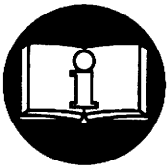
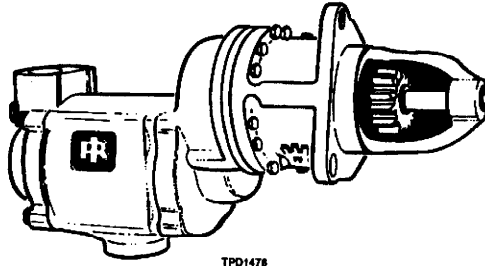


# INSTALLATION AND MAINTENANCE MANUAL for SERIES 150LFPC AND 150LFPE LUBE-FREE STARTERS



## ⚠ 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.**

- For safety, top performance, and maximum durability of parts, do not operate Series 150LFPC and 150LFPE 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 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 150LFPC and 150LFPE Starters on compressed air only. They are not designed or sealed for operation on compressed gas.
- 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.
- Operate this starter only when properly installed on the engine.
- For personal protection, do not remove any labels. Replace any damaged label.
- 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.

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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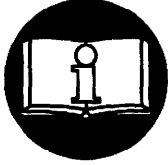

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**INGERSOLL-RAND®**  
**ENGINE STARTING SYSTEMS**



## WARNING LABEL IDENTIFICATION



### WARNING

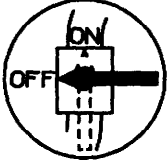

FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.

	<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 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.</p>

# PLACING STARTER IN SERVICE

## INSTALLATION

### NOTICE

**For maximum performance, read this manual prior to the installation or operation of Series 150LF 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.

8. The Drive Housing (42) on the 150LFP Starter has two sets of tapped holes for piston control hoses. These are located 120° apart so that the hoses can always be attached at or near the top of the Drive Housing. The tapped holes not in use are plugged with pipe plugs.

## 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.

#### 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.

\* Registered trademark of Loctite Corporation.

\*\* Registered trademark of Permabond Corporation.

## PLACING STARTER IN SERVICE

### 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 delay 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).

### NOTICE

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. Install a 1/4" hose line from the "DEL" side of the Starter Control Valve to the "IN" port on the Starter Drive Housing.

### NOTICE

**There will be two sets of control ports in the Drive Housing. Use the set of control ports that is above the center of the starter.**

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. 150BM-A674 Muffler or No. 150BM-A735 Road Splash Deflector in the exhaust port on the Motor Housing of the starter.
17. 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.

### 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 6 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.

### 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.**

## PLACING STARTER IN SERVICE

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

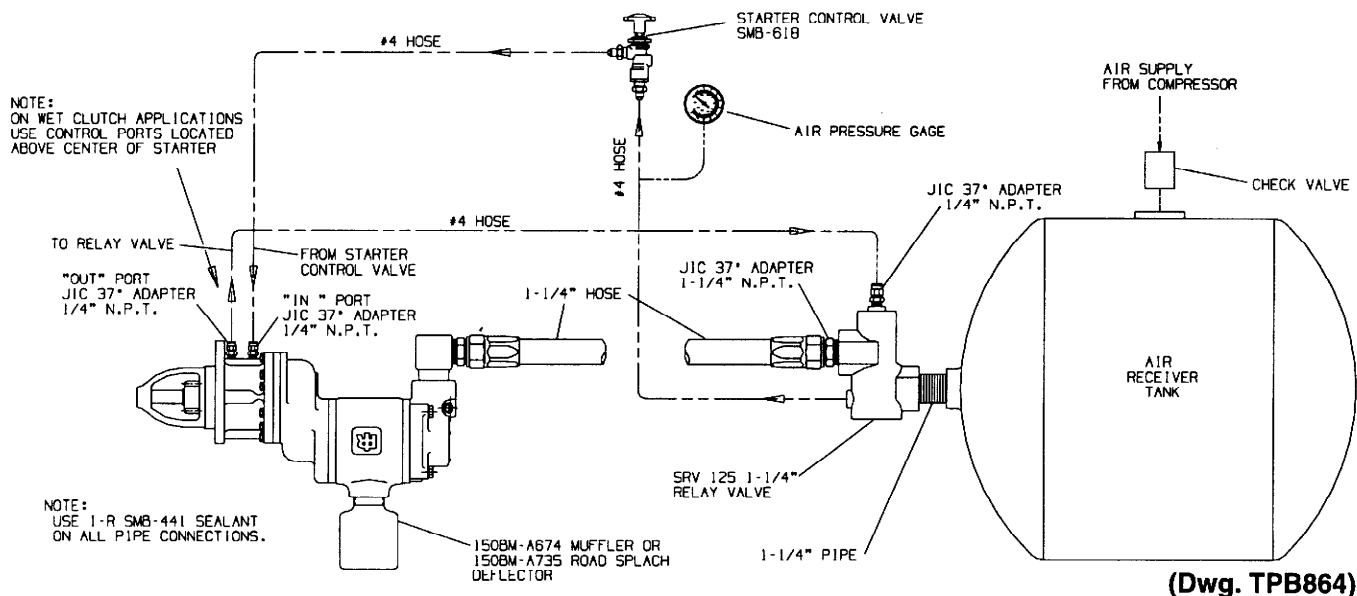
**Do not separate the Motor Housing from the Drive Housing or from the Gear Case. Reinstall the Motor Housing Cover Cap Screws and alternately tighten them to 25 ft-lb (34 Nm) of torque.**

### 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 150LFP Starter.

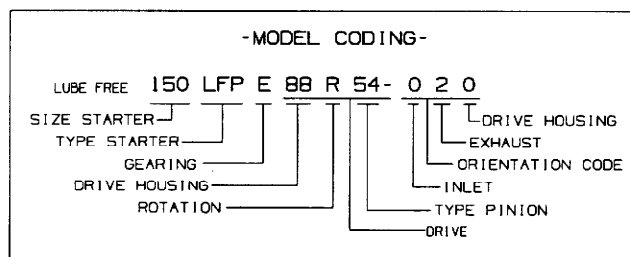
1. Disconnect the 1/4" hose at the "OUT" port on the Drive Housing and plug the hole in the Drive Housing with a 1/4" pipe plug.
2. Remove the 3/8" pipe plug from the center of the Motor Housing Cover.
3. Engage the Drive Pinion with the flywheel by applying pressure to the "IN" port on the Drive Housing.
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.

## TYPICAL VEHICULAR INSTALLATION



*Series 150LFPC and 150LFPE Lube-Free Starters are designed for use in Class 7 and Class 8 Vehicles.*

## HOW TO ORDER A STARTER

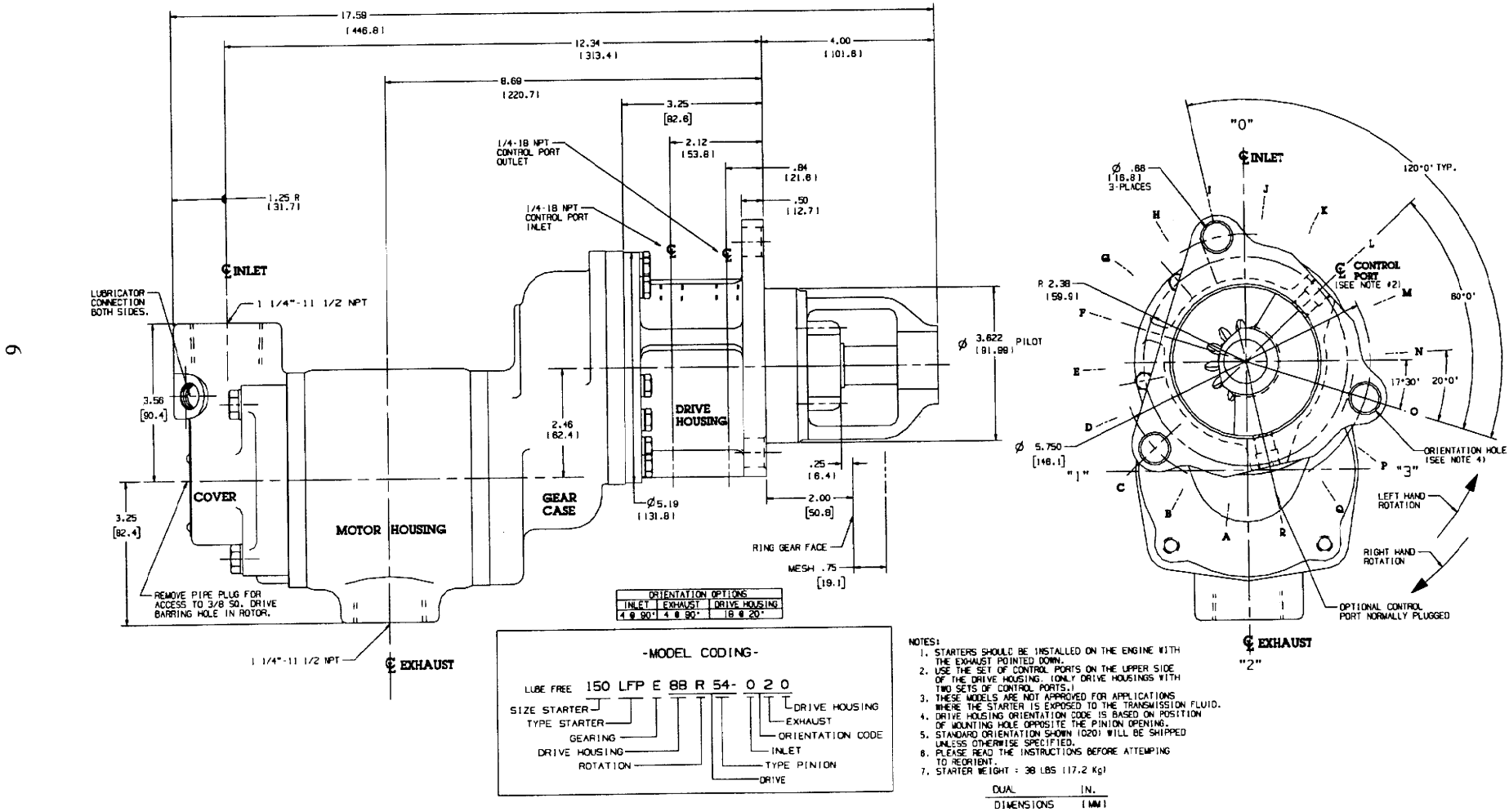


(Dwg. TPD1472)

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

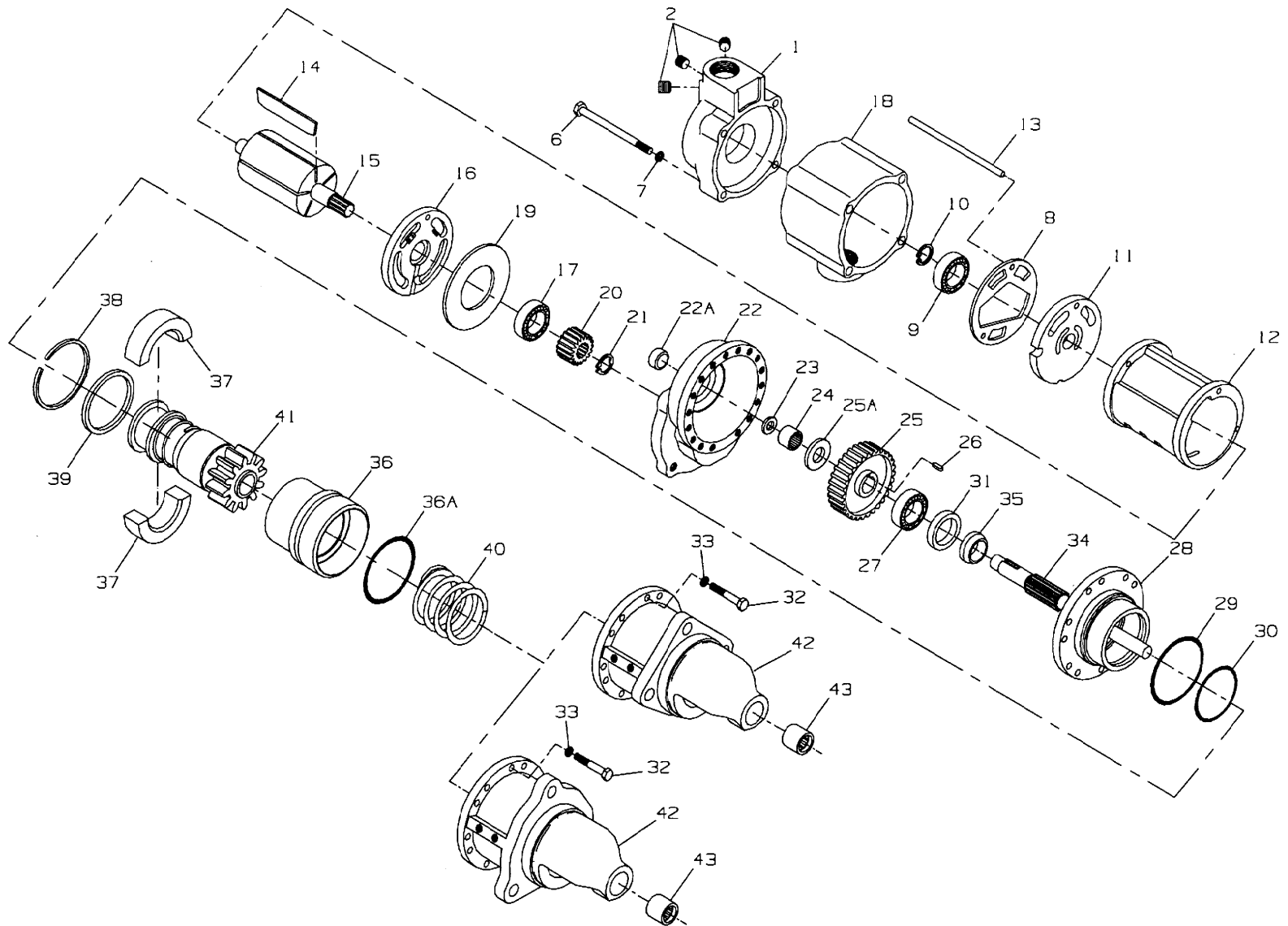
# 150LFP MOUNTING DIMENSIONS

MAINTENANCE SECTION



(Dwg. TPA1255-2)

# MODEL 150LFP STARTER WITH TYPE 81 AND 88 DRIVE HOUSING



MAINTENANCE SECTION

(Dwg. TPA1355)

PART NUMBER FOR ORDERING

PART NUMBER FOR ORDERING

1	Motor Housing Cover Assembly (1-1/4" inlet)	150BMP-A102A	25	Drive Gear	
2	Housing Cover End Plug (3)	HSPPS-3		for "C" Models (43 teeth)	10BMC-9
*	Nameplate	150BM-301		for "E" Models (45 teeth)	150BME-9
*	Nameplate Screw (3)	R4K-302	◆ 25A	Drive Gear Thrust Washer	10BM-15
6	Motor Housing Cover Cap Screw (4)	107-25	◆ 26	Drive Gear Key	10BM-610
7	Cover Cap Screw Lock Washer (4)	D02-504	◆ 27	Drive Shaft Front Bearing	T02-33
◆ 8	Motor Housing Cover Gasket	150LF-283	28	Gear Case Cover Assembly	150BMP-378
◆ 9	Rear Rotor Bearing	R3H-24	◆ 29	Gear Case Cover Seal	150BMP-607
◆ 10	Rear Rotor Bearing Retainer	G57-729	◆ 30	Piston Seal	150BMP-604
11	End Plate	150LF-12A	◆ 31	Drive Shaft Grease Seal	150BMP-271
12	Cylinder	150LF-3	32	Drive Housing Cap Screw (9)	10BM-744
13	Cylinder Dowel	10BM-98	33	Drive Housing Cap Screw Lock Washer (12)	10BM-67
◆ 14	Vane Packet (set of 5 Vanes)	150LF-42-5	34	Drive Shaft	150BMP-8-2
15	Rotor	150LF-53	35	Drive Shaft Collar	10BM-30
16	End Plate	150LF-11A	36	Piston Assembly	04331393
◆ 17	Front Rotor Bearing	10BM-24	◆ 36A	Piston O-ring	150BMP-337
18	Motor Housing	10BM-40	37	Shift Ring (consists of two halves)	101BMP-705-1
◆ 19	Gear Case Gasket	150LF-284	38	Shift Ring Retainer	10BMP-606
20	Rotor Pinion		39	Shift Ring Spacer	10BMP-602
	for "C" Models (16 teeth)	101BMPD-17	40	Piston Return Spring	101BMP-701-1
	for "E" Models (13 teeth)	150BME-17	41	Starter Drive	
◆ 21	Rotor Pinion Retainer	10BM-69		for R54 type models	101BMP-299-1
22	Gear Case Assembly	10BM-37		for L54 type models	101BMP-299-2
22A	Plug	R2-227		for R53 type models	101BMP-299-3
◆ 23	Bearing Ejecting Washer	10BM-25		for R51 type models	150BMP-299-4
◆ 24	Drive Shaft Rear Bearing	10BM-399			

\* Not illustrated.

◆ Indicates Tune-up Kit part.

MAINTENANCE SECTION



PART NUMBER FOR ORDERING



PART NUMBER FOR ORDERING



42	Drive Housing for 88 type models .....	150BMP-A300-88	*	Check Valve .....	150BMP-1056
	for 81 type models .....	150BMP-A300-81	*	Check Relief Valve .....	150BMP-1054
◆ 43	Drive Housing Bearing .....	ML50K-318	◆ *	Plastic Gasket .....	SMB-431
*	Pipe Sealant .....	SMB-441	*	Road Splash Deflector Assembly .....	150BM-A735
*	Solenoid Valve (12V) .....	150BMP-1051B	*	Muffler Assembly .....	150BM-A674
*	Solenoid Valve (24V) .....	150BMP-2451B	*	Tune-up Kit (includes illustrated parts 8, 9, 10, 14, 17, 19, 21, 23, 24, 25A, 26, 27, 29, 30, 31, 36A, 43 and SMB-431 Plastic Gasket) .....	150LF-TK1
*	Starter Control Valve .....	SMB-618			
*	Relay Valve .....	SRV-125			

\* 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 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 #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 airline contaminants that have built up in the motor.

## LUBRICATION

Each time a Series 150LFPC or 150LFPE 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.

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

### NOTICE

Before disassembling the motor, check the nameplate on the starter to determine whether you have a "LH" model or "RH" model.

For "LH" models, End Plate (16) is used as the Rear End Plate.

For "RH" models, End Plate (11) is used as the Rear End Plate.

1. Unscrew the Motor Housing Cover Cap Screws (6).
2. Pull the Motor Housing Cover (1) from the Motor Housing (18).
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 (22).
5. Position the motor assembly vertically, grasping the Rotor Pinion (20) in leather-covered or copper-covered vise jaws.
6. Remove the Rear Rotor Bearing Retainer (10) and the Rear Rotor Bearing (9).
7. Lift off End Plate (11) or (16), and Cylinder (12) and remove the Vanes (14) from the slots in the Rotor.
8. Position the Rotor vertically, pinion end up, and grasp the short hub in leather-covered or copper-covered vise jaws.
9. Remove the Rotor Pinion Retainer (21) and lift off the Rotor Pinion.
10. Support the End Plate as close to the Rotor as possible and remove the Rotor from the Front Rotor Bearing (17). Do not let the Rotor fall when it is removed.

### Disassembly of the Gear Case

1. Set the Gear Case and Drive Housing Unit upright on the workbench with the Drive Housing (42) upward.
2. Remove the Drive Housing Cap Screws (32) 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 Bearing Ejecting Washer (23) and continue to turn it until in Drive Shaft Rear Bearing (24) is jacked from the Gear Case (22).

## MAINTENANCE SECTION

### Disassembly of the Drive Housing

1. With the Drive Housing Unit lying on the workbench, grasp the Drive Gear (25) and pull the assembled Drive Shaft (34) from the Starter Drive (41).
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 (26).
3. Stand the Drive Shaft Assembly, bearing end up, in a sleeve that contacts the Drive Shaft Collar (35) and press the Drive Shaft from the bore of the Drive Shaft Front Bearing (27).
4. Position the Drive Housing vertically, grasping the Gear Case Cover (28) in leather-covered or 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 Piston Assembly (36) and Starter Drive will probably remain with the Drive Housing; make certain they do not fall on the floor.

#### NOTICE

**Do not remove the Drive Shaft Grease Seal (29) from the Gear Case Cover unless it is absolutely necessary and you have a new Seal on hand. The Seal is always destroyed in the removal process. If the Seal must be removed, press it from the Gear Case Cover.**

5. Withdraw the Piston (36) and Starter Drive (41) from the Drive Housing and withdraw the Piston Return Spring (40).
6. Remove the Shift Ring Retainer (38) and Shift Ring Spacer (39) from the small bore of the Piston.
7. Slide the Piston forward toward the drive pinion until the two halves of the Shift Ring (37) are free. Slide the Piston from the Starter Drive.

#### NOTICE

**Do not remove the Drive Housing Bearing (43) from the Drive Housing unless you have a new Bearing on hand. The Bearing is always destroyed in the removal process.**

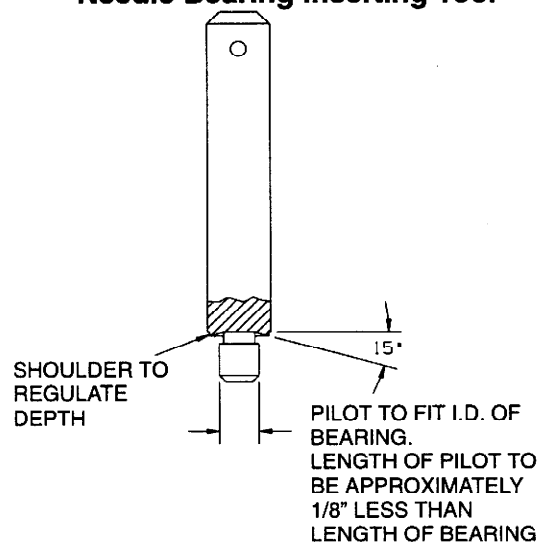
8. If the Bearing must be removed, press it from the Drive Housing.

## 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. Except for bearings, 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.
7. The Cylinder Dowel (13) maintains the alignment of the Motor Housing Cover (1), End Plate (16) or (11), Cylinder (12) and End Plate. 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.
8. 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)

## MAINTENANCE SECTION

### Assembly of the Motor

#### NOTICE

Before assembling the motor, check the nameplate on the starter to determine whether you have a “LH” model or “RH” model.

For “LH” models, End Plate (16) is used as the Rear End Plate.

For “RH” models, End Plate (11) is used as the Rear End Plate.

1. Position the Rotor (15) vertically, splined end down.
2. Place End Plate (11) or (16), 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 7.

3. Install the Rear Rotor Bearing (9) onto the hub of the Rotor until it contacts the Rear End Plate. Make certain the End Plate does not bind against the Rotor.
4. Install the Rear Rotor Bearing Retainer (10) in the groove on the hub of the Rotor.
5. Grasp the Motor Housing Cover (1), motor bore face upward, in leather-covered or 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.

#### NOTICE

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

**For “LH” models:** While facing the air inlet on the Motor Housing Cover, insert the Cylinder Dowel (13) in the dowel hole on the **right** of the inlet with the extended kidney port on the End Plate on the **left** of the inlet.

**For “RH” models:** While facing the air inlet on the Motor Housing Cover, insert the Cylinder Dowel (13) in the dowel hole on the **left** of the inlet with the extended kidney port on the End Plate on the **right** of the inlet.

#### NOTICE

Make sure that the Motor Housing Gasket (8) is installed with the Cylinder Dowel hole positioned and properly oriented relative to the Cylinder Dowel. The Cylinder Dowel Gasket is the hole between the two angled ports in the Gasket. Refer to illustration on page 7.

6. Place the Motor Housing Gasket in the bore of the Motor Housing Cover.

7. Place the assembled End Plate and Rotor into the Motor Housing Cover so 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.
8. Place the Cylinder (12) 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 End Plate, Gasket and Motor Housing Cover.
9. Place the Motor Housing (18) down over the Cylinder making certain the prick punch marks on the Motor Housing Cover and Motor Housing are aligned.
10. Set the End Plate, crescent-grooved side first, onto the Cylinder so that the Cylinder Dowel passes through the dowel hole in the End Plate. Make sure that all notches and ports are in alignment.
11. Install the Front Rotor Bearing (17) onto the splined shaft of the Rotor until it seats against the End Plate. Do not bind the End Plate against the Rotor.
12. Slide the Rotor Pinion (20) onto the rotor shaft.
13. Install the Rotor Pinion Retainer (21) in the groove on the rotor that the concave side of the Retainer faces the Rotor Pinion.
14. Apply a light coat of grease to the Gear Case Gasket (19) and place the Gasket in the motor bore of the Gear Case (22).
15. 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 up. 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 (6) and Lock Washers (7). Tighten the Cap Screws alternately to 25 ft-lb (34 Nm) torque.

### Assembly of the Drive Gear

1. If the Drive Shaft Grease Seal (29) was removed from the Gear Case Cover (28), press in a new Seal so that the inner lips of the Seal face the bearing recess for the Drive Shaft Front Bearing (27).
2. Apply a thin film of Ingersoll-Rand No. 130 Grease to the Drive Shaft (34) and the bore of the Drive Shaft Front Bearing and Drive Shaft Collar (35) and Drive Gear (25).
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 on to the keyway end of the Drive Shaft until it seats against the Drive Shaft Collar. Pack the Bearing with Ingersoll-Rand No. 130 Grease.
5. Install the Drive Gear Key (26) in the keyway on the Drive Shaft.
6. Press the Drive Gear (25), long hub first, on the Drive Shaft until it contacts the Drive Shaft Front Bearing.

## MAINTENANCE SECTION

### Assembly of the Gear Case

1. Set the assembled motor and Gear Case (22) on end with the Gear Case upward.
2. Place the Bearing Ejecting Washer (23) in the bearing recess.
3. Using a needle bearing inserting tool, press the Drive Shaft Rear Bearing (24), 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 11.
4. Wipe a thin film of Ingersoll–Rand No. 130 Grease on the Drive Gear Thrust Washer (25A) 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 (25) and a uniform coat of Ingersoll–Rand No. 130 Grease to the Drive Shaft (34), working the grease between all the gear teeth, splines and 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 Shaft Rear Bearing.
7. Liberally coat the Gear Case Cover Seal (30) and Piston Seal (29) with O–ring lubricant and install them in their respective grooves on the Gear Case Cover (28).
8. 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 lip 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 Piston

1. Stand the Starter Drive, pinion end down, on the workbench. Place the Piston (36), large diameter first, down over the Starter Drive.
2. Lubricate the two halves of the Shaft Ring (37) with Ingersoll–Rand No. 130 Grease. Place the two halves of the shift ring in the channel at the upper end of the Starter Drive and lift the Piston so that the Shift Ring enters the piston bore and seats against the shoulder inside the Piston.
3. Slip the Shift Ring Spacer (39) against the Shift Ring and install the Shift Ring Retainer (38) in the groove in the piston bore. Install the Piston O–ring (36A) in the groove on the Piston.

### Assembly of the Drive Housing

1. If the Drive Housing Bearing (43) was removed, stand the Drive Housing (42) upright. 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 into the Bearing.
2. Wipe a thin film of Ingersoll–Rand No. 130 Grease on the bore of the Drive Housing.
3. Stand the Drive Housing on its small end.
4. Roll the Piston Return Spring (40) in Ingersoll–Rand No. 130 Grease. Set the Piston Return Spring in the Drive Housing so that it seats in the counterbore at the bottom of the Housing.
5. Coat the outside of the Piston with Ingersoll–Rand No. 130 Grease and insert the assembled Piston and Starter Drive, pinion end first, into the Drive Housing.
6. Apply a thin film of Ingersoll–Rand No. 130 Grease to the surface of the Drive Shaft (34).
7. Carefully take the assembled Drive Housing and install it on the assembled motor and Gear Case so that the Drive Shaft passes through the Starter Drive and enters the bore of the Drive Housing Bearing.
8. Orient the Drive Housing so that the prick punch mark made prior to disassembly is aligned with the prick punch mark on the Gear Case and Cover (28).
9. Install the Drive Housing Cap Screws (32) and Lock Washers (33) 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 clutch should ratchet smoothly with a slight clicking action.
2. Turn the pinion **opposite the direction of starter rotation**. The gearing and motor should rotate freely with no binding.
3. Connect an air hose to the small pipe tapped hole nearest the Gear Case. When a little air is admitted, the drive pinion should advance to the engaged position and air should escape from the hole nearest the mounting flange.
4. 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. The bevels on the pinion teeth should be on the trailing edge of the direction of rotation. If the direction of rotation is incorrect, the motor is improperly assembled. See Assembly of the Motor.

## 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	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.
	Foreign material in Starter Drive	Remove obstruction.
	Damaged or worn Drive parts	Check Drive components and replace if necessary.
	Clogged control hoses	Remove the control hoses attached to the Drive Housing and clean them by blowing compressed air through them.  <div style="text-align: center;"><b>⚠ WARNING</b></div> <p><b>Firmly secure the hose end before turning on the air. Make certain no one is in line with the discharge end of the control hose.</b></p>
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.**

## **NOTES**

