TECH DEVELOPMENT

Publication T1-723
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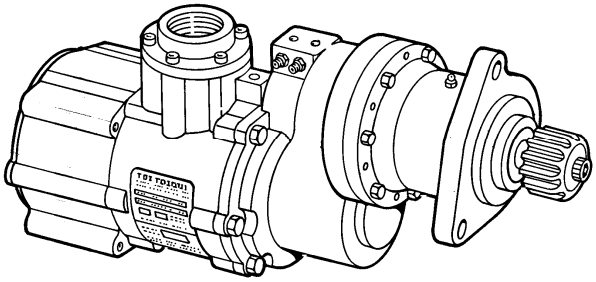
SERVICE MANUAL



T100-V

*TURBO**TWIN*** Engine Air Starters

SECTION 1.0 INTRODUCTION

1.1 GENERAL INFORMATION

This manual provides information for servicing, disassembly, and reassembly of the TDI Turbotwin T100-V air starters. If there are questions not answered by this manual, please contact your local TDI distributor or dealer for assistance. Illustrations and exploded views are provided to aid in disassembly and reassembly.

The TDI Turbotwin T100-V engine starters are specially designed for starting today's automated, low-emission engines. The Turbotwin uses aerodynamic speed control, eliminating the need for a mechanical automatic trip valve (ATV) to control starter speed.

The Turbotwin T100-V air starters are suited to operate within a wide range of inlet pressures and ambient temperatures. These starters are designed for operation with either compressed air or natural gas.

The robust turbine motor design in the Turbotwin T100-V starters has no rubbing parts, and is therefore tolerant of hard and liquid contamination in the supply gas with almost no adverse affects. The motor is well adapted to running on "sour" natural gas.

As with all TDI air starter products, there are no rubbing parts so there is no lubrication required. This eliminates failures due to lubricator problems, the expense of installing and maintaining the system, and the messy and hazardous oil film around the starter exhaust. The starter is factory grease packed for the life of the starter so it requires no maintenance.

NOTE

Throughout this manual, the term "air" is used to donate the starter drive medium. Unless otherwise stated, "air" means compressed air or natural gas.

Please review the rest of this manual before attempting to provide service to the Turbotwin T100-V starters.

1.2 WARNINGS, CAUTIONS, & NOTES

Throughout this manual, certain types of information will be highlighted for your attention:

WARNING - used where injury to personnel or damage to equipment is possible.

CAUTION - used where there is the possibility of damage to equipment.

NOTE - use to point out special interest information.

1.3 DESCRIPTION OF OPERATION

The Turbotwin T100-V starters are powered by a pair of axial flow turbines coupled to a simple planetary gear reduction set. The T100-V starters incorporate an inertia bendix drive coupled to the starter gearbox drive train to provide a means of disengaging the pinion from the engine's ring gear.

The high horsepower of the turbine air motor combined with the spur gear speed reducer results in a very efficient and compact unit. The Turbotwin T100-V starters can be used over a wide range of drive pressures from 40 psig (2.6 BAR) to 150 psig (10 BAR) and are suitable for operation on air or natural gas.

1.4 INSTALLATION AND SERVICE

It is important to properly install and operate the TDI Turbotwin T100-V starters to receive the full benefits of the turbine drive advantages. It must be installed in accordance with the instructions provided by Tech Development, Inc. (TDI).

WARNING

Failure to properly install the starter or failure to operate it according to instructions provided byTDI may result in damage to the starter or engine, or cause personal injury. **DO NOT OPERATE THIS STARTER UNLESS IT IS PROPERLY INSTALLED ON AN ENGINE.**

Repair technicians or service organizations without turbine starter experience should not attempt to repair this starter until they receive factory approved training from TDI, or its representatives. Proper operation and repair of your TDI Turbotwin will assure continuous reliability and superior performance for many years.

1.5 NAMEPLATE INFORMATION

The nameplate located on the turbine housing provides important information regarding the construction of your T100-V starters. Refer to *Figure* 1.

NOTE

You should always have the starter's Part Number, Serial Number, Operating Pressure, and Direction of Rotation information before calling your TDI distributor or dealer.

TURBOTWIN™
PNUEMATIC STARTER
TECH DEVELOPMENT INC.
6800 POE AVE.,DAYTON OH

MODEL NO.	SERIAL NO.	CW (RH)	(CCW) LH
T112V	9911-210	X	

PART NUMBER
T112-60031-01R-1-03 …

AIR OR NAT. GAS USAGE HOUSING PROOF PRESSURE IS 600 PSIG

MAX OPERATING INLET PRESS. 150 PSIG

WARNING DO NOT OPERATE UNLOADED, WITHOUT EXHAST GUARD OR WITHOUT EXHAUST FITTING

Figure 1. TDI Turbotwin Nameplate

2.0 DESCRIPTION OF BASIC GROUPS

2.1 GENERAL

The TDI TurboTwin T100-V air starters are lightweight, compact units driven by a dual stage turbine type air motor. The starter is composed of three basic assembly groups: Turbine Housing Assembly; Gearbox Housing Assembly; and Drive Assembly.

2.2 TURBINE HOUSING ASSEMBLY

The Turbine housing assembly, refer to figure 3, consists of a stage one (16) and a stage two (5) turbine wheel mounted on sungear shaft (31) . The front bearing (8) is secured by a retainer plate (30). The aft bearing (8) is preloaded by a wavy spring (10).

The ring gear (28) is installed between the turbine assembly (25) and the gearbox housing and secured by six screws.

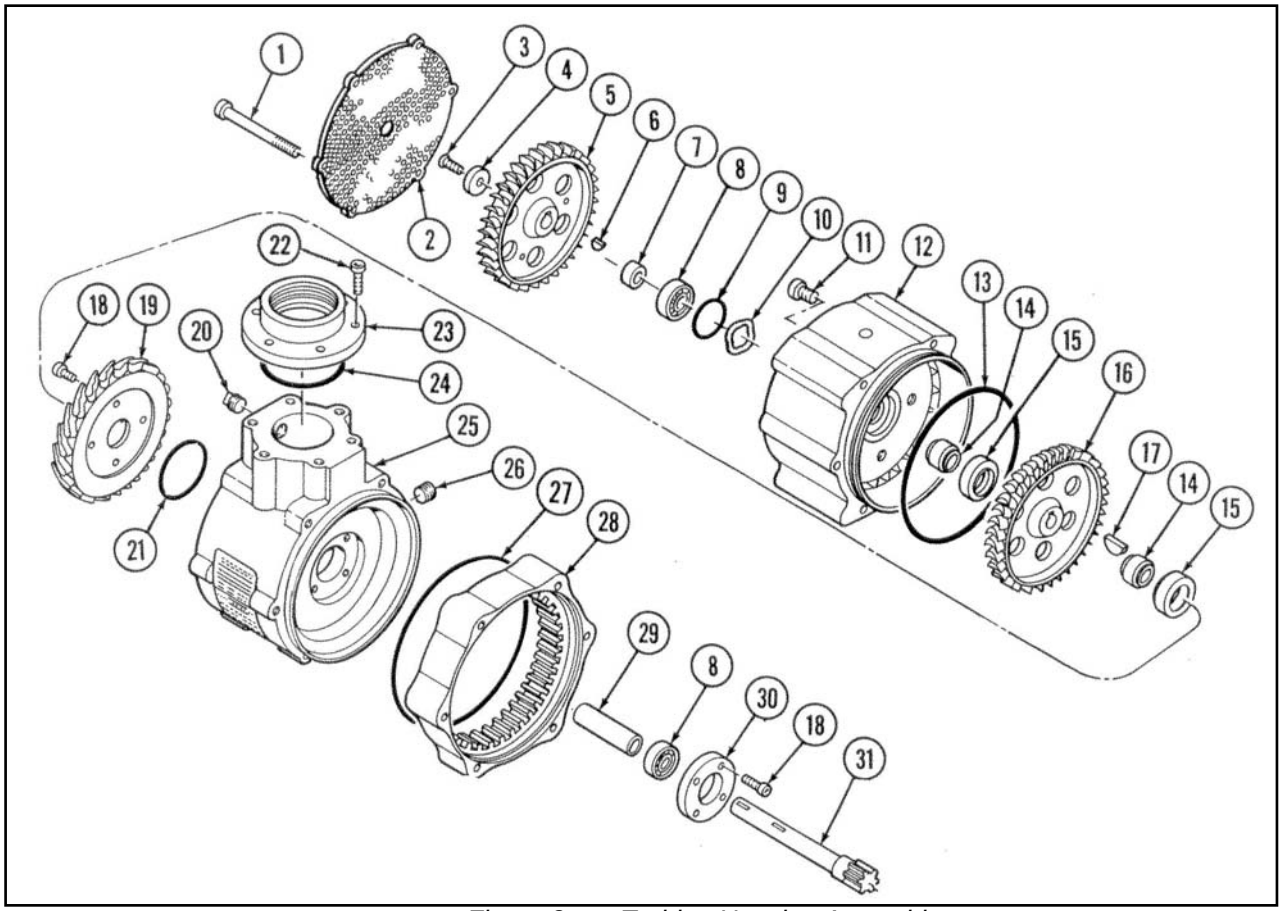


Figure 3. Turbine Housing Assembly

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2.3 GEARBOX HOUSING ASSEMBLY

The gearbox housing assembly, refer to figures 4, consist of a planet gear carrier shaft (33), three planet gears (35), needle bearings (36), gear spacers (34), and planet pins (37).

The carrier shaft is mounted on two ball bearings (39) in the gearbox housing (49). The aft bearing is preloaded by use of spring washers (40). The forward bearing is installed into the bearing housing (44), which is secured by four screws (45) to the gearbox housing. The spur gear (46) is installed on the carrier shaft and secured by the bearing locknut (48).

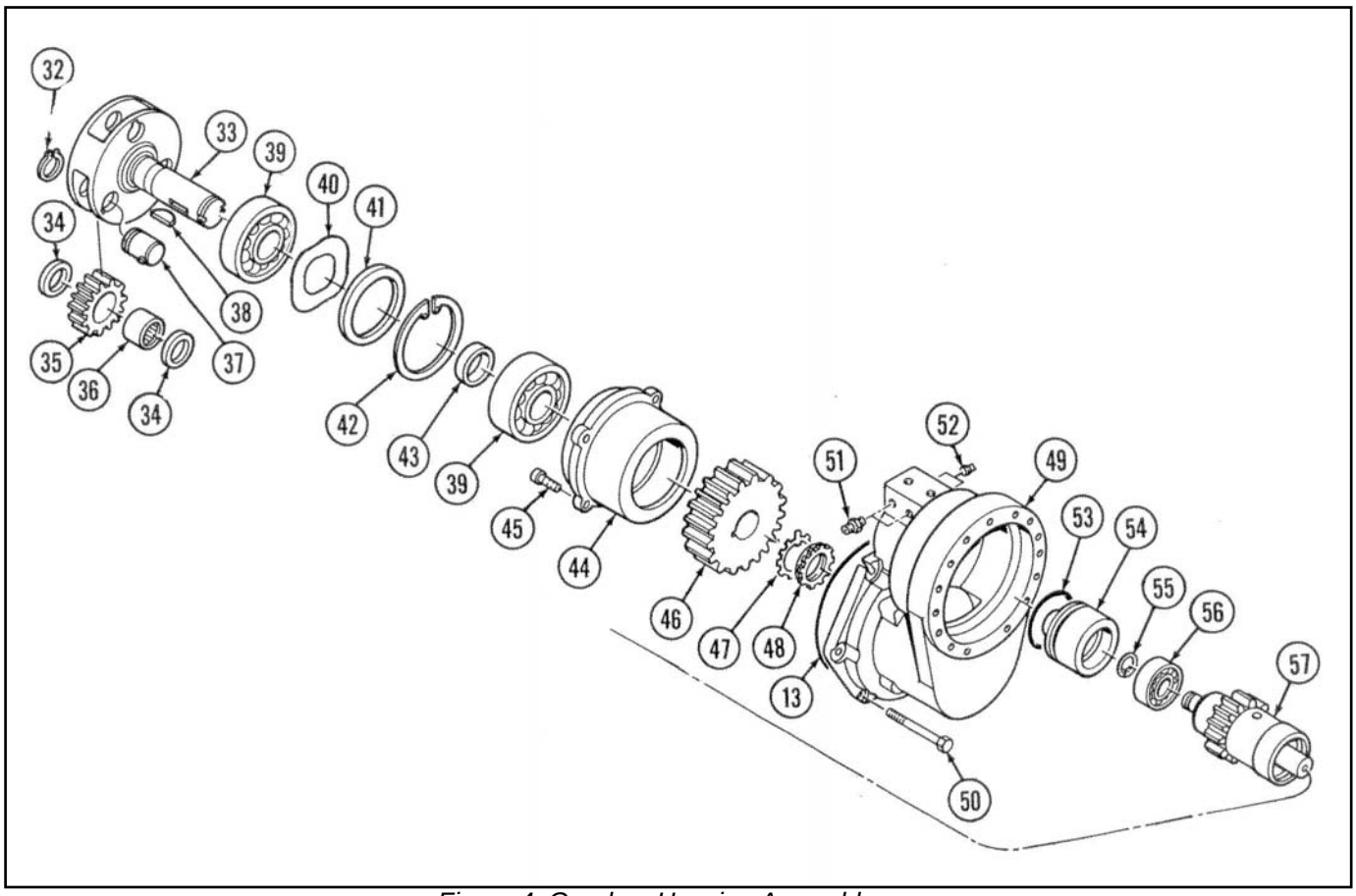

Figure 4. Gearbox Housing Assembly

2.4 DRIVE ASSEMBLY

The drive assembly, refer to figure 5, consists of a piston (54), helical shaft spline (57), dental clutch (59) and drive pinion shaft (62). The clutch assembly (57 thru 65) is installed into the spur gear (66). The spur gear (66) is supported by the aft bearing (67), which is secured by the retaining ring (68).

The roller bearing (69) is installed into spur gear (65) and secured by retaining ring (70). The forward bearing (69) is pressed into the drive housing. The lip seal (76) is pressed into the forward side of drive housing (73).

The pinion collar (77) is installed on pinion shaft (63) behind pinion (78), which is secured by washer (79) and screw (80).

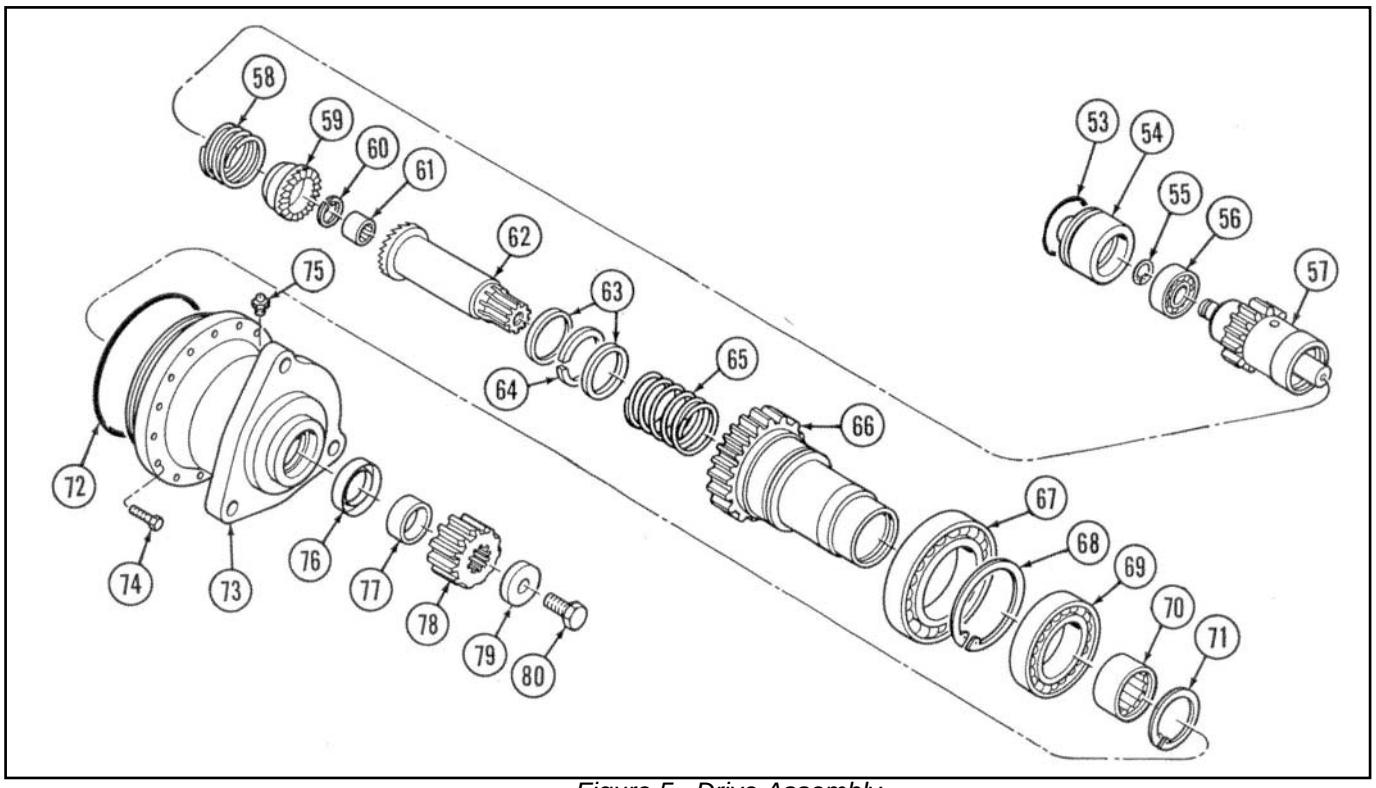

Figure 5. Drive Assembly

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SECTION 3.0 DISASSEMBLY

3.1 GENERAL

Always mark adjacent parts on the starter housing; Nozzle 2/ Containment Ring (12), Turbine Housing (25), Gearbox Housing (49), and Drive Housing (73) so these parts can be located in the same relative position when the starter is reassembled.

Do not disassemble the starter any further than necessary to replace a worn or damaged part

Always have a complete set of seals and o-rings on hand before starting any overall of a Turbotwin T100-V starter. Never use old seals or o-rings.

The tools listed in *Table 1* are suggested for use by technicians servicing the T100-V Turbotwin starters. The best results can be expected when these tools are used, however the use of other tools are acceptable. Contact TDI for a list of additional tools that maybe required when overhauling T100-V air starters.

TOOL DESCRIPTION	TDI/PN
Spanner wrench	52-20134
Spanner wrench	52-21345
Shaft Removal Tool	2-26945
Stage 2 Rotor Puller Tool	52-20076
Carrier Shaft Holding Tool	52-20202
Tool, Bearing Pressing	52-20143
Tool, Bearing/Seal	2-26943

Table 1. T100-V Service Tools

3.2 DRIVE HOUSING

3.2.1 Removal of Drive Housing

Mark position of drive assembly (73) relative to gearbox housing (49) for reference during reassembly.

Remove the eight screws (74) and pull drive assembly from gearbox housing. If drive housing is too tight, tap it with a mallet to loosen.

Remove o-ring (72) from aft end of drive housing(73).

3.2.2 Pre-engaged Drive Disassembly

Secure pinion (78) in a soft tooth vise while supporting aft end of the T100-V air starter. Rotate pinion screw (80) counterclockwise to remove using a 3/4" socket and wrench.

NOTE

Use only a soft tooth vise to secure the pinion to avoid damaging pinion.

This screw is torqued to 100 lb ft during assembly therefore a large wrench may be required when removing screw.

Remove washer (79), pinion (78) and spacer (77) from pinion shaft (62). If pinion is too tight, place a screwdriver underneath pinion and lift up on pinion to remove from shaft.

Remove helical spline shaft assembly (55-64) from spur gear shaft (66). Remove spring (65) from shaft. Use press tool and arbor press to remove spur gear shaft (66) from drive housing (73).

Use a screwdriver to remove lip seal (76) from forward end of drive housing (73).

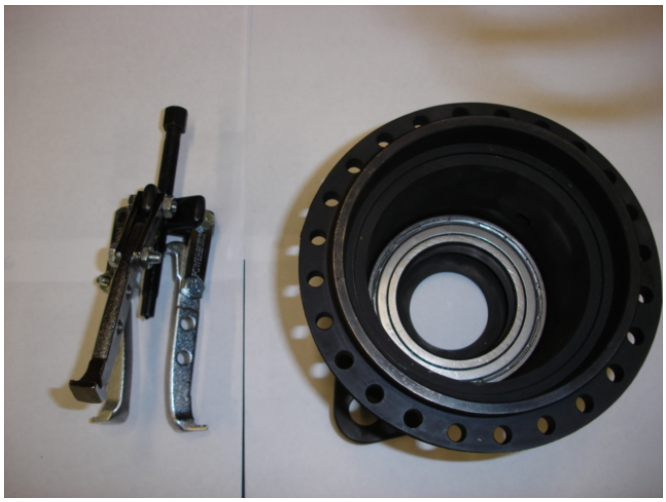
Use press tool and arbor press to remove spur gear shaft (66) from drive housing (73).

Remove retainer ring (71) and bearing (70) from forward end of spur gear shaft (66).

Remove retainer ring (68) and press bearing (67) from spur gear shaft (66) as shown.

Remove retainer ring (55) and bearing (56) from helical spline shaft (57).

Remove bearing from drive housing using bearing puller and pressing as shown.



3.3 GEARBOX HOUSING

3.3.1 Removal of Gearbox Housing

Remove the screws (50) securing the gearbox (49) to the turbine assembly (25).

Remove ring gear (28) from turbine (25) or gearbox assembly (49). The ring gear could remain on either assembly when separation occurs.

3.3.2 Gearbox Disassembly

Place gearbox assembly (49) on flat surface with aft end facing up.

Remove four screws (45) and lift carrier shaft assembly (33) from gearbox housing.

Place carrier shaft assembly on carrier shaft holding tool (52-20202) and use a screwdriver to remove tang of lock washer (47) from slot of retainer nut (48).

Place TDI tool P/N 52-20134 (Spanner Wrench) over shaft and into slots of retainer nut (48). Hold carrier shaft assembly down and turn spanner wrench CCW to remove retainer nut, lock washer (47), spur gear (46), and woodruff key (38) from carrier shaft (33).

Use an arbor press to remove carrier shaft (33) from bearing housing (44). The bearing housing must be elevated and supported to remove carrier shaft.

NOTE

Do not support the bearing housing on the four lips as they could break while pressing on carrier shaft.

Remove spring washers (40), spring retaining plates (41), and bearing spacer (43) from carrier shaft.

Remove aft bearing (39) from shaft by pressing shaft while supporting bearing.

3.3.3 Planet Gear Disassembly

Remove retainer ring (32) from planet shaft (37) and push planet shaft through assembly.

Slide the planet gear (35) from carrier shaft and remove two spacers (34).

Use press tool to remove needle bearing (36) from planet gear (35).

3.4 TURBINE HOUSING

3.4.1 Stage 2 Rotor Removal

Place the turbine assembly (25) with ring gear (28) on a flat surface with (exhaust) end up and remove the six screws (1), and the screen (2).

Secure the stage 2 rotor (5) and remove the turbine screw (3) and washer (4).

Install the rotor puller tool P/N 52-20076 and remove the stage 2 rotor.

Remove woodruff key (6) from the turbine shaft (31).

3.4.2 Turbine Shaft Removal

Place the turbine housing on a flat surface with the sun gear end facing up.

Remove four screws (18) and bearing retainer plate (30) from turbine housing.

Using the shaft removal tool P/N 2-26945, press on the aft end of the turbine shaft (31) while supporting the turbine housing (25).

Press the turbine shaft (31) through the aft bearing (8) until the shaft is completely out of the housing (25).

Remove the woodruff key (17), seal spacer (14), bearing spacer (29), and bearing (8) from turbine shaft

(31). The forward bearing can be removed from the shaft by pressing the shaft through the bearing while supporting bearing.

Separate the stage 2 nozzle assembly (12) from the turbine assembly (25) by firmly holding the turbine assembly, while tapping nozzle 2 with a mallet. If nozzle 2 is too tight, it can be removed by installing two threaded screws into nozzle 2 and using them as jacks to separate nozzle 2 from the turbine assembly.

NOTE

Rotate the stage 1 rotor if necessary to allow the jacks to travel through the large holes in the rotor. The jacks will damage the stage 1 rotor if pressure is applied to the rotor while removing nozzle 2.

Remove stage 1 rotor (16) and o-ring (12) from nozzle 2.

Remove the four screws (18) and nozzle 1 (19) from the turbine assembly.

Remove o-ring (21) from aft end of turbine housing.

Remove the seal spacer (14) from the forward side of nozzle 2 (12). Place the stage 2 nozzle on the exhaust end. Press through the forward lip seal onto the bearing (8) until it, including the aft lip seal and seal spacer disengages from the nozzle. Turn the nozzle over and press on the forward lip seal to remove.

SECTION 4.0 CLEANING and INSPECTION

4.1 CLEANING

Degrease all metal parts, except bearings, using a commercially approved solvent. Refer to *Table 2.*

Clean aluminum parts using the solutions per *Table 2*; soak for 5 minutes. Remove parts, rinse in hot water, and dry thoroughly.

Clean corroded steel parts with a commercially approved stripper.

Clean corroded aluminum parts by cleaning as stated above and then immerse the parts in chromic-nitric-phosphoric acid pickle solution per *Table 2*. Rinse in hot water and dry thoroughly.

MATERIAL or COMPOUND	MANUFACTURER
Degreasing Solvent	Commercially Available
Acetone	Commercially Available
Aluminum Cleaning Solution	Diversey Corp., 212 W. Monroe, Chicago, IL 60606 Dissolve 5 oz of Diversey 808 per gallon of water at 155°- 165°F.
Steel Cleaner - Rust & Corrosion	Oakite Products Corp., 50 Valley Rd., Berkeley Heights, NJ 07992 Mix 3-5 lb. of Oakite rust Stripper per gallon of water; use at 160°- 180°F.
Chromic-Nitric-Phosphoric Acid Pickle Solution	Mix 8lb. of chromic acid, 1.9 gal. of phosphoric acid, 1.5 gal. of nitric acid with enough water to make a total of 10 gal. of solution.
WARNING Follow all instructions provided with the MSDS sheets on the materials and compounds listed above.	

Table 2. Cleaning Materials and Compounds

4.2 INSPECTION

Use *Table 3* as a guide to check for acceptable condition of the parts listed.

Check all threaded parts for galled, crossed stripped, or broken threads.

Check all parts for cracks, corrosion, distortion, scoring, or general damage.

Check all bearing bores for wear and scoring. Bearing bores shall be free of scoring lines, not to exceed 0.005″ width and 0.005″ depth.

Check gear teeth and turbine housing ring gear for wear. In general, visually check for spalling, fretting, surface flaking, chipping, splitting, and corrosion. If wear is apparent, check the gear teeth dimensions in accordance with *Table 4*. Nicks and dents that cannot be felt with a .020 inch radius scribe are acceptable.

Part Description	Check For	Requirements (Defective Parts Must Be Replaced)
Pinion	Chipped Teeth, Cracks	Defective unit to be replaced. Use figure 5 as a guideline for acceptable pinion wear.
Drive Housing	Cracks and breakage	Cracks are not acceptable
Planet Gear	Cracked, chipped, or galled teeth. Wear must not exceed limits per Table 4.	Wear must not exceed limits per table 4. There shall be no evidence of excessive wear.
Carrier Shaft	Cracks, scoring or raised metal in planet shaft holes and keyways. Integrity of knurl connection.	Deformation of metal smearing in planet pin holes & keyways not acceptable. Scoring on bearing diameter not to exceed .005″ depth. Wear must not exceed limits per Table 4.
Planet Pins	Wear grooves or flat spots	Wear grooves in flat spots not permitted. Wear must not exceed limits per Table 4.
Washers	Wear created grooves	Wear must not exceed limits per Table 4.
Gearbox Housing	Cracks and Breakage	Cracks and breakage not acceptable.
Sungear / Turbine Shaft	Cracks, scoring, wear created grooves, chipped or broken gear- teeth, galling or scoring on bearing surface of shaft. Raised metal on the keyway.	Wear must not exceed limits per Table 4.
Spacers	Parallelism of end surfaces	Ends must be parallel within 0.0005″.
Turbine Housing Ring Gear	Cracks and breakage Cracks, wear, chipped, or broken gear teeth.	Cracks and breakage are not acceptable. Minor surface damage is permitted if function is not impaired. Wear must not exceed limits per Table 4.
Seal Assembly	Wear grooves or scratched surfaces on carbon ring.	Wear is not permitted.
Seal Spacer	Wear Grooves	No wear permitted.
Needle Bearings	Freedom of needle rollers	Replace bearings
Ball bearings	Freedom of rotation without excessive play between races	Replace bearings
Containment Ring/ Nozzle	Corrosion, erosion, cracks and broken nozzle edges.	Cracks and breakage are not acceptable. Minor surface damage is permitted if function is not impaired.
Turbine Rotors	Corrosion, erosion, cracks and broken edges. Tip wear; bore and key way wear	Minor tip rub is permitted if function is not impaired. Wear is not permitted.

Table 3. Parts Inspection Check Requirements

PART DESCRIPTION	LIMIT, Inches
Ring gear / Turbine Housing Internal measurement between two .084″ diameter pins.	5.0890 max.
Sun Gear / Turbine Shaft Bearing diameter External measurement over two .096 diameter pins. 7.5:1 9:1 11.4:1	0.6690 min 0.952 min 0.808 min 0.670 min
Planet Gear External measurement over two .0864″ diameter pins. 7.5:1 9:1 11.4:1	 2.3067 min 2.3699 min 2.4359 min
Carrier Shaft Bearing Diameter Planet Pin Bore	 1.1800 min 0.8750 max
Planet Pins Bearing Diameter	 0.873 min
Thrust Washer Thickness	 .055 min

Table 4. Parts Wear Limits

SECTION 5.0 ASSEMBLY

5.1 GENERAL

The tools listed in *Table 1* are suggested for use by technicians servicing the T100-V starters. The best results can be expected when the proper tools are used, however, use of other tools is acceptable.

CAUTION

Replace all screws , O-rings, lip seals, and bearings when the T100-V starter is reassembled. These parts are included in the overhaul kit shown in Section 6.0

NOTE

Always press the inner race of a ball bearing when installing a bearing on a shaft. Always press the outer race of a ball bearing when installing into a housing.

Refer to Section 6.0, for a list of kits and components, which are available to aid in rebuilding T100-V starters.

Lubricate all O-rings with petroleum jelly or Parker-O-Ring Lube before assembly. Refer to *Table 5* for a list of materials to be use during assembly.

MATERIALS	SOURCE
Petroleum Jelly	Commercially Available
Parker-O-Ring Lube	Commercially Available
Loctite RC290	Commercially Available
Grease, gearbox	TDI P/N 9-94121-001

Table 5. Materials for Assembly

CAUTION

The screws that secure the Containment Ring/ Stage 2 Nozzle must have a drop of Loctite RC290 applied to the threads before being used.

5.2 TURBINE HOUSING

5.2.1 Turbine Shaft Installation

Press the bearing (8) onto the shaft (31) until seated. Support the shaft and press on the inner race only with press tool P/N 2-26943.

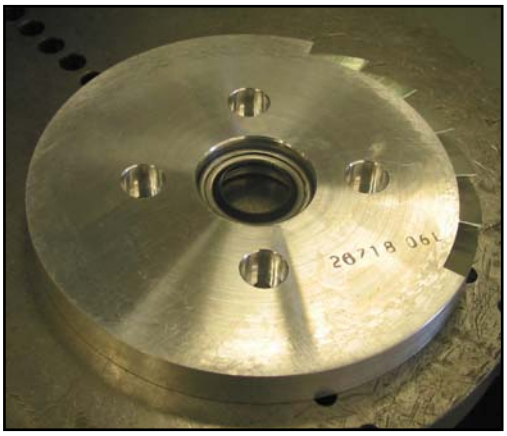
Press the bearing/shaft assembly (8, 31), keyway end first, into bearing housing of the turbine housing (25). Use press tool P/N 2-26943 if required. *D*o not press on the end of the shaft because the load could damage the balls of the bearing.
Install bearing retainer plate (30) and secure with four screws (18). Torque screws to 81 in-lbs.

Place turbine housing with sun gear end down on a flat surface, while using ring gear to support turbine housing. Install long bearing space (29) and seal spacer (14) over shaft.

Install o-ring (21) into the aft face of the turbine housing (25).

5.2.2 Nozzle 1 Installation

Press the lip seal (15) into nozzle 1 (19) using press tool P/N 2-26943 with the lips facing up.

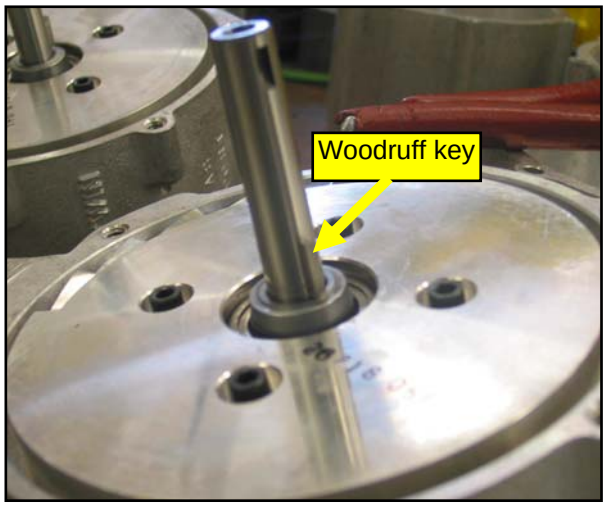


Install nozzle 1 onto the turbine housing (25). Orient the nozzles facing the air inlet (23) and install four screws (18) to secure the nozzle. Do not tighten the screws at this time.

Install the large woodruff key (17) for stage 1 rotor into the turbine shaft (31).

NOTE

The rotation of the turbine assembly is opposite from the pinion rotation, therefore this nozzle must be configured for LH (CCW) if the pinion rotation is RH (CCW), or configured for RH (CW) if pinion rotation is LH (CCW).



5.2.3 Rotor 1 Installation

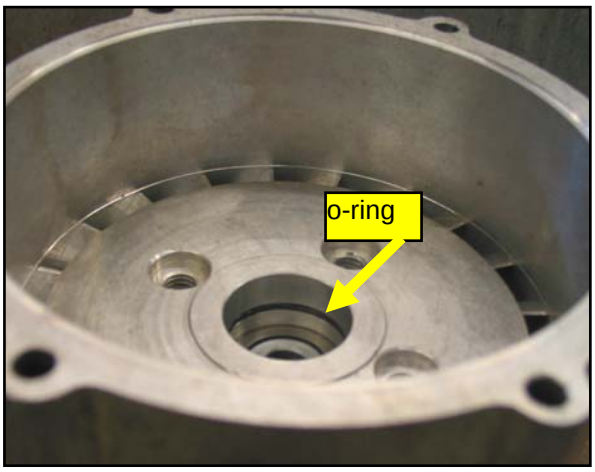
Install the stage 1 rotor (16), while supporting sun gear end of shaft, onto the turbine shaft by aligning the slot in the rotor with the woodruff key and hand press the rotor until firmly seated. Use press tool P/N 2-26943 if required.

Visually inspect that the key was not pushed out during assembly. Note that the direction of rotation was oriented properly. This turbine rotor can be installed backwards.

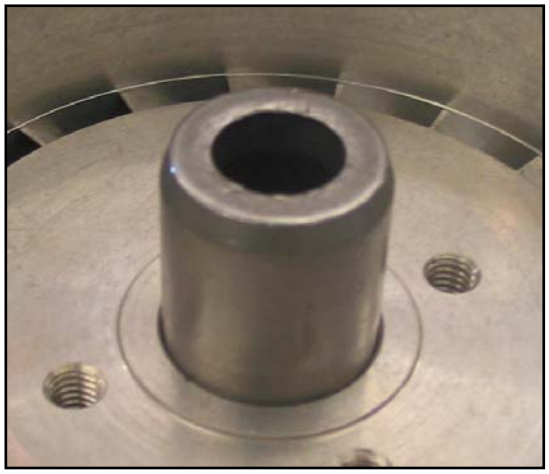
Install spacer (14) onto aft end of turbine shaft (30).

5.2.4 Nozzle 2 Installation

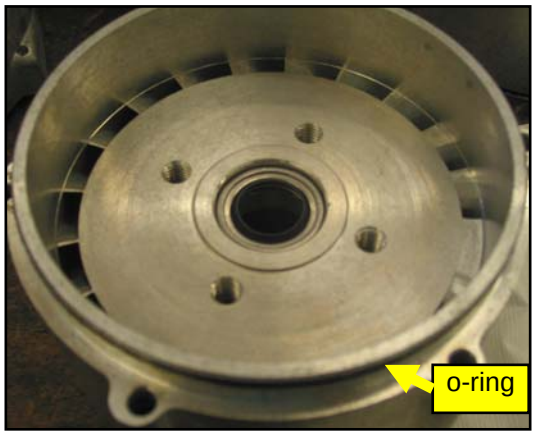
Place o-ring into the inner groove of the nozzle/ containment assembly, as shown.



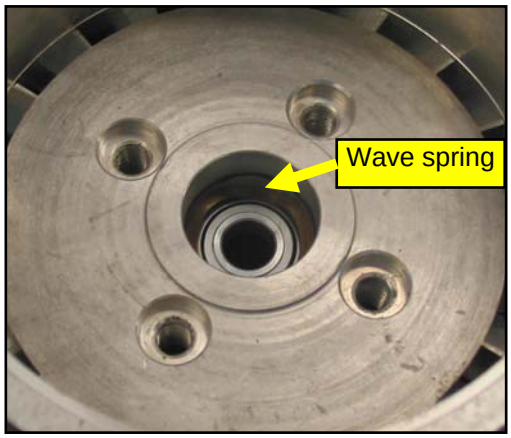
Place lip seal onto seal spacer and press the lip seal and spacer into forward end of nozzle assembly.



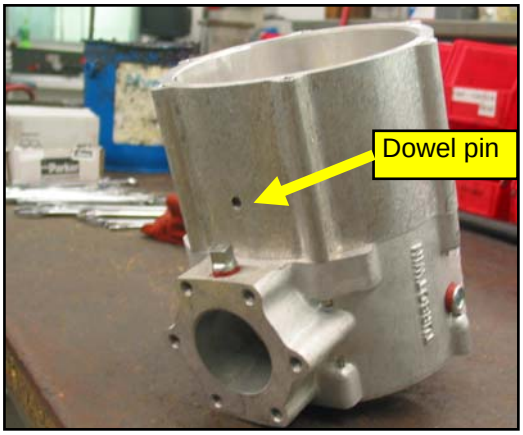
Place an o-ring into the groove on the nozzle assembly, as shown.



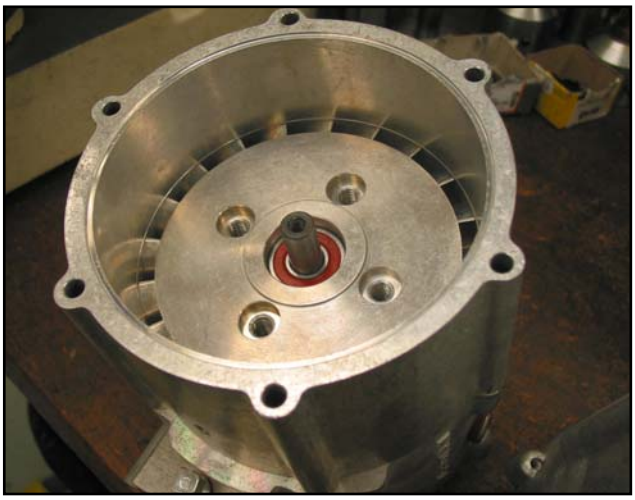
Place a wave spring washer (10) into the nozzle assembly so that it rests on the lip seal.



Place the completed nozzle assembly onto the completed turbine housing with the dowel pin on the same side as the inlet. Press down on the nozzle assembly until it is completely seated, making sure to line up the holes.



Place the turbine assembly onto the arbor press and place a bearing (8) onto the turbine shaft. Using the press and tool 2-26943, press the bearing into the nozzle assembly.



Rotate the turbine shaft so that two of the four holes in the nozzle assembly are lined up with holes in the rotor. The four holes are used to access and tighten the screws securing nozzle 1. Torque screws to 81 in.-lbs.

Rotate the turbine shaft again so that the other two holes in the nozzle assembly are lined up with holes in the rotor. Again, torque the turbine housing screws to 81 in.-lbs.

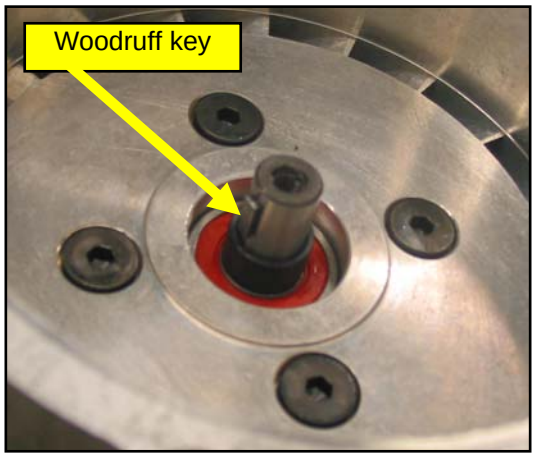
NOTE

The rotation of the turbine assembly is opposite from the pinion rotation, therefore this nozzle must be configured for LH (CCW) rotation if the pinion rotation is RH (CW), or configured for RH (CW) if pinion rotation is LH (CCW).

Apply Loc-tite 242 and to the threads and install four screws (11). Hand-thread the screws into the nozzle assembly. Torque the four screws to 100 in.-lbs.

Place a bearing spacer (7) over the turbine shaft.

Insert a woodruff key (6) into the upper slot on the turbine shaft, as shown. Use the pliers to squeeze the woodruff key into the shaft.

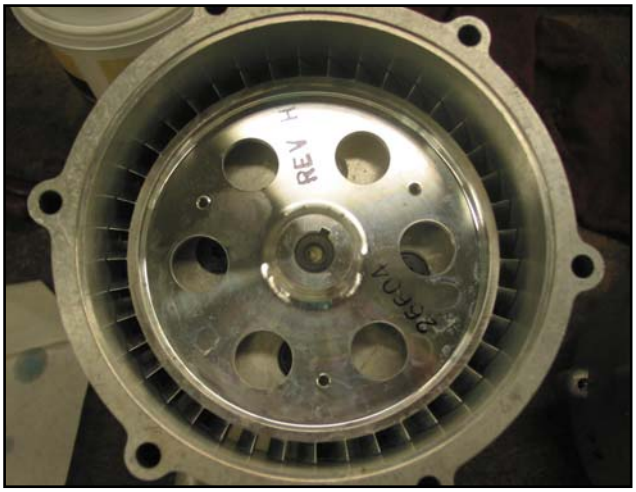


Place a turbine rotor (5) over the turbine shaft, as shown. Make sure the notch in the turbine rotor is lined up with the woodruff key. Press down on the rotor until it is completely seated.

Obtain a rotor retention screw (3) and place a washer (4) on it. and hand-thread the screw into the turbine shaft.

Using the torque wrench, torque the rotor retention screw to 220 in.-lbs.

Install the exhaust screen (2) and secure with six screws (1). Tighten the screws to 113 in-lb.



5.2.5 Air Inlet Installation

Place the O-ring (24) into the groove on the air inlet (23).

Install the 2″ NPT air inlet flange (23) and secure with six screws (22). Tighten the six screws to 385 in-lb.

5.3 GEARBOX HOUSING

5.3.1 Planetary Gear Carrier Reassembly

Press needle bearing (36) into planet gears (35). The planet gears are not identified by part number, therefore, dimensionally check if correct gears are being used. Use table 4 for over the wire measurements.

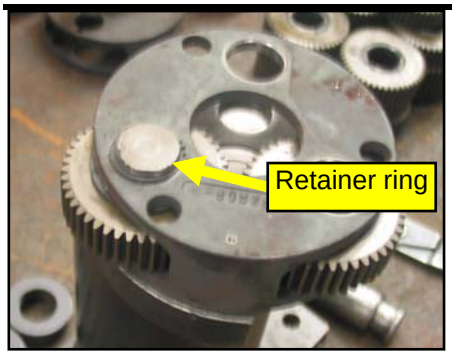
With a thrust washer (34) on each side of gear, slide gear into carrier slots (33), and align with pin holes.

Lightly slide plant shafts into aligned holes, making sure retainer ring groove on end of pins goes in first.

NOTE

Make sure that anti-rotation pins on shafts are properly located in retaining slots of carrier shaft (32).

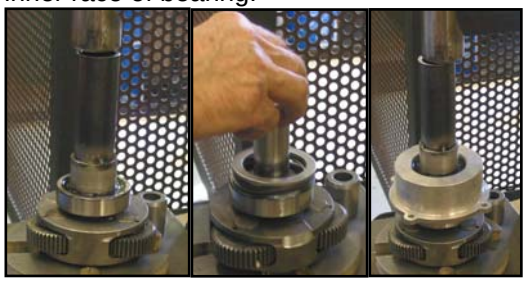
Install retainer ring (32) onto planet shaft (37) using a retainer ring tool.



5.3.2 Gearbox Reassembly

Install bearing (39) into the bearing housing (44) and secure with retaining ring (42).

Press aft bearing (39) onto carrier shaft (33) using TDI Tool P/N 52-20143. Pressing force should be on the inner race of bearing.

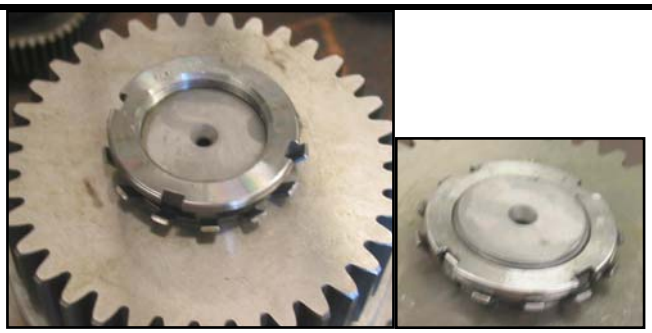


Install 4 spring washers (40), spring retaining plate (41) and bearing spacer (43) onto shaft and locate against bearing as shown above.

Position bearing housing assembly (39,42,44) over carrier shaft (33) and press until firmly seated as shown above.

Install woodruff key (38) into slot on carrier shaft (33) and install spur gear (46) on carrier shaft aligning slot on gear with woodruff key.

Place bearing housing assembly on carrier shaft holding tool P/N 2-20202. Install lockwasher (47) and retainer nut (48). Torque to 90-100 ft.lb. Tang lock washer into retainer nut slot.



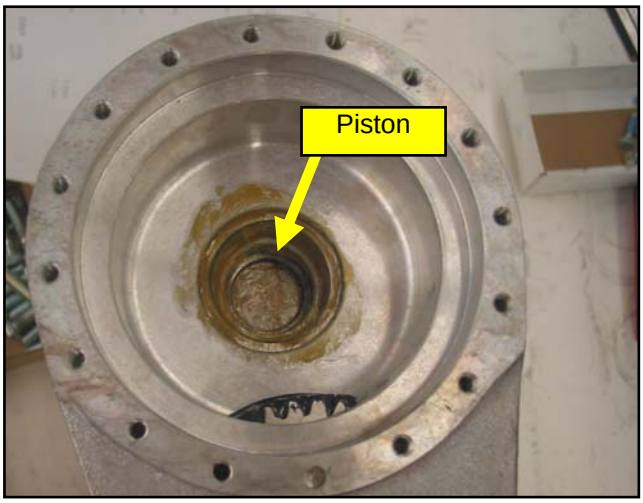
Place O-ring (13) onto outer diameter of gearbox housing (49).

Apply grease to spur gear as shown.

Install carrier shaft assembly into aft side of gearbox housing (49) and secure with four screws (45) as shown above. Torque to 113 in-lbs.

Apply lubrication to o-ring and piston and install o-ring (53) onto piston (54).

Install piston into forward side of gearbox housing (49).



5.4 DRIVE HOUSING

5.4.1 Drive Reassembly

Install bearing (70) into forward end of spur gear shaft (66) and secure with retaining ring (71).

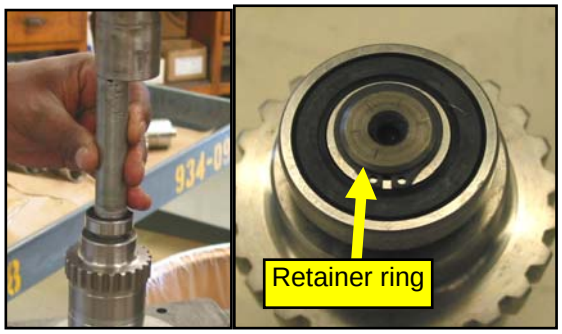
Press bearing (67) onto spur gear shaft (66) and secure with retaining ring (68).

Press bearing (69) into drive housing (73) until seated firmly into housing.

Press lip seal (76) into forward end of drive housing (73) and install O-ring (72) into O-ring groove on drive housing.

Install spur gear assembly (66-71) into drive housing (73) until firmly seated.

Install bearing (56) onto aft end of drive shaft assembly (57-62) and secure with retaining ring (55).



Lubricate inner diameter of spur gear assembly (66) using TDI grease P/N: 9-94121.

Install spacer (63), spring (65), and pinion spacer (77) onto pinion drive shaft assembly and install into aft end of spur gear (66). The gears on helical shaft (57) must be aligned into the aft end of the spur gear shaft (66).

Press the helical shaft assembly into the spur gear shaft until end of shaft protrudes from forward end of drive housing.

Maintain pressing force and install pinion onto drive shaft (62). Secure with screw (80). Torque to 100 ft. lb.

5.5 FINAL ASSEMBLY

Place turbine assembly with aft end on a flat surface and install ring gear (28).

Thoroughly grease planet gears (35), ring gear (28), sun gear (31), spur gears using TDI grease P/N: 9-94121.

Rotate carrier shaft (33) slightly, and at the same time, align gearbox into the front of turbine housing (25).

Install six gearbox to turbine assembly screws (50) and torque 113 in-lbs.

Install drive assembly (73) onto gearbox assembly (49) and secure with eight screws (74). Torque to 113 in. lbs.

SECTION 6.0 PARTS LIST

ILLUSTRATED PARTS LIST FOR MODEL T100-V SERIIES AIR STARTERS

KEY NO.	DESCRIPTION	PART NUMBER	OVERHAUL KIT P/N: T10V-28574
1	Screw (6)	11F- 25020-064	x
2	Exhaust Guard	2-28175	
3	Screw	14F- 25028-012	x
4	Washer	9-93047	
5	Rotor 2 (See Note)	2-26604	
6	Woodruff Key	9-90211-006	
7	Bearing Spacer	9-93091-005	x
8	Bearing (2)	9-91224	x
9	O-ring	9-90001-027	x
10	Wave Spring Washer	9-90439	x
11	Screw (4)	11A-37516-008	
12	Nozzle 2, R.H. (See Note)	2-27825-00R	
12	Nozzle 2, L.H. (See Note)	2-27825-00L	
13	O-ring (2)	9-90001-050	x
14	Seal Spacer (2)	9-93083-001	x
15	Lip Seal (2)	2-26719	x
16	Rotor 1 (See Note)	2-26603	
17	Woodruff Key	9-90211-009	
18	Screw (8)	14F-19024-008	x
19	Nozzle 1, R.H., 9 Nozzles (See Note)	2-26718-09R	
19	Nozzle 1, L.H., 9 Nozzles (See Note)	2-26718-09L	
19	Nozzle 1, R.H., 12 Nozzles (See Note)	2-26718-12R	
19	Nozzle 1, L.H., 12 Nozzles (See Note)	2-26718-12L	
19	Nozzle 1, R.H., 15 Nozzles (See Note)	2-26718-15R	
19	Nozzle 1, L.H., 15 Nozzles (See Note)	2-26718-15L	

KEY NO.	DESCRIPTION	PART NUMBER	OVERHAUL KIT P/N: T10V-28574
19	Nozzle 1, R.H., 21 Nozzles (See Note)	2-26718-21R	
19	Nozzle 1, L.H., 21 Nozzles (See Note)	2-26718-21L	
20	Pipe Plug	9-93556-004	
21	O-ring	9-90001-034	x
22	Screw (6)	14F-31218-016	x
23	Inlet Flange	1-18967	
24	O-ring	9-90001-037	x
25	Turbine Housing	2-27869	
26	Pipe Plug	9-93501-004	
27	O-Ring	9-90001-050	x
28	Ring Gear	2-27870	
29	Bearing Spacer	9-93091-001	
30	Clamping Plate	2-26750	
31	Turbine Shaft (7.5:1)	2-26554	
31	Turbine Shaft (9.0:1)	2-27238	
31	Turbine Shaft (11.4:1)	2-28710	
32	Retainer Ring (3)	9-92001-001	
33	Carrier Shaft (7.5:1)	2-27798-002	
33	Carrier Shaft (9.0:1)	2-27798-001	
33	Carrier Shaft (11.4:1)	2-27798-003	
34	Spacer, Gear (6)	9-93004	
35	Planet Gear (3) (7.5:1)	1-19441	
35	Planet Gear (3) (9.0:1)	1-18779	
35	Planet Gear (3) (11.4:1)	1-19440	
36	Needle Bearing (3)	9-91004-001	x
37	Planet Shaft (3)	2P-20182	

KEY NO.	DESCRIPTION	PART NUMBER	OVERHAUL KIT P/N: T10V-28574
38	Woodruff Key	9-90227-025	
39	Bearing (2)	9-91351	x
40	Wave Spring Washer	9-90402-025	
41	Spring Retaining Plate	2-27731	
42	Retaining Ring	9-92001-033	
43	Bearing Spacer	9-93007-003	
44	Housing, Bearing	2-27726	
45	Screw (4)	14F-25020-012	x
46	Gear, Spur	2-27712	
47	Lockwasher, Bearing	9-93061-007	
48	Locknut, Bearing	9-92127-007	
49	Housing, Gearbox	2-27728	
50	Screw (6)	71F-25020-36	x
51	Fitting, Filter	2-28270	
52	Plug, Pipe (2)	9-93556-004	
53	O-Ring, Piston	9-90001-327	
54	Piston	2-27921	
55	Retainer Ring	9-92001-041	
56	Bearing	9-91254	x
57	Spline, Helical Shaft, R.H. (See Note 1)	2-27977-00R	
57	Spline, Helical Shaft, L.H. (See Note 1)	2-27977-00L	
58	Spring, Compression	9-90444	
59	Clutch, Helical, R.H.	2-27713	
59	Clutch, Helical, L.H.	2-27716	
60	Ring, Retainer	9-92001-037	
61	Bearing, Needle Roller	9-91409	x

KEY NO.	DESCRIPTION	PART NUMBER	OVERHAUL KIT P/N: T10V-28574
62	Shaft, Drive Pinion R.H.	2-28169-001	
62	Shaft, Drive Pinion L.H.	2-28169-002	
63	Washer, Thrust (2)	9-93120	x
64	Ring, Retainer	2-28051	x
65	Spring, Compression	9-90447	
66	Gearshaft, Spur	2-27711	
67	Bearing, Ball	9-91431	x
68	Ring, Retaining	9-92001-036	
69	Bearing, Ball	9-91434	x
70	Bearing, Needle Roller	9-91435	x
71	Ring, Retainer	9-92001-042	
72	O-Ring	9-90001-158	x
73	Housing, SAE	2-27729	
74	Screw (8)	71F-25020-016	x
75	Fitting, Vent	9-93662-012	
76	Seal, Lip	2-22084	x
77	Spacer, Pinion	2-28178	
78	Pinion, 6/8P, 12T, Bi-directional	2-28167	
78	Pinion, 6/8P, 15T, Bi-directional	2-28568	
78	Pinion, 3.5 MOD, 15T, Bi-directional	2-28242	
78	Pinion, 3.5 MOD, 17T, Bi-directional	2-28632	
79	Washer, Pinion	9-93124	x
80	Screw	71F-50020-016	x

Note: The rotation of the turbine assembly is opposite from the pinion rotation, therefore the rotors and nozzles must be configured for LH (CCW) rotation if the pinion rotation is RH (CW), or configured for RH (CW) if pinion rotation is LH (CCW).