SERVICE MANUAL
60/61 SERIES
MODELS DS AND LS
AIR/GAS STARTERS

POW-R-QUIK
EXCELLENCE IN AIR STARTING SYSTEMS

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Telephone: 216-362-0755 -- Fax: 216-362-0799
A Division of Maradyne Corporation

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GENERAL INFORMATION

Purpose - This manual contains installation and service instructions for the POW-R-QUIK Models DS-60, DS-61 and LS-60, LS-61 air and gas starting systems.

NOTE: The DS and LS series are very similar. The difference being the LS series uses thrust bearings instead of thrust washers in the motor assembly. Therefore all parts are interchangeable between the DS and LS series with the **exception** of the inlet and end plates and the thrust washers and thrust bearings.

Applications - These systems are primarily utilized in petroleum drilling and production equipment, air and gas compressor engines, mining equipment, off-highway vehicles, locomotives, marine engines, construction equipment, diesel powered generator sets, fire pump engines and cogeneration equipment. When in doubt regarding the proper starting system for a particular application, the detailed installation instructions should be reviewed or a POW-R-QUIK starting specialist should be contacted.

The LS-60/LS-61 air starters are designed to operate without any lubrication supplied to the air motor; however, on applications involving severe service conditions such as unfiltered air supply, or prolonged cranking lubrication is required. Consult with a POW-R-QUIK starting system specialist should you have any questions.

Parts and Service - Parts and service are available through POW-R-QUIK's worldwide distributor network. Operating valves and other starting system components are available individually or in completely packaged installation or rebuild kits. Air and nitrogen supply systems are also available as options. For guaranteed reliability use only original POW-R-QUIK starting system components.

WARNING

DO NOT OPERATE STARTERS AT AIR OR GAS PRESSURE ABOVE 180 PSIG. PROPER VENTILATION IS REQUIRED FOR ALL ENGINES STARTED BY NATURAL GAS. DO NOT OPERATE STARTER WITH THE EXHAUST PLUGGED OR IN ANY WAY OBSTRUCTED.

CAUTION SHOULD BE TAKEN WHEN OPERATING ON GAS APPLICATIONS BECAUSE OF THE DANGER OF FIRE, EXPLOSION, OR INHALATION.

WHEN REPAIRING A GAS OPERATED STARTER, ALWAYS PLUG THE EXHAUST AND USING REGULATED 35 PSIG COMPRESSED AIR CONNECT LINE TO INLET AND CHECK FOR LEAKS BY IMMERSING STARTER IN LIGHT OIL OR NON-FLAMMABLE SOLVENT.

DESCRIPTION

The POW-R-QUIK air and gas starting systems consist of four basic components: The starter, lubricator, operating valves and air or gas supply.

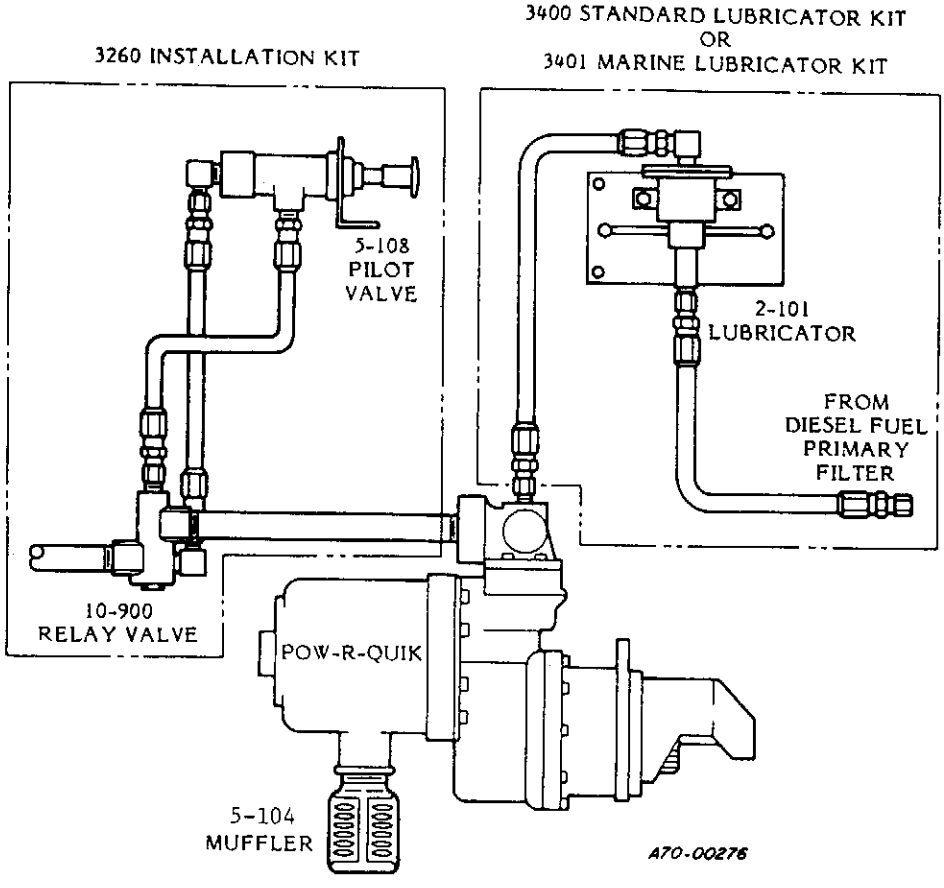
NOTE

1. The DS series must be operated with lubrication supplied to the air motor. The LS series can be operated without lubrication for short crank cycles only. Should the cranking time exceed five (5) seconds, lubrication must be provided to the air motor.

It is recommended that lubrication is provided on all starters used with natural gas engines.

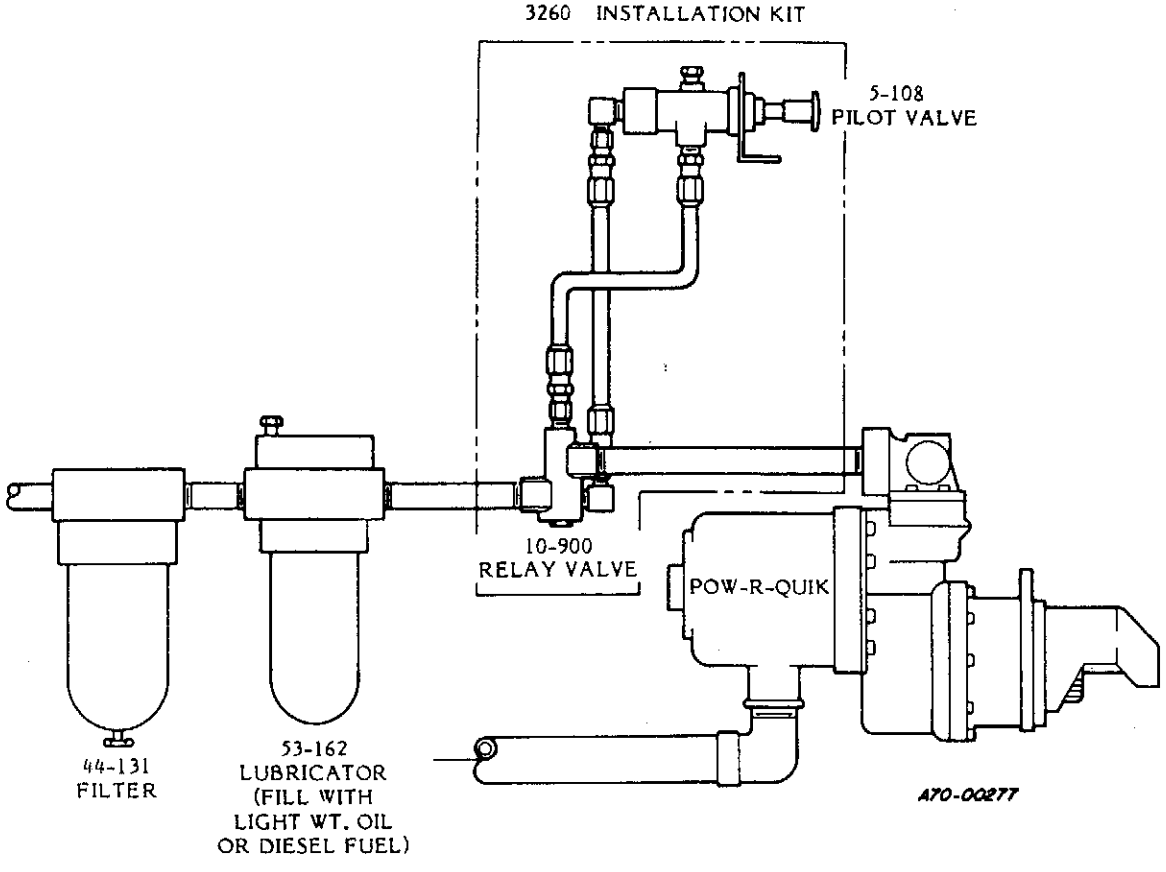
2. Operation of the LS series without lubrication may result in loss of efficiency.

Shown in figures 2.1 through 2.4 are schematics of typical POW-R-QUIK air and gas starting systems.



NOTE: LUBRICATION IS OPTIONAL ON LS SERIES FOR DIESEL ENGINES. FOR LOWER PRESSURE STARTING OR COLD WEATHER STARTING IT IS RECOMMENDED YOU USE LUBRICATION.

Figure 2.1. Typical Diesel Engine Installation



NOTE: LUBRICATON IS REQUIRED ON ALL DS & LS STARTERS FOR NATURAL GAS ENGINES AND ALL ENGINES WITH LONG CRANK CYCLES.

Figure 2.2. Typical Gas Engine Installation

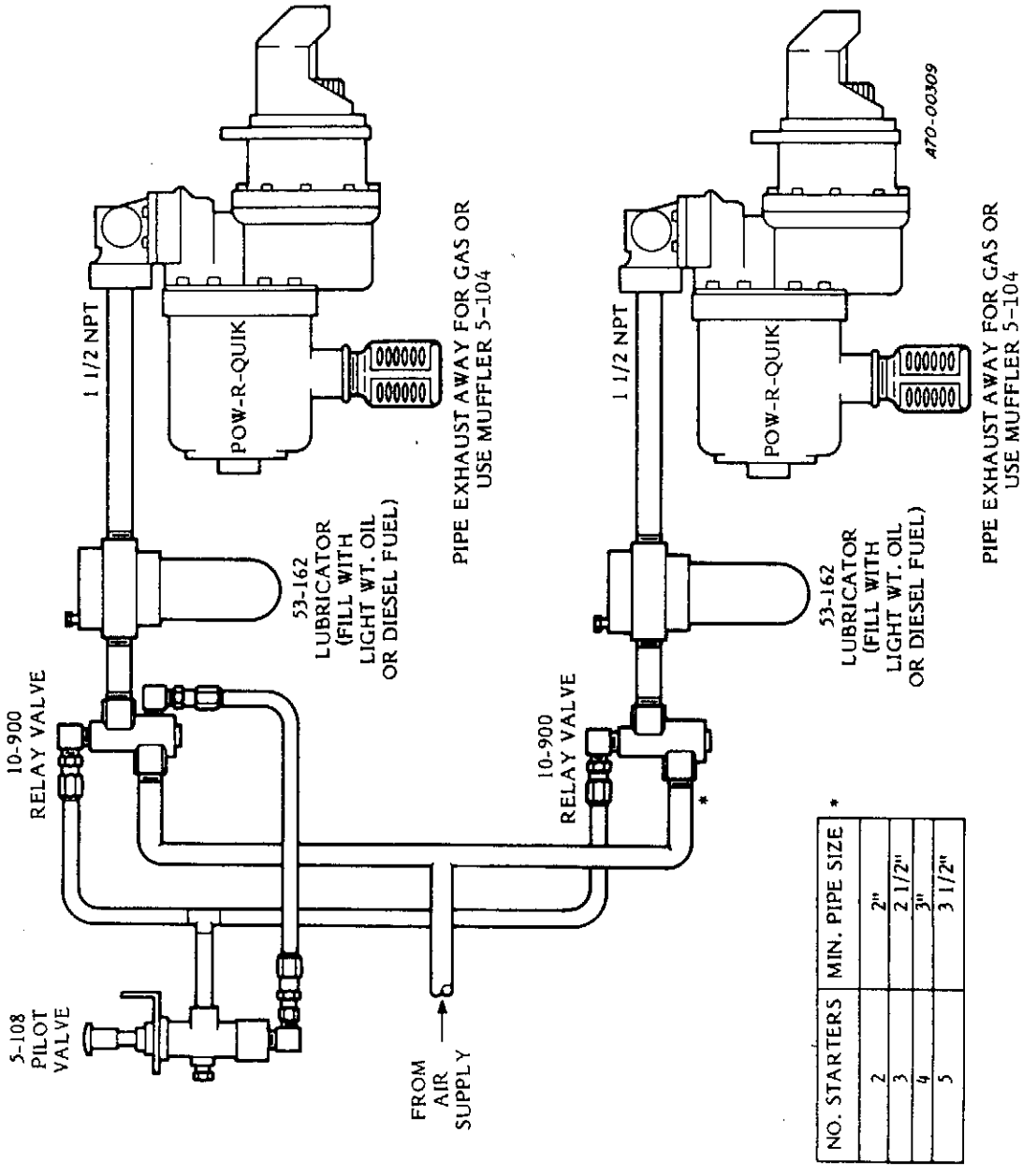


Figure 2.3. Typical Multiple Starters Installation

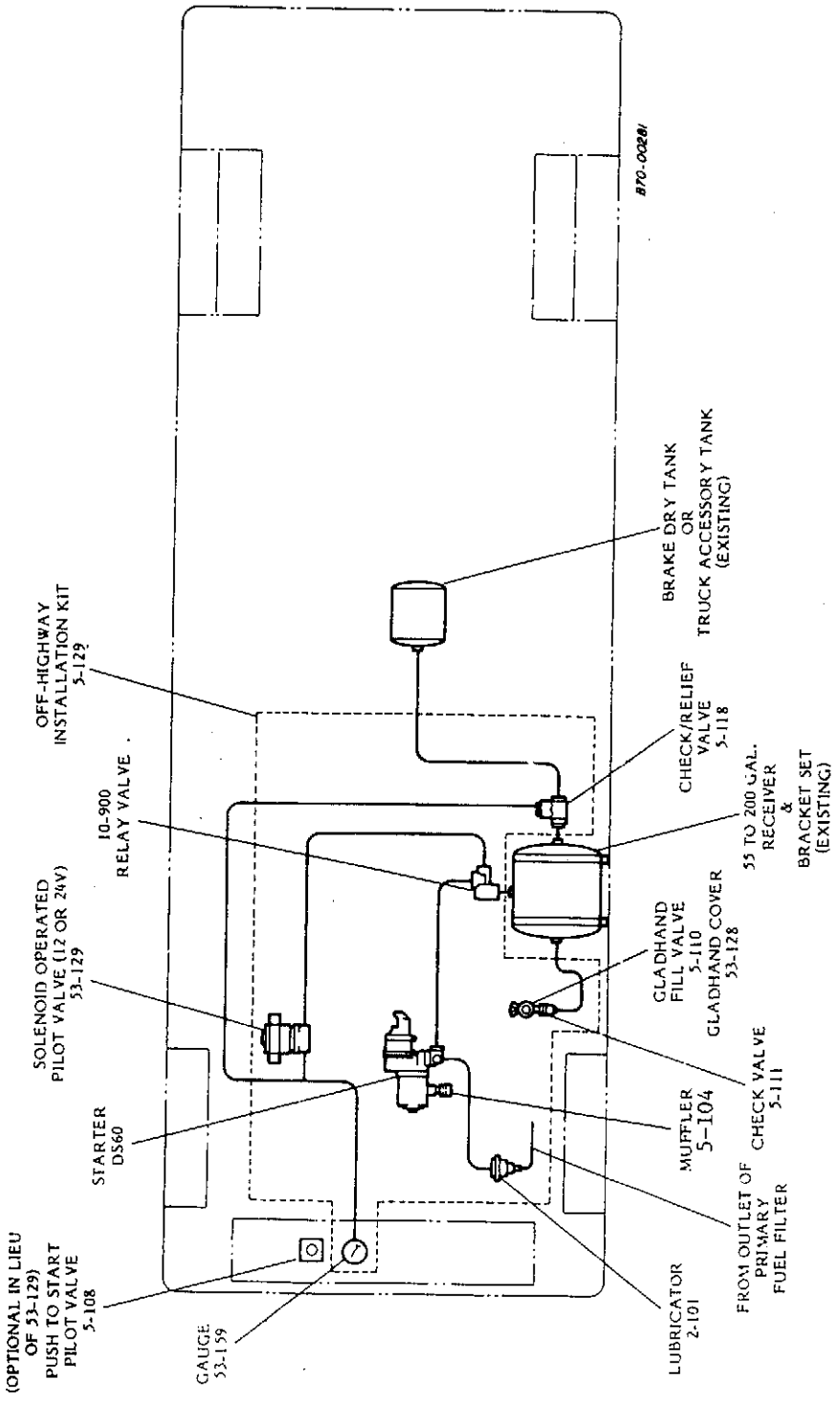


Figure 2.4. Typical Off-Highway Air Starting System

Starter - The DS and LS series starters with inertia drive may be operated manually or automatically from compressed air, natural gas or nitrogen. They are designed for use on diesel engines with displacements up to 12,900 cubic inches (211.4 liters) and gas engines with displacements up to 20,000 cubic inches (327.7 liters).

Listed in Table 2-1 are the various DS/LS-60 and DS/LS-61 starters available and the features of each.

TABLE 2-1 STARTER DESIGNATIONS

DS/LS-60 Standard 2.19:1 Gear Ratio

Model	Rotation	Pitch	Teeth	Blank Size	Pressure Angle	PD*
RH1	Right	6/8	12	12	20	2.000
LH1	Left	6/8	12	12	20	2.000

DS/LS-61 Standard 2.64:1 Gear Ratio

Model	Rotation	Pitch	Teeth	Blank Size	Pressure Angle	PD*
RH1	Right	6/8	12	12	20	2.000
LH1	Left	6/8	12	12	20	2.000

* For Layout Purposes Only. Other Drives and mounting adapters may be available upon request.

NOTE

Starters are available with a choice of SAE #2 or SAE #3 flanges. SAE #1 and some non-SAE flanges may also be ordered.

MAINTENANCE

General - Experienced mechanics will have no difficulty performing field repairs on the POW-R-QUIK starters. For guaranteed quality, use only genuine POW-R-QUIK parts, part kits and remanufactured starters.

All POW-R-QUIK factory remanufactured starters are backed up by POW-R-QUIK's warranty program.

Periodic Maintenance Inspections - The following inspections should be performed monthly or during all regular engine servicing or inspections.

1. Check the in-line lubricator for proper operation by viewing the starter's exhaust stream during the starting cycle or by feeling the starter exhaust outlet when the starter is not operating.

2. If an oil mist is absent from the exhaust stream and/or from the starter outlet, check the oil level and refill, if necessary, with SAE #10 oil to 1/4" from the top.

3. Re-check the lubricator and, if necessary, adjust the "Dial Set" knob for the oil drip rate, which is one drop every four seconds for most applications. This can be observed through the sight glass.

!!!CAUTION!!!

IF, AFTER PERFORMING THE ABOVE DESCRIBED STEPS, THE LUBRICATOR IS NOT WORKING PROPERLY, THE LUBRICATOR MUST BE CLEANED, REPAIRED OR REPLACED.

Check a positive displacement type lubricator (POW-R-QUIK P/N 2-101) in the same manner as an in-line lubricator (Step 1). Make sure lubricator is hooked up to a non-pressurized fuel line. Install a tee connection coming off the fuel filter, and hook up lubricator line to bottom of tee. Lubricator operates only when the engine is shut off, therefore a tee connection will insure there is diesel fuel available for lubrication. **IF LUBRICATOR IS HOOKED UP TO A PRESSURIZED FUEL LINE, DIESEL FUEL WILL CONTINUOUSLY LEAK INTO THE STARTER.**

4. If oil mist is not present in the exhaust stream and/or the starter outlet, check the lubricator prime by either injecting multiple bursts of compressed air into the outlet port of the lubricator or into the hose if it is attached to the lubricator.

5. Check the lubricator inlet hose for proper connection to one of three sources listed below:

A. Primary fuel filter outlet.

B. Diesel fuel tank drain connection. (Use POW-R-QUIK Filter P/N 73-102)

C. Remote oil reservoir (filled with SAE #10 oil).

!!!CAUTION!!!

IF PRIMING IS UNSUCCESSFUL AFTER PERFORMING THE PRECEDING STEPS WITH ACCEPTABLE FLUID LEVELS, THE LUBRICATOR SHOULD BE CLEANED, REPAIRED OR REPLACED.

6. If an air filter with a manual drain is used, check for moisture accumulation and drain if necessary. Check the filter element and clean or replace, as required.

7. Inspect all threaded connections for tightness.

NOTE

In applications not using lubrication, if excessive vane wear occurs, it is advisable that a lubricator be installed.

INSTALLATION, REMOVAL AND ASSEMBLY

Starter Installation -

NOTE

Before installing the starter it should be noted that the three (3) major housings of the starter may be rotated a full 360 degrees. Refer to figure 3.1.

1. Position the starter on the engine flywheel housing with the starter drive housing properly positioned in the flywheel housing.

2. Align the three (3) bolt holes in the mounting flange with the proper bolt holes in the flywheel housing. Install and properly torque the three bolts.

3. Install the air hose on the inlet adaptor. Make sure air/gas lines are free of contaminant or foreign material before connecting to air starter.

4. Install exhaust piping or muffler, if applicable.

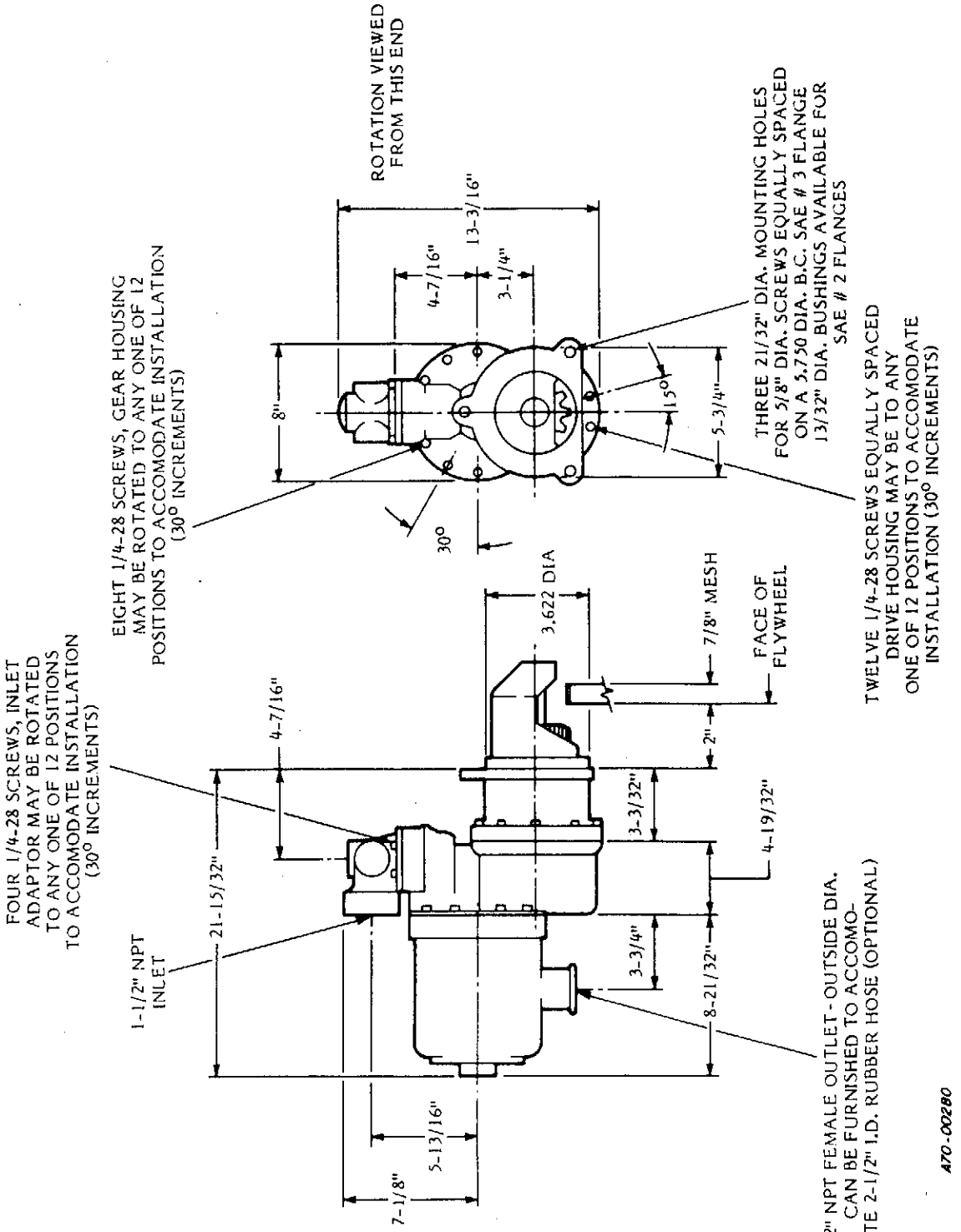


Figure 3.1. Starter Orientation

Starter Removal -

1. Remove the air hose from the starter's inlet adapter. If applicable, remove any exhaust piping or muffler and any lubricator hose that may be attached to the starter.

2. Loosen, but do not remove, the three (3) starter mounting bolts.

3. Support the starter with one hand and remove the three (3) mounting bolts with the other.

4. Remove the starter from the engine.

Vane Kit Installation -

A. Disassembly for Vane Kit Installation:

NOTE

Prior to any operation, use a center punch and mark the starter housings at each side of all parting lines.

1. Disconnect all starter lines.

NOTE

Refer to starter parts list for parts identification.

2. Remove eight screws (#17) and lockwashers (#16) from the rotor housing (#1) and separate it from the gear housing (#13). Discard the screws, and lockwashers and the o-ring (#33).

3. Remove the retaining ring (#3), end plate (#4) and thrust washer, or thrust bearing assembly if LS series, (#6) from the rotor assembly. Discard the retaining ring (#3) and thrust washer/bearing (#6).

4. Remove and discard all vanes (#12) from the rotor assembly.

5. Disconnect and remove the rotor casing assembly (#5) from the inlet plate (#7) and gear housing (#13).

6. Inspect all rotor slots for burrs or foreign matter. Clean rotor and remove burrs.

7. Inspect the rotor casing (#5), rotor assembly (#2), end plate (#4) and rotor housing (#1) for damage. Replace damaged parts. Clean all parts that are going to be used again.

B. Assembly:

1. Install a new o-ring (#33) on the gear housing (#13).

2. Install the rotor casing assembly (#5) with the **long** roll pin end extended through the inlet plate (#7) and into the gear housing (#13).

NOTE

Be sure that the inlet air passage or baffle on the rotor casing assembly (#5) properly aligns with the air passage on the inlet end plate (#7) and gear housing (#13).

3. Insert the vanes (#12) into the rotor slots on the rotor assembly (#2).

4. Position new thrust washer/bearing (#6) on the end of the rotor assembly (#2).

NOTE

Thrust washers and thrust bearing assemblies are not interchangeable!

5. Install the end plate (#4) on the rotor casing (#5), making certain that the short roll pin on the rotor casing is properly inserted into the end plate (#4).

6. Install the retaining ring (#3) on the rotor assembly (#2), making certain that the retaining ring seats properly into the appropriate groove.

7. Properly pack bearing (#8) with lithium and molybdenum disulfide based grease.

8. With the new o-ring (#33) properly positioned on the gear housing (#13), work the rotor housing (#1) over the rotor casing (#5) until the rotor assembly's shaft is seated in the bearing (#8) and the two housings make contact.

9. Rotate the rotor housing (#1) until its center punch mark lines up with the punch mark on the gear housing (#13).

10. Install the eight new screws (#17) and lockwashers (#16) that hold the rotor housing (#1). Alternately tighten these screws to 10-12 ft. lbs. (13.6 - 16.3 Nm) of torque.

11. Pour a small amount of light weight oil or diesel fuel into the starter air inlet (#37).

12. Bench test the reassembled starter using a 1-1/2" air hose, or install the starter on the engine for testing.

13. Install the air lines, make sure air/gas lines are free of contaminant or foreign material before connecting to the air starter.

14. Engine test the starter.

Rebuild Kit Installation -

NOTE

Refer to starter parts list for parts identification.

A. Disassembly for Rebuild Kit Installation

1. Perform steps outlined in "Disassembly for Vane Kit Installation", page 12.

2. Remove the rotor assembly (#2) by pulling the rotor assembly straight away from the gear housing (#13).

3. Remove the retaining ring (#11) from the gear end of the rotor shaft splines.

4. Lift the rotor spur gear (#10) from the rotor shaft splines.

5. Using the proper bearing puller, remove the bearing (#9) from the rotor shaft.

6. Remove the bearing spacer (#23).

7. Remove the inlet end plate (#7) and the thrust washer/bearing (#6).

8. Discard the bearing (#9), bearing spacer (#23), thrust washer/bearing (#6) and retaining ring (#11).

9. Remove the three screws (#42) from the grease cap (#40). Remove the grease cap (#40) from the rotor housing (#1) and discard the o-ring (#41).

10. Remove and discard the bearing (#8) and seal (#39) from the rotor housing (#1).

11. Remove the four screws (#17) with lockwashers (#16) from the inlet adapter (#37).

12. Remove the inlet adapter (#37) and o-ring (#35). Discard the o-ring (#35).

13. Remove the twelve screws (#17) with lockwasher (#16) from the drive housing (#26). Remove the drive housing (#26).

14. Remove and discard the bearing and seal (#20) from the drive housing (#26).

15. Remove the set screw on the starter drive (#15) and remove the starter drive from the arbor shaft (#30).

16. Remove the large diameter retaining ring (#31) from the gear housing (#13).

17. Remove the retaining ring (#32) from the sealing spacer (#18).

18. Pull the arbor shaft sub-assembly (#30) out of the gear housing (#13).

19. Using the proper gear puller, separate the sealing spacer (#18) from the arbor shaft sub-assembly (#30).

20. Remove and discard the bearing (#9) and o-rings (#24 and #25) from the sealing spacer (#18).

21. Inspect and, if necessary, remove and discard the needle bearing (#14) located in the gear housing (#13).

22. Inspect the starter drive (#15) for visible damage or clutch slippage. Replace if necessary.

NOTE

A replacement starter drive (#15) is not included in the rebuild kit. Make sure the drive meshing spring is returned to its proper position if drive is removed.

!!!CAUTION!!!

Do not apply solvent to starter drive, as it may remove the factory applied lubricant.

23. Inspect all parts. Clean all re-usable parts, except drive (see CAUTION) in a good commercial cleaning solvent and dry with compressed air. Replace any parts that cannot be re-used.

B. Assembly:

1. Position the thrust washer/bearing (#6) on the splined end of the rotor shaft assembly (#2).

2. With the small outside diameter of the inlet end plate (#7) facing the rotor body, slide the inlet end plate (#7) into position on the rotor assembly shaft (#2). When properly installed the thrust washer/bearing (#6) will rest in the counterbore of the inlet end plate (#7).

3. Position the bearing spacer (#23) on the rotor assembly shaft adjacent to the inlet end plate (#7).

4. Support the opposite end of the rotor shaft and press the new bearing (#9) on the rotor assembly shaft until it bottoms lightly against the bearing spacer (#23). Make certain that the inlet end plate (#7) will rotate freely after the bearing (#9) is installed.

5. Mount the rotor spur gear (#10) on the splined end of the rotor assembly and install the gear retaining ring (#11).

6. Install the rotor casing assembly (#5) with the long roll pin placed through the inlet end plate (#7), making certain that the air passage (baffle) in the rotor casing assembly (#5) and the air passage in the inlet end plate (#7) properly align.

7. Insert the vanes (#12) into the slots on the rotor assembly (#2).

8. Position the new thrust washer/bearing (#6) on the short end of the rotor assembly shaft.

9. Install the end plate (#4) on the rotor assembly (#2) , making certain that the thrust washer/bearing (#6) is seated in the counterbore of the end plate (#4) and that the short roll pin of the rotor casing (#5) is inserted properly into the end plate (#4).

10. Install the retaining ring (#3) into to proper groove on the rotor assembly (#2).

11. Working from outside the rotor housing (#1), position the seal (#39) in the rotor shaft bore with the open end of the seal facing toward the inside of the rotor housing (#1).

12. Gently push the seal (#39) inward until the open end of the seal (#39) is flush with the inside surface of the rotor housing (#1).

13. Press the bearing (#8) into the rotor shaft bore, directly behind the seal (#39).

14. Properly pack the bearing (#8) with lithium and molybdenum disulfide base grease.

15. Install the rotor housing (#1) over the rotor casing assembly (#5) with the exhaust port positioned so that the punch marks will align properly upon completion of assembly.

16. Check to see that the rotor spins freely by turning the spur gear (#10).

17. While turning the spur gear (#10), observe the rotor vanes (#12) through the exhaust port to make certain they are free.

18. Press the needle bearing (#14) into the gear housing (#13) if the old bearing was removed. Lubricate the bearing with lithium and molybdenum disulfide base grease.

19. Install the new o-ring (#33) on the gear housing (#13).

20. With the long roll pin in the rotor casing assembly (#5) aligned with the proper hole in the gear housing(#13), install the eight screws (#17) with lockwashers (#16) that hold the gear housing (#13) to the rotor housing (#1). Make certain that the punch marks (made during disassembly) on the rotor housing (#1) align with the punch marks on the gear housing (#13). The gear housing (#13) may be rotated a full 360 degrees, at 30 degree increments.

21. Torque the eight gear housing to rotor housing screws 10-12 ft. lbs. (13.6 - 16.3 Nm).

22. Install the o-rings (#24 and #25) on the sealing spacer (#18).

23. Press the bearing (#9) into the sealing spacer (#18) and install the retaining ring (#32) to secure the bearing (#9).

24. Slip the sealing spacer (#18), with the bearing (#9) and the o-rings (#24 and #25) installed, over the double keyway end of the arbor shaft (#30).

25. Applying pressure, only to the race of the bearing (#9), bottom the bearing race against the shoulder on the arbor shaft (#30).

26. Push or press the starter drive gear (#27) onto the arbor shaft (#30). Make sure the key (#28) is in place and the recessed part of the gear is facing the gear box.

27. Position the bronze thrust washer (#34) on the arbor shaft, against the starter drive gear (#27).

28. Insert the arbor shaft (#30), with parts installed, into the gear housing (#13).

29. Install retaining ring (#31) and slide the starter drive assembly (#15) over the meshing spring onto the arbor shaft (#30). Make sure the drive is properly aligned and slips over the keys. Align the drive set screw with the hole in the arbor shaft and tighten. Install and set the locking ring.

30. Lubricate the needle bearing (#20) with lithium and molybdenum disulfide based grease and press the bearing (#20) into the drive housing (#26). *See recommended procedure*

All new DS & LS air starters have the drive (#15) cut down so the shaft does not protrude past the drive housing.

***Recommended Procedure for Installing P/N 24-116 Bearing Kit:**

A. On some starter applications, the excess shaft length may not be a problem. If there is reason to believe that a protruding bearing end on the drive housing will not cause interference in and around the flywheel environment, the end of the drive's shaft need not be altered. Use the long end of the stop gauge to insert the bearing as detailed.

B. Insert stop gauge into drive housing bore as shown in Figure 2 with the long end of the gauge inside the bore and shoulder resting squarely against the face of the counterbore. Press bearing in from the outboard side until it hits the stop gauge.

C. Remove stop gauge and insert rotary seal into the bore from the inside using the stop gauge as an insertion tool. Take care that the seal's lip is in the proper sealing direction as shown otherwise sir will be trapped in the bearing bore and the seal will not go in.

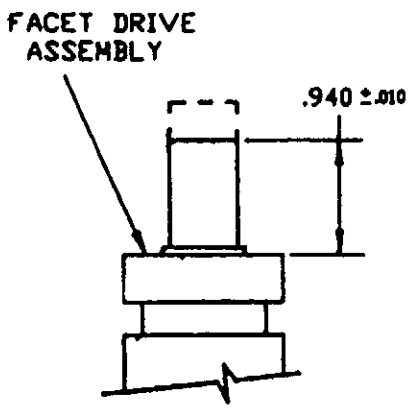


FIGURE 1

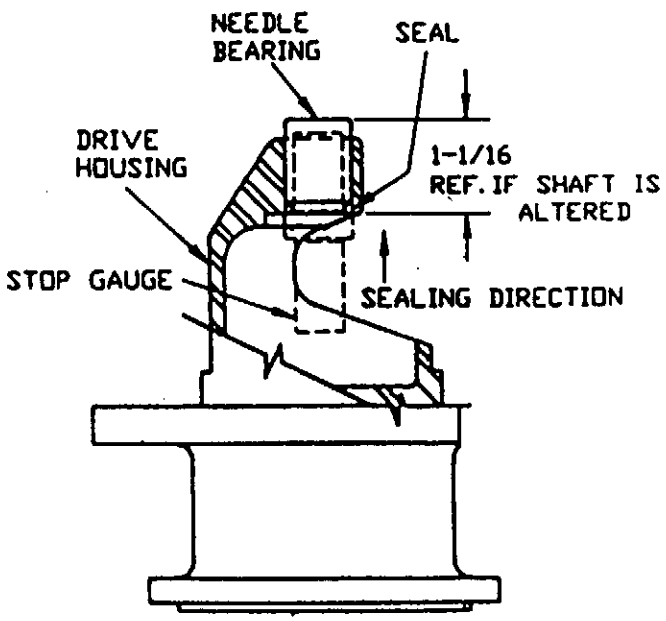


FIGURE 2

Alternate Installation Procedure - Starter Drive Modification

A. Measure the shaft end length of the 8-104 or 8-105 drive assembly shown in Figure 1. It should measure .940+/-.010 as shown. If not, alter the shaft length by making a square cut across the end of the shaft with an abrasive saw, taking care to limit heat input causing subsequent discoloration of the surface. Break all sharp edges.

B. Insert stop gauge into drive housing bore as shown in Figure 2. Make sure the short end of the gauge is inserted and the gauge shoulder rests squarely against the face of the counterbore. Press bearing in from the outboard side until it hits the stop gauge. The bearing end should be 1-1/16" from the face of the counterbore. If not, knock in or out with drift tool to 1-1/6" dimension.

C. Insert seal as described in Step C above.

31. Slip the starter drive housing (#26) over the starter drive assembly (#15)until the mating surfaces of the drive housing (#26) and gear housing (#13) make contact.

32. Rotate the starter drive housing (#26) to align with the punch marks made during disassembly.

33. Install the twelve starter drive housing to gear housing screws (#17) with lockwasher (#16) and torque to 10-12 ft. lbs. (13.6 - 16.3 Nm).

34. Pour a small amount of light weight oil or diesel fuel into the starter air inlet (#37).

35. Position new o-ring (#35) on gear housing (#13).

36. Align the punch marks on the inlet adapter (#37) with the punch marks on the gear housing (#13) and install the four screws (#17) with the lockwashers (#16). Alternately torque the screws to 10-12 ft. lbs. (13.6 - 16.3 Nm).

37. Install the grease cap (#40) with the new o-ring (#41) and three screws (#42). Tighten screw to 8-10 ft. lbs. (10.9 - 13.6 Nm).

38. Bench test the reassembled starter using a 1-1/2" air hose, or install the starter on the engine for testing.

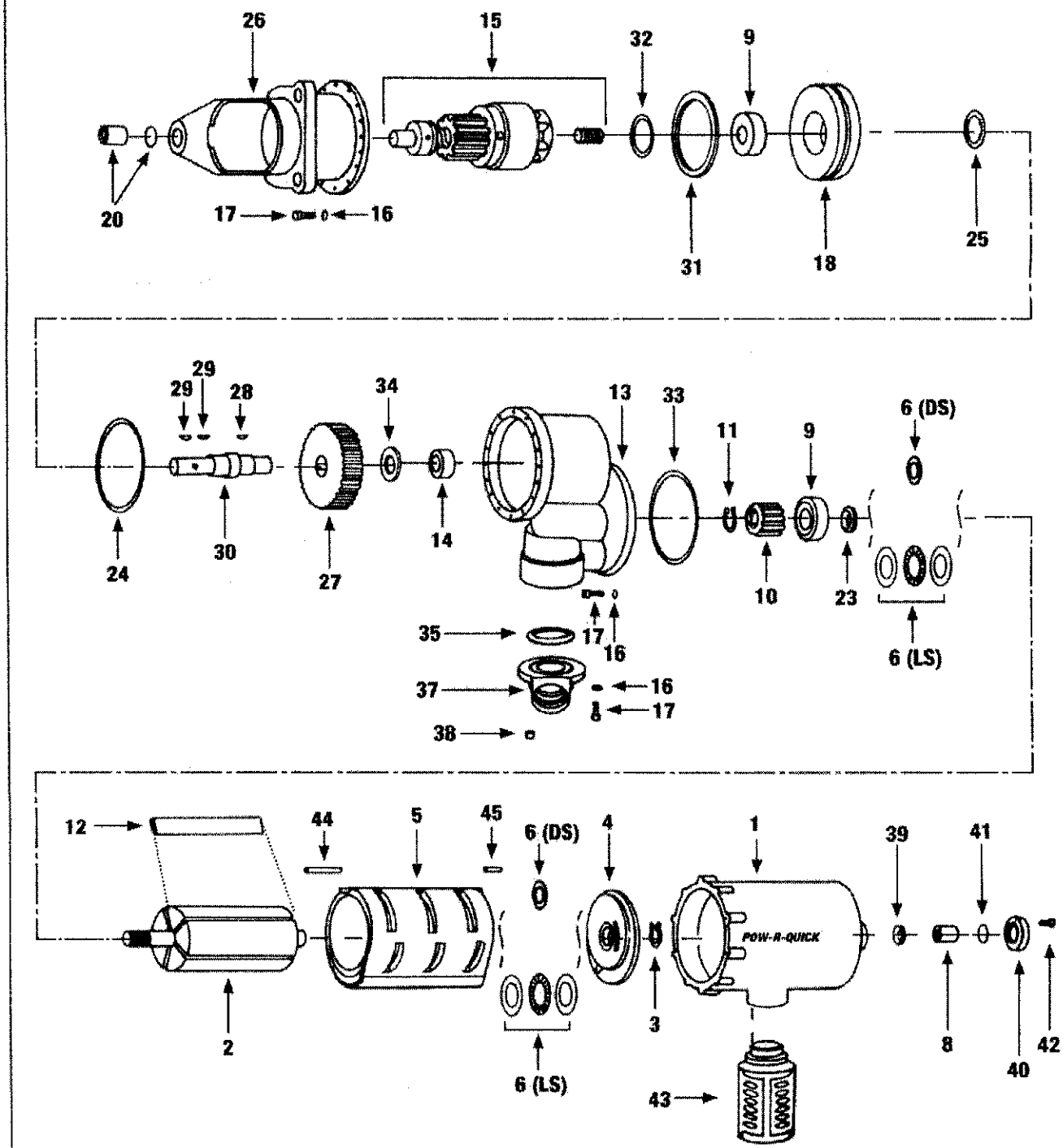
39. Install the air lines. Make sure air/gas lines are free of contaminant or foreign material before connecting to air starter.

40. Engine test the starter.

POW-R-QUIK

Performance · Reliability · Quality

60 Series Starter Parts List



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See reverse for kits and part information

POW-R-QUIK

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60 Series Starter Parts List

	Index No.	Part No.	Description	Quantity Per Unit
■	1	26-109	Rotor Housing	1
■	2	30-102	Rotor Assembly	1
▲ ●	3	25-119	Rotor Retaining Ring	1
	4	29-105R or 29-105L	End Plate DS — *NO LONGER AVAILABLE* ★ / *NO LONGER AVAILABLE* †	1
■	4	26-108R or 26-108L	End Plate LS	1
■	5	34-102R or 34-102L	Rotor Casing Assembly	1
▲ ●	6	38-116 or	Thrust Washer (DS)	2
▲ ●	6	38-128	Thrust Bearing Assembly (LS)	2
▲ ●	6	21-610	Thrust BR Race	4
▲ ●	6	21-622	Thrust BR	2
	7	29-106R or 29-106L	Inlet End Plate (DS) — *NO LONGER AVAILABLE* ★ / *NO LONGER AVAILABLE* †	1
■	7	29-107R or 29-107L	Inlet End Plate (LS)	1
▲ ●	8	24-114	Bearing	1
▲ ●	9	24-115	Bearing, Double Sealed	2
■	10	28-104	Rotor Spur Gear (DS/LS-60)	1
■	10	28-107	Rotor Spur Gear (DS/LS-61)	1
▲ ●	11	25-116	Gear Retaining Ring	1
▲ ●	12	14-108	Rotor Vane	5
■	13	26-122	Gear Housing	1
●	14	24-112	Needle Bearing	1
■	15	8-104	Starter Drive (DS/LS RH)	1
■	15	8-105	Starter Drive (DS/LS LH)	1
▲ ●	16	38-112	Lockwasher	24
▲ ●	17	18-117	1/4 - 28 Screw	24
■	18	68-105	Sealing Spacer	1
●	20	24-116	Bearing Kit (Seal - 71 x 7038, Bearing BAM 1316)	1
■	21	4681100	Name Plate (not shown)	1
▲ ●	23	68-104	Bearing Spacer	1
●	24	25-130	Outer O-ring	1
●	25	25-129	Inner O-ring	1
■	26	26-111	Starter Drive Housing	1
■	27	28-105	Starter Drive Gear (DS/LS-60)	1
■	27	28-106	Starter Drive Gear (DS/LS-61)	1
●	28	33-102	Woodruff Key 1/4" x 1"	1
●	29	33-103	Woodruff Key 3-16" x 7/8"	2
■	30	23-105	Arbor Shaft	1
●	31	53-167	Outer Retaining Ring	1
●	32	53-166	Inner Retaining Ring	1
▲ ●	33	25-121	O-ring	1
●	34	38-117	Thrust Washer	1
●	35	25-128	Inlet O-ring	1
■	37	44-120	Inlet Adapter	1
●	38	82-500	1/8" Pipe Plug	1
▲ ●	39	24-114	Seal	1
■	40	26-116	Grease Cap	1
▲ ●	41	53-161	O-ring	1
▲ ●	42	18-121	Cap Screw	3
■	43	5-104	Muffler (optional)	1
▲ ●	44	18 x 1	Long Roll Pin	1
▲ ●	45	18 x 12	Short Roll Pin	1

▲ **Kit 3-166** VANE KIT ● **Kit 3-168** MAJOR REPAIR KIT ■ **Sold Separately**

Conversion Kits ★ **Kit 6-3-244** DS 60/61 to LS 60/61 (Right Hand Rotation) † **Kit 6-3-245** DS 60/61 to LS 60/61 (Left Hand Rotation)

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See reverse for kits and part information