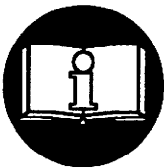
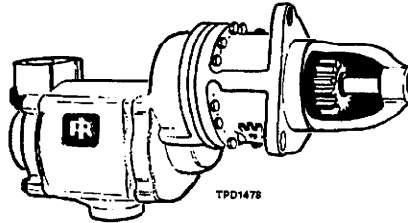


# INSTALLATION AND MAINTENANCE MANUAL

## for

### SERIES 150LF AND 150LFG LUBE-FREE STARTERS



#### ▲ WARNING

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

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

- For safety, top performance, and maximum durability of parts, do not operate Series 150LF and 150LFG Starters at air pressures over the pressure rating stamped on the nameplate. Use supply lines of adequate size as directed in the installation instructions in this manual.
- Always turn off the air or gas supply and disconnect the air supply hose before installing, removing or adjusting any accessory on this starter, or before performing any maintenance on this starter.
- Operate Series 150LF on compressed air only. They are not designed or sealed for operation on compressed gas.
- Series 150LFG Starters are designed for gas operation. They are not totally sealed in dynamic operation since the exhaust must be vented or piped away and there is a possibility of leakage around the output shaft when rotating. Caution should be taken when operating these starters on gas because of the danger of fire, explosion, or inhalation.
- After reassembling a 150LFG 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 outlined in this manual. This manual should be filed in a permanently available location.
- Operate this starter only when properly installed on the engine.
- Do not remove any labels. Replace any damaged label.
- Use only recommended Ingersoll-Rand accessories.

#### NOTICE

All Ingersoll-Rand Starters are available with a spark resistant pinion by special request. For applications where potentially explosive conditions exist, it is recommended that these pinions be specified. However, these pinions will wear faster than standard pinions and a reduction in service life should be expected.

#### 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.

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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Printed in U.S.A.


**INGERSOLL-RAND®**  
**ENGINE STARTING SYSTEMS**

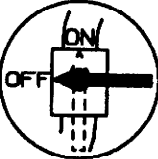
# WARNING LABEL IDENTIFICATION


## ⚠ WARNING

FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.

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

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

	<b>⚠ WARNING</b>
	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.

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

# PLACING STARTER IN SERVICE

## INSTALLATION

### NOTICE

For maximum performance, read this manual prior to the installation or operation of Series 150LF and 150LFG Lube-Free Starters.

#### General Information

1. This starter must be installed according to the instructions in this manual.
2. On all vehicular installations and on stationary engines subject to vibration, 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. When mounting a starter, make the hose connections at the receiver and have the starter end of the hose handy for attaching to the starter. Wherever possible, attach the air hoses to the starter before mounting the starter on the flywheel housing. There are two reasons for following this procedure:
  - a. After mounting the starter, it is often difficult or impossible to make hose connections due to space limitations.
  - b. Once attached, the hoses carry some of the weight of the starter making it easier to complete the mounting.
4. Engine design often demands that the starter be mounted underneath in extremely close quarters. Therefore, even though two of the mounting bolt holes are easy to get at, the third one is often quite inaccessible. The tools usually needed in the installation of a starter are a regular ratchet wrench, sockets, universal joint, socket extension and a single or double-end ratcheting box wrench.
5. Starter efficiency is greatly impaired by improper hook-up. Hoses smaller than 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 use of tees and elbows and the length of the supply line should be kept to a minimum. In normal installations, hoses running from the air tank to the starter should be No. 20 and fittings should be 1-1/4". Control hoses should be No. 4 and fittings should be 1/4".
6. A leak in any of the connections means that the system will drain overnight and will have to be repressurized the next morning by using another vehicle or compressor. Make the 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, Loctite®\* Pipe Sealant or Perma-Lok LH050®\*\*.

Always run the air supply line from the side or top of the receiver, never at or near the bottom. Moisture will collect at the bottom of the receiver causing corrosion in the starter motor. Freezing in cold weather can make the starter 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.

7. Installation of a "glad hand" for emergency repressurizing the system is recommended. 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.

Whenever possible, always mount the starter so that the exhaust port is downward. This will help prevent any accumulation of water in the starter motor.

## RELAY VALVE LOCATION

Ingersoll-Rand recommends that the Relay Valve be mounted on the air tank. As an alternate location, the Relay Valve can be mounted on the starter. Mounting on the starter gives better control of the air supply closer to the point of use and provides more starts per tank of air. However, mounting on the starter adds overhung weight and subjects the air supply lines to dynamic pressure at all times.

### 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 on page 7 and note that the Drive Housing can be located in any one of eighteen radial positions relative to the Gear Case. The exhaust port (motor housing) can be located in any one of four radial positions relative to the Gear Case and 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 to determine the required orientation of the Drive Housing relative to the Gear Case. If the Drive Housing has to be reoriented, remove the twelve Drive Housing Cap Screws and rotate the Drive Housing to its required position.

\* Registered trademark of Loctite Corporation.

\*\* Registered trademark of Pernabond Corporation.

## PLACING STARTER IN SERVICE

### NOTICE

**Do not separate the Drive Housing from the Gear Case Cover. Reinstall the Drive Housing Cap Screws and tighten them to 100 in-lb (11 Nm) of torque.**

3. With the Drive Housing properly oriented relative to the gear case, see if the exhaust port will be at the bottom and if the inlet port will be in a good location for hose installation. If either or both of these members must be reoriented, remove the four Motor Housing Cover Cap Screws and rotate the Motor Housing and/or Motor Housing Cover to its desired position.

### NOTICE

**Do not separate the Motor Housing from the Drive Housing or from the Gear Case. Reinstall the Motor Housing Cover Cap Screws and alternately tighten them to 25 ft-lb (34 Nm) of torque.**

### Mounting the Starter

1. Study the piping diagram on page 5. Ingersoll-Rand recommends 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. Drain off any water that may have accumulated in the bottom of the tank.**

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.
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-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.

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.

### NOTICE

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

9. Run a piece of heavy duty garden hose or some other similar large diameter hose from the Relay Valve on the receiver to the starter location on the engine to determine the exact length of 1-1/4" air hose required.
10. Attach the 1-1/4" 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 if it is feasible 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 possible, 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 bellhousing. Tighten the mounting bolts to 100 ft-lb (136 Nm) of torque.
14. If the exhaust is not to be piped away, install a No. 150BM-A674 Muffler or No. 150BM-A735 Road Splash Deflector in the exhaust port on the Motor Housing of the starter.
15. Pressurize the starting system and check every connection on the tank and the two pressure ports on the Relay Valve with a soap bubble test. There must be no leaks.

### Barring Over the Engine

To set injectors and/or for timing purposes, it may be necessary to bar over the engine so that an individual piston can be stopped at any location. This is very easily done with a Series 150LF or 150LFG starter.

1. Disconnect the 1/4" hose at the "OUT" port on 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. Turn the Rotor manually until the engine is cranked to its desired position.

# PLACING STARTER IN SERVICE

## RELAY VALVE LOCATION

Ingersoll-Rand recommends that the Relay Valve be mounted on the air tank. As an alternate location, the Relay Valve can be mounted on the starter. Mounting on the starter gives better control of the air supply closer to the point of use and provides more starts per tank of air. However, mounting on the starter adds overhung weight and subjects the air supply lines to dynamic pressure at all times.

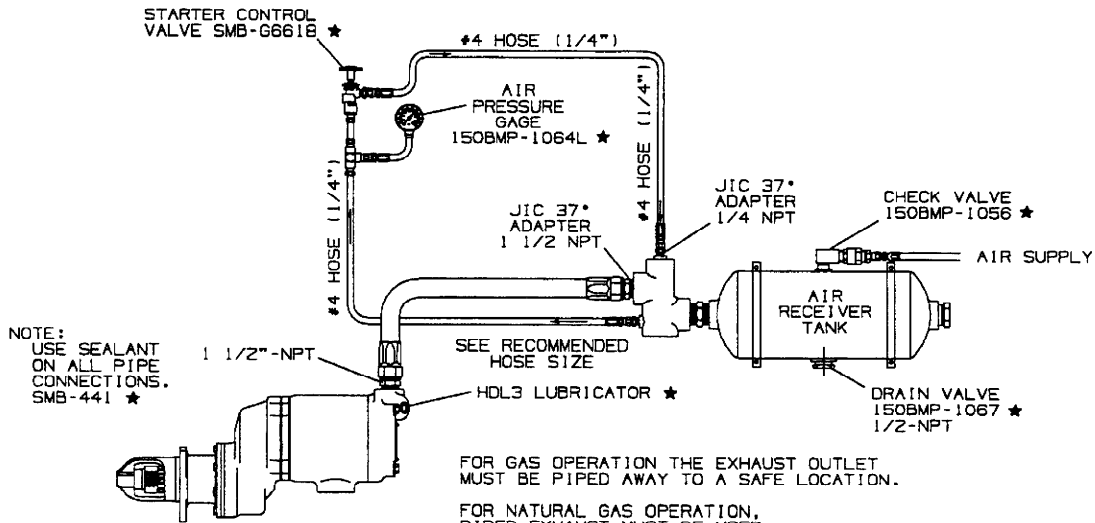
## GAS-OPERATED STARTERS

### 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. MBA31 Plastic Gasket, as directed, and the following procedures for assembly and testing must be explicitly followed.

1. Apply a thin film of sealant between the Motor Housing Cover and the Motor Housing, between the Motor Housing and the Gear Case, and between the Gear Case Cover and the Gear Case and install them.
2. Apply sealant to both sides of the four Housing Cover Washers (6) and under the head of the four Motor Housing Cover Cap Screws. Assemble, install and tighten to 25-30 ft-lb (33.9-40.6 Nm) torque.
3. Apply a thin film of sealant to the Housing Cover End Plug and the Lubricator Port Plug as they are assembled.
4. Leaving off the Drive and Housing, apply sealant to both sides of the Drive Housing Cap Screw Lock Washers and Screws Assemble and install to hold the Cover in place.
5. Allow four hours curing time.
6. 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.

## PIPING DIAGRAM FOR A BASIC INERTIA TYPE SYSTEM



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

\* INGERSOLL-RAND PART NUMBER

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.

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 & STARTER VALVES (SRV) SIZES FOR TYPICAL ONE STARTER INSTALLATIONS. SYSTEMS WITH MANY FITTINGS OR LONG HOSES SHOULD BE ANALYZED & SIZED INDIVIDUALLY.

STARTER	HOSE LGTH.	HOSE SIZE	SRV SIZE
3BM, 5BM	0-30'	#12 (3/4")	SRV100
SS175	0-30'	#12 (3/4")	SRV100
150BM/LF, SS350	0-10'	#16 (1")	SRV100
	10-30'	#20 (1 1/4")	SRV125
SS810, 815, 825, 850 ST750, 799	0-50'	#24 (1 1/2")	SRV150

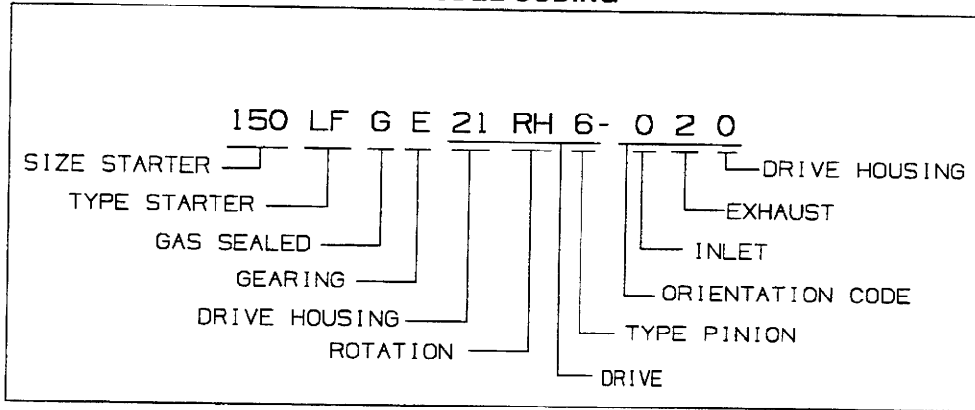
(Dwg. TPC585)

# PLACING STARTER IN SERVICE

Series 150LF and 150LFG Lube-Free Starters are designed for use in Class 7 and Class 8 Vehicles.

## HOW TO ORDER A STARTER

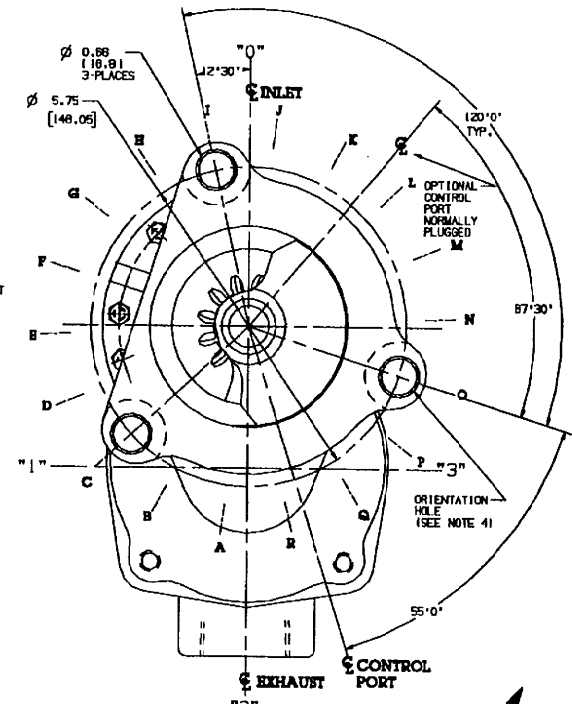
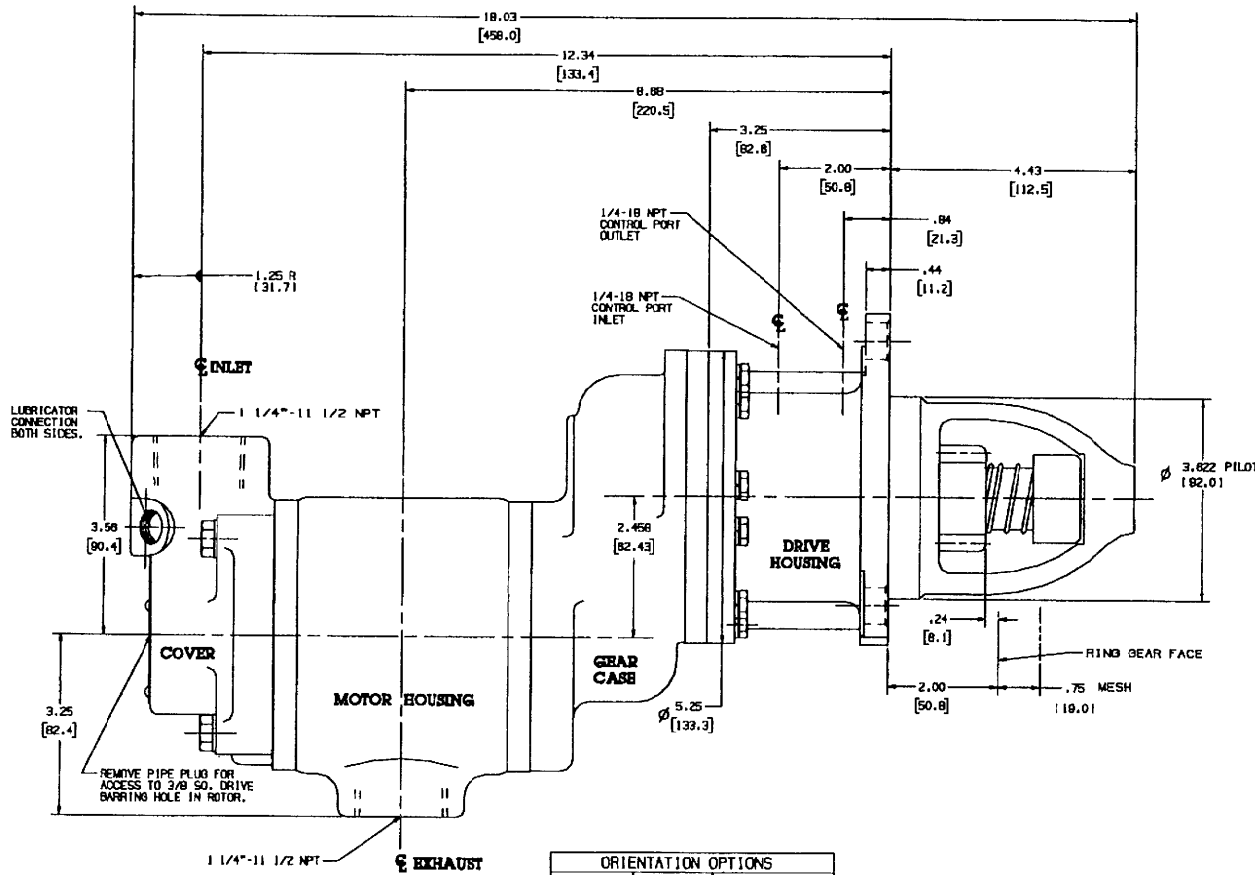
### MODEL CODING



(Dwg. TPD1539)

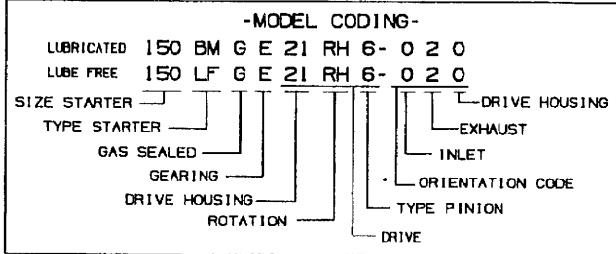
For specific models or special applications, contact your nearest Ingersoll-Rand Distributor or SALES HEADQUARTERS, Engine Starting Systems, PO Box 1776, Liberty Corner, NJ 07938 (908) 647-6000

# 150LF MOUNTING DIMENSIONS

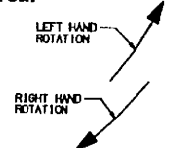


MAINTENANCE SECTION

ORIENTATION OPTIONS		
INLET	EXHAUST	DRIVE HOUSING
4 @ 90°	4 @ 90°	18 @ 20°



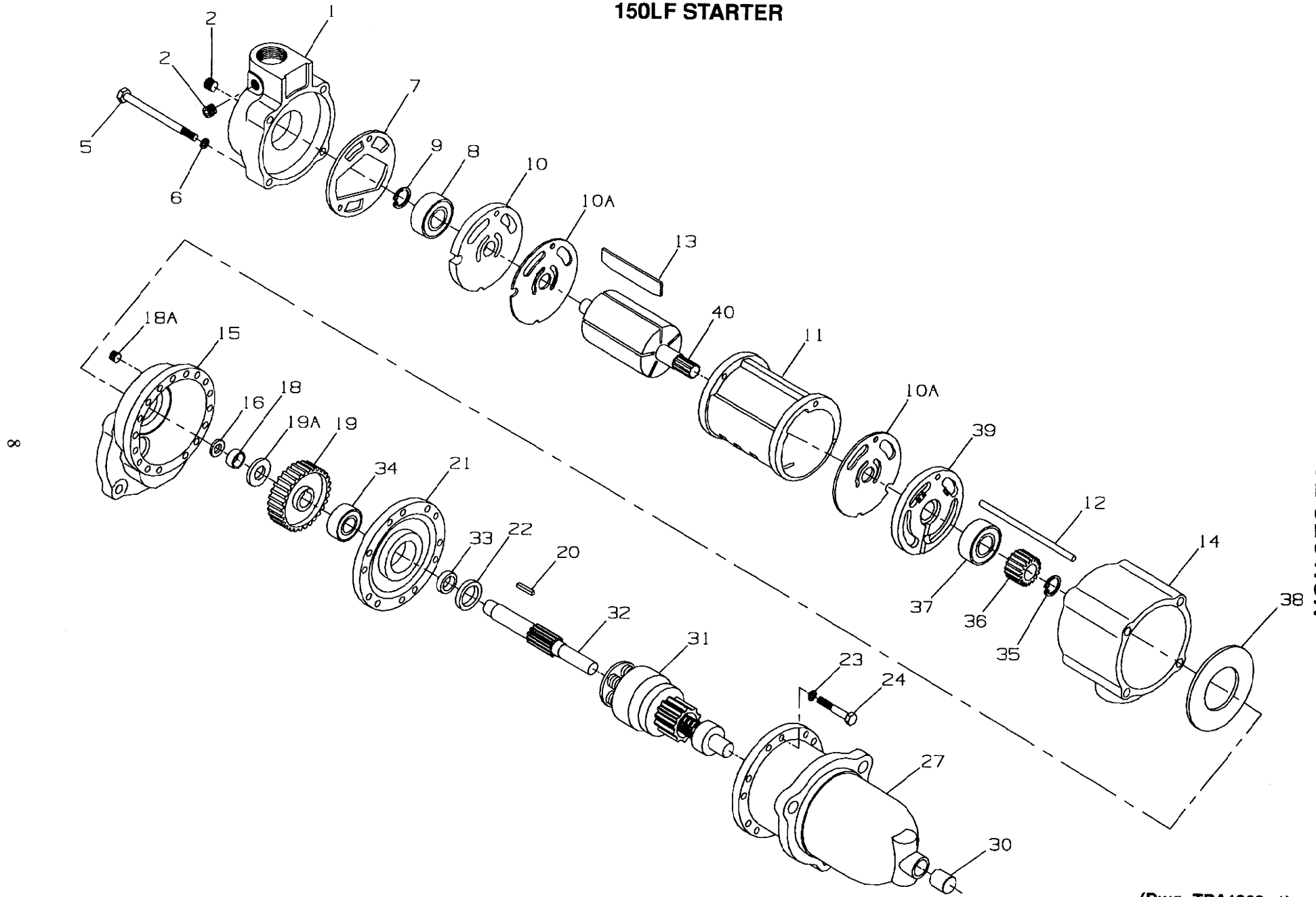
- NOTES:
- STARTERS SHOULD BE INSTALLED ON THE ENGINE WITH THE EXHAUST POINTED DOWN.
  - USE THE SET OF CONTROL PORTS ON THE UPPER SIDE OF THE DRIVE HOUSING. (ONLY DRIVE HOUSINGS WITH TWO SETS OF CONTROL PORTS.)
  - THESE MODELS ARE NOT APPROVED FOR APPLICATIONS WHERE THE STARTER IS EXPOSED TO THE TRANSMISSION FLUID.
  - DRIVE HOUSING ORIENTATION CODE IS BASED ON POSITION OF MOUNTING HOLE OPPOSITE THE PINION OPENING.
  - STANDARD ORIENTATION SHOWN (020) WILL BE SHIPPED UNLESS OTHERWISE SPECIFIED.
  - PLEASE READ THE INSTRUCTIONS BEFORE ATTEMPTING TO REORIENT.
  - STARTER WEIGHT = 38 LBS (17.2 Kg)



DUAL DIMENSIONS INCH (MM)

(Dwg. TPA1253-2)

# 150LF STARTER



(Dwg. TPA1262-1)



PART NUMBER FOR ORDERING 

PART NUMBER FOR ORDERING 


9

1	Motor Housing Cover Assembly for LF Models ..... for LFG Models .....	150BMP-A102A 150LFG-A102	19	Drive Gear for C ratio ..... for E ratio .....	150BMC-9 150BME-9
2	Housing Cover End Plug (3) .....	HSPPS3	◆ 19A	Drive Gear Thrust Washer .....	10BM-15
*	Nameplate .....	150BM-301	◆ 20	Drive Gear Key .....	10BM-610
*	Nameplate Screw (3) .....	R4K-302	21	Gear Case Cover Assembly .....	10BM-478
5	Motor Housing Cover Cap Screw (4) .....	107-25	◆ 22	Drive Shaft Grease Seal .....	150BMP-271
6	Cover Cap Screw Washer (4) .....	D02-504	23	Drive Housing Cap Screw Lock Washer (12) ...	10BM-67
◆ 7	Motor Housing Cover Gasket .....	150LF-283	24	Drive Housing Cap Screw (12) .....	10BM-744
◆ 8	Rear Rotor Bearing for LF Models ..... for LFG Models .....	R31I-24 150LFG-25	27	Drive Housing Assembly .....	9BM-300-H2
◆ 9	Rear Rotor Bearing Retainer .....	G57-729	◆ 30	Drive Housing Bearing .....	ML50K-318
10	Rear End Plate .....	150LF-12A	31	Starter Drive for Models LFE21LH11-020 and LFGE21LH11-020 .....	10BM-299-19
◆ 10A	End Plate Face (2) .....	150LF-11A		for Models LFE21RH6-20 and LFGE21RH6-020 .....	10BM-299-21
11	Cylinder .....	150LF-3		for Model LFGE22RH5-020 .....	10BM-299-22
12	Cylinder Dowel .....	10BM-98	32	Drive Shaft for Models LFE21LH11-020, LFE21RH6-20, LFGE21LH11-020 and LFGE21RH6-20 .....	10BM-8
◆ 13	Vane Packet (set of 5 Vanes) .....	150LF42-5		for Model LFGE22RH5-020 .....	10BM-108
14	Motor Housing .....	10BM-40	33	Drive Shaft Collar .....	10BM-30
15	Gear Case Assembly for LF Models ..... for LFG Models .....	10BM-37 150LFG-37	◆ 34	Drive Shaft Front Bearing for LF Models ..... for LFG Models .....	T02-33 150LFG-33
◆ 16	Bearing Ejecting Washer .....	10BM-25	◆ 35	Rotor Pinion Retainer .....	10BM-69
◆ 18	Drive Shaft Rear Bearing for LF Models ..... for LFG Models .....	10BM-399 150LFG-399			
18A	Plug .....	R2-227			

MAINTENANCE SECTION

\* Not illustrated.  
◆ Indicates Tune-up Kit part.

PART NUMBER FOR ORDERING 

PART NUMBER FOR ORDERING 

36	Rotor Pinion		*	Starter Control Valve .....	SMB-618
	for "C" Models .....	101BMPD-17	*	Relay Valve .....	SRV-125
	for "E" Models .....	150BME-17	*	Check Valve .....	150BMP-1056
◆ 37	Front Rotor Bearing		*	Check Relief Valve .....	150BMP-1054
	for LF Models .....	10BM-24	*	Tune-up Kit (for LF Models)	
	for LFG Models .....	150LFG-24		(includes illustrated parts 7, 8, 9, 10A [2],	
◆ 38	Gear Case Gasket .....	150LF-284		13, 16, 18, 19A, 20, 22, 30, 34, 35, 37, 38	
39	Front End Plate .....	150LF-11		and non-illustrated part no. SMB-431	
40	Rotor .....	150LF-53		Plastic Sealant) .....	150LF-TK1
*	Road Splash Deflector Assembly .....	150BM-A735	*	Tune-up Kit (for LFG Models)	
*	Muffler Assembly .....	150BM-A674		(includes illustrated parts 7, 8, 9, 10A [2],	
◆ *	Plastic Gasket .....	SMB-431		13, 16, 18, 19A, 20, 22, 30, 34, 35, 37, 38	
*	Pipe Sealant .....	SM-441		and non-illustrated part no. SMB-431	
*	Solenoid Valve (12V) .....	150BMP-1051B		Plastic Sealant) .....	150LFG-TK1
*	Solenoid Valve (24V) .....	150BMP-2451B			

\* Not illustrated.

◆ Indicates Tune-up Kit part.

## 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.

### NOTICE

Every three or four months, remove the No. 20 hose at the Relay Valve and pour 1/3 cup of diesel fuel into the hose. Reconnect the hose to the Relay Valve and crank the engine. This will thoroughly flush the motor and remove any air line contaminants that have built up in the motor.

## LUBRICATION

Each time a Series 150LF or 150LFG Starter is disassembled for maintenance or repair, lubricate the starter as follows:

1. Lubricate all open bearing and gear teeth with a liberal coat of Ingersoll-Rand No. 130 Grease.
2. Cover the bore of the Motor Housing Cover (1) with Ingersoll-Rand No. 130 Grease.
3. Apply a thin film of Ingersoll-Rand No. 130 Grease to the Drive Shaft (34) and the bore of the Drive Shaft Front Bearing (27), Drive Shaft Collar (35) and Drive Gear (19).
4. Wipe a thin film of Ingersoll-Rand No. 130 Grease on the Drive Gear Thrust Washer (25A).
5. Apply about 8 ounces of Ingersoll-Rand No. 130 Grease to the assembled Drive Gear (25) and a uniform coat to the Drive Shaft, working the grease between all gear teeth, splines and bearing surfaces.
6. Lubricate both halves of the Shaft Ring (37) with Ingersoll-Rand No. 130 Grease.
7. Wipe a thin film of Ingersoll-Rand No. 130 Grease in the bore of the Drive Housing (45).
8. Roll the Piston Return Spring (40) in Ingersoll-Rand No. 130 Grease.
9. Coat the outside of the Piston (36) with Ingersoll-Rand No. 130 Grease.

## 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.

\* Registered trademark of E.I. DU PONT DE NEMOURS & CO., Inc.

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 Series 150LF Starters. Never reuse old seals or gaskets.
5. Always mark adjacent parts on the Motor Housing Cover (1), Motor Housing (18), Gear Case (22) and Drive Housing (42) so these members can be located in the same relative position when the starter is reassembled.
6. Never wash the Starter Drive in a 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

1. Unscrew the Motor Housing Cover Cap Screws (5).
2. Pull the Motor Housing Cover (1) from the Motor Housing (14).
3. Slide the Motor Housing from the motor.
4. Grasp the rear end of the motor, and pull the entire assembly away from the Gear Case (15).
5. Position the motor assembly vertically, grasping the Rotor Pinion (20) in copper-covered vise jaws.
6. Remove the Rear Rotor Bearing Retainer (9).
7. The Rear Rotor Bearing (8) is press fit on the rotor shaft. Use a bearing puller to remove it.

### WARNING

**This Bearing has been lubricated with KRYTOX®\* flourinated grease. Provide adequate ventilation where temperatures exceed 400°F. Do not permit grease to contaminate tobacco products.**

8. Lift off the Rear End Plate (10), End Plate Face (10A), and Cylinder (11), and remove the Vanes (13) from the slots in the Rotor.
9. Reposition the Rotor vertically, pinion end up, and grasp the short hub in copper-covered vise jaws.
10. Remove the Rotor Pinion Retainer (35) and lift off the Rotor Pinion (36).
11. Support the Front End Plate (39) as close to the Rotor as possible, and press the Rotor from the Front Rotor Bearing (37). Do not let the Rotor fall when it is pressed free.

### WARNING

**This Bearing has been lubricated with KRYTOX® flourinated grease. Provide adequate ventilation where temperatures exceed 400°F. Do not permit grease to contaminate tobacco products.**

## MAINTENANCE SECTION

### Disassembly of the Gear Case

1. Set the gear case and drive housing unit upright on the workbench with the Drive Housing (27) upward.
2. Remove the Drive Housing Cap Screws (24) and lift off the Drive Housing, Drive Gear and Starter Drive.
3. Thread a 5/16"-18 thread cap screw into the tapped hole in the Beading Ejecting Washer (16) and continue to turn it until the Drive Shaft Rear Bearing (18) is jacked from the Gear Case (15).

#### WARNING

This Bearing has been lubricated with KRYTOX flourinated grease. Provide adequate ventilation where temperatures exceed 400°F. Do not permit grease to contaminate tobacco products.

### Disassembly of the Drive Housing

1. With the drive housing unit lying on the workbench, grasp the Drive Gear (19) and pull the assembled Drive Shaft (32) from the Starter Drive (31).
2. If the Drive Gear must be removed from the Drive Shaft, support the Drive Gear on the table of an arbor press, and press the Drive Shaft from the Drive Gear. Remove the Drive Gear Key (20).
3. Stand the drive shaft assembly, bearing end up, in a sleeve that contacts the Drive Shaft Collar (33), and press the Drive Shaft from the bore of the Drive Shaft Front Bearing (34).

#### WARNING

This Bearing has been lubricated with KRYTOX flourinated grease. Provide adequate ventilation where temperatures exceed 400°F. Do not permit grease to contaminate tobacco products.

4. Position the Drive Housing (27) vertically, grasping the Gear Case Cover (21) in copper-covered vise jaws. Tap the underside of the drive housing mounting flange with a soft hammer to dislodge the Drive Housing from the Gear Case Cover. Lift off the Drive Housing. The Starter Drive will probably remain with the Drive Housing; make certain that it does not fall on the floor.
5. Do not remove the Drive Shaft Grease Seal (22) from the Gear Case Cover unless it is absolutely necessary and you have a new Seal on hand. If the Seal must be removed, press it from the Gear Case Cover.
6. Do not remove the Drive Housing Bearing (30) from the Drive Housing unless you have a new Bushing on hand. If the Bearing must be removed, press it from the Drive Housing.

### Cleaning the 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. **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 a suitable cleaning solution in a well ventilated area.

### Inspection of Parts

1. Discard all O-rings and gaskets. These should not be reused.
2. Check all grease seals. If these appear worn or distorted, remove them from their parent member and discard. **Discard any grease 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.
5. Check the Vanes for separation, chipping, wear, checks, etc. 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.

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## ASSEMBLY

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### 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 oil before installation.
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 bearings 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.

## MAINTENANCE SECTION

### 7. For LF Models:

Lubricate all open bearing and gear teeth with a liberal coat of Ingersoll-Rand No. 130 Grease. Work about 3 cc into the teeth of the Drive Gear.

### For LFG Models:

Lubricate Starter Drive Housing Bearing (30) and gear teeth with a liberal coat of Ingersoll-Rand No. 130 Grease. Work about 3 cc into the teeth of the Drive Gear.

### NOTICE

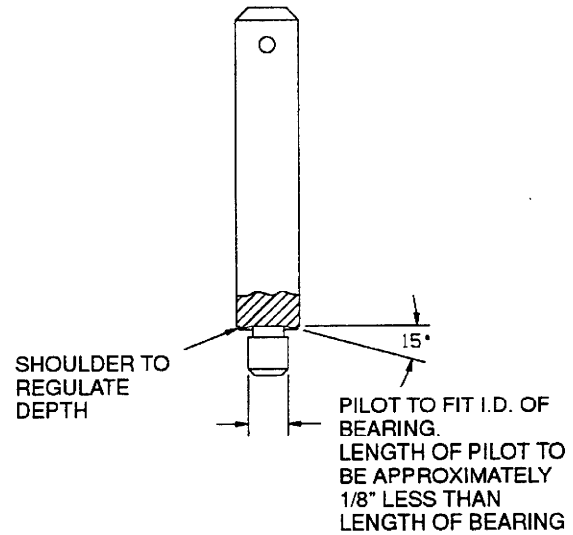
The Rear Rotor Bearing (8), Drive Shaft Rear Bearing (18), Drive Shaft Front Bearing (34) and Front Rotor Bearing (37) are lubricated with **KRYTOX flourinated grease and should be replaced if worn or damaged. Do not re-lubricate these bearings.**

### WARNING

When using parts lubricated with **KRYTOX flourinated grease, provide adequate ventilation where temperatures exceed 400°F. Do not permit grease to contaminate tobacco products. Wash hands before smoking.**

- Lubricate the Gear Case and Gear Case components with Ingersoll-Rand No. 130 Grease.
- When assembling the motor, always use new O-rings.
- Before installing O-rings, coat liberally with O-ring lubricant. After the O-ring is installed, coat the O-ring again with O-ring lubricant and apply O-ring lubricant to O-ring grooves.
- The Cylinder Dowel (11) maintains the alignment of the Motor Housing Cover (1), Front End Plate (39), Cylinder (11) and Rear End Plate (10). The end of the Dowel fits into a shallow hole in the face of the Motor Housing Cover. It is important that the end of the Dowel is in the hole and remains there during assembly.
- 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 Motor

- Position the Rotor (40) vertically, splined end down.
- Place an End Plate Face (10A) followed by the Rear End Plate (10), crescent grooved side first, onto the hub of the Rotor.

### NOTICE

**Make sure that all notches and ports are in alignment. Refer to illustration on page 8.**

- Install the Rear Rotor Bearing (8) onto the hub of the Rotor until it contacts the Rear End Plate. Make certain the End Plate does not bind against the Rotor.

### For LFG Models:

### WARNING

**This Bearing has been lubricated with KRYTOX flourinated grease. Provide adequate ventilation where temperatures exceed 400°F. Do not permit grease to contaminate tobacco products.**

- Install the Rear Rotor Bearing Retainer (9) in the groove on the hub of the Rotor.
- Grasp the Motor Housing Cover (1), motor bore face upward, in copper-covered vise jaws. Swivel the vise so that the air inlet is facing you. Cover the bore of the bearing recess with a thin film of Ingersoll-Rand No. 130 Grease.

## MAINTENANCE SECTION

6. Check the nameplate on the Starter to determine whether you have an “LH” model or “RH” model.

**For “LH” models:** While facing the air inlet on the Motor Housing Cover, insert the Cylinder Dowel (12) in the dowel hole on the right of the inlet.

**For “RH” models:** While facing the air inlet on the Motor Housing Cover, Insert the Cylinder Dowel (12) in the dowel hole on the left of the inlet.

### NOTICE

**Make certain the Cylinder Dowel is installed in the proper dowel hole. If you put it in the wrong dowel hole, the motor will rotate in the wrong direction.**

7. Place the Motor Housing Gasket (7) in the bore of the Motor Housing

### NOTICE

**Make sure that the Motor Housing Gasket is installed with the Cylinder Dowel hole positioned upward and properly oriented relative to the Cylinder Dowel. The Cylinder Dowel hole in the Gasket is the hole which is centered between the two angled ports in the Gasket.**

8. Place the assembled End Plate and Rotor into the Motor Housing Cover that the Cylinder Dowel passes through the dowel hole in the End Plate, and so that the air port in the End Plate aligns with the port in the Gasket and Motor Housing Cover.
9. Place the Cylinder (11) down over the Rotor so that the Cylinder Dowel passes through the dowel hole in the Cylinder, and so that the air port in the Cylinder is aligned with the air port in the Rear End Rate, Gasket and Motor Housing Cover.
10. Place the Motor Housing (14) down over the Cylinder making certain that the prick punch marks on the Motor Housing Cover and Motor Housing are aligned.
11. Liberally coat each Vane (13) with Ingersoll–Rand No. 50 Oil and insert a Vane into each slot in the Rotor. Make certain the straight edge of each Vane faces the Cylinder.
12. Set the End Plate Face followed by the Front End Plate (39), crescent grooved side first, onto the Cylinder so that the Cylinder Dowel passes through the dowel hole in the End Plate and End Plate Face. Make sure that all notches and ports are in alignment.
13. Install the Front Rotor Bearing (37) onto the splined shaft of the Rotor until it seats against the Front End Plate. Do not bind the End Plate against the Rotor.

**For LFG Models:**

### ⚠ WARNING

**This Bearing has been lubricated with KRYTOX flourinated grease. Provide adequate ventilation where temperatures exceed 400°F. Do not permit grease to contaminate tobacco products.**

14. Slide the Rotor Pinion (36) onto the rotor shaft.
15. Install the Rotor Pinion Retainer (35) in the groove on the rotor shaft so that the concave side of the Retainer faces the Rotor Pinion.
16. Apply a light coat of Ingersoll–Rand No. 130 Grease to the Gear Case Gasket (38) and place the Gasket in the motor bore of the Gear Case.
17. Set the Gear Case on the assembled motor, making certain the prick punch marks on the Gear Case are aligned with those on the Motor Housing.
18. Turn the entire assembly over so that the Motor Housing Cover is upward. Make sure that the Cylinder Dowel remains seated in the shallow hole in the face of the Motor Housing Cover.
19. Install the Motor Housing Cover Cap Screws (5) and lock Washers (6). Tighten the Cap Screws alternately to 25 ft–lb (34 Nm) of torque.

### Assembly of the Drive Gear

1. If the Drive Shaft Grease Seal (22) was removed from the Gear Case Cover (21), press in a new Seal so that the inner lips of the Seal face the bearing recess for the Drive Shaft Front Bearing (34).
2. Apply a thin film of Ingersoll–Rand No. 130 Grease to the Drive Shaft (32) and the bore of the Drive Shaft Front Bearing, Drive Shaft Collar (34), and Drive Gear (19).

**For LFG Models:**

### ⚠ WARNING

**This Bearing has been lubricated with KRYTOX flourinated grease. Provide adequate ventilation where temperatures exceed 400°F. Do not permit grease to contaminate tobacco products.**

3. Press the Drive Shaft Collar, beveled end first, onto the keyway end of the Drive Shaft until it seats against the shoulder of the shaft.
4. Press the Drive Shaft Front Bearing onto the keyway end of the Drive Shaft until it seats against the Drive Shaft Collar.

**For LF Models:**

Pack the Bearing with Ingersoll–Rand No. 130 Grease.

## MAINTENANCE SECTION

For LFG Models:

### WARNING

**This Bearing has been lubricated with KRYTOX flourinated grease. Provide adequate ventilation where temperatures exceed 400°F. Do not permit grease to contaminate tobacco products.**

5. Install the Drive Gear Key (20) in the keyway on the Drive Shaft.
6. Press the Drive Gear (19), long hub first, on the Drive Shaft until it contacts the Drive Shaft Front Bearing.

### Assembly of the Gear Case

1. Set the assembled motor and Gear Case (15) on end with the Gear Case upward.
2. Place the Bearing Ejecting Washer (16) in the bearing recess.
3. Using a needle bearing inserting tool, press the Drive Shaft Rear Bearing (18), unstamped end first, into the bearing recess until the trailing face of the Bearing is flush with the face of the bearing recess. Refer to illustration on Page 13.

**For LF Models:**

Work some Ingersoll–Rand No. 130 Grease between the–rollers of the Bearing.

**For LFG Models:**

### WARNING

**This Bearing has been lubricated with KRYTOX flourinated grease. Provide adequate ventilation where temperatures exceed 400°F. Do not permit grease to contaminate tobacco products.**

4. Wipe a thin film of Ingersoll–Rand No. 130 Grease on the Drive Gear Thrust Washer (19A), and place the Washer on the lip of the bearing recess in the Gear Case.
5. Apply about 8 ounces of Ingersoll–Rand No. 130 Grease to the assembled Drive Gear (19) and a uniform coat of the recommended grease to the Drive Shaft (32), making certain to work the grease between all the gear teeth, splines bearing surfaces.
6. Insert the assembled Drive Gear and Shaft, short hub end first, into the Gear Case so that the short hub enters the Drive Rear Bearing.
7. Slide the assembled Gear Case Cover, bearing recess first, down over the Drive Shaft until it seats against the Gear Case.

### NOTICE

**Check the inner tip of the Drive Shaft Grease Seal to make certain that it did not fold outward toward the end of the Drive Shaft. If it did, fold outward, you must reinstall the Gear Case Cover, using a fine pointed instrument to roll the lip of the seal in the proper direction.**

### Assembly of the Drive Housing

1. If the Drive Housing Bearing (30) was removed, stand the Drive Housing (27) 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 (31) 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 (30).
3. Place the Starter Drive on the Drive Shaft.
4. Place the Drive Housing over the Drive onto the Gear Case Cover (21). Rotate the Drive Housing into the required orientation as indicated by the punch marks. At the same time, align the Cap Screw holes in the Gear Case, Cover and Housing.
5. Install the Drive Housing Cap Screws (23) and lock Washers (24), and tighten the Cap Screws to 100 in–lb (11 Nm) of torque.

### TESTING THE STARTER

1. Turn the pinion by hand in the direction of Starter rotation. The pinion should advance smoothly and easily to the stop.
2. Turn the pinion opposite the direction of Starter rotation. The gearing and motor should rotate freely with no binding.
3. Attach an air hose to the inlet and operate the motor slowly to see that it functions properly and that the drive pinion rotates in the proper direction. If the direction of rotation is incorrect, the motor was improperly assembled.
4. The chamfers on the pinion teeth should be on the following side of the teeth.

## MAINTENANCE SECTION

### 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 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	Worn Motor Parts	<p>Remove the Motor from the Motor Housing (1) and disassemble the Motor. Examine all parts and replace any that are worn or damaged. Use the following guidelines for determining unserviceable parts:</p> <ol style="list-style-type: none"> <li>1. <b>Vanes (13).</b> Install a set of new Vanes if any Vane is cracked, checked or worn to the extent that it width is 11/16" (17 mm) at either end.</li> <li>2. <b>Rotor Bearings (8) or (37).</b> Replace if any roughness or looseness is apparent.</li> </ol> <p><b>For LFG Models:</b></p> <div style="text-align: center; border: 1px solid black; padding: 2px; width: fit-content; margin: 10px auto;">  <b>WARNING</b> </div> <p><b>This Bearing has been lubricated with KRYTOX where temperatures exceed 400°F. Do not permit grease to contaminate tobacco products. Wash hands before smoking.</b></p> <ol style="list-style-type: none"> <li>3. <b>Rotor (40).</b> Replace if body has deep scoring that cannot be removed by polishing with emery cloth.</li> <li>4. <b>Cylinder (11).</b> Replace if there are any cracks or deep scoring.</li> <li>5. <b>End Plates (10) or (39).</b> Clean up scoring by rubbing it with emery cloth placed on a flat surface. Remove and inspect the Control Valve. Thoroughly clean the Control Valve or install a new Control Valve if necessary.</li> </ol>



## MAINTENANCE SECTION

### TROUBLESHOOTING GUIDE

Trouble	Probable Cause	Solution
Loss of Power ( <i>Continued</i> )	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 for proper pressure.
	Dirt buildup inside Motor	Disconnect air line to Motor. Flush Motor by pouring 10 cc of a suitable cleaning solution into the air inlet of the Motor. Re-connect the air line. Operate the start button. If engine starts, shut off engine. Start and stop engine several times to insure complete removal of dirt buildup.
Starter drive does not engage ring gear or engages and disengages ring gear very slowly	Clogged or faulty Control Valve	Remove and inspect the Control Valve or install a new Control Valve if necessary.

#### NOTICE

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

#### SALES HEADQUARTERS

#### Ingersoll-Rand Company

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201-647-6000

## **NOTES**

## **NOTES**

