SERVICE MANUAL
MODELS LS-23 AND LS-24
PRE-ENGAGED
LUBE-FREE
AIR/GAS STARTERS

POW-R-QUIK

EXCELLENCE IN AIR STARTING SYSTEMS

4540 West 160th Street - Cleveland, Ohio 44135-2628
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 LS-23 and LS-24 air and gas starting systems.

Application. These systems are primarily utilized in petroleum drilling and production equipment, air and gas compressor engines, water well drilling rigs, highway vehicles, 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 system specialist should be contacted.

The LS-23/LS-24 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, prolonged cranking, or in starting environments with excessive heat buildups, consult with a POW-R-QUIK starting system specialist.

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.

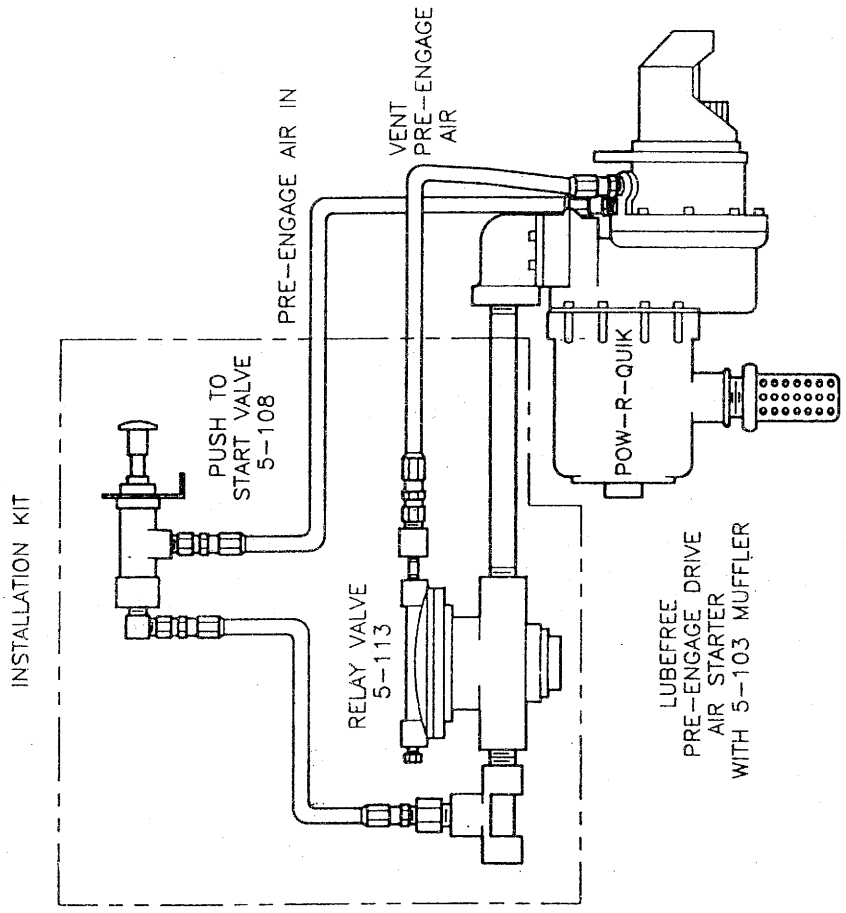

FIGURE 1. TYPICAL DIESEL ENGINE INSTALLATION

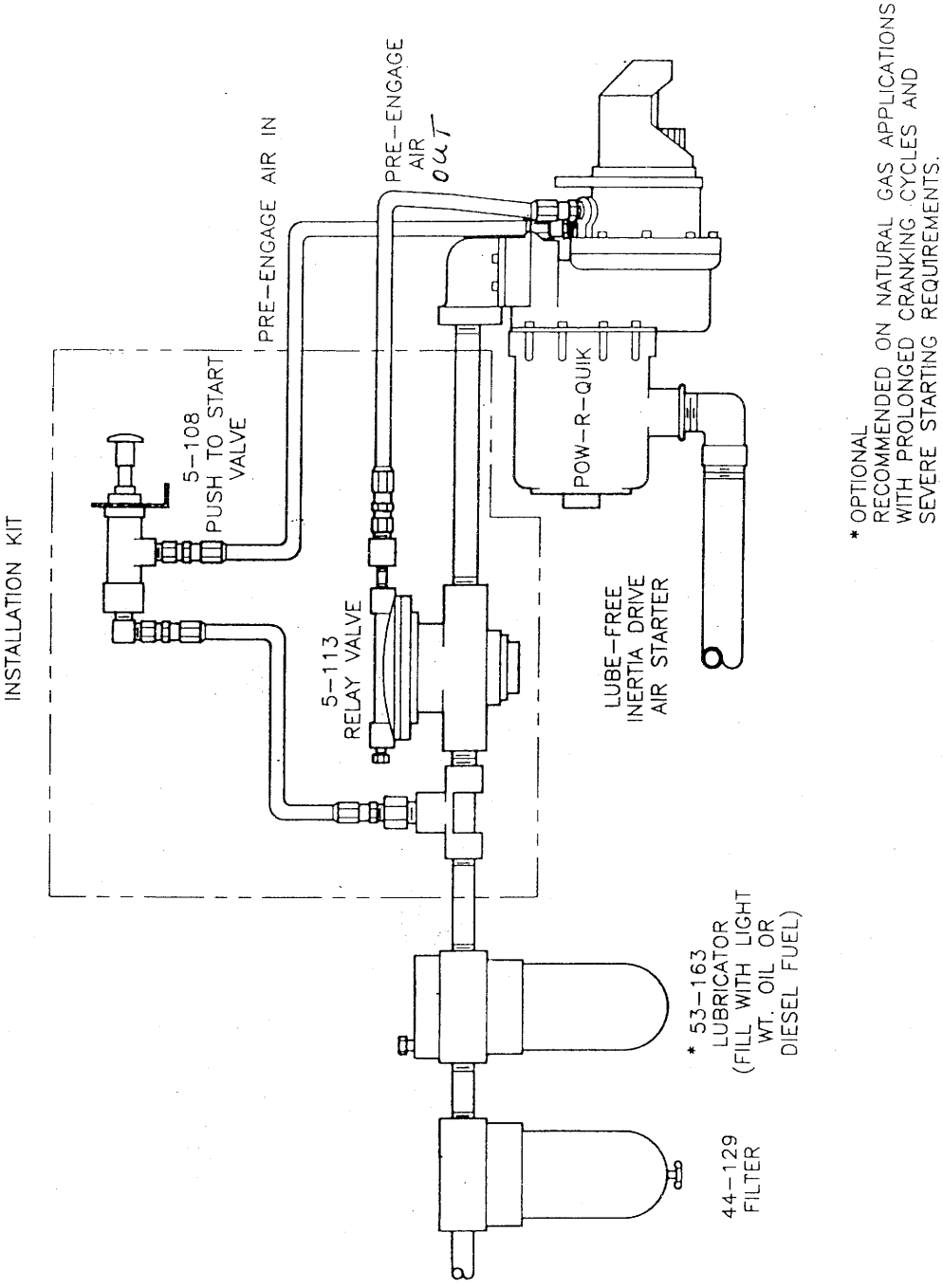

FIGURE 2. TYPICAL GAS ENGINE INSTALLATION

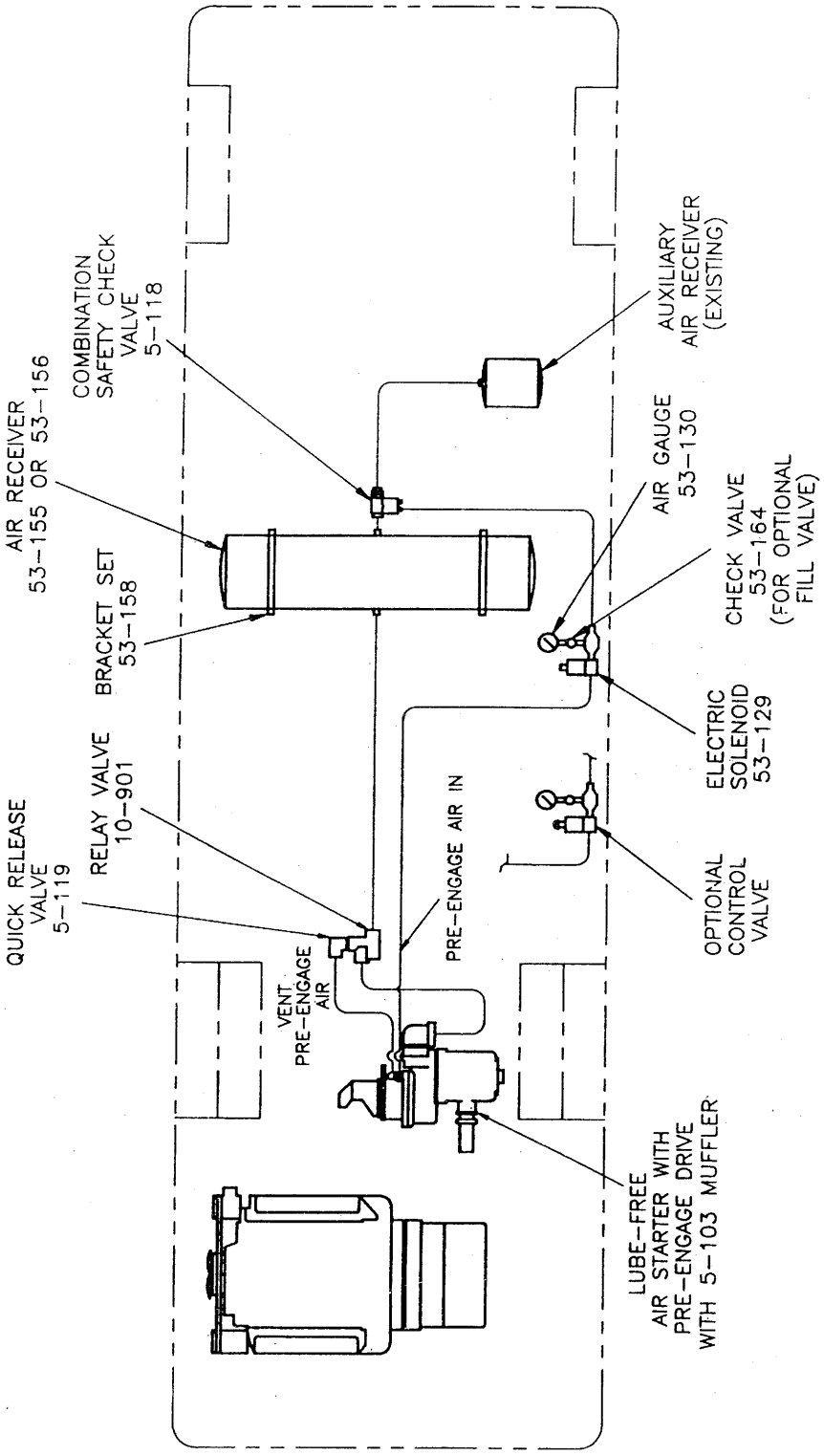

FIGURE 3. TYPICAL TRANSIT BUS AIR STARTING SYSTEM

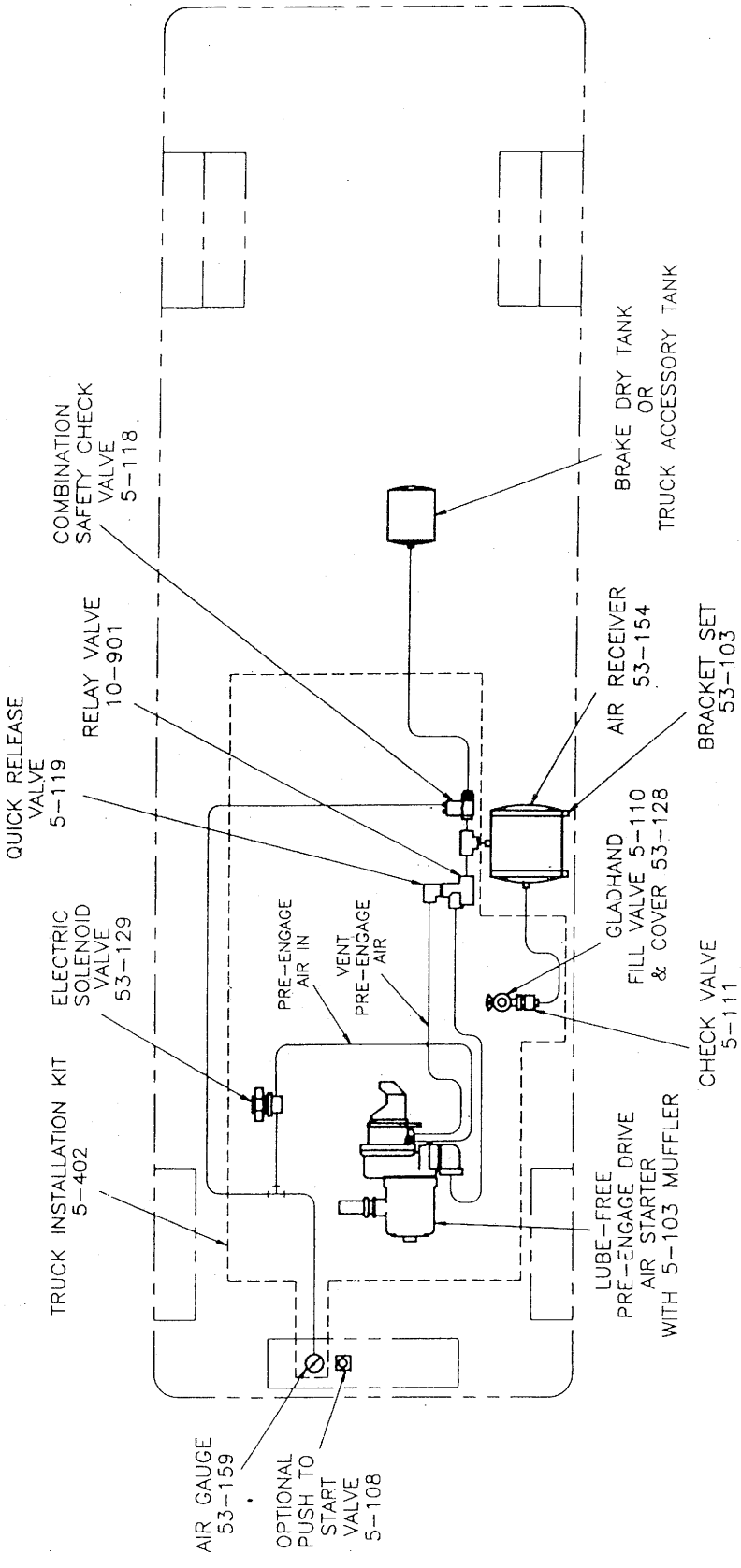

FIGURE 4. TYPICAL TRUCK AIR STARTING SYSTEM

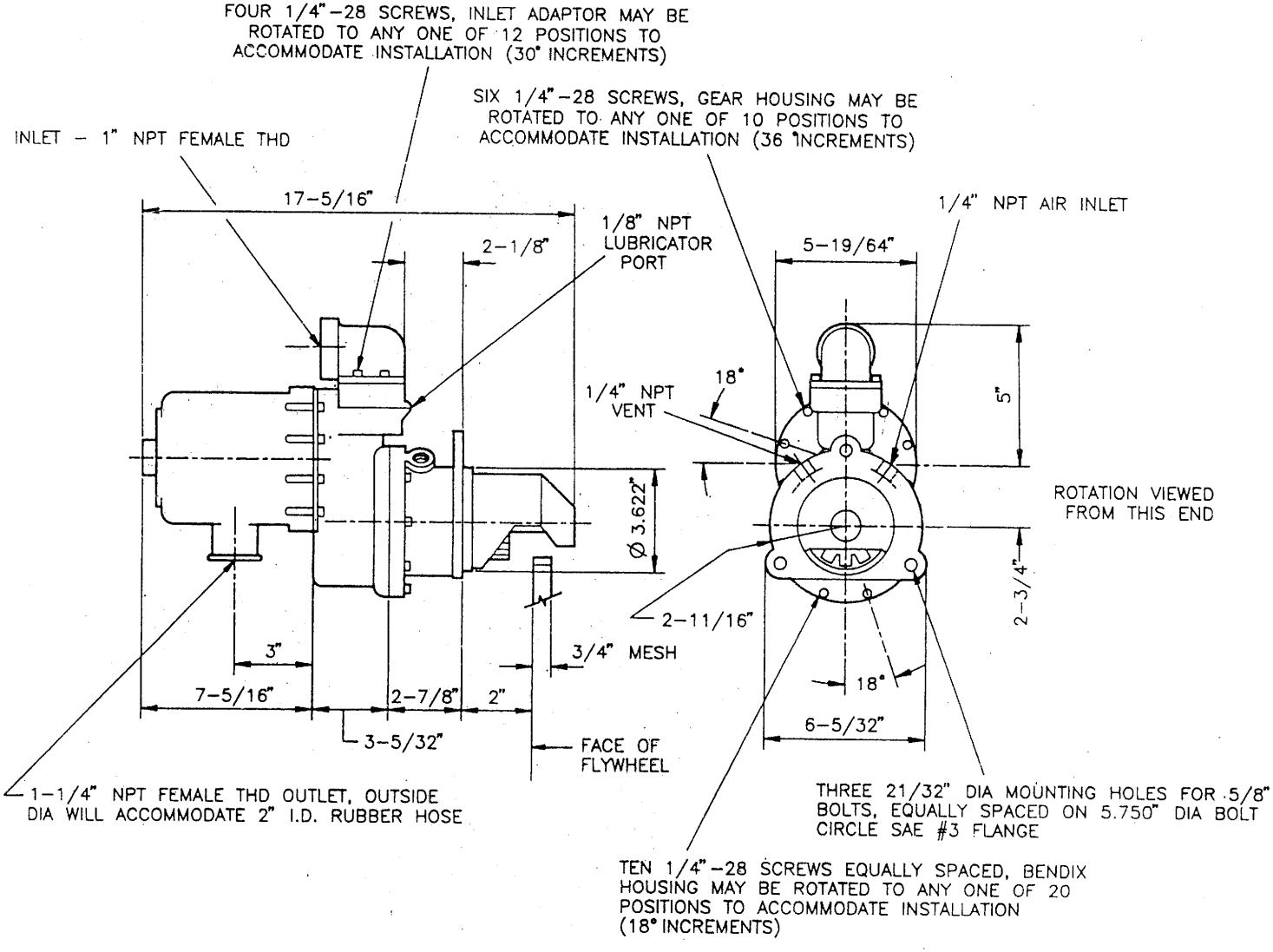

FIGURE 5. STARTER ORIENTATION

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 5.

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. Use minimum 1" air line. Blow all air lines before installation.

4. Install pre-engage air lines from 1/4" NPT pre-engage air inlet and vent ports on starter drive housing to the control valves, as shown in Figure 1.

5. Install exhaust piping or muffler, if applicable.

Starter Removal.

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

2. Disconnect pre-engage air lines on starter drive housing.

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

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

5. Remove the starter from the engine.

Vane Kit Installation.

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 7. for parts identification.

2. Remove six (6) screws (#26) and lockwashers (#27) from the rotor housing (#1) and separate it from the gear housing (#21). Discard the screws, lockwashers and the o-ring (#20).

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

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

5. Disconnect and remove the rotor casing assembly (#2) from the inlet end plate (#3) and the gear housing (#21).

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.

Assembly.

1. Install a new o-ring (#20) on the gear housing (#21).

2. Install the rotor casing assembly (#2) with the long roll pin extended through the inlet end plate (#3) and into the gear housing (#21).

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 gear housing (#21).

4. Insert vanes (#12) into the rotor slots on the rotor assembly (#5).

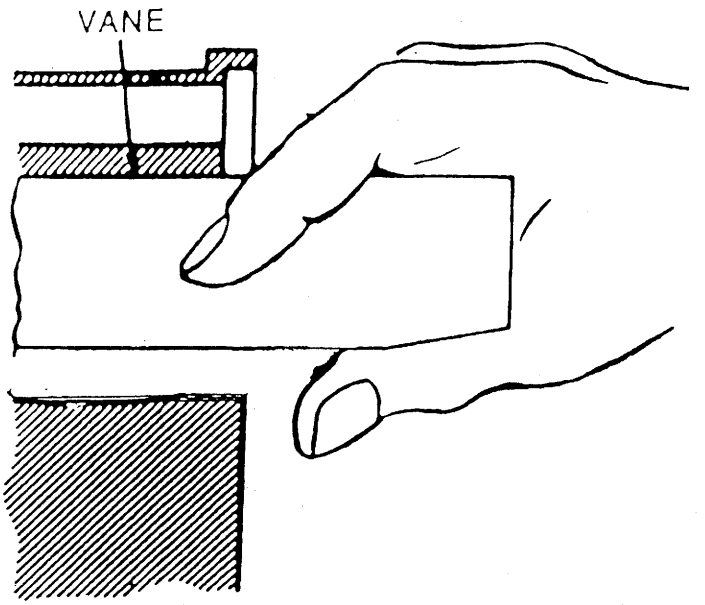

FIGURE 6. VANE INSTALLATION

5. Make sure bearing assembly (#6) is packed with bearing grease.

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

7. 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).

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

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

10. With the new o-ring (#20) properly positioned on the gear housing (#21), 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.

11. Rotate the rotor housing (#1) until its center punch mark lines up with the punch mark on the gear housing (#21).

12. Install the six screws (#26) and lockwashers (#27) that hold the rotor housing (#1). Alternately tighten these screws to 6-8 ft. lbs. (8.16 - 10.88 NM) of torque.

13. Pour a small amount of light weight oil or diesel fuel into

the starter air inlet (#25).

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

15. Install the air lines. If the pre-engage starter is to be engine tested, install pre-engage air inlet and vent lines.

16. Engine test the starter.

Rebuild Kit Installation.

NOTE

Refer to Figure 7. for parts identification.

Disassembly For Rebuild.

1. Perform steps outlined in "Disassembly For Vane Kit Installation".

2. Remove rotor shaft assembly including the rotor shaft (#5), inlet end plate (#3), sealing spacer (#14), bearing (#17), and gear (#18). This should be removed manually by pulling straight away from the gear housing (#21).

3. Disassemble the rotor shaft section by removing retaining ring (#19) from the gear end of the shaft.

4. Lift gear (#18) off the shaft splines and remove bearing (#17) with bearing pullers.

5. Remove sealing spacer (#14) with o-rings (#15 & #16). Remove inlet end plate (#3) and thrust bearing assembly (#6).

6. Discard bearing (#17), o-rings (#15 & #16), thrust bearing assembly (#6), and retaining ring (#19).

7. Remove three screws (#40) and grease cap (#39) from rotor housing (#1). Discard o-ring (#38).

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

9. Remove four screws (#26) with lockwashers (#27) from inlet adapter (#25).

10. After removing inlet adapter (#25), remove and discard o-ring (#24).

11. Clean inlet screen (#23), if required.

12. Remove ten screws (#26) with lockwashers (#27) from drive housing (#37). These screws compress the pre-engage spring and are under tension. ***CAUTION*** The drive housing will bounce outward about an inch after these screws are removed. Remove the drive housing.

13. Remove and discard bearing (#36), snap ring (#34), and rotary seal (#45) from drive housing (#37).

14. Pull starter drive (#35), spring (#46), cylinder (#43), and piston (#44) from arbor shaft (#30), then pull the arbor shaft subassembly out of gear housing (#21).

15. Disassemble the arbor shaft subassembly by removing thrust washer (#29) and gear (#32).

16. Separate bearing (#33) from starter drive (#35) by removing retaining ring and washer (#35).

17. Inspect and, if necessary, remove and discard needle bearing (#28), located in gear housing (#21).

18. Remove o-rings (#47) & (#48) from piston (#44) and cylinder (#43).

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-23 and LS-24 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.

Assembly.

1. Position thrust bearing assembly (#6), then inlet end plate (#3) on the splined end of rotor shaft assembly (#5). The

smaller outside diameter on the end plate should be facing the slotted rotor body and the small counterbore should fit over the thrust bearing assembly (#6).

2. Position new o-rings (#15 & #16) on sealing spacer (#14) and place on the rotor shaft assembly adjacent to inlet end plate (#3).

3. Press new bearing (#17) on the shaft until it bottoms lightly against sealing spacer (#14). Make certain that the end plate will rotate freely.

4. Mount rotor spur gear (#18) on splined end of rotor shaft assembly and install retaining ring (#19) with the use of snap ring pliers.

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 new springs (#13) on 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 6. Make sure bearing assembly (#6) is packed with bearing grease.

7. Position the new thrust bearing assembly (#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 bearing assembly (#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 retaining 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. Slip the rotor housing (#1) over the rotor casing assembly with the exhaust port pointing as necessary for punch marks to align properly at assembly.

13. Check to see that the rotor is free to rotate by turning the spur gear (#18).

14. Check for freeness of vanes by rotating rotor slowly and observing vanes through exhaust port.

15. Press the needle bearing (#28) into the gear box housing (#21).

16. Install new o-ring (#20) on gear housing (#21).

17. Align the long roll pin in the rotor casing assembly (#2) with the hole in the gear housing (#21) and attach the gear housing (#21) to the rotor housing (#2) with six screws (#26) and lock washers (#27) (Refer to marks made during disassembly). The gear housing may be rotated 360° in 36° increments, with respect to the rotor housing. Torque the six screws (#26) to 6-8 ft. lbs. (8.16 - 10.88 NM).

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 gear housing (#21).

18. Press the starter drive gear (#32) onto the arbor (#30). Make sure the key (#31) is in place.

19. Check the radial ball bearing (#33) on the starter drive, (#35) and replace washer & retaining ring (#35) if needed. Keep the sealing side of the bearing toward the splined portion of the arbor shaft (#30).

20. Install new o-rings in piston (#44) and cylinder (#43), and apply grease to the sealing faces of the cylinder.

21. Place about one-fourth pint of lithium and molybdenum disulfide based grease into the gear box housing (#21).

22. Press the gear on to the arbor shaft (#30) with the gear recess facing the short end of the shaft. Place the thrust washer (#29) on the arbor shaft against the gear and insert the arbor shaft with parts attached, into the housing (#21).

23. Slide the cylinder (#43), piston (#44), spring (#46), and starter drive (#35) over the arbor shaft spline (#30).

24. Lubricate the needle bearing (#36) with lithium and molybdenum disulfide based grease and press the rotary seal (#45) into the drive housing (#37) with the lipside up, until it is flush with the inside of the housing. Install bearing (#36) and snap ring (#34).

25. The drive housing (#37) may be located 360° in 18° increments

with respect to the gear housing (#21). (Refer to marks made during disassembly for proper orientation).

26. Slide drive housing (#37) over the starter drive (#35) and spring (#46) , and, pressing with enough force to compress the spring, attach the drive housing (#37) to the gear housing (#21) with ten screws (#26) and lockwashers (#27). Torque the screws to 6-8 ft. lbs. (8.16 - 10.88 NM).

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

28. Position new o-ring (#24) and inlet strainer (#23) on the gear housing (#21).

29. Align inlet adapter (#25) with punch marks on gear housing and install four screws (#26) and lockwashers (#27). Alternately tighten screws to 6-8 ft. lbs. (8.16 - 10.88 NM) of torque.

30. Remove the starter from the vise or fixture.

31. Install the grease cap (#39) with a new o-ring (#38) and three screws (#40). Tighten screws to 10-12 in. lbs. (1.13NM - 1.36 NM).

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

33. Install the air lines. If testing the pre-engage starter on an engine, install pre-engage air inlet and vent lines.

34. Engine test the starter.

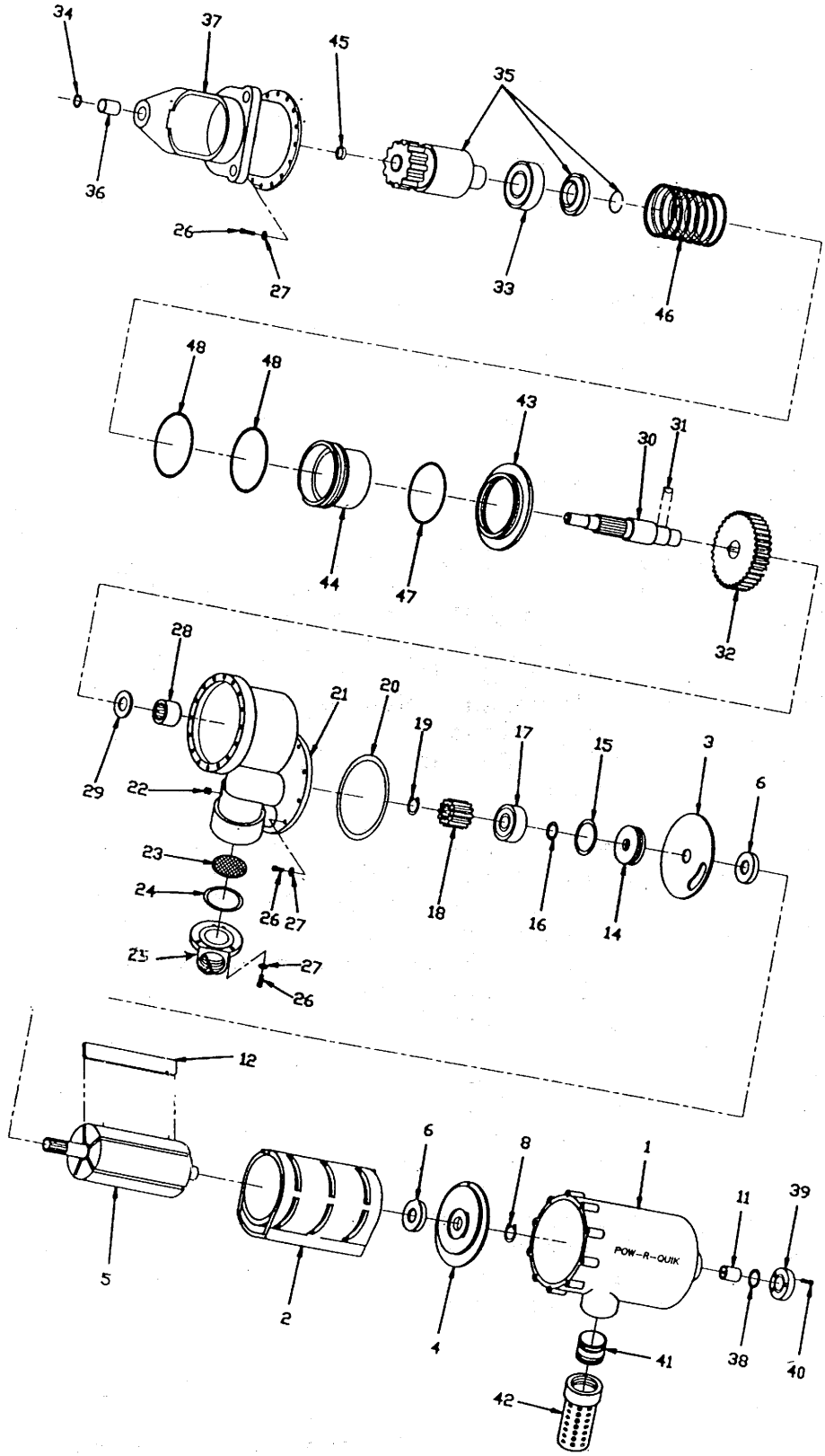

FIGURE 7. LS-23 AND LS-24 PRE-ENGAGE STARTER COMPONENTS

LS-23/LS-24 STARTER PARTS LIST
PRE-ENGAGE

INDEX NO.	PART NO.	DESCRIPTION	QUANTITY PER UNIT
-1	26-106	Rotor Housing	1
-2	34-101R or 34-101L*	Rotor Casing Assembly	1
-3	29-503RX or 29-503L*	Inlet End Plate	1
-4	29-502RX or 29-502L*	End Plate	1
-5	30-101	Rotor Shaft Assembly - Standard	1
	30-104	Rotor Shaft Assembly - Super Torque	1
-6	38-123X	Thrust Bearing Assembly	2
-8	25-117	Retaining Ring, Rotor	1
-11	24-105	Bearing, Needle	1
-12	14-105	Rotor Vanes - Standard	5
		Vane Springs	5
-14	68-107	Sealing Spacer	1
-15	25-127	O-ring, Outer	1
-16	25-131	O-ring, Inner	1
-17	24-106	Bearing, Ball	1
-18	28-102	Gear, Starter Spur - LS-23	1
	28-108	Gear, Starter Spur - LS-24	1
-19	25-118	Retaining Ring, Gear - LS-23	1
	25-115	Retaining Ring, Gear - LS-24	1
-20	50-128	O-ring, Gear Housing	1
-21	26-508	Gear Housing	1
-22	82-500	Pipe Plug	1
-23	24-120	Screen, Inlet	1
-24	25-126	O-ring, Inlet	1
-25	44-119	Adapter, Inlet	1
-26	18-117	Screw	20
-27	38-112	Lockwasher	20
-28	24-103	Bearing, Needle	1
-29	38-115	Thrust Washer	1
-30	21-670	Arbor Shaft	1
-31	33-101	Key, Woodruff	1

* Use right hand "R" end plates and rotor casing assembly for right hand Model LS-23 and LS-24 starters. Use opposite for left hand models.

LS-23/LS-24 STARTER PARTS LIST (CONTINUED)
PRE-ENGAGE

INDEX NO.	PART NO.	DESCRIPTION	QUANTITY PER UNIT
-32	28-103	Gear, Starter Drive - LS-23	1
	28-109	Gear, Starter Drive - LS-24	1
-33	21-711	Bearing, Ball	1
-34	21-720	Snap Ring	1
-35	8-109	Drive, Model LS-23/LS-24 PR1	1
	8-110	Drive, Model LS-23/LS-24 PL1	1
	8-111	Drive, Model LS-23/LS-24 PR2	1
-36	21-714	Bearing, Needle	1
-37	21-707	Housing, Drive	1
	21-706	Housing, Drive SAE #1 (PR2-1)	
-38	53-160	O-ring, Grease Cap	1
-39	26-115	Grease Cap	1
-40	18-121	Screw	3
-41	6-107	Nipple (optional)	1
-42	5-103	Muffler (optional)	1
-43	21-701	Cylinder	1
-44	21-702	Piston	1
-45	21-721	Seal, Rotary	1
-46	20-121	Spring, Pre-Engage	1
-47	21-815	O-ring, Cylinder	1
-48	21-916	O-ring, Piston	2

LS-23/LS-24 STARTER PARTS LIST (CONTINUED)
PRE-ENGAGE

INDEX NO.	PART NO.	DESCRIPTION	QUANTITY PER UNIT
	3-133	**VANE KIT FOR LS-23 AND LS-24 STARTERS INCLUDES:**	
- 6	38-123X	Thrust Bearing Assembly	2
- 8	25-117	Retaining Ring	1
-12	14-105	Rotor Vanes	5
-13	20-125	Vane Springs	5
-20	50-128	O-ring	1
-26	18-117	Screws	6
-27	38-112	Lockwashers	6
	3-142	**REBUILD KIT FOR LS-23 AND LS-24 PRE-ENGAGE STARTERS INCLUDES:**	
- 6	38-123X	Thrust Bearing Assembly	2
- 8	25-117	Retaining Ring	1
-11	24-105	Bearing	1
-12	14-105	Rotor Vanes	5
-13	20-125	Vane Springs	5
-14	68-107	Sealing Spacer	1
-15	25-127	O-ring	1
-16	25-131	O-ring	1
-17	24-106	Bearing	1
-19	25-118	Retaining Ring (For LS-23)	1
	25-115	Retaining Ring (For LS-24)	1
-20	50-128	O-ring	1
-24	25-126	O-ring	1
-26	18-117	Screws	20
-27	38-112	Lockwashers	20
-28	24-103	Bearing	1
-36	21-714	Bearing	1
-38	53-160	O-ring	1
-40	18-121	Screws	3
-45	21-721	Seal, Rotary	1
-47	21-815	O-ring, Cylinder	1
-48	21-916	O-ring, Piston	2

LS-23/LS-24 STARTER PARTS LIST (CONTINUED)
PRE-ENGAGE

INDEX NO.	PART NO.	DESCRIPTION	QUANTITY PER UNIT
	3-227-23RH	**MOTOR KIT (ASSEMBLED) FOR LS-23 RIGHT HAND STARTERS INCLUDES:**	
- 2	34-101R	Rotor Casing Assembly	1
- 3	29-503R	Inlet End Plate	1
- 4	29-502R	End Plate	1
- 5	30-101	Rotor Assembly	1
- 6	38-123	Thrust Bearing Assembly	2
- 8	25-117	Retaining Ring	1
-12	14-105	Rotor Vanes	5
-13	20-125	Vane Springs	5
-14	68-107	Sealing Spacer	1
-15	25-127	O-ring	1
-16	25-131	O-ring	1
-17	24-106	Bearing	1
-18	28-102	Gear	1
-19	25-118	Retaining Ring	1
-20	50-128	O-ring	1
-26	18-117	Screws	6
-27	38-112	Lockwashers	6
	3-227-23LH	**MOTOR KIT (ASSEMBLED) FOR LS-23 LEFT HAND STARTERS INCLUDES:**	
- 2	34-101L	Rotor Casing Assembly	1
- 3	29-503L	Inlet End Plate	1
- 4	29-502L	End Plate	1
- 5	30-101	Rotor Assembly	1
- 6	38-123	Thrust Bearing Assembly	2
- 8	25-117	Retaining Ring	1
-12	14-105	Rotor Vanes	5
-13	20-125	Vane Springs	5
-14	68-107	Sealing Spacer	1
-15	25-127	O-ring	1
-16	25-131	O-ring	1
-17	24-106	Bearing	1
-18	28-102	Gear	1
-19	25-118	Retaining Ring	1
-20	50-128	O-ring	1
-26	18-117	Screws	6
-27	38-112	Lockwashers	6

LS-23/LS-24 STARTER PARTS LIST (CONTINUED)
PRE-ENGAGE

INDEX NO.	PART NO.	DESCRIPTION	QUANTITY PER UNIT
	3-227-24RH	**MOTOR KIT (ASSEMBLED) FOR LS-24 RIGHT HAND STARTERS INCLUDES:**	
- 2	34-101R	Rotor Casing Assembly	1
- 3	29-503RX	Inlet End Plate	1
- 4	29-502RX	End Plate	1
- 5	30-101	Rotor Assembly	1
- 6	38-123	Thrust Bearing Assembly	2
- 8	25-117	Retaining Ring	1
-12	14-105	Rotor Vanes	5
-13	20-125	Vane Springs	5
-14	68-107	Sealing Spacer	1
-15	25-127	O-ring	1
-16	25-131	O-ring	1
-17	24-106	Bearing	1
-18	28-108	Gear	1
-19	25-115	Retaining Ring	1
-20	50-128	O-ring	1
-26	18-117	Screws	6
-27	38-112	Lockwashers	6
	3-227-24LH	**MOTOR KIT (ASSEMBLED) FOR LS-24 LEFT HAND STARTERS INCLUDES:**	
- 2	34-101L	Rotor Casing Assembly	1
- 3	29-503L	Inlet End Plate	1
- 4	29-502L	End Plate	1
- 5	30-101	Rotor Assembly	1
- 6	38-123	Thrust Bearing Assembly	2
- 8	25-117	Retaining Ring	1
-12	14-105	Rotor Vanes	5
-13	20-125	Vane Springs	5
-14	68-107	Sealing Spacer	1
-15	25-127	O-ring	1
-16	25-131	O-ring	1
-17	24-106	Bearing	1
-18	28-108	Gear	1
-19	25-115	Retaining Ring	1
-20	50-128	O-ring	1
-26	18-117	Screws	6
-27	38-112	Lockwashers	6