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Air Starters

SERIES 150BMPC and 150BMPE

Installation and Maintenance Information



Save These Instructions

IR *Ingersoll Rand*

Product Safety Information

Intended Use:

These air starters are intended for use in starting reciprocating internal combustion engines. These starters are designed to be operated from a remote location after proper installation on the engine requiring starting.

For additional information refer to Air Starters for Internal Combustion Engines Product Safety Information Manual Form 45558624.

Manuals can be downloaded from ingersollrandproducts.com

Model Series 150BMPC And 150BMPE Air Starters Guidelines

WARNING

Failure to observe the following warnings could result in injury:

- Always release the start button immediately after the engine starts.
- Operate these starters on compressed air only. They are not designed or sealed for operating on compressed gas.

NOTICE

The use of other than genuine Ingersoll-Rand replacement parts may result in decreased Starter performance and increased maintenance, and may invalidate all warranties.

For top performance and maximum durability of parts, do not operate these starters at air pressures over the pressure rating stamped on the nameplate or less than 70psig (4.8 bar/483 pa). Use adequate size supply lines as directed in the installation section of this manual.

Lubrication

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.

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. HDL 2 Lubricator installed as shown in Dwg. TPB_688 and Dwg. TPB_389. Use either diesel or 10W non-detergent motor oil for lubricant.

CAUTION

When a HDL3 Lubricator is used, make certain that the oil supply line pressure is not greater than 15 psi. If there is pressure in the line, the Lubricator will continuously leak lubricant through the Starter and out the exhaust. If the cranking cycle is more than 10 seconds, we recommend the Ingersoll-Rand No. HDL2 installed in the main air supply line. Use a good quality 10w non-detergent oil and adjust the lubricator to a minimum flow rate of 3 drops per second.

Placing the Starter in Service

Installation

NOTICE

For maximum performance, read this manual prior to the installation or operation of Series 150BMPC and 150BMPE Air Starters.

General Instructions

1. Always make certain your Air Starter is properly installed. A little extra time and effort spent in doing a top quality job will contribute considerably toward a reliable starting system that does a superior job of starting your engine quickly under all conditions.
2. We strongly recommend that on all vehicular installations and on stationary engines subject to vibration, you 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. In the actual mounting of an Air Starter, it is 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. Wherever possible - and many times it is necessary - attach the air hoses to the Starter before mounting the Starter on the flywheel housing. The reason for following this procedure is twofold:
 - (a) After mounting the Starter, it is often impossible to make hose connections due to space limitations.
 - (b) Once the hoses are attached, they carry some of the weight of the Starter and make it easier to complete the mounting.
4. 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 get at, the third one is often quite inaccessible. When installing an Air Starter, you will usually need a regular ratchet wrench, sockets, universal joint and socket extension.

Another handy tool for Starter installations is a single or double-end ratcheting box wrench.

5. The efficiency of an Air 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 in the exhaust port will restrict the exhaust and choke the motor. The number of tees and elbows, and the length of the supply line should be kept to a minimum. Use 1-1/4" hose or pipe for supply lines up to 15 feet long; use 1-1/2" hose or pipe if the supply line is over 15 feet long.
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 use of another vehicle or compressor. Make your 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** Pipe Sealant. Always run your 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 and could cause corrosion in the starter motor or, worse yet, freeze solid in the cold weather so that the Starter would be 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 overnight.
7. We recommend installation of a "glad hand" for emergency repressurizing of the system. 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.
8. Whenever possible, always mount the Air Starter so that the exhaust post is downward. This will help prevent any accumulation of water in the starter motor.

* Registered trademark of Loctite Corporation.

Orientation of the Air Starter

If the factory orientation will not fit your engine due to radial location of the housing, or location of the inlet and/or exhaust ports, reorient the starter as follows:

1. Look at the dimension illustration and note that the drive housing can be located in any one or the 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 and 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 N m) of torque.

3. Now that you have the drive housing properly oriented relative to the gear case, 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 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 these members from each other or from the gear case. Reinstall the motor housing cover cap screws and alternately tighten them to 25 ft-lb (34 N m) of torque.

Mounting the Air Starter

1. Study the piping diagram as shown in Dwg. TPB711. We strongly recommend that the Starter be connected exactly as shown in the drawing.
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.
3. If you are going to connect to a receiver tank that is already in service, bleed off the air pressure to the tank.

WARNING

Bleed off the air pressure through a valve or pet cock. 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.

4. Using a 1-1/4" short nipple, install the SRV125 Starter Relay Valve on the end of the receiver tank as shown in Dwg. TPB_711.

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 Start Control Valve on the dash panel (for vehicular installation) or some other appropriate panel (for stationary installation).
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 Start 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. 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 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 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 it is at all practical, liberally grease the teeth on the ring gear with a good, sticky gear grease. This will help promote the life of the ring gear and Starter Pinion.
13. Hoist or jack the Starter into position, and mount it on the flywheel bellhousing. Tighten the mounting bolts to 100 ftlb (136 N m) 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. On any starter with the number 83 or 88 in the model number, 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. Mount an HDL3 Lubricator on or near the Starter as described under "Installation of HDL3 Lubricator".
18. Pressurize the complete starting system and check every connection with a soap bubble test. There must be no leaks.

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 an 150BMP Starter.

1. Disconnect the 1/4" hose at the "OUT" port on the Drive Housing, 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 a minimum of 70 psig (4.8 bar/483 kPa) to the "IN" port on the Drive Housing.
4. Insert a 5/16" hexagon wrench through the hole in the Motor Housing Cover to engage the hexagon recess at the rear of the Rotor.
5. Manually, rotate the Rotor until the engine is cranked to its desired position.

Installation of the HDL3 lubricator

The HDL3 Lubricator is self-priming and may be installed directly on the Starter or remotely located. Although the Lubricator is capable of drawing lubricant from a source 4 ft (1.2 m) lower than the point of installation, we recommend installing the Lubricator as close as possible to the oil source.

We recommend using the unpressurized fuel return line as the source of lubricant. However, oil may be supplied from a separate receiver or the diesel fuel tank. When the diesel fuel tank is the lubricant source, install a 10 micron to 50 micron fuel filter (No. HDL1-47) in the oil supply line at the fuel tank. The lubricant supply line should be tee'd into the fuel return line with the leg of the tee going to the lubricator pointed down to insure that the lubricator does not draw air instead of oil.

Mount the HDL3 Lubricator as follows:

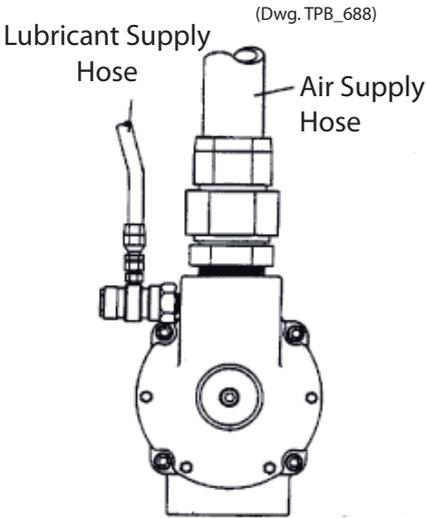
1. If you are going to mount the HDL3 Lubricator on the Starter, remove one of the 3/8" pipe plugs from the inlet boss on the Starter, and replace it with the HDL3. If you are going to mount the HDL3 at a remote location, use two U-bolts and base clamp (No. HDL1-A40) available for the Lubricator.
2. If you mounted the HDL3 at a remote location, install a 1/4" hose from the end of the Lubricator having both a male and female thread to one of the 3/8" pipe tapped holes on the Starter inlet boss.

3. Install a 1/4" hose from the 1/8" NPT oil inlet in the side of the HDL1 to the unpressurized fuel line, diesel fuel tank or separate oil reservoir. Tighten the fitting at the Lubricator to 15 to 36 ft-lb (20.3 to 40.8 N m) torque. The thread on the fitting must be clean; assemble it without sealing compound or Teflon** tape.

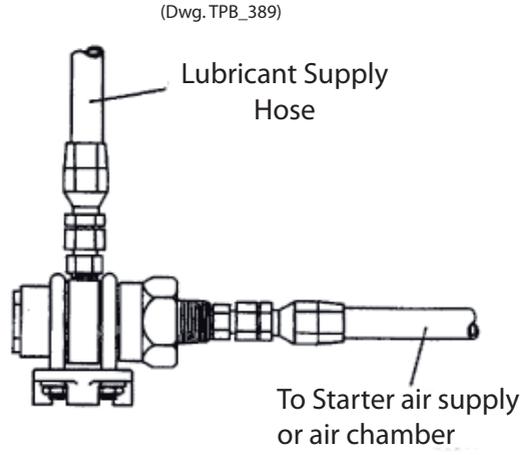
NOTICE

Before initial operation, manually fill the oil supply line.

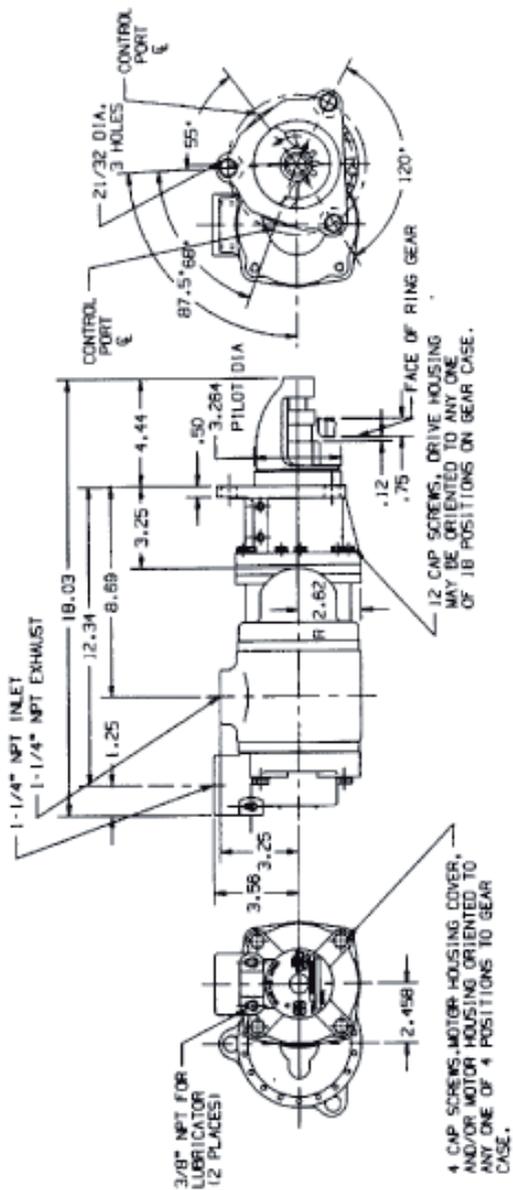
4. If a separate lubrication reservoir is used, fill it with diesel fuel or a light motor oil such as SAE 10 or 10w.



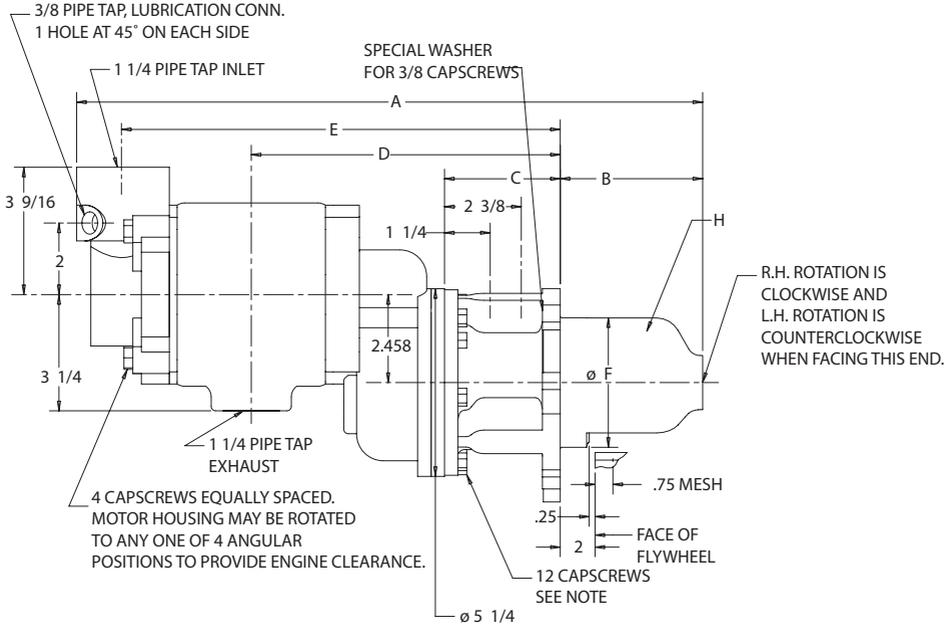
Mounted on starter



Mounted at Remote Location

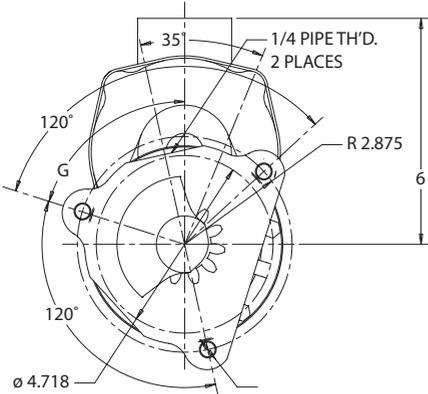


Mounting Dimensions for all Series (except 150BMPB83LH-11, 150BMPC81R15 and 150BMPE81R51)



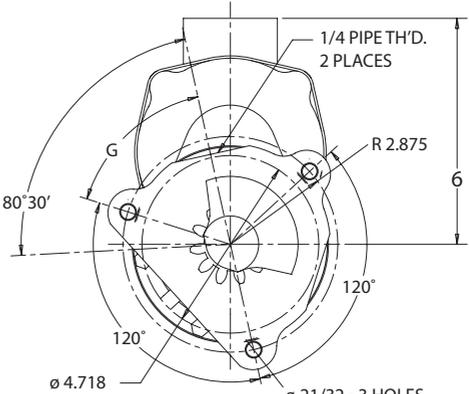
NOTE: DRIVE HOUSING HAS 12 SUITABLY SPACED HOLES FOR ATTACHING GEAR CASE. GEAR CASE HAS 17 HOLES 20° APART. THIS MAKES 18 ANGULAR POSITIONS OF THE DRIVE HOUSING AVAILABLE WITH THE MOTOR AND GEAR CASE IN THE VERTICAL POSITIONS AS SHOWN.

(Dwg.TPA_923)



END VIEW NO. 5
SAE FLANGE
TYPE NO. 3

ø 21/32 - 3 HOLES FOR MOUNTING WITH 5/8 CAPSCREWS. BUSHING AVAILABLE FOR ALL MODELS FOR MOUNTING WITH 3/8 CAPSCREWS.



END VIEW NO. 6
SAE FLANGE
TYPE NO. 3

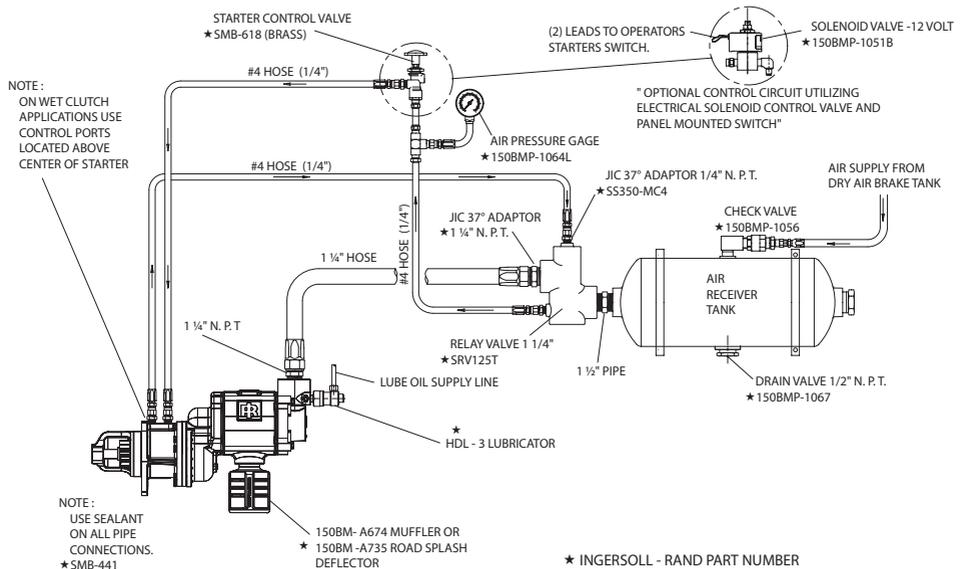
ø 21/32 - 3 HOLES FOR MOUNTING WITH 5/8 CAPSCREWS. BUSHING AVAILABLE FOR ALL MODELS FOR MOUNTING WITH 3/8 CAPSCREWS.

(Dwg.TPA_923)

MODEL NO.	Pinon Data			End View	A	B	C	D	E	F	G
	Pitch	Teeth	Pitch Dia.								
C78RH-6, E78RH-6	6/8	11	2.000	5	18-1/32	4-7/16	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C78RH-54, E78RH-54	6/8	11	2.000	5	17-19/32	4	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C78RH-53, E78RH-5	6/8	11	2.000	5	17-19/32	4	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C78RH-5, E78RH-5	8/10	12	1.625	5	18-1/32	4-7/16	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C78LH-11, E78LH-11	6/8	11	2.000	5	18-1/32	4-7/16	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C78RH-52, E78RH-52	6/8	11	2.000	6	19-19/32	6	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C78RH-44, E78RH-44	6/8	11	2.000	5	18-1/32	4-7/16	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C78RH51, E78RH-51	8/10	13	1.750	5	18-1/32	4-7/16	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C78LH-55, E78LH-55	6/8	11	2.000	5	17-19/32	4	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C83RH-6, E83RH-6	6/8	11	2.000	5	18	4-7/16	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C88L-54, E88L54	6/8	11	2.000	5	17-19/32	4	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C88R-54, E88R54	6/8	11	2.000	5	17-19/32	4	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C88R-51, E88R51	8/10	13	1.750	5	17-19/32	4	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C88L-53, E88R33	8/10	12	1.625	5	17-19/32	4	3-1/4	8-11/16	12-11/32	3.624	72-1/2°
C81R15	8/10	10	1.1251	Refer to Dwg. TPA_1312-1							
E81R54	6/8	11	2.00								

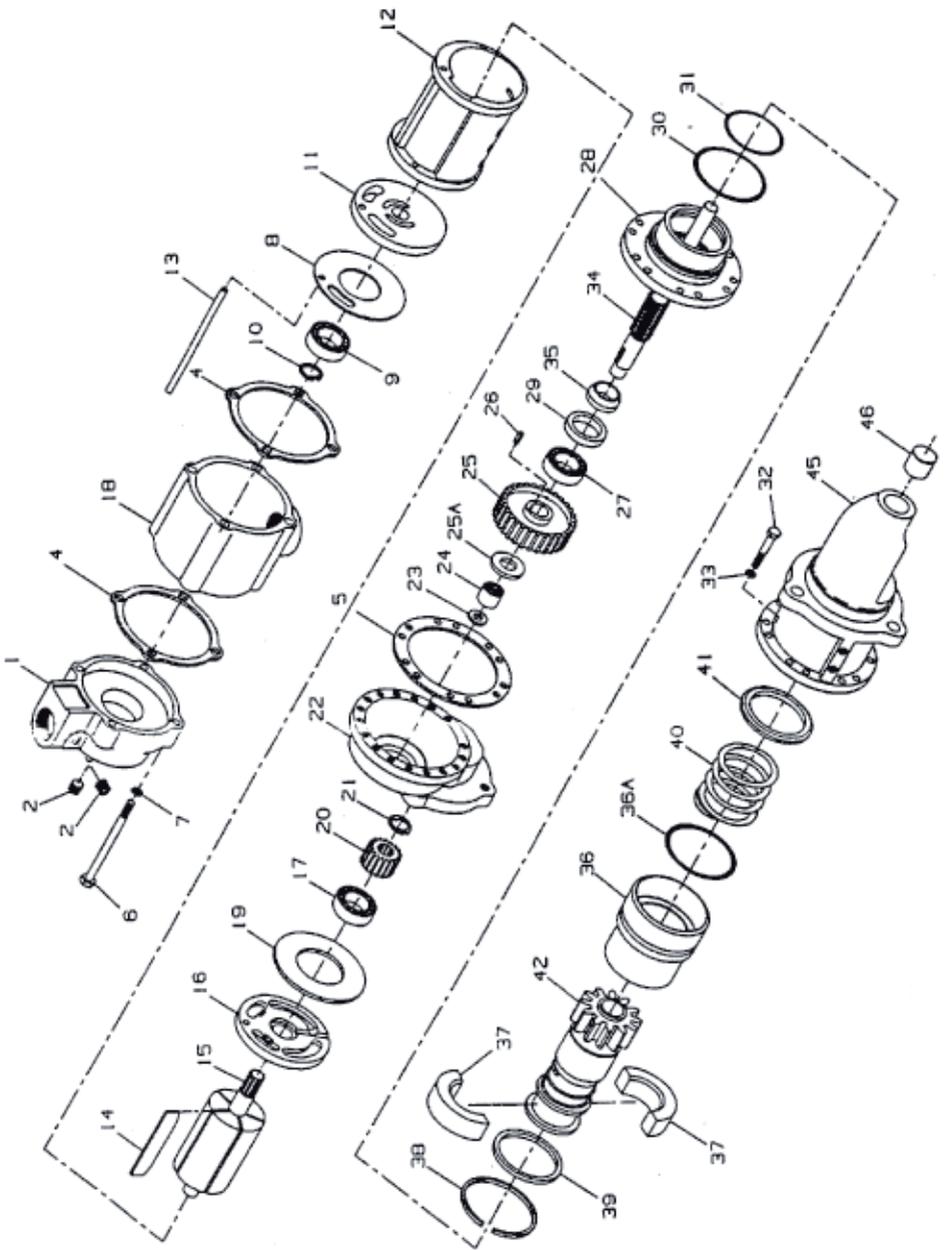
Note: Listed Pitch Diameter is for layout purposes only.

Piping Diagram for Vehicular Installation



(Dwg. TPB_711)

Series150BMPC And150BMPE Air Starters -Exploded View



Model150BMPE88

SERIES 150BMPC and 150BMPE - Parts List

Item	Part Description	Part Number
1	Motor Housing Cover Assembly (1-1/4" inlet)	150BMP-A102A
2	Housing Cover End Plug	HSPPS-3
3	Lubricator Port Plug (2)	T15E-368
4	Gasket (2)	150BMP-283
5	Gasket	150BMP-284
*	Nameplate	150BM-301
*	Nameplate Screw (3)	R4K-302
6	Motor Housing Cover Cap Screw (4)	107-25
7	Cover Cap Screw Lock Washer (4)	D02-504
8	Motor Housing Cover Gasket	150LF-283
9	Rear Rotor Bearing	R3H-24
10	Rear Rotor Bearing Retainer	G57-729
11	Rear End Plate	150LF-12A
12	Cylinder	150BM-3
13	Cylinder Dowel	10BM-98
14	Vane Packet (set of 5 Vanes)	10BM-42-5
15	Rotor	10BMP-53
16	Front End Plate	150LF-11A
17	Front Rotor Bearing	10BM-24
18	Motor Housing	10BM-40
19	Gear Case Gasket	150LF-284
20	Rotor Pinion	
	for "C" Models (16 teeth)	101BMPD-17
	for "E" Models (13 teeth)	150BME-17
21	Rotor Pinion Retainer	10BM-69
22	Gear Case Assembly	10BM-37
22A	Gear Case Machined	10BM-X37
23	Bearing Ejecting Washer	10BM-25
24	Drive Shaft Rear Bearing	10BM-399
25	Drive Gear	
	for "C" Models (43 teeth)	10BMC-9
	for "E" Models (45 teeth)	150BME-9
25A	Drive Gear Thrust Washer	10BM-15
26	Drive Gear Key	10BM-610
27	Drive Shaft Front Bearing	T02-33

Item	Part Description	Part Number
28	Gear Case Cover Assembly	
	for E83LH-11, all 81 & 88	150BMP-378
	for all others	10BM-378-1
29	Drive Shaft Grease Seal	
	for E83LH-11, 83RH-6 & all 81 & 88	150BMP-271
	for all others	10BM-271
30	Gear Case Cover Seal	150BMP-607
31	Piston Seal	150BMP-604
32	Drive Housing Cap Screw (12)	10BM-744
33	Drive Housing Cap Screw Lock Washer (12)	10BM-67
34	Drive Shaft	
	for C78RH-52 and E78RH-52	150BMP-8-1
	for C78RH-53, E78RH-53 C78RH-54, C78RH-54 C78RH-55 and E78RH-55 & all 88	150BMP-8-2
	C81R15	150BMP-8-2A
	for all others	101BMP-8-1
35	Drive Shaft Collar	10BM-30
36	Piston Assembly	
	for E83LH-11, 83RH-6 all 88	04331393
	for all others	101BMP-703-1
36A	Piston Ring	
	All 88	150BMP-337
	for E83LH-11 or 83RH-6	150BMP-337
	for all others	101BMP-704-1
37	Shift Ring (consists of two halves)	101BMP-705-1
38	Shift Ring Retainer	10BMP-606
39	Shift Ring Spacer	10BMP-602
40	Piston Return Spring	101BMP-700-1
41	Return Spring Seat	
	for E83LH-11	150BMP-191
	for all others	101BMP-701-1

Item	Part Description	Part Number
42	Starter Drive	101BMP-299-1
	for C78RH-6, E78RH-6 C78RH-44, E78RH-44 C78RH-54 and E78RH-54	
	for C78LH-11, E78LH-11 C78LH-55, E78LH-55 & 83LHH-11	101BMP-299-2
	for C78RH-5, E78RH-5, C78RH-53 and E78RH-53	101BMP-299-3
	C81R15	150BMP-299-15
	C88L54	101BMP-299-2
	C88R51	150BMP-299-4
	C88R53	101BMP-299-3
	C88R54	101BMP-299-1
	◆43	3/8" Mounting Bolt Lock Washer (3)
◆44	3/8" Mounting Bolt Bushing (3)	9BM-7-2
■45	Drive Housing Assembly	101BMP-300-1
	for C78RH-5, E78RH-5 C78RH-6, E78RH-6, C78LH-11 E78LH-11, C78RH-51 and E78RH-51	
	for C78RH-44 and E78RH-44	101BMP-300-2
	for C78RH-52 and E78RH-52	150BPMP-A300-3

Item	Part Description	Part Number
■45	for C78RH-53 and E78RH-53, C78RH-54 and E78RH-54, C78LH-55 and E78LH-55	150BMP-A300-4
	for E83LH-11 or 83RH-6	150BMP-A300-83
	for C88L54, C88R51, C88R53, C88R54	150BMP-A300-88
	for C81R15	150BMP-A300-81B
46	Drive Housing Bearing	
	for C81R15	150BMP-363-10
	for all others	ML50K-318
*	Air Strainer Assembly	K4U-A267AT
*	Air Strainer Cap	K4U286AT
*	Air Strainer Plug	22SR-165
*	Air Strainer Screen	K4U-61AT
*	Air Strainer Nipple (1-1/4" x 2-1/2")	KKM-286
*	Road Splash Deflector Assembly	150BM-A735
*	Muffler Assembly	150BM-A674
*	Tune-up Kit (consists of illustrated parts 8, 9 10, 14, 19, 21, 23, 24, 25A, 26, 27, 29, 30 31 and 36A)	150BM-TK2

- ◆ Illustrated parts 43 and 44 are required only when 3/8" cap screws are used for attaching the Starter to engine.
- Ⓟ If the Motor Housing Cover being replaced has a 1" inlet, also order No. 11BMP-800-3 Adapter (1-1/4" x 1").
- See NEW STYLE DRIVE HOUSING, refer to Dwg. TPA_923.

* Not Illustrated

■ NEW STYLE DRIVE HOUSING

To improve the performance and durability of these Starters, the Drive Housing has been redesigned to include a roller bearing instead of the old style bronze Bushing, Bushing Oiler and Oiler Plug. Since the bearing itself is not interchangeable with the corresponding bushing, bronze Drive Housing Bushings remain available as repair parts. Order as follows:

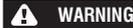
Drive Housing Bushing 5BM-6-15

Bushing Oiler..... 9BM-642

Bushing Oiler Plug..... WF-109

101BMP-300-1 and 101BMP-300-2 drive housings are discontinued. Starters can be converted to accept 150BMP-A300-83 by ordering 150BMP-378 gear case cover assembly.

Maintenance



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

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

Disassembly

General Instructions

1. Always mark adjacent parts on the Motor Housing Cover (1), Motor Housing (18), Gear Case (22) and Drive Housing (45) so these members can be located in the same relative position when the Starter is reassembled.
2. Do not disassemble the Starter any further than necessary to replace a worn or damaged part.
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 set of vanes, seals and O-rings on hand before starting any overhaul of a 150BMP Starter. Never reuse old seals or O-rings.
5. 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.

Disassembly of the Motor

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 copper-covered vise jaws.
6. Remove the Rear Rotor Bearing Retainer (10).
7. The Rear Rotor Bearing (9) is press fit on the rotor shaft. Use a bearing puller to remove it.
8. Lift off the Rear End Plate (11) and Cylinder (12), and remove the Vanes (14) from the slots in the Rotor.
9. Position the Rotor vertically, pinion end up, and grasp the short hub in copper-covered vise jaws.
10. Remove the Rotor Pinion Retainer (21) and lift off the Rotor Pinion (20).
11. Support the Front End Plate (16) as close to the Rotor as possible, and press the Rotor from the Front Rotor Bearing (17). Do not let the Rotor fall when it is pressed free.

Disassembly of the Gear Case

1. Set the gear case and drive housing unit upright on the workbench with the Drive Housing (45) 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 the Drive Shaft Rear Bearing (24) is jacked from the Gear Case (22).

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 (42).
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 (45) vertically, grasping the Gear Case Cover (28) 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 Piston Assembly (36) and Starter Drive will probably remain with the Drive Housing; make certain they do not fall on the floor.
5. 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.
6. Withdraw the Piston (36) and Starter Drive (42) from the Drive Housing. Withdraw the Piston Return Spring (40) and Return Spring Seat (41).
7. Remove the Shift Ring Retainer (38) and Shift Ring Spacer (39) from the small bore of the Piston.
8. 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.
9. Do not remove the Drive Housing Bearing (46) from the Drive Housing unless you have a new Bearing on hand. The Bearing is always destroyed in the removal process. 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 clean kerosene or other solvent. Dry the parts with compressed air.

Inspection of Parts

1. Discard all O-rings and gaskets. These should not be reused.
2. Check all grease seals. If these appear worn 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 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

General Instructions

1. Always press on the inner ring of a ball bearing when pressing that bearing onto a shaft. Always press against the outer ring of a ball bearing when pressing that bearing into a bearing recess. Failure to follow these instructions may ruin the bearing.
2. When pressing a needle bearing into a bearing recess, always press against the stamped end of the bearing using a piloted arbor that contacts only the outer rim of the shell. The use of a flat arbor, or installing the bearing wrong end first, may fracture the shell or lock the needles against rotation.
3. Wipe a thin film of SAE 10 oil on the Vanes, Rotor and Cylinder bore.
4. Lubricate all open bearing and gear teeth with a liberal coat of Ingersoll-Rand Lubricant No. 28. About 3 cc on the drive gear is sufficient. Excessive grease may rob the Starter of power during cold weather.
15. Slide the Rotor Pinion (20) onto the rotor shaft.
16. Install the Rotor Pinion Retainer (21) in the groove on the rotor shaft so that the concave side of the Retainer faces the Rotor Pinion.
17. 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).
18. Place gasket (4) on motor housing.
19. Set the Gear Case on the assembled motor with the Gasket (55) between the Gear Case Gasket and the Motor Housing, making certain the punch marks on the Gear Case are aligned with those on the Motor Housing.
20. Turn the entire assembly over so that the Motor Housing Cover is upward.
21. Install the Motor Housing Cover Cap (6) and Lock Washer (7). Tighten the Cap Screws to 25 ft-lb (34 Nm) of torque.

Assembly of the Motor

1. Position the Rotor (15) vertically, splined end down, on the table of an arbor press.
2. Place the Rear End Plate (11), crescent groove side first, onto the hub of the Rotor.
3. Press 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 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 grease.
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 (13) in the dowel hole to the right 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 to the left of the inlet.
Important: 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 Cover Gasket (8), properly oriented relative to the Cylinder Dowel and the air port in the Motor Housing Cover, in the bore of the Motor Housing Cover, with the Gasket (47) in between.
8. 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.
9. 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 Rear End Plate, Gasket and Motor Housing Cover.
10. Place gasket (4) down over cylinder.
11. Place the Motor Housing (18) down over the Cylinder making certain that the punch marks on the Motor Housing Cover and Motor Housing are aligned.
12. Wipe each Vane (14) with a film of SAE No. 10 oil, and insert a Vane into each slot in the Rotor. Make certain the straight edge of each Vane faces the Cylinder.
13. Set the Front End Plate (16), crescent grooved side first, onto the Cylinder so that the Cylinder Dowel passes through the dowel hole in the End Plate.
14. Press the Front Rotor Bearing (17) onto the splined shaft of the Rotor until it seats against the Front End Plate. Do not bind the End Plate against the Rotor.

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 moly-base grease to the Drive Shaft (34) and the bore of the Drive Shaft Front Bearing and Drive Shaft Collar (35).
3. Press the Drive Shaft Collar, beveled end first, onto the keyway end of the Drive Shaft until it sets against the shoulder of the splines.
4. Press the Drive Shaft Front Bearing onto the keyway end of the Drive Shaft until it seats against the Drive Shaft Collar.
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.

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. 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. Work some Ingersoll-Rand Bearing Grease No. 11 between the rollers of the bearing.
4. Wipe a thin film of 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 Grease No. 11 to the assembled Drive Gear (25) and Drive Shaft (34), making certain to work 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. Moisten the Gear Case Cover Seal (30) and Piston Seal (31) with O-ring lubricant and install them in their respective grooves on the Gear Case Cover (28).
8. Place gasket (5) on gear case face.
9. Install the Gasket (56) on the Gear Case and slide the assembled Gear Case Cover, bearing recess first, down over the Drive Shaft until it seats against the Gear Case. Important: 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

- Stand the Starter Drive (42), pinion end down, on the workbench. Place the Piston (36), large diameter first, down over the Starter Drive.
- Place the two halves of the Shift Ring (37) in the wide channel at the upper end of the Piston.
- Slip the Shift Ring Spacer (39) against the Shift Ring, and install the Shift Ring Retainer (38) in the groove in the piston boss.
- For Model 150BMP83LH-11, moisten the Piston O-ring (36A) with O-ring lubricant, and install it in the groove on the Piston. For all other Models, install the Piston Ring (36A) in the groove on the Piston.

Assembly of the Drive Housing

- If the Drive Housing Bearing (46) was removed, stand the Drive Housing (45) upright and press a new Drive Housing Bearing, open end first, into the Drive Housing until the closed end of the Bearing is flush with the face of the Drive Housing. Work some Ingersoll-Rand Grease No. 11 in the Bearing.
- Wipe a thin film of Ingersoll-Rand Bearing Grease No. 11 on the bore of the Drive Housing.
- Stand the Drive Housing on its small end, and insert the Return Spring Seat, small bore first, into the bore of the Drive Housing.
- Set the Piston Return Spring (40) in the Drive Housing so that it seats in the counterbore of the Return Spring Seat.
- Moisten the outside of the Piston with O-ring lubricant, and insert the assembled Piston and Starter Drive, pinion end first, into the Drive Housing.

- Apply a thin film of Ingersoll-Rand Bearing Grease No. 11 to the surface of the Drive Shaft (34).
- 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.
- Orient the Drive Housing so that the punch mark made prior to disassembly is aligned with the punch mark on the Gear Case.
- 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 Starter

- Turn the pinion by hand in the direction of Starter rotation. The clutch should ratchet smoothly with a slight clicking action.
- Turn the pinion opposite the direction of Starter rotation. The gearing and motor should rotate freely with no binding.
- Attach an air hose to the inlet and operate the motor slowly to see that it functions properly and the drive pinion direction. If the direction of rotation is incorrect, the motor was improperly assembled.
- Connect an air hose to the small pipe tapped hole nearest the Gear Case. When you admit a little air, the drive pinion should advance to the engaged position, and air should escape from the tapped hole nearest the mounting flange.

Troubleshooting Guide

Trouble	Probable Cause	Solution
Loss of power	Worn motor parts	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: <ol style="list-style-type: none"> Vanes (14) Install a set of new vanes if any vane is cracked, spalled or worn to the extent that its width is 11/16" (17mm) at either end. Rotor Bearings (9 or 17) - Replace if any roughness or looseness is apparent. Rotor (15) - Replace if the body has deep scoring that cannot be removed by polishing with emery cloth. Cylinder (12) - Replace if there are any cracks or deep scoring. End Plates (11 or 16) - clean up scoring by rubbing it with emery clothed placed on a flat surface.
	Inadequate lubrication	Check the Lubricator, inlet hose, fitting and oil supply hose to make sure they are vacuum tight and free off leaks. Tighten all joints and replace the Lubricator, if necessary.
Starter drive (42) does not engage gear or engages and disengages ring gear very slowly.	Clogged control hoses	Remove the control hoses attached to the Drive Housing (45) and clean them by blowing compressed air through them. Firmly secure the hoses in a vise before tuning on the air. Warning: Make certain no one is in line with the discharge end of the control hose.
	Clogged or faulty control valve	Remove and inspect the Control Valve. Thoroughly clean the Control Valve or install new Control Valve, if necessary.

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