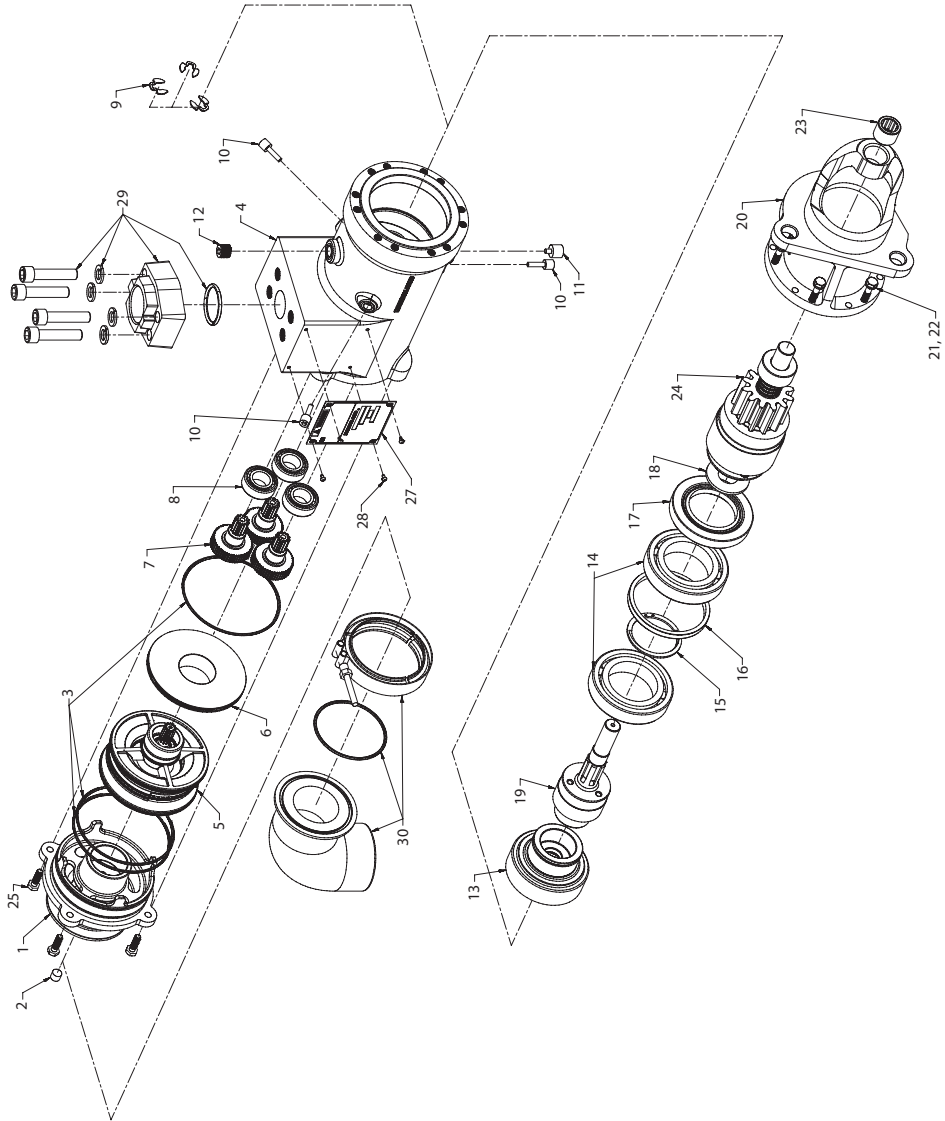
如有任何事宜, 请垂询就近的 **Ingersoll Rand** 办事处或经销商。

ST400G Gas Turbine Starter Parts Drawing



(Dwg. TPE\_1024)

# ST400G Gas Turbine Starter Exploded Diagram



Dwg. TPE\_1022)

## ST400G Gas Turbine Starter Parts List

Item	Part Description	Part Number	Item	Part Description	Part Number	
1	Cover End	04613410	19	Drive Shaft		
2	Pipe Plug	Y17-50-S		for ST400GCI03R25	04612792	
3	O-Ring (5)	ST400-244		for ST400GCI03L26	04612792	
4	Housing	04613089		for ST400GCI03R29	04662882	
5	Motor Assembly			for ST499GCI03R25	04612792	
	for ST400GCI03R25	ST400R-A53		for ST499GCI03L26	04612792	
	for ST400GCI03L26	ST400L-A53		for ST499GCI03R29	04662882	
	for ST400GCI03R29	ST400R-A53		20	Housing	9BM-300-H2
	for ST499GCI03R25	ST499R-A53		21	Cap Screw (6)	10BM-744
	for ST499GCI03L26	ST499L-A53		22	Washer (6)	10BM-67
	for ST499GCI03R29	ST499R-A53	23	Bearing	ML50K-318	
6	Front Deflector	ST400-111	24	Drive		
7	Planet Gear (3)	ST400-10A		for ST400GCI03R25	10BM-299-21	
8	Bearing (3)	ST400-278		for ST400GCI03L26	10BM-299-19	
9	Snap Ring (3)	04560157		for ST400GCI03R29	10BM-299-22	
10	Magnetic Plug (3)	04658621		for ST499GCI03R25	10BM-299-21	
11	Magnetic Plug	CE110-29		for ST499GCI03L26	10BM-299-19	
12	Pipe Plug	Y17-51-S		for ST499GCI03R29	10BM-299-22	
13	Ring Gear	ST400-37A		25	Cap Screw (4)	Y99-43
14	Bearing(2)	ST400-22	26	Warning Plate	04612313	
15	Retaining Ring	ST400-366	28	Drive Screw (4)	Y60-43	
16	Spacer	04658639	29	Flange Kit	ST400G-K17	
17	Seal	04561114	30	Exhaust Elbow Kit	ST400G-K350	
18	Thrust Washer	04658779				

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## Maintenance

### WARNING

Always wear eye protection when operating or performing any maintenance on this starter.

Always turn off the air or gas supply and disconnect the air supply hose before installing, removing or adjusting any accessory on this starter or before performing any maintenance on this starter.

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## Disassembly

### General Instructions

1. Do not disassemble the starter any further than necessary to replace worn or damaged parts.
2. When grasping a part in a vise always use leather-covered or copper-covered vise jaws to protect the surface of the part and help prevent distortion. This is particularly true of threaded members.
3. Do not remove any part which is a press fit in or on a subassembly unless the removal of that part is necessary for replacement or repairs.
4. Always have a complete set of seals and O-rings on hand before starting any overhaul. Never reuse old seals or gaskets.
5. Always mark adjacent parts on the End Cover (1), Housing (4), and Drive Housing (20) so these members can be located in the same relative position when the starter is reassembled.
6. Never wash the Starter Drive (24) in a solvent.
7. Do not press any bearing from a part unless you have a new bearing on hand for installation.

### Disassembly of the Motor Housing

1. If replacing the Motor Assembly (5), remove both Magnetic Plugs (10,11) and drain the oil from the gearing before beginning disassembly of the Starter. Inspect the Magnetic Plugs for metal particles. Very fine metal particles are normal. Remove particles and reinstall plugs. Tighten each plug to a final torque of 60 in-lb (7 Nm). Large particles or chips are an indication of a problem.
2. Remove the four End Cover Cap Screws (25) from Housing (4).
3. Pull the End Cover (1) from the Motor Housing (4). To dislodge the End Cover rotate it until the ears clear the Motor Housing. Using a plastic hammer, tap the ears alternately until the End Cover can be removed from the Motor Housing.
4. Grasp the rear end of the motor and pull the entire assembly away from the Housing (4). If the Motor Assembly is difficult to remove, insert a pry bar into the intake port and gently lift the Motor Assembly upward.

### Disassembly of the Drive Housing

1. Set Housing unit upright on the workbench with the Housing (20) upward.
2. Remove the Housing Cap Screw (21) and Housing Washers (22) and lift off the Housing (20) and Drive (24).

### Disassembly of the Drive Gearing

1. Place the Housing (4) in a hydraulic press, drive end down.
2. Align three bolts through housing contacting face of Ring

3. Gear (13). Apply a load to the bolts and press out Ring Gear (13), Bearings (14), Retaining Ring (15), Spacer (16), Seal (17) and Thrust Washer (18) and Shaft (19).
3. Remove Seal (17), one Bearing (14) and Spacer (16).
4. Using snap ring pliers remove Retaining Ring (15) and remove Bearing (14).
5. Do not disassemble Drive Shaft (19) from Ring Gear (13) unless damage is evident. If damage is evident place Drive Shaft and Ring Gear in arbor press, shaft end down and disassemble.

### Disassembly of the Planet Gear

1. Using snap ring pliers and working through the front end remove the three Snap Rings (9) from the Planet Gears (7).
2. Place the Housing (4) in an arbor press, drive end up.
3. Apply a load to the Planet Gear (7) and press out each Planet Gear (7) and Bearing (8).

### Cleaning Parts

Once the Starter has been disassembled, clean all parts for inspection.

1. Wipe all dirt, grease, etc. from the Starter Drive and sealed bearings.

### NOTICE

**Do not wash these parts in kerosene or other solvent as this will dilute and contaminate any sealed-in lifetime lubricant.**

2. Wash all parts except the Starter Drive or any sealed bearing in clean kerosene or other solvent. Dry the parts with compressed air.

### Inspection of Parts

1. Discard all O-rings and gaskets. These should not be reused.
2. Check all grease seals. If they appear worn or distorted, remove them from their parent member and discard.

### NOTICE

**Discard any seal that was removed during disassembly of the starter.**

3. Check all needle bearings. Discard any needle bearing that was pressed from a parent member during disassembly of the starter. Remove and discard any other needle bearing that appears worn, distorted, has loose needles or does not run freely.
4. Check all ball bearings. These should run freely without any rough spots or binding. Discard any bearing that gives any indication of wear.

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## Assembly

### General Instructions

1. Always press on the **inner** ring of a ball-type bearing when installing the bearing on a shaft.
2. Always press on the **outer** ring of a ball-type bearing when pressing the bearing into a bearing recess.
3. Whenever grasping a starter or part in a vise, always use leather-covered or copper-covered vise jaws. Take extra care with threaded parts or housings.
4. Always clean every part and wipe every part with a thin film of **Ingersoll Rand** No. 50 Oil before installation.
5. Check every bearing for roughness. If an open bearing must be cleaned, wash it thoroughly in a clean, suitable, cleaning solution and dry with a clean cloth. Sealed or shielded bearings should never be cleaned. Work **Ingersoll Rand** No. 130 Grease thoroughly into every open bearing before installation.

6. When assembling the motor always use new O-rings.
7. Before installing O-rings, coat liberally with O-ring lubricant and apply O-ring lubricant to O-ring grooves. After the O-ring is installed, coat the O-ring again with O-ring lubricant.

### Assembly of the Motor Housing

1. Place the Housing (4) in an Arbor Press, exhaust end up, press three Bearings (8) into the Housing.
2. Press three Planet Gears (7), shaft end down, into bearings.
3. Remove Housing from Arbor Press and install three Snap Rings (9). Working through front end, on the three Planet Gear Shafts. Install Front Deflector (6), through exhaust end, with flat face down.
4. Install Front Deflector (6), through exhaust end, with flat face down.



5. Before installing the Motor Assembly, coat the O-rings on the Motor Assembly and the inside of the Cylinder with O-ring lubricant. Install the Motor Assembly through the rear of the Motor Housing with geared end of the Rotor toward the front.
6. Coat two O-rings (3) with O-ring lubricant and install in the grooves on the End Cover (1).
7. Install the End Cover (1) on the rear of the Motor Housing using Starter Assembly Cap Screws (25). Tighten to a final torque of 120 in-lb (13 Nm).

**NOTICE**

**After assembling the exhaust cover to the starter, add 10 to 15 ml of Dextron@\*\*\*II Automatic Transmission Fluid through the pipe plug hole in the Exhaust Cover.**

8. Install pipe plug (2) and tighten to 60 in-lb (7 Nm).

**Assembly of Drive Gearing**

1. Using a hydraulic press, press Drive Shaft (19) into Ring Gear (13).
2. Slide one Bearing (14) onto Drive Shaft (19).
3. Using snap ring pliers, install Retaining Ring (15).
4. Slide Spacer (16) onto Drive Shaft (19).
5. Slide other Bearing (14) onto Drive Shaft (19).
6. Install seal (17) into Motor Housing (4) using arbor press.

**Assembly of Drive Housing**

1. If the Drive Housing Bearing (23) was removed, stand the Drive Housing (20) upright and press a new Drive Housing Bearing, unstamped end first, into the Drive Housing until the unstamped end of the Bearing is flush with the inside face of the Drive Housing boss. Work some **Ingersoll Rand** No. 130 Grease in the Bearing.

**NOTICE**

**Do not clean the Starter Drive (24) with solvent. If Starter Drive appears dry, apply Ingersoll Rand No. 130 Grease to the threads under the pinion.**

2. Apply a thin film of **Ingersoll Rand** No. 130 Grease to the surface of the Drive Shaft (24).
3. Install the Thrust Washer (18), with bevelled inner ring down, on the Drive Shaft (19).
4. Place the Starter Drive on the Drive Shaft.
5. Place the Drive Housing over the Drive onto the Motor Housing (4). Rotate the Drive Housing into the required orientation. At the same time, align the Cap Screw holes in the Drive and Motor Housings.
6. Install the Drive Housing Cap Screw (21) and Washer (22) and tighten the Cap Screws to 120 in-lb (13 Nm) of torque.
7. Install the Drive Housing Cap Screws (23) and Lock Washers (24) and tighten the Cap Screws to 120 in-lb (13 Nm) of torque.

**Troubleshooting Guide**

Trouble	Probable Cause	Solution
Motor will not run	No air supply	Check for blockage or damage to air supply lines or tank.
	Damaged motor assembly	Inspect Motor Assembly and power train and repair or replace if necessary.
	Foreign material in motor and/or piping	Remove Motor Assembly and/or piping and remove blockage.
	Blocked exhaust system	Remove Housing Exhaust Cover ( 1 ) and check for blockage.
	Defective Control Valve or Relay Valve	Replace Control Valve or Relay Valve.
	Low air pressure to Starter	Check air supply.
	Restricted air supply line.	Check for blockage or damage to air lines.
Loss of Power	Relay Valve malfunctioning	Clean or replace lines or Relay Valve. Lube Relay Valve.
	Exhaust flow restricted	Check for blocked or damaged piping. Clean or replace piping. Check for dirt or foreign material and clean or remove. Check for ice build-up. Melt ice and reduce moisture build-up to Starter.
	Worn motor parts	Remove the motor from the Motor Housing (14) and disassemble the motor. Examine all parts and replace any that are worn or damaged.
	Lack of air to starter	Check for clogged or damaged air line between relay valve and starter. Check relay valve to determine if it is functioning properly. Check air tank.

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**Notes:**

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