

BRUKSANVISNING / USER MANUAL

# SS175 SS350 Series Installation and Maintenance 03532561

Ingersoll Rand SS350GB01R85-02H · SS350GB01R85-02J ·  
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## Service · Kalibrering · Originalreservdelar

Service · Calibration · Genuine spare parts



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## Starters

**Series SS175 and SS350**

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# Installation and Maintenance Information

**EN** Installation and Maintenance Information

**ZH** 安装和维护信息

**JA** 据付および保守の情報



**Save These Instructions**

**IR** *Ingersoll Rand®*

## Product Safety Information

### Intended Use:

These air starters are intended for use in starting reciprocating internal combustion engines. These starters are designed to be operated from a remote location after proper installation on the engine requiring starting.

For additional information refer to Air Starters for Internal Combustion Engines Product Safety Information Manual Form 45558624.

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

The Ingersoll Rand Starter is a precision piece of equipment intended to give efficient, economical performance over a long period of time. However, as with any product, performance, economy and durability are determined for the most part by a few simple common sense procedures that can be recommended only by the manufacturer and adhered to only by the customer.

The recommendations outlined in this manual are based on over 30 years of experience in the air and gas starter field. Study these recommendations and follow them. They can save you considerable time and expense. This manual should be filed in a permanently available location.

## Lubrication

### WARNING

Do not lubricate starters with flammable or volatile liquids such as kerosene or jet fuel.

For temperatures above 32° F (0° C), use a good quality SAE 10 non detergent motor oil.

For temperatures below 32° F (0° C), use diesel fuel. We cannot too strongly emphasize the importance of proper lubrication of the Starter. It is the prime requisite for top performance and maximum durability, yet requires so little time there is really no excuse for disregarding it.

Either one of two lubrication systems is recommended. For typical Starter installations where the cranking cycle is less than 10 seconds, we recommend an Ingersoll Rand No. HDL2 Lubricator installed as shown on Page 3. Use either diesel fuel or 10W non detergent motor oil for lubricant. If the cranking cycle is more than 10 seconds, we recommend the Ingersoll Rand Lubricator No. NL-24-8 installed in the main air supply line. Use a good quality 10W non detergent oil and adjust the Lubricator to flow 1 to 2 drops per second.

## Installation

### General Information

1. Always make certain your Air Starter is properly installed. A little extra time and effort spent in doing a top quality job will contribute considerably toward a reliable starting system that does a superior job of starting your engine quickly under all conditions.
2. We strongly recommend that on all vehicular installations, and on stationary engines subject to vibration, you use hoses of the specified diameter instead of rigid pipe connections. Vehicle and engine vibration will soon loosen rigid pipe connections, whereas hoses will absorb the vibration, and connections will remain tight.
3. In the actual mounting of an Air Starter, it is best to have the hose connections already made at the receiver, and to have the Starter end of the hose handy for attaching to the Starter. Wherever possible and many times it is necessary attach the air hoses to the Starter before mounting the Starter on the flywheel housing. The reason for following this procedure is twofold:
  - a. After mounting the Starter, it is often impossible to make hose connections due to space limitations.
  - b. Once the hoses are attached, they carry some of the weight of the Starter and make it easier to complete the mounting.
4. The efficiency of an Air Starter can be greatly impaired by an improper hook-up. Hoses smaller than those recommended will reduce the volume of air to the motor, and the use of reducers in the exhaust port will restrict the exhaust and choke the motor. The number of tees and elbows, and the length of the supply line should be kept to a minimum. For SS175, use 1" hose or pipe for supply lines up to 30 feet long; use 1-1/4" hose or pipe if the supply line is over 30 feet long. For SS350, use 1-1/4" hose or pipe for supply lines up to 30 feet long; use 1-1/2" hose or pipe if the supply line is over 30 feet long.
5. A leak in any of the connections means that the system will drain overnight and will have to be repressurized the next morning by use of another vehicle or compressor. Make your connections right the first time 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 Loctite® \* Pipe Sealant. Teflon tape is not recommended. Always run your 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 and could cause corrosion in the starter motor or, worse yet, freeze solid in cold weather so that the Starter would be inoperative. After all connections have been made, check each joint with a soap bubble test. There must be no leaks. The slightest leak will cause the system to lose pressure overnight.

6. We recommend installation of a "glad hand" for emergency repressurizing of the system. To keep the "glad hand" clean and free of dirt, and to protect it from distortion, a second "glad hand" closed by a pipe plug can be mated to it, or a glad hand protector bracket can be used.
7. Always mount the Air Starter so that the exhaust port is downward. This will help prevent any accumulation of water in the starter motor.

### Orientation of the Air 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, reorient the Starter as follows:

1. Look at the proper outline drawing on Page 4 or 5 and note that the drive housing can be located in any one of eight radial positions relative to the exhaust. The air inlet (motor housing cover) can be located in any one of four radial positions relative to the exhaust port.
2. Study the engine mounting requirements, and determine the required orientation of the drive housing relative to the exhaust port. The exhaust port should be aimed downward when installed on the engine. If the drive housing has to be reoriented, remove the four drive housing cap screws and rotate the drive housing to the required position.

### NOTICE

Do not separate the drive housing from the gear case.

Reinstall the drive housing cap screws and alternately tighten them to 20 ft-lb (27 Nm) of torque.

3. Now that you have the drive housing properly oriented relative to the exhaust port, notice whether or not the inlet port will be favourably located for hose installation. If this must be reoriented, remove the four motor housing cover cap screws, and rotate the motor housing cover to its desired position. Reinstall the motor housing cover cap screws and alternately tighten them to 20 ft-lb (27 Nm) of torque.

### NOTICE

There are eight holes through the motor housing cover, four of which are not used and are plugged. If the orientation requires that the plugged holes be used to accommodate the housing cover cap screws, use a flatend drift to carefully drive the plugs inward. Then reinstall them in the other four holes.

## Mounting the Air Starter

1. Study the piping diagrams on page 6. We strongly recommend that the Starter be connected exactly as shown.
2. The air receiver tank for a Starter installation must have a working pressure capability equal to or greater than the maximum pressure at which the Starter will be operated.
3. If you are going to connect to a receiver tank that is already in service, bleed off the air pressure in the tank.

### NOTICE

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

4. Using a 1" or 1-1/4" short nipple, install the SRV100 or 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.**

5. Install the No. SMB-618 Starter Control Valve on the dash panel (for vehicular installations) or some other appropriate panel (for stationary installations).
6. Attach No. TA-STR-100 Starter Instruction Label to the control panel adjacent to the Starter Control Valve Solenoid.
7. 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.
8. Connect the Starter Control Valve to the Relay Valve live air port with 1/4" hose. Install a Tee in this line with a short feeder hose to the Pressure Gauge.

### NOTICE

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

9. Measure the distance from the Relay Valve on the receiver to the starter location on the engine to determine the exact length of 1-1/4" or 1" air hose required.
10. Attach the air hose to the outlet side of the Relay Valve, and run the hose through the frame, etc. to its final position at the starter location.
11. At this point, determine whether or not 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.
12. Liberally grease the teeth on the pinion and ring gear with a good, sticky gear grease. This will help promote the life of the ring gear and the drive pinion.
13. Mount the Starter on the flywheel housing. Tighten the mounting bolts as follows:
  - a. For 5/8" bolt, 90 ft-lb (122 Nm) of torque
  - b. For 3/8" bolt, 30 ft-lb (41 Nm) of torque
14. Install a 1/4" hose line from the "DEL" side of the Starter Control Valve to the "IN" port on the Starter Drive Housing.
15. Install a 1/4" hose line from the "OUT" port on the Starter Drive Housing to the small pipe tapped port on top of the Starter Relay Valve.
16. On air-operated Starters, install a Muffler or Road Splash Deflector in the exhaust port of the Starter. Use No. 150BMA674 Muffler or No. SS175-A735 Road Splash Deflector on SS175 Starters. Use No. SS350-A674 Muffler or No. SS350-A735 Road Splash Deflector on SS350 Starters.



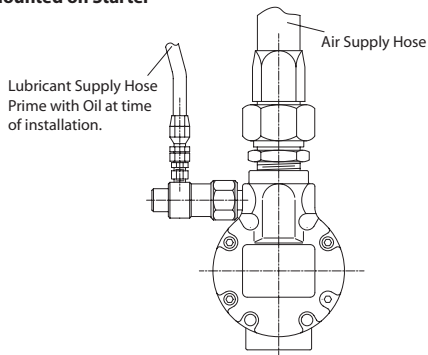
### WARNING

**If the Starter is gas operated, the exhaust must be piped away to a location where it will not be ignited or inhaled.**

17. Mount an HDL2 Lubricator on or near the Starter as described under "Installation of HDL2 Lubricator".
18. Pressurize the complete starting system and check every connection with a soap bubble test- There must be no leaks.

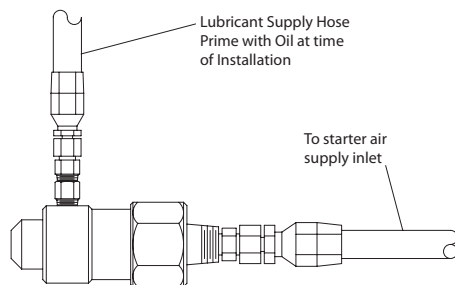
## Installation of HDL2 Lubricator

### Mounted on Starter



(Dwg. TPB789-3)

### Mounted at Remote Location



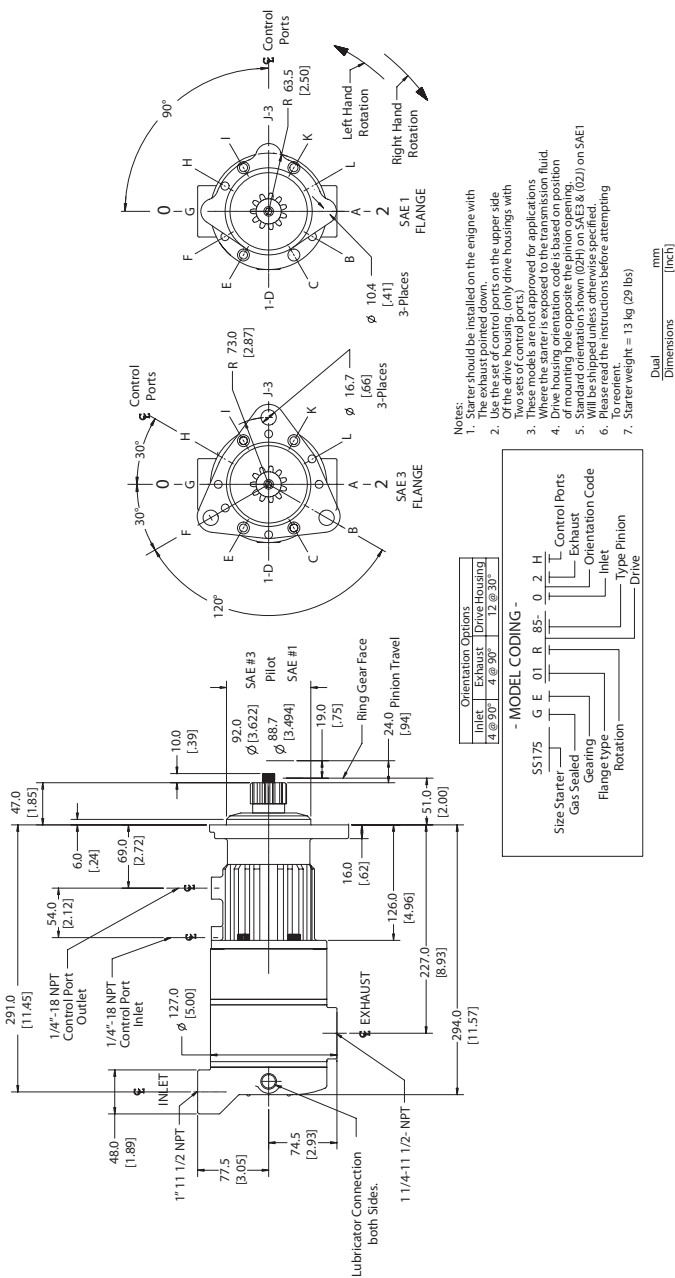
(Dwg. TPC494-3)

The HDL2 Lubricator is self-priming and may be installed directly on the Starter or remotely located. Although the Lubricator is capable of drawing lubricant from a source 4 ft (1.2 m) lower than the point of installation, we recommend the lubricating oil lines be as short as practical. We recommend using the unpressurized fuel return line as the source of lubricant- However, oil may be supplied from a separate reservoir or the diesel fuel tank. When the diesel fuel tank is the lubricant source, install a 10 micron to 50 micron fuel filter (Part No. HDL1-47) in the oil supply line at the fuel tank. The lubricant line should be tee'd into the fuel return line with the leg of the tee going to the lubricator directed in the down direction to insure that the lubricator does not draw air instead of oil.

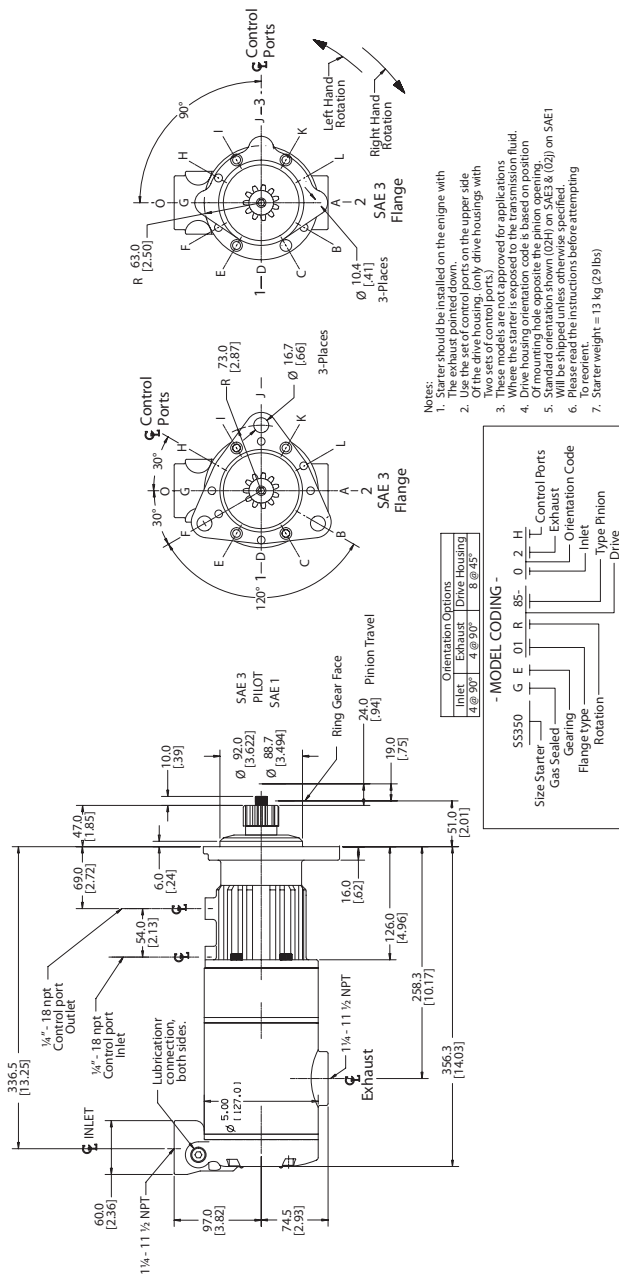
### Mount the HDL2 Lubricator as follows:

1. If you are going to mount the HDL2 Lubricator on the Starter, remove one of the 3/8" pipe plugs from the Motor Housing Cover on the Starter, and replace it with the HDL2. If you are going to mount the HDL2 at a remote location, use two U-bolts and base clamp available for the Lubricator.
2. If you mounted the HDL2 at a remote location, install a 1/4" hose from the end of the Lubricator having both a male and female thread to one of the 3/8" pipe tapped holes on the Starter Motor Housing Cover.
3. Install a No. 6 hose from the 1/8" NPT oil inlet in the side of the HDL2 to the unpressurized fuel line, diesel fuel tank or separate oil reservoir. Tighten the fitting at the Lubricator to 15 to 36 ft-lb (20.3 to 48.8 Nm) torque. **Important:** This connection must be vacuum tight. The thread on the fitting must be clean; assemble it without sealing compound or Teflon\*\* tape.  
**Note:** Before initial operation, manually fill the oil supply line.
4. If a separate lubrication reservoir is used, fill it with diesel fuel or an SAE 10 or 10W light, non detergent motor oil.

\* Registered trademark of E. I. DuPont.



(Dwg. TPA929-3)



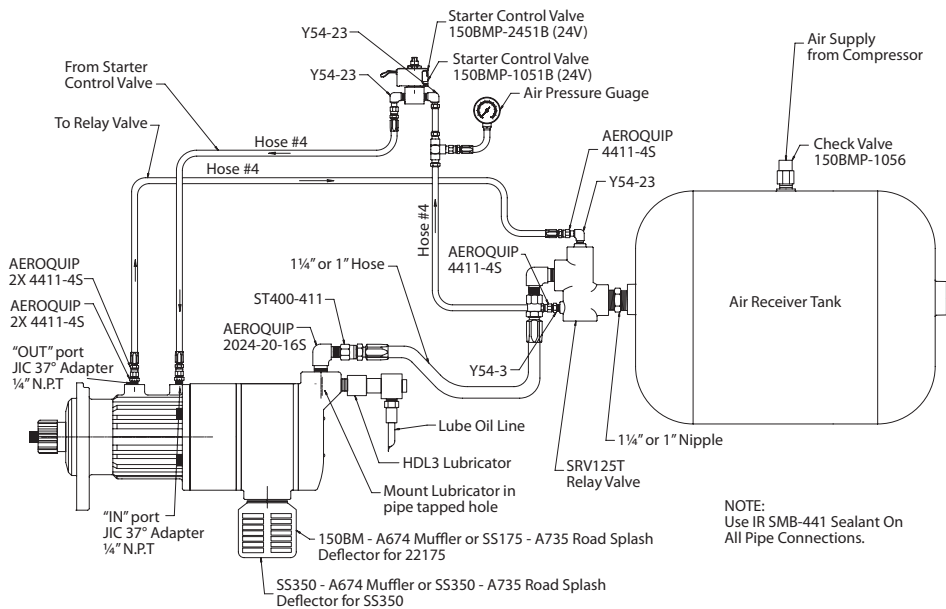
1. Starter should be installed on the engine with the exhaust pointed down.
2. Use the set of control ports on the upper side of the drive housing. (Only drive housings with two sets of control ports.)
3. These models are not approved for applications where the starter is exposed to the transmission.
4. Drive housing orientation code is based on position of mounting hole opposite the pinion opening.
5. Standard orientation shown (02H) on SAE3 & 0 will be shipped unless otherwise specified.
6. Please read the instructions before attempting to reorient.
7. Starter weight = 13 ka (29 lbs)

| Dual       | mm     |
|------------|--------|
| Dimensions | [Inch] |

(Dwg. TPA930-3)

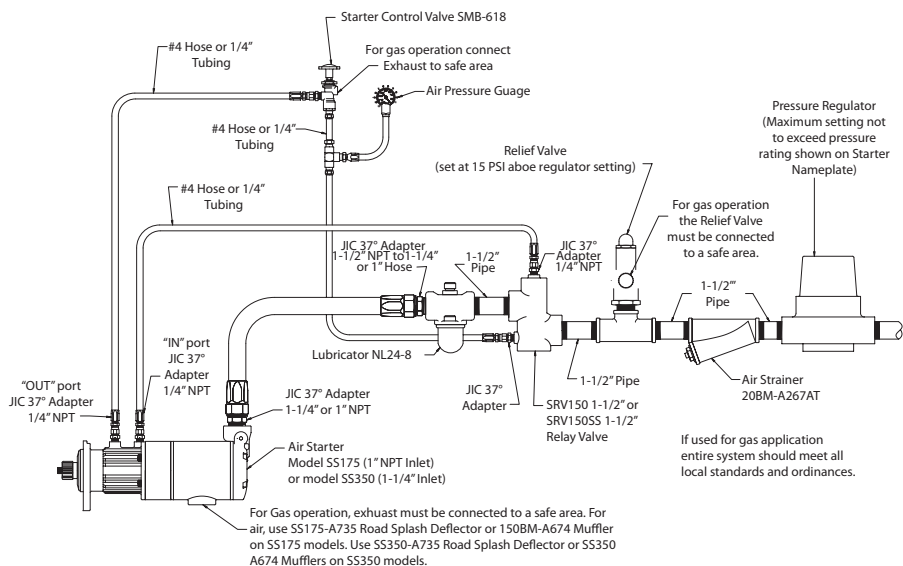
## Piping Diagram

### Typical Vehicular Installation:



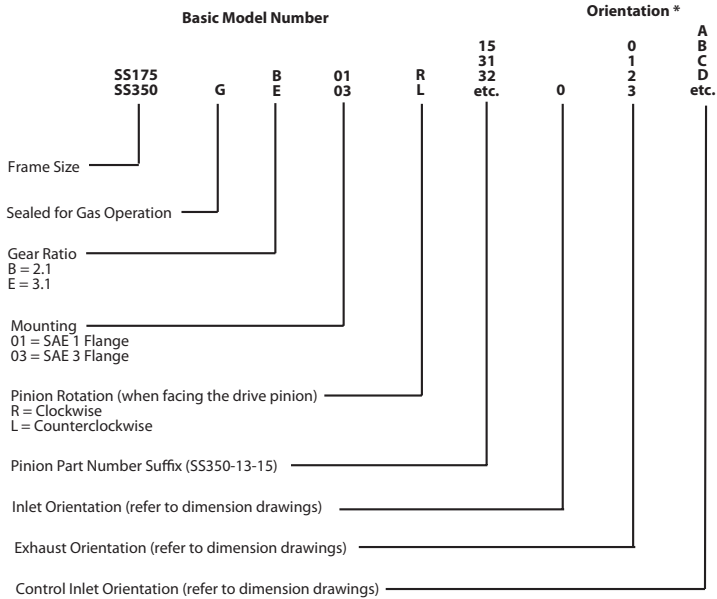
(Dwg. TPB715-1)

### Typical Stationary Installation:



(Dwg. TPA942-1)

## Model Code Identification



\* The following orientation combinations are not possible because of space limitations and other considerations:

### ON FLANGE MOUNT STARTERS

|       |       |       |       |
|-------|-------|-------|-------|
| 0-0-E | 0-1-H | 0-2-E | 0-3-H |
| 0-0-C | 0-1-F | 0-2-C | 0-3-F |
| 0-0-K | 0-1-B | 0-2-K | 0-3-B |
| 0-0-I | 0-1-L | 0-2-I | 0-3-L |

## Accessories

The following accessories are available for use on installations involving an SS175 or SS350 Starter:

| Part Number  | Name of the Part                                                              | Part Number      | Name of the Part      |
|--------------|-------------------------------------------------------------------------------|------------------|-----------------------|
| SMB-618      | Starter Control valve                                                         | <b>for SS175</b> |                       |
| HDL2         | Lubricator                                                                    | 150BM-A674       | Muffler               |
| HDL1-47      | Lubricator Filter                                                             | SS175-A735       | Road Splash Deflector |
| NL-24-8      | Air Line Lubricator                                                           | SRV100           | 1" Relay Valve        |
| SMB-441      | Sealant for Pipe Threads                                                      | SS175-HN16       | 1" Pipe Nipple        |
| 150BMP-1051B | 12V Solenoid valve                                                            | <b>for SS350</b> |                       |
| 150BMP-2451B | 24V Solenoid Valve                                                            | SS350-A674       | Muffler               |
| 150BMP-1054  | Combination Pr. Relief/Check Valve                                            | SS350-A735       | Road Splash Deflector |
| 150BMP-1056  | Check Valve                                                                   | SRV125           | 1-1/4" Relay Valve    |
| 150BMP-1064  | Pressure Gauge                                                                | SS350-HN20       | 1-1/4" Pipe Nipple    |
| K4U-A267AT   | 1-1/4" Air Strainer                                                           |                  |                       |
| 20BM-A267AT  | 1-1/2" Air Strainer                                                           |                  |                       |
| 150BMP-1067  | Drain Valve                                                                   |                  |                       |
| SRV150-SS    | 1-1/2" Relay Valve (Stainless Steel)<br>(for gas applications where required) |                  |                       |

## 产品安全信息

### 用途:

此类空气启动器应用于往复式内燃机的启动。此类启动器应在正确安装到需要启动的内燃机上后, 进行远程操作。

更多信息请参见内燃机空气启动器产品安全信息手册表 **45558624**。

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

**Ingersoll Rand** 启动器是一种精密装置, 可长时间提供高效和经济性能。但是, 如同任何产品一样, 性能、经济性和耐用性大多都是由少数简单的常识步骤确定, 只能由制造商建议, 并仅由客户遵守。本手册中略述的建议根据 30 多年以来在空气和气动启动器领域总结的经验。学习和采纳这些建议。它们可让您节省大量时间和费用。本手册应存放在固定位置。

## 润滑



### 警告

不要使用煤油或喷气机燃油等易燃、易挥发的液体来润滑启动器。

若温度高于 **32° F (0° C)**, 可使用优质 SAE 10 非去垢性机油。

若温度低于 **32° F (0° C)**, 可使用柴油。我们不会过度强调正确润滑启动器的重要性。这对达到最高性能和最大耐用性至关重要, 然而所需时间如此之少以致没有理由不对其予以处理。

## 安装信息

1. 确保正确安装气动启动器。花费少量额外时间和精力完成的出色工作将可造就一个可靠的启动系统, 而该系统可在所有情况下快速启动发动机。
2. 我们强烈建议在受到振动的所有车载装置和固定发动机上, 您可以使用指定直径的软管而非刚性连接管。车辆和发动机振动会很快松动刚性管连结, 而软管会缓冲此振动, 从而使连结保持紧固。
3. 在实际安装气动启动器的过程中, 最好已在接收器中连接软管, 并使软管的启动器末端便于连接到启动器。在飞轮外壳上安装启动器之前, 很多时候都需要在可行之处将空气软管连接到启动器。对于为何要遵循该步骤, 有以下两个方面的原因:
  - a. 在安装启动器之后, 常常因空间限制而无法连接软管。
  - b. 在连接软管之后, 它们会支撑启动器的部分重量, 以便更容易完成安装。
4. 连结不当会大大削减气动启动器的效率。使用小于所建议尺寸的软管将会导致进入到达中的压缩空气量不足, 而且使用排气管端口中的渐缩管将可以限制排气, 同时会堵塞塞马。三通和弯头的数量以及供应管线的长度都应最小化。对于 SS175, 如果供应管线长达 30 英尺, 可使用 1" 软管或管道; 如果供应管线超过 30 英尺, 可使用 1-1/4" 软管或管道。对于 SS350, 如果供应管线长达 30 英尺, 可使用 1-1/4" 软管或管道; 如果供应管线超过 30 英尺, 可使用 1-1/2" 软管或管道。
5. 任何连接装置出现泄漏状况都表明, 系统将会整夜排放并必须在第二天早上通过使用另一台车辆或压缩机来增压。第一次要正确连接以避免不必要的费用和延迟。在整个系统的所有螺纹连接装置上, 使用 **Ingersoll Rand** No. SMB-441 Sealant, 非硬化的 No. 2 Permatex 或 Loctite® 管道密封剂。建议不要使用特氟隆胶带。务必从接收器的侧面或顶部运行空气供应管线, 切勿在底部或底部附近运行。空气中的水分聚集在接收器底部, 便可能腐蚀启动器电动机或在寒冷天气下水凝结造成固体 (更为糟糕的情况) 以致无法使用。在进行所有连接后, 可使用肥皂气泡泡测试检查每个接头。确保不会出现渗漏状况。稍有泄漏便会导致系统很快失压。
6. 对于系统的紧急增压, 我们建议使用 "glad hand" 安装。要保持 "glad hand" 干净和没有污物, 以及避免变形, 可将其连接到由管道塞子密封的第二个 "glad hand"; 或可使用 "glad hand" 保护器托架。
7. 总是安装气动启动器以便排气管端口朝下。这将有助于预防启动器电动机中出现水份积聚现象。

### 气动启动器的定向

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:

1. 请参见 页 4 或 页 5 上的略图, 并且注意传动箱可位于与排气装置相对 8 个径向位置的任一处。进气口 (电动机外壳盖) 可位于与排气管端口相对的 4 个径向位置中的任一处。
2. 学习发动机安装要求, 并确定与排气管端口相对的传动箱的所需定向。当在发动机上安装时, 排气管端口应向下。如果传动箱必须重新定向, 可卸下 4 个传动箱有头螺丝, 然后将传动箱旋转至所需位置。

### 注意

切勿分开传动箱和齿轮箱。

重新安装传动箱有头螺丝, 并交替地将其旋紧至 20 英尺-磅 (27 牛米) 扭矩。

3. 既然已正确定向与排气管相对的传动箱, 注意进气口是否处于有利于软管安装的位置。如果这必须重新定向, 可卸下 4 个电动机外壳盖有头螺丝, 然后将电动机外壳盖旋转至所需位置。重新安装电动机外壳盖有头螺丝, 并交替地将其旋紧至 20 英尺-磅 (27 牛米) 扭矩。

### 注意

马外壳盖中有 8 个孔, 其中 4 个无用, 因此用塞子堵住。如果定向要求将堵塞孔用以安装外壳盖有头螺丝, 使用平端移动以小心向内驱动塞子。然后将其重新安装到其他 4 个孔中。

### 安装气动启动器

1. 学习 页 6 上的管道布置图。我们强烈建议按如图所示的方式准确连接启动器。
2. 启动器装置的空气储气罐必须具有工作压力性能 (等于或大于启动器将会操作的最大压力)。
3. 如果要连接到正在工作的储气罐, 可排出箱中的气压。

### 注意

通过阀或旋塞排出气压。当储气罐仍处于增压状态时, 切勿从罐上拔下塞子。排出积聚在罐底部的水份。

4. 使用 1" 或 1-1/4" 的短螺纹连接套将 SRV100 或 SRV125 启动器主启动阀安装在接收箱末端, 如管道布置图所示。

### 注意

确保连接到主启动阀的进口侧 (在阀座上标注为字母 "IN")。

5. 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。
6. 将 No. TA-STR-100 启动器说明标签贴在邻近启动器控制阀电磁阀的控制面板上。
7. 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。
8. 将启动器控制阀连接到具有 1/4" 软管的主启动阀活动气端口上。使用短软管将此管道中的三通管安装到压力表上。

### 注意

确保将软管连接到启动器控制阀的 "SUP" 侧。

9. 测量储气罐的主启动阀和发动机的启动器位置之间的距离以确定所需的 1-1/4" 或 1" 进气软管的确切长度。
10. 将进气软管连接到主启动阀的出口侧, 并使软管从机架等穿过启动器处的最终位置。

11. 在此，可在实际安装起动机之前或之后，确定将软管连接到起动机是否可行或实用。在多数情况下，可能需要在安装之前将软管连接到起动机。
12. 请使用优质粘性齿轮润滑油来充分润滑小齿轮和环形齿轮上的齿轮。这将有助于延长环形齿轮和传动小齿轮的寿命。
13. 将起动机安装在飞轮外壳上。按以下方式旋紧装配螺栓：
  - a. 对于 5/8" 螺栓，扭矩是 英尺·磅 (122 纳米)
  - b. 对于 3/8" 螺栓，扭矩是 30 英尺·磅 (41 纳米)
14. 请在起动机控制阀的“DEL”侧和起动机传动箱上的“IN”端口之间安装 1/4" 软管管线。
15. 在起动机传动箱的“OUT”端口和起动机继动阀顶端的小管道分接部分之间安装 1/4" 软管管线。
16. 在气动起动机上，请在起动器的排气管端口中安装消音器或公路防溅导向板。使用 SS175 起动机上的 No. 150BMA674 消音器或 No. SS175-A735 公路防溅导向板。使用 SS350 起动机上的 No. SS350-A674 消音器或 No. SS350-A735 公路防溅导向板。

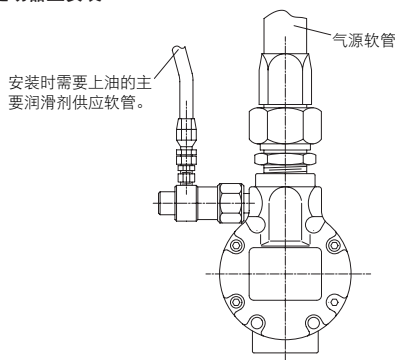
### 警告

如果以气动方式操作起动机，必须将废气排至无法燃烧或吸入的地方。

17. 根据“安装 HDL2 润滑器”说明，将 HDL2 润滑器安装在起动机上或起动机附近。
18. 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。

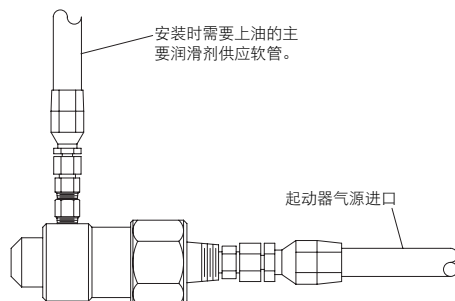
## 安装 HDL2 润滑器

### 在起动机上安装



(Dwg. TPB789-3)

### 在远处安装



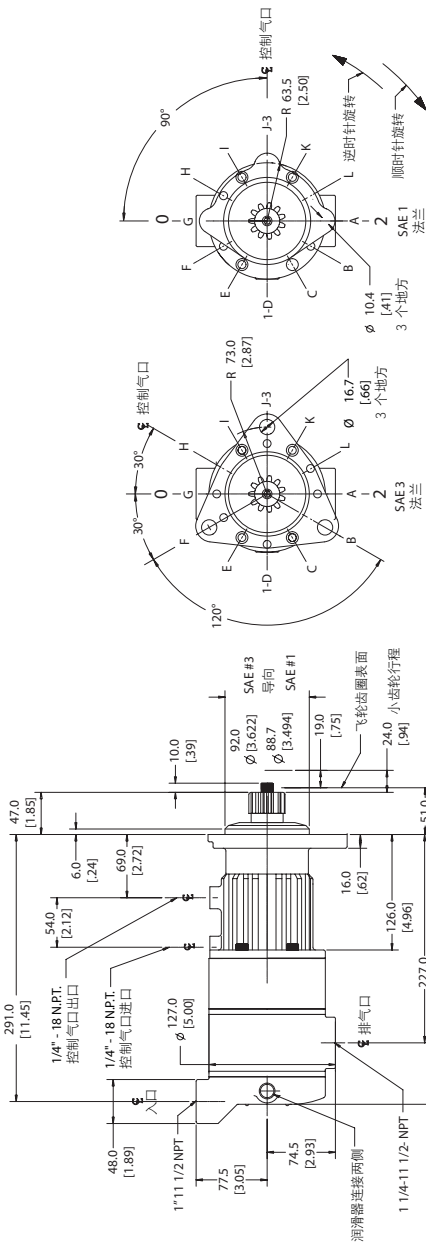
(Dwg. TPC494-3)

HDL2 润滑器可自动充满，并可直接安装在起动机上或位于远处。虽然润滑器能从较安装点低 4 英尺 (1.2 米) 的油源处吸油，但我们建议使用最短的润滑油管道。我们建议使用非增压回油管作为润滑剂的来源 - 但是，也可从单独接收器或柴油箱供油。当柴油箱是润滑油来源时，可在燃油箱的油供应管线中安装一个 10 微米至 50 微米的燃油过滤器 (部件号 HDL1-47)。润滑剂供应管线应装入具有 T 形管支管 (向下流入润滑器) 的回油管，以确保润滑器无法吸气而不是油。

### 按以下方式安装 HDL2 润滑器：

1. 如果要在起动机上安装 HDL2 润滑器，可从起动器的电动机外壳盖取下 3/8" 管道塞子，然后将其更换为 HDL2。如果要在远处安装 HDL2，可使用润滑器可用的两个 U 形螺栓和压板。
2. 如果在远程位置安装了 HDL2，便可在具有外螺纹和内螺纹的润滑器末端和起动机电动机外壳上的 3/8" 管道分接孔之间安装 1/4" 软管。
3. 请在 HDL2 侧的 1/8" NPTF 油进口到非增压燃油管线、柴油箱或单独油箱之间安装 6 号软管。将润滑器的装置旋紧至 15 至 36 英寸·磅 (20.3 至 48.8 纳米) 扭矩。重要信息：该连接必须是真空密封。装置的螺纹必须清洁；不可使用密封剂或 Teflon\*\* 胶带安装，注意：在首次操作之前，可手动将油注入供油管线中。
4. 如果使用单独润滑剂储存罐，可向其中注入柴油或 SAE 10 或 10W 轻质非去垢剂型机油。

\* E. I. Dupont 的注册商标。



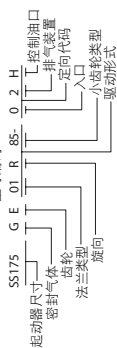
注意:

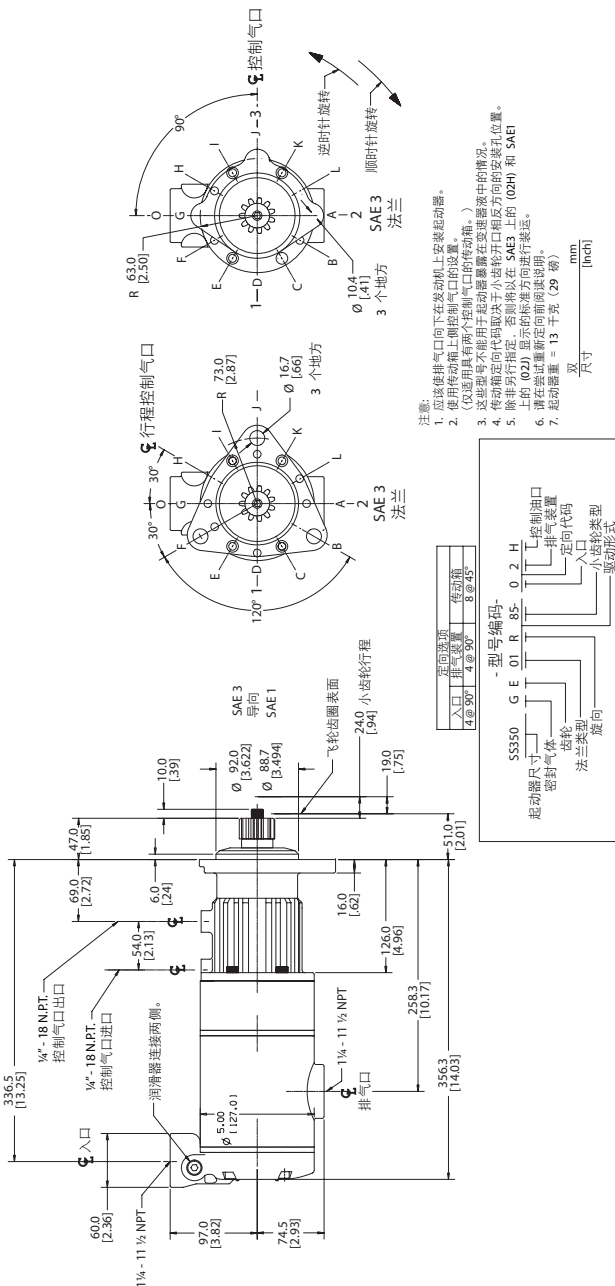
1. 应将该排气口向下在发动机上安装启动器。
2. 使用传动箱上侧控制气口的设置。  
(仅适用于具有两个控制气口的传动箱。)
3. 这些型号不能用于启动器暴露在变速器液中的情况。
4. 传动箱定向代码取决于小齿轮开口和反方向的安装孔位置。
5. 除非另行指定, 否则将以往 SAE3 上的 (02H) 和 SAE1 上的 (02D) 表示的转向方向更改为逆时针。
6. 传动箱的启动器必须逆时针启动。
7. 启动重量 = 13 千克 (29 磅)

mm  
inches

| 定向选项    |          |
|---------|----------|
| 入口      | 传动箱      |
| 4 @ 90° | 12 @ 30° |

- 型号编码 -





總計

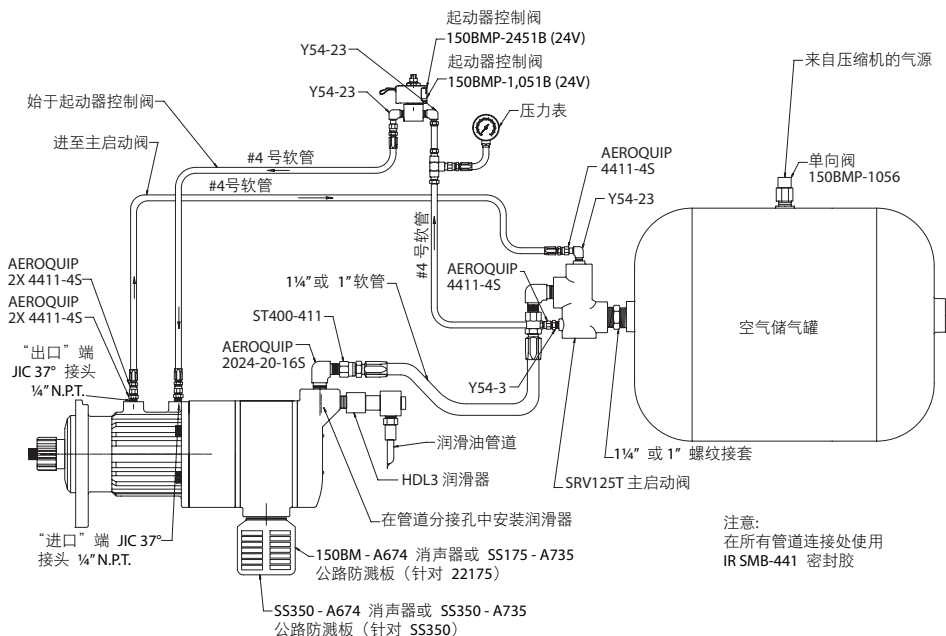
2. 使用传动排气口则控制排气口的设置。
3. (适用于具有两个控制气口的传动箱。)
4. 这些型号不能用于引起发动机与变速器液中的情况。
5. 传动箱型号代码用于小齿轮箱与相交方向的安装孔位置。
6. 除非另行指定, 否则将以上 SAE 上的 (02H) 和 SAE 上的 (02I) 显示的规格值进行搬运。
7. 请在齿式变速箱上安装 (29 齿)。
8. 齿式变速箱 = 13 号 (29 齿)。

| 双<br>尺寸 | mm<br>[inch] |
|---------|--------------|
|---------|--------------|

英寸

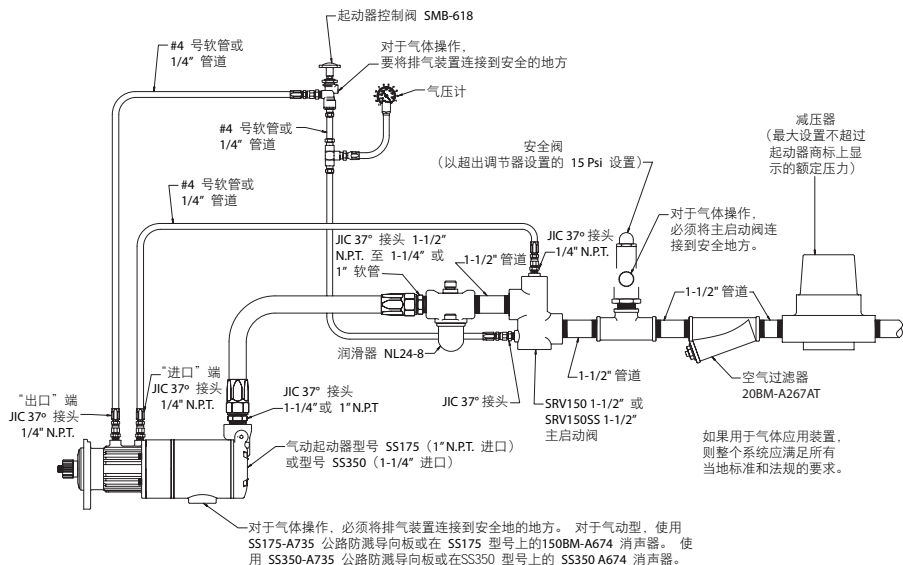
## 管道布置图

## 典型的车载安装：



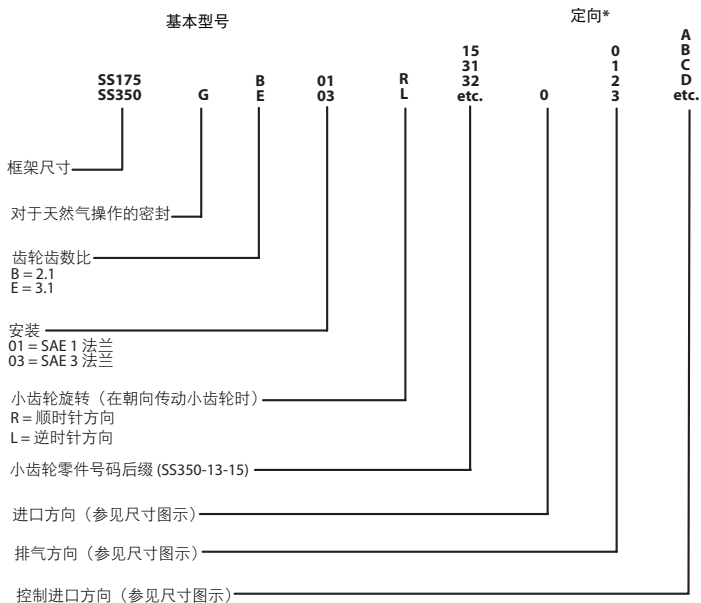
(Dwg. TPB715-1)

## 典型的固定安装：



(Dwg. TPA942-1)

## 型号代码标识



\* 由于空间有限和对其他因素的考虑，以下方向不可能结合使用:

## 关于法兰装置起动机

|       |       |       |       |
|-------|-------|-------|-------|
| 0-0-E | 0-1-H | 0-2-E | 0-3-H |
| 0-0-C | 0-1-F | 0-2-C | 0-3-F |
| 0-0-K | 0-1-B | 0-2-K | 0-3-B |
| 0-0-I | 0-1-L | 0-2-I | 0-3-L |

## 配件

以下附件涉及安装 SS175 或 SS350 起动机时可以使用:

| 部件的编号        | 部件名称                                | 部件的编号      | 部件名称          |
|--------------|-------------------------------------|------------|---------------|
| SMB-618      | 起动机控制阀                              | 对于 SS175   |               |
| HDL2         | 润滑器                                 | 150BM-A674 | 消声器           |
| HDL1-47      | 润滑剂过滤器                              | SS175-A735 | 公路防溅导向板       |
| NL-24-8      | 空气管道润滑器                             | SRV100     | 1" 主启动阀       |
| SMB-441      | 管螺纹密封胶                              | SS175-HN16 | 1" 管道螺纹接套     |
| 150BMP-1051B | 12V 电磁阀                             | 对于 SS350   |               |
| 150BMP-2451B | 24V 电磁阀                             | SS350-A674 | 消声器           |
| 150BMP-1054  | 组合阀 安全/单向阀                          | SS350-A735 | 公路防溅导向板       |
| 150BMP-1056  | 单向阀门                                | SRV125     | 1-1/4" 主启动阀   |
| 150BMP-1064  | 压力表                                 | SS350-HN20 | 1-1/4" 管道螺纹接套 |
| K4U-A267AT   | 1-1/4" 空气过滤器                        |            |               |
| 20BM-A267AT  | 1-1/2" 空气过滤器                        |            |               |
| 150BMP-1067  | 排水阀                                 |            |               |
| SRV150-SS    | 1-1/2" 主启动阀 (不锈钢)<br>(根据需要使用气体应用装置) |            |               |

## 製品に関する安全性

### 製品に関する安全性

これらのエースターターは、往復内燃機関の始動に使用することを目的としています。これらのエースターターは、始動させる必要のある往復内燃機関に正しく取り付けられた後、離れた場所から操作するように設計されています。

詳細は、「内燃機関用エースターター製品安全情報説明書 45558624」を参照してください。

www.irools.com から説明書をダウンロードすることができます。

**Ingersoll Rand** 始動装置は、長期間に渡って効率のよい、経済的な性能を示すことを目的とした精密機器です。しかし、どの製品もそうであるように、性能、経済性および耐久性は、大部分が、製造者によってのみ推奨でき、顧客によってのみ支持できる2~3の単純な常識的な手順によって決定されます。

### 潤滑



#### 警告

始動装置の潤滑に、灯油またはジェット燃料のような可燃性または揮発性液体を使用しないでください。

温度が 32°F (0°C) 以上の場合、高品質の SAE 10 非洗浄性モーターオイルを使用します。

温度が 32°F (0°C) を下回る場合、ディーゼル燃料を使用します。始動装置の適切な潤滑の重要性は、どれほど強調しても強調し過ぎることはありません。適切な潤滑は、最高の性能および最大の耐久性の第一要件であり、しかもほとんど時間を必要としないのでこれを軽視する理由は全くありません。

### 再組付け

#### 一般情報

- ご使用の空気始動装置が正しく再組立されているか常に確認します。最高品質の仕事の実行に費やした僅な、余分な時間および努力は、ご使用のエンジンをすべての条件下で素早く始動させるという優れた仕事を実行する、信頼できる始動システムにかなり貢献します。
- すべての車両への再組付けおよび振動に晒される固定エンジンについて、配管による固定した接続を行うのではなく、規定の口径のホースを使用することを強く推奨します。車両およびエンジンの振動により固定した配管接続は直ぐ緩みますが、ホースの場合、振動を吸収し、接続は強固なままです。
- 空気始動装置を実際に取り付ける場合は、ホースは前以て受け手側の接続を済ませ、ホースの始動装置側の端は、始動装置に取り付けられるように近くに置いておくのが一番良い方法です。可能な場合いつでも、また必要なときはいつでも、始動装置をフライホイール筐体に取り付ける前に空気ホースを始動装置に取り付けます。この手順に従う理由は、二つあります。
  - 始動装置を取り付けた後、ホースの接続は、スペースの制限からしばしば不可能となります。
  - ホースは一旦取り付けられると、始動装置の重量の何割かを支え、取り付けを更に容易にします。
- [空気始動装置]の効率は、不適切な接続によって非常に損なわれることがあります。推奨したのもより小さいホースをご使用になった場合、モーターへの空気量は、減少し、排気ポートに減速機を使用した場合、排気を制限し、モーターを詰まらせず、1分岐と肘継手の数および供給ラインの長さは、最小限に保ってください。SS175 の場合、30 フィート長までの供給ラインには 1 インチのホースまたは導管を使用し、30 フィート長を超える場合は、1-1/4 インチのホースまたは導管を使用します。SS350 の場合、30 フィート長までの供給ラインには 1-1/4 インチのホースまたは導管を使用し、30 フィート長を超える場合は、1-1/2 インチのホースまたは導管を使用します。
- どこかの接続部に漏れがあるということ、システムが一晚中空気を流出しているということであり、翌日の朝、別の車両またはコンプレッサを使用して再度圧力を上げる必要があります。接続部を始めから確かめて間違いないようにして、不要なコストや怪我の発生を避けます。システム全体のすべてのネジ接続は、**Ingersoll Rand** No. SMB-441 シーラント非硬化剤 No. 2 Permatex または **Loctite®** バイブシーラントを使用します。テフロンテープは推奨しません。

この取扱説明書で概説されている推奨内容は、空気およびガスの始動装置の分野に於ける30年以上に渡る経験に基いています。これらの推奨内容を検討し、従ってください。これらの推奨内容によって時間と費用の節約が可能になります。この取扱説明書は、永久に利用できる場所にファイルしてください。

2種類の潤滑システムのどちらも推奨します。クランクキングサイクルが 10 秒以下の典型的な始動装置再組付けの場合、**Ingersoll Rand** No. HDL2 Lubricator を ページ 3 に示されるように再組付けすることを推奨します。潤滑油には、ディーゼル燃料または 10W 非洗浄性モーターオイルを使用します。クランクキング サイクルが10秒を超える場合、**Ingersoll Rand** Lubricator No. NL-24-8 を主要給気ラインに再組付けすることを推奨します。良質の 10W 非洗浄性オイルを使用して Lubricator の流速を毎秒 1~2 滴に調整します。

- ご使用の給気ラインを常に受け器の側面または上端から入るようにし、決して底部またはその付近から入ることのないようにします。空気内の湿気は、受け器の底部で集まり、始動装置モーター内の腐食の原因になる可能性があります。さらに悪い場合、寒い気候で固く凍り始動装置が運転できなくなります。すべての接続を終了した後に、各接合部をせっけん泡試験でチェックします。漏れが全くないことが必要です。ほんの僅かな漏れであっても一晩中、システムの圧力損失を引き起こします。
- システムの緊急再加圧用に「友好的な握手」の再組付けを推奨します。「友好的な握手」を清浄かつ埃の無い状態に保ち、変形から防ぐために、パイプ栓で閉じられる二番目の「友好的な握手」を仲間入りさせることが可能であるかまたは友好的握手保護ブラケットを使用できます。
- 空気始動装置は、常に、排気ポートが下に向くように取り付けます。こうすると、始動装置モーターに水が溜まるのを防ぐのに役立ちます。

### 空気始動装置の向き

工場で設定された向きが、駆動筐体の放射状配置または吸気/排気ポートの配置のためにご使用のエンジンに合わない場合、以下のようにして始動装置の向きを変えてください:

- ページ 4 または ページ 5 にある適切な外形寸法図をご覧になり、駆動部筐体が排気管に対し、8箇所の放射状位置のどの位置にも配置できることにご注意ください。吸気口（モーター筐体カバー）は、排気ポートに対し4箇所の放射状位置のどの位置にも配置できます。
- エンジンの取り付け要求を検討し、排気ポートに対する駆動部筐体の必要な向きを決定します。排気ポートは、エンジンに再組付けするとき、下向きにしてください。駆動部筐体の向きを変える必要がある場合、4本の駆動部筐体キャップ ネジを外し、駆動部筐体を要求される位置に回転させます。

#### 備考

駆動部筐体を変速装置から分離させないでください。

駆動部筐体キャップ ネジを元のように再組み付けして、20 ft-lb (27 Nm) のトルクで交互に締め付けます。

- これで、駆動筐体は、排気ポートに対し、正しい向きにできたので、吸気ポートがホースの再組付けに対し好ましい配置となっているか注意します。これで向きを変える場合、4本のモーター筐体カバーキャップネジを外し、モーター筐体カバーを希望の位置に回転させます。駆動部筐体カバーキャップネジを元のようには再組付けして、20 ft-lb (27 Nm) のトルクで交互に締め付けます。

### 備考

モーター筐体カバーには8個の穴があり、使用しないものには栓をします。向きによって、栓をした穴が筐体カバーキャップネジの収納に使用することが必要になった場合、水平方向のすき間を使用して慎重に栓を押し込みます。それから、駆動部筐体キャップネジを残りの4箇所の穴に元のように再組付けします。

### 空気始動装置の取り付け

- ページ 6 の配管図を検討します。始動装置が表示された通り正しく接続されることを強く推奨します。
- 始動装置再組付け用の空気受けタンクは、始動装置が運転される最大圧力以上の動作圧力性能を有する必要があります。
- 既に使用中の受けタンクに接続しようとする場合、タンク内の空気を徐々に減らして無くします。

### 備考

空気をバルブまたはコックを通して徐々に減らして無くします。タンクにまだ圧力が掛かっている間にタンクから栓を抜くことをしないでください。タンクの底に溜まった水があれば排出します。

- 1-1/1 インチ または 1-1/4 インチのショート ニップルを使用して、配管図に示されているように空気受けタンクの端に SRV100 または SRV150 始動装置リレーバルブを取り付けます。

### 備考

バルブ本体に刻印された“IN (入)”という用語で表示された [リレーバルブ] の吸気側に接続されていることを確実にします。

- ダッシュパネル (車両再組み付け用) または他の適切なパネル (固定再組み付け用) に、No. SMB-618 始動装置制御バルブを再組付けします。
- [始動装置制御バルブソレノイド] に隣接する制御パネルに No. TA-STR-100 始動装置指示ラベルを付けます。
- No. 150BMP-1064 風圧計を制御バルブまたはその周囲に取り付けます。風圧計は、[制御バルブ] の運転員が容易に見ることのできる場所に配置してください。
- [始動装置制御バルブ] を [リレーバルブ] の使用中空気ポートに 1/4 インチホースで接続します。このラインに [風圧計] に至る短いフィーダーホースの付いたT字型分岐を再組付けします。

### 備考

ホースが始動装置制御バルブの“SUP”側に接続されていることを確実にします。

- 受け器上の [リレーバルブ] からエンジン上の始動装置の位置までの距離を測定し、必要とする 1-1/4 インチまたは 1 インチの空気ホースの正確な長さを決定します。
- [リレーバルブ] の排気側に空気ホースを取り付け、このホースをフリュームなどを通して、始動装置のある場所の最終位置まで敷きます。
- この時点で、始動装置を実際に取り付ける前または後に、ホースを始動装置に付けることが可能または実際の、またはそうでないかを決定します。多くのケースで、始動装置を取り付ける前に、ホースを始動装置に付けることが必要である場合があります。
- ピニオンおよびリング ギアの歯に良質の粘着性ギア グリースを十分に付けます。こうすることは、リング ギアおよび駆動ピニオンの寿命を延ばすのに役立ちます。
- 始動装置をフライホイール筐体上に取り付けます。取り付けボルトを以下のように締め付けます。
  - 5/8 インチ ボルトに対しては 90 ft-lb (122 Nm) のトルク
  - 3/8 インチ ボルトに対しては 30 ft-lb (41 Nm) のトルク
- [始動装置制御バルブ] の“DEL”側から [始動装置駆動筐体] 上の“IN”ポートに 1/4 インチ ホース ラインを再組付けします。

- 1/4 インチ ホース ラインを [始動装置ドライブ筐体] 上の“OUT”ポートから [始動装置リレーバルブ] の上端の細管のタップ付きポートに再組付けします。
- 空気操作の [始動装置] については、[始動装置] の排気ポートに [マフラー] または [道路泥除け装置] を再組付けします。SS175 始動装置には No. 150BMA674 マフラーまたは No. SS175-A735 道路泥除け装置を使用します。SS350 始動装置には No. 350-A674 マフラーまたは No. SS350-A735 道路泥除け装置を使用します。

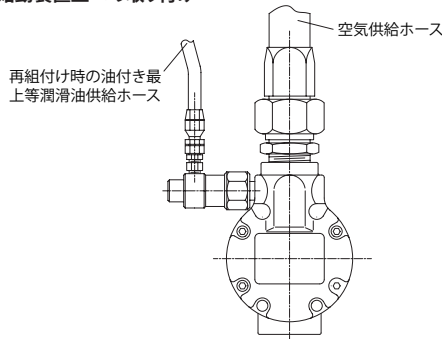
### 警告

始動装置がガス操作式の場合、排気は、配管によって発火または吸入の生じない場所に排出する必要があります

- “HDL2 ルブリケータの再組付け”の下に説明されているように [始動装置] 上またはその周囲に HDL2 ルブリケータを取り付けます。始動システム全体に圧力を加え、すべての接続部をしっかりと泡試験でチェックします。漏れの無いことが必須です。

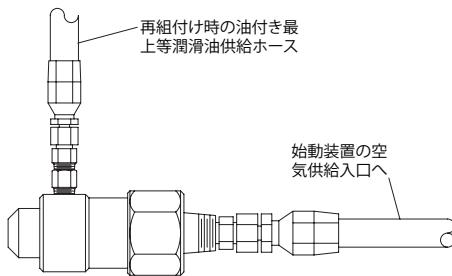
### HDL2 ルブリケータの再組付け

#### 始動装置上への取り付け



(Dwg. TPB789-3)

#### 離れた位置での取り付け



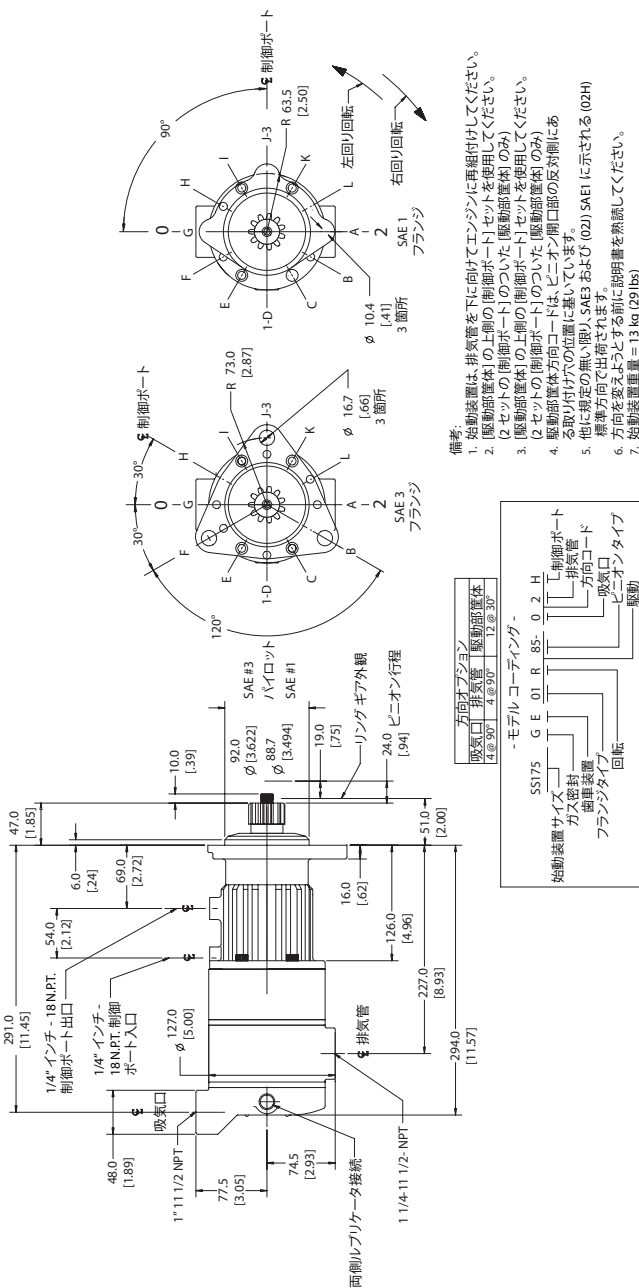
(Dwg. TPC494-3)

HDL2 ルブリケータは自給式で、始動装置上に直接再組付けするかまたは離れた位置に配置することもできます。ルブリケータは、再組付け位置から 4 ft (12m) 低い供給源から潤滑油をくみ上げることができますが、潤滑油ラインを実用的な程度に短くすることを推奨します。潤滑油の供給源として圧力が加わっていない燃料戻りラインを使用されることを推奨します。しかし、油は、別の容器またはディーゼル燃料タンクから供給することもあります。ディーゼル燃料タンクが潤滑油供給源であるときは、10 ~ 50 ミクロンの燃料フィルター (部品 No. HDL1-47) を燃料タンクの油供給ラインに再組付けします。潤滑油ラインは、T字型分岐で燃料戻りラインに組込まれるようにして、T字型分岐の脚が下向きにルブリケータに向かい、ルブリケータが油の代わりに空気を取り込むことがないことを保証するようにしてください。

**HDL2 ルブリケーターを以下のように取り付けます。**

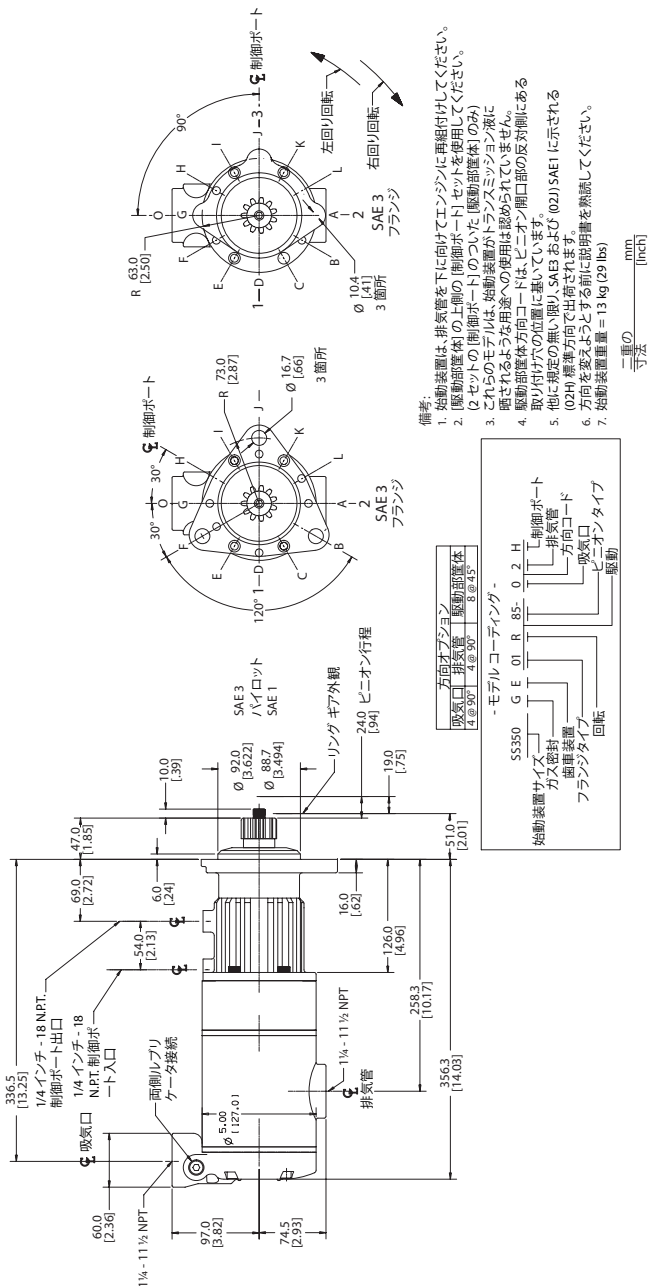
1. HDL2 ルブリケーターを始動装置上に取り付ける場合、始動装置上の [モーター筐体カバー] から 3/8 インチパイプ栓を外してHDL2と取り替えます。HDL2 を離れた位置に取り付ける場合、[ルブリケーター] に使用できる 2 本の U ボルトおよび基礎取付金具を使用します。
2. HDL2 を離れた位置に取り付けた場合、雄ネジ、雌ネジの両方を有するルブリケーターの末端から [始動装置モーター筐体カバー] 上の 3/8 インチ管のタップ付きの穴に 1/4 インチ ホースを再組付けします。
3. HDL2 の側面の 1/8 インチ NPTF 注油口から圧力の掛かっている燃料ライン、ディーゼル燃料タンクまたは別の油容器に No. 6 ホースを再組付けします。ルブリケーターの取り付け金具を 15 ~ 36 ft-lb (20.3 ~ 48.8 Nm) のトルクで締め付けます。**重要：**この接続は、真空気密にする必要があります。取り付け金具上のネジは清浄である必要があり、シーリング材またはTeflon\*\* テープを使用せずに取り付け金具を組み立てます。**注意：**初期運転の前に、手で油供給ラインを油で満たします。
4. 別の Lubrication 容器を使用する場合、この容器をディーゼル燃料、またはSAE10 または 10W の薄い、非洗浄性のモーター オイルで満たします。

\* E. I. Dupont の登録商標



1. 始動装置は、排気管を下に向けてエンジンを再組付けしてください。
2. 駆動装置の上部の(制御ポート)セットを使用してください。
3. 駆動装置の上部の(制御ポート)セットを使用してください。
4. 駆動装置の上部の(制御ポート)セットを使用してください。
5. 駆動装置方向ユーティリティ、SAE3 および (02) SAE1 に示される (02H) 型に適合の方向に、エンジン開口部に対してある角度付けを基にしています。
6. 燃料は指定の無い限り、SAE3 および (02) SAE1 に示される (02H) 標準方向で出荷されます。
7. 方向を変えようとする前に、燃焼室を熟読してください。
8. 始動装置重量 = 13 kg (29 lbs)

| 二重の寸法 | mm | [Inch] |
|-------|----|--------|
|-------|----|--------|



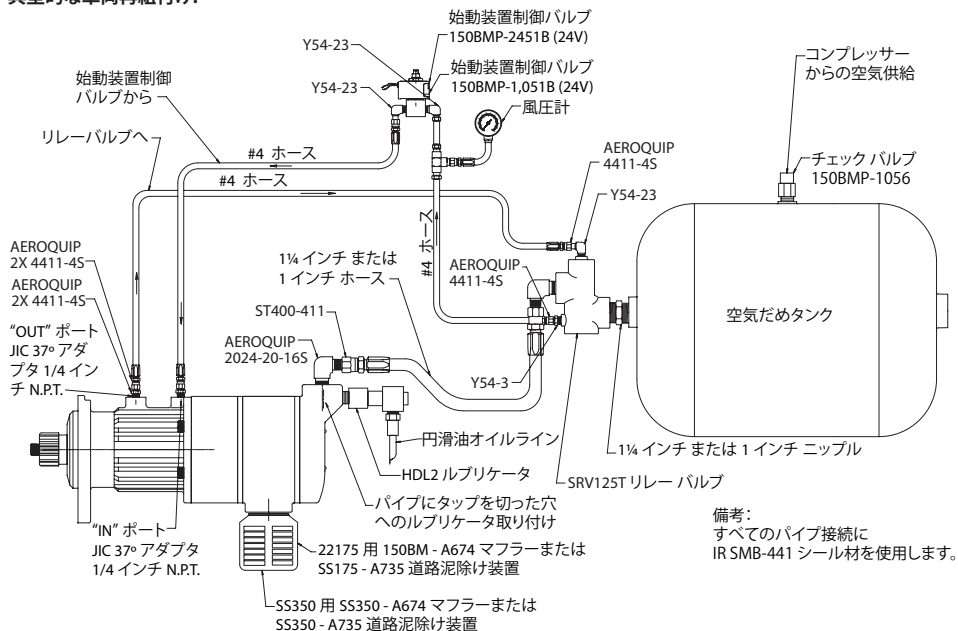
備考:

1. 始動装置は、排気管を下に向けてエンジンに直組付けてください。
2. 駆動部(エンジン)の上部の「制御ポート」セットを使用してください。
3. セットのモデルは、始動装置がトランスミッション液に浸されるような用途での使用はしないでください。
4. 駆動部(エンジン)の方向は、ヒートン開口部の反対側にある取り付け方向の位置に置いてください。
5. 他、特定の無い限り、SAE および (O2) SAE に示される (O2H) 標準方向に出力荷重をください。
6. 方向を変えようとするときは、出力荷重を減らしてください。
7. 始動装置の重量 = 13 kg (29 lbs)

二重の寸法

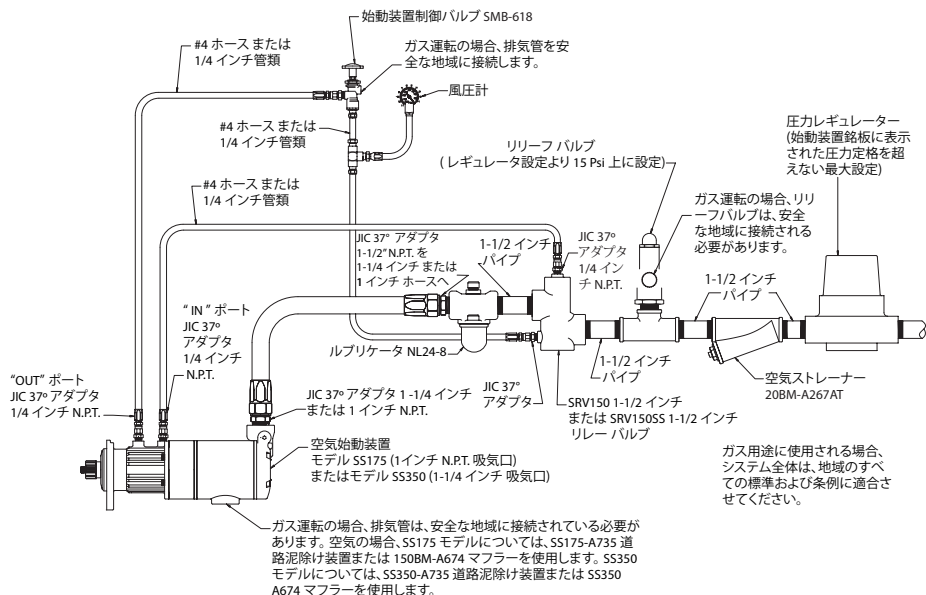
## 配管図

## 典型的な車両再組付け:



(Dwg. TPB715-1)

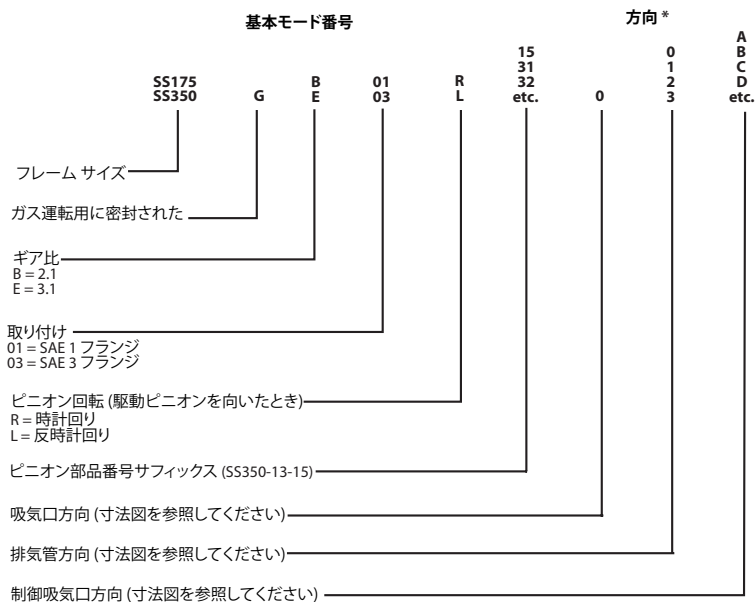
## 典型的な固定再組付け:



(Dwg. TPA942-1)

03532561\_ed7

## モデルコード識別



スペースの制限などの考慮すべき事項のため、以下の方向の組み合わせは不可能です:

## フランジ取り付け始動装置について

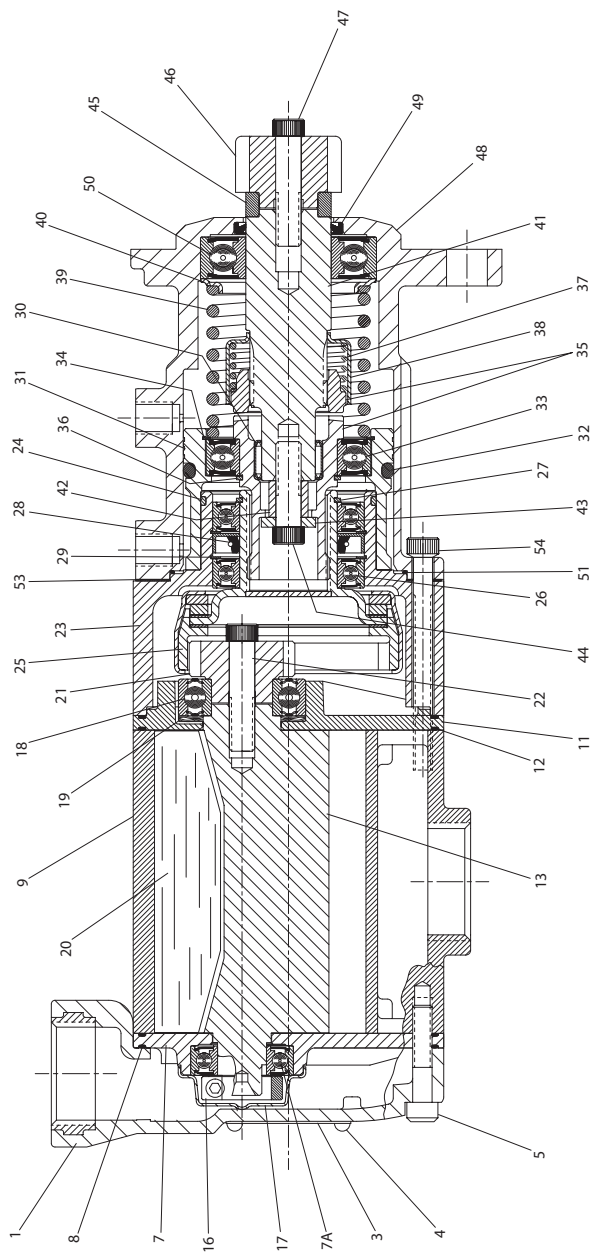
|       |       |       |       |
|-------|-------|-------|-------|
| 0-0-E | 0-1-H | 0-2-E | 0-3-H |
| 0-0-C | 0-1-F | 0-2-C | 0-3-F |
| 0-0-K | 0-1-B | 0-2-K | 0-3-B |
| 0-0-I | 0-1-L | 0-2-I | 0-3-L |

## 付属品

以下の付属品は、SS175 または SS350 始動装置を含み再組付けに使用できます。

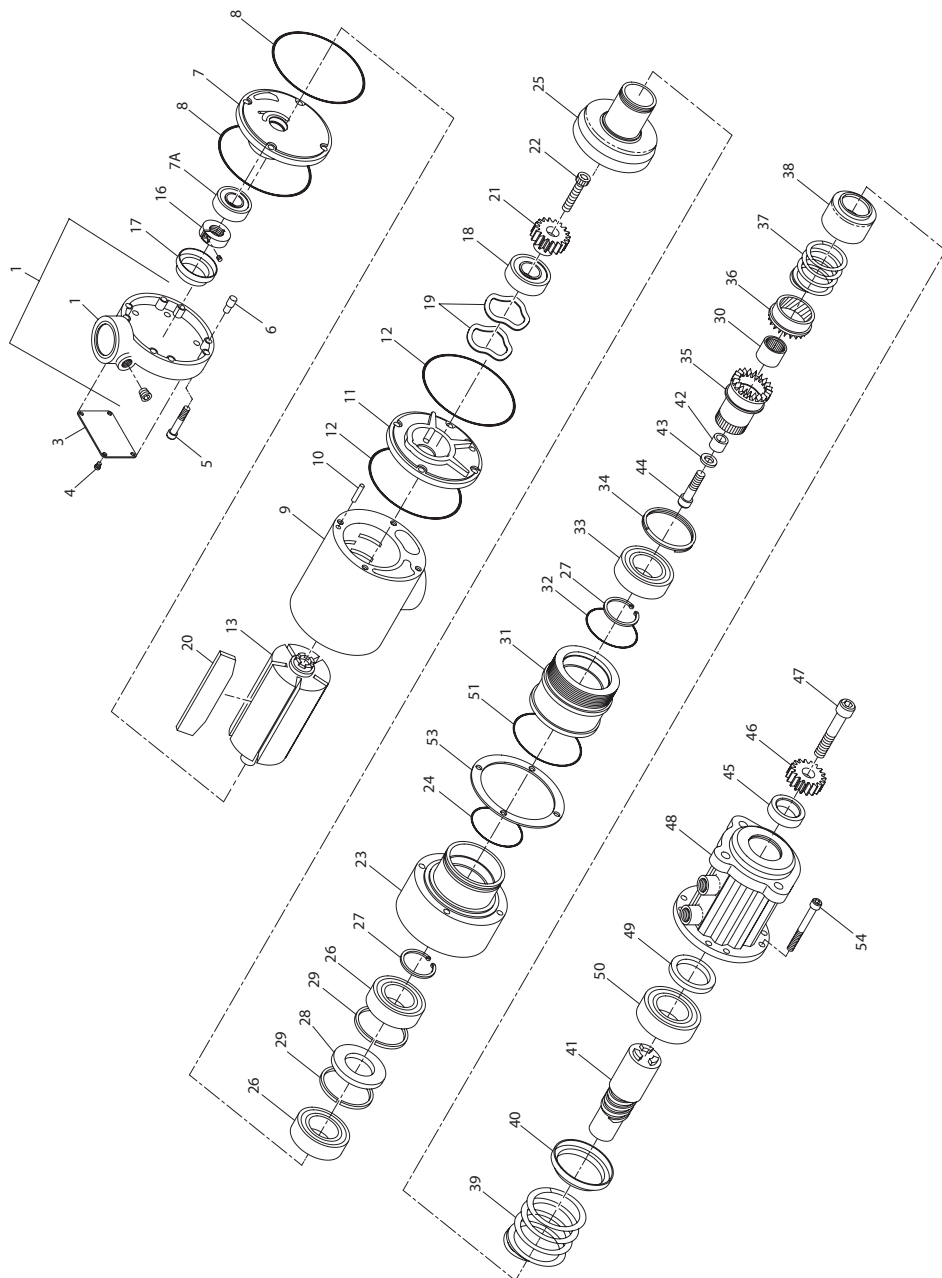
| 部品番号         | 部品名                                        | 部品番号       | 部品名                |
|--------------|--------------------------------------------|------------|--------------------|
| SMB-618      | 始動装置制御バルブ                                  | SS175 用    |                    |
| HDL2         | ルブリケータ                                     | 150BM-A674 | マフラー               |
| HDL1-47      | ルブリケータ フィルター                               | SS175-A735 | 道路泥除け装置            |
| NL-24-8      | 空気ライン ルブリケータ                               | SRV100     | 1インチ リレー バルブ       |
| SMB-441      | パイプ ネジ用シール材                                | SS175-HN16 | 1インチ パイプ ニップル      |
| 150BMP-1051B | 12V ソレノイドバルブ                               | SS350 用    |                    |
| 150BMP-2451B | 24V ソレノイドバルブ                               | SS350-A674 | マフラー               |
| 150BMP-1054  | コンビネーション Pr.<br>リリーフ/チェックバルブ               | SS350-A735 | 道路泥除け装置            |
| 150BMP-1056  | チェックバルブ                                    | SRV125     | 1-1/4 インチ リレー バルブ  |
| 150BMP-1064  | 圧力計                                        | SS350-HN20 | 1-1/4 インチ パイプ ニップル |
| K4U-A267AT   | 1-1/4 インチ 空気ストレーナー                         |            |                    |
| 20BM-A267AT  | 1-1/2 インチ 空気ストレーナー                         |            |                    |
| 150BMP-1067  | ドレインバルブ                                    |            |                    |
| SRV150-SS    | 1-1/2 インチ リレー バルブ (ステンレス鋼)<br>(ガス用途が必要な場合) |            |                    |

# SS175 and SS350 Series Starter - Cross Sectional View



(Dwg. TPA934-1)

## SS175 and SS350 Series Starter - Exploded Diagram



(Dwg. TPA931-3)

## SS175 Series Starter - Parts List

| Item | Part Description                    | Part Number | Item | Part Description                                                                                      | Part Number   |
|------|-------------------------------------|-------------|------|-------------------------------------------------------------------------------------------------------|---------------|
| 1    | Motor Housing Cover Assembly        | SS175-A102  | 31   | Piston Kit                                                                                            | SS350-K703    |
| 2    | 3/8" Pipe Plug (2)                  | HSPPS-3     | 32   | Piston O-Ring                                                                                         | SS350-337     |
| 3    | Nameplate                           | SS800-301   | 33   | Piston Bearing                                                                                        | SS350-339     |
| 4    | Nameplate Screw (4)                 | R4K-302     | 34   | Piston Bearing Retaining Ring                                                                         | SS350-107     |
| 5    | Motor Housing Cover Capscrew (4)    | SS350-25    | 35   | Clutch Jaw Kit (includes both Jaws and Bearing)                                                       |               |
| 6    | Bolt Hole Plug (4)                  | SS350-103   |      | for Right Hand Rotation Models                                                                        | SS350R-K587   |
| 7    | Rear Endplate (includes item 7A)    |             |      | for Left Hand rotation Models                                                                         | SS350L-K587   |
|      | for Right Hand Rotation Models      | SS350R-12   | 36   | Clutch Jaw Retaining Ring                                                                             | SS350-109     |
|      | for Left Hand rotation Models       | SS350L-12   | 37   | Clutch Jaw Spring                                                                                     |               |
| 7A   | Rear Rotor Bearing                  | SS350-24    |      | for Right Hand Rotation Models                                                                        | SS350R-583    |
| 8    | Endplate O-Ring (2)                 | SS350-67    |      | for Left Hand rotation Models                                                                         | SS350L-583    |
| 9    | Cylinder Housing Kit                | SS175-K3    | 38   | Clutch Spring Cup                                                                                     | SS350-367     |
| 10   | Cylinder Dowel (4)                  | SS350-98    | 39   | Piston Return Spring                                                                                  | SS350-700     |
| 11   | Front Endplate                      | SS350-11    | 40   | Return Spring Seat                                                                                    | SS350-191     |
| 12   | Endplate O-Ring (2)                 | SS350-67    | 41   | Drive Shaft                                                                                           |               |
| 13   | Rotor                               | SS175-53    |      | for Right Hand Rotation Models                                                                        | SS350R-8      |
| 16   | Rear Rotor Bearing Retaining Nut    | SS350-65    |      | for Left Hand rotation Models                                                                         | SS350L-8      |
| 17   | Retaining Nut Cover                 | SS350-64    | 42   | Drive Shaft Spacer                                                                                    | SS350-180     |
| 18   | Front Rotor Bearing                 | AM-318      | 43   | Drive Shaft Washer                                                                                    | SS350-177     |
| 19   | Front Rotor Bearing Wave Washer (2) | SS350-224   | 44   | Drive Shaft Capscrew                                                                                  |               |
| 20   | Vane Packet (set of 5 Vanes)        | SS175-42-5  |      | for SS350R-8                                                                                          | SS350-179     |
| 21   | Rotor Pinion                        |             |      | for SS350L-8                                                                                          | 10554897      |
|      | for "B" ratio Models                | SS350B-17   | 45   | Drive Shaft Collar                                                                                    | SS350-175     |
|      | for "E" ratio Models                | SS350E-17   | † 46 | Drive Pinion                                                                                          | ---           |
| 22   | Rotor Pinion Retaining Screw        |             | 47   | Drive Pinion Retaining Screw                                                                          |               |
|      | for "B" ratio Models                | SS350-394   |      | for SS350R-8                                                                                          | 10554889      |
|      | for "E" ratio Models                | SS350E-732  |      | for SS350L-8                                                                                          | SS350-394     |
| 23   | Gear Case                           | SS350-37-03 | 48   | Drive Housing Kit                                                                                     |               |
| 24   | Gear Case O-Ring                    | SS350-151   |      | for SAE 1 Flange Mounting                                                                             | SS350-K300-01 |
| 25   | Drive Gear                          |             |      | for SAE 3 Flange Mounting                                                                             | SS350-K300-03 |
|      | for "B" ratio Models                | SS350B-9    | 49   | Drive Housing Seal                                                                                    | SS350-271     |
|      | for "E" ratio Models                | SS350E-9    | 50   | Drive Housing Bearing                                                                                 | SS350-363     |
| 26   | Drive Gear Bearing (2)              | SS350-359   | 51   | Drive Housing O-Ring                                                                                  | SS350-243     |
| 27   | Bearing Retaining Ring              | SS350-109   | 53   | Drive Housing Gasket                                                                                  | SS350-245     |
| 28   | Gear Case Seal                      | SS350-272   | 54   | Drive Housing Capscrew (4)                                                                            | SS350-744     |
| 29   | Gear Case Seal Retaining Ring (2)   | SS350-270   | *    | Tune-up Kit (includes illustrated parts 8 (2), 12 (2), 14, 18, 20, 24, 27, 28, 32, 36, 49, 51 and 53) |               |
| 30   | Needle Bearing                      | SS350-278   |      |                                                                                                       |               |

\* Not illustrated

† To order the proper Drive Pinion, refer to Drive Pinion Selection Chart

## SS350 Series Starter - Parts List

| Item | Part Description                    | Part Number    | Item | Part Description                                                                                      | Part Number   |
|------|-------------------------------------|----------------|------|-------------------------------------------------------------------------------------------------------|---------------|
| 1    | Motor Housing Cover Assembly        | SS350-A102     | 30   | Needle Bearing                                                                                        | SS350-278     |
| 2    | 3/8" Pipe Plug (2)                  | H5PPS-3        | 31   | Piston Kit                                                                                            | SS350-K703    |
| 3    | Nameplate                           | SS800-301      | 32   | Piston O-Ring                                                                                         | SS350-337     |
| 4    | Nameplate Screw (4)                 | R4K-302        | 33   | Piston Bearing                                                                                        | SS350-339     |
| 5    | Motor Housing Cover Capscrew (4)    | SS350-25       | 34   | Piston Bearing Retaining Ring                                                                         | SS350-107     |
| 6    | Bolt Hole Plug (4)                  | SS350-103      | 35   | Clutch Jaw Kit (includes both Jaws and Bearing)                                                       |               |
| 7    | Rear Endplate (includes item 7A)    |                |      | for Right Hand Rotation Models                                                                        | SS350R-K587   |
|      | for Right Hand Rotation Models      | SS350R-12      |      | for Left Hand rotation Models                                                                         | SS350L-K587   |
|      | for Left Hand rotation Models       | SS350L-12      | 36   | Clutch Jaw Retaining Ring                                                                             | SS350-109     |
|      | for Model SS350GE03R31-1707         | SS350R-11-1605 | 37   | Clutch Jaw Spring                                                                                     |               |
| 7A   | Rear Rotor Bearing                  | SS350-24       |      | for Right Hand Rotation Models                                                                        | SS350R-583    |
| 8    | Endplate O-Ring (2)                 | SS350-67       |      | for Left Hand rotation Models                                                                         | SS350L-583    |
| 9    | Cylinder Housing Kit                | SS350-K3       | 38   | Clutch Spring Cup                                                                                     | SS350-367     |
| 10   | Cylinder Dowel (4)                  | SS350-98       | 39   | Piston Return Spring                                                                                  | SS350-700     |
| 11   | Front Endplate                      |                | 40   | Return Spring Seat                                                                                    | SS350-191     |
|      | for Model SS350GE03R31-1707         | SS350-11-1604  | 41   | Drive Shaft                                                                                           |               |
|      | for all other models                | SS350-11       |      | for Right Hand Rotation Models                                                                        | SS350R-8      |
| 12   | Endplate O-Ring (2)                 | SS350-67       |      | for Left Hand rotation Models                                                                         | SS350L-8      |
| 13   | Rotor                               | SS350-53A      | 42   | Drive Shaft Spacer                                                                                    | SS350-180     |
| 16   | Rear Rotor Bearing Retaining Nut    | SS350-65       | 43   | Drive Shaft Washer                                                                                    | SS350-177     |
| 17   | Retaining Nut Cover                 | SS350-64       | 44   | Drive Shaft Capscrew                                                                                  |               |
| 18   | Front Rotor Bearing                 | AM-318         |      | for SS350R-8                                                                                          | SS350-179     |
| 19   | Front Rotor Bearing Wave Washer (2) | SS350-224      |      | for SS350L-8                                                                                          | 10554897      |
| 20   | Vane Packet (set of 5 Vanes)        | SS350-42-5     | 45   | Drive Shaft Collar                                                                                    | SS350-175     |
| 21   | Rotor Pinion                        |                | † 46 | Drive Pinion                                                                                          | ---           |
|      | for "B" ratio Models                | SS350B-17      | 47   | Drive Pinion Retaining Screw                                                                          |               |
|      | for "E" ratio Models                | SS350E-17      |      | for SS350R-8                                                                                          | 10554889      |
| 22   | Rotor Pinion Retaining Screw        |                |      | for SS350L-8                                                                                          | SS350-394     |
|      | for "B" ratio Models                | SS350-394      | 48   | Drive Housing Kit                                                                                     |               |
|      | for "E" ratio Models                | SS350E-732     |      | for SAE 1 Flange Mounting                                                                             | SS350-K300-01 |
| 23   | Gear Case                           | SS350-37-03    |      | for SAE 3 Flange Mounting                                                                             | SS350-K300-03 |
| 24   | Gear Case O-Ring                    | SS350-151      | 49   | Drive Housing Seal                                                                                    | SS350-271     |
| 25   | Drive Gear                          |                | 50   | Drive Housing Bearing                                                                                 | SS350-363     |
|      | for "B" ratio Models                | SS350B-9       | 51   | Drive Housing O-Ring                                                                                  | SS350-243     |
|      | for "E" ratio Models                | SS350E-9       | 53   | Drive Housing Gasket                                                                                  | SS350-245     |
| 26   | Drive Gear Bearing (2)              | SS350-359      | 54   | Drive Housing Capscrew (4)                                                                            | SS350-744     |
| 27   | Bearing Retaining Ring              | SS350-109      | *    | Tune-up Kit (includes illustrated parts 8 (2), 12 (2), 14, 18, 20, 24, 27, 28, 32, 36, 49, 51 and 53) | SS350-TK2     |
| 28   | Gear Case Seal                      | SS350-272      |      |                                                                                                       |               |
| 29   | Gear Case Seal Retaining Ring (2)   | SS350-270      |      |                                                                                                       |               |

\* Not Illustrated

† To order the proper Drive Pinion, refer to Drive Pinion Selection Chart

## Drive Pinion Selection Chart

### Series SS175

| Starter Model Number | Pinion Part Number | Starter Model Number | Pinion Part Number |
|----------------------|--------------------|----------------------|--------------------|
| SS175GB01R15-02H     | SS350R-13-15       | SS175GE03L38-02H     | SS350R-13-38       |
| SS175GB01R15-02J     |                    | SS175GB01R77-02J     | SS350R-13-77       |
| SS175GE01R15-02J     |                    | SS175GB03R77-02H     |                    |
| SS175GE03R15-00H     |                    | SS175GE01R77-02J     |                    |
| SS175GE03R15-02H     |                    | SS175GE03R77-02H     |                    |
| SS175CE01R21-02J     | SS350R-13-21       | SS175GB01R85-02J     | SS350R-13-85       |
| SS175GE01R29-02J     | SS350R-13-29       | SS175GB03R85-02J     |                    |
| SS175GE03R29-02A     |                    | SS175GE01R85-02J     |                    |
| SS175GE03R29-02H     |                    | SS175GE03R85-02H     |                    |
| SS175GE01R31-02J     | SS350R-13-31       | SS175GB01R99-00D     | SS350R-13-99       |
| SS175GE03R31-02H     |                    | SS175GE01R99-00D     |                    |
| SS175GE03R31-02J     |                    | SS175GE01R99-1369    |                    |
| SS175GE03L32-00H     |                    | SS175GE01R99-1389    |                    |
| SS175GE03L32-02H     | SS350L-13-32       |                      |                    |
| SS175GE03R37-00H     | SS350R-13-37       |                      |                    |
| SS175GE03R37-02F     |                    |                      |                    |
| SS175GE03R37-02H     |                    |                      |                    |

### Series SS350

| Starter Model Number | Pinion Part Number | Starter Model Number | Pinion Part Number |
|----------------------|--------------------|----------------------|--------------------|
| SS350GE03R21-02H     | SS350R-13-21       | SS350GB03L32-02H     | SS350L-13-32       |
| SS350GB01R29-02J     | SS350R-13-29       | SS350GE03L32-00D     |                    |
| SS350GE01R29-00L     |                    | SS350GE0L32-00G      |                    |
| SS350GE01R29-02J     |                    | SS350GE03L32-00H     |                    |
| SS350GE03R29-00A     |                    | SS350GE03L3-00L      |                    |
| SS350GE03R2900L      |                    | SS350GE03L32-01C     |                    |
| SS350GE03R29-01J     |                    | SS350GE03L32-01I     |                    |
| SS350GE03R29-02B     |                    | SS350GE03L32-02F     |                    |
| SS350GE03R29-02F     |                    | SS350GE0332-02G      |                    |
| SS350GE03R29-02H     |                    | SS350GE03L32-02H     |                    |
| SS350GE03R29-03J     |                    | SS350GE03L32-03G     |                    |
| SS350GE03R29-1543    |                    | SS350GE03L32-1513    |                    |
| SS350GE03R29-1547    |                    | SS350GE03L32-1550    |                    |
| SS350GE03R29-1587    |                    | SS350GE03R37-02H     | SS350R-13-37       |
| SS350GB03R31-00A     | SS350R-13-31       | SS350GB01R77-02J     | SS350R-13-77       |
| SS350GE01R31-02J     |                    | SS350GB03R77-01D     |                    |
| SS350GE03R31-00A     |                    | SS350GB03R77-02H     |                    |
| SS350GE03R31-00F     |                    | SS350GE03R83-02H     | SS350R-13-83       |
| SS350GE03R31-00G     |                    | SS350GB01R85-00F     | SS350R-13-85       |
| SS350GE03R31-00H     |                    | SS350GB01R85-02H     |                    |
| SS350GE03R31-00L     |                    | SS350GB01R85-02J     |                    |
| SS350GB03R31-02H     |                    | SS350GB03R85-02H     |                    |
| SS350GE03R31-01D     |                    | SS350GB03R85-1537    |                    |
| SS350GE03R31-02A     |                    | SS350GE01R85-02H     |                    |
| SS350GE03R31-02B     |                    | SS350GE01R85-02J     |                    |
| SS350GE03R31-02F     |                    | SS350GE03R85-02H     |                    |
| SS350GE03R31-02G     |                    | SS350GB01R99-00D     | SS350R-13-99       |
| SS350GE03R31-02H     |                    | SS350GE03R99-02H     |                    |
| SS350GE03R31-02L     |                    |                      |                    |
| SS350GE03R31-1552    |                    |                      |                    |
| SS350GE03R31-1574    |                    |                      |                    |
| SS350GE03R31-1707    |                    |                      |                    |

## Disassembly of the Starter

### General Information

1. Always mark adjacent parts on the Motor Housing Cover (1), Cylinder Housing (9), Gear Case (23) and Drive Housing (48) so these members can be located in the same relative position when the Starter is reassembled.
2. Do not disassemble the Starter any further than necessary to replace a worn or damaged part.
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 vanes, seals and O-rings on hand before starting any overhaul of a Starter. **Never reuse old seals or O-rings.**
5. 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.

### Disassembly of the Drive Housing

1. With the Starter in a horizontal position and supported on the workbench, grasp the Drive Pinion (46) in copper covered vise jaws.



#### CAUTION

**Do not use excessive clamping force on the Drive Pinion. Grasp it just firmly enough to hold it. Make certain the Starter is firmly supported on the workbench.**

2. Using an 8 mm hexagon wrench, remove the Drive Pinion Retaining Screw (47).
3. Loosen the vise and withdraw the Drive Pinion from the Drive Shaft (41).
4. Stand the Starter on end with the Drive Shaft upward.
5. Using a 6 mm hexagon wrench, remove the four Drive Housing Cap Screws (54).



#### CAUTION

**When unscrewing the Drive Housing Cap Screws, hold the Drive Housing (48) down against the expansion of the Piston Return Spring (39).**

6. Lift off the Drive Housing.

#### NOTICE

**The Gear Case (23) might come off with the Drive Housing. Separate the two if this occurs.**

7. Do not remove the Drive Housing Bearing (50) or Drive Housing Seal (49) from the Drive Housing unless it is absolutely necessary, and you have a new Drive Housing Bearing and Seal on hand for replacement. These members are always damaged in the removal process. If it is necessary to remove the Drive Housing Bearing or Seal, stand the Drive Housing on the workbench with the seal end up. Drive or press the Seal and Bearing from the Drive Housing.

### Disassembly of the Piston and Clutch

1. With the Starter standing on end as in Step 4 of the preceding section, lift off the Return Spring Seat (40) and Piston Return Spring (39).
2. Grasp the Piston (31) and slide the Piston, Clutch Jaws (35) and Drive Shaft (41) as a unit from the Gear Case (23).
3. Using a small, thin-bladed screwdriver, remove the Piston Bearing Retaining Ring (34) from the groove inside the Piston.
4. Slide the Piston off the Piston Bearing (33).
5. Remove the Piston O-ring (32) from the Piston.
6. Using a pair of snap ring pliers, remove the Clutch Jaw Retaining Ring (36) from the rear Clutch Jaw.
7. Press the Piston Bearing from the rear Clutch Jaw.

8. Grasp the Drive Pinion in copper-covered vise jaws so that the three driving lugs are upward.
9. While engaging the lugs on the Drive Shaft with those on the Drive Pinion, use an 8 mm hexagon wrench to unscrew the Drive Shaft Cap Screw (44). Remove the Drive Shaft Cap Screw, Washer (43) and Spacer (42).
10. Pull the rear Clutch Jaw from the Drive Shaft.

#### NOTICE

**Do not remove the needle bearing from inside the rear Clutch Jaw unless a new needle bearing is available and ready to install. This bearing will be damaged in the removal process.**

11. Slide the front Clutch Jaw, Clutch Spring (37) and Clutch Spring Cap (38) from the Drive Shaft.

### Disassembly of the Gear Case

1. Pull the Gear Case (23) along with the Drive Gear (25) and its associated parts, from the motor.
2. Remove the Gear Case O-ring (24).
3. Using a pair of retaining ring pliers, remove the Bearing Retaining Ring (27).
4. Slide the Drive Gear from the bore of the Drive Gear Bearings (26) and Gear Case.

**Note:** It is possible that the rear Drive Gear Bearing will remain on the shaft of the Drive Gear.

5. Slide the Drive Gear Bearings from the bore of the Gear Case and/or from the shaft of the Drive Gear.
6. DO not remove the Gear Case Seal (28) from the bore of the Gear Case unless you have a new Seal on hand ready for installation. If it is necessary to remove the Gear Case Seal, use a small, thin-bladed screwdriver and remove the Gear Case Seal Retaining Ring (29) from each side of the Gear Case Seal.
7. Press the Gear Case Seal from the Gear Case.

### Disassembly of the Motor

1. With the motor in a vertical position, Motor Housing Cover (1) upward, grasp the Cylinder Housing (9) in copper covered vise jaws.



#### CAUTION

**Do not use excessive clamping force on the Cylinder Housing. Grasp it just firmly enough to support the motor.**

2. Using a 6 mm hexagon wrench, remove the four Motor Housing Cover Cap Screws (5) and remove the Motor Housing Cover.
3. Lift the Retaining Nut Cover (17) from the Rear End Plate (7).
4. Using a 3 mm hexagon wrench, loosen the clamping screw in the Rear Rotor Bearing Retaining Nut (16).
5. Unscrew the Rear Rotor Bearing Retaining Nut.
6. Lay the motor on its side, and grasp the Rotor Pinion in copper-covered vise jaws.
7. Using an 8 mm hexagon wrench, unscrew the Rotor Pinion Retaining Screw (22).
8. Pull the Rotor Pinion from the Front Rotor Bearing (18).
9. Thread the Rotor Pinion Retaining Screw back into the front of the Rotor (13) about five or six turns.
10. Lay the motor on its side and, with a soft face hammer, tap the head of the Pinion Retaining Screw to drive the Rotor and Rear End Plate (7) from the opposite end of the Cylinder Housing (9).
11. Support the Rear End Plate on the table of an arbor press and press the Rotor from the Rear Rotor Bearing (7A).



#### CAUTION

**The Rear Rotor Bearing (7A) is bonded to the Rear End Plate (7) with Loctite®. Removal of the Rear Rotor Bearing requires the use of heat. Observe all normal precautions for the handling of hot material.**

12. Apply enough heat to the periphery of the bearing recess to break the Loctite bond which holds the Bearing to the Rear End Plate.
13. Being careful so as to not get burned, press the Rear Rotor Bearing from the Rear End Plate.
14. Using a wooden hammer handle, or similar piece of wood, reach through the bore of the Cylinder Housing and tap the Front End Plate (11) free from the Cylinder Dowels (10).
15. Slide the Front Rotor Bearing (18) and Front Rotor Bearing Wave Washers (19) from the Front End Plate.

### Cleaning the Parts

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

1. Wipe all dirt, grease, etc., from the sealed bearings. 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 sealed bearings 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 and replace any which are worn or distorted.

## Assembly of the Starter

### General Instructions

1. Always press on the inner ring of a ball bearing when pressing that bearing onto a shaft. Always press against the outer ring of a ball bearing when pressing that bearing into a bearing recess. Failure to follow these instructions may ruin the bearing.
2. When pressing a needle bearing into a bearing recess, always press against the stamped end of the bearing using a piloted arbor that contacts only the outer rim of the shell. The use of a flat arbor, or installing the bearing wrong end first, may fracture the shell or lock the needles against rotation.
3. Wipe a thin film of SAE 10 non detergent oil on the Vanes, Rotor, Cylinder bore and Drive Housing Bore.
4. Lubricate all rubbing surfaces with **Ingersoll Rand** Grease No. 130. Pay special attention to lubricating the gear teeth, clutch teeth, splines and related drive parts, needle bearings and sliding area of the drive shaft. 5. When assembling the Motor, always use new O-rings.
6. Before installing O-rings, coat liberally with O-ring lubricant. After O-ring is installed, coat O-ring again with O-ring lubricant and apply O-ring lubricant to O-ring grooves.

### Assembly of the Motor

1. To install the Rear Rotor Bearing (7A) in the Rear End Plate (7), apply a small amount of Loctite 680\*\* or equivalent and activator to the outside of the outer race of the Rear Rotor Bearing.
2. Install the Bearing in the recess in the Rear End Plate and allow Loctite to cure.

### NOTICE

**Do not get any Loctite in the bearing; damage to the Bearing could result. Do not get any on the inside diameters of the Bearing; grease will prevent the Loctite from working.**

\* Registered trademark of Loctite Corporation.

3. Place the Rotor (13) on an arbor press with the three-jaw drive end down.
4. Set the Rear End Plate (7) flat side down, on the upper end of the Rotor.
5. Place two pieces of .004" (0.10 mm) thick shim stock in opposite positions on the end of the Rotor under the end plate.
6. Using a hollow arbor that seats against the inner race of the bearing, press the Rear End Plate down against the shim stock.
7. Remove the Rear End Plate from the arbor press and grasp the Rotor in copper covered vise jaws with the threaded hub upward.

### NOTICE

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

3. Check the needle bearing in the rear Clutch Jaw. If the bearing is worn, distorted or has loose needles, replace the two piece Clutch Jaw.

### NOTICE

**The clutch jaws are a matched set and must be replaced with a matched set.**

4. Check all ball bearings- These should run freely without any rough spots or binding- Discard any bearing that gives any indication of wear.
5. Check the Vanes for separation, chipping or other wear. See that they fit freely in the vane slots in the Rotor. We recommend that a complete new set of Vanes be installed whenever the Starter is disassembled.

\* Registered trademark of Loctite Corporation.

8. Start the Rear Rotor Bearing Retaining Nut (16), shoulder side first, on the hub of the Rotor.
9. Adjust the Rear Rotor Bearing Retaining Nut until there is a slight drag on the shim stock. Remove the shim stock. Using a 3 mm hexagon wrench, tighten the clamping screw in the Retaining Nut to 10 in-lb (1.1 Nm) torque.

### NOTICE

**The clearance between the Rear End Plate and the Rotor can be from .002" (0.05 mm) to .005" (0.13 mm) after tightening the clamping screw.**

10. Remove the assembled Rotor and Rear End Plate from the vise and stand them upright on the workbench with the Rotor upward.
11. Take one of the End Plate O-rings (8) and coat it liberally with O-ring lubricant. Set the End Plate O-ring down over the Rotor into the groove in the Rear End Plate. Make certain the entire O-ring is in the groove and that it has sufficient O-ring lubricant on it to hold it in the groove.
12. Check the Cylinder Dowels (10) pressed into each end of the Cylinder Housing (9). If the Dowels are bent or broken, remove them and install new Cylinder Dowels.
13. Set the Cylinder Housing on end on two pieces of wood at least 3/4" (19 mm) thick, so that when the Rotor is installed there is clearance for the driving lugs on the hub to extend beyond the face of the Cylinder Housing.

### NOTICE

**Check the model number of the Starter to determine the direction of rotation. Model numbers having the letter "R" are right-hand rotation; model numbers having the letter "L" are left-hand rotation.**

**For right-hand rotation Models: Stand the Cylinder Housing on end on the two pieces of wood so that the pipe tapped exhaust port is facing you, and so that the kidney-shaped air port is on the left side of the Cylinder Housing.**

**For left-hand rotation Models: Stand the Cylinder Housing on end on the two pieces of wood so that the pipe tapped exhaust port is facing you, and so that the kidney-shaped air port is on the right side of the Cylinder Housing.**

14. Take the assembled Rear End Plate and Rotor and insert the Rotor down through the Cylinder Housing so that the Cylinder Dowels are aligned with the dowel holes in the Rear End Plate.

15. Tap the Rear End Plate into place so that it seats against the face of the Cylinder Housing. Make certain the End Plate O-ring does not come out of the groove in the End Plate.
16. Fit the Retaining Nut Cover (17) on the hub of the Rear End Plate.
17. Coat a second End Plate O-ring (8) with O-ring lubricant and place it in the groove in the trailing face of the Rear End Plate. Make certain the entire O-ring is in the groove.
18. Place the Motor Housing Cover (1) on the Rear End Plate, making certain that it is oriented relative to the exhaust port in the Cylinder Housing, exactly the way it was prior to disassembly.
19. Using a 6 mm hexagon wrench, install the four Motor Housing Cover Cap Screws (5) and tighten them to 20 ft-lb (27 Nm) of torque.
20. Install the two 3/8" Pipe Plugs (2) in the Motor Housing Cover and tighten them securely.
21. Turn the motor end-for-end so that the front hub of the Rotor is upward.
22. Wipe each Vane (20) with a film of light oil and install a Vane in each vane slot in the Rotor. Make certain the tapered edge of each Vane faces the center of the Rotor.
23. Coat an End Plate O-ring (12) with a liberal amount of O-ring lubricant and place it in the groove on the flat side of the Front End Plate (11). Make certain the entire O-ring is in the groove and that there is a sufficient amount of lubricant to hold it in place.
24. Place the Front End Plate, flat side first, down over the hub of the Rotor so that the Cylinder Dowels are aligned with the dowel holes in the End Plate.
25. Tap the Front End Plate with a soft face hammer until it seats against the Cylinder Housing. Make certain the End Plate O-ring does not slip out of the groove in the End Plate.
26. Place the two Front Rotor Bearing Wave Washers (19) in the bottom of the bearing recess in the Front End Plate.
27. Install the Front Rotor Bearing (18) in the bearing recess in the Front End Plate.
28. Place the Rotor Pinion (21), lug side first, in the bore of the Front Rotor Bearing so that it engage: the lugs on the end of the rotor shaft.

### NOTICE

#### Check to make sure the lugs are engaged.

29. Using an 8 mm hexagon wrench, install the Rotor Pinion Retaining Screw (22) and tighten it to 55 ft-lb (74 Nm) of torque.

#### Assembly of the Gear Case

1. Stand the Gear Case (23), large open end up, on the workbench.
2. Install a Gear Case Seal Retaining Ring (29) in the first or upper groove in the small bore of the Gear Case.
3. Place the Gear Case on an arbor press, large end down. Press the Gear Case Seal (28), lip side first, into the small bore of the Gear Case until it seats against the Retaining Ring.
4. Install the second Gear Case Seal Retaining Ring in the second groove in the small bore of the Gear Case.
5. Slide a Drive Gear Bearing (26) on the hub of the Drive Gear (25) until it seats.
6. Wipe a thin film of O-ring lubricant on the lip of the Gear Case Seal and on the shaft of the Drive Gear.
7. Insert the shaft of the Drive Gear into the large open end of the Gear Case and through the Gear Case Grease Seal. Make certain that the lip of the Grease Seal does not turn inside out or that the garter spring does not come off. Push the Drive Gear into the Gear Case until the Drive Gear Bearing seats against the Gear Case Retaining Ring.
8. Slide the second Drive Gear Bearing into the small end of the Gear Case until it seats against the second Gear Case Seal Retaining Ring.
9. Using a pair of retaining ring pliers, install the Bearing Retaining Ring (27) in the groove on the hub of the Drive Gear.
10. Coat the Gear Case O-ring (24) with O-ring lubricant and install it in the groove on the hub of the Gear Case.

#### Assembly of the Piston and Drive Shaft

1. Grasp the Drive Pinion (46) in copper-covered vise jaws so that the lugs on the Drive Pinion are upward.

### CAUTION

**Do not use excessive clamping force on the Drive Pinion. Grasp it just firmly enough to hold it.**

2. Stand the Drive Shaft (41) on end so that the lugs on the large end of the Drive Shaft engage the lugs on the Drive Pinion. Install the Drive Pinion Retaining Screw (47) and tighten finger tight.
3. Lubricate the spline on the Drive Shaft with **Ingersoll Rand** Grease No. 130.
4. Slide the Clutch Spring Cup (38), small end first, over the splined end of the Drive Shaft until it seats against the shoulder on the Drive Shaft.
5. Slide the Clutch Spring (37) over the splined end of the Drive Shaft and into the Clutch Spring Cup.

### CAUTION

**Make certain you install the correct Clutch Spring. Clutch Springs for Starters having the letter "L" in the Model number are color coded "red." Clutch Springs for Starters having the letter "R" in the Model number have a natural metallic finish.**

6. Work some **Ingersoll Rand** Grease No. 130 in the splines and teeth of the front Clutch Jaw (35), and slide the front Clutch Jaw, small diameter end first, over the splines on the Drive Shaft and against the Clutch Spring.
7. Slide the Needle Bearing (30) over the end of the Drive Shaft.
8. Press the Piston Bearing (33) on the shaft of the rear Clutch Jaw (35), and install the Clutch Jaw Retaining Ring (36).
9. Work some **Ingersoll Rand** Grease No. 130 into the Needle Bearing inside the rear Clutch Jaw and on the teeth of the rear Clutch Jaw.
10. Place the rear Clutch Jaw, teeth end first, on the end of the Drive Shaft so that the teeth of both Clutch Jaws are engaged.
11. Make certain the splines on the front Clutch Jaw are engaged with the splines on the Drive Shaft by pushing the rear clutch Jaw downward against the compression of the Clutch Spring. While holding the assembly in this position, drop the Drive Shaft Spacer (42) into the bore of the rear Clutch Jaw, followed by the Drive Shaft Washer (43).
12. Using an 8 mm hexagon wrench, install the Drive Shaft Cap Screw (44) and tighten it to 55 ft-lb (74 Nm) of torque.
13. Work the rear Clutch Jaw back and forth against the compression of the Clutch Spring to make certain that it moves freely and travels 15/32" (12 mm). When the Clutch Jaw is pressed down against the Clutch Spring and released, it must return freely. Remove the Drive Pinion Retaining Screw and Drive Pinion.
14. Take the assembled Clutch Jaw and Drive Shaft and insert it, splined end first, into the large diameter bore of the Piston (31) until the Piston Bearing is seated.
15. Install the Piston Bearing Retaining Ring (34) in the groove in the Piston.
16. Coat the Piston O-ring (32) with O-ring lubricant and install it in the groove on the Piston.

#### Assembly of the Drive Housing

1. Stand the Drive Housing (48) on an arbor press with the large open bore upward. Press the Drive Housing Seal (49), lip side first, into the recess at the bottom of the housing bore.
2. Using a sleeve that contacts the outer race of the Drive Housing Bearing (50), press the Bearing into the bearing recess at the bottom of the housing bore until it seats.

## Assembly of the Starter

1. Grasp the assembled motor in a large vise so that the Rotor Pinion (21) is upward.



### CAUTION

**Do not use excessive clamping force on the Drive Pinion. Grasp it just firmly enough to hold it.**

2. Liberally coat an End Plate O-ring (12) with O-ring lubricant, and place it in the groove on the face of the Front End Plate (11). Make certain the entire O-ring is in the groove.
3. Work approximately 150 cc of **Ingersoll Rand** Grease No. 130 into the teeth on the Drive Gear (25) and Rotor Pinion (21).
4. Orient the Gear Case (23) exactly the way it was prior to disassembly of the Starter, and place it on the face of the motor so that the Rotor Pinion meshes with the Drive Gear. Make certain the End Plate O-ring stays in the groove on the face of the Front End Plate.
5. Place the Drive Housing Gasket (53) on the face of the Gear Case, making certain all holes are properly aligned.
6. Lubricate the internal splines of the Drive Gear and the hub of the Gear Case adjacent to the Gear Case O-ring (24) with **Ingersoll Rand** Grease No. 130.
7. Place the assembled Clutch Jaw (35), Drive Shaft (41) and Piston (31) over the hub of the Gear Case so that the splines on the Clutch Jaw engage the internal splines of the Drive Gear, and so that the piston skirt slides down over the hub of the Gear Case until it seats.
8. Wipe a film of **Ingersoll Rand** Grease No. 130 on the exterior of the Drive Shaft, Piston and Piston Return Spring (39).
9. Place the Piston Return Spring over the end of the Drive Shaft so that it seats against the Piston Bearing Retaining Ring ((34) in the front of the Piston. Place the Return Spring Seat (40) on the end of the Piston Return Spring so that the small lip on the Seat fits inside the Return Spring.
10. Liberally coat the Drive Housing O-ring (51) with O-ring lubricant, and install the O-ring in the counterbore at the base of the Drive Housing (48).
11. Liberally coat the bore of the Drive Housing with **Ingersoll Rand** Grease No. 130.
12. Making certain that the Drive Housing O-ring stays in place, place the Drive Housing down over the Piston Return Spring and Piston until it seats against the Gear Case and is oriented exactly the way it was prior to disassembly.
13. Using a 6 mm hexagon wrench, install the four Drive Housing Cap Screws (54) in the holes in the flange of the Drive Housing. Tighten the Drive Housing Cap Screws to 20 ft-lb (27 Nm) of torque.
14. Place the Drive Shaft Collar (45) over the lugs on the end of the Drive Shaft. If necessary, tap it into place with a plastic hammer.
15. Place the Drive Pinion (46) on the end of the Drive Shaft so that the lugs on the Pinion engage those on the Shaft.
16. Insert the Drive Pinion Cap Screw (47) through the Drive Pinion and thread it into the Drive Shaft.
17. Place the Starter in a horizontal position so that it is supported on the workbench. Grasp the Drive Pinion in copper-covered vise jaws and, using an 8 mm hexagon wrench, tighten the Drive Pinion Retaining Screw to 55 ft-lb (74 Nm) of torque.

## Testing the Starter

1. Turn the Drive Pinion (46) by hand in the direction of Starter rotation. The clutch should ratchet smoothly with a slight "clicking" action.

### NOTICE

**Proper Starter rotation is indicated when facing the Drive Pinion. That is, a Starter having the letter "R" in the model number is designated as a right-hand rotation model, and the Drive pinion will rotate clockwise when facing the Drive Pinion.**

2. Turn the Drive Pinion in the opposite direction of Starter rotation. The gearing and motor should rotate freely with no binding.
3. Attach an air hose to the "IN" port on the Drive Housing (48), and apply 50 psig (3.4 bar/345 kPa) air pressure. The Drive Pinion should move outward and air should escape from the "OUT" port.
4. Plug the "OUT" port and apply 150 psig (10.3 bar/1034 kPa) air pressure to the "IN" port. Check to make certain no air is escaping. Measure the distance from the face of the Drive Pinion farthest from the mounting flange to the machined face of the mounting flange. It should be 2.75" (70.0 mm  $\pm$  1.5 mm). With the air pressure on and the Drive Shaft extended, push the Drive Pinion toward the Drive Housing until the Pinion rotates slightly and comes to a solid stop. While holding the Drive Pinion against the stop, measure again the distance from the face of the Drive Pinion to the machined face of the mounting flange. The difference between the two measurements must be .47" (12.0 mm  $\pm$  0.9 mm). Remove the pressure from the "IN" port and measure again the distance from the face of the Drive Pinion to the machined face of the mounting flange. It should be 1.82" (46.2 mm  $\pm$  1.5 mm).
5. Attach a 3/8" (9 mm) air hose to the inlet of the motor and apply 90 psig (6.2 bar/620 kPa) air pressure. The Starter motor should run smoothly.
6. Plug the exhaust port and apply 30 psig (2.1 bar/207 kPa) air pressure to the inlet of the motor. Immerse the Starter for thirty seconds in a nonflammable solvent. If the Starter is properly sealed, no bubbles will appear.

## Troubleshooting Guide

| Trouble                                        | Probable Cause                           | Solution                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|------------------------------------------------|------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Loss of Power                                  | Worn Motor Parts                         | Remove the motor from the Motor Housing (9) and disassemble the motor. Examine all parts and replace any that are worn or damaged. Use the following guidelines for determining unserviceable parts:<br>1. <b>Vanes (20)</b> - Install a set of new vanes if any vane is separated, cracked, spalled or worn to the extent that its width is 0.67" (17 mm) or less at either end.<br>2. <b>Rotor Bearing (7A) or (18)</b> - Replace if any roughness or looseness is apparent.<br>3. <b>Rotor (13)</b> - Replace if the body has deep scoring that cannot be removed by polishing with emery cloth.<br>4. <b>Cylinder Housing (9)</b> - Replace if there are any cracks or deep scoring.<br>5. <b>End Plates (7 or 11)</b> - Clean up scoring by rubbing it with emery cloth placed on a flat surface. |
|                                                | Inadequate Lubrication                   | Check the Lubricator, inlet hose, fitting and oil supply hose to make sure they are vacuum tight and free of leaks. Tighten all joints and replace the Lubricator if necessary.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |
| Air or Gas Leakage                             | Worn O-rings                             | Check the End Plate O-rings (8 or 12) and Drive Housing O-ring (51). Plug the exhaust. Apply 30 psig (2.1 bar/207 kPa) air to the inlet and Immerse the unit for 30 seconds in nonflammable solvent. If bubbles appear, replace the O-ring, Gaskets or Seals.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| Pinion does not engage the flywheel            | Broken clutch jaws or other broken parts | Refer to <b>Disassembly of the Piston and clutch.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Motor runs, pinion engages but does not rotate | Broken Shafting, Gearing or Clutch Jaws  | Refer to <b>Disassembly of the Piston and clutch.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
| Excessive butt engagements                     | Dry helical spline                       | Refer to <b>Disassembly of the Piston and Clutch.</b> Lubricate the helical spline with <b>Ingersoll Rand Grease No. 130.</b>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |

## Parts and Maintenance

### NOTICE

The use of other than genuine Ingersoll Rand replacement parts may result in safety hazards, decreased Starter 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.

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

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Notes:

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