SERVICE MANUAL
MODEL LS-16
AIR/GAS STARTER

POW-R-QUIK

EXCELLENCE IN AIR STARTING SYSTEMS

6501 Barberton Avenue - Cleveland, Ohio 44102
Telephone: 216-281-7810 -- Fax: 216-281-2077
A Division of Maradyne Corporation

SECTION 1

GENERAL INFORMATION

1.1 Purpose. This manual contains installation and service instructions for the POW-R-QUIK model DS16 air and gas starting systems.

1.2 Application. These systems are primarily utilized in petroleum drilling and production equipment, gas compressor engines, water well drilling rigs, highway vehicles, marine engines, construction equipment, diesel powered generator sets 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 system specialist should be contacted.

1.3 Parts and Service. Parts and service are available through POW-R-QUIK's worldwide distributor network. Lubricators, operating valves and other STARTING SYSTEM COMPONENTS ARE AVAILABLE INDIVIDUALLY OR IN COMPLETELY PACKAGED INSTALLATION AND REBUILD KITS. AIR AND NITROGEN SUPPLY SYSTEMS are also available as options. For guaranteed reliability use only original Pow-R-Quik starting system components. For the name of the nearest Pow-R-Quik sales and service outlet contact:

SECTION 2

DESCRIPTION

2.1 Air/Gas Starting System. The POW-R-QUIK Model LS16 air and gas starting system consists of four basic components: The starter, lubricator, operating valves and air or gas supply.

NOTE

Contact the Pow-R-Quik distributor nearest you for information on genuine Pow-R-Quik starting system components.

Show in Figures 2.1 and 2.2 are schematics of typical POW-R-QUIK air and gas starting systems.

NOTE: CAUTION - PROPER VENTILATION IS REQUIRED FOR ALL ENGINES STARTED BY NATURAL GAS

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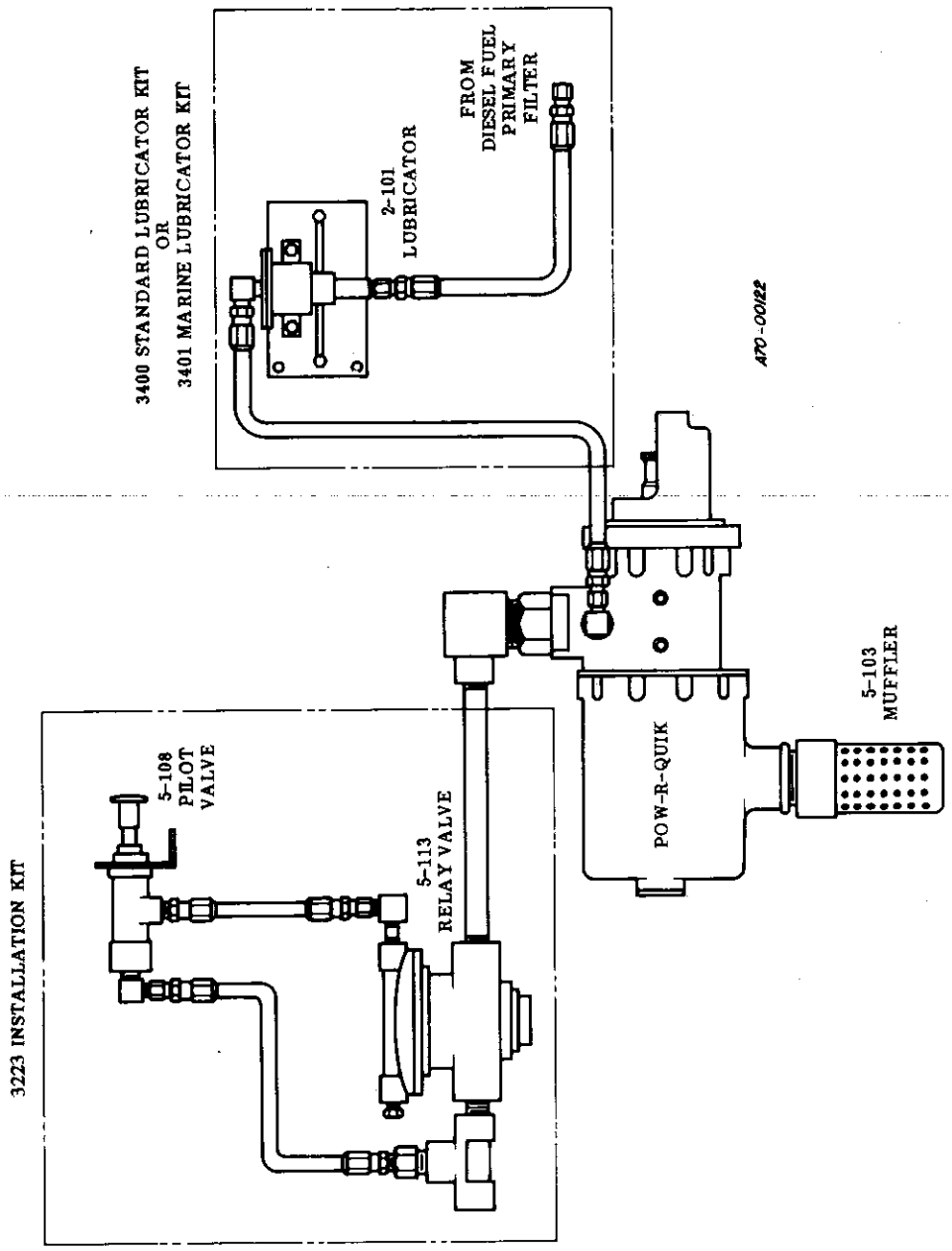


Figure 2.1. Typical Diesel Engine Installation

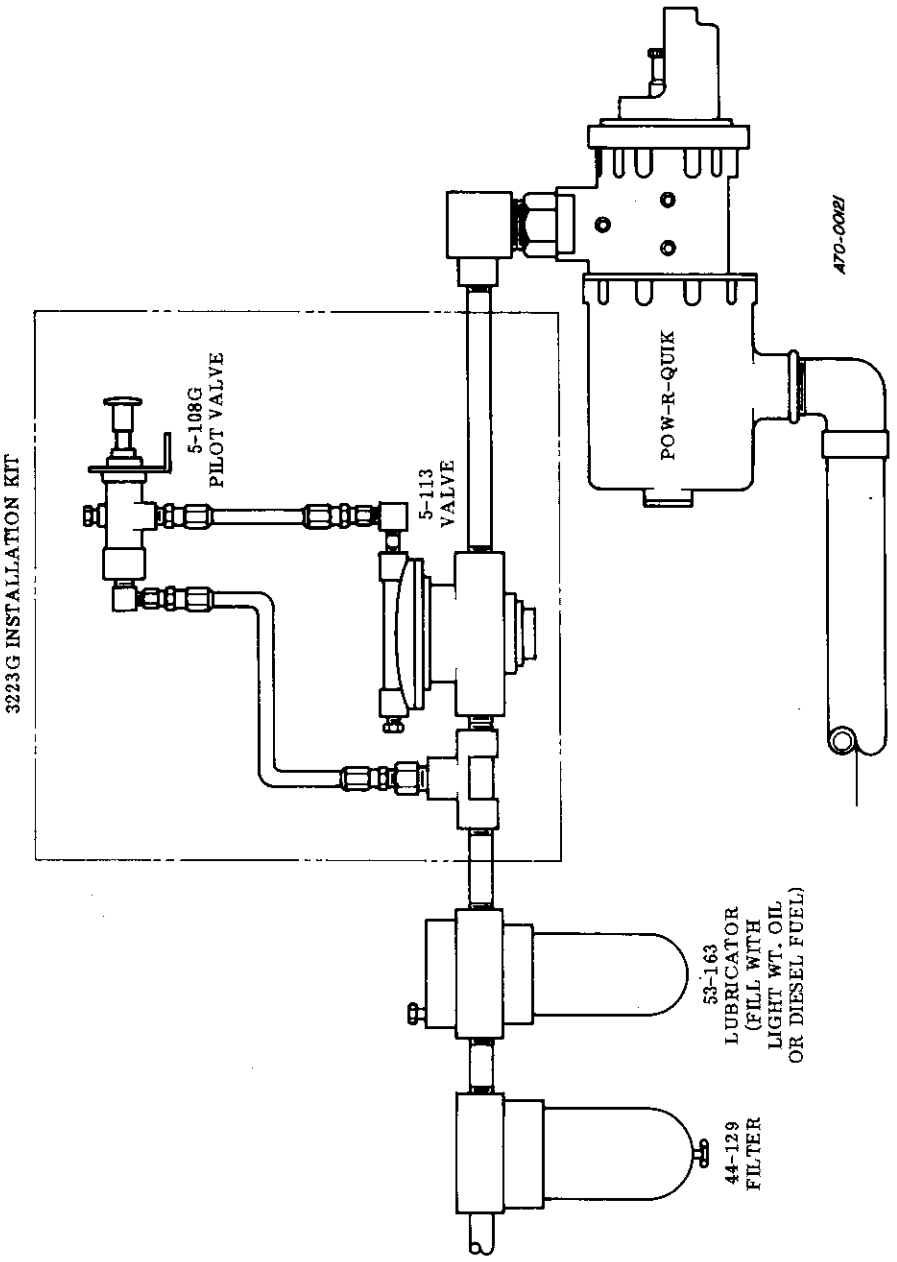


Figure 2.2. Typical Gas Engine Installation

2.2 Starter. The DS16 Starter with inertia drive may be operated manually or automatically from compressed air, natural gas or nitrogen. It is designed for use on diesel engines with displacements up to 500 cubic inches (8.2 litres) and gas engines with displacements up to 1,000 cubic inches (16.4 litres).

Listed in Table 2-1 are the various LS 16 starters available and the features of each.

Table 2-1. Starter Designations

Model	Rotation	Pitch	Teeth	Blank Size	Pressure Angle	PD*
DS16 RH1	Right	6/8	11	12	20°	2.000
DS16 LH1	Left	6/8	12	12	20°	2.000
DS16 RH2	Right	8/10	12	13	20°	1.625
DS16 RH3	Right	8/10	13	14	20°	1.750
DS16 RH4	Right	8/10	10	11	20°	1.375
DS16 LH4	Left	8/10	10	11	20°	1.375
DS16 RH5	Right	3 MOD	9	9.5	15°	1.122
DS16 RH6	Right	8/10	9	10	20°	1.250
DS16 LH6	Left	8/10	9	10	20°	1.250
DS16 RH7	Right	3 MOD	11	11.7	15°	1.382
DS16 RH8	Right	8/10	11	12	20°	1.500
DS16 RH9	Right	10/12	9	10	20°	1.000

* For Layout Purposes Only. Other drives and mounting adaptors may be available upon request.

NOTE

LS-16 Starters are available with a choice of SAE #1, #2, or #3 flanges.

SECTION 3

MAINTENANCE

3.1 General. Experienced mechanics will have no difficulty performing field repairs on the LS-16 starter. 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.

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

a. Check lubricator for proper operation. If applicable, check the lubricant level and refill, if necessary.

b. 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.

c. Inspect all threaded connections for tightness.

3.3 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°. Refer to Figure 3.1.

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

b. 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.

c. Install the air hose on the inlet adaptor.

d. Install exhaust piping or muffler, if applicable.

3.4. Starter Removal

a. Remove the air hose from the starter's inlet adaptor. If applicable, remove any exhaust piping or muffler.

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

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

d. Remove the starter from the engine.

3.5. Vane Kit Installation.

3.5a. Disassembly For Vane Kit Installation.

NOTE

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

(1) Disconnect all starter air lines.

NOTE

Refer to Figure 3.2 for parts identification.

(2) Remove nine (9) screws (#22) and lockwashers (#35) from the rotor housing (#1) and separate it from the inlet housing (#18). Discard the screws, lockwashers and the O-ring (#37).

(3) Remove the snap ring (#8), end plate (#4) and thrust washer (#6) from the rotor assembly (#5). Discard the snap ring (#8) and thrust washer (#6).

(4) Remove and discard all vanes (#12) and springs (#13) from the rotor assembly.

(5) Disconnect and remove the rotor casing assembly (#2) from the inlet end plate (#3) and the inlet housing (#18).

3.5.b. Inspection.

(1) Check all rotor slots for burrs or foreign matter. Clean rotor and remove burrs.

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

3.5.c. Assembly.

(1) Install a new O-ring (#37) on the inlet housing (#18).

(2) Install the rotor casing assembly (#2) with the long roll pin extended through the inlet plate (#3) and into the inlet housing (#18).

NOTE

Be sure that the inlet air passage or baffle on the rotor casing assembly (#2) properly aligns with the air passage on the inlet end plate (#3) and inlet housing (#18).

(3) Assemble the new springs (#13) on the new vanes (#12).

(4) Insert the assembled springs (#13) and vanes (#12) into the rotor slots on the rotor assembly (#5). Be sure the springs (#13) are placed downward into the rotor slots as shown in Figure 3.3.

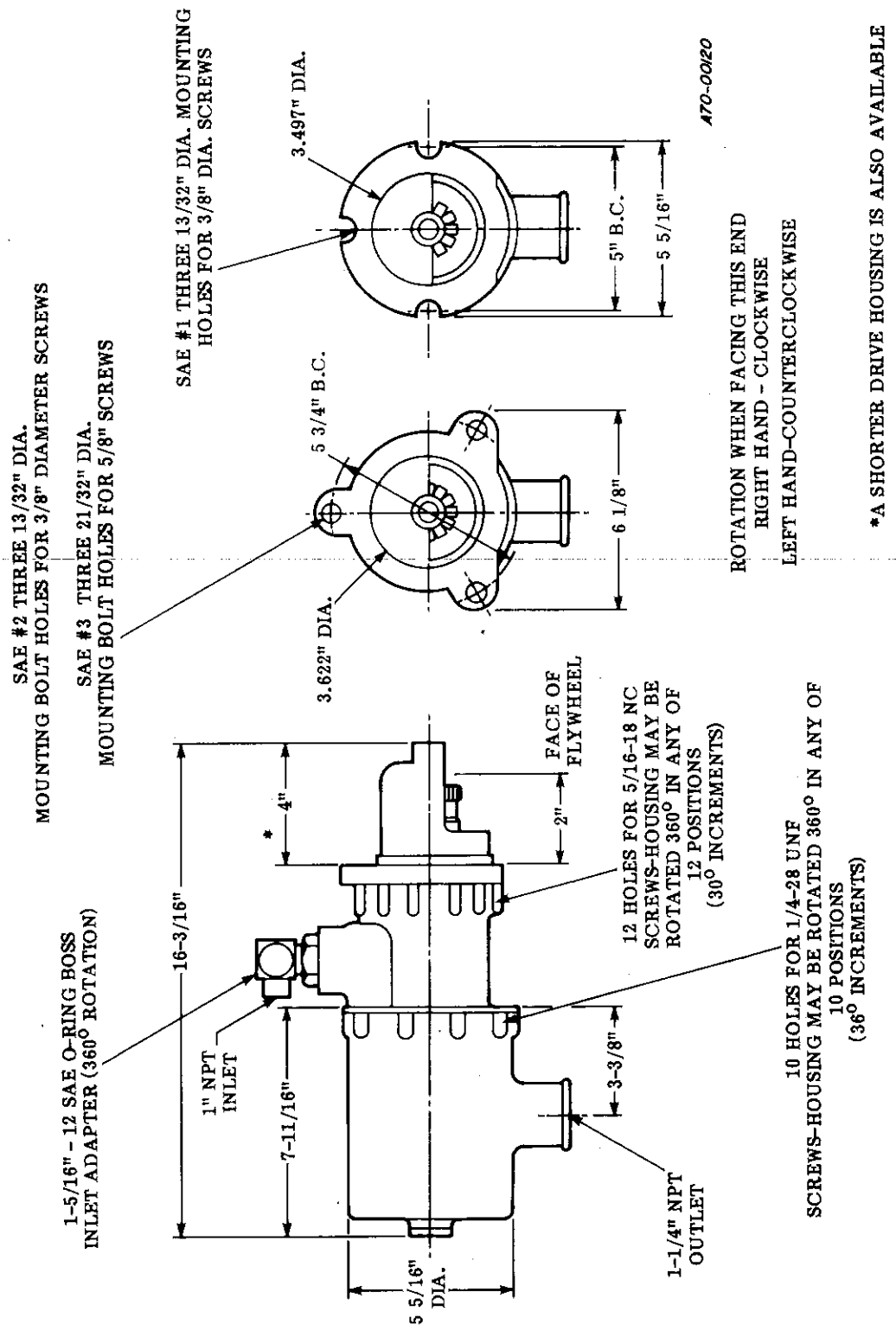


Figure 3.1. Starter Orientation

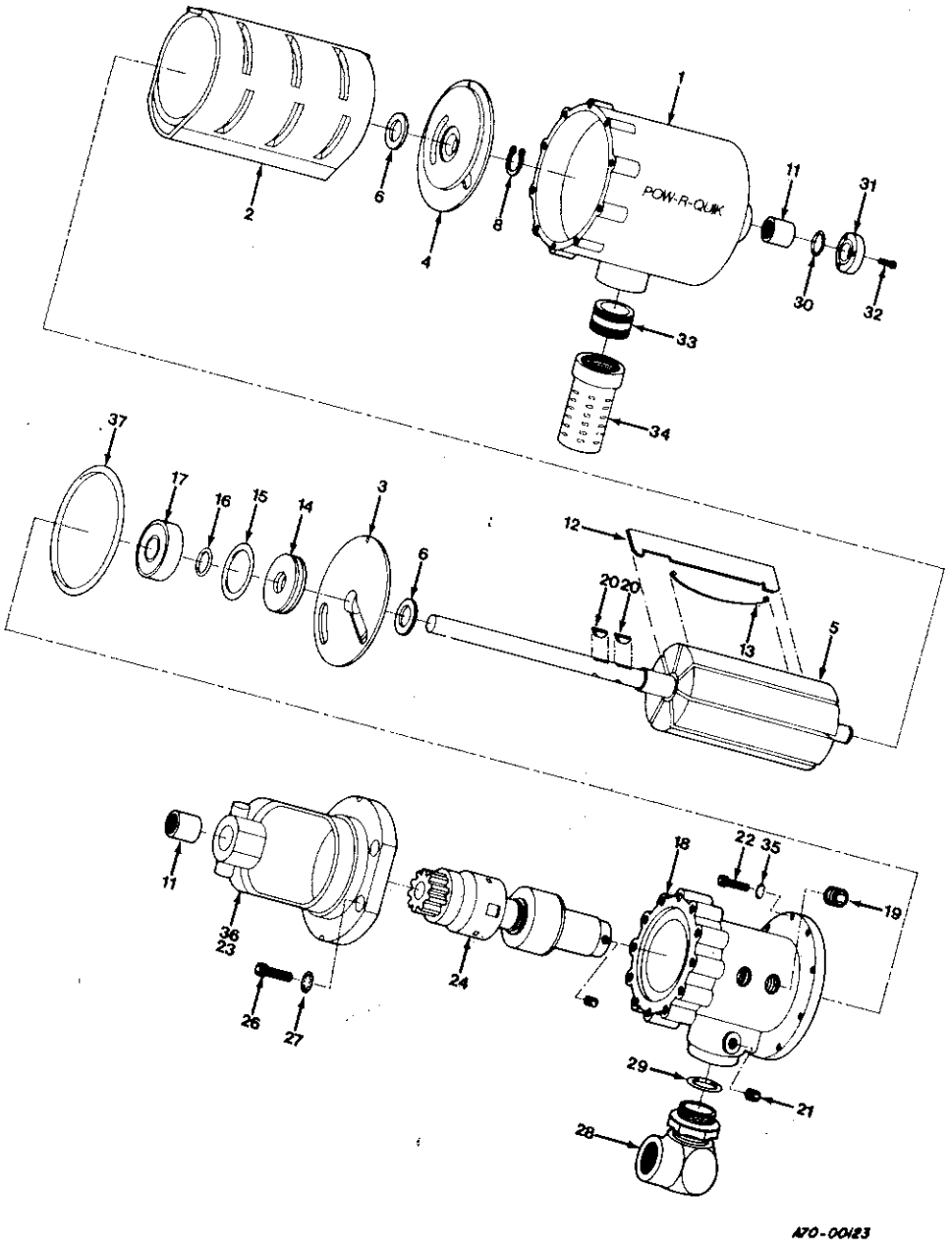


Figure 3.2. LS-16 Starter Components

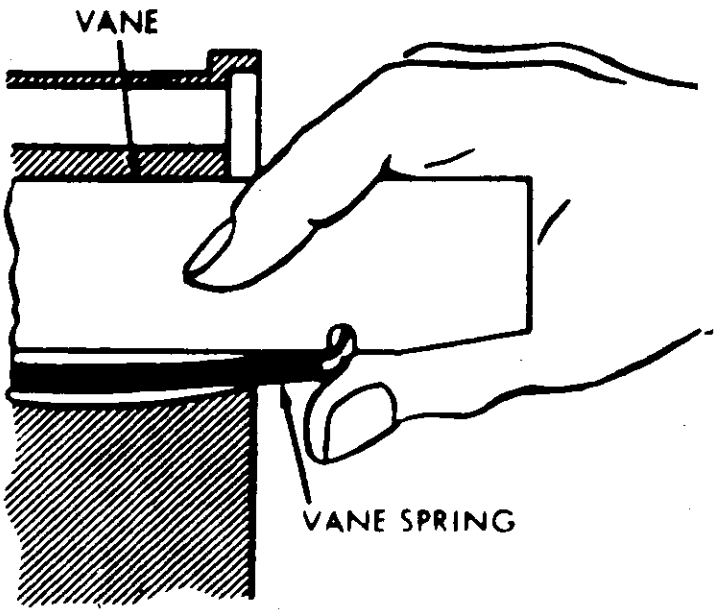


Figure 3.3. Vane and Spring Installation

(5) Position the new thrust washer (#6) on the end of the rotor assembly (#5).

(6) Install the end plate (#4) on the rotor casing (#2), making certain that the short roll pin on the rotor casing is properly inserted into the end plate (#4).

(7) Install the snap ring (#8) on the rotor assembly (#5), making certain that the snap ring seats properly into the appropriate groove.

(8) Properly pack bearing (#11) with lithium and molybdenum disulfide based grease.

(9) With the new O-ring (#37) properly positioned on the inlet housing (#18), work the rotor housing (#1) over the rotor casing (#2) until the rotor assembly's shaft is seated in the bearing (#11) and the two housings make contact.

(10) Rotate the rotor housing (#1) until its center punch mark lines up with the punch mark on the inlet housing (#18).

(11) Install the nine screws (#22) and lockwashers (#35) that hold the rotor housing (#1). Alternately tighten these screws to 10-12 ft. lbs. (13.6 - 16.3 Nm) of torque.

(12) Pour a small amount of light weight oil or diesel fuel into the starter air inlet (#28).

(VANE SPRINGS OPTIONAL)

(13) Bench test the reassembled starter, using a 1" air hose, or install the starter on the engine for testing.

(14) Install the air lines.

(15) Engine test the starter.

3.6 Rebuild Kit Installation.

NOTE

Refer to Figure 3.2 for parts identification.

3.6.a. Disassembly For Rebuild.

(1) Perform steps outlined in paragraph 3.5.a, "Disassembly For Vane Kit Installation".

(2) Remove three screws (#32) and grease cap (#31) from rotor housing (#1). Discard O'ring (#30).

(3) Remove and discard old bearing (#11) from rotor housing (#1).

(4) After performing the above mentioned steps, remove the four (4) screws (#26) with lock washers (#27) from the drive housing (#23 or #36). Remove the drive housing.

(5) Remove and discard the bearing (#11) from the drive housing (#23 or #36).

(6) Remove the inlet adaptor (#28) and discard the O-ring (#29).

(7) Remove the two (2) access plugs (#19) located in the side of the inlet housing (#18).

(8) Rotate the starter drive (#24) until the drive set screw (which locks the drive in position on the shaft) is visible through the access port.

(9) Insert a screwdriver through the appropriate port and loosen the drive set screw until it stops against the inside of the starter drive locking collar, which partially blocks access to the set screw. Refer to Figure 3.4.

(10) Using the screwdriver, move the locking collar to expose the head of the set screw.

(11) Continue to loosen the set screw (but do not remove set screw) until the starter drive (#24) can be removed.

NOTE

Some older starter drives included a coil spring which is visible through one access port and a set screw visible through the other. On these starter drives, lift the drive collar with one screwdriver and loosen the set screw with another screwdriver. See Figure 3.4.

(12) Separate the rotor assembly (#5) from the inlet housing (#18).

NOTE

It may be necessary to gently pry the inlet end plate (#3) from the inlet housing (#18), using a screwdriver or to lightly tap the drive shaft end of the rotor assembly with a rubber mallet.

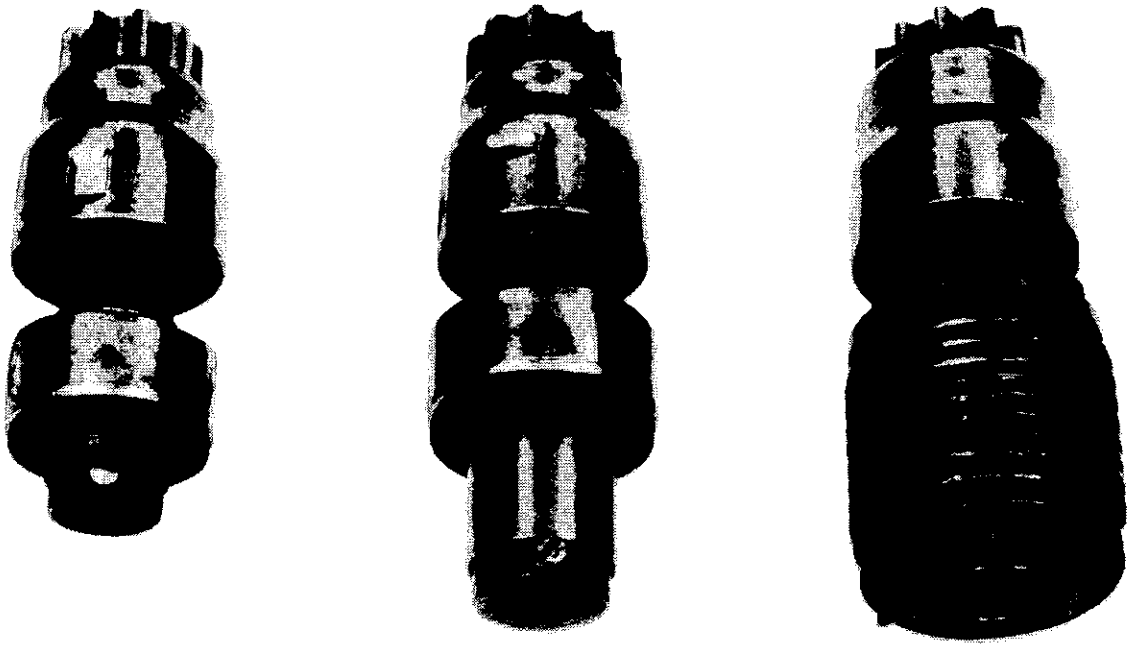


Figure 3.4. Three Types of LS-16 Starter Drives

(13) With a bench vise or other fixture supporting the inlet end plate, press or very gently tap the drive shaft end of the rotor assembly (#5) with a rubber mallet. This will help free the inlet end plate (#3), sealing spacer (#14) and bearing (#17) for removal. See Figure 3.5.

(14) Remove and discard the bearing (#17) from the drive shaft.

(15) Remove the sealing spacer (#14) and discard both O-rings (#15 and #16).

(16) Remove the inlet end plate (#3).

(17) Remove and discard the thrust washer (#6) from the drive shaft end of the rotor assembly (#5).

3.6.b. Inspection.

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

NOTE

A replacement starter drive is not included in the LS 16 rebuild kit.

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

CAUTION

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

3.6.c. Assembly.

(1) Install the new thrust washer (#6) on the long end of the rotor assembly shaft (drive end).

(2) Place the inlet end plate (#3) on the shaft and over the thrust washer.

(3) Mount the new O-rings (#15 and #16) on the sealing spacer (#14) and install the sealing spacer on the shaft next to the inlet end plate.

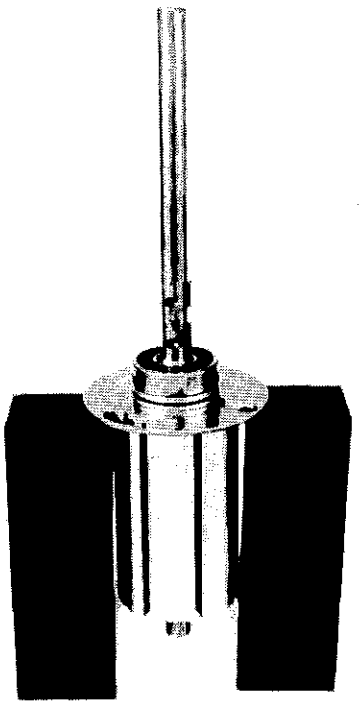


Figure 3.5. Inlet End Plate, Spacer and Bearing Removal

(4) Press the new bearing (#17) on the shaft until it bottoms lightly against the sealing spacer. Hold the shaft and make certain that the end plate will rotate freely.

(5) Install the rotor casing assembly (#2) with the long roll pin placed through the inlet end plate (#3). Make certain that the air passage (baffle) on the rotor casing assembly (#2) is properly aligned with the air passage on the inlet end plate (#3).

(6) Install the new springs (#13) on the new vanes #12 and insert into the slots on the rotor assembly (5). Be sure the springs (#13) are placed downward into the rotor slots. Refer to Figure 3.3.

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

(8) Install the end plate (#4) on the rotor casing, making certain that the thrust washer (#6) is in place and that the short roll pin on the rotor casing (#2) is properly inserted into the end plate (#4).

(9) Properly set the snap ring (#8) into the appropriate groove on the rotor assembly (#5).

(10) Install the new bearing (#11) in the rotor housing (#1) with the bearing end surface flush with the inside surface of the rotor housing.

(11) Properly pack the bearing (#11) with lithium and molybdenum disulfide based grease.

(12) Install the rotor housing (#1).

(13) Position the starter in a bench vise or other fixture with the long shaft end of the starter up.

(14) Install the new O-ring (#37) on the inlet housing (#18).

(15) Place the inlet housing (#18) over the drive shaft and in position against the rotor housing.

(16) With the air passages (baffle) on the rotor casing (#2) and inlet end plate (#3) aligned with the air passage of the inlet housing (#18), carefully insert the long roll pin in the rotor casing (#2) through the inlet end plate (#3) and into the inlet housing (#18).

(17) Align the center punch mark on the rotor housing (#1) with the center punch mark on the inlet housing (#18).

(18) Install the nine (9) new screws (#22) with lockwashers (#35) and alternately tighten the screws to 10-12 ft. lbs. (13.6 - 16.3 Nm) of torque.

(19) With the two (2) hardened keys (#20) in place on the long end of the rotor shaft, slide the starter drive (#24) over the shaft and align the set screw with its appropriate locking hole.

NOTE

The rotor shaft has two (2) set screw locking holes. Check Figure 3.4 to determine which position is correct.

(20) Lock the drive set screw and install both access plugs (#19).

(21) Install the new bearing (#11) on the drive housing (#23 or #36).

(22) Properly pack the new bearing with lithium and molybdenum disulfide based grease.

(23) Slip the drive housing (#23 or #36) over the shaft and align the center punch mark on the drive housing with the punch mark on the inlet housing (#18).

(24) Install the four (4) screws (#26) and lockwashers (#27) in the drive housing. Alternately tighten each to 10-12 ft. lbs. (13.6 - 16.3 Nm) of torque.

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

(26) Position a new O-ring (#29) on the inlet adaptor (#28) and install the adaptor on the inlet housing (#18).

(27) Remove the starter from the vise or fixture.

(28) Install the grease cap (#31) with a new O-ring (#30) and three (3) screws (#32).

(29) Bench test the rebuilt starter, using a 1 inch air hose and/or install on the engine for test.

(30) Install the air lines.

(31) Engine test the starter.

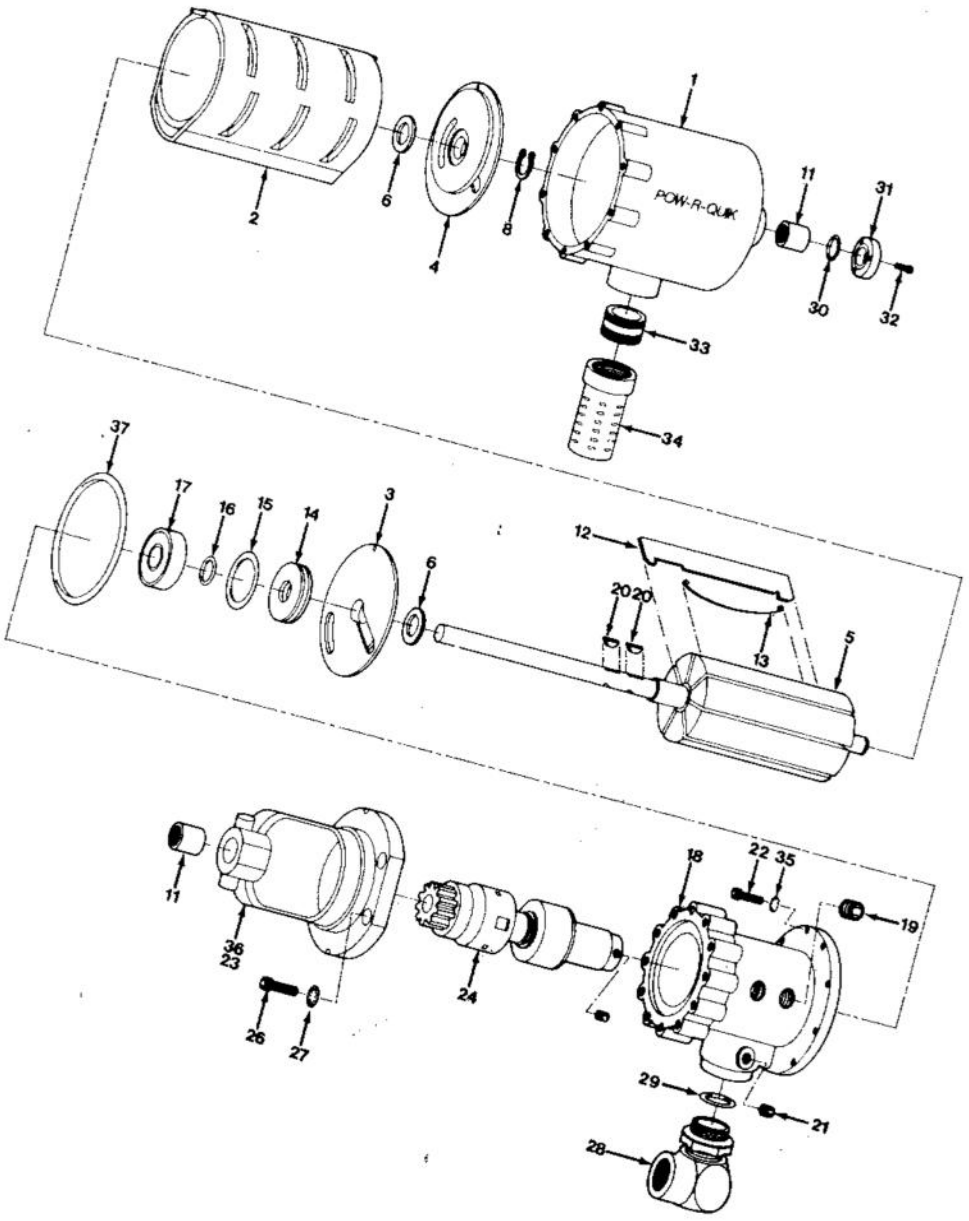
SECTION 4

PARTS

4.1. General - The parts list as shown is for the standard LS-16 Air/Gas Starters only.

NOTE

Special starters with a PQS (POWER-R-QUIK Special) designation may require different parts. Contact a factory representative. (See paragraph 1.3, Parts and Service.)



(VANE SPRINGS OPTIONAL)

Figure 4.1. LS-16 Starter Components

LS 16 STARTER PARTS LIST

INDEX NO.	PART NO.	DESCRIPTION	QUANITY PER UNIT
4.1			
-1	26-106	Rotor Housing	1
-2	34-101R or 34-101L*	Rotor Casing Assembly	1
-3	29-503R or 29-503L*	Inlet End Plate	1
-4	29-502R or 29-502L*	End Plate	1
-5	30-103	Rotor Shaft Assembly SAE #1 Flange	1
-5	30-108	Rotor Shaft Assembly SAE #3 Flange	1
-6	38-123	Thrust Bearing Assembly	2
-8	25-117	Rotor Retaining Ring	1
-11	24-105	Bearing	2
-12	14-105	Rotor Vane	7
-14	68-107	Sealing Spacer	1
-15	25-127	O-RIng	1
-16	25-131	O-ring	1
-17	24-106	Bearing	1
-18	21-682	Inlet Housing	1
-19	21-689	Plug	2
-20	21-688	Woodruff Key (Hardened)	2
-21	82-500	Plug	2
-22	18-117	Screw	9
-23	21-653	Drive Housing (SAE #3)	1
-24	8-11	Drive for LS-16 RH1	1
	8-117	Drive for LS-16 LH1	1
	8-115	Drive for LS-16 RH2	1
	8-126	Drive for LS-16 RH3	1
	8-120	Drive for LS-16 RH4	1
	8-124	Drive for LS-16 LH4	1
	8-118	Drive for LS-16 RH5	1
	8-121	Drive for LS-16 RH6	1
	8-126	Drive for LS-16 LH6	1
	8-123	Drive for LS-16 RH7	1
	8-122	Drive for LS-16 RH8	1
	8-125^	Drive for LS-16 RH9	1
-26	21-668	Screw	4
-27	21-669	Lockwasher	4
-28	21-662	Inlet Adapter	1
-29	53-171	O-ring	1
-30	53-160	O-ring	1
-31	25-115	Grease Cap	1
-32	18-121	Screw	3
-33	6-107	Nipple (Optional)	1
-34	5-103	Muffler (Optional)	1
-35	38-112	Lockwasher	9
-36	21-667	Drive Housing (SAE #1)	1
-36	21-653	Drive Housing (SAE #3)	1
-37	50-128	O-ring	
	3-131	**VANE KIT FOR LS-16 STARTER INCLUDES:**	
-12	14-105	Rotor Vane	7
-6	38-123	Thrust Bearing Assembly	2
-8	25-117	Retaining Ring	1
-22	18-117	Screw	9

LS 16 STARTER PARTS LIST (CONTINUED)

INDEX NO.	PART NO.	DESCRIPTION	QUANITY PER UNIT
4.1			
-35	38-112	Lockwasher	9
-37	50-128	O-ring	1
	3-132	**REBUILD KIT FOR LS-16 STARTER INCLUDES:**	
-12	14-105	Rotor Vane	7
-22	18-117	Screw	9
-32	18-121	Screw	3
-11	24-105	Bearing	2
-17	24-106	Bearing	1
-26	21-668	Screw	4
-27	21-669	Lockwasher	4
-8	25-117	Retaining Ring	1
-15	25-127	O-ring	1
-16	25-131	O-ring	1
-35	38-112	Lockwasher	9
-37	50-128	O-ring	1
-30	53-160	O-ring	1
-29	53-171	O-ring	1
-14	68-107	Sealing Spacer	1
-6	38-123	Thrust Bearing Assembly	2
-5	30-103	Rotor Assembly	1
-2	34-101L	Rotor Casing Assembly	1
-12	14-106	Rotor Vanes	7
-13	20-122	Vane Springs	7
-3	29-501L	Inlet End Plate	1
-14	68-107	Sealing Spacer	1
-15	25-127	O-ring	1
-16	25-131	O-ring	1
-17	24-106	Bearing	1
-37	50-128	O-ring	1
-22	18-117	Screws	9
-35	38-112	Lock Washers	9
-20	21-688	Woodruff Key (Hardened)	2
-26	21-668	Screws	4
-27	21-669	Lockwashers	4
	3-114-LH	**DS-16LH MOTOR KIT (Assembled) for Left Hand Starters includes:**	
-8	25-117	Retainer Ring	1
-4	29-500R	End Plate	1
-6	38-114	Thrust Washer	2
-5	30-103	Rotor Assembly	1
-2	34-101R	Rotor Casing Assembly	1
-12	14-106	Rotor Vanes	7
-13	20-122	Vane Springs	7
-3	29-501R	Inlet End Plate	1
-14	68-107	Sealing Spacer	1
-15	25-127	O-ring	1
-16	25-131	O-ring	1
-17	24-106	Bearing	1
-37	50-128	O-ring	1
-22	18-117	Screws	9
-35	38-112	Lockwashers	9
-20	21-688	Woodruff Key (Hardened)	2
-26	21-668	Screws	4
-27	21-669	Lock Washers	4

DISTRIBUTOR SALES TO EXPORT

Sales made by the Dealer for export accounts will become the full responsibility of the Dealer, including: papers of transaction, parts and service, all warranty costs, licenses, and all other obligations therein associated.

APPLICABLE LAW AND TERMS OF SALE

Orders shall be subject only to the terms and conditions set forth herein notwithstanding any terms and conditions that may be contained in any order, acknowledgment, or other form of buyer. Such terms and conditions of buyer shall not bind **POW-R-QUIK** unless specifically accepted by it in writing, whether or not they materially alter the order. Orders shall be governed, in all respects, by the laws of the State of Ohio.

WARRANTY

POW-R-QUIK provides a limited warranty on the products it manufactures and sells under the company name against the failure to perform properly within certain limits of time, application, performance, installation, abuse and alteration, because of a defect in material and/or workmanship. Copies of **POW-R-QUIK**'s standard product warranties are provided with its products and its distributor/dealer sales manuals and are available upon request from **POW-R-QUIK**.

POW-R-QUIK standard product warranties will apply and Distributors, Dealers, Sales Representatives, or Agents are not authorized to make other warranties on resale with respect to **POW-R-QUIK**. It is imperative that the product warranty be read carefully.

POW-R-QUIK is not obligated to incorporate new design modifications to products in service or in the Distributor's or Dealer's inventories.

ORIGINAL EQUIPMENT MANUFACTURERS AND GOVERNMENT ACCOUNTS

POW-R-QUIK reserves the right to solicit business and to make sales directly to original equipment manufacturers and to government accounts. Dealers will be protected where negotiated and stated in writing a request to service these accounts.