StartMaster®

Air Starting Systems

Air Starter Service Manual

SERIES SM250 • SM251 • SM2514

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SECTION 1 - INTRODUCTION

All of the starters in the StartMaster Series SM250, except for natural gas applications, are of the reduction drive, pre-engaged type incorporating an integral lubricator, integral muffler, and an optional relay valve. The starters are available with a variety of pinions, right-hand or left-hand rotation, and are equipped with either SAE-1 or SAE-3 flanges, or 6 and 7 inch diameter saddle mounts.

AIR MOTOR

A common design of air motor is used with each of the starters in the Series SM250. This air motor utilizes a single rotor and incorporates the StartMaster positive blade displacement feature -- a cam device that mechanically maintains the rotor blades in close proximity to the housing sleeve surface for positive starting. The air motor casing also provides a mounting for the internal sequencing valve which controls pinion engagement, automatic lubrication, and delivery of starting air pressure to the motor. All air starters may be disassembled and the air motor sleeve reversed to achieve opposite pinion rotation, if a corresponding change is made in the facet drive unit.

DRIVE GROUP

The Series SM250 drive group is composed of a drive shaft assembly, a reduction gear set, a gear case and a drive housing.

The drive shaft assembly consists of a facet drive unit and drive shaft gear (of the reduction gear set) mounted on opposite ends of the drive shaft. This assembly is supported by two roller bearings (one located in the nose of the drive housing and the other located in the gear case) and a ball bearing mounted in the gear case cover.

NOTE

In the SM251 and 2514 series starters, the drive shaft assembly is supported by two roller bearings behind the pinion.

Included in the reduction gear set are the rotor pinion and drive shaft gear. The rotor pinion is splined to the rotor shaft and retained by the pinion retaining ring. The drive shaft gear is keyed and pressed to the drive shaft.

SERIES OPTIONS

Automatic Lubricator - The integral automatic lubricator employs engine fuel oil from the fuel return line to lubricate the rotor blades. Fuel is forced through a seal into the inlet air stream during starter operation.

Built-In Relay Valve - The built-in relay valve provides for internal control of starter operation. A constant supply of system air pressure is available at the starter inlet at all times. This device eliminates the need for an external relay valve.

Integral Muffler - All StartMaster Series SM250 air starters (with exception of gas operation starters) are provided with an integral muffler which is attached to the air exhaust port on the air motor.

Gas Operation - Several models in the StartMaster Series SM250 employ natural gas to provide an operating force for motor rotation. This application may utilize an external lubrication system and an external relay valve. However, a built-in lubricator is available if desired.

Electric Key Starting - An electric solenoid valve is available as an option in the StartMaster Series SM250 air starters. The solenoid is usually mounted on the air motor casing at the drive end.

Due to the number of different combinations available in the StartMaster Series SM250, it is suggested that the user refer to the product's specification sheet and the technical data sheet for additional information.

SECTION II
OPERATION OF STARTMASTER SERIES SM250 AIR STARTERS

All of the starters in the StartMaster Series SM250 employ the same basic airflow path through the starter both for operation of the pre-engagement feature and for the initiation of starter rotation. A description of basic starter operation is given in the following section. Please refer to Figure 2.1 and 2.2.

In the relay valve type of starters, system air pressure from the supply tank is constantly applied at the air motor casing inlet port (1) where it is held by the sequencing valve air-foil seal (2) and seat (3). Air pressure, however, is available to the dashboard starter control (4) through port "B".

When the dashboard control is opened, air pressure flows back to the starter and enters port "A" on the opposite side of the air motor casing from port "B". The air fills a longitudinal passage (5) in the casing and travels to a vertical passage in the lower end plate (6). Air from the end plate then enters an annular groove in the gear case (7).

After passing through a longitudinal passage in the gear case (8) and a vertical passage in the drive housing (9), the air fills a space (10) between the drive shaft bearing retainer and the actuator piston. When air pressure is applied to the actuator piston, it moves the piston rearward against spring pressure and engages the pinion gear (11) on the facet drive assembly (12) with the ring gear on the engine.

When the piston is moved to its full rearward position (as shown in Figure 2.2), it uncovers a second vertical passage (13) in the drive housing separate from the inlet passage. This action allows air to flow from the piston chamber, through a longitudinal passage in the gear case (14), to a second annular groove (15). From this groove, the air enters a short passage in the motor casing and fills a space behind the sequencing valve piston (16), forcing the piston to move forward against spring pressure (17) and unseating the sequencing valve air-foil. Unseating of the sequencing valve air-foil allows full system air pressure to enter the inlet plenum (18) and to flow at high velocity through directional inlet slots in the housing sleeve. The airflow applies pressure to the rotor blades, causing the rotor to turn. As the rotor turns, the air trapped between the blades expands, creating an additional force which is applied to the rotor. At the bottom of the air motor casing, an outlet is provided to discharge the air from the exhaust plenum. Rotation of the rotor shaft is transferred through the reduction drive gear train to the facet drive pinion which is engaged with the engine ring gear.

When engine start has been accomplished, the control valve (4) is returned to the off position. Air then is exhausted from the control valve and the resulting pressure drop allows the return springs in the facet drive assembly (19) and sequencing valve to disengage the pinion, eliminating airflow through the rotor.

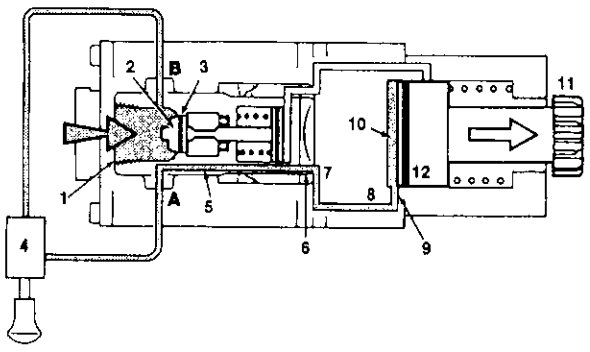


Figure 2.1

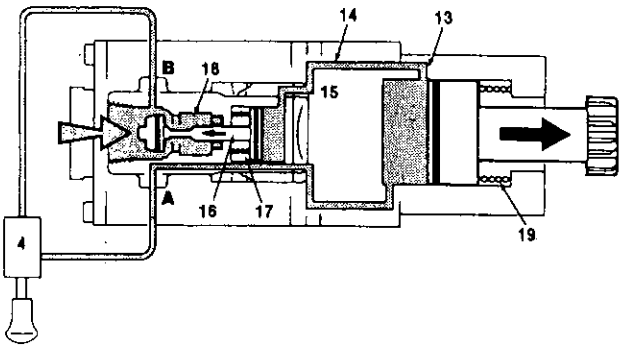


Figure 2.2

SECTION III
STARTMASTER SERIES SM250
AIR STARTER

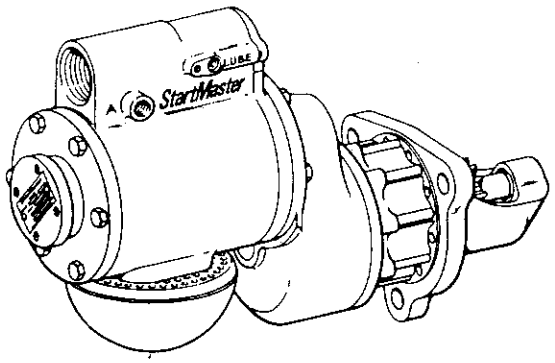


Figure 3.1

AIR MOTOR

A complete discussion of the construction and overhaul of the air motor is contained in Section VI.

DISASSEMBLY OF DRIVE GROUP

Disassemble the drive group in accordance with the parts indexing shown in Fold-Out No. 1.

1. Remove the muffler (1) and muffler retaining assembly

NOTE

For gas starters remove exhaust adapter. Discard exhaust adapter seal.

2. Clamp muffler flange in vise equipped with copper lined jaws. See Figure 3.2.

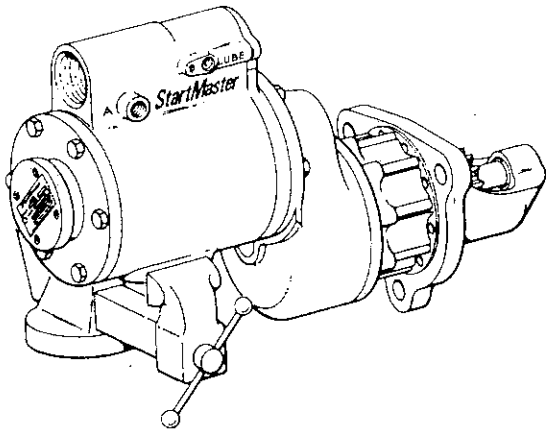


Figure 3.2

3. Scribe reference marks as follows:

1. Drive Housing Adapter and Drive Housing.
2. Gear Case, Lower End Plate, and Air Motor Case.

See Figure 3.3

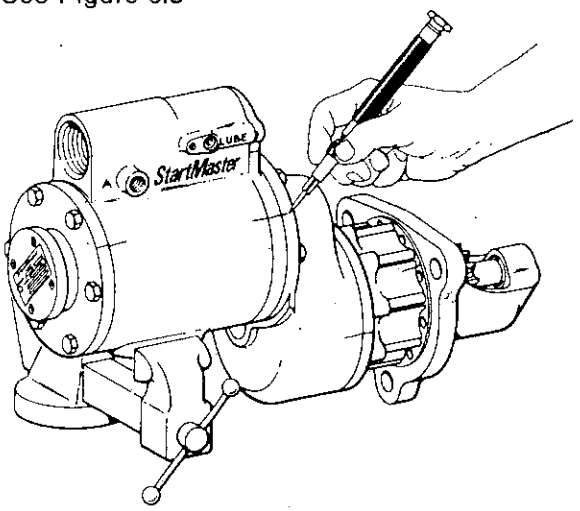


Figure 3.3

4. Remove nine drive housing adapter screws (34).

5. Remove the drive housing adapter, making sure that the drive housing bushing (31) remains in place.

6. Remove drive housing, bushing and retainer (31).

7. Remove retainer (32) from bushing.

8. Press out the drive housing bearing (36) and seal (35) from adapter. See Figure 3.4.

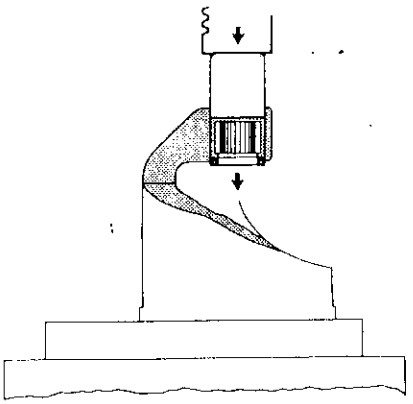


Figure 3.4

9. Remove the drive return spring (30).

10. Remove the facet drive assembly (29).

11. Remove the nine drive housing screws (26) and lockwashers (25).

12. Using two drive housing screws inserted into the threaded jacking holes in the drive housing flange, jack the drive housing from the gear case. See Figure 3.5.

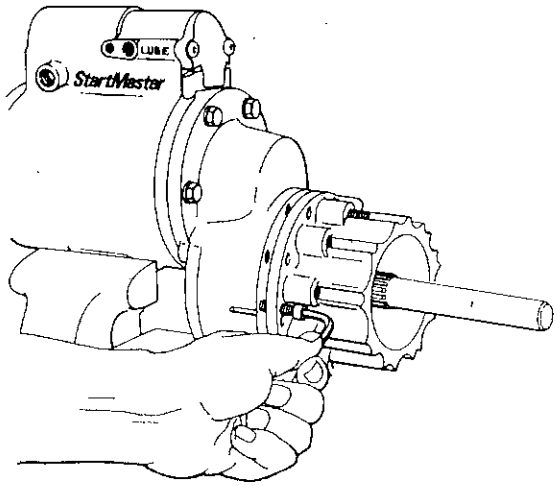


Figure 3.5

Remove thrust washer from front end of the drive shaft. Remove the two (2) jacking screws.

13. Support the drive housing and press out drive shaft (28), drive shaft bearing (10), and drive gear (9) as shown in Figure 3.6.

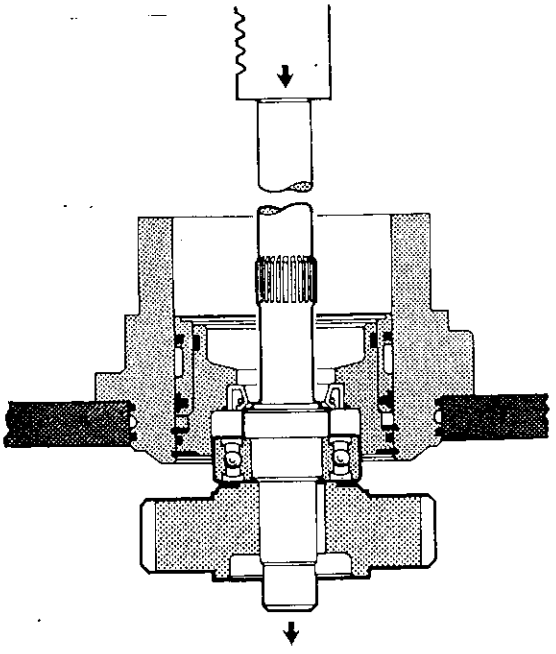


Figure 3.6

14. Reverse drive shaft in arbor and, after supporting drive shaft gear, press out shaft and bearing from drive gear. Remove drive shaft gear key (27). See Figure 3.7.

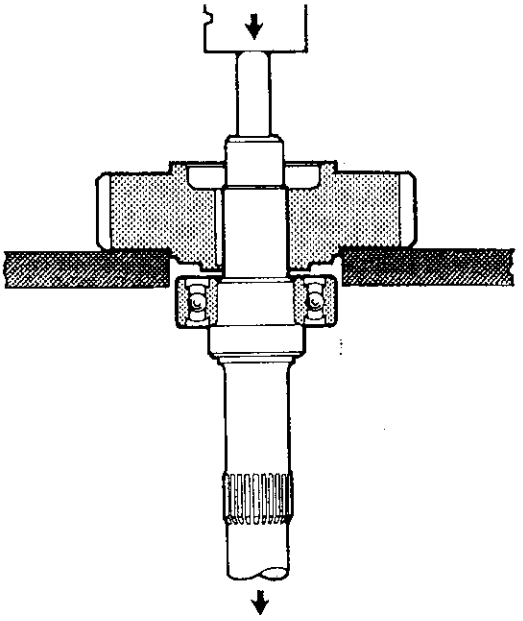


Figure 3.7

15. Support drive shaft bearing in arbor and press out shaft from bearing as shown in Figure 3.8.

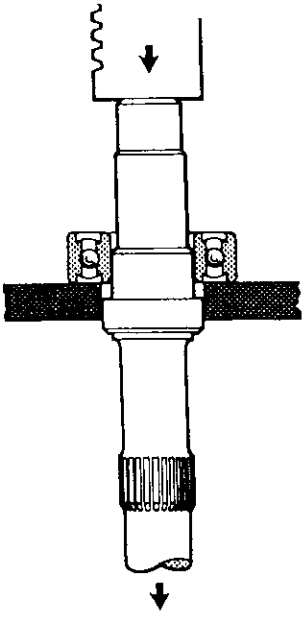


Figure 3.8

16. Remove the front retaining ring (12) from the drive housing, as shown in Figure 3.9.

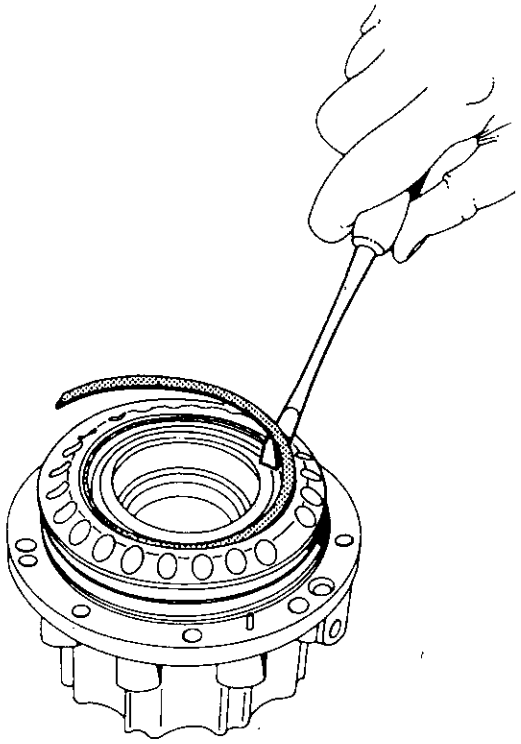


Figure 3.9

17. Place drive housing in a press supported by its flange and press out the bearing retainer (14). See Figure 3.10.

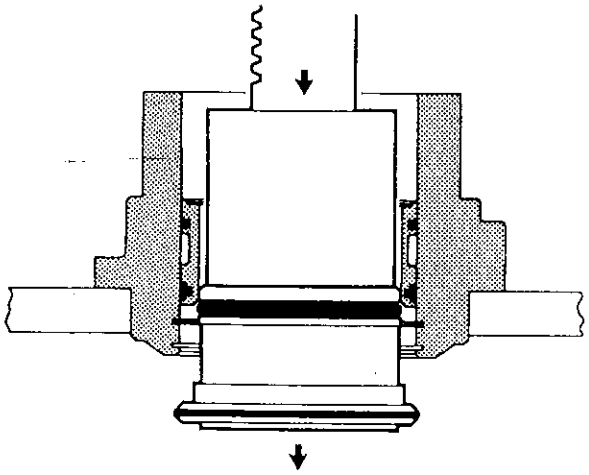


Figure 3.10

CAUTION

Press slowly and evenly making certain that the leading edge of the retainer does not become caught in the retaining ring groove. Hydraulic press not recommended.

18. Support bearing retainer and press out the drive shaft seal (11). See Figure 3.11.

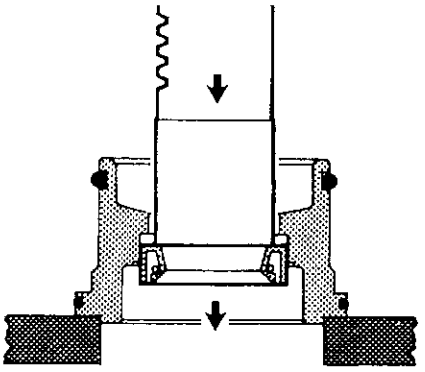


Figure 3.11

19. Invert the drive housing and remove the second retaining ring (15). This will provide additional clearance for pressing out the piston actuator (19).

20. Remove the piston actuator in the direction shown in Figure 3.12.

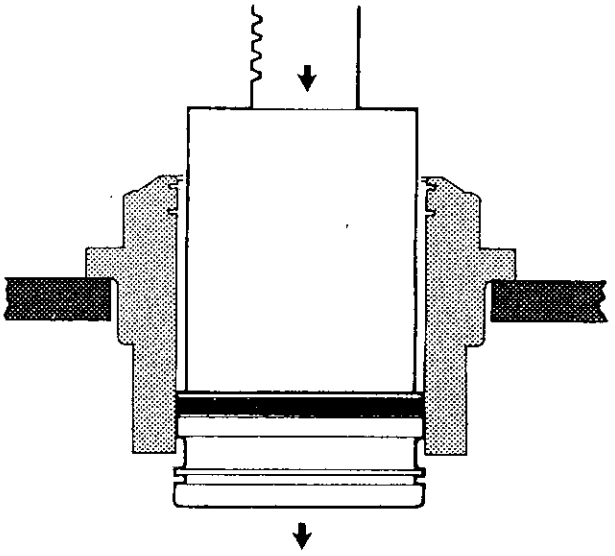


Figure 3.12

21. Using a thin knife blade or screwdriver, remove the piston actuator ring (17). A slight warming of the ring using a 60 watt light bulb will aid in ring removal. Remove piston actuator seal and discard both seal and ring.

22. Remove the six gear case screws (6) and lockwashers (5).

23. Remove gear case (4) using a knife edge or wide scraper blade to separate the gear case flange from the lower end plate. Remove all traces of old gasket (3) and O-ring (2) from lower end plate.

24. Support the gear case (4) as shown in Figure 3.13 and press out the gear case bearing (7).

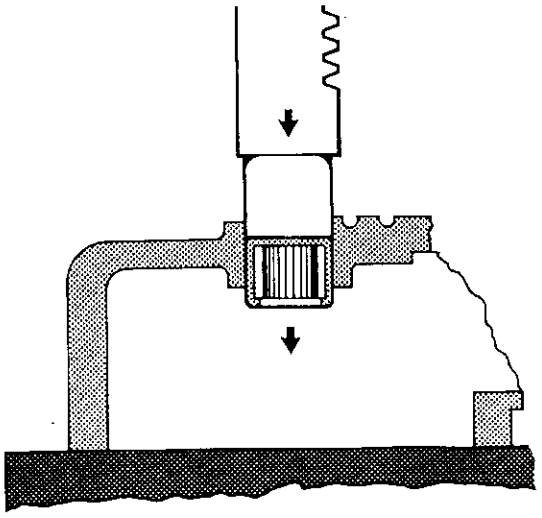


Figure 3.13

CLEANING, INSPECTION AND PARTS REPLACEMENT

CLEANING

WARNING

Perform all cleaning procedures in a well ventilated area and away from flames.

1. Clean all parts removed during disassembly using commercially approved solvents. Do not spin open ball bearings with compressed air. Do not use hot tank soak.

2. Clean the facet drive unit by wiping thoroughly with a clean cloth.

CAUTION

Do not immerse sealed assemblies such as the drive unit in cleaning solvent. Doing so will wash away internal lubrication.

INSPECTION AND PARTS REPLACEMENT

1. Replace all gaskets and seals removed during disassembly.

2. Inspect all parts removed during disassembly for evidence of excessive or abnormal wear or other damage. Particular attention should be given to the following parts:

DRIVE HOUSING - Visually inspect the drive housing for cracks or breakage and replace if necessary.

DRIVE HOUSING ADAPTER - Visually inspect the drive housing adapter for cracks or breakage. If cracked or broken, the drive housing adapter must be replaced.

BEARINGS - Check the drive housing bearing and the gear case bearing to ensure that the bearing rollers move freely and have not been flattened or otherwise damaged. Check the drive shaft ball bearing for freedom of rotation without excessive play between the races. Replace questionable bearings.

FACET DRIVE UNIT - Inspect the drive unit for worn (loose), missing or damaged parts and broken or battered gear teeth. Check the drive pinion for damage or excessive wear. Defective drive assemblies cannot be rebuilt and must be replaced as a unit in accordance with Service Bulletin No. 4.

DRIVE SHAFT GEAR - Inspect the drive shaft gear for cracked or broken teeth or excessive wear. Check for unusual contact patterns indicating run out between gears, misalignment or improper engagement. Replace a damaged or questionable drive shaft gear.

ACTUATOR PISTON - Inspect the actuator piston for deep scoring marks or other excessive wear. Replace a questionable actuator piston.

OVERHAUL

Replace the following drive group parts during complete overhaul of Series SM250:

- Drive Housing Bearing
- Gear Case Bearing
- Drive Shaft Ball Bearing
- Facet Drive Unit
- Actuator Piston
- All Gaskets, Seals and O-Rings

REASSEMBLY OF DRIVE GROUP

Reassembly of the drive group can be accomplished by referring to Fold-Out No. 1 and the following instructions:

1. Press a new gear case bearing (7) into gear case (4) flush to .010" (2.54 mm) below surface of gear case and pack with Lithium base grease. See Figure 3.14.

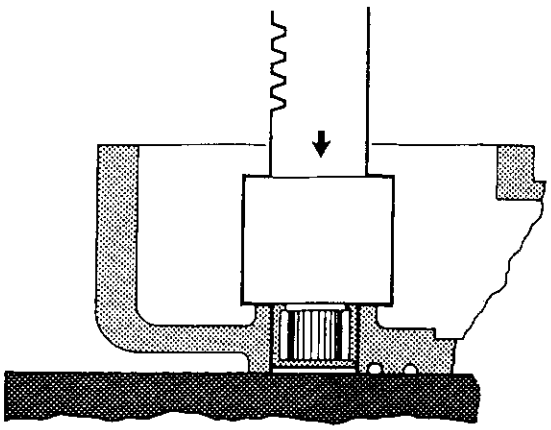


Figure 3.14

2. With air motor muffler flange clamped in vise, place a new gasket (3) and O-ring (2) in correct position on lower end plate. Position gear case (4) on lower end plate according to scribe marks, install six gear case screws (6) and lockwashers (5), and torque to 141 - 171 in. lbs. (15.9 to 19.3 N · m).

NOTE

Gas starter end plates require two O-ring seals.

Apply Loctite No. TL277 sparingly to all gear case screws.

3. Pack gear case with 1/4 lb. of Lithium base general purpose grease.

4. Press a new drive shaft bearing (10) onto drive shaft (28), as shown in Figure 3.15.

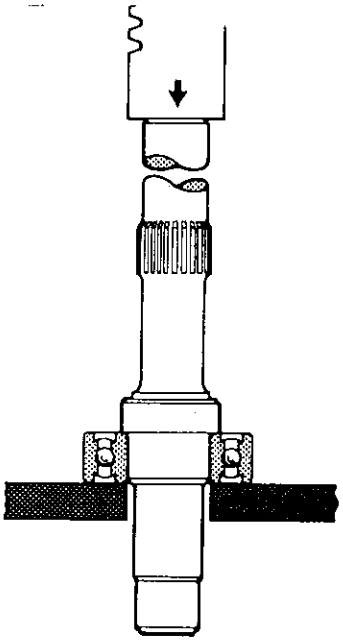


Figure 3.15

5. Insert the drive shaft key (27) into the shaft (28) and orient the drive shaft gear (9) to the shaft and key with the raised boss toward the bearing. Press gear onto the shaft, as shown in Figure 3.16.

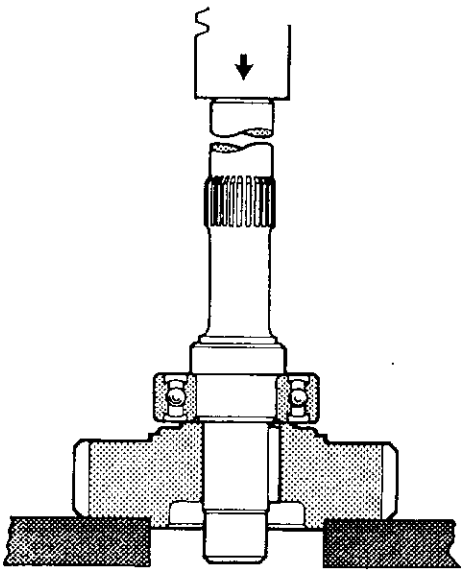


Figure 3.16

6. Install a new drive housing seal (15) and bearing retainer seal (24) on bearing retainer (13). Apply Lithium base general purpose grease to bearing retainer seal.

7. Install a new drive shaft seal (13) in bearing retainer (16). Apply Lithium base general purpose grease to I.D. of seal. See Figure 3.17.

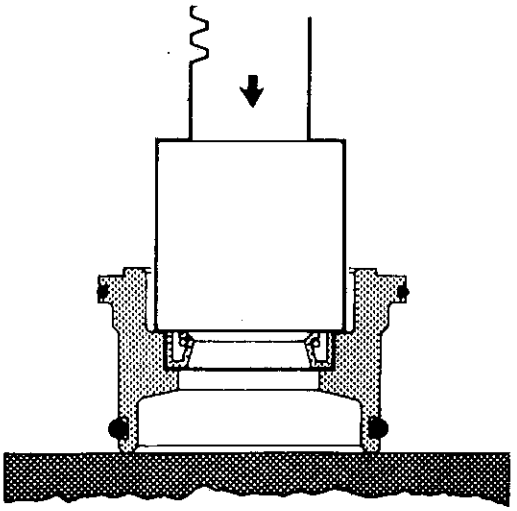


Figure 3.17

8. Install inner retaining ring (15) in drive housing (24).

9. Press the bearing retainer (14) into position in the drive housing (24), as shown in Figure 3.18.

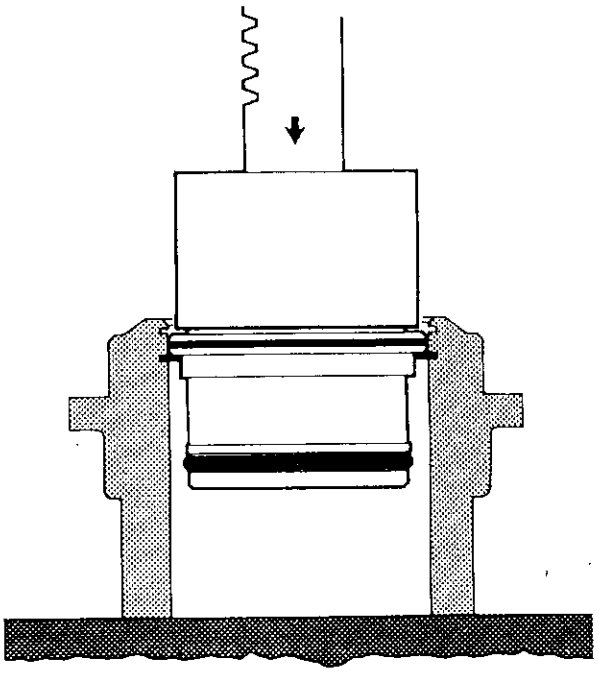


Figure 3.18

10. Install outer retaining ring (12) in drive housing (24).

11. Place drive housing (24) in arbor and press drive shaft (28), drive shaft bearing (10) and gear assembly (9) into bearing retainer (14). See Figure 3.19.

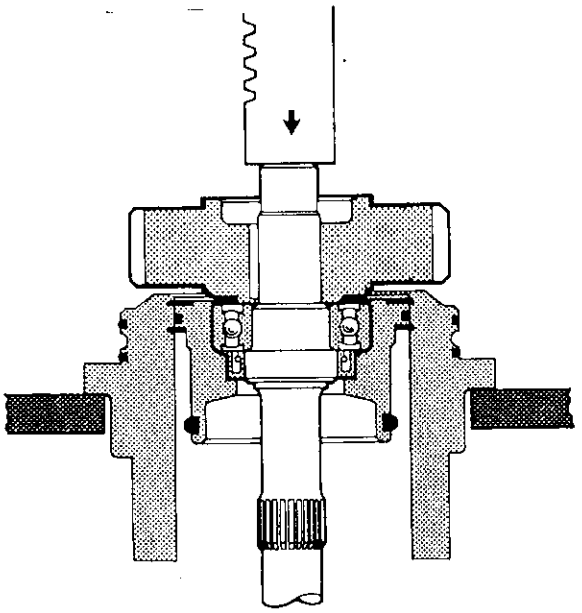


Figure 3.19

12. Install new inner (21) and outer drive housing seal (20). Install new upper drive housing seal (23).

13. Apply Lithium base grease to both faces of thrust washer (8) and place thrust washer on drive shaft assembly (28).

14. Position the drive housing (24) according to gear case pin (22), align drive shaft gear (9) teeth with rotor pinion, and push drive shaft end into gear case bearing (7). ***Caution: Do not rotate drive housing during assembly as this may cut O-rings causing leakage.***

15. Install the nine drive housing screws (6) and lockwashers (5) and torque to 97 - 109 in. lbs. (11.1 to 12.3 N · m).

16. Lubricate the splines and plain end of drive shaft assembly (28) with low temperature Lubriplate grease.

17. Install a new actuator piston seal (18) on actuator (19). After seal is in place, install a new piston actuator ring (17) over piston seal. Apply a coat of low temperature Lubriplate grease to actuator ring.

18. With the actuator ring end facing the bearing retainer (14), insert the actuator piston into the drive housing (24) as far as possible. See Figure 3.20.

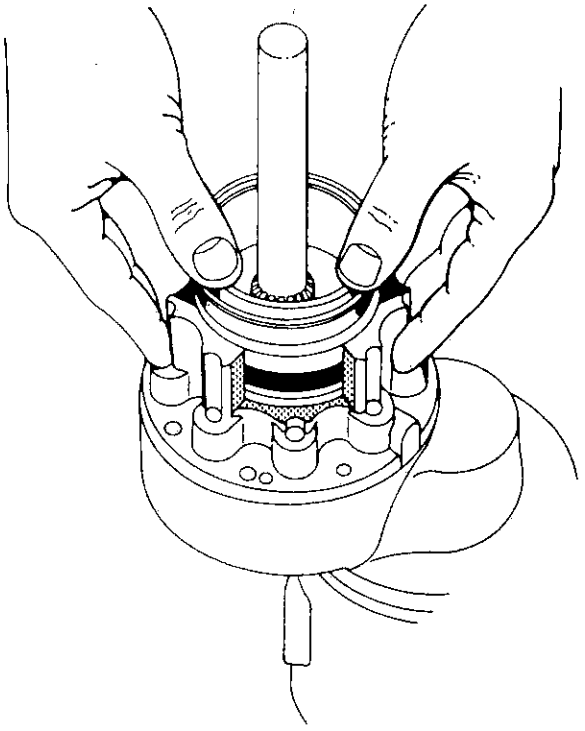


Figure 3.20

19. Place facet drive assembly (29) on drive shaft assembly (28) and turn to align splines. With splines in alignment, push facet drive assembly toward bearing retainer (14) until it contacts the piston actuator (19). From this point, push the

facet drive assembly and piston actuator toward the bearing retainer until the actuator seats firmly in the retainer. See Figure 3.21.

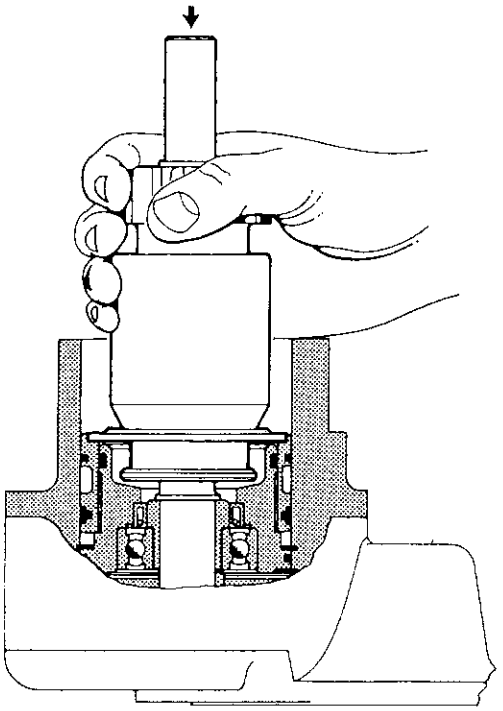


Figure 3.21

20. Press the drive housing bearing (36) into the drive housing adapter to depth shown in Figure 3.22.

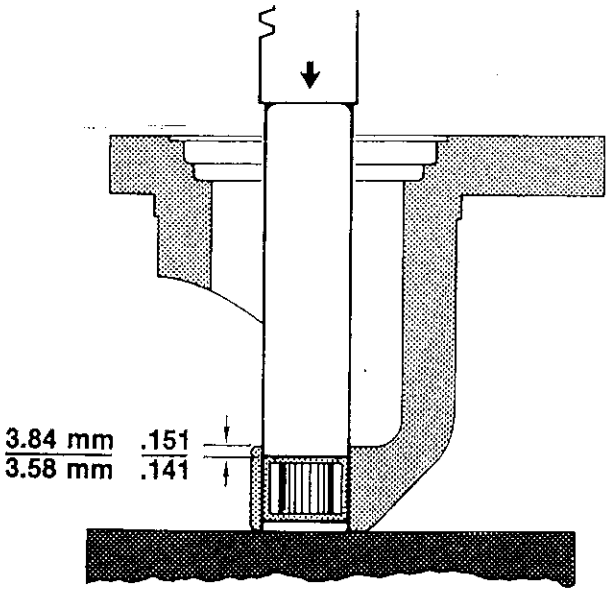


Figure 3.22

21. Press the shaft seal (35) in until it seats against the drive housing bearing, as shown in Figure 3.23. Do not reposition the drive housing bearing during seal installation.

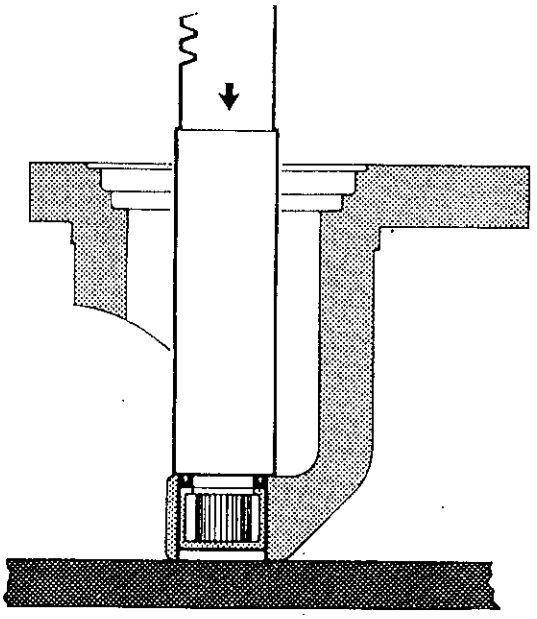


Figure 3.23

Note

On Series 250 starters incorporating an SAE-1 flange, press the drive housing bearing flush to .010" (.254 mm) below surface. No separate seal is used in this type. See Figure 3.24.

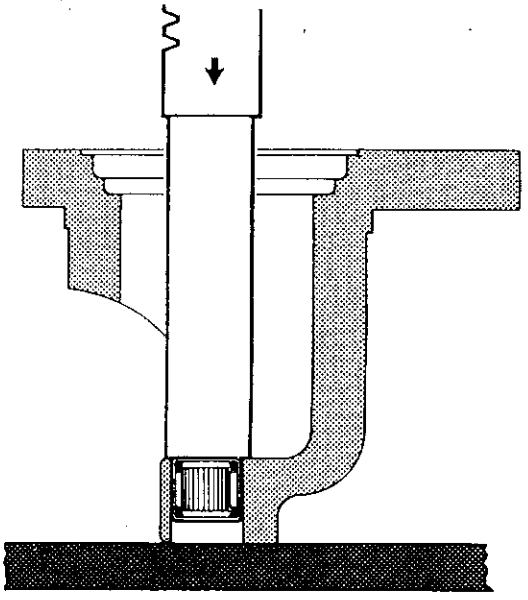


Figure 3.24

22. Pack drive housing bearing (36) with Lithium base general purpose grease.

23. Install retaining ring (32) on drive housing bushing (31) and insert short end of bushing into drive housing adapter (33). See Figure 3.25.

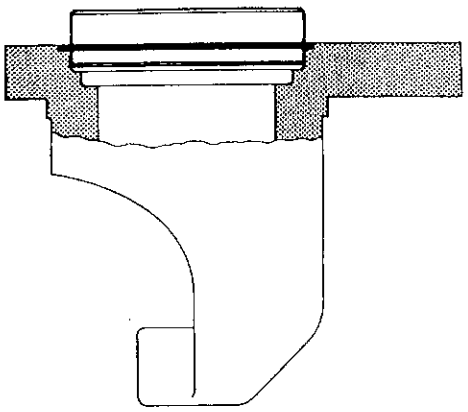


Figure 3.25

24. Insert drive return spring (30) into drive housing bushing (31).

25. Position the drive housing adapter (33) according to the scribe marks and install the adapter over the facet drive assembly (29) until it contacts the mating surface on the drive housing (24). Install the nine drive housing adapter screws (34) and torque to 216 - 264 in. lbs. (24.4 to 29.8 N · m).

26. Remove the starter assembly from the vise and install the muffler retaining assembly and lockwasher. Torque to 141 - 171 in. lbs. (15.9 to 19.3 N · m).

27. Insert the starter muffler (1) in place in the air motor case. Install the muffler screw and torque to 98 - 118 in. lbs. (11.1 to 13.3 N · m).

NOTE

For gas starters, place a new seal on the exhaust adapter and install adapter using exhaust adapter screw and lockwasher. Torque to 98 - 118 in. lbs. (11.0 to 13.4 N · m).

28. Starter testing and run-in should be accomplished in accordance with pertinent specifications.

SECTION IV
STARTMASTER SM251 SERIES
AIR STARTER

The StartMaster SM251 Series air starters differ from the SM250 Series starters only in the type of drive housing adapter, mounting flange and facet drive assembly utilized. See Figure 4.1.

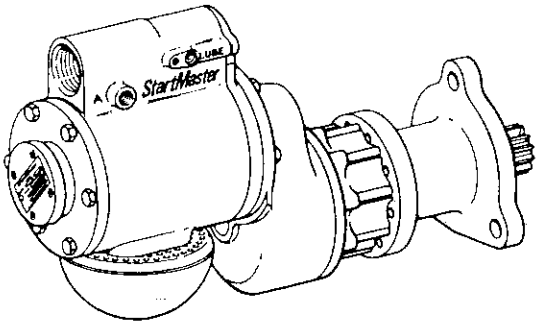


Figure 4.1

AIR MOTOR

A complete discussion of the construction and overhaul of the air motor is contained in Section VI.

DISASSEMBLY OF DRIVE GROUP

Disassemble the SM251 Series starters in accordance with the parts shown in Fold-Out No. 2 and the following instructions:

1. Remove the muffler (1) and muffler retaining assembly.

2. Clamp muffler flange in vise equipped with copper jaws. See Figure 4.2.

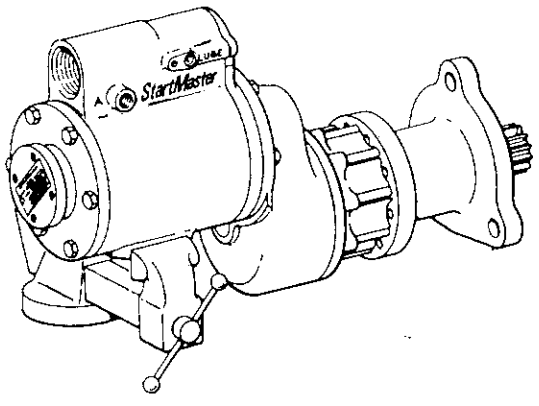


Figure 4.2

3. Scribe reference marks as follows:

1. Drive Housing Adapter and Drive Housing.

2. Gear Case, Lower End Plate and Air Motor Case.

See Figure 4.3.

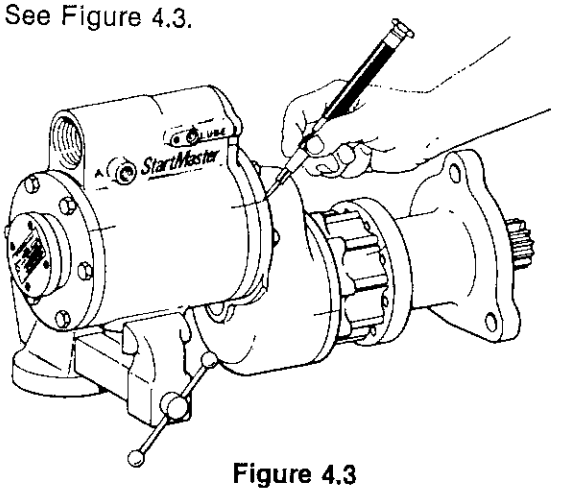


Figure 4.3

4. Remove the nine drive housing adapter screws (37) and lockwashers (36).

5. Remove the drive housing adapter (35), facet drive assembly (31) and facet pinion unit, making sure that the drive housing bushing remains in place.

6. Clamp the starter pinion (45) in a vise equipped with copper-lined jaws. Attach facet drive clamping Tool No. 22776 and remove pinion screw (29) from the drive unit using Tool No. 20795. See Figure 4.4.

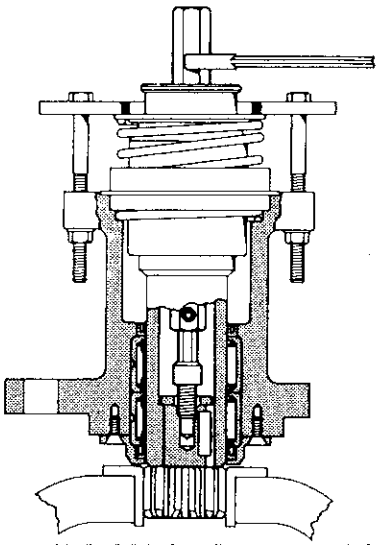


Figure 4.4

7. Thread an 8" piece of 3/8" stock (3/8 - 24 x 1/2"). Screw the threaded end into the threaded bore of the facet pinion (45). Remove the pinion from the vise. Using a medium sized ballpeen hammer, tap the threaded bar on the end to force the pinion from the drive housing. See Figure 4.5. Remove the pinion key (44).

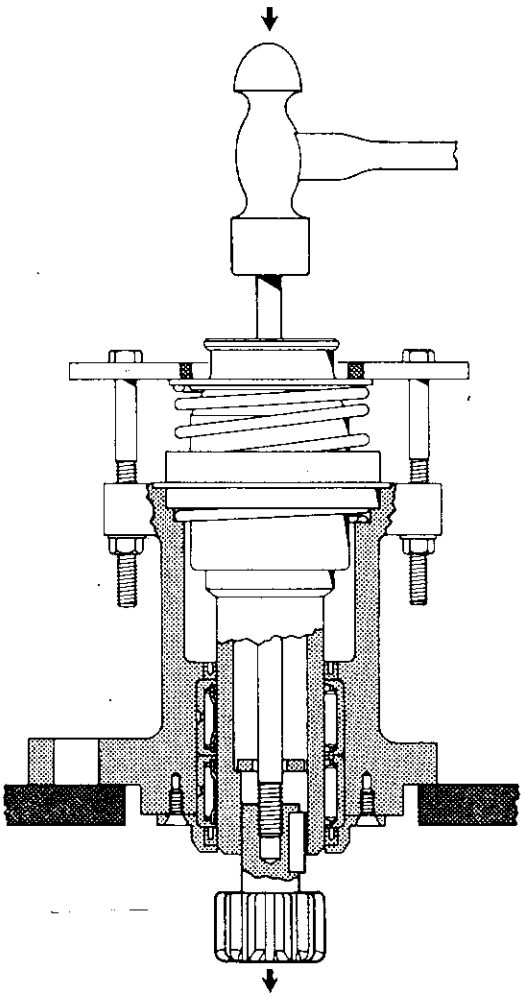


Figure 4.5

8. Pull the facet drive assembly (31) from the drive housing adapter (35).

9. Remove the drive return spring (32) from the facet drive assembly (31).

10. Remove the six bearing cover screws (43) and remove the bearing cover (42).

NOTE

These screws are secured with Loctite No. 242. The application of mild heat may aid in removal.

11. Remove and discard the facet drive assembly seal (41) in the bearing cover.

12. Place the drive housing adapter (35) in an arbor and press out the two facet drive bearings (39) (40) and facet drive assembly seal (38), as shown in Figure 4.6.

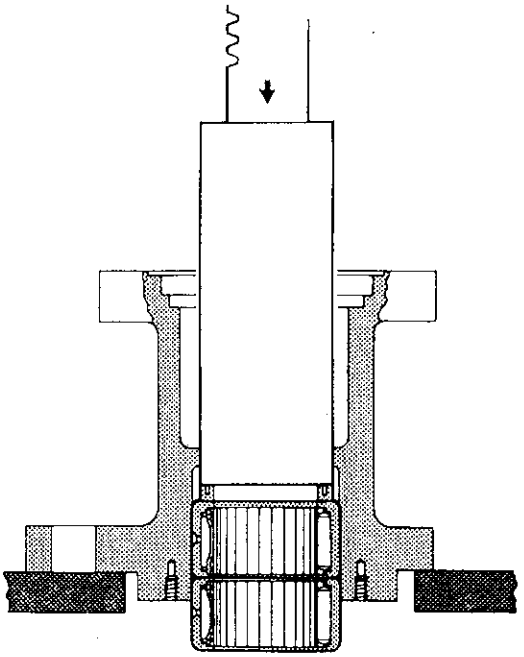


Figure 4.6

13. Remove the nine drive housing screws (26) and lockwashers (25).

14. Using two drive housing screws inserted into the threaded jacking holes in the drive housing flange, jack the drive housing from the gear case. See Figure 4.7.

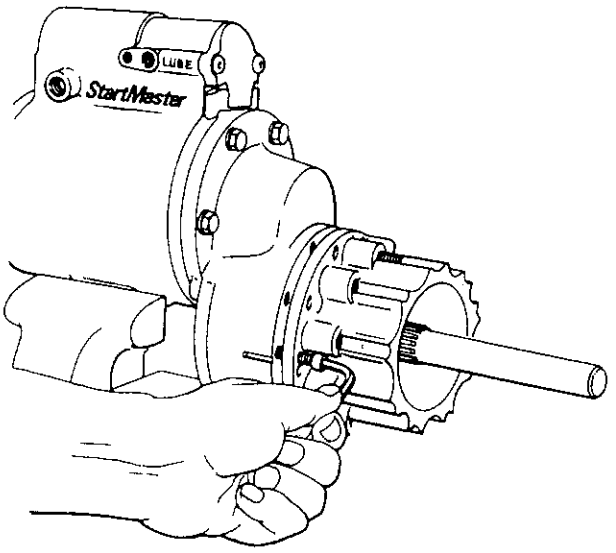


Figure 4.7

Remove thrust washer from front end of the drive shaft. Remove the two (2) jacking screws.

15. Support the drive housing and press out drive shaft (28), drive shaft bearing (10), and drive gear (9), as shown in Figure 4.8.

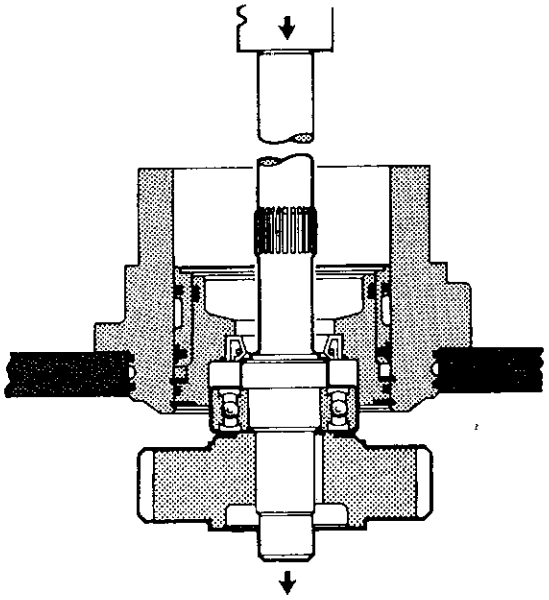


Figure 4.8

16. Reverse drive shaft in arbor and, after supporting drive shaft gear, press out shaft and bearing from drive gear. Remove drive shaft gear key (27). See Figure 4.9.

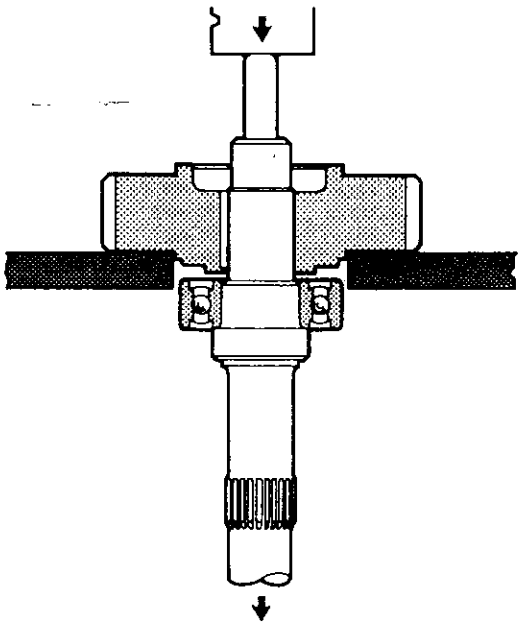


Figure 4.9

17. Support drive shaft bearing in arbor and press out shaft from bearing as shown in Figure 4.10.

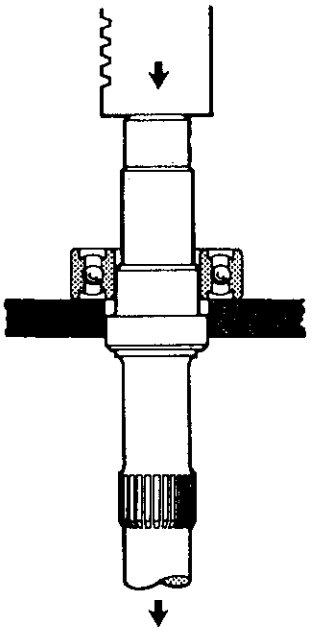


Figure 4.10

18. Remove the front retaining ring (12) from the drive housing, as shown in Figure 4.11.

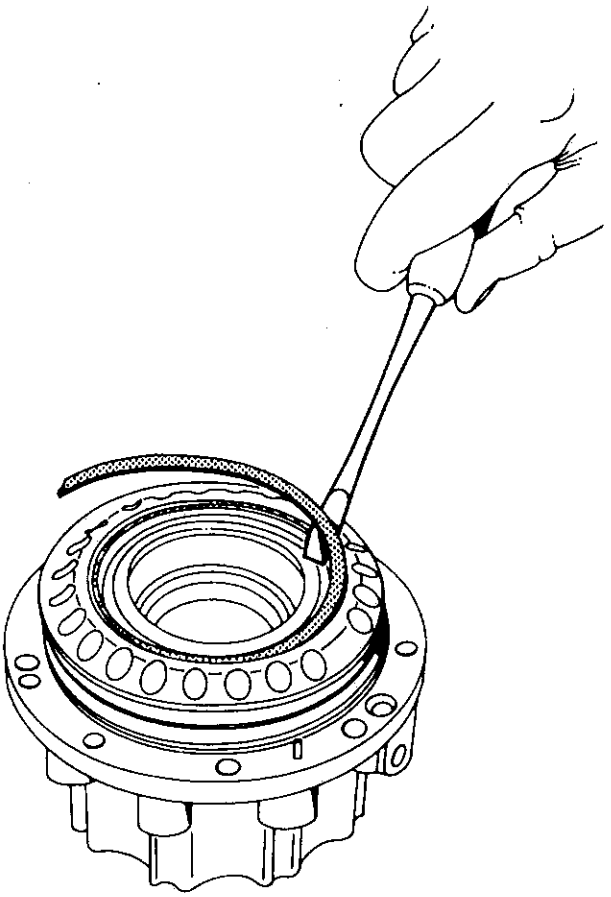


Figure 4.11

19. Place drive housing in a press supported by its flange and press out the bearing retainer (14). See Figure 4.12.

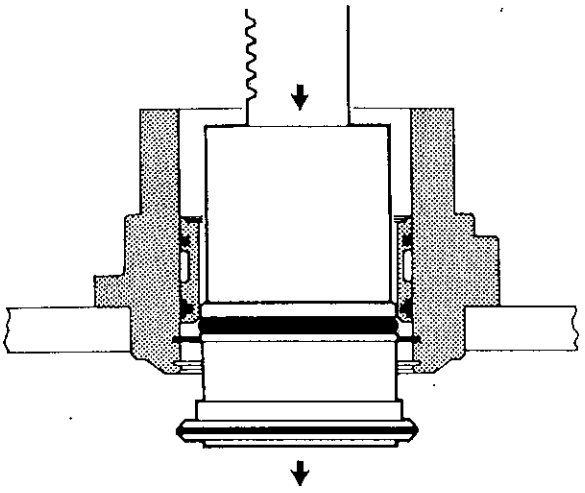


Figure 4.12

CAUTION

Press slowly and evenly making certain that the leading edge of the retainer does not become caught in the retaining ring groove.

20. Support the bearing retainer and press out the drive shaft seal (11). See Figure 4.13.

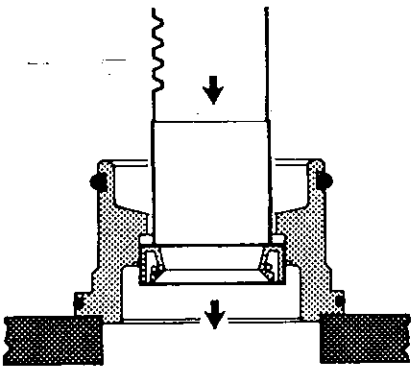


Figure 4.13

21. Invert the drive housing and remove the second retaining ring (15). This will provide additional clearance for pressing out the piston actuator (19).

22. Remove the piston actuator in direction shown in Figure 4.14.

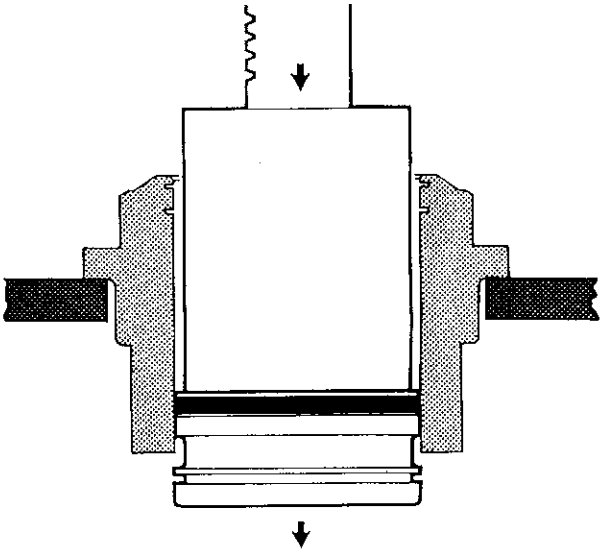


Figure 4.14

23. Using a thin knife blade, remove the piston actuator ring (17). A slight warming of the ring using a 60 watt light bulb will aid in ring removal. Remove piston actuator seal and discard both seal and ring.

24. Remove the six gear case screws (6) and lockwashers (5).

25. Remove gear case (4) using a thin knife edge or wide scraper blade to separate the gear case flange from the lower end plate. Remove all traces of old gasket (3) and O-ring from lower end plate.

26. Support the gear case (4) as shown in Figure 4.15 and press out the gear case bearing (7).

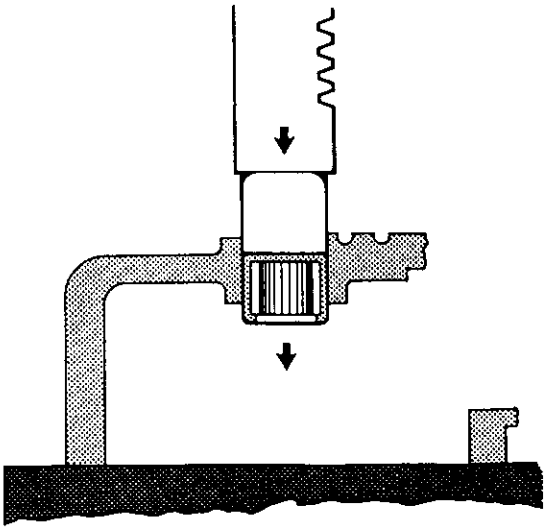


Figure 4.15

CLEANING, INSPECTION AND PARTS REPLACEMENT

CLEANING

WARNING

Perform all cleaning procedures in a well ventilated area and away from flames.

1. Clean all parts removed during disassembly using commercially approved solvents. Do not spin open ball bearings with compressed air. Do not use hot tank soak.

2. Clean the facet drive unit by wiping thoroughly with a clean cloth.

CAUTION

Do not immerse sealed assemblies such as the drive unit in cleaning solvent. Doing so will wash away internal lubrication.

INSPECTION AND PARTS REPLACEMENT

1. Replace all gaskets and seals removed during disassembly.

2. Inspect all parts removed during disassembly for evidence of excessive or abnormal wear or other damage. Particular attention should be given to the following parts:

DRIVE HOUSING - Visually inspect the drive housing for cracks and breakage and replace if necessary.

DRIVE HOUSING ADAPTER - Visually inspect the drive housing adapter for cracks or breakage. If cracked or broken, the drive housing adapter must be replaced.

BEARINGS - Check the drive housing bearing and the gear case bearing to ensure that the bearing rollers move freely and have not been flattened or otherwise damaged. Check the drive shaft ball bearing for freedom of rotation without excessive play between the races. Replace questionable bearings.

FACET DRIVE UNIT - Inspect the drive unit for worn (loose), missing or damaged parts and broken or battered gear teeth. Check the drive pinion for damage or excessive wear. Defective drive assemblies cannot be rebuit and must be replaced as a unit.

DRIVE SHAFT GEAR - Inspect the drive shaft gear for cracked or broken teeth or excessive wear. Check for unusual contact patterns indicating run out between gears, misalignment or improper engagement. Replace a damaged or questionable drive shaft gear.

ACTUATOR PISTON - Inspect the actuator piston for deep scoring marks or other excessive wear. Replace a questionable actuator piston.

DRIVE PINION - Inspect the drive pinion for broken, battered or excessively worn teeth. Replace a questionable drive pinion.

OVERHAUL

Replace the following drive group parts during complete overhaul of Series SM251:

Drive Bearings
All Gaskets, Seals and O-rings
Facet Drive Unit
Drive Pinion
Actuator Piston

REASSEMBLY OF DRIVE GROUP

Reassemble the StartMaster Series SM251 drive assembly generally in reverse order of the indexing shown in Fold-Out No. 2 and in accordance with the following instructions:

1. Press a new gear case bearing (7) into gear case (4) flush to .010" below surface of gear case and pack with Lithium base grease. See Figure 4.16.

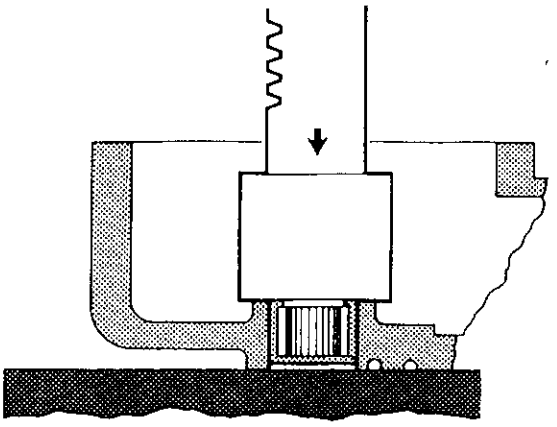


Figure 4.16

2. With air motor muffler flange clamped in vise, place a new gasket (3) and O-ring (2) in correct position on lower end plate. Position gear case (4) on lower end plate according to scribe marks, install six gear case screws (6) and lockwashers (5), and torque to 141 -171 in. lbs. (15.9 to 19.3 N·m).

3. Pack gear case with 1/4 lb. of Lithium base general purpose grease.

4. Press a new drive shaft bearing (10) onto drive shaft (28), as shown in Figure 4.17.

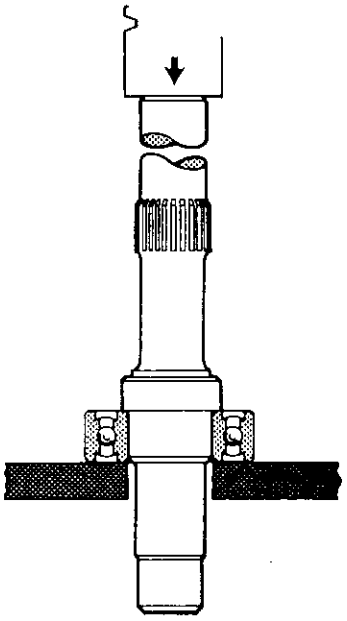


Figure 4.17

5. Insert the drive shaft key (27) into the shaft (28) and orient the drive shaft gear (9) to the shaft and key with the raised boss toward the bearing. Press gear onto the shaft, as shown in Figure. 4.18.

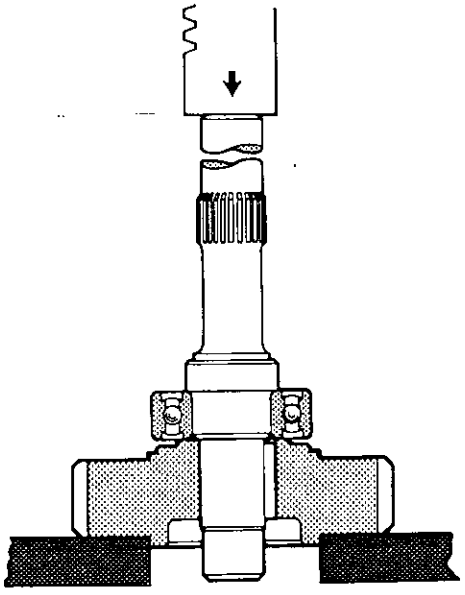


Figure 4.18

6. Install a new drive housing seal (13) and bearing retainer seal (16) on bearing retainer (14). Apply Lithium base general purpose grease to bearing retainer seal.

7. Install a new drive shaft seal (11) in bearing retainer. Apply Lithium base general purpose grease to I.D. of seal. See Figure 4.19.

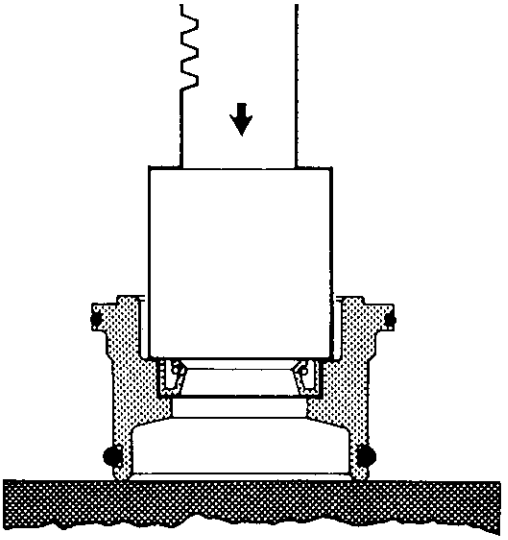


Figure 4.19

8. Press the bearing retainer into position in the drive housing (24), as shown in Figure 4.20.

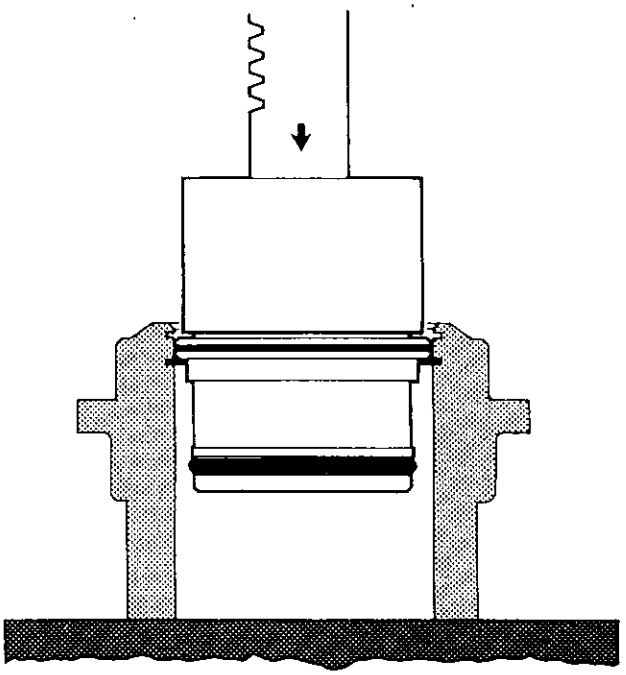


Figure 4.20

9. Install outer retaining ring (12) in drive housing.

10. Place drive housing in arbor and press drive shaft (28), drive shaft bearing (10) and gear assembly (9) into bearing retainer (14). See Figure 4.21.

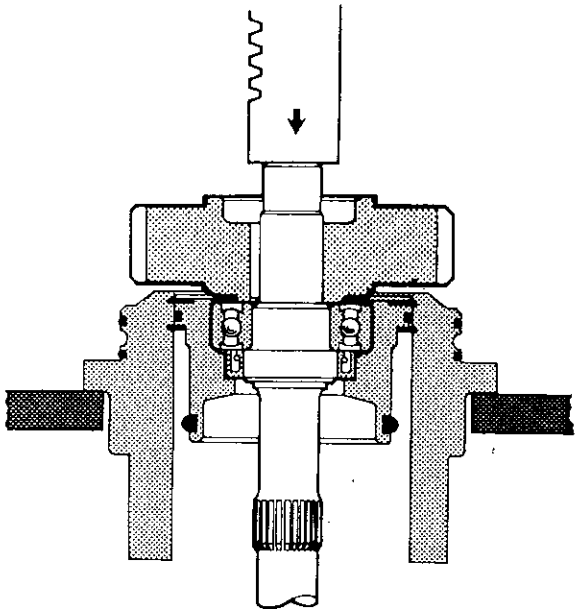


Figure 4.21

11. Install new inner (21) and outer (20) drive housing seals. Install new upper drive housing seal (23).

12. Apply Lithium base grease to both faces of thrust washer (8) and place thrust washer on drive shaft assembly.

13. Position the drive housing (24) according to scribe marks and gear case pin (22), align drive shaft gear teeth with rotor pinion and push drive shaft into gear case bearing (7).

14. Install the nine drive housing screws (26) and lockwashers (25) and torque to 97 - 109 in. lbs. (11.1 to 12.3 N·m).

15. Lubricate the splines and plain end of drive shaft assembly (28) with low temperature Lubriplate grease.

16. Install a new actuator piston seal (18) on actuator (19). After seal is in place, install a new piston actuator ring (17) over piston seal. Apply a coat of low temperature Lubriplate grease to actuator ring.

17. With the actuator ring end facing the bearing retainer (14), insert the actuator piston into the drive housing (24) as far as possible. See Figure 4.22.

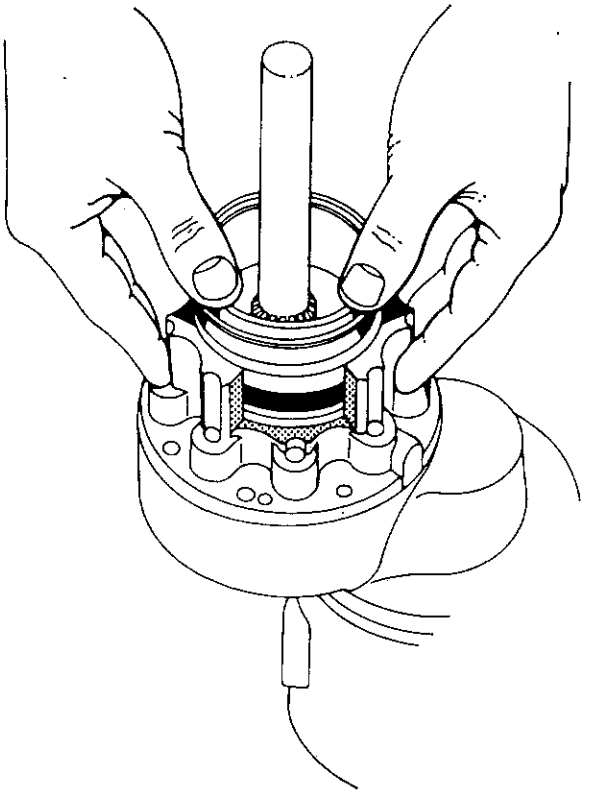


Figure 4.22

18. Press the facet drive assembly seal (41) into bearing cover (42), as shown in Figure 4.23. Lubricate the inside diameter with Lithium base grease.

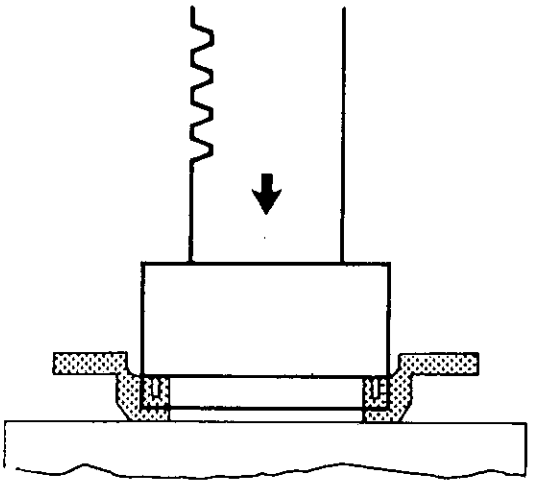


Figure 4.23

19. Press the facet drive assembly seal (38) into

the drive housing adapter. See Figure 4.24. Coat the I.D. of the seal with Lithium base general purpose grease.

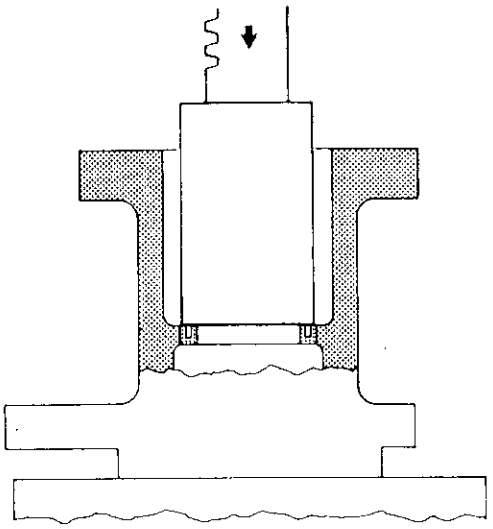


Figure 4.24

20. Press the first facet drive bearing (39) into the drive housing adapter (35) until it bottoms in the adapter.

21. Press the second facet drive bearing (40) in the same manner as above, until it bottoms against the first bearing. Pack both bearings with Lithium base general purpose grease. See Figure 4.25.

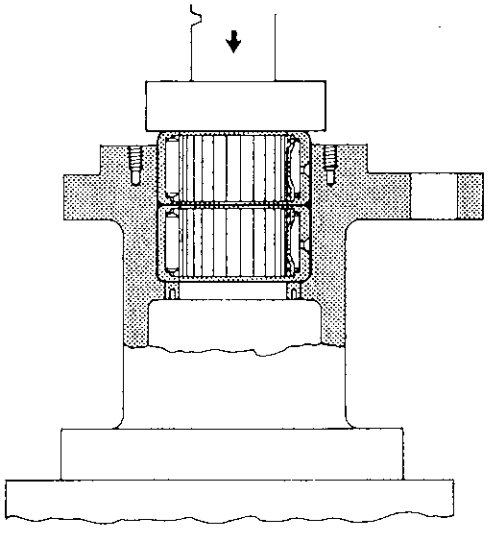


Figure 4.25

22. Install the bearing cover (42). Apply Loctite screw lock No. 242 to the six bearing cover screws (43) and torque to 59 - 73 in. lbs. (6.7 to 8.2 N · m).

23. Install retaining ring (34) in groove in drive housing bushing (33).

24. Install the drive housing bushing in the drive housing adapter. Be sure the retaining ring seats firmly against the adapter. See Figure 4.26.

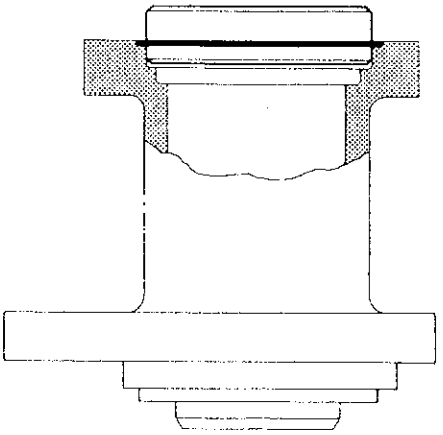


Figure 4.26

25. Insert the drive return spring (32) into the drive housing bushing (33).

26. Lubricate the splines and plain end of the facet drive assembly shaft (31) and insert plain end into the drive housing adapter (35).

27. Attach Tool No. 22776 to drive housing adapter by collasping the drive return spring (32) with the facet drive unit (31) and securing with three nuts as shown in Figure 4.27.

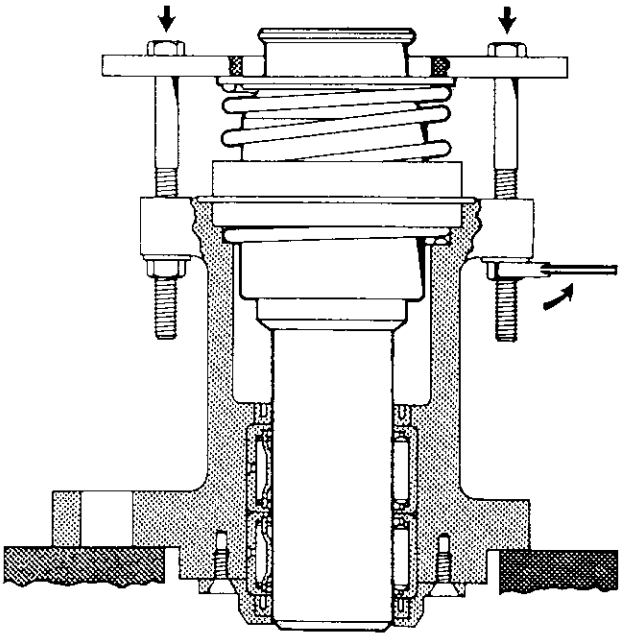


Figure 4.27

28. Press the drive pinion (45) into the facet drive shaft as shown in Figure 4.28.

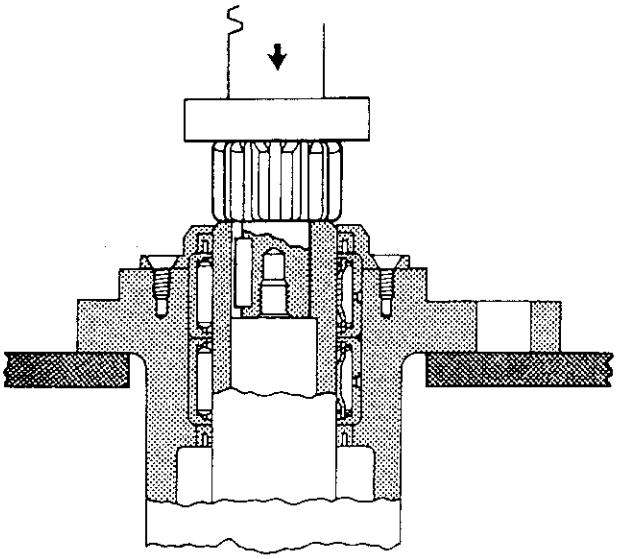


Figure 4.28

29. Apply Loctite screw lock No. 271 to pinion screw thread (29) and install screw using Tool No. 20796. Tighten to 508 - 620 in. lbs. (57.4 - 70.1 N · m). See Figure 4.29. Remove Tool No. 22776.

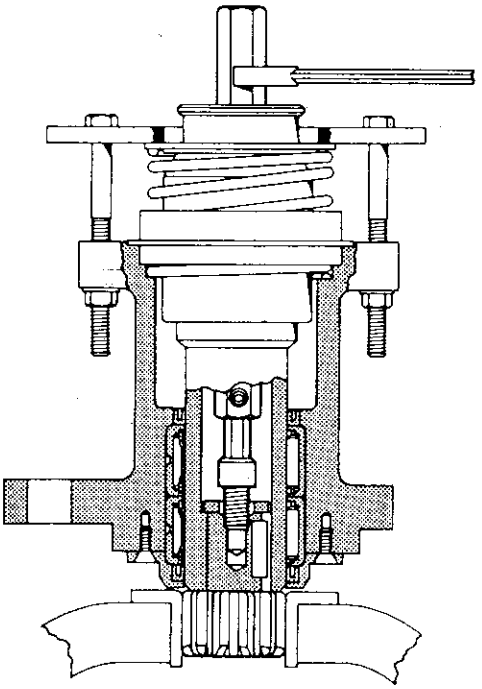


Figure 4.29

30. Position the scribe marks on the drive housing adapter (35) and the drive housing (24). Align the facet drive assembly (31) and drive shaft splines and install the drive housing adapter and facet drive assembly.

31. Install the nine drive housing adapter screws (37) and lockwashers (36) and torque to 216 - 264 in. lbs. (24.4 to 29.8 N · m).

32. Remove the starter assembly from the vise and install the muffler retaining assembly and lockwasher. Torque to 141 -171 in. lbs. (15.9 to 19.3 N · m).

33. Insert the starter muffler (1) in place in the air motor case. Install the muffler screw and torque to 98 - 118 in. lbs. (11.1 to 13.3 N · m).

34. Starter testing and run-in should be accomplished in accordance with pertinent specifications.

SECTION V
STARTMASTER SM2514 SERIES
AIR STARTER

The StartMaster SM2514 Series air starters differ from the SM250 Series starters only in the type of drive housing adapter, mounting flange and facet drive assembly utilized. See Figure 5.1.

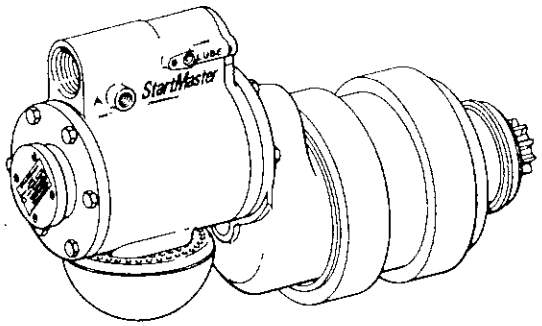


Figure 5.1

AIR MOTOR

The air motor of the SM2514 Series starters is identical to those used in the Series SM250 and SM251 Series air starters.

A complete discussion of the construction and overhaul of the air motor is contained in Section VI.

DISASSEMBLY OF DRIVE GROUP

Disassemble the SM2514 Series starters in accordance with the parts shown in Fold-Out No. 3 and the following instructions:

1. Remove the muffler (1), muffler retaining assembly and sleeve lockwasher.

2. Clamp muffler flange in vise equipped with copper jaws. See Figure 5.2.

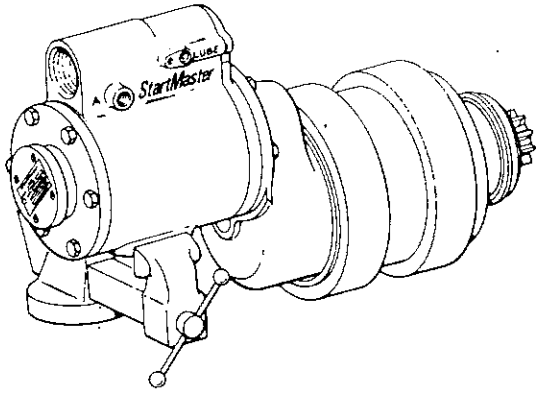


Figure 5.2

3. Scribe reference marks as follows:

1. Drive Housing Adapter and Drive Housing.

2. Gear Case, Lower End Plate and Air Motor Case.
See Figure 5.3.

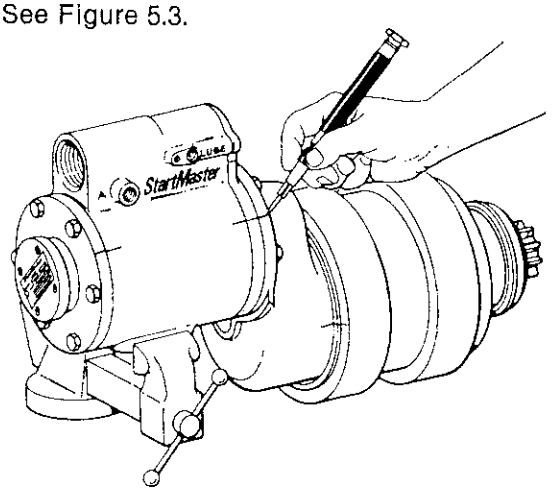


Figure 5.3

4. Remove the nine drive housing adapter screws (30), and lockwashers (36).

5. Remove the drive housing adapter (35), facet drive assembly (31) and facet pinion unit (47), making sure that the drive housing bushing remains in place.

6. Clamp the starter pinion (47) in a vise equipped with copper-lined jaws. Attach facet drive clamping tool No. 22776 and remove pinion screw (29) from the drive unit using Tool No. 20796. See Figure 5.4.

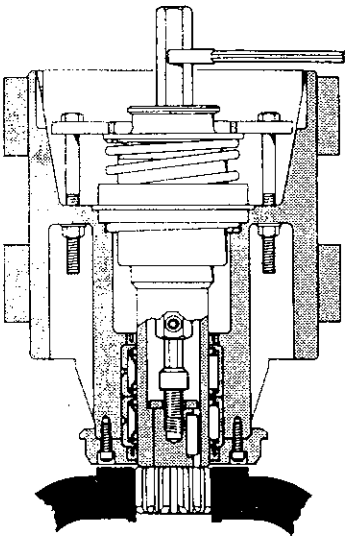


Figure 5.4

7. Thread an 8" piece of 3/8" stock (3/8 -24 x 1/2"). Screw the threaded end into the threaded bore of the facet pinion (47). Remove the pinion from the vise. Using a medium sized ballpeen hammer, tap the threaded bar on the end to force the pinion from the drive housing. See Figure 5.5. Remove the pinion key (46).

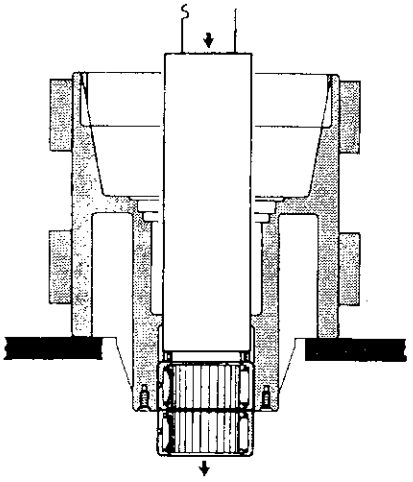


Figure 5.5

8. Pull the facet drive assembly (31) from the drive housing adapter (35).

9. Remove the drive return spring (32) from the facet drive assembly.

10. Remove the six bearing cover screws (45) and remove the bearing cover (44).

11. Remove and discard the facet drive assembly seal (43) in the bearing cover.

12. Place the drive housing adapter in an arbor and press out the two facet drive bearings (41) (42) and seal (40), as shown in Figure 5.6.

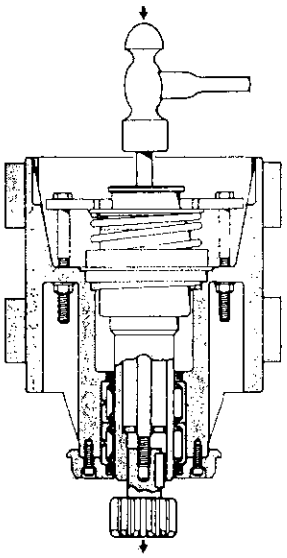


Figure 5.6

13. Remove the nine drive housing screws (26) and lockwashers (25).

14. Using two drive housing screws inserted into the threaded jacking holes in the drive housing flange, jack the drive housing from the gear case. See Figure 5.7.

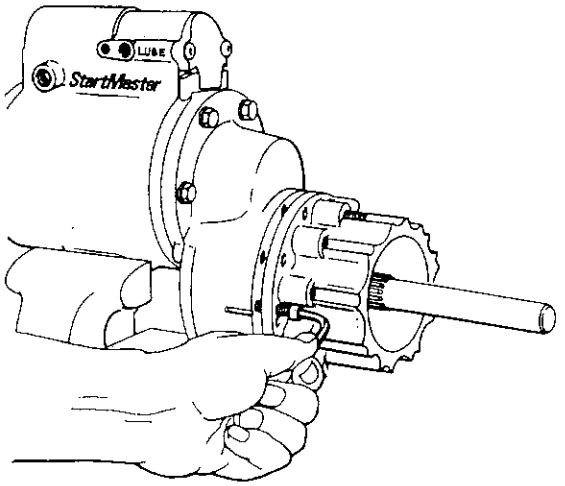


Figure 5.7

Remove thrust washer from front end of the drive shaft. Remove the two (2) jacking screws.

15. Support the drive housing and press out drive shaft (28), drive shaft bearing (10), and drive gear (9) as shown in Figure 5.8.

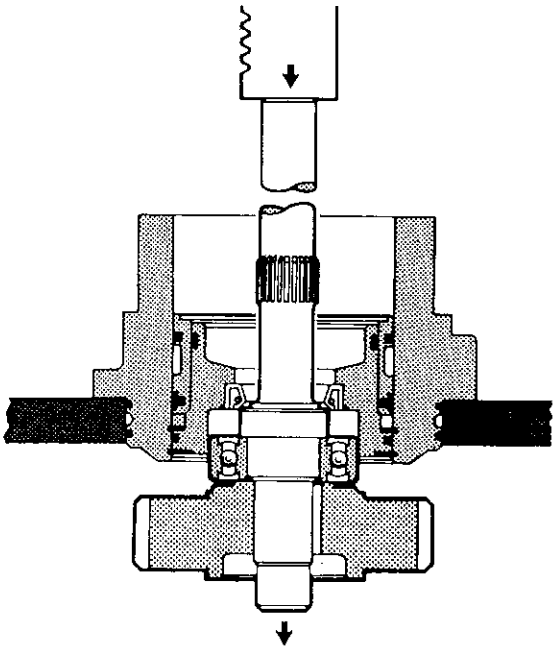


Figure 5.8

16. Reverse drive shaft in arbor and, after supporting drive shaft gear, press out shaft and bearing

from drive gear. Remove drive shaft gear key (27). See Figure 5.9.

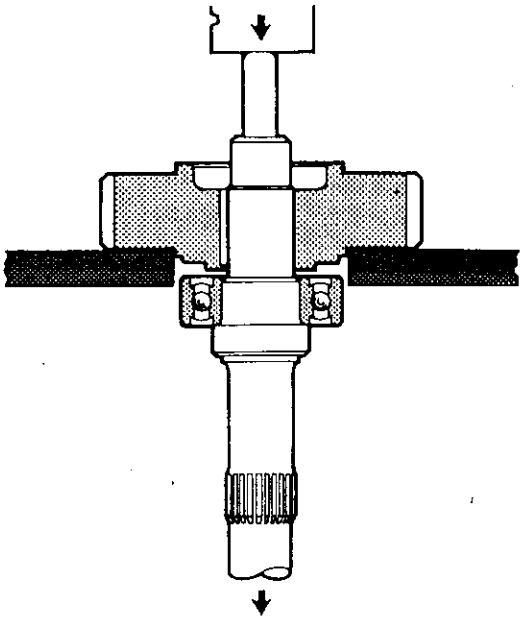


Figure 5.9

17. Support drive shaft bearing in arbor and press out shaft from bearing as shown in Figure 5.10.

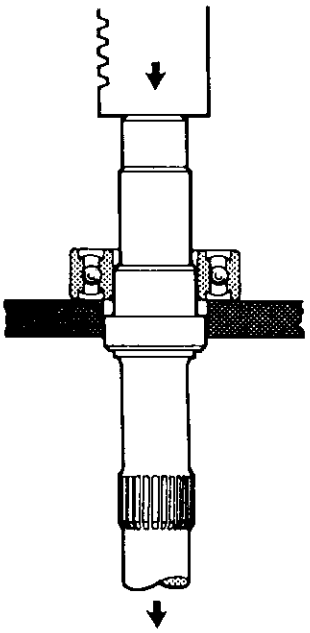


Figure 5.10

18. Remove the front retaining ring (12) from the drive housing, as shown in Figure 5.11.

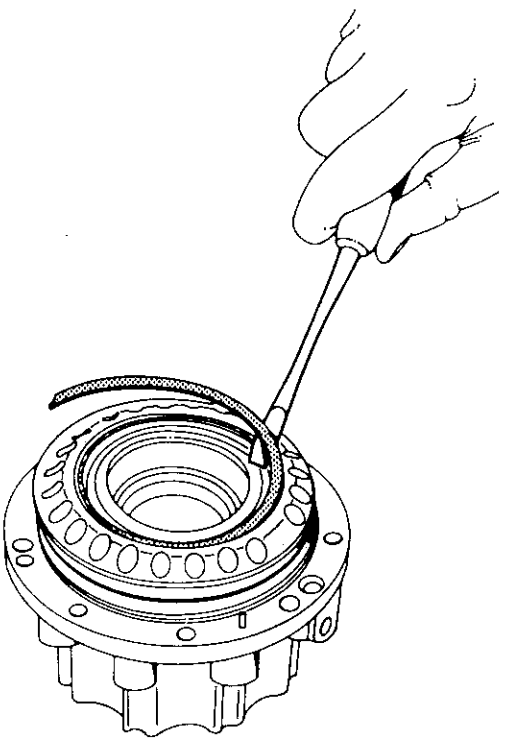


Figure 5.11

19. Place drive housing in a press supported by its flange and press out the bearing retainer (14). See Figure 5.12.

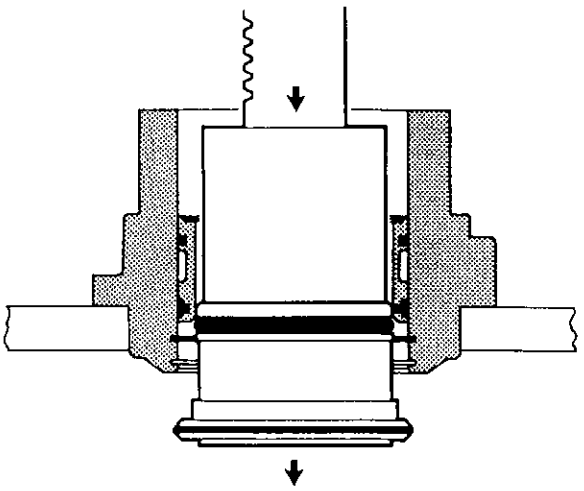


Figure 5.12

CAUTION

Press slowly and evenly making certain that the leading edge of the retainer does not become caught in the retaining ring groove.

20. Support the bearing retainer and press out the drive shaft seal (11). See Figure 5.13.

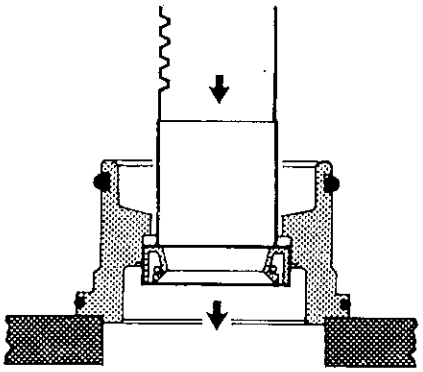


Figure 5.13

21. Invert the drive housing and remove the second retaining ring (15). This will provide additional clearance for pressing out the piston actuator (19).

22. Remove the piston actuator in direction shown in Figure 5.14.

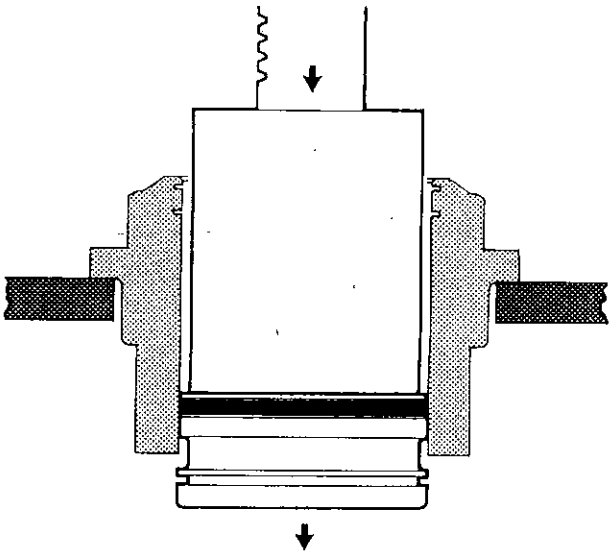


Figure 5.14

23. Using a thin knife blade or screwdriver, remove the piston actuator ring (17). A slight warming of the ring using a 60 watt light bulb will aid in ring removal. Remove piston actuator seal and discard both seal and ring.

24. Remove the six gear case screws (6) and lockwashers (5).

25. Remove gear case (4) using a knife edge to separate the gear case flange from the lower end plate. Remove all traces of old gasket (3) and O-ring (2) from lower end plate.

26. Support the gear case (4) as shown in Figure 5.15 and press out the gear case bearing (7).

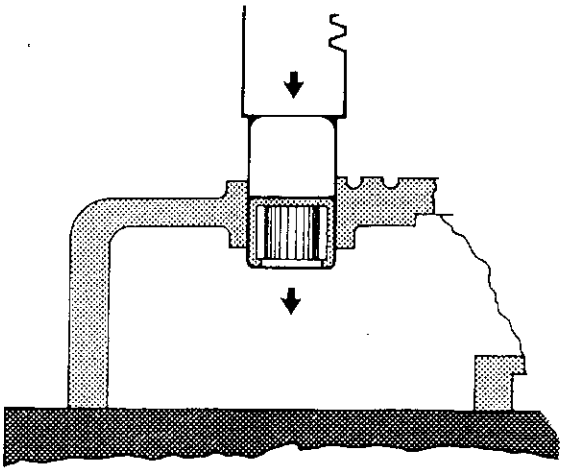


Figure 5.15

CLEANING, INSPECTION AND PARTS REPLACEMENT

CLEANING

WARNING

Perform all cleaning procedures in a well ventilated area and away from flames.

1. Clean all parts removed during disassembly using commercially approved solvents. Do not spin open ball bearings with compressed air.

2. Clean the facet drive unit by wiping thoroughly with a clean cloth.

CAUTION

Do not immerse sealed assemblies such as the drive unit in cleaning solvent. Doing so will wash away internal lubrication.

INSPECTION AND PARTS REPLACEMENT

1. Replace all gaskets and seals removed during disassembly.

2. Inspect all parts removed during disassembly for evidence of excessive or abnormal wear or other damage. Particular attention should be given to the following parts:

DRIVE HOUSING - Visually inspect the drive housing for cracks and breakage and replace if necessary.

DRIVE HOUSING ADAPTER - Visually inspect the drive housing adapter for cracks or breakage. If cracked or broken, the drive housing adapter must be replaced.

BEARINGS - Check the drive housing bearing and the gear case bearing to ensure that the bearing rollers move freely and have not been flattened or otherwise damaged. Check the drive shaft ball bearing for freedom of rotation without excessive play between the races. Replace questionable bearings.

FACET DRIVE UNIT - Inspect the drive unit for worn (loose), missing or damaged parts and broken or battered gear teeth. Check the drive pinion for damage or excessive wear. Defective drive assemblies cannot be rebuilt and must be replaced as a unit.

DRIVE SHAFT GEAR - Inspect the drive shaft gear for cracked or broken teeth or excessive wear. Check for unusual contact patterns indicating run out between gears, misalignment, or improper engagement. Replace a damaged or questionable drive shaft gear.

ACTUATOR PISTON - Inspect the actuator piston for deep scoring marks or other excessive wear. Replace a questionable actuator piston.

DRIVE PINION - Inspect the drive pinion for cracks, excessively worn or broken teeth. Replace questionable drive pinions.

SADDLE SPACER - Inspect the saddle spacers for evidence of cracks, scoring and excessive wear. Replace questionable spacers.

OVERHAUL

Replace the following drive group parts during complete overhaul of Series SM2514:

- Drive Bearings
- All Gaskets, Seals and O-rings
- Facet Drive Unit
- Drive Pinion
- Actuator Piston

REASSEMBLY OF DRIVE GROUP

Reassemble the StartMaster SM2514 Series drive assembly generally in reverse order of the indexing shown in Fold-Out No. 3 and in accordance with the following instructions:

1. Press a new gear case bearing (7) into gear case (4) flush to .010" (.254 mm) below surface of gear case and pack with Lithium base grease. See Figure 5.16.

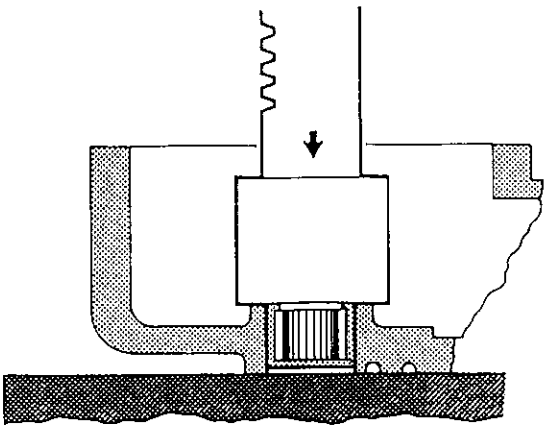


Figure 5.16

2. With air motor muffler flange clamped in vise, place a new gasket (3) and O-ring (2) in correct position on lower end plate. Position gear case (4) on lower end plate according to scribe marks, install six gear case screws (6) and lockwashers (5), and torque to 141 - 171 in. lbs. (15.9 to 19.3 N·m).

3. Pack gear case with 1/4 lb. of Lithium base general purpose grease.

4. Press a new drive shaft bearing (10) onto drive shaft (28), as shown in Figure 5.17.

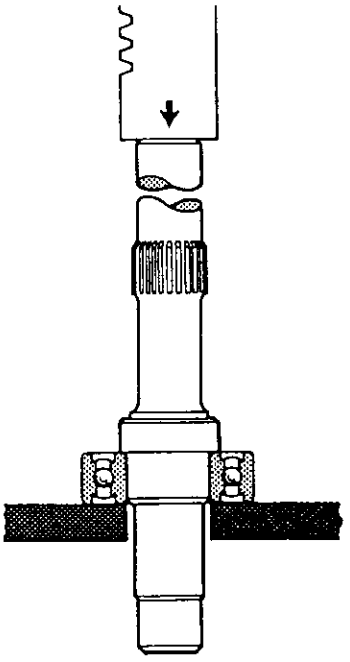


Figure 5.17

5. Insert the drive shaft key (27) into the shaft (28) and orient the drive shaft gear (9) to the shaft and key with the raised boss toward the bearing. Press gear onto the shaft as shown in Figure 5.18.

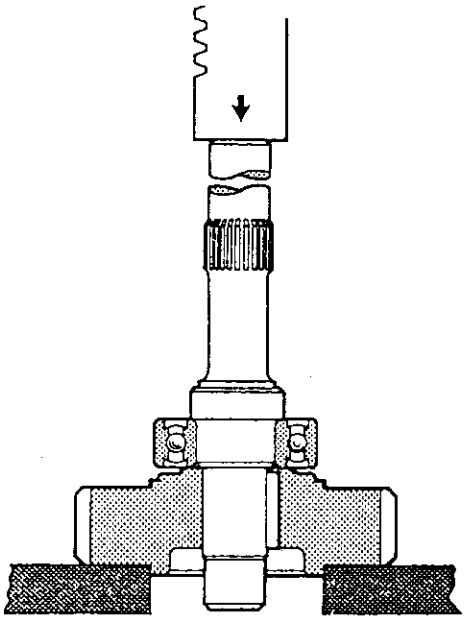


Figure 5.18

6. Install a new drive housing seal (13) and bearing retainer seal (16) on bearing retainer (14). Apply Lithium base general purpose grease to bearing retainer seal.

7. Install a new drive shaft seal (11) in housing retainer (14). Apply Lithium base general purpose grease to I.D. of seal. See Figure 5.19.

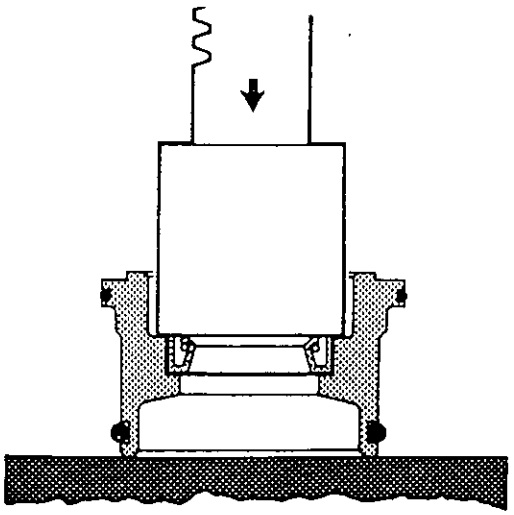


Figure 5.19

8. Install inner retaining ring (15) in drive housing (24).

9. Press the bearing retainer (14) into position in the drive housing (24), as shown in Figure 5.20.

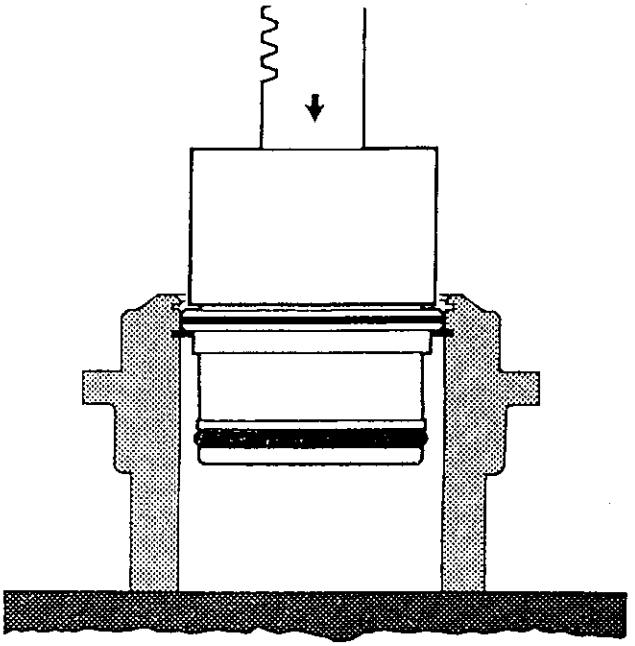


Figure 5.20

10. Install outer retaining ring (12) in drive housing.

11. Place drive housing in arbor and press drive shaft (28), drive shaft bearing (10) and gear assembly (9) into bearing retainer (14). See Figure 5.21.

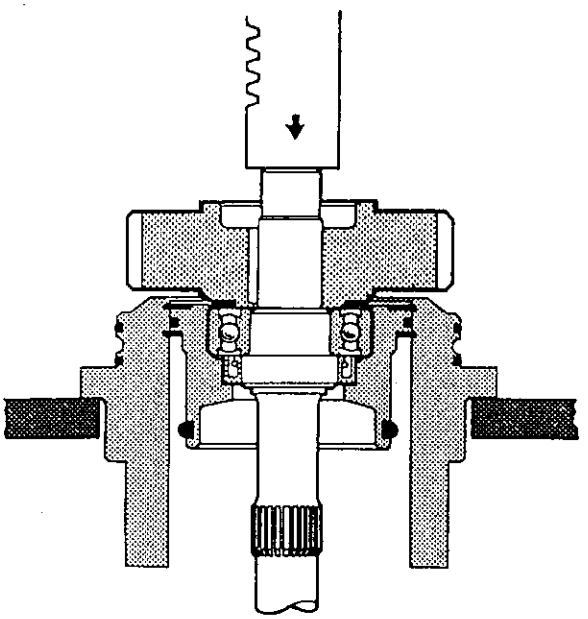


Figure 5.21

12. Install new inner (21) and outer (20) drive housing seals. Install new upper drive housing seal (23).

13. Apply Lithium base grease to both faces of thrust washer (8) and place thrust washer on drive shaft assembly (28).

14. Position the drive housing (24) according to scribe marks and gear case pin (22), align drive shaft gear (9) teeth with rotor pinion and push drive shaft (28) into gear case bearing (7).

15. Install the nine drive housing screws (26) and lockwashers (25) and torque to 97 - 109 in. lbs. (11.1 to 12.3 N·m).

16. Lubricate the splines and plain end of drive shaft assembly (28) with low temperature Lubriplate grease.

17. Install a new actuator piston seal (18) on actuator (19). After seal is in place, install a new piston actuator ring (17) over piston seal. Apply a coat of low temperature Lubriplate grease to actuator ring.

18. With the actuator ring end facing the bearing retainer (14), insert the actuator piston into the drive housing (24) as far as possible. See Figure 5.22.

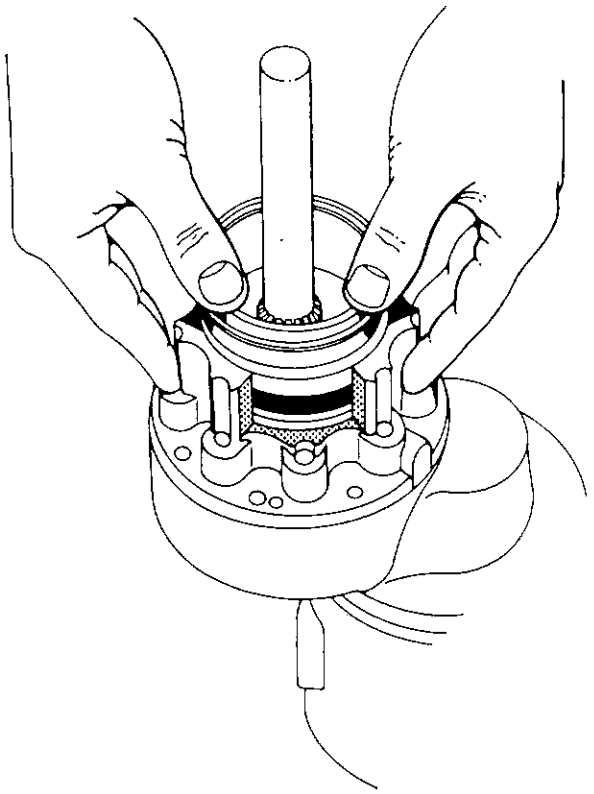


Figure 5.22

19. Press the facet drive assembly seal (43) into bearing cover (44), as shown in Figure 5.23.

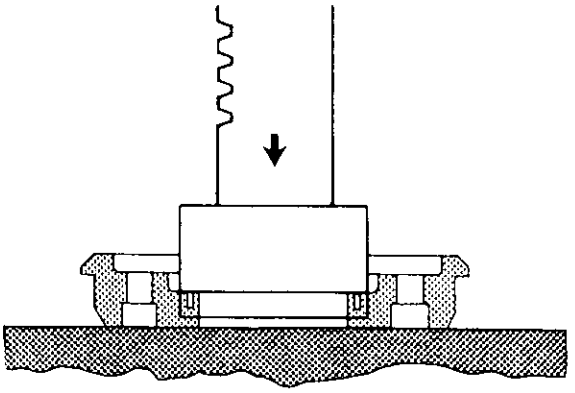


Figure 5.23

20. Press the facet drive assembly seal (40) into the drive housing adapter. See Figure 5.24. Coat the I.D. of the seal with Lithium base general purpose grease.

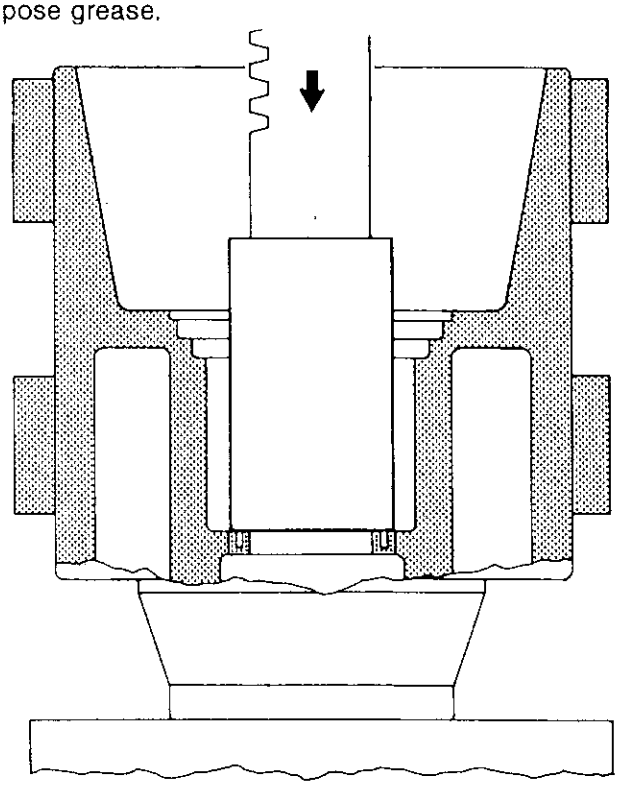


Figure 5.24

21. Press the first facet drive bearing (41) into the drive housing adapter (35) until it bottoms in the adapter.

22. Press the second facet drive bearing (42) in the same manner as above, until it bottoms against the first bearing. Pack both bearings with

Lithium base general purpose grease. See Figure 5.25.

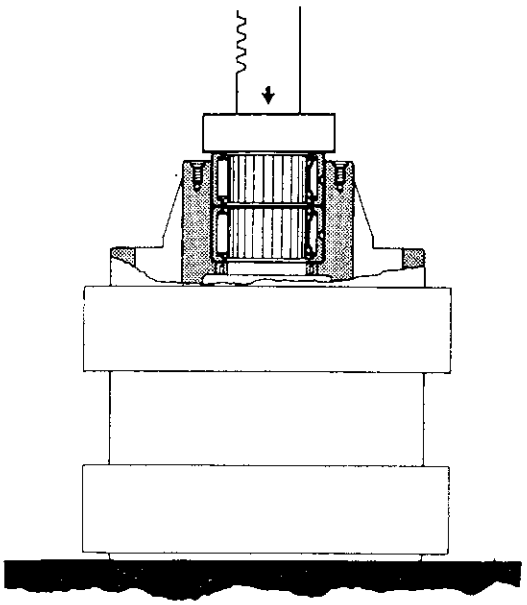


Figure 5.25

23. Install the bearing cover (34). Apply Loctite screw lock No. 242 to the six bearing cover screws (45) and torque to 59 - 73 in. lbs. (6.7 to 8.2 N · m).

24. Install retaining ring (34) in groove in drive housing bushing (33).

25. Install the drive housing bushing in the drive housing adapter. Be sure the retaining ring seats firmly against the adapter. See Figure 5.26.

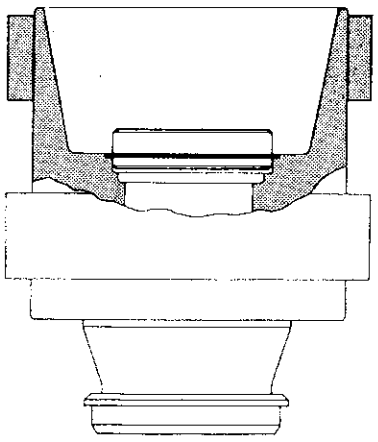


Figure 5.26

26. Insert the drive return spring (32) into the drive housing bushing (33).

27. Lubricate the splines and plain end of the facet drive assembly shaft (31) and insert plain end into the drive housing adapter (33).

28. Attach Tool No. 22776 to drive housing adapter by collapsing the drive return spring (32) with the facet drive unit (32) and securing with three nuts as shown in Figure 5.27.

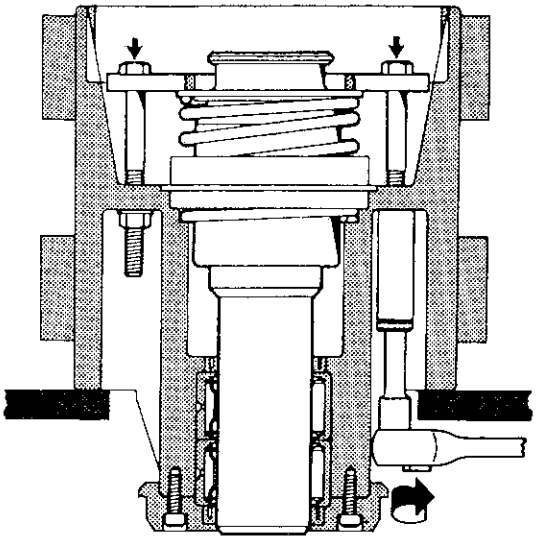


Figure 5.27

29. Press the drive pinion (47) into the facet drive shaft as shown in Figure 5.28.

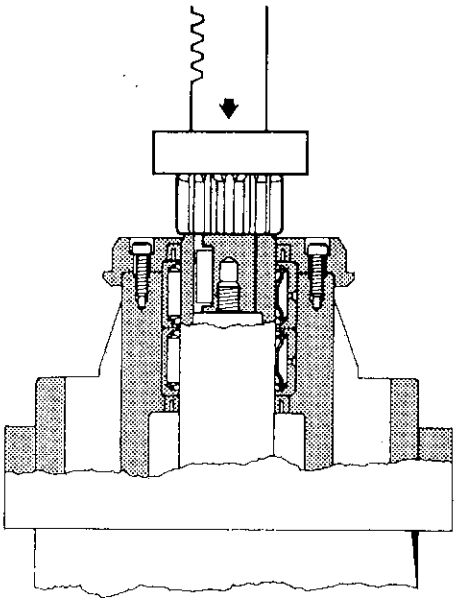


Figure 5.28

30. Apply Loctite screw lock No. 271 to pinion screw thread (29) and install screw using Tool No. 20796. Tighten to 508 - 620 in. lbs. (57.4 -70.1 N·m). Remove Tool No. 22776.

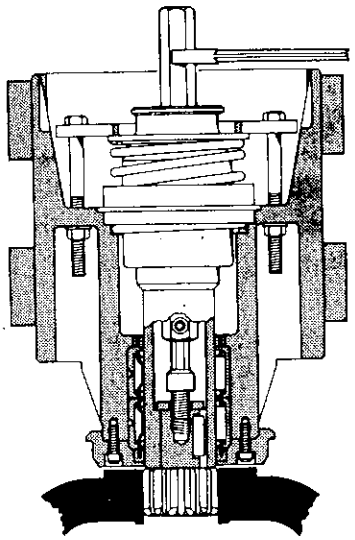


Figure 5.29

31. Position the scribe marks on the drive housing adapter (35) and the drive housing (24). Align the facet drive assembly (31) and drive shaft splines and install the drive housing adapter and facet drive assembly.

32. Install the nine drive housing adapter screws (37) and lockwashers (36) and torque to 97 - 119 in. lbs. (11.0 to 13.4 N · m).

33. Remove the starter assembly from the vise and install the muffler retaining assembly and lockwasher. Torque to 141 - 171 in. lbs. (11.0 to 13.4 N · m).

34. Insert the starter muffler (1) in place in the air motor case. Install the muffler screw and torque to 98 - 118 in. lbs. (11.1 to 13.3 N · m).

SECTION VI
STARTMASTER SERIES SM250
AIR MOTOR AND SEQUENCING VALVE ASSEMBLY

CONSTRUCTION

The StartMaster air motor (Figure 6.1) consists of a casing, lower and upper end plate assemblies, rotor assembly, sleeve assembly, and sequencing valve assembly.

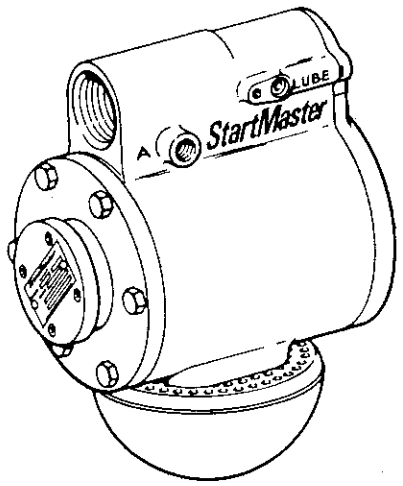


Figure 6.1

The casing is a cast aluminum unit which provides a means of support for the other motor components. It also contains passages that direct the airflow within the starter.

The rotor assembly consists of a rotor body attached to a steel shaft. Five rotor blades or vanes are mounted in slots in the rotor body. This assembly is the rotating element of the motor. A rotor pinion is attached to the drive end of the rotor.

The upper and lower end plate assemblies both consist of an end plate with blade positioning cam and a ball bearing. The lower end plate is equipped with a single row, shielded bearing and is secured to the motor housing by the drive housing or gear case bolts. The upper end plate is also equipped with a single row, shielded bearing and is secured to the casing by six end plate screws. The upper end plate bearing is retained in the end plate by a bearing cover. Both end plates support and position the rotor assembly in the housing. An O-ring located between each end plate and the housing prevents air leakage.

The sleeve assembly is a cast-iron unit which directs the airflow to the rotor assembly in the proper direction and provides a sealing surface for the rotor blades. The inside diameter of the sleeve is cast eccentrically to the outside diameter which allows for the expansion of the air trapped between rotor blades as it passes from the inlet plenum to the exhaust plenum.

On some models the sequencing valve assembly is housed in the air inlet port and allows for pre-engagement of the facet pinion with the engine ring gear prior to delivery of pressurized air to the rotor assembly. The valve consists of a piston and shaft to which is attached an inlet air-foil.

OPERATION

See Section II

DISASSEMBLY

Disassemble the StartMaster Series SM250 air motor in accordance with the index numbering shown in Fold-Out No. 4 and the following instructions:

1. Remove the muffler (48) and muffler retaining assembly (27).

NOTE

For gas starters remove the exhaust adapter. Discard the exhaust adapter seal.

2. Clamp muffler flange in vise equipped with copper lined jaws, as shown in Figure 6.2.

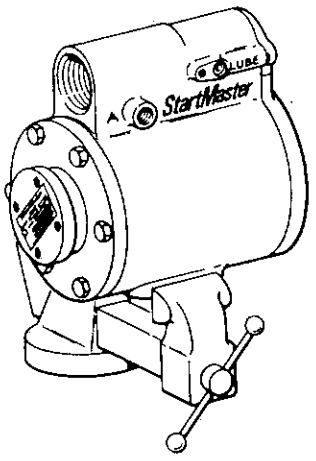


Figure 6.2

3. Scribe reference marks as follows:

1. Gear Case and Drive Housing.
2. Gear Case and Lower End Plate.
3. Lower End Plate and Air Motor Casing.
4. Air Motor Casing and Upper End Plate.

See Figure 6.3.

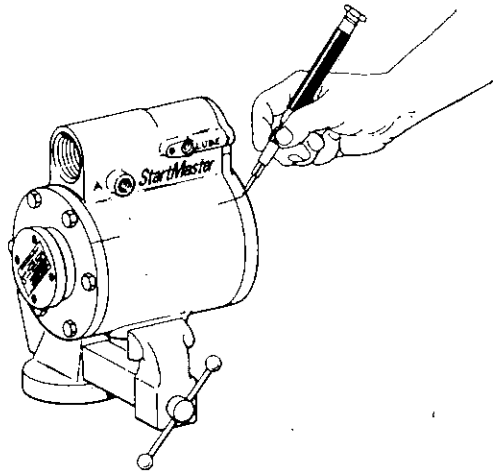


Figure 6.3

4. Remove the nine housing screws (34) and jack the drive housing and gear assembly from the gear case using two (2) bolts in jack holes. Remove and discard the three drive housing seals. Remove thrust washer.

NOTE: For 2514 Series Starters, drive housing adapter must be removed. See Section V.

5. Remove the six gear case screws. Using a knife edge or wide scraper blade to separate the gear case flange from the lower end plate, remove and discard the gasket and O-ring from the lower end plate.

6. Grasp the rotor pinion (44) and slide the rotor (30) and lower end plate assembly from the air motor casing (35) as shown in Figure 6.4. Remove the rotor blades (31) and discard the end plate seals (36).

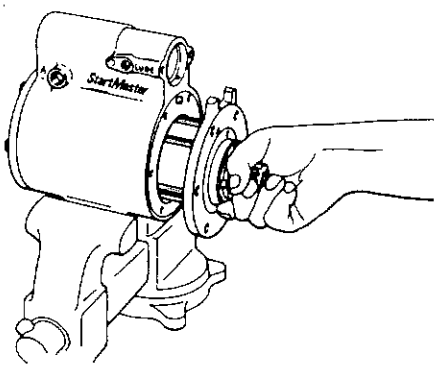


Figure 6.4

7. Using snap ring pliers, remove the pinion retaining ring (45) from the rotor shaft. See Figure 6.5.

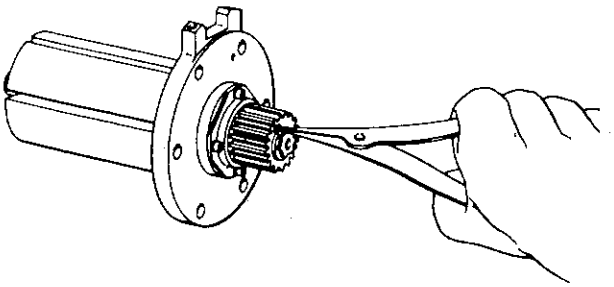


Figure 6.5

8. Heat the rotor and end plate assembly to approximately 350 degrees F (177 degrees C) for 1/2 hour to soften the Loctite on the rotor shaft. Support the rotor and end plate assembly and press the rotor shaft from the lower end plate and rotor pinion (45). See Figure 6.6. Remove Pinion.

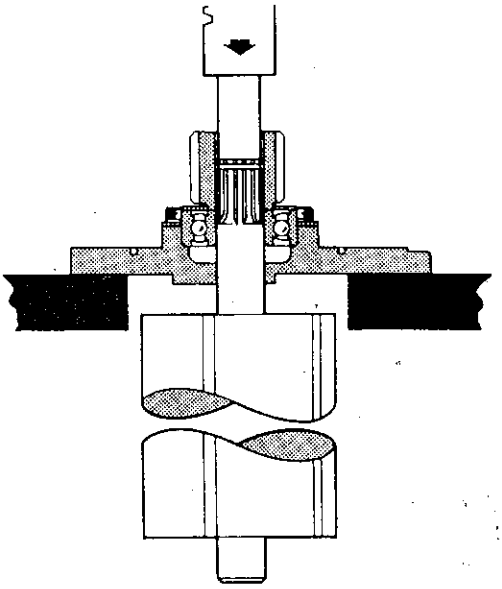


Figure 6.6

NOTE

For optional field disassembly only, use shaft jack Tool No. 20098 to press shaft. See Figure 6.7.

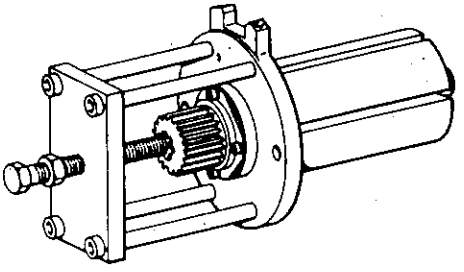


Figure 6.7

9. Remove the four bearing retainer screws (43) and lockwashers (42) from the lower end plate bearing retainer (41) and remove the retainer.

10. Press the lower end plate bearing (40) from the end plate as shown in Figure 6.8.

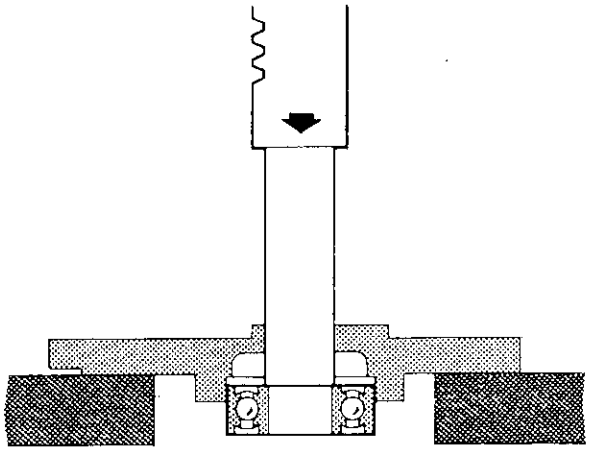


Figure 6.8

11. Remove the four bearing retainer screws (21) and lockwashers (22) from the upper end plate bearing cover (23) and remove the cover.

12. Remove the six upper end plate screws (26) and lockwashers (27) and, using a knife edge, separate the upper end plate (28) from the air motor casing (35). Discard the upper end plate seal (29).

13. Press the upper end plate bearing (25) from the end plate as shown in Figure 6.9.

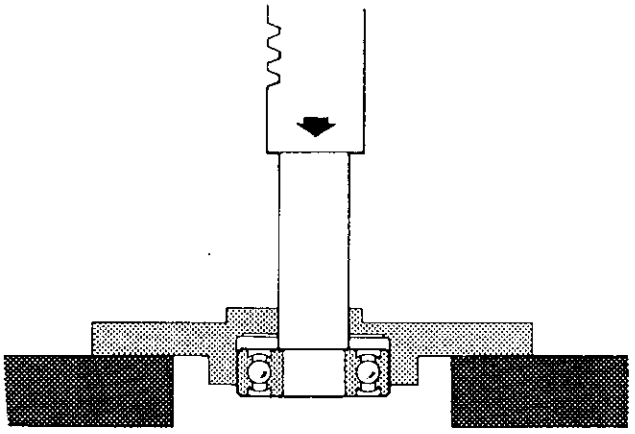


Figure 6.9

14. Remove air motor sleeve (32) from the air motor casing. Remove the sleeve adapter (34) and discard the adapter seal (33).

15. Remove the two sequencing stop screws (20) and remove the sequencing stop (18).

16. Using a screwdriver, remove the retainer ring (17) from the sequencing stop (18) and remove the dampening piston (16).

NOTE

Dampening piston is not used on non-relay and gas type starters.

17. Chip away the paint and compound from the lubrication boss areas to expose the seal support set screws (37). See Figure 6.10.

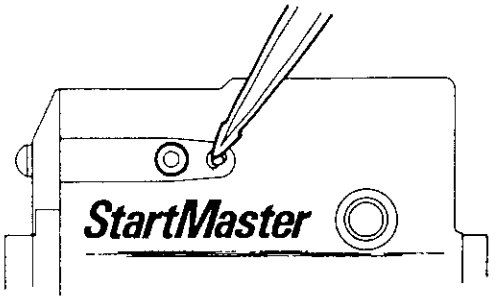
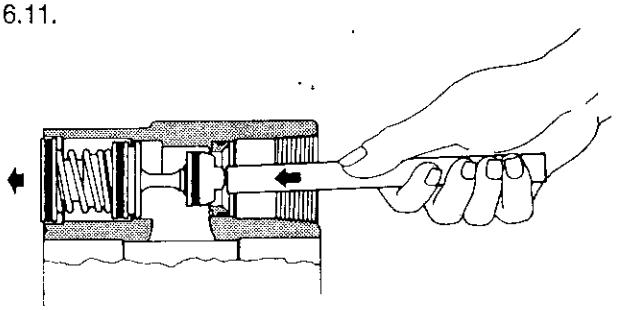


Figure 6.10

18. Remove the seal support set screws (37) and push the sequencing valve assembly out of the air motor casing in direction shown in Figure 6.11.



19. Insert a drift punch into the hole in the sequencing valve piston (9). This will provide leverage when removing the air-foil (1). See Figure 6.12.

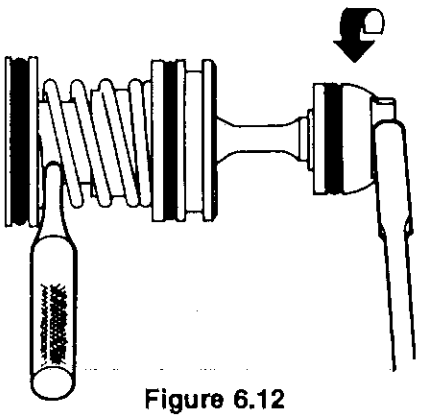


Figure 6.12

20. Using a 3/8" open-end wrench, remove the sequencing valve air-foil (1) and lockwasher (8). Discard the air-foil seal (2).

21. Remove the seal support assembly (5) and sequencing valve spring (7) from the valve. Discard the seal support assembly (5).

22. Remove and discard the piston seals (14) from the sequencing valve assembly.

23. Using a screwdriver, remove the retaining ring (13) from the sequencing valve piston and remove the piston ring (12). Discard the piston seal (10).

24. Remove and discard the piston seal (11) - if used - from I.D. of the sequencing valve (9).

CLEANING, INSPECTION AND PARTS REPLACEMENT

CLEANING

WARNING

Perform all cleaning procedures in a well ventilated area and away from open flames.

1. Clean all parts removed during disassembly *using commercially approved solvents. Do not use hot tank soak.*

2. Clean all sealed ball bearings by wiping thoroughly with a clean cloth.

CAUTION

Do not immerse sealed assemblies such as shielded ball bearings in cleaning solvents. Doing so will wash away internal lubrication.

3. Remove all dirt, grease, gasket residue and burrs from mating gasket surfaces.

INSPECTION AND PARTS REPLACEMENT

1. Replace all gaskets and seals removed during disassembly.

2. Inspect all parts removed during disassembly for evidence of excessive or abnormal wear or other damage. Particular attention should be given to the following parts:

MOTOR HOUSING - Visually inspect the exterior of the housing and the sleeve bore for cracks. If the liner requires remachining or honing, do not exceed an inside diameter of 3.543" (89.99 mm). Hone to a smooth crosshatch pattern. Visually inspect all parts for chipping and all bolt holes for stripped or broken threads. A housing with damaged inlet port, outlet port or bolt hole threads or cracks must be replaced. Inspect the sequencing valve port I.D. and the sequencing valve seat for evidence of excessive wear.

ROTOR ASSEMBLY - Visually inspect the rotor body for cracks at the bottom of the blade slots, scored areas and nicks, and to ensure that it is tight on the shaft. Check to see that the rotor shaft is not bent and the bearing seating surfaces are not deeply scored or worn. Damage to any part of the rotor requires replacement of the complete rotor assembly.

BLADES - Inspect the blades for cracks, delamination, chipping and warpage. Particular attention should be given to the sealing surface of the blades. If the sealing edge chamfer is no longer visible, the blade should be considered worn-out. Damaged or worn blades should be replaced in sets of five only.

END PLATE ASSEMBLIES - Inspect the end plate assemblies for scored surfaces and other damage. Ball bearings which were removed from end plates must be replaced. If housings are not removed, they should be checked for freedom and smoothness of rotation.

GEAR CASE - Visually inspect the gear case and cover for cracks and breakage and replace if necessary.

ROTOR PINION - Inspect the rotor pinion for cracked or broken teeth or excessive wear. Check for unusual contact patterns indicating run out between gears, misalignment or improper engagement. Replace any damaged or questionable gears.

SEQUENCING VALVE ASSEMBLY - Visually inspect the piston, piston ring, air-foil and dampening piston for evidence of excessive wear or misalignment. Replace any damaged or questionable parts.

OVERHAUL

The following air motor group parts must be replaced during complete overhaul of the Series SM250:

Upper and Lower End Plate Bearings
All Rotor Blades
All Gaskets and Seals
Sequencing Valve Seal Support Assembly

REASSEMBLY

Reassemble the StartMaster Series SM250 air motor generally in reverse of the indexing shown in Fold-Out No. 4 and in accordance with the following instructions:

1. Install the piston seal (11) in I.D. of sequencing valve piston (9). Apply a small amount of Dow Compound #7.

NOTE

Piston and piston seal are not used on on-relay valve and gas starters.

2. Replace piston seal (10) and install piston ring (12) on sequencing valve piston (9) using retaining ring (13).

3. Replace piston seal (14) on sequencing valve piston. Apply Dow Compound #7 grease to seal O.D.

4. Install a new seal support seal (4) on seal support (5). Lubricate the I.D. of the seal support with Dow Compound #7 grease.

5. Place sequencing valve spring (7) on sequencing valve piston (12). Install seal support (5) on piston with seals toward air-foil end, as shown in Figure 6.13. Install sequencing valve air-foil (1) and lockwasher (8) on the piston. Insert a drift punch into the hole in the sequencing valve to provide leverage and torque the air-foil to 40-50 in. lbs. (4.5 to 5.6 N·m). Replace air-foil seal (2).

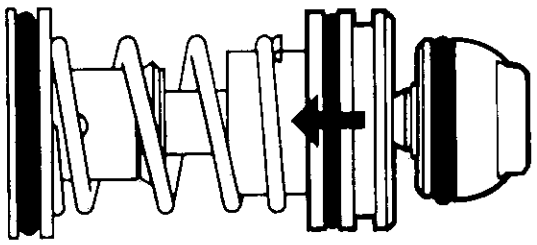


Figure 6.13

6. Insert the sequencing valve assembly into the port in the air motor casing in position shown in Figure 6.14. Push the piston forward against spring pressure and seat seal support assembly in the casing to a point where the groove in the seal support assembly becomes visible in the seal support screw holes. Be sure to align the piston correctly in the support assembly and apply even pressure so as not to damage the piston seal. Apply a small amount of Loctite No. 242 to the two seal support screws (37) and install in casing. Torque to 20-25 in. lbs. (2.3 to 2.8 N·m).

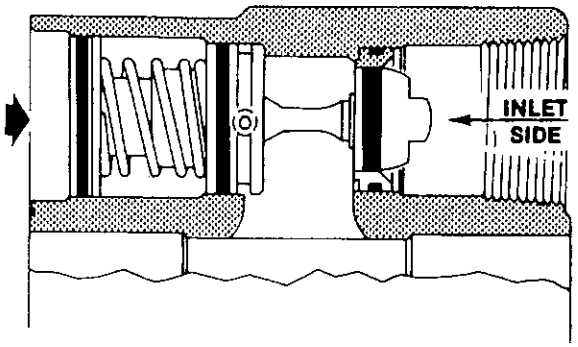


Figure 6.14

7. Check to see that sequencing valve air-foil (1) and seal are seated in valve seal.

NOTE

Seal must allow no leakage when pressurized to 50 p.s.i. ± 1 p.s.i. from inlet side.

8. Place a new sleeve adapter seal (33) in the sleeve adapter (34) and install adapter on the air motor sleeve assembly. Align ramp in sleeve adapter with arrow on sleeve to ensure desired rotation of rotor assembly. See Figure 6.15.

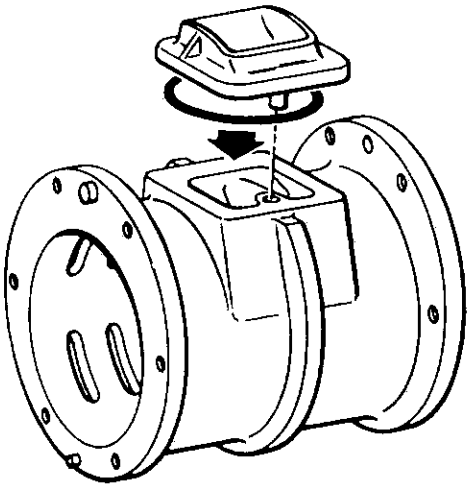


Figure 6.15

9. Align the direction arrows of the air motor sleeve assembly (32) for the desired air motor rotation (opposite starter pinion rotation). Roughly orient the air motor sleeve to align the air inlet passage with the passage in the motor

casing. Press the air motor sleeve into the air motor casing, as shown in Figure 6.16.

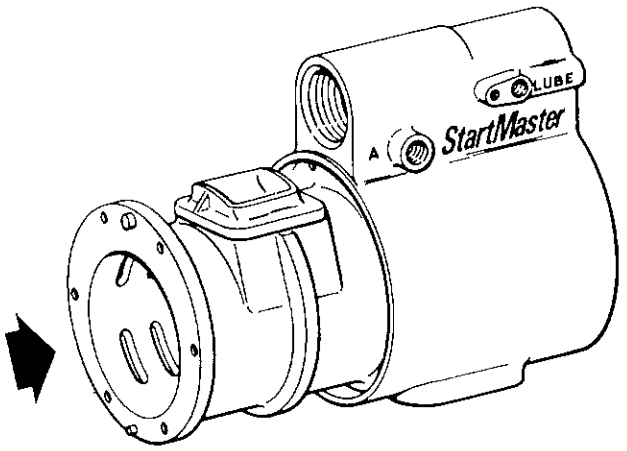


Figure 6.16

10. Press the lower end plate bearing (40) into the lower end plate (39), as shown in Figure 6.17. Install the bearing retainer (41) using the four bearing retainer screws (43) and lockwashers (42). Torque the screws to 25-30 in. lbs. (2.8 to 3.4 N · m).

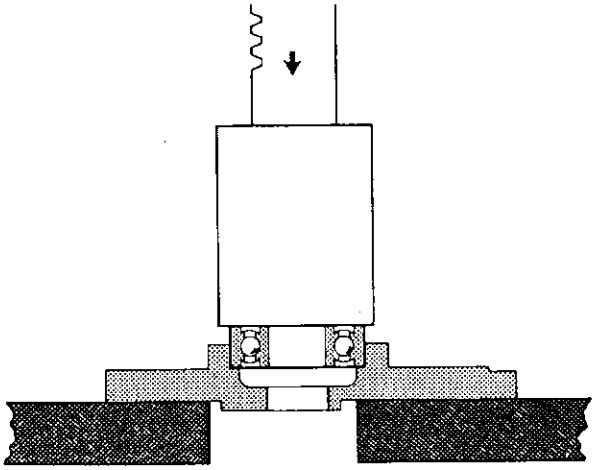


Figure 6.17

11. Heat the lower end plate and bearing assembly to 350 degrees F (177 degrees C) for 1/2 hour to expand the inner race of the end plate bearing. Support the end plate assembly as shown in Figure 6.18 and place two .003" (.08 mm) feeler gauges on the end plate. Apply a small amount of Loctite No. 35 maximum strength retaining compound to the rotor shaft bearing diameter. Insert the rotor assembly until it bottoms against the feeler gauges and hold in position for approximately 30 seconds while the bearing cools to grip the rotor shaft.

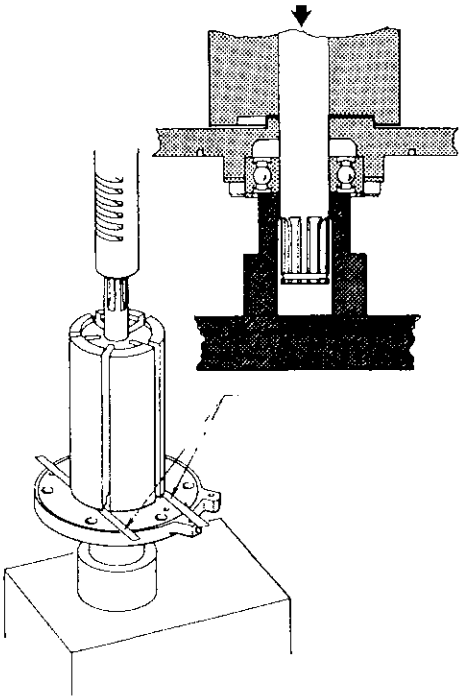


Figure 6.18

NOTE

After the end plate and rotor assembly have cooled, check the rotor end clearance. Rotor clearance should be between .003" and .006" (.08 to .15 mm).

12. Invert the end plate and rotor assembly in the arbor and press the rotor pinion (44) into the rotor shaft. Install the pinion retainer (45). See Figure 6.19.

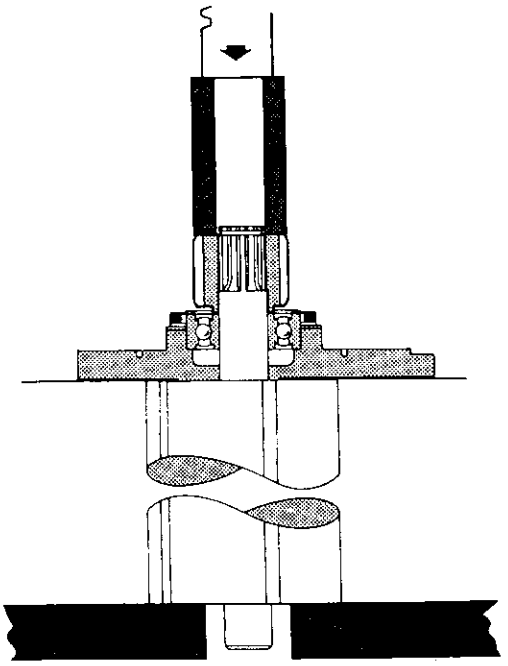


Figure 6.19

13. Press the upper end plate bearing (25) into the upper end plate (28) as shown in Figure 6.20. A slight warming of the end plate will aid in installing bearing. Install a new seal (24) on the bearing cover (23) and install the bearing cover using the four bearing retainer screws (21). Torque screws to 25-30 in. lbs. (2.8 to 3.4 N·m). Place a new end plate seal (29) in upper end plate.

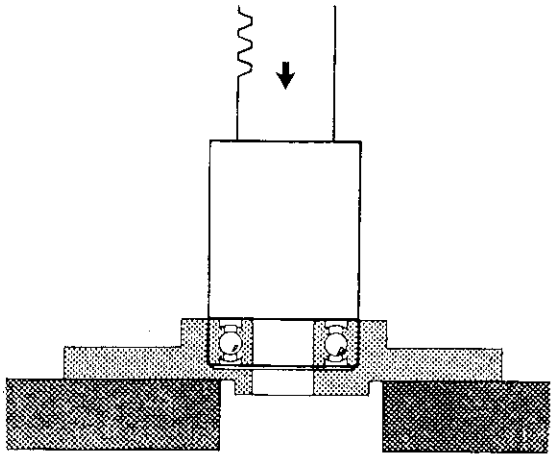


Figure 6.20

14. Clamp the muffler flange in a vise equipped with copper jaws.

15. Place the upper end plate roughly in position on the air motor casing and install the six end plate screws (26) and lockwashers (27) loosely in the air motor sleeve assembly - do not torque at this point.

16. Install a new end plate seal (29) on the lower end plate and new seals (36) in the air motor casing.

17. Assembly the five rotor blades (31) in the rotor (30) and slide the rotor assembly into the air motor sleeve.

18. Grasp the rotor pinion and spin the rotor assembly several times in the sleeve. Spinning the rotor assembly will centrifugally move the rotor blades outward so that the rotor assembly shaft will seat properly into the bearing and will ensure freedom of movement of the rotor.

19. Loosely install two gear case screws through the lower end plate into the sleeve assembly. Using these screws and the upper end plate screws (26), rotate the sleeve assembly to align scribe marks on the upper and lower end plates and the air motor casing.

20. Install dampening plunger (16) in sequencing valve stop (18) using retaining ring (17).

21. Install a new sequencing valve stop seal (15) on the stop and install the stop loosely in place using sequencing valve stop screws (20) and lockwashers (19).

22. Check final alignment of end plate scribe marks and check alignment of sequencing valve stop between ears of the lower end plate. Remove the two gear case screws from the lower end plate.

23. Torque the upper end plate screws to 141-161 in. lbs. (15.9 to 18.2 N·m).

24. Torque the sequencing valve stop screw to 90-110 in. lbs. (10.2 to 12.4 N·m).

25. Install new seal on the lower end plate and place a new gear case gasket in position on the end plate.

26. Position the gear case on the lower end plate and align the scribe marks. Install the six gear case screws and torque to 141-161 in. lbs. (15.9 to 18.2 N·m).

27. Pack the gear case with 1/4 lb. of Lithium base general purpose grease.

28. Install three new drive housing seals on the drive housing. Insert the drive shaft assembly into the gear case bearing and position the drive housing to the gear case using the scribe mark. Install the nine drive housing screws and lockwashers and torque to 97-119 in. lbs. (11.1 to 13.3 N·m).

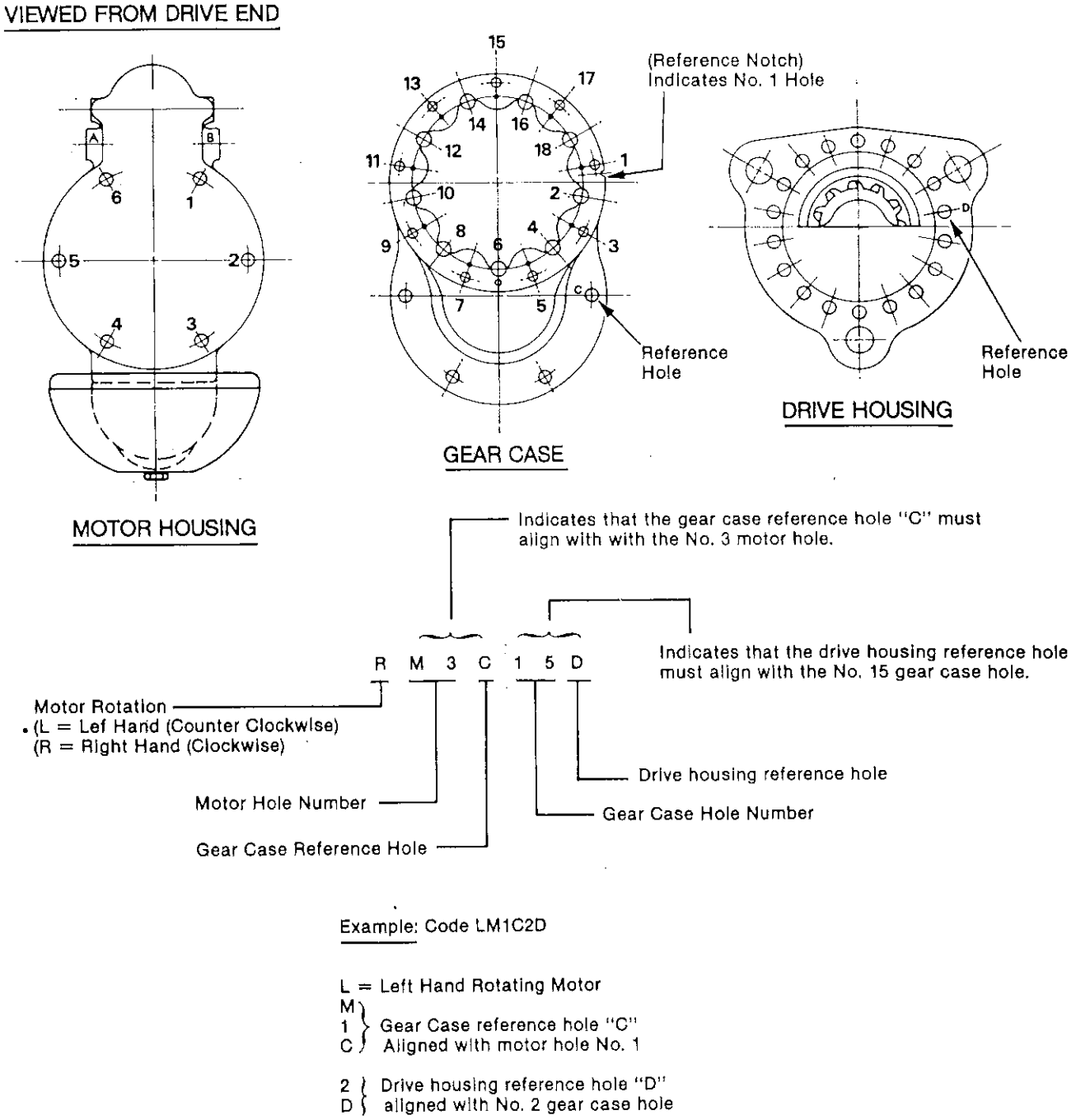
29. Remove the starter from the vise and install the muffler retaining assembly (46) and lockwasher (47). Torque to 141-161 in. lbs. (15.9 to 18.2 N·m).

30. Install the muffler (48) or exhaust adapter (gas starters) using the muffler screw (49) and torque the screw to 98-118 in. lbs. (11.1 to 13.3 N·m).

SECTION VII
STARTMASTER SERIES SM250
STARTER ASSEMBLY CODE

SM250 SERIES AND SM251 SERIES ASSEMBLY CODES

All SM250 Series and SM251 Series assembly codes are composed of six symbols. The first symbol, the letter "R" or the letter "L", indicates the direction of rotation of the motor shaft as viewed from the shaft end of the motor (R - Right-Hand or clockwise, L -Left-Hand or counterclockwise). The next three symbols indicate the motor hole that must align with the reference hole on the gear case "B". The remaining two symbols indicate the gear case hole that must align with the drive housing reference hole.



Example: Code LM1C2D

L = Left Hand Rotating Motor

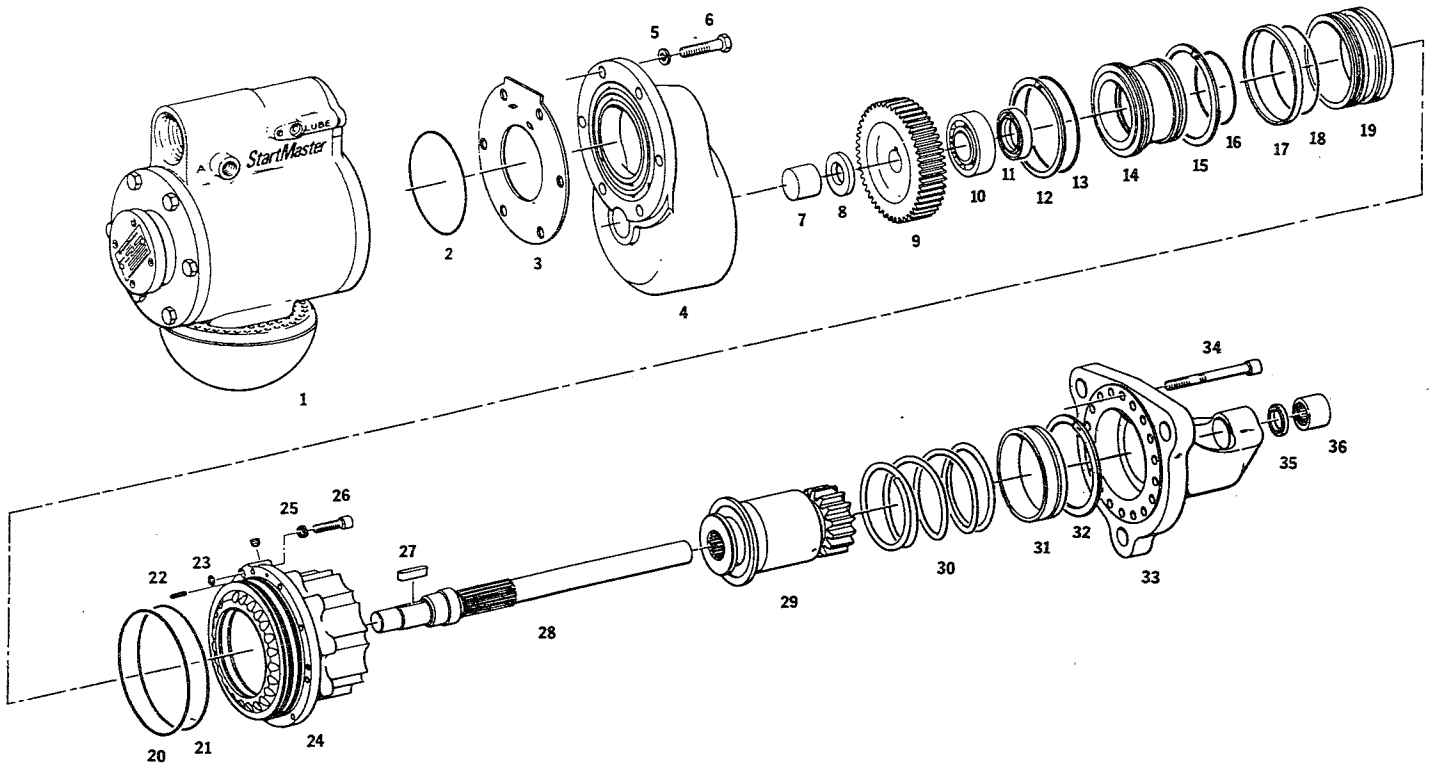
M, 1, C } Gear Case reference hole "C" Aligned with motor hole No. 1

2, D } Drive housing reference hole "D" aligned with No. 2 gear case hole

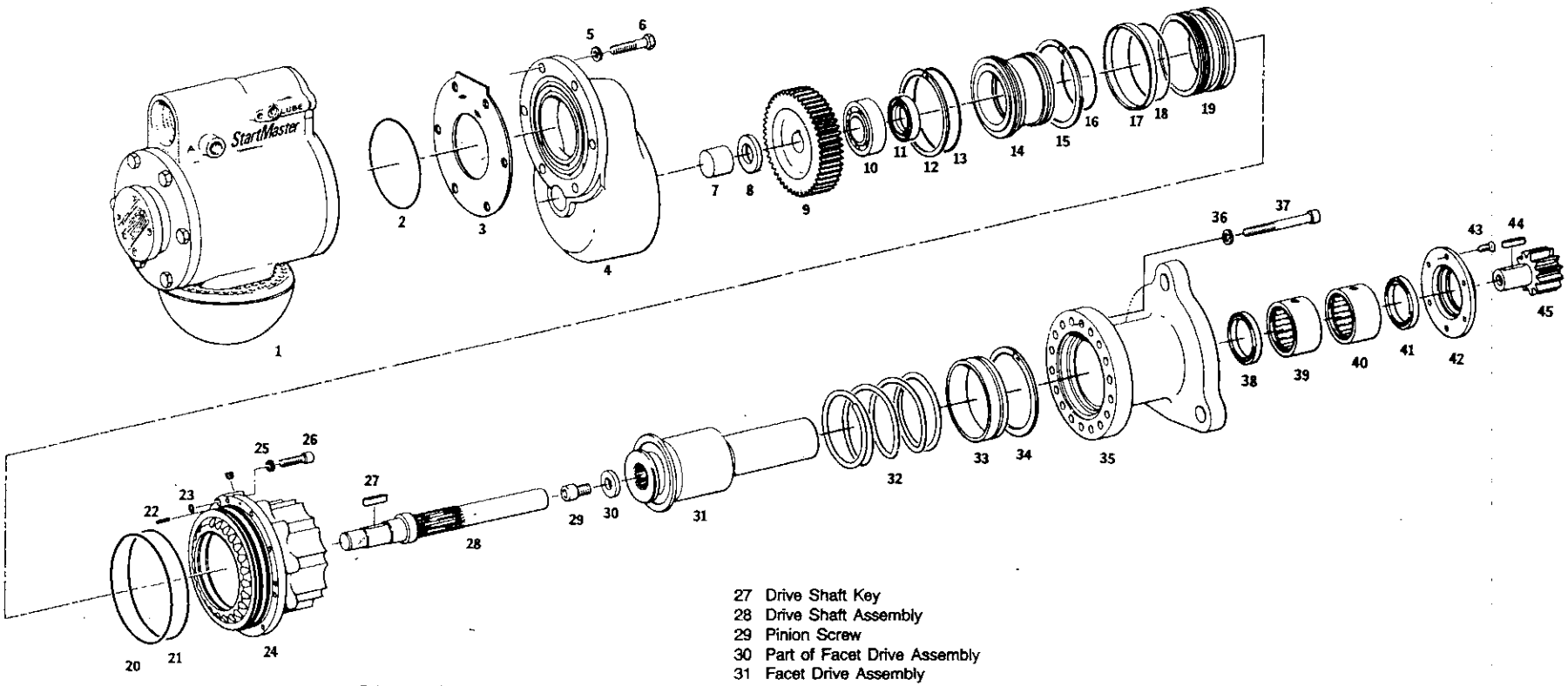
Figure 7.1

Section VII

1 Air Motor Assembly (See Fold out #4)
2 Lower End Plate Seal
3 Gear Case Gasket
4 Gear Case
5 Gear Case Lockwasher (Seal Washer for Nat. Gas Models)
6 Gear Case Screw
7 Gear Case Bearing
8 Thrust Washer
9 Drive Shaft Gear
10 Drive Shaft Bearing
11 Drive Shaft Seal
12 Retaining Ring
13 Drive Housing Seal
14 Bearing Retainer
15 Retaining Ring
16 Bearing Retainer Seal
17 Actuator Piston Ring
18 Actuator Piston Seal
19 Actuator Piston
20 Drive Housing Seal
21 Drive Housing Seal
22 Gear Case Pin
23 Drive Housing Seal
24 Drive Housing
25 Drive Housing Lockwasher
26 Drive Housing Screw
27 Drive Shaft Key
28 Drive Shaft Assembly
29 Facet Drive Assembly
30 Drive Return Spring
31 Drive Housing Bushing
32 Retaining Ring
33 Drive Housing Adapter
34 Drive Housing Adapter Screw
35 Drive Shaft Seal
36 Drive Housing Adapter Bearing

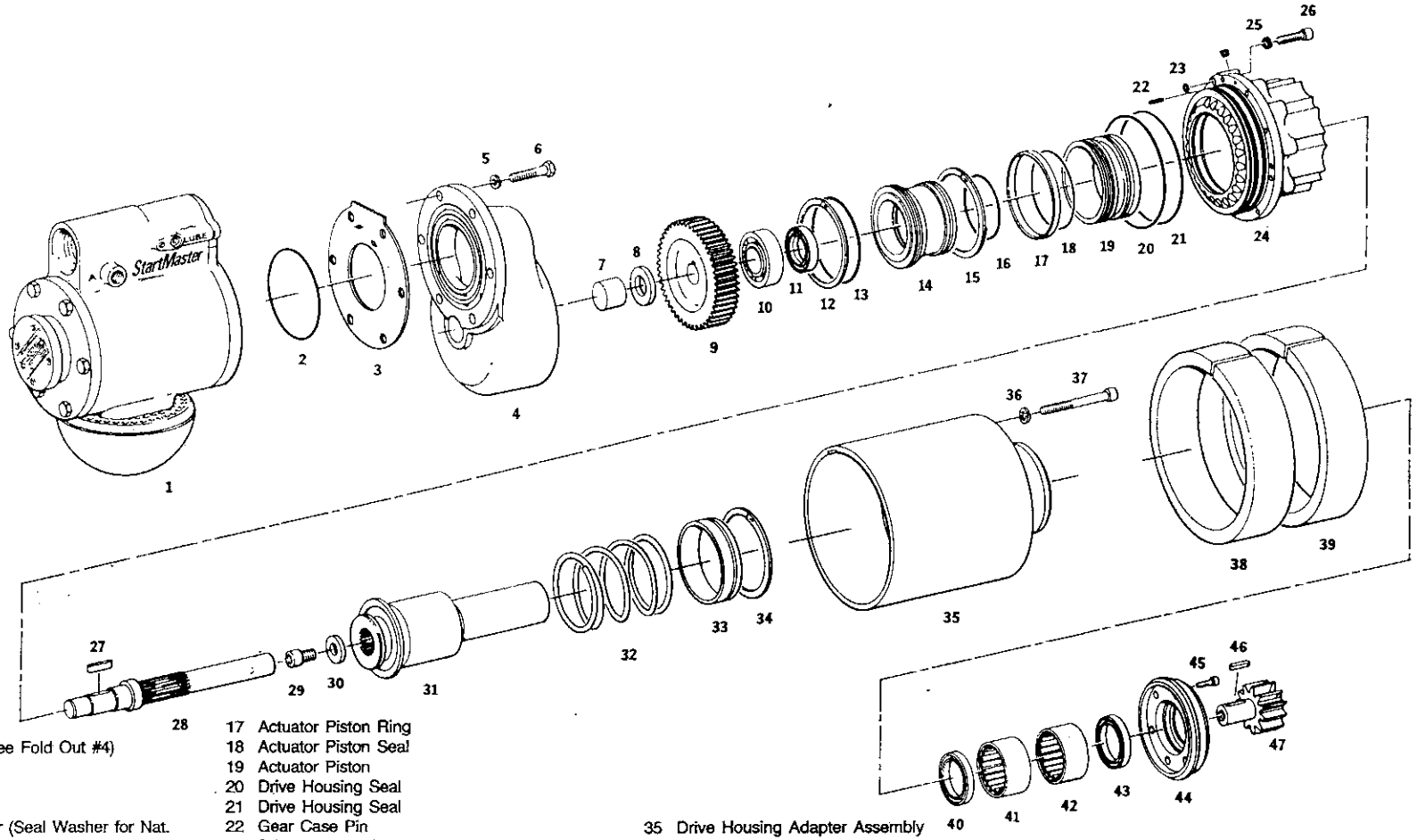


STARTMASTER 250 DRIVE ASSEMBLY
FOLD-OUT NO. 1



1 Air Motor Assembly (See Fold Out #4)
2 Lower End Plate Seal
3 Gear Case Gasket
4 Gear Case
5 Gear Case Lockwasher (Seal Washer for Nat. Gas Models)
6 Gear Case Screw
7 Gear Case Bearing
8 Thrust Washer
9 Drive Shaft Gear
10 Drive Shaft Bearing
11 Drive Shaft Seal
12 Retaining Ring
13 Drive Housing Seal
14 Bearing Retainer
15 Retaining Ring
16 Bearing Retainer Seal
17 Actuator Piston Ring
18 Actuator Piston Seal
19 Actuator Piston
20 Drive Housing Seal
21 Drive Housing Seal
22 Gear Case Pin
23 Drive Housing Seal
24 Drive Housing
25 Drive Housing Lockwasher
26 Drive Housing Screw
27 Drive Shaft Key
28 Drive Shaft Assembly
29 Pinion Screw
30 Part of Facet Drive Assembly
31 Facet Drive Assembly
32 Drive Return Spring
33 Drive Housing Bushing
34 Retaining Ring
35 Drive Housing Adapter Assembly
36 Housing Adapter Lockwasher
37 Drive Housing Adapter Screw
38 Facet Drive Assembly Seal
39 Facet Drive Bearing
40 Facet Drive Bearing
41 Facet Drive Assembly Seal
42 Bearing Cover
43 Bearing Cover Screw
44 Drive Pinion Key
45 Drive Pinion

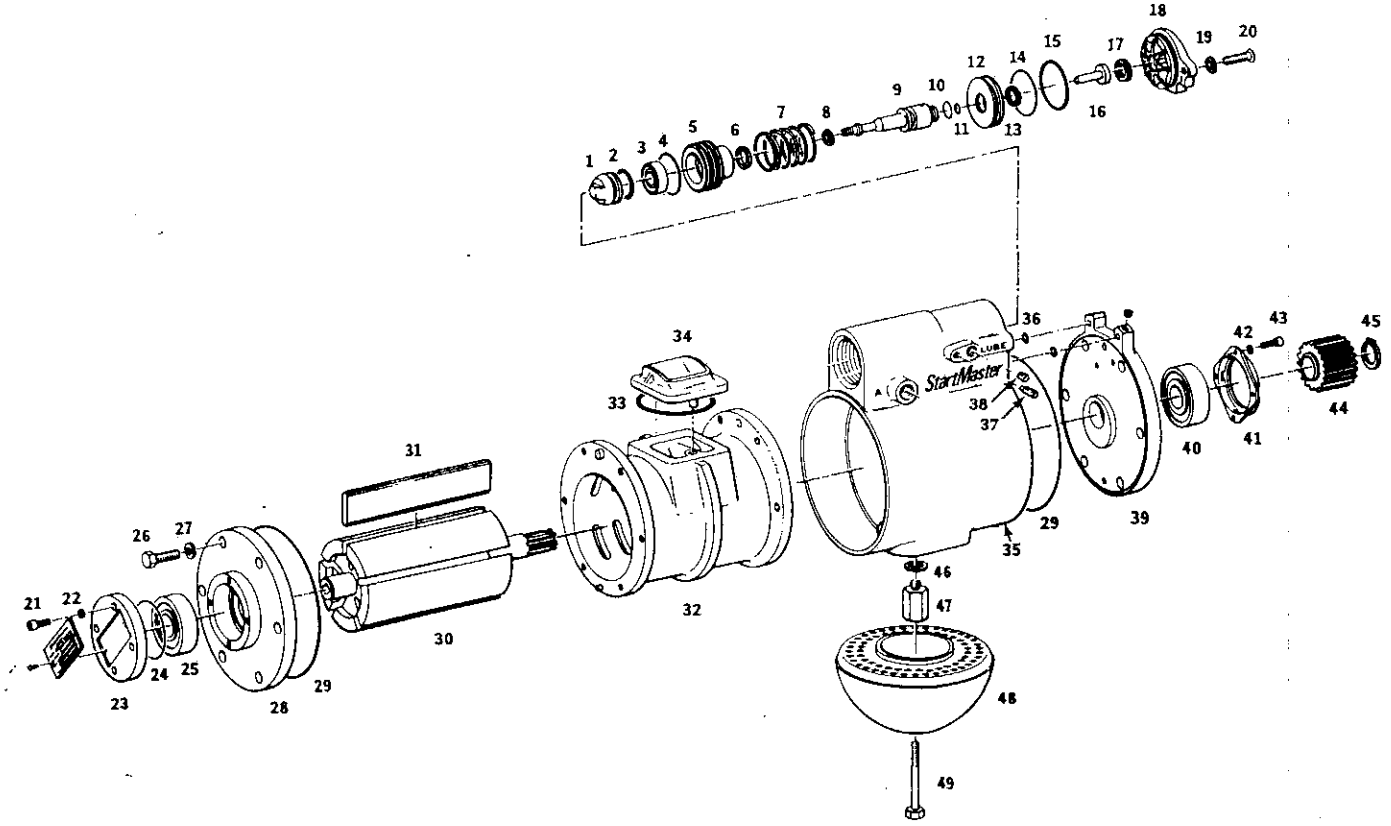
STARTMASTER 251 DRIVE ASSEMBLY
FOLD-OUT NO. 2



1 Air Motor Assembly (See Fold Out #4)
2 Lower End Plate Seal
3 Gear Case Gasket
4 Gear Case
5 Gear Case Lockwasher (Seal Washer for Nat. Gas Models)
6 Gear Case Screw
7 Gear Case Bearing
8 Thrust Washer
9 Drive Shaft Gear
10 Drive Shaft Bearing
11 Drive Shaft Seal
12 Retaining Ring
13 Drive Housing Seal
14 Bearing Retainer
15 Retaining Ring
16 Bearing Retainer Seal
17 Actuator Piston Ring
18 Actuator Piston Seal
19 Actuator Piston
20 Drive Housing Seal
21 Drive Housing Seal
22 Gear Case Pin
23 Drive Housing Seal
24 Drive Housing
25 Drive Housing Lockwasher
26 Drive Housing Screw
27 Drive Shaft Key
28 Drive Shaft Assembly
29 Pinion Screw
30 Part of Facet Drive Assembly
31 Facet Drive Assembly
32 Drive Return Spring
33 Drive Housing Bushing
34 Retaining Ring
35 Drive Housing Adapter Assembly
36 Housing Adapter Lockwasher
37 Drive Housing Adapter Screw
38 Saddle Spacer
39 Saddle Spacer
40 Facet Drive Assembly Seal
41 Facet Drive Bearing
42 Facet Drive Bearing
43 Facet Drive Assembly Seal
44 Bearing Cover
45 Bearing Cover Screw
46 Drive Pinion Key
47 Drive Pinion

STARTMASTER 2514 DRIVE ASSEMBLY
FOLD-OUT NO. 3

1 Sequencing Valve Airfoil
2 Airfoil Seal
3 Part of Item #5
4 Seal Support Seal
5 Seal Support Assembly
6 Piston Seal
7 Sequencing Valve Spring
8 Airfoil Lockwasher
9 Sequencing Valve Piston
10 Piston Seal
11 Piston Seal
12 Piston Ring
13 Retaining Ring
14 Piston Seal
15 Sequencing Stop Seal
16 Dampening Plunger
17 Retaining Ring
18 Sequencing Stop
19 Sequencing Stop Lockwasher
20 Sequencing Stop Screw
21 Bearing Retainer Screw
22 Bearing Retainer Lockwasher
23 Bearing Cover
24 Bearing Cover Seal
25 End Plate Bearing
26 End Plate Screw
27 End Plate Lockwasher (Seal Washer for Nat. Gas Models)
28 Upper End Plate
29 End Plate Seal
30 Rotor Assembly
31 Rotor Blade
32 Air Motor Sleeve Assembly
33 Sleeve Adapter Seal
34 Sleeve Adapter
35 Air Motor Casing
36 End Plate Seal
37 Seal Support Screws
38 Pipe Plug
39 Lower End Plate
40 End Plate Bearing
41 Bearing Retainer
42 Bearing Retainer Lockwasher
43 Bearing Retainer Screw
44 Rotor Pinion
45 Pinion Retainer
46 Sleeve Lockwasher
47 Muffler Retaining Assembly
48 Air Starter Muffler (Exhaust Adapter for Nat. Gas Models)
49 Muffler Screw



STARTMASTER SERIES 250 AIR MOTOR
FOLD-OUT NO. 4