04561858
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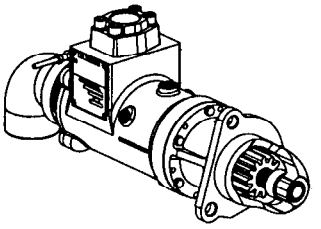
December, 1998

INSTALLATION AND MAINTENANCE MANUAL
for
ST400G GAS TURBINE STARTER



TPE_1025

⚠ WARNING

IMPORTANT SAFETY INFORMATION ENCLOSED.
READ THIS MANUAL BEFORE OPERATING STARTER.

FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.

- For safety, maximum performance and maximum durability of parts, do not operate ST400G Starters at air/gas pressures over the pressure rating stamped on the nameplate. Use supply lines of adequate size as directed in the installation instructions in this manual.
- Always turn off the air or gas supply and disconnect the air or gas supply hose before installing, removing or adjusting any accessory on this starter, or before performing any maintenance on this starter.
- Model ST400G Starters are designed for gas operation. They are not totally sealed in dynamic operation since the exhaust must be vented or piped away and there is a possibility of leakage around the output shaft when rotating. Caution should be taken when operating Model ST400G Starters on gas because of the danger of fire, explosion, or inhalation.
- After assembling a starter, always test it in accordance with the procedures outlined in this manual. Never install a reassembled starter that has not been tested in accordance with the procedures in this manual.
- Do not lubricate starters with flammable or volatile liquids such as kerosene or jet fuel.
- Operate this starter only when properly installed on the engine.
- Do not remove any labels. Replace any damaged label.
- Use accessories recommended by Ingersoll–Rand.

NOTICE

The use of other than genuine Ingersoll–Rand replacement parts may result in safety hazards, decreased starter performance and increased maintenance, and will 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 Servicenter.

It is the responsibility of the employer to place the information in this manual into the hands of the operator.

DEMAND I-R GET REAL GENUINE PARTS

Refer All Communications to the Nearest Ingersoll–Rand Office or Distributor.

Printed in U.S.A.

INGERSOLL-RAND®
ENGINE STARTING SYSTEMS

WARNING LABEL IDENTIFICATION

⚠ WARNING

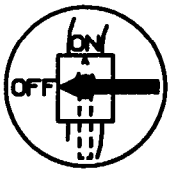
FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.

⚠ WARNING

Always wear eye protection when performing maintenance on this starter.

⚠ WARNING

Always wear hearing protection when testing this starter.



⚠ WARNING

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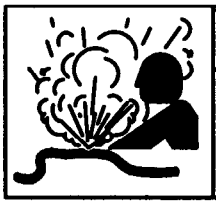
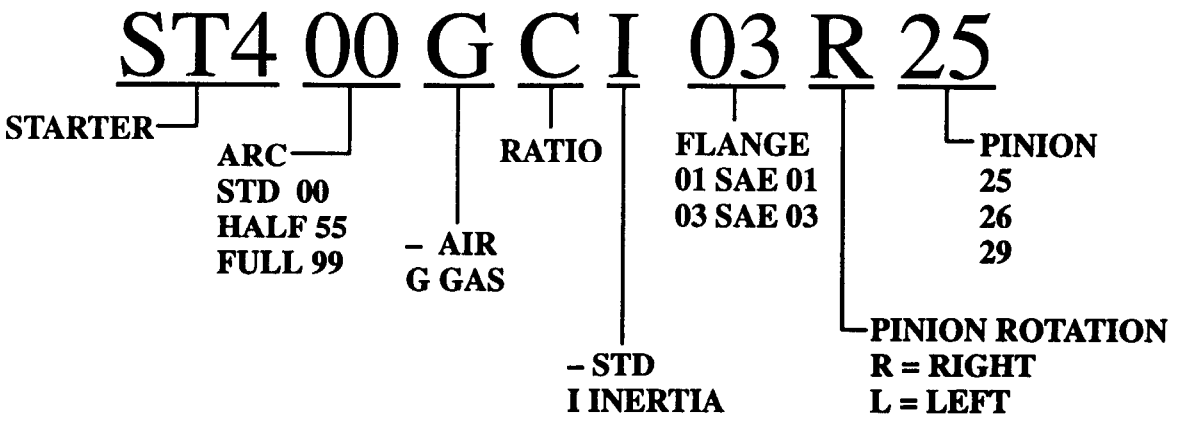


⚠ WARNING

Do not use damaged, frayed or deteriorated air hoses and fittings.

HOW TO ORDER A STARTER



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

PINION DATA

TEETH	BLANK	D.P.	P.A.	ROTATION	PINION NO.
11	12	6/8	20 DEG	RIGHT	25
12	13	8/10	20 DEG	RIGHT	29
11	13	6/8	20 DEG	LEFT	26

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

INSTALLATION

NOTICE

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

General Information

1. This starter is designed for flange mounting at the inlet. The Flange Mounting Kit is required for installation. All piping, hoses and valving must be clean prior to installation. Make sure that the starter inlet is free of dirt and foreign material during installation.
2. Engine design often requires mounting the starter underneath in extremely close quarters, and even though two of the mounting bolt holes are easy to reach, the third one is less accessible. To install a starter, the following tools are required: regular ratchet wrench, sockets, universal joint, socket extension and single or double–end box wrench.
3. Improper hook–up impairs the efficiency of a Starter. Pressure Lines smaller than those recommended will reduce the volume of air to the motor and the use of reducers for piped–away applications in the exhaust port will restrict the exhaust causing back pressure to the motor resulting in reduced performance. Keep the number of tees and elbows, and the length of the supply line to a minimum. Use 1–1/4" hose or pipe for supply lines up to 15 feet long: use 2" hose or pipe if the supply line is over 15 feet long.
4. Install a 300 mesh strainer in the inlet line for each starter. These 300 mesh strainers provide 50 micron filtration and offer significant protection against supply line contaminants which could damage the turbine components. Ingersoll–Rand offers 3 sizes: ST900–267–24 for 1–1/4 inch lines, ST900–267–32 for 2 inch lines and ST900–267–64 for 4 inch lines. Replacement elements are: ST900–266–24 for 1–1/4 inch, ST900–266–32 for 2 inch and ST900–266–64 for 4 inch lines.
5. Make your connections bubble tight to avoid unnecessary costs and delays. On all threaded connections throughout the system, use Ingersoll–Rand No. SMB–441 Sealant, non–hardening No. 2 Permatex or always run the air supply line from the side or top of the receiver, never at or near the bottom. Moisture in the air collects at the bottom of the receiver resulting in damage which could cause the valves to become inoperative. Periodically, open the petcock at the bottom of the tank to drain the water.
6. Whenever using a hazardous gas to operate the starter, there must be no leaks in inlet or exhaust piping or from any other starter joints. Pipe away all discharges to a safe area.
7. We recommend installation of a "glad hand" in vehicular applications for emergency re–pressurizing of the system. To keep the "glad hand" clean and free of dirt and to protect it from damage, a second "glad hand" closed by a pipe plug can be mated to it, or a "glad hand" protector bracket can be used.

Orientation of the Starter

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

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

Mounting the Air Starter

1. Study the piping diagram on Page 6.
2. The air receiver tank for a starter installation must meet SAE J10B specifications or conform to ASME specifications. It must have a working pressure capability equal to or greater than the maximum pressure at which the starter will be operated.
3. When connecting the starter to a receiver tank that is already in service, bleed off the air pressure by opening the drain valve.

⚠ WARNING

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

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

NOTICE

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

5. Install the No. SMB–G618 Starter Control Valve on the dash panel (for vehicular installations) or some other appropriate panel (for stationary installations).
6. 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.
7. Connect the Starter Control Valve to the Relay Valve with 1/4" hose. Install a Tee in this line with a short feeder hose to the Pressure Gauge.

NOTICE

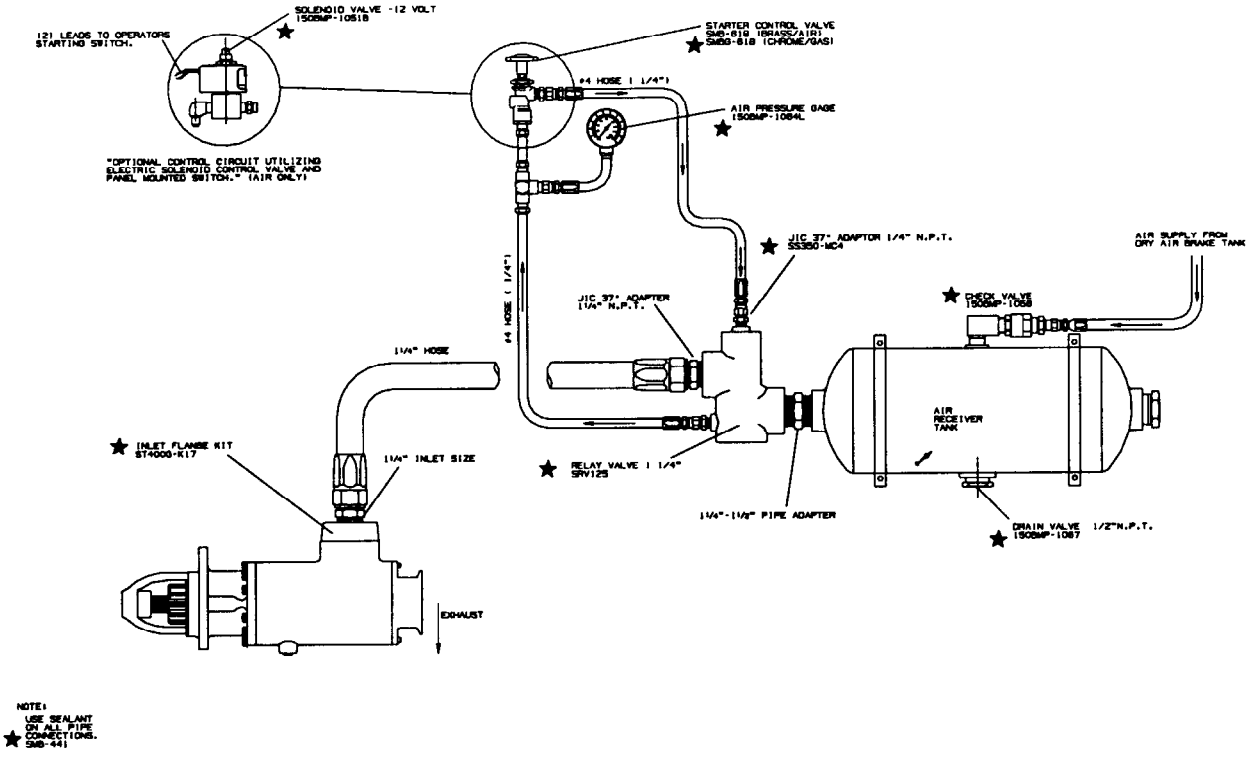
Make certain the hose is connected to the "SUPPLY" side of the Starter Control Valve.

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

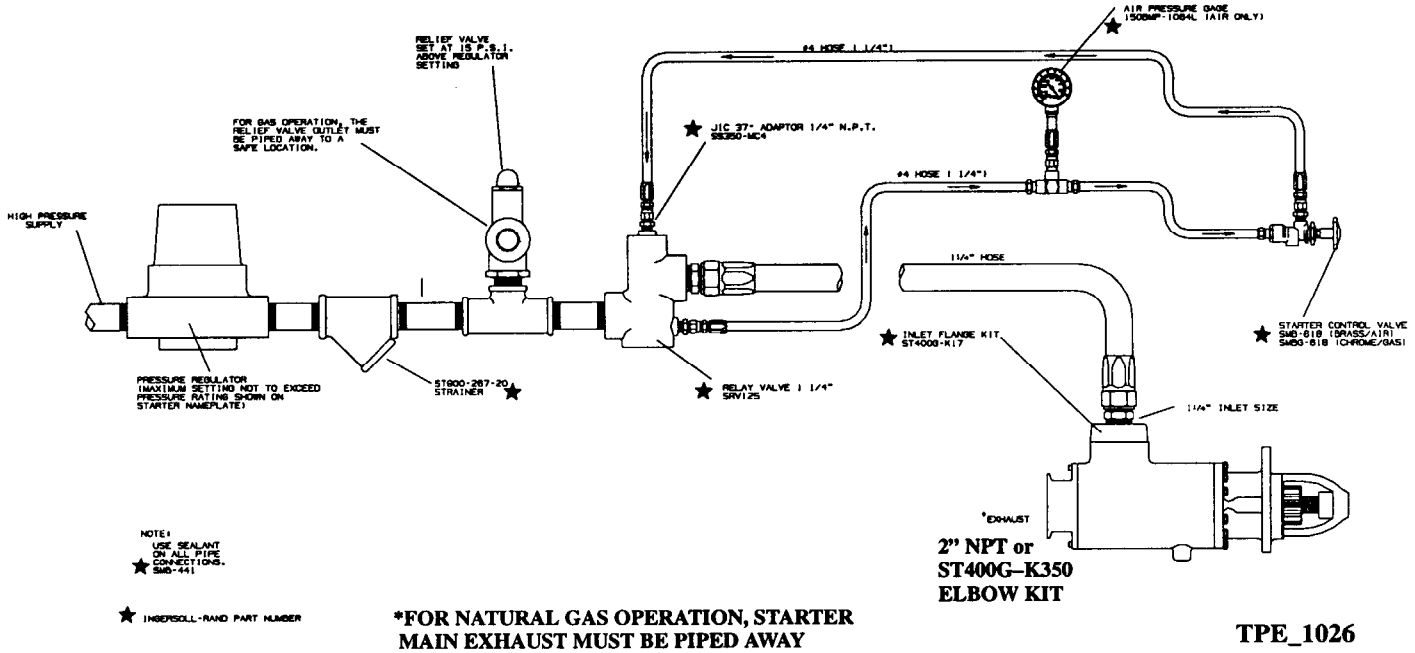
GAS–OPERATED STARTERS

1. Apply a thin film of sealant to the Housing Cover End Plug and the Lubricator Port Plug as they are assembled.
2. Plug the exhaust. Connect air line to the inlet, regulate the air pressure to 40 psig (2.8 bar/280 kPa) and immerse the unit for 30 seconds in light oil, or non–flammable solvent. If there are any bubbles, the unit is unfit for gas operation. Tighten where necessary and/or apply sealant to area showing leak. Retest.

PIPING DIAGRAM FOR A TYPICAL VEHICULAR INSTALLATION – INERTIA



PIPING DIAGRAM FOR A TYPICAL STATIONARY INSTALLATION – INERTIA



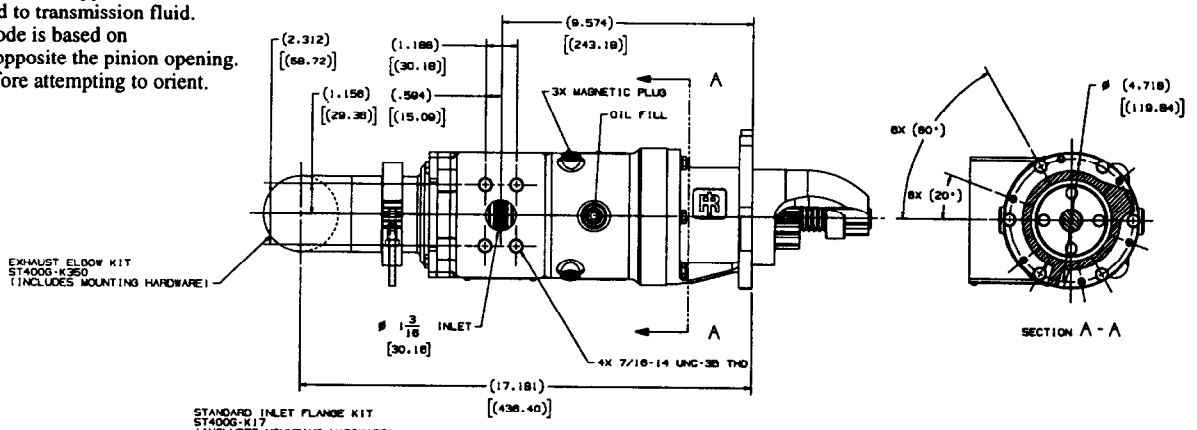
★ INGERSOLL-RAND PART NUMBER

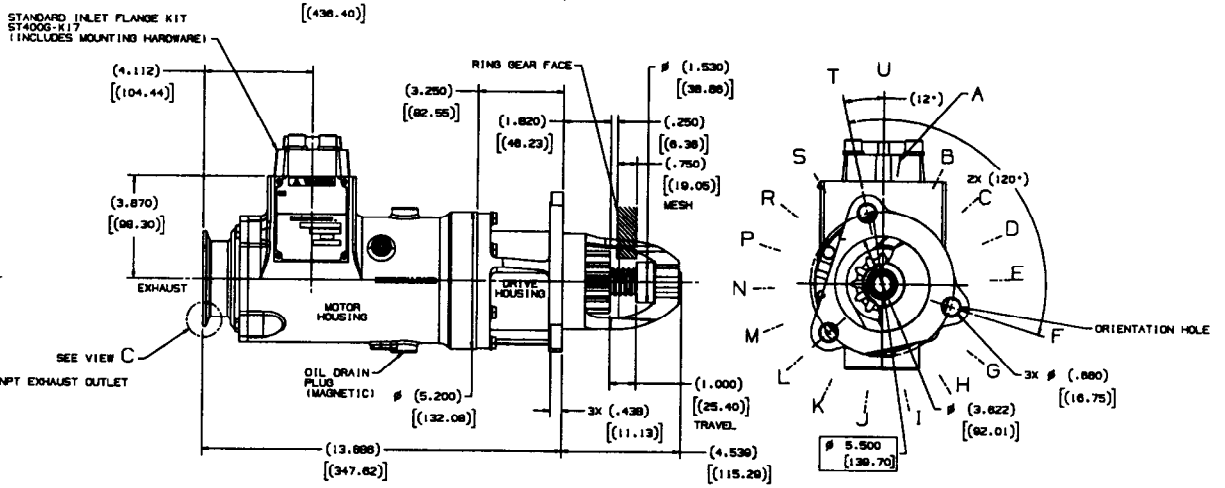
***FOR NATURAL GAS OPERATION, STARTER MAIN EXHAUST MUST BE PIPED AWAY**

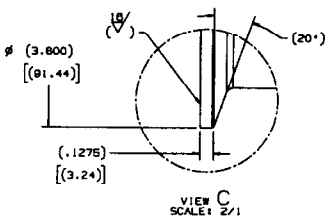
TPE_1026

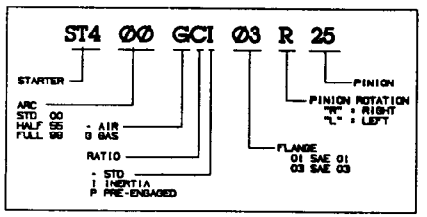
NOTES:

1. Starter should be mounted on the engine with the exhaust pointed down if possible.
2. These models are not approved for applications where the Starter is exposed to transmission fluid.
3. Drive Housing orietation code is based on position of mounting hole opposite the pinion opening.
4. Please read instructions before attempting to orient.
5. Starter weight is 32 lbs.









PINION DATA

TEETH	BLANK	D.P.	P.A.	ROTATION	PINION NO.
11	12	8/8	20°	RIGHT	25
12	13	8/10	20°	RIGHT	29
11	12	8/8	20°	LEFT	28

ORIENTATION OPTIONS
DRIVE HOUSING
18 @ 20°

DUAL DIMENSIONS INCH MM

ST400GC103R25 INERTIA GAS PHOENIX

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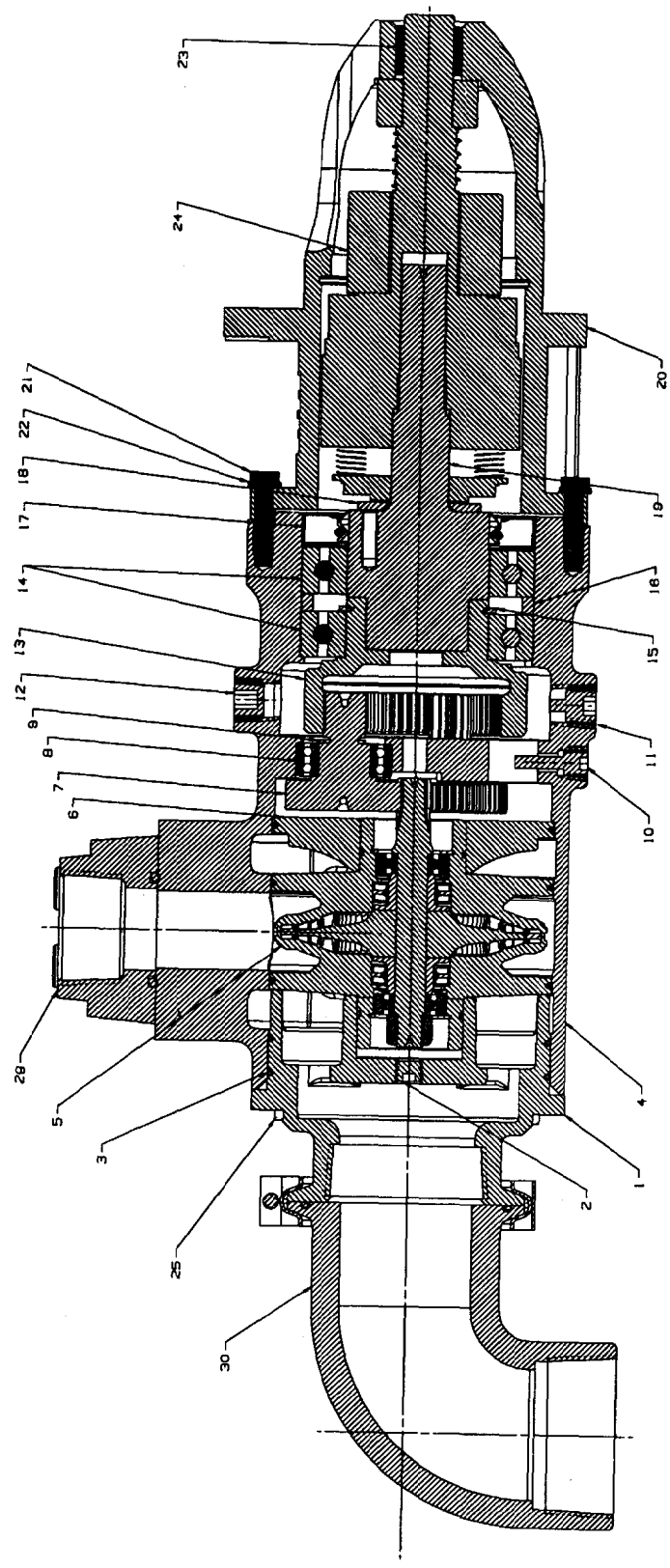

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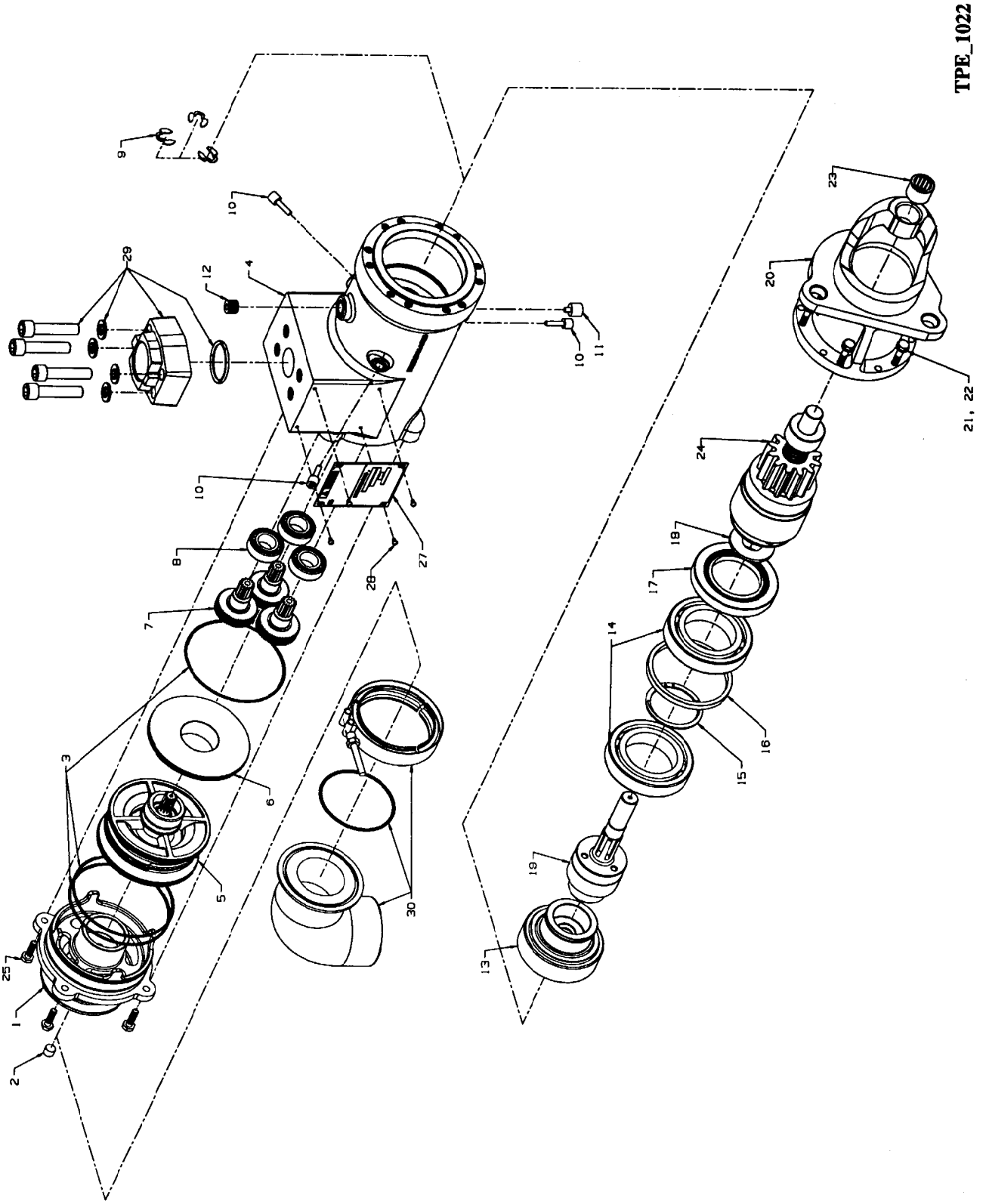
ST400GC103R25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		PART NUMBER FOR ORDERING			PART NUMBER FOR ORDERING
1	Cover End	04613410	19	Drive Shaft	
2	Pipe Plug	Y17–50–S		for ST400GCI03R25	04612792
3	O–Ring (5)	ST400–244		for ST400GCI03L26	04612792
4	Housing	04613089		for ST400GCI03R29	04662882
5	Motor Assembly			for ST499GCI03R25	04612792
	for ST400GCI03R25	ST400R–A53		for ST499GCI03L26	04612792
	for ST400GCI03L26	ST400L–A53		for ST499GCI03R29	04662882
	for ST400GCI03R29	ST400R–A53	20	Housing	9BM–300–H2
	for ST499GCI03R25	ST499R–A53	21	Cap Screw (6)	10BM–744
	for ST499GCI03L26	ST499L–A53	22	Washer (6)	10BM–67
	for ST499GCI03R29	ST499R–A53	23	Bearing	ML50K–318
6	Front Deflector	ST400–111	24	Drive	
7	Planet Gear (3)	ST400–10A		for ST400GCI03R25	10BM–299–21
8	Bearing (3)	ST400–278		for ST400GCI03L26	10BM–299–19
9	Snap Ring (3)	04560157		for ST400GCI03R29	10BM–299–22
10	Magnetic Plug (3)	04658621		for ST499GCI03R25	10BM–299–21
11	Magnetic Plug	CE110–29		for ST499GCI03L26	10BM–299–19
12	Pipe Plug	Y17–51–S		for ST499GCI03R29	10BM–299–22
13	Ring Gear	ST400–37A	25	Cap Screw (4)	Y99–43
14	Bearing (2)	ST400–22	27	Warning Plate	04612313
15	Retaining Ring	ST400–366	28	Drive Screw (4)	Y60–43
16	Spacer	04658639	29	Flange Kit	ST400G–K17
17	Seal	04561114	30	Exhaust Elbow Kit	ST400G–K350
18	Thrust Washer	04658779			

MAINTENANCE SECTION

⚠ WARNING

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

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

DISASSEMBLY

General Instructions

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

Disassembly of the Motor Housing

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

Disassembly of the Drive Housing

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

Disassembly of the Drive Gearing

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

Disassembly of the Planet Gear

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

Cleaning Parts

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

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

NOTICE

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

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

Inspection of Parts

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

NOTICE

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

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

ASSEMBLY

General Instructions

1. Always press on the **inner** ring of a ball–type bearing when installing the bearing on a shaft.
2. Always press on the **outer** ring of a ball–type bearing when pressing the bearing into a bearing recess.
3. Whenever grasping a starter or part in a vise, always use leather–covered or copper–covered vise jaws. Take extra care with threaded parts or housings.
4. Always clean every part and wipe every part with a thin film of Ingersoll–Rand No. 50 Oil before installation.
5. Check every bearing for roughness. If an open bearing must be cleaned, wash it thoroughly in a clean, suitable, cleaning solution and dry with a clean cloth. Sealed or shielded bearings should never be cleaned. Work Ingersoll–Rand No. 130 Grease thoroughly into every open bearing before installation.
6. When assembling the motor always use new O–rings.
7. Before installing O–rings, coat liberally with o–ring lubricant and apply O–ring lubricant to O–ring grooves. After the O–ring is installed, coat the O–ring again with O–ring lubricant.

Assembly of the Motor Housing

1. Place the Housing (4) in an Arbor Press, exhaust end up, press three Bearings (8) into the Housing.
2. Press three Planet Gears (7), shaft end down, into bearings.
3. Remove Housing from Arbor Press and install three Snap Rings (9), working through front end, on the three Planet Gear Shafts.
4. Install Front Deflector (6), through exhaust end, with flat face down.
5. Before installing the Motor Assembly, coat the O–rings on the Motor Assembly and the inside of the Cylinder with O–ring lubricant. Install the Motor Assembly through the rear of the Motor Housing with geared end of the Rotor toward the front.
6. Coat two O–rings (3) with O–ring lubricant and install in the grooves on the End Cover (1).
7. Install the End Cover (1) on the rear of the Motor Housing using Starter Assembly Cap Screws (25). Tighten to a final torque of 120 in–lb (13 Nm).

NOTICE

8. **After assembling the exhaust cover to the starter, add 10 to 15 ml of Dextron®***II Automatic Transmission Fluid through the pipe plug hole in the Exhaust Cover.**
9. Install pipe plug (2) and tighten to 60 in–lb (7 Nm).

Assembly of Drive Gearing

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

Assembly of Drive Housing

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

NOTICE

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

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

TROUBLESHOOTING GUIDE

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

NOTICE

SAVE THESE INSTRUCTIONS. DO NOT DESTROY.

NOTES

NOTES