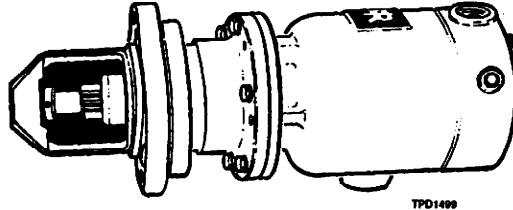


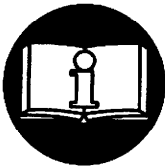
# INSTALLATION AND MAINTENANCE MANUAL

## for

### SERIES 5BMG STARTERS



#### ⚠ WARNING



**IMPORTANT INFORMATION CONTAINED IN OPERATION AND MAINTENANCE MANUAL FOR SAFE STARTER OPERATION. THIS MATERIAL MUST BE READ PRIOR TO OPERATING THE STARTER.**

**FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.**

1. For safety, top performance, and maximum durability of parts, do not operate Series 5BMG Starters at pressure over the pressure rating stamped on the nameplate. Use supply lines of adequate size as directed in the installation instructions in this manual.
2. 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
3. Series 5BMG 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.
4. Caution should be taken when operating these starters on gas because of the danger of fire, explosion, or inhalation. After assembling a starter, always test 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.
5. Operate this starter only when properly installed on the engine.
6. Do not lubricate starters with flammable or volatile liquids such as kerosene, diesel or jet fuel.
7. For personal protection, do not remove any labels. Replace any damaged label.
8. Use only recommended Ingersoll-Rand accessories.

#### 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 Servicenter.

Specific Test Data, when applicable, can be found in the Special Instructions Section of this manual.

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

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

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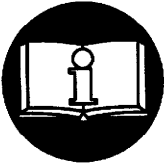
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# WARNING LABEL IDENTIFICATION


## ⚠ WARNING

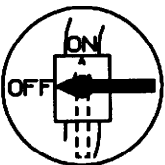
FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.

	<b>⚠ WARNING</b>
	<p>Important information contained in Installation and Maintenance Manual for safe starter operation.</p> <p>This material must be read prior to installing or operating the starter.</p>

	<b>⚠ WARNING</b>
	<p>Always wear eye protection when operating or performing maintenance on this starter.</p>

	<b>⚠ WARNING</b>
	<p>Always wear hearing protection when operating this starter.</p>

	<b>⚠ WARNING</b>
	<p>Do not use damaged, frayed or deteriorated air hoses and fittings.</p>

	<b>⚠ WARNING</b>
	<p>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.</p>

# PLACING STARTER IN SERVICE

## INSTALLATION

### NOTICE

For maximum performance, read this manual prior to the installation or operation of Series 5BMG Starters.

### General Information

1. It is strongly recommended that on all vehicular installations and on stationary engines subject to vibration, that hoses of the specified diameter be used instead of rigid pipe connections to the starter. Vehicle and engine vibration will soon loosen rigid pipe connections, whereas hoses will absorb the vibration and connections will remain tight.
2. In the actual mounting of a starter, it may be 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.
3. Engine design often demands that the starter be mounted underneath in extremely close quarters, and even though two of the mounting bolt holes are easy to reach, the third one is often less accessible. To install a starter, the following tools are required: regular ratchet wrench, sockets, universal joint, socket extension and a single or double-end box wrench.
4. The efficiency of an Air or Gas 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 for piped-away applications in the exhaust port will restrict the exhaust causing back pressure to the motor resulting in reduced performance. The number of tees and elbows, and the length of the supply line should be kept to a minimum. Use 3/4" (19 mm) hose or pipe, or larger, for supply lines.
5. A leak in any of the connections in live air lines means that the system will drain overnight and will have to be re-pressurized the next morning by use of another vehicle or compressor. 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 Loctite®\* Pipe Sealant.
6. 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.

\* Registered trademark of Loctite Corporation.

### Mounting the Starter

1. Study the Piping Diagram as shown in Figure 1. We 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.

### ⚠ 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.**

3. If you are going to connect to a receiver tank that is already in service, bleed off the air pressure by opening the drain valve. Drain off any water that may have accumulated in the bottom of the tank.

### NOTICE

**Make certain the connection between the SRV100 Starter Relay and the Receiver Tank is made to the inlet side of the Relay Valve indicated by the word "IN" cast on the valve body.**

4. Using a 1-1/4" short nipple, install the SRV100 Starter Relay Valve on the end of the receiver tank as shown in Figure 1.
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.
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.

### NOTICE

**When connecting the Starter Control Valve to the Relay Valve make certain the hose is connected to the "SUP" side of the Starter Control Valve.**

8. 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.
9. Using a piece of heavy duty garden hose, or some other similar large diameter hose, run it from the Relay Valve on the receiver to the Starter location on the engine to determine the exact length of 3/4" hose required.

## PLACING STARTER IN SERVICE

10. Attach the 3/4" 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. If practical, liberally grease the teeth on the ring gear with a good, sticky gear grease or motorcycle chain lubricant. This will help promote the life of the ring gear and the starter Pinion.
13. Place the starter into position, and mount it on the flywheel bell housing. Tighten the mounting bolts to 55–60 ft–lb (75–81 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. If the exhaust is not to be piped away, install a No. 3BM–WM07 Muffler in the exhaust port on the Motor Housing of the starter.
17. Pressurize the complete starting system and check every connection with a soap bubble test. There must be no leaks.

### 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, reorient the starter as follows:

1. Look at the dimension illustration (Figures 2 and 3) and note that the Drive Housing (24) can be located in any one of six radial positions relative to the Motor Housing (16). The inlet (Motor Housing Cover (1)) can be located in any one of six radial positions relative to the exhaust ports (Motor Housing).

### NOTICE

**When rotating the Drive Housing and/or the Motor Housing, do not allow them to separate.**

2. Study the engine mounting requirements and determine the required orientation of the Drive Housing relative to the Motor Housing. If the Drive Housing has to be reoriented, remove the six Drive Housing Cap Screws (22) and rotate the Drive Housing

to its required position. Reinstall the Drive Housing Cap Screws and tighten them to 9 ft–lb (12.2 Nm) of torque.

### NOTICE

**When rotating the Drive Housing and/or the Motor Housing Cover, do not allow them to separate.**

3. Now that you have the Drive Housing properly oriented relative to the Motor Housing, notice whether or not the exhaust port will be at the bottom, and whether or not the inlet port will be favorably located for hose installation. If either or both of these members must be reoriented, remove either the six Drive Housing Cap Screws or six Motor Housing Cover Cap Screws and rotate the Motor Housing and/or Motor Housing Cover to the desired position. Reinstall the Motor Housing Cover Cap Screws and alternately tighten them to 9 ft–lb. (12.2 Nm) of torque.

### Barring Over the Engine

Occasionally, for setting injectors and/or for timing purposes, it may be desirable to bar over the engine in such a manner that any given piston can be stopped at any given location. This is very easily done with a 5BMG starter.

1. Disconnect the 1/4" hose at the "OUT" portion the Drive Housing, and plug the hole in the Drive Housing with a 1/4" pipe plug.
2. Remove the 3/8" pipe plug from the center of the Motor Housing Cover.
3. Engage the Drive Pinion with the flywheel by applying pressure to the "IN" port on the Drive Housing.
4. Insert a 5/16" hexagonal wrench through the hole in the Motor Housing Cover to engage the hexagonal recess at the rear of the Rotor.
5. Manually, rotate the Rotor until the engine is cranked to its desired position.

### Air or Gas Supply and Connections

Low pressure (under 150 psig; 10.3 bar/1034 kPa) reduces the efficiency of starters. Low pressure not only wastes time, but also costs money. High pressure (over 150 psig; 10.3 bar/1034 kPa) raises performance beyond the rated capacity of the starter.

Make sure all hoses and fittings are the correct size and are tightly secured. See Figure 1 for a typical piping arrangement.

# PLACING STARTER IN SERVICE

## GAS OPERATED STARTERS

### ⚠ WARNING

When repairing a gas operated starter or when converting a starter from air operation to gas operation, it is necessary to use Ingersoll-Rand No. SMB-431 Plastic Gasket as directed and the following procedures for assembly and testing must be followed exactly.

1. After installing the motor in the Motor Housing (16), coat the contacting faces of the Housing and Housing Cover (1) with Plastic Gasket and position the Cover on the Housing.

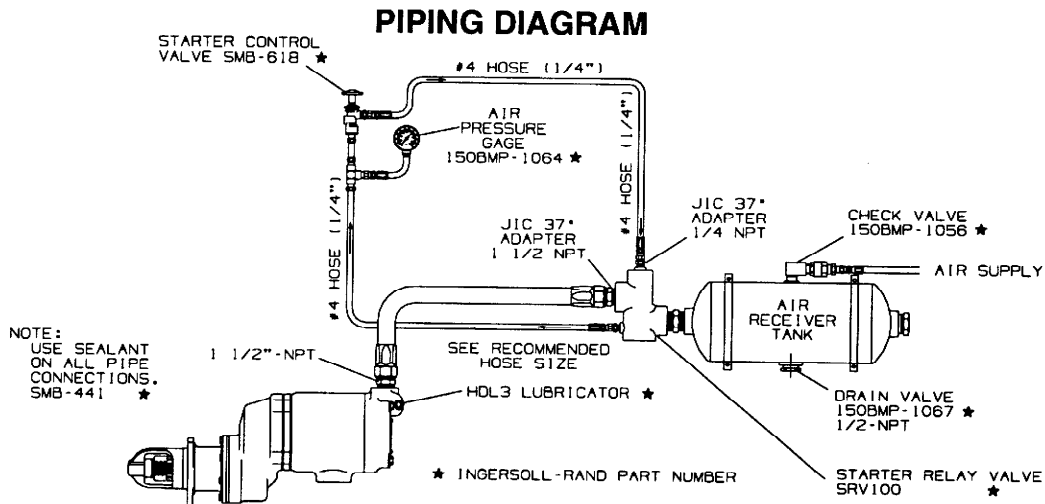
### NOTICE

Do not allow the Plastic Gasket to get into the threaded holes.

2. Apply a small amount of Plastic Gasket to the thread on each of the six Cover Cap Screws (7) and run the

Screws, a little at a time, to 100 in-lb (11.3 Nm) torque.

3. Apply Plastic Gasket to the thread on each of the three Lubricator Connection Plugs; then run each firmly into the Housing Cover.
4. Insert Plastic Gasket into each nameplate screw hole and install the Nameplate and Screws.
5. Allow four hours drying time.
6. Remove the Drive (30) from the Drive Shaft (31) to prevent flushing and/or contamination of the Drive in step 9.
7. Slide the Drive Shaft Collar (21) onto the Drive Shaft and install the Shaft in the Rotor (13).
8. Screw a 1" pipe plug into the exhaust port.
9. Connect air line to the inlet, regulate the 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 not safe for gas operation.



The performance of the starter is dependent on the pressure at the inlet of the starter. This pressure is effected by the pressure drop between the air receiver tank and the starter. The most significant pressure drops will occur in fittings (valves, tees, elbows, etc.). The next significant source of pressure drop is the hose. The following table provides recommended hose and starter relay valves (SRV) sizes for typical one starter installations. Systems with many fittings or long hoses should be analyzed and sized individually.

For gas operation, the exhaust outlet must be piped away to a safe location.  
 For natural gas operation, piped exhaust must be used and drive housing vent plug replaced with suitable hose which connects into piped exhaust system.  
 For air applications a muffler or splash guard deflector must be used.

STARTER	HOSE LENGTH	HOSE SIZE	SRV SIZE
5BMG	0-30'	#12 (3/4")	SRV100

Figure 1

(Dwg. TPC598)

## PLACING STARTER IN SERVICE

*Series 5BMG Starters are designed for air or gas operation in off-highway, marine, and stationary applications.*

### HOW TO ORDER A STARTER

#### SERIES 5BMG STARTERS

Model	Pinion Drive			
	Teeth/Blank	D.P./Module	P.A.	Rotation
5BMGA53RH-1F	11/12	6/8	20	R
5BMGA53RH-2F	12/13	8/10	20	R
5BMGA56RH-3F	10/11	8/10	20	L
5BMGA56RH-5F	11/12	6/8	20	R
5BMGA56RH-49F	9/9.5	3	15	R
5BMGA56RH-52F	11/11.7	3	15	R

### STARTER DRIVES AND STARTER HOUSINGS

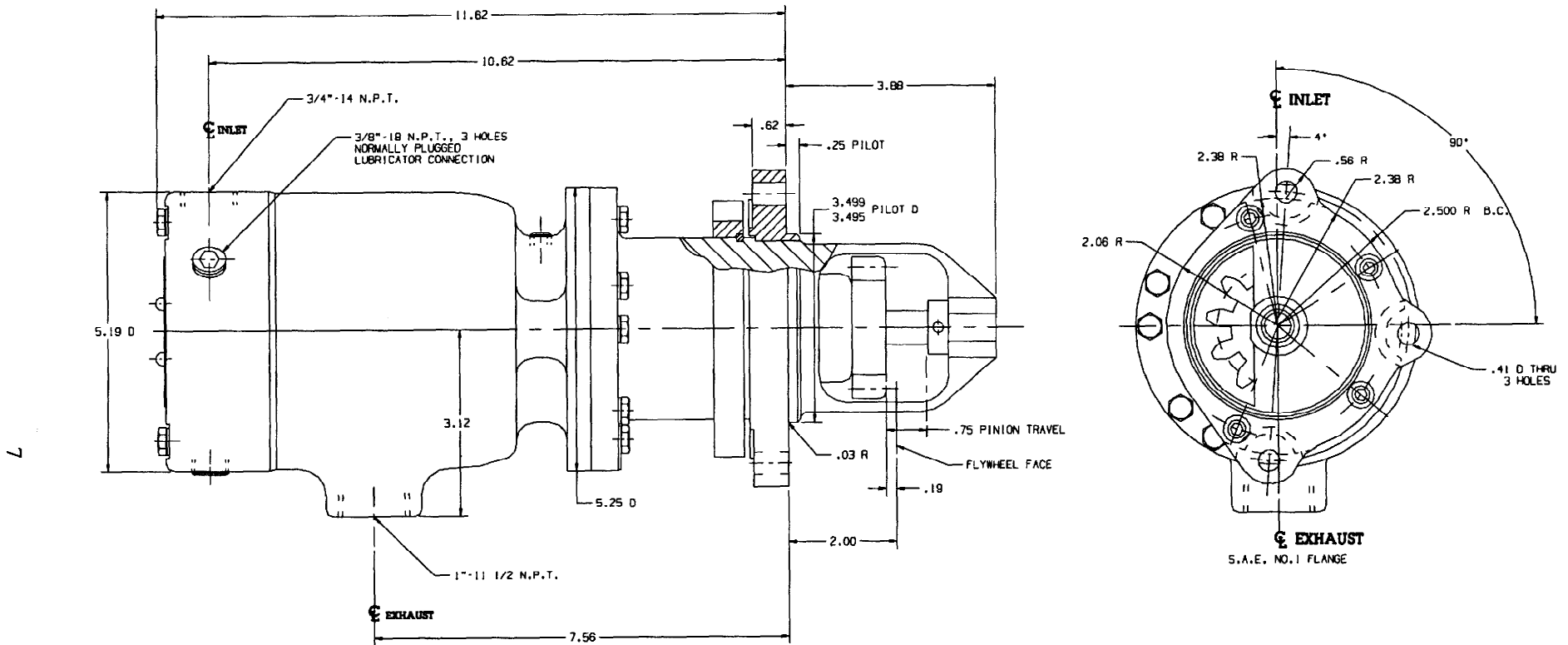
The starter drive that utilized the large rectangular spring has been discontinued. The replacement drive is longer by 5/8 inch. This has necessitated the use of a different

drive housing for those certain starter models. The following table should be helpful in identifying the new and old relationships.

NEW STYLES			OLD STYLE			
Model	Drive	Housing	Model	Drive	Housing	Drive Shaft
5BMGA53RH-1F	5BM-299-31	5BMR-APDR-3	5BMGA11RH-1	5BM-299-1	5BM-300-1	5BM-8-1
5BMGA53RH-2F	5BM-299-9	5BMR-APDR-3	5BMGA11RH-2	5BM-299-2	5BM-300-1	5BM-8-1
5BMGA56RH-5F	5BM-299-9	5BMR-APDR-1	5BMGA12RH-5F	5BM-299-2	5BM-300-2	5BM-8-2
5BMGA56RH-3F	5BM-299-33	5BMR-APDR-1	5BMGA12RH-3F	5BM-299-18	5BM-300-2	5BM-8-2
5BMGA56RH-49F	5BM-299-28	5BMR-APDR-1	5BMGA12RH-49F	5BM-299-28	5BM-300-2	5BM-8-2
5BMGA56RH-52F	5BM-299-26	5BMR-APDR-1	5BMGA12RH-52F	5BM-299-26	5BM-300-2	5BM-8-2

All new style Starters use 5BM-8-2 Drive Shaft.

## MOUNTING DIMENSIONS FOR 5BMG STARTER WITH S.A.E. NO. 1 FLANGE



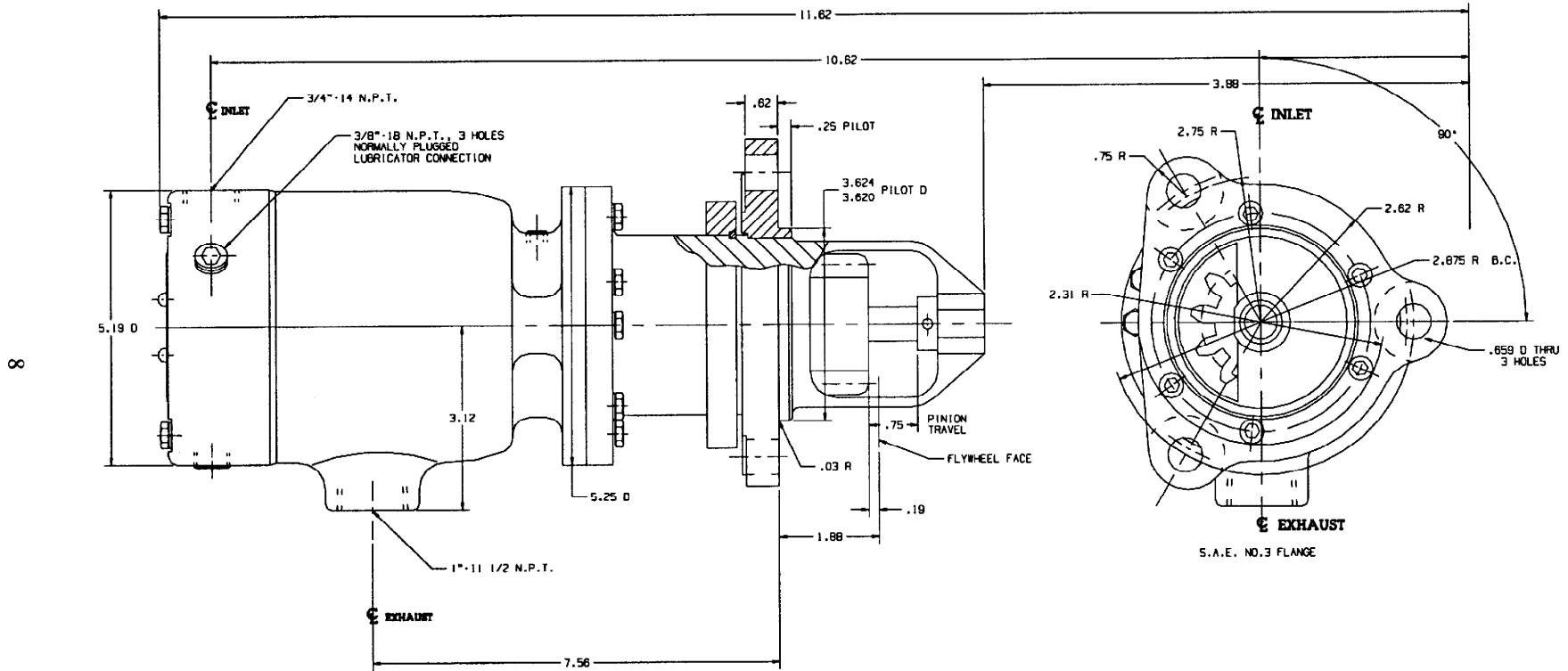
### NOTES:

1. These starters are sealed for gas operation at the factory. If necessary to reorient the inlet (cover) in the field, approved assembly procedures must be used to assure the resealing for gas operations.
2. Any previously published standard models not listed, or on RTPA-209-03, will require price and delivery quotation.
3. All starter models showing a "56" in the 6th and 7th positions are equipped with rotating flanges. They will be interchangeable with previous models with the same suffix.  
Example: 5BMGA56RH-49F will fit an engine previously fitted with a 5BMGA12RH-49F.

Figure 2

(Dwg. TPA1375)

## MOUNTING DIMENSIONS FOR 5BMG STARTER WITH S.A.E. NO. 3 FLANGE



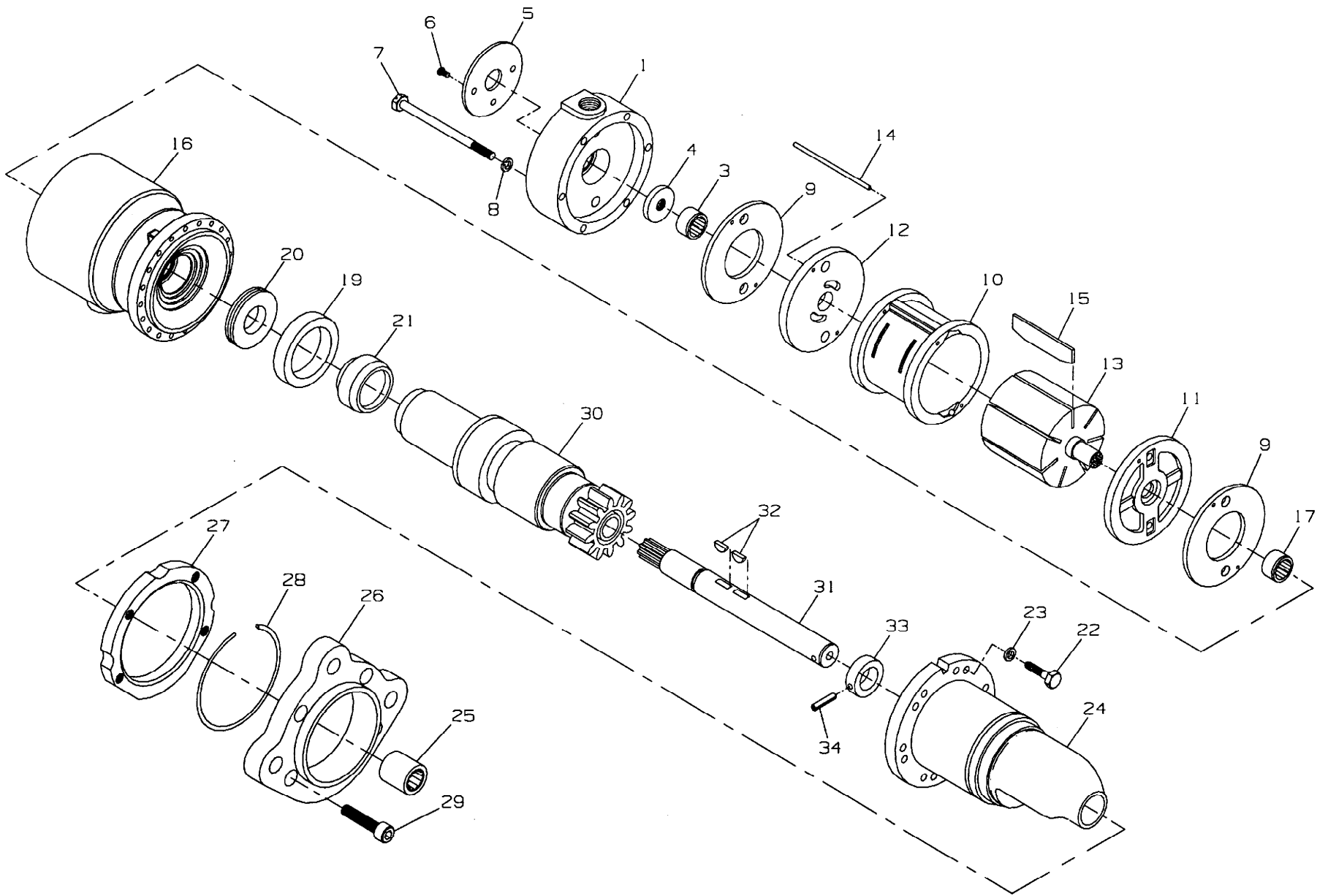
**NOTES:**

1. These starters are sealed for gas operation at the factory. If necessary to reorient the inlet (cover) in the field, approved assembly procedures must be used to assure the resealing for gas operations.
2. Any previously published standard models not listed, or on RTPA-209-01, will require price and delivery quotation.
3. 3 - mounting holes 5BMGA52RH-6F are at 90° and .53 diameter.

Figure 3

(Dwg. TPA1376)





PART NUMBER FOR ORDERING

PART NUMBER FOR ORDERING

1	Motor Housing Cover	5BM-102	*	Plastic Gasket	SMB-431
	Lubricator Connection Plug (3)	HSPPS-3		Drive Housing Module (Independent Mounting Flange Type) (includes Drive Housing Bearing)	
3	Rotor Bearing	5BM-24		for Models A56RH-3F, A56RH-5F, A56RH-49F and A56RH-52F	5BMR-APDR-1
4	Bearing Ejecting Washer	5BM-25		for Models A53RH-1F and A53RH-2F	5BMR-APDR-3
5	Nameplate	150BM-301		Drive Housing	5BMR-300-1
6	Nameplate Screw (3)	R4K-302		Drive Housing Bearing	150BM-363-10
7	Motor Housing Cover Cap Screw (6)	R3H-66		Mounting Flange	
8	Cover Cap Screw Lock Washer (6)	L01-67		for Models A56RH-3F, A56RH-5F, A56RH-49F and A56RH-52F	5BMR-301-1
◆	Motor Gasket (2)	5BM-283	24	for Models A53RH-1F and A53RH-2F	5BMR-301-3
10	Cylinder	5BM-3	◆ 25	Mounting Flange Clamp Ring	
★	Front End Plate	5BM-11	⊕ 26	for Models A56RH-3F, A56RH-49F and A56RH-52F	5BMR-302-1
★	Rear End Plate	5BM-12		for Models A53RH-1F and A53RH-2F	5BMR-302-3
13	Rotor	5BM-53		Clamp Ring Retainer	5BMR-303-1
14	Cylinder Dowel	5BM-98		Clamp Ring Screw (4)	SHCSN5-18-4
◆	Vane Packet (set of 7 Vanes)	5BM-42-7	⊕ 27		
16	Motor Housing	5BM-40-1			
◆	Rotor Bearing	5BM-24			
◆	Housing Grease Seal	5BM-271			
◆	Drive Shaft Thrust Washer	5BM-80			
21	Drive Shaft Collar	5BM-30-1			
22	Drive Housing Cap Screw (6)	R3H-68A	⊕ 28		
23	Housing Cap Screw Lock Washer (6)	L01-67	⊕ 29		

\* Not illustrated.

◆ Indicates Tune-up Kit part.

★ For any Model with the "LH" in its symbol, the position of the End Plates (11 and 12) are transposed. Before ordering an End Plate, examine the Plate to be replaced. If it is marked 12, order a Rear End Plate; if it is marked 11, order a Front End Plate.

⊕ These parts only used in combination with Independent Mounting Flange Type Drive Housing.

PART NUMBER FOR ORDERING



PART NUMBER FOR ORDERING



30	Starter Drive for Models A53RH-2F and A56RH-5F .....	5BM-299-9	*	Lubricator (In-Line) .....	NL24-B
	for Model A56RH-3F .....	5BM-299-33	*	Check Valve .....	150BMP-1056
	for Model A56RH-52F .....	5BM-299-26	*	Check Relief Valve .....	150BMP-1054
	for Model A56RH-49F .....	5BM-299-28	*	Tune-up Kit (includes illustrated parts 9 (2), 15, 17, 19, 20 and 25) .....	5BM-TK2
	for Model A53RH-1F .....	5BM-299-31	*	Mounting Bolt Bushing (3) for use with 3/8" mounting bolt .....	9BM-7-2
31	Drive Shaft .....	5BM-8-2		for use with 1/2" mounting bolt .....	150BM-7-1
32	Drive Shaft Key (2) .....	TC-18	*	Mounting Bolt Lock Washer (3) for use with Mounting Bolt Bushing No. 9BM-7-2 .....	9BM-321
33	Drive Spacer .....	5BM-277-1		for use with Mounting Bolt Bushing No. 150BM-7-1 .....	9BM-421
34	Drive Spacer Pin .....	5BM-278	*	Sticker .....	TA-STR-100
*	Solenoid Valve (12V) .....	150BMP-1051B	*	Tag .....	TA-GAS-A
*	Solenoid Valve (24V) .....	150BMP-2451B			
*	Starter Control Valve .....	SMB-618			
*	Relay Valve .....	SRV-100			
*	Lubricator .....	HDL2			

\* Not illustrated.

## MAINTENANCE SECTION

### WARNING

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

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

### LUBRICATION

Each time the Series 5BMG Starters are disassembled for maintenance, repair or replacement of parts, lubricate the starter as follows:

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.

### CAUTION

When an HDL2 Lubricator is used, make certain that the oil supply line pressure is no greater than 5 psi. If there is pressure on the line, the Lubricator will continuously leak lubricant through the starter and out the exhaust.

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. 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 No. NL-24-8 Lubricator installed in the main air or gas supply line. Use a good quality 10W non-detergent oil and adjust the Lubricator to flow 1 to 3 drops per second.

### DISASSEMBLY

#### General Instructions

1. Do not disassemble the starter any further than necessary to replace or repair damaged parts.
2. Whenever 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 and housings.
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 repairs or replacement.
4. Always have a complete set of seals and O-rings on hand before starting any overhaul of Series 5BMG Starters mark. Never reuse old seals or gaskets.
5. Always mark adjacent parts so that these members can be located in the same relative position when the starter is reassembled.

6. Never wash the Starter Drive in solvent.
7. Do not press any needle bearing from a part unless you have a new needle bearing on hand for installation. Needle bearings are always damaged during the removal process.

#### Disassembly of the Motor Housing

1. If replacing the motor assembly, unscrew the Motor Housing Cover Cap Screws (7).
2. Separate the Motor Housing Cover (1) from the Motor Housing (16).
3. Remove the Rear End Plate (12) and the Cylinder Dowel (14).
4. If required, remove the Rotor Bearing (3), Bearing Ejecting Washer (4) and Motor Gasket (9) from the Motor Housing Cover.
5. Remove the Rotor (13) and Vanes (15) from the Cylinder (10).
6. Work the Cylinder from the Motor Housing. Remove the Front End Plate (11), Motor Gasket (9), Rotor Bearing (17) from the Motor Housing.

#### Disassembly of the Drive Housing

1. Separate the Drive Housing (24) from the Motor Housing (16) by removing the Drive Housing Cap Screws (22).
2. Remove the Starter Drive (30) from the Drive Housing.
3. Remove the Drive Shaft Thrust Washer (20) from the Motor Housing.
4. Remove the Housing Grease Seal (19) from the Starter Drive.
5. Remove the Drive Shaft Collar from the Drive Shaft.
6. Pull the Drive Shaft (31) from the Starter Drive. Do not lose the Drive Shaft Keys (32).
7. If required, unscrew the Clamp Ring Screws (29), remove the Mounting Flange (26), Clamp Ring Retainer (28), and the Mounting Flange Clamp Ring (27).

### ASSEMBLY

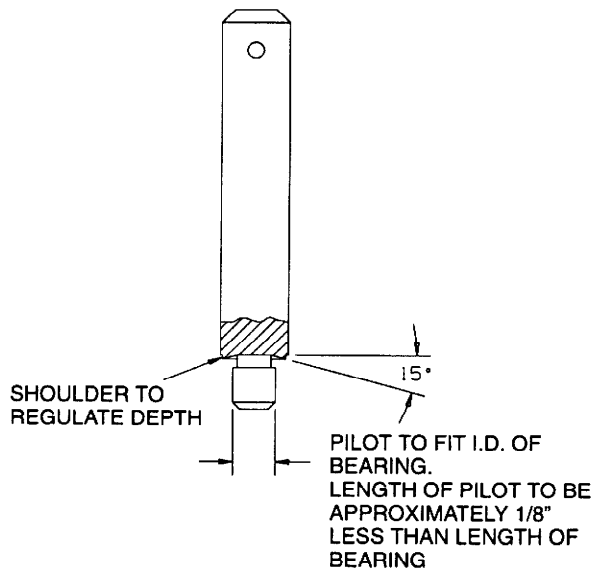
#### General Instructions

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 and housings.
4. Always clean every part and wipe every part with a thin film of oil before installation.

## MAINTENANCE SECTION

5. Check every bearing for roughness. If an open bearing must be cleaned, wash it thoroughly in a suitable cleaning solution and dry with a clean cloth. Sealed or shielded bearing should never be cleaned. Work grease thoroughly into every open bearing before installation.
6. Apply a film of O-ring lubricant to all O-rings before final assembly.
7. Unless otherwise noted, always press on the stamped end of a needle bearing when installing the needle bearing in a recess. Use a bearing inserting tool similar to the one shown in Dwg. TPD786.

### Needle Bearing Inserting Tool



(Dwg. TPD786)

### Assembly of the Drive Housing

1. Secure the Drive Spacer (33) to the Drive Shaft (31) with the Drive Spacer Pin (34).
2. With the Drive Shaft Key (32) in the keyway in the Drive Shaft, insert the Drive Shaft into the Starter Drive (30).
3. Using a needle bearing inserting tool, press the Drive Housing Bearing (25), unstamped end first, into the Drive Housing (24) until the trailing face of the

Bearing is flush with the bearing recess. Refer to Dwg. TPD786.

4. Place the Drive Shaft Collar (21) on the Drive Shaft.
5. Place the Housing Grease Seal (19) on the Starter Drive.
6. Replace the Drive Shaft Thrust Washer (20) within the Motor Housing (16).
7. Carefully insert the assembled Drive Shaft and Starter Drive into the Drive Housing. Make sure that the end of the Drive Shaft goes through the Drive Housing Bearing.
8. Secure the Drive Housing to the Motor Housing with the Drive Housing Cap Screws (22). Tighten to 9 ft-lb (12.2 Nm) torque.
9. If required, place the Mounting Flange Clamp Ring (27), the Clamp Ring Retainer (28) and the Mounting Flange (26) onto the Drive Housing. Secure the Clamp Ring to the Mounting Flange with the Clamp Ring Screws (29). Tighten to 18 ft-lb (24.4 Nm) torque.

### Assembly of the Motor Housing

1. From the motor end of the Motor Housing (16), reinstall the Rotor Bearing (17).
2. Reinstall the front Motor Gasket (9) and the Front End Plate (11) into the Housing.
3. Aligning the Cylinder Dowel holes in the Cylinder (10) and the Front End Plate, work the Cylinder into the Housing.
4. Place the Cylinder Dowel (14) through the Cylinder and the Front End Plate.
5. Place the Rotor (13) into the Motor Housing.
6. Reinstall lightly lubricated Vanes (15) into the slots in the Rotor.
7. If required, replace the Bearing Ejecting Washer (4) and the Rotor Bearing (3) into the Motor Housing Cover (1).
8. Reinstall the Rear End Plate (12). Make sure that the Cylinder Dowel goes through the dowel hole in the End Plate.
9. Place the Motor Gasket (9) on the Rear End Plate.
10. Secure the Motor Housing Cover to the Motor Housing with the Motor Housing Cover Cap Screws (7). Tighten to 9 ft-lb (12.2 Nm) torque.

## MAINTENANCE SECTION

### TROUBLESHOOTING GUIDE

Trouble	Probable Cause	Solution
Motor will not run	No air or gas supply	Check for blockage or damage to 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 and check for blockage.
	Defective Control Valve or Relay Valve	Replace Control Valve or Relay Valve.
Loss of Power	Low air or gas pressure to starter	Check air or gas supply.
	Restricted air or gas supply line	Check for blockage or damage to air or gas lines.
	Relay Valve malfunctioning	Clean or replace lines or Relay Valve. Lube Relay Valve.
	Exhaust flow restricted	Check for blocked or damaged piping. Clean or replace piping. Check for dirt or foreign material and clean or remove. Check for ice build-up. Melt ice and reduce moisture build-up to starter.
	Damaged Motor Assembly	Replace Motor Assembly.

#### NOTICE

**SAVE THESE INSTRUCTIONS. DO NOT DESTROY.**

**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.**



