



P7061
03539319
Edition 3
January 2010

Turbine Powered Starters

Model ST400

Installation and Maintenance Information



Save These Instructions

 **Ingersoll Rand**

Product Description

These compressed air powered Turbine Engine Starters are intended to be incorporated into a system, the primary purpose of which is to initiate operation of reciprocating internal combustion engines.

 **WARNING**

General Product Safety Information

- Read and understand this manual before operating this product.
- 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**

Product Safety Information - When Placing the Starter in Service

- Always install, operate, inspect and maintain this product in accordance with all applicable standards and regulations (local, state, country, federal, etc.).
- Operate ST400 Starters on compressed air only. They are not designed or sealed for operation on compressed gas.
- Be sure all air supply, lines & fittings are of the proper size and tightly secured.
- Ensure an accessible emergency shut-off valve has been installed in the air supply line, and make others aware of its location.
- Always use clean dry air at pressures not to exceed the maximum inlet pressure rating stamped on the product nameplate. Higher pressure may result in hazardous situations including excessive speed, rupture or incorrect output torque.
- Always turn off the air 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.
- Operate this starter only when properly installed on the engine.
- Do not use damaged, frayed or deteriorated air hoses and fittings.
- Use only proper cleaning solvents to clean parts. Use only cleaning solvents which meet current safety and health standards. Use cleaning solvents in a well ventilated area.
- Do not remove any labels. Replace any damaged label.
- Starter is not insulated from electric shock.
- Starters weigh in excess of 25 pounds (11.3 kgm). Use caution when handling.

 **WARNING**

Product Safety Information - When Using the Starter

- Always wear eye protection when operating or performing maintenance on this starter.
- Always wear hearing protection when operating this starter.
- Use accessories recommended by Ingersoll Rand.
- Particles in the air system may pass through the starter during operation. Avoid the path of the exhaust flow during starter operation.

Safety Symbol Identification



Wear Respiratory Protection



Wear Eye Protection



Wear Hearing Protection



Read Manuals Before Operating Product

(Dwg. MHP2598)

Parts and Maintenance

 **CAUTION**

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 motors for applications in which Ingersoll Rand was not consulted. Repairs should be made only by authorized trained personnel. Consult your nearest Ingersoll Rand Authorized Service center.

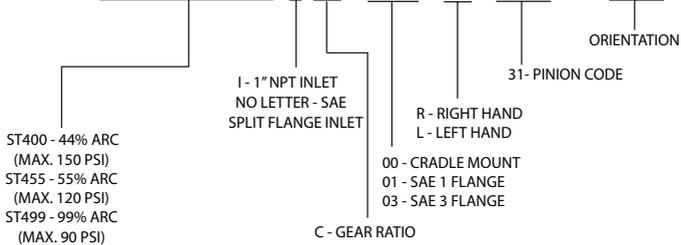
When the life of the starter has expired, it is recommended that the starter be disassembled, degreased and parts be separated by material so that they can be recycled.

Manuals can be downloaded from www.ingersollrandproducts.com

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

How to Order a Starter

ST400 IC 03 R 31-030



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

TEETH	BLANK	D.P.	MOD.	P.A.	ROTATION	PINION
10	10	8/10		20 DEG	RIGHT	ST400-13-15
12	12	8/10		20 DEG	RIGHT	ST400-13-29
12	12	6/8		20 DEG	RIGHT	ST400-13-31
12	12	6/8		20 DEG	LEFT	ST400-13-32
9	9		3	15 DEG	RIGHT	ST400-13-77
11	11		3	15 DEG	RIGHT	ST400-13-85
11	12	8/10		20 DEG	RIGHT	SS350R-13-21
13	14		3.5	15 DEG	RIGHT	SS350R-13-895
24		12/14		12 DEG	LEFT	SS175L-13-1448
10	11	10/12		20 DEG	RIGHT	04335055
9	10			15 DEG	RIGHT	04595799
17	18		3.5	15 DEG	RIGHT	04334371
11			3.5	20 DEG	RIGHT	04333969
13	13		3.5	15 DEG	RIGHT	04332292
14	16		3.5	15 DEG	RIGHT	04595807
14			3.5	14.5 DEG	LEFT	04334363
12			4	14.5 DEG	LEFT	04331724
14	15		3.5	20 DEG	LEFT	04334389

For different models or special applications, contact your nearest **Ingersoll Rand distributor** or **Ingersoll Rand Engine Starting Systems** at:

1-888-STARTAIR
1-888-78278247

Orientation of the Air Starter

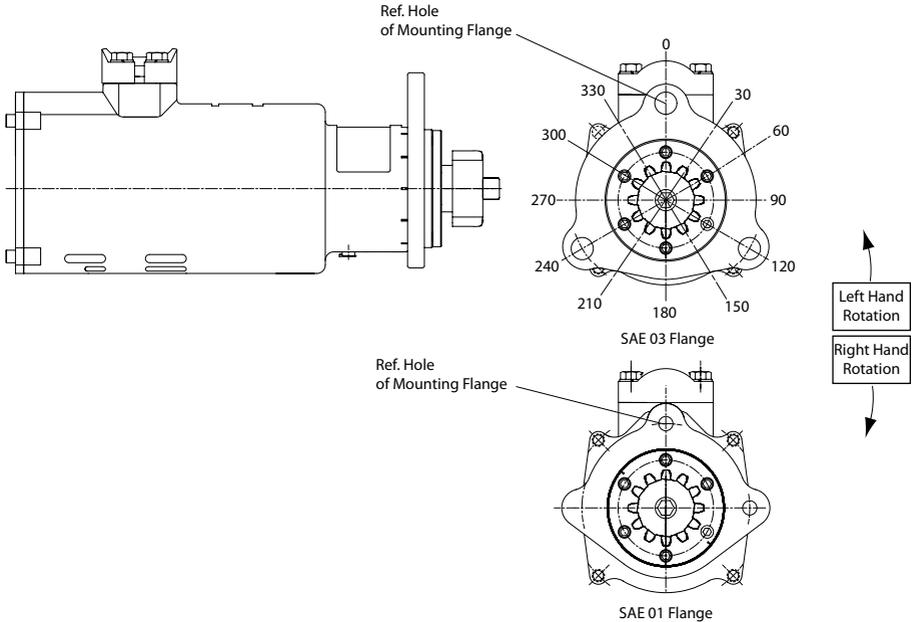
We recommend that starters be ordered to proper orientation for your specific mounting or installation requirements. However, if the starter must be reoriented for installation, proceed as follows

1. Loosen six flange screws.
2. Turn Flange to desired orientation. Note the orientation marks on the exterior of the Housing. Each mark measures 30° of arc. There is a "0" mark which aligns with the starter inlet.
3. Tighten the six flange screws to 3-4 ft. lbs. (4-6 Nm) torque.

To purchase pre-oriented starter:

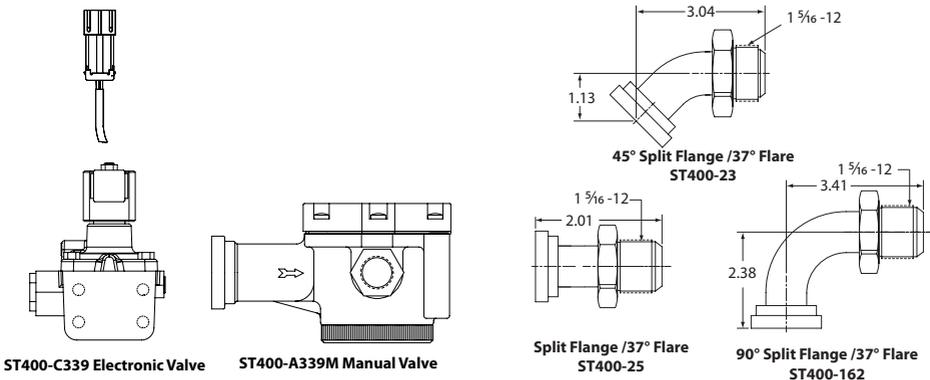
It is necessary to provide the orientation code which is the angle of the Mounting Flange relative to the starter inlet port ("0" mark on the Housing). Therefore, the orientation code will be an angular measurement. To obtain the orientation code, proceed as follows:

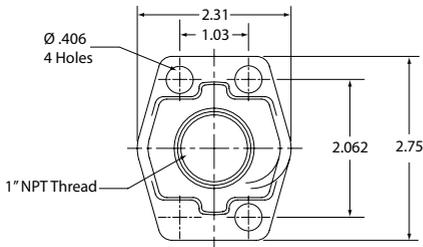
1. Orient the starter so that the inlet port is pointed straight up. The "0" mark on the Housing near the Mounting Flange should be visible and pointed straight up.
2. With the starter at this setting, position yourself so that the Drive Pinion (2) is facing you.
3. Rotate the Mounting Flange clockwise until the desired orientation is reached.
4. You will derive the orientation code from a clockwise measurement of the angle from the "0" mark (inlet port) to the reference hole of the Mounting Flange. The Housing has indicator marks every 30°. Example: ST400C03R31-060.



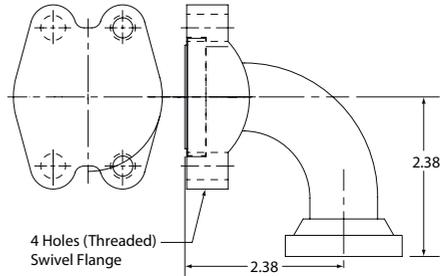
(Dwg. TPD1670-1)

How to Order System Components

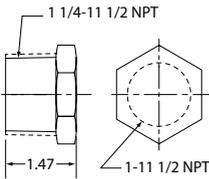




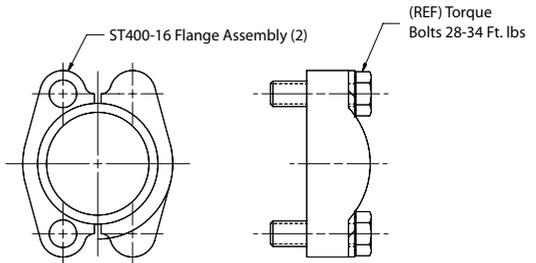
Flange Kit ST400-K17
 Kit Includes :
 Flange, O-ring, Bolts (4), Washer (4)



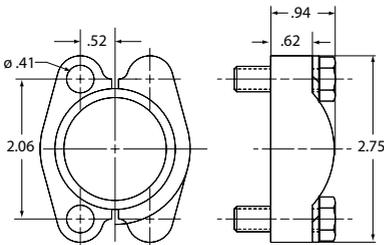
90° Tank Flange ST400-161



Reducer Bushing ST400-81

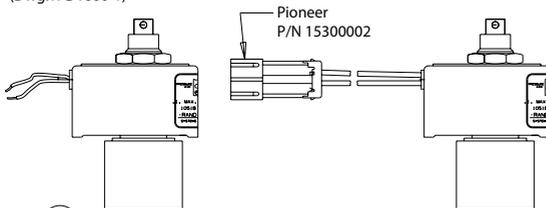


(Dwg.TPD1664-1)



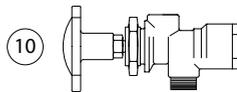
Flange	
Part Number	Part Description
ST400-16	Flange Kit

(Dwg.TPD1660-1)



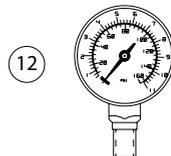
11 Solenoid Actuated Control Valve

Part Number	Voltage	Part Description
150BMP-1051B	12V DC	Loose Wires
150BMP-A1051C	12V DC	Pioneer Connector P/N 15300002
150BMP-2451B	24V DC	Loose Wires



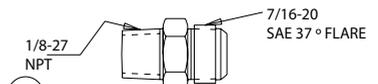
Push Button Control Valve

Part Number	Part Description
SMB-618	
SMB-G618	Chrome Plate



Pressure Gauges 150 psi

Part Number	Part Description
150BMP-1064	1/8 NPT DASH MNT.
150BMP-1064L	1/4 NPT TEE' MNT.



Connector

Part Number	Part Description
ST400-52	Male Connector

(Dwg.TPD1662)

NOTICE

When connecting the starter to an air receiver tank that is already in service, bleed off the air pressure in the tank prior to installation.

Valve

1. Mount the ST400-A339 or ST400-B339 Electronic Valve or ST400-A339M Manual Valve to the air receiver as shown in the installation diagrams.
2. Air flow arrow must point toward the starter. Using the supplied flange fitting, tighten the four flange bolts to 28-35 ft-lbs (38-47 Nm) torque.
3. For electrical installations, install the ST400-A618 Electrical Switch on the dash panel. See Dwg. TPB973 for making wire connections. For air installations, install the SMB-618 Starter Control Valve on the dash panel. Connect the air lines as shown in Dwg. TPB976.

Mounting the Starter

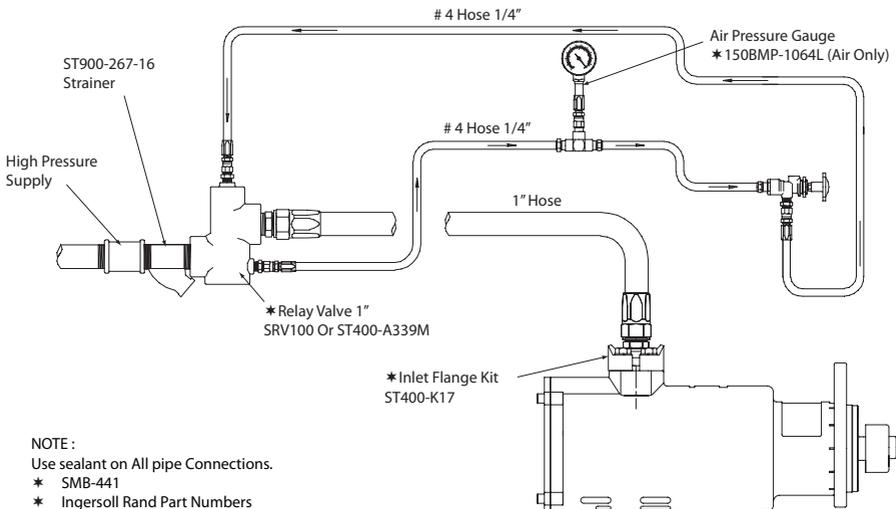
1. To determine the exact length of #16 hose required, run a piece of hose or some other flexible tubing of the same diameter from the valve on the air receiver to the starter mounting location on the engine. After determining the hose length required, attach O-ring sealed flange fittings as required.
2. Attach the hose to the outlet side of the valve with the ST400-16 4 bolt split-flange provided. Tighten bolts to 28-35 ft-lbs (38-47 Nm) torque.
3. At this point, determine if it is convenient to attach the hose to the starter before actually mounting it on the engine.
4. If possible, liberally grease the teeth of the ring gear with a good, sticky gear grease or motorcycle chain lubricant. This will help to promote the life of the starter pinion and engine ring gear.
5. Mount the starter in position and bolt it to the engine.

System Actuation

Pressurize the complete starting system and using a soapy solution, check the following locations in the live air line for leaks:

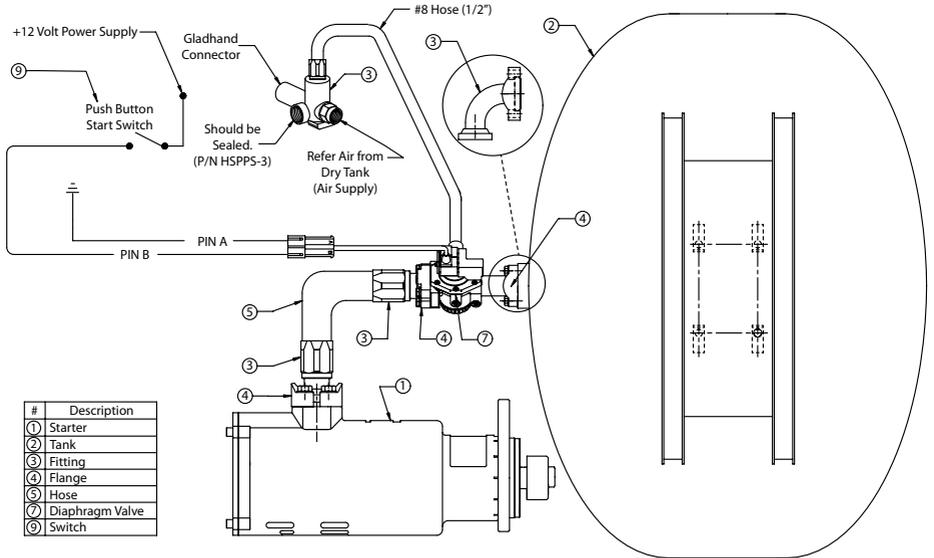
- Valve/tank connection
- Fill-line to check valve on ST400 valve
- Air supply line to 2-way check valve

ST400 Installation Diagram - Stationary Industrial



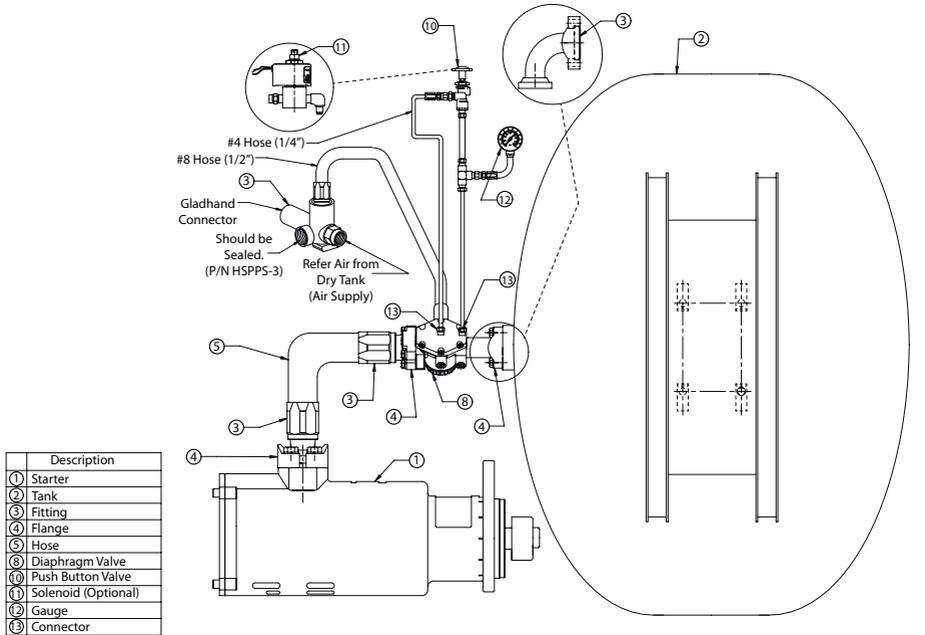
(Dwg.TPA1592)

ST400 Installation Diagram - Electro - Mechanical



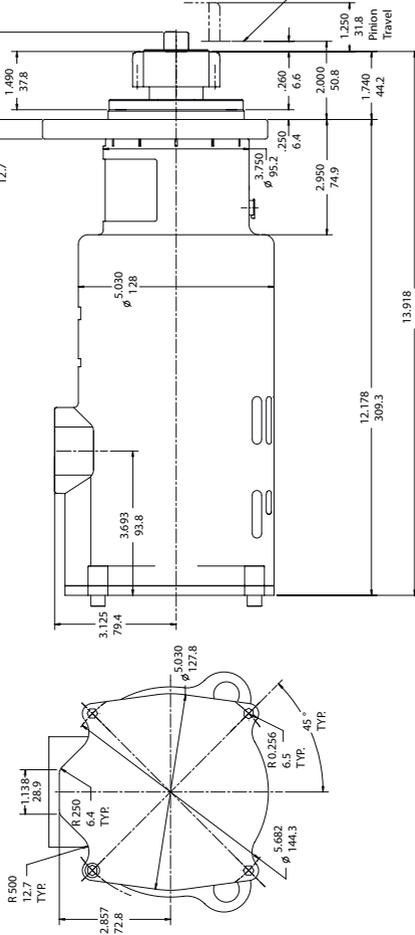
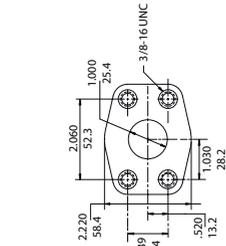
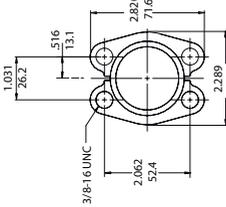
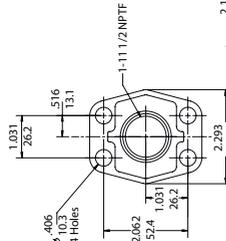
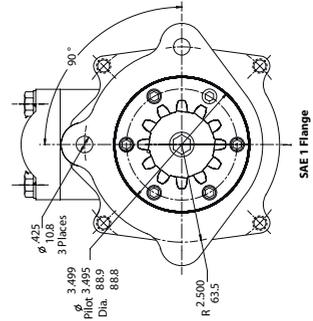
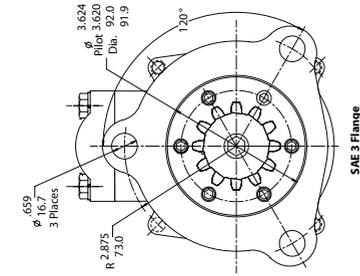
(Dwg. TPB973-1)

ST400 Installation Diagram - Manual



(Dwg. TPB976)

ST400 Starter Dimensions

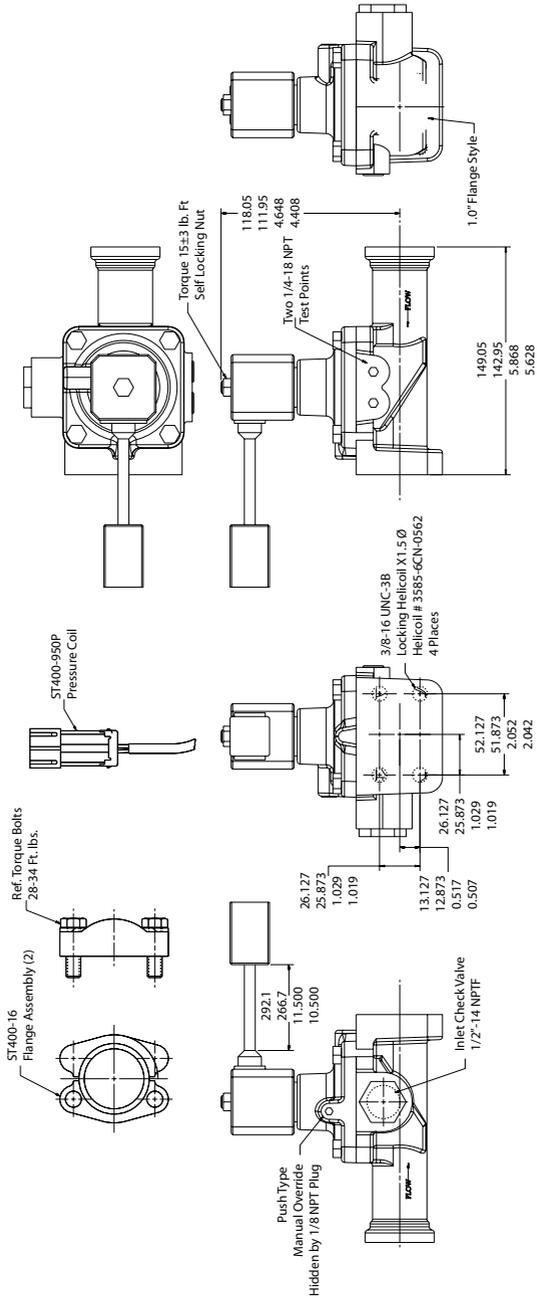


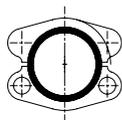
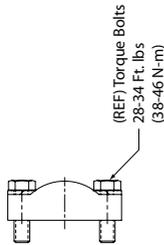
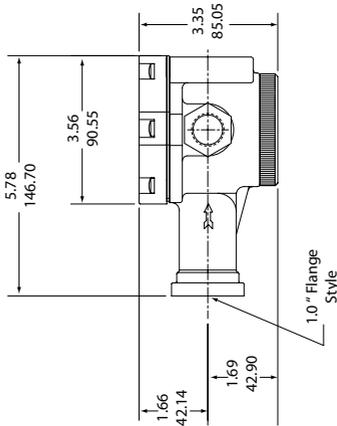
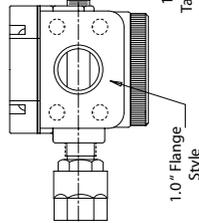
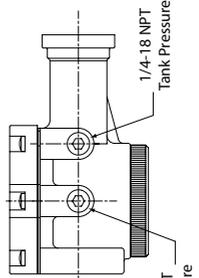
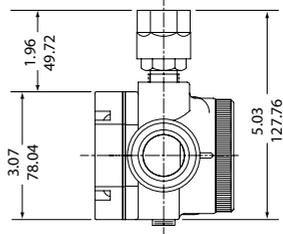
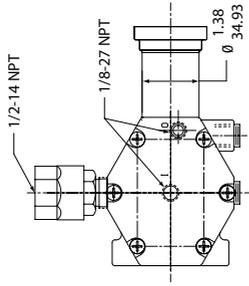
- Notes:
 1. Weight 24lbs (11.0 Kg)
 2. Flange Rotation Infinite
 Refer marks Every 30°

Dual
 Dimensions Inch
 mm

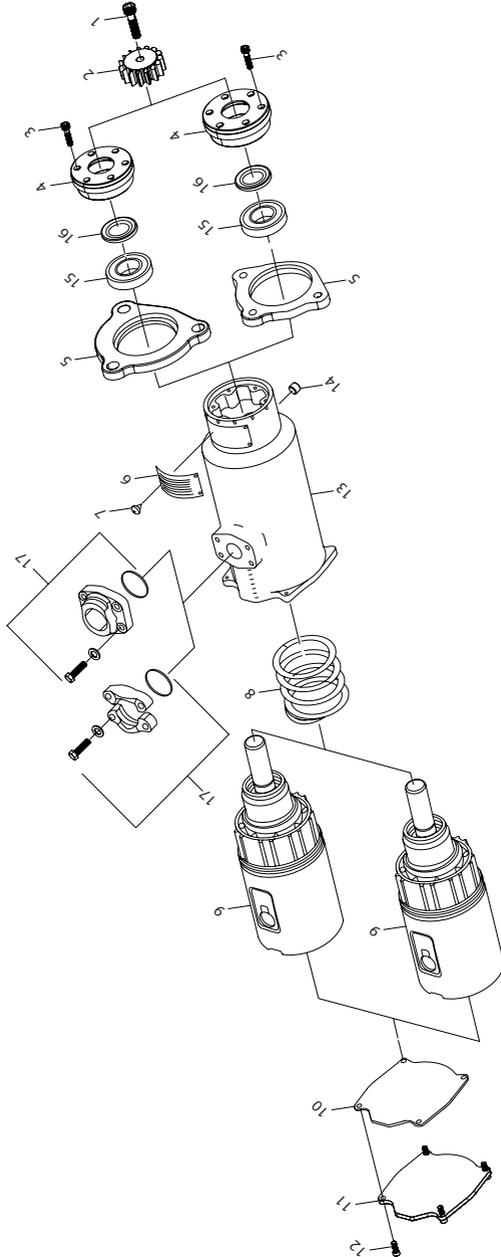
(Dwg.TPA1400-1)

ST400-C339 Electronic Valve





ST400 Turbine Powered Starter- Exploded View



(Dwg.TPA1374-1)

ST400 Turbine Powered Starter- Parts List

Item	Part Description	Part Number	Item	Part Description	Part Number
1	Drive Pinion Screw	SS350-394	5	Flange	
2	Drive Pinion		5	SAE 1 Flange	ST4W300-01
	for ST400C01R15	ST400-13-15		SAE 3 Flange	ST400-300-03
	for ST400C03R21	ST400-13-21	6	Nameplate	ST400-301
	for ST400C03R29	ST400-13-29	7	Nameplate Tack	ST400-100
	for ST400C03R31	ST40013-31	8	Return Spring	ST400-700
	for ST400C03R071	04335055	9	Liner Assembly	
	for ST400C03R77	ST400-13-77		Standard Arc Right Hand	ST400-A41R
	for ST400C03R79	04595799		Standard Arc Left Hand	ST400-A41L
	for ST400C03R85	ST400-13-85		55 % Arc Right Hand	ST455-A41R
	for ST400C03R91	04595807		55 % Arc Left Hand	ST455-A41L
	for ST400C03R95	04334371		Full Arc Right Hand	ST499-A41R
	for ST400C03R832	04333969		Full Arc Left Hand	ST499-A41L
	for ST400C03R893	4332292	10	Housing Cover Gasket	ST400-283
	for ST400C03R895	SS350-13-895	11	Housing Cover	ST400-562
	for ST400C03L30	ST400-13-32	12	Housing Cover Bolts (4)	ST400-563
	for ST400C03L32	ST400-13-32	13	Housing	04615092
	for ST400C03L92	04334363	14	Vent Plug	ST400-546
for ST400C03L101	04331724	15	Front Drive Shaft Bearing	ST400-363	
for ST400C03L895	ST400-13-32	16	Drive Housing Seal	ST400-271	
for ST400C03L942	04334389	17	Inlet Flange Assembly	04564522	
for ST400C03L1448	SS175L-13-1448		(includes Flange (2), Flange Mounting Bolts (4), Lock Washers (4) and O-ring)	Or ST400-16	
3	Flange Cap Screws (6)	04564522			
4	Flange Cover			Starters with "I" in model number	ST400-K17
	for SAE 1 Flange	ST400-480-01 Or 04615118			
	for SAE 3 Flange	ST400-480-03 Or 04615100			
	for Cradle Mounting	04332334			

Maintenance, Disassembly / Assembly Instructions for Starter

WARNING

Always wear eye protection when operating or performing any maintenance on this starter. Always turn off the air 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.

Disassembly

General Information

1. Do not disassemble the Starter any further than necessary to replace worn 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 of a Model ST400 Starter. Never reuse old seals or gaskets.
5. When disassembling, always mark adjacent parts so the members can be located in the same relative position when the starter is reassembled.
6. Never wash the Liner Assembly (9) in a solvent.

Disassembly of the Starter

1. Remove the Drive Pinion Screw (1) from the drive shaft and remove the Drive Pinion (2).

2. Remove the six Flange Cap Screws (3) from the Housing (13).
3. Remove the Flange Cover (4) and Flange (5) simultaneously by pulling up on the Flange.
4. Remove the Front Drive Shaft Bearing (15) from the Flange Cover.
5. Remove the Drive Housing Seal (16) from the Flange Cover.
6. Turn the starter over and secure it vertically in a fixture.

NOTICE

Use care when removing the Housing Cover Bolts (12) holding the Housing Cover (11) to the starter. The Liner (9) is spring loaded and will protrude approximately one inch beyond the Housing when released.

7. To remove the Housing Cover (11), slowly loosen the four Housing Cover Bolts (12) while holding the Housing Cover (11) in place.
8. Slide the Liner Assembly (9) out of the Housing.
9. Remove the Return Spring (8).

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.

Assembly of the Starter

1. Place the Housing (13), front end down so that the Return Spring (8) can be placed into the Housing.
2. Slide the Liner Assembly (9) into the Housing. Orient the Liner so that the notch aligns correctly with the Housing inlet port and Liner air inlet port aligns with the Housing air inlet port. Attach Housing Cover Gasket (10) to Housing Cover.
3. Attach the Housing Cover (11) to the Housing with just one Housing Cover Bolt (12). Engage only a few threads so that the Housing Cover can be easily rotated.

4. While pushing the Liner Assembly down against the Return Spring, rotate the Housing Cover over the Liner to hold it down.
5. Tighten the Housing Cover Cap Screws to 5-6 ft-lb (6.7-8 Nm) torque.
6. Press the Drive Housing Seal (16) into the Flange Cover (4) with the sealing lip pointed down.
7. Press the Front Drive Shaft Bearing (15) into the Flange Cover.
8. Fit the Flange (5) onto the Flange Cover so that the counterbore of the Flange slides over the shoulder of the Flange Cover correctly.
9. Carefully slide this assembly over the drive shaft. Be careful not to tear the Seal lip. Orient the Flange correctly.
10. Apply Loctite to the six Flange Cap Screws (3). Torque to 3-4 ft-lb (4-5.4 Nm).
11. Attach the Drive Pinion (2) to the drive shaft using the Drive Pinion Cap Screw (1) and tighten to 53-58 ft-lb (72-79 Nm) torque with loctite.

Test and Inspection Procedure

WARNING

When 90 psig air pressure is applied to the starter, the Drive Pinion will be rotating at 2,800 rpm and Drive Shaft and Drive Pinion will move forward 1.25". Keep face and hands away from rotating Drive Pinion.

CAUTION

Do not run the starter at free speed.

Orientation:

Mounting Flange must be oriented per the customer's order or engineering drawing. If orientation is not specified by customer, standard orientation will be supplied. Check orientation print on page 5.

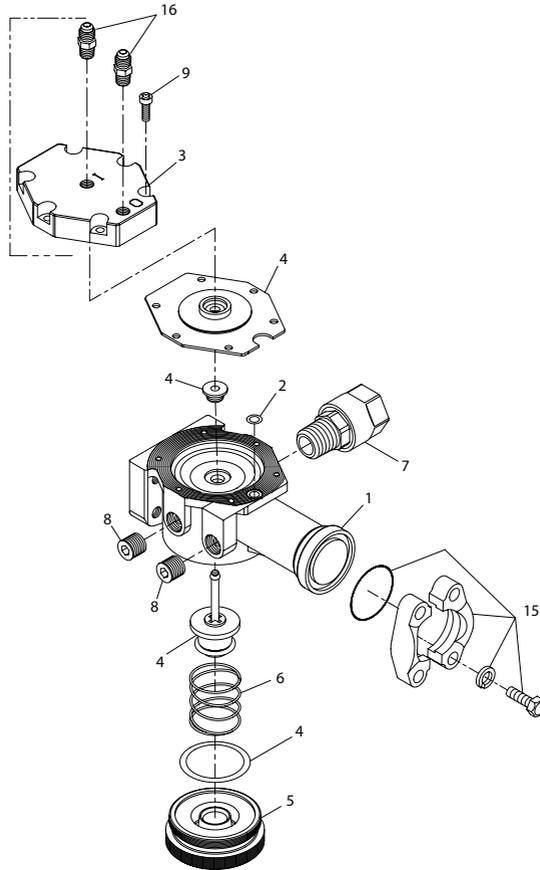
Confirm Overrunning of Clutch:

Turn the Drive Pinion by hand in the direction of rotation. The clutch should ratchet smoothly.

Confirm Drive Rotation:

Turn the Drive Pinion by hand in the direction opposite of rotation. The clutch should not ratchet.

Manual Valve Assembly ST400-A339M - Exploded View



(Dwg. TPA1402-1)

Manual Valve Assembly ST400-A339M - Part List

Item	Part Description	Part Number	Item	Part Description	Part Number
1	Valve Housing	ST400-339	7	Check Valve	ST400-1056
2	O-ring	Y325-010	8	Plug (2)	HSPPS-2
3	Housing Cover	ST400-338M	9	Cover Screws (6)	Y222-156-C
4	Valve Kit (includes O-ring, Plunger and Pin Assembly, Grommet Seal and Diaphragm Assembly)	ST400-K619	15	Flange Assembly (includes Inlet Flange (2 halves), Flange Mounting Bolts (4), Lock Washers (4) and O-ring)	ST400-16
5	Cap	ST400-616A	16	Male Connector	ST400-52
6	Spring	ST400-615A			

Maintenance, Disassembly / Assembly Instructions for Manual Valve

**WARNING**

Always wear eye protection when operating or performing any maintenance on this starter. Always turn off the air and electrical supply and disconnect the air and electrical supply before installing or removing any component on this valve, before making any adjustments on this valve or before performing any maintenance on this valve.

Disassembly

General Information

1. Do not disassemble the valve any further than necessary to replace worn 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 of the valve. Never reuse old seals or gaskets.

Disassembly of the Valve

1. Unscrew the Check Valve (7) from the Valve Housing (1). Remove Plugs (8) from the Valve Assembly.
2. Remove the six Cover Screws (9) from the Cover and Valve Housing.
3. Remove the Diaphragm (4) from the Valve Housing and the O-ring (2) from the pocket in the Valve Housing.
4. Unscrew the Cap (5) from the Valve Housing. Remove the O-ring (4) from the Cap. The Spring (6) and Plunger should come out with the Cap. If not, remove them from the Valve Housing.
5. Remove the Grommet (4) from the Valve Housing.

Assembly

General Information

1. Whenever grasping a valve or part in a vise, always use leather-covered or copper-covered vise jaws. Take extra care with threaded parts or housings.
2. Apply a film of o-ring lubricant to all O-rings before final assembly.

Assembly of the Valve

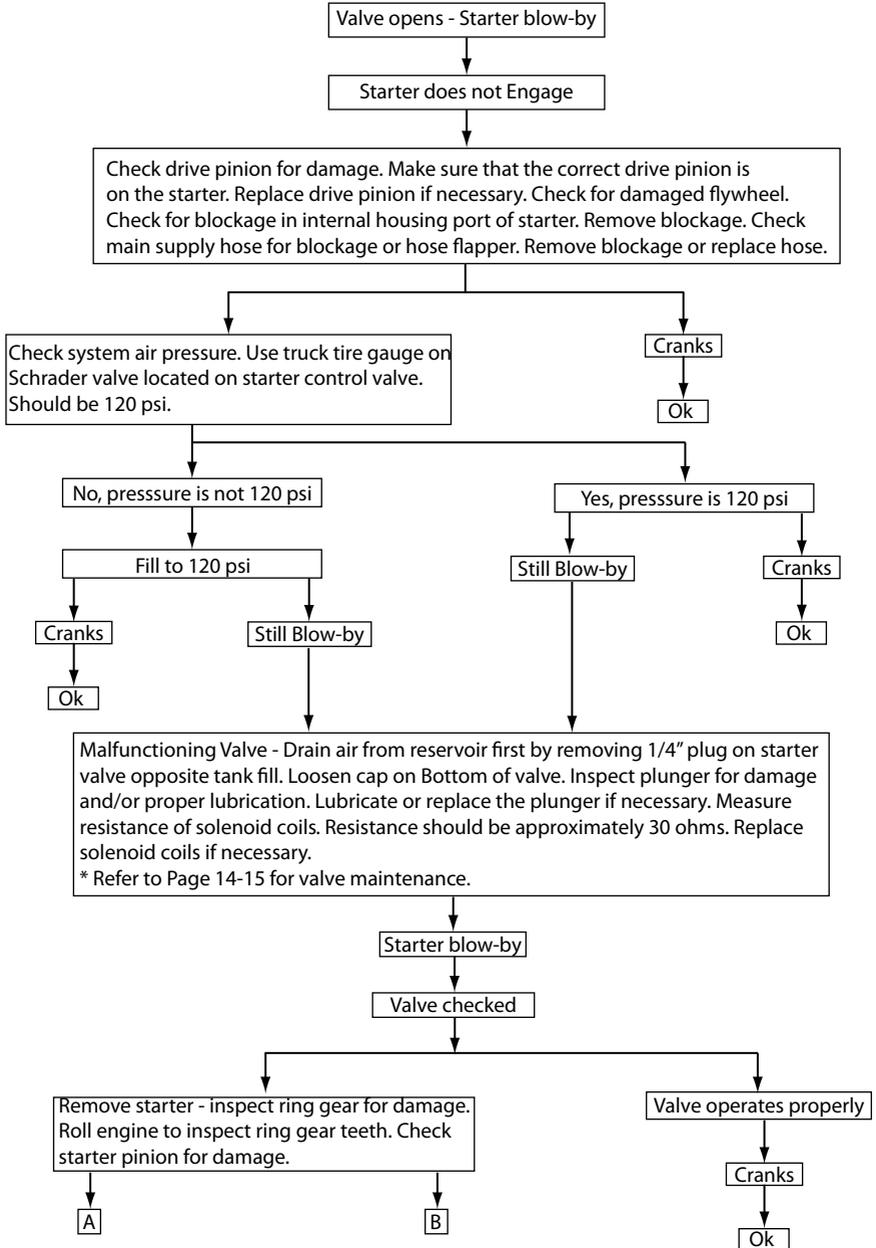
1. Insert the rounded end of the Grommet (4) in the top of the Valve Housing (1) through the valve body hole. The top can be identified by the concentric raised rings.
2. Lubricate the O-rings on the Valve Stem (4) and Plunger (4) with O-ring Lubricant. Push this assembly through the Grommet from the bottom of the Valve so that the Plunger seals on the valve seat.
3. Turn the Valve Housing over and place the Spring (6) on the Plunger with the smaller diameter of the Spring leading.

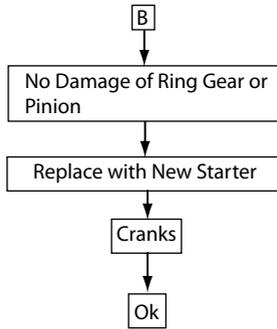
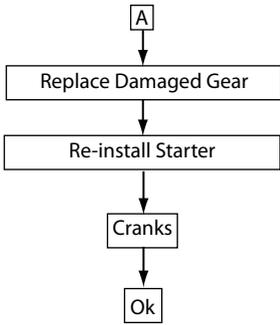
4. Place the large O-ring (4) on the Cap (5). Guide the Spring and Plunger into the Cap while screwing the Cap into the Valve Housing. Tighten the Cap until it seats snugly against the Valve Housing.
5. Place the O-ring (2) into the pocket of the Valve Housing.
6. Place the Diaphragm (4) on the Valve Housing, making sure that the punched hole of the Diaphragm is aligned over the O-ring and that the plastic disk of the Diaphragm is up.
7. Set the Housing Cover on the Valve Body so that the O-ring shoulder fits into the diaphragm hole.
8. Attach the six Cover Screws (9) through the Cover and Diaphragm and into the Housing. Alternately tighten the Screws to 45-55 in - lb (5.1 - 6.2 Nm) torque. Screw the Check Valve (7) into the Valve Body to 40-50 ft/lbs (54-67Nm).

Test and Inspection Procedure

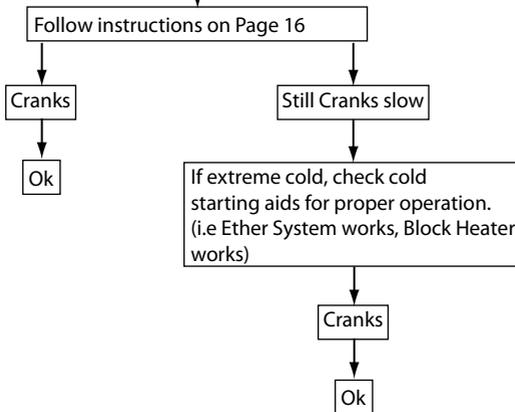
Solenoids: Using a solenoid tester, apply 9 VDC minimum to 24 VDC maximum to Solenoid. The Solenoid should activate the Armature with a minimum 9 volt charge and a "clicking" sound indicates that the Solenoid is functioning properly. Follow this procedure for both the Exhaust Solenoid and the Pressure Solenoid.

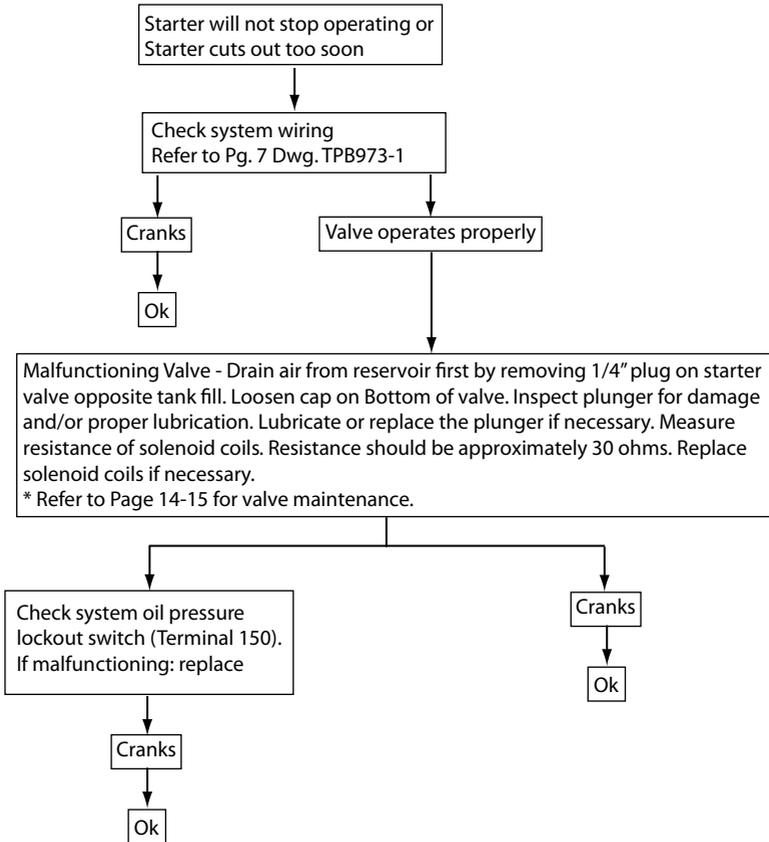
Air Starter System Diagnosis ST400 Starter





Low Power - Cranks engine slow





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