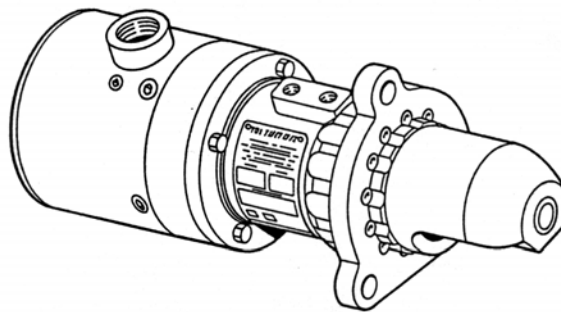


SERVICE MANUAL



T30-I **TURBOTWIN ENGINE AIR STARTERS**

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SECTION 1.0 INTRODUCTION

1.1 GENERAL INFORMATION

This manual provides information for servicing, disassembly, and re-assembly of the TDI Turbotwin T30-I air starter. 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 re-assembly.

The TDI Turbotwin T30-I engine air starter is 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 motor speed.

The Turbotwin T30-I air starter is suited to operate within a wide range of inlet pressures and ambient temperatures. This starter is designed for operation with either compressed air or natural gas.

The robust turbine motor design in the Turbotwin T30-I air starter 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 denote 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 TDI Turbotwin T30-I air starter.

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 likely.

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 T30-I air starter is powered by a pair of axial flow turbines coupled to a simple planetary gear reduction set. The T30-I air starter 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 planetary gear speed reducer results in a very efficient and compact unit. The Turbotwin T30-I air starter can be used over a wide range of drive pressures from 30 psig (2 BAR) to 120 psig (8 BAR) and is suitable for operation on either air or natural gas.

The T30-I weighs approximately 29 pounds (13KG) and is capable of delivering over 21 HP (16 kW) of cranking power at the maximum pressure of 120 psig (8 BAR).

1.4 INSTALLATION AND SERVICE

It is important to properly install and operate the T30-I air starter 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 by TDI may result in damage to the starter or engine, or cause personal injury. DO NOT OPERATE THIS STARTER UNLESS IT IS PROPERLY ATTACHED TO 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 T30-I air starter, refer to *Figure 1*. The part number coding explanation, refer to *Figure 2*, can help you when talking to your distributor.

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™ PNEUMATIC STARTER TECH DEVELOPMENT INC. 6800 POE AVE., DAYTON OH	
		MODEL NO. T30-I	SERIAL NO. 9704-146
PART NUMBER T306-60017-02R			
AIR OR NAT. GAS USAGE HOUSING PROOF PRESSURE IS 600 PSIG			
MAX OPERATING INLET PRESS. 120 PSIG			
WARNING: DO NOT OPERATE UNLOADED, WITHOUT EXHAUST GUARD OR WITHOUT EXHAUST FITTING			

Figure 1. TDI TURBOTWIN Nameplate

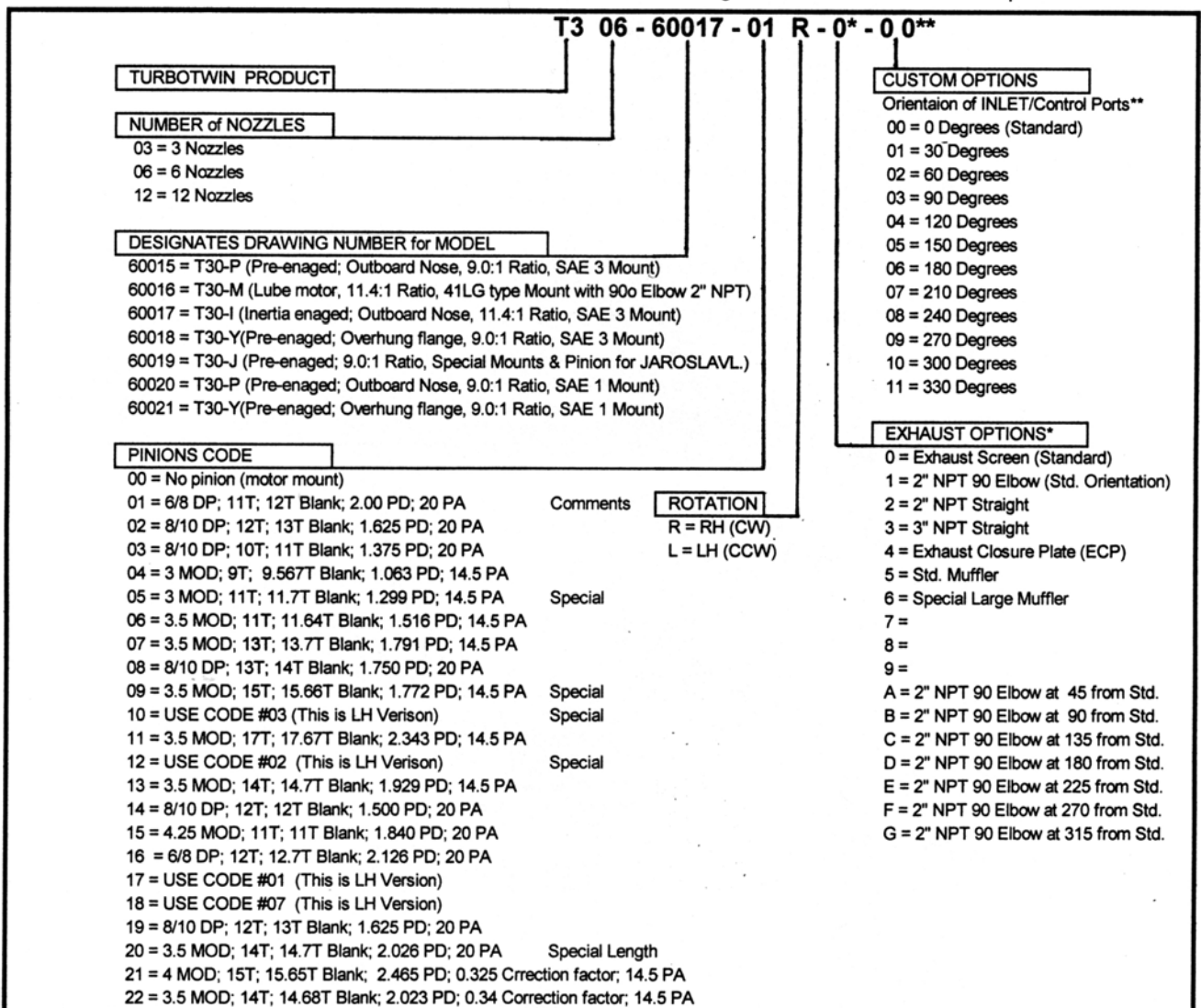


Figure 2. T30 Series Air Starter Nameplate Identification

**SECTION 2.0 DESCRIPTION OF
BASIC GROUPS**

2.1 GENERAL

The TDI Turbotwin T30-I air starter is a lightweight, compact unit driven by a two stage turbine air motor. The starter is composed of three basic assembly groups: Turbine Housing Assembly, Gearbox Housing Assembly, and Bendix Drive Assembly.

2.2 TURBINE HOUSING ASSEMBLY

The Turbine housing assembly, refer to figure 3, consists of a stage one (15) and a stage two (6) turbine rotor mounted on sungear shaft (22). The front bearing (8) is secured by a retainer plate (20) and the aft bearing is pre-load by a spring washer (9).

The ring gear (23) is installed into the front of the turbine housing (19) and secured by four screws.

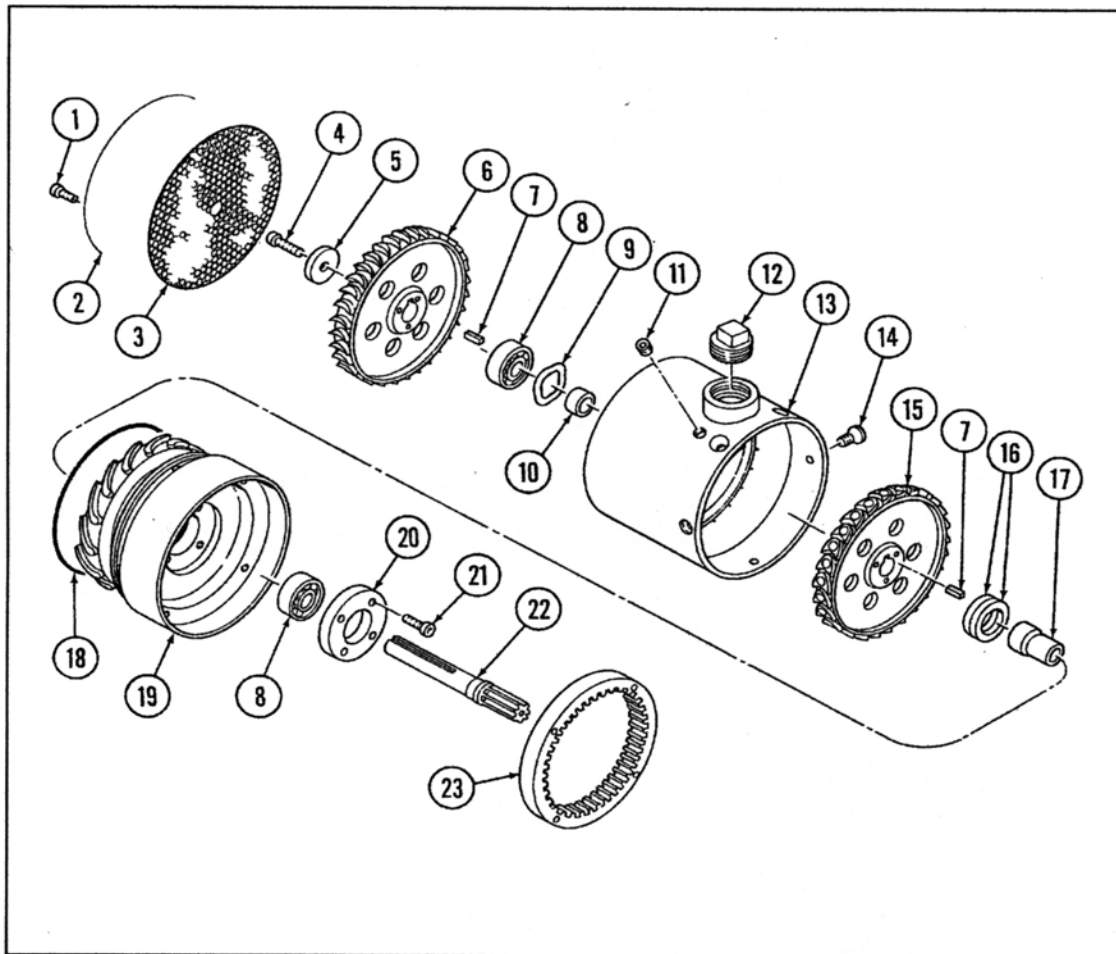


Figure 3. Turbine Housing Assembly

2.3 GEARBOX HOUSING ASSEMBLY

The gearbox housing assembly, refer to figure 4, consist of a planet gear carrier and output shaft (24), three planet gears (27), needle bearings (28), spacers (26), and planet shafts (25).

The carrier shaft is mounted on two ball bearings (29) in the gearbox housing (32). The retainer nut (35) secures the carrier shaft in the gearbox housing. The front bearing (29) is secured by a retainer plate (36). The aft bearing (29) is preloaded by use of a spring washer (30).

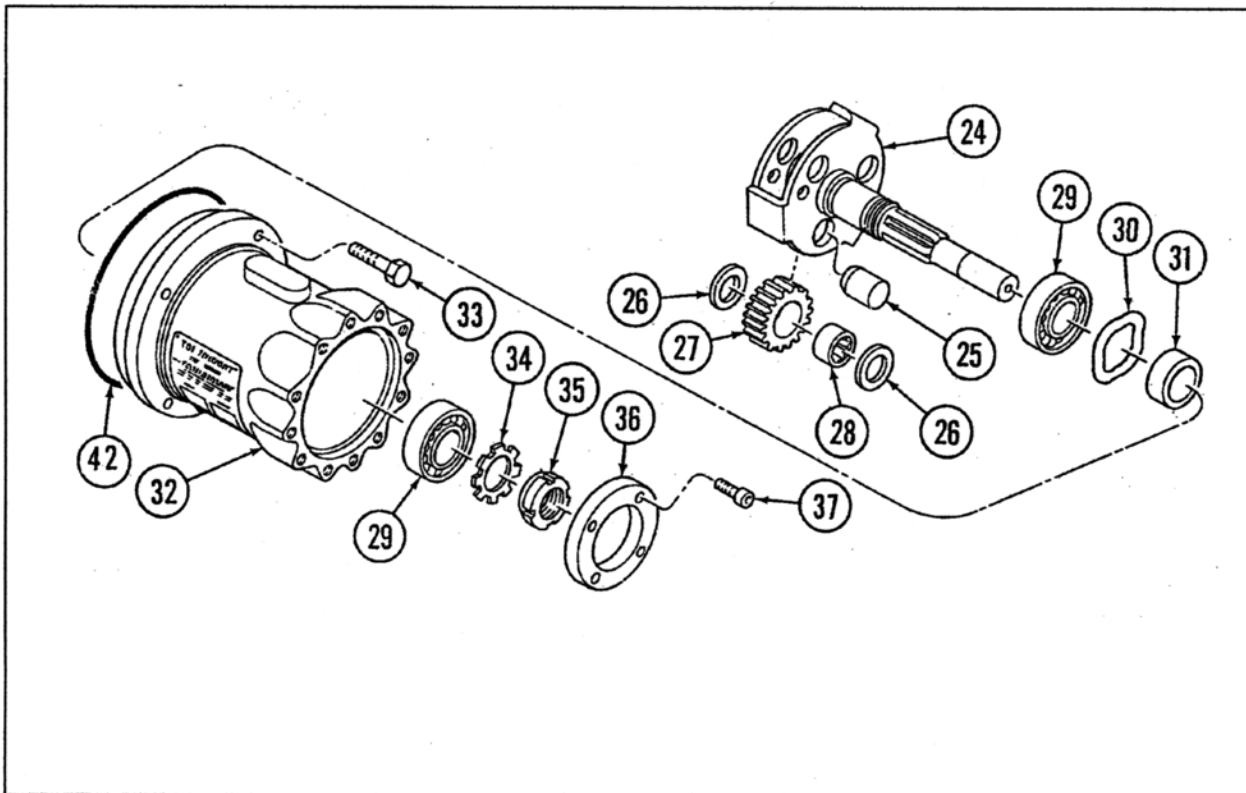


Figure 4. Gearbox Housing Assembly

2.4 BENDIX DRIVE ASSEMBLY

The Bendix drive assembly, refer to figure 5, consist of an inertial engagement drive or "bendix" (39) and drive housing (41). Twelve screws (37) secure the drive housing to the gearbox housing.

The front end of the drive is mounted into a needle bearing (40), which is installed in the nose of the drive housing.

A drive spacer (38) is installed between the bendix drive (39) and carrier shaft.

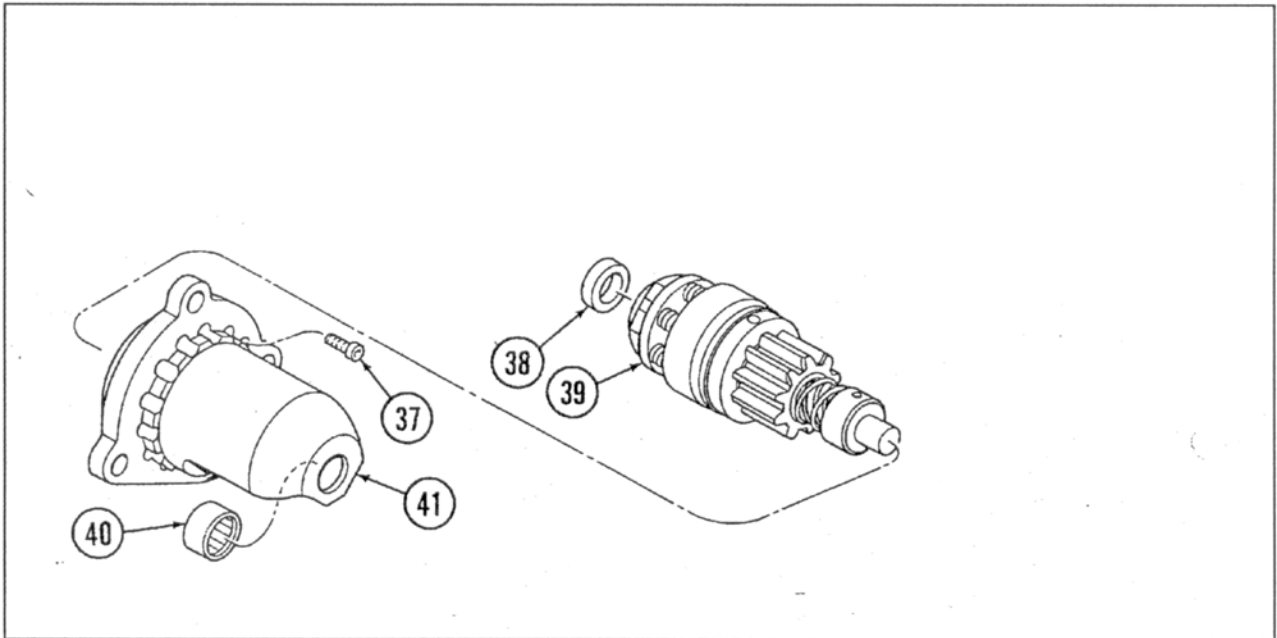


Figure 5. Bendix Drive Assembly

SECTION 3.0 DISASSEMBLY

3.1 GENERAL

Always mark adjacent parts on the starter housing; Nozzle 2/ Containment Ring (13), Turbine Housing (19), Gearbox Housing (32), and Bendix Drive Housing (41) so these parts can be located in the same relative position when the starter is re-assembled.

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 T30-I air starter. Never use old seals or o-rings.

The tools listed in *Table 1* are suggested for use by technicians servicing the Turbotwin T30-I air starter. The best results can be expected when these tools are used, however, the use of other tools are acceptable.

TOOL DESCRIPTION	TDI/PN
Spanner wrench	2-27272
Stage 2 Rotor Puller Tool	52-20076
Tool, Turbine Bearing	45-25294
Tool, Bearing/Seal	2-26943

Table 1. T30-I Service Tool Kit (P/N: T30-27639)

3.2 DRIVE HOUSING

3.2.1 Removal of Drive Housing

Mark position of bendix pinion opening relative to gearbox housing for reference during re-assembly.

Remove the 12 screws (37) and pull drive housing (41) from gearbox housing (32). If drive housing is too tight, tap it with a mallet to loosen.

3.2.2 Removal of Bendix Drive

Pull bendix drive (39) from carrier shaft assembly (24) and remove drive spacer (38).

3.3 GEARBOX HOUSING

3.3.1 Removal of Gearbox Housing

Remove four screws (33) and separate the gearbox assembly from the turbine assembly.

3.3.2 Gearbox Disassembly

Set the gearbox on the gearbox holding tool with the three holes on the gearbox over the dow pins on the holding tool as shown in figure 6.

Bend the tab on the bearing locking washer (34) to release the bearing retaining nut (35)

Install spanner wrench on the bearing retaining nut and turn CCW to remove.

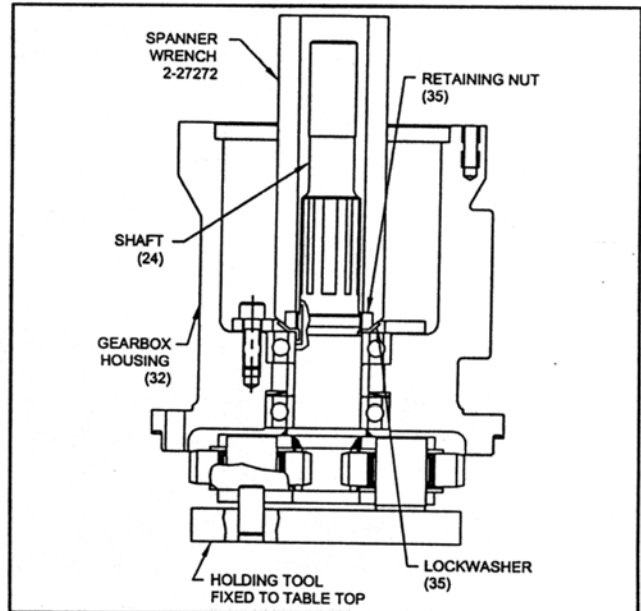


Figure 6. Gearbox Retainer Nut Removal

Apply pressure to the carrier shaft (24) to remove it from the gearbox housing (32). An arbor press and brace may be required.

Press bearing (29) out of gearbox housing (32) by tapping inner race.

3.3.3 Carrier Shaft/Planet Gear Disassembly

Place carrier shaft/gear assembly on arbor press with splined shaft up. With carrier shaft (24) supported, press each planet shaft (25) out opposite the spline shaft. Refer to figure 7.

Remove the planet gears (27) and spacers (26) from the carrier shaft weldment (24).

Remove the square key (7) from turbine shaft (22).

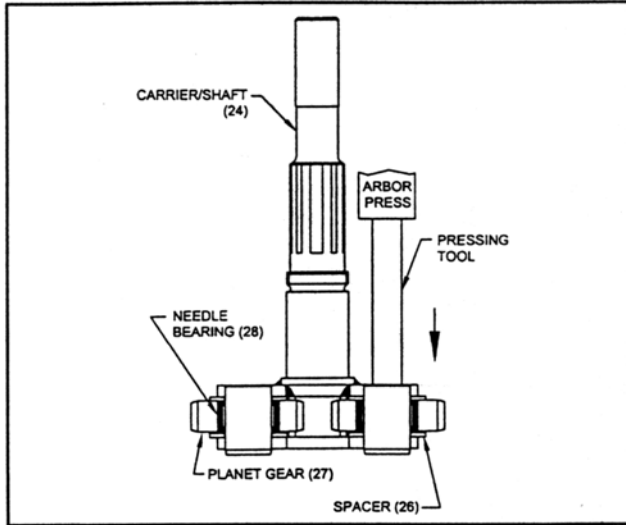


Figure 7. Carrier Shaft Disassembly

Needle bearings (28) may be pressed out if replacement is required.

3.4 TURBINE HOUSING

3.4.1 Stage 2 Rotor Removal

Remove eight screws (1), exhaust support (2), and exhaust screen (3).

Hold the stage 2 rotor (6) and remove the turbine screw (4) and washer (6).

Install rotor puller tool P/N 52-20076 and remove the stage 2 rotor per figure 8.

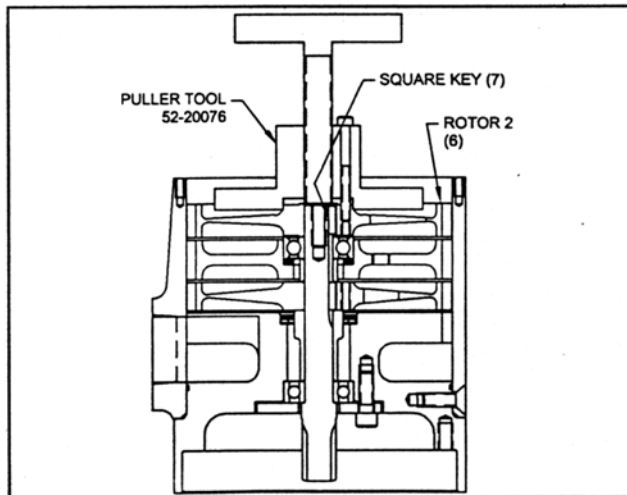


Figure 8. Turbine Rotor Removal

3.4.2 Turbine Housing Disassembly

Remove five screws (14) from the stage 2 nozzle (13) and separate it from turbine housing (13). If turbine housing is too tight, it can be removed by installing two threaded screws into nozzle 2 (exhaust end) and using them as jacks to separate the turbine housing from nozzle 2. Refer to Figure 9.

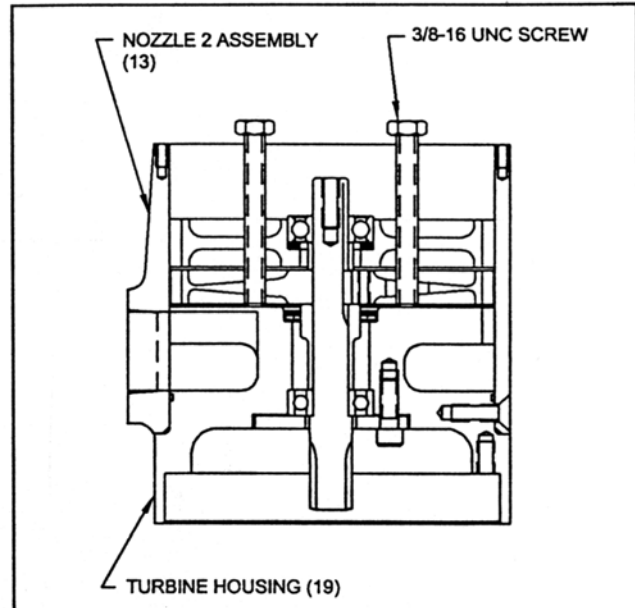


Figure 9. Nozzle 2 Removal

Remove the bearing spacer (10) (9) from the turbine shaft.

Remove turbine bearing (8) and preload spring (9) from nozzle 2 (13).

Remove four screws (21) and bearing retainer plate from turbine housing (19).

Press turbine shaft (22) through turbine housing (19) as shown in figure 10. Remove bearing spacer from turbine shaft.

Remove the stage 1 rotor (15) and square key (7).

Press turbine shaft. (22) through bearing (8) to remove bearing from shaft.

Press the lip seal (16) from the turbine housing by applying pressure to the seal through the housing.

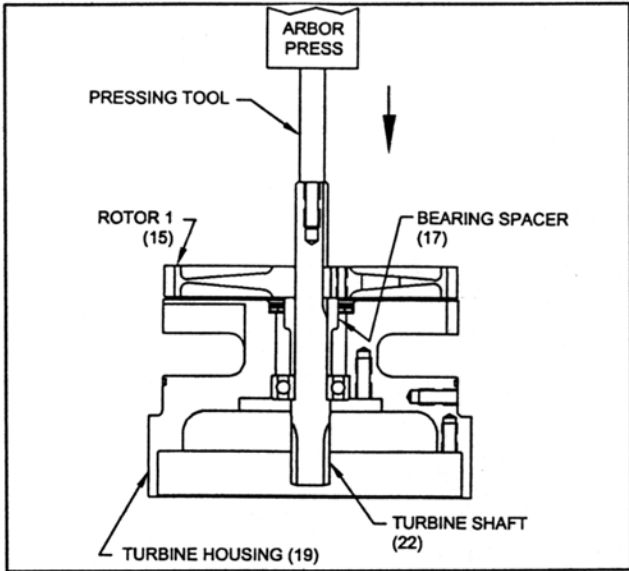


Figure 10. Turbine Shaft Removal

SECTION 4.0 CLEANING and INSPECTION

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

4.1 CLEANING

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

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.

NOTE

Never wash bendix assembly or bearings in cleaning solvents. It is recommended that the bearings be replaced with new parts.

MATERIAL or COMPOUND	MANUFACTURER
Degreasing Solvent (Trichloroethylene) (O-T-634)	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 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 all threaded parts for galled, crossed stripped, or broken threads.

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.

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

Part Description	Check For	Requirements (Defective Parts Must Be Replaced)
Bendix	Worn, loose, or missing parts	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	Cracks and breakage	Cracks and breakage are not acceptable. Minor surface damage is permitted if function is not impaired.
Ring Gear	Cracks, wear, chipped, or broken gear teeth.	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	0.6690 min
External measurement over two .096 diameter pins.	
7.5:1	0.952 min
9:1	0.808 min
11.4:1	0.670 min
Planet Gear External measurement over two .0864" diameter pins.	
7.5:1	2.3067 min
9:1	2.3699 min
11.4:1	2.4359 min
Carrier Shaft Bearing Diameter	1.1800 min
Planet Pin Bore	0.8750 max
Planet Pins Bearing Diameter	0.873 min
Thrust Washer Thickness	.055 min

Table 4. Parts Wear Limits

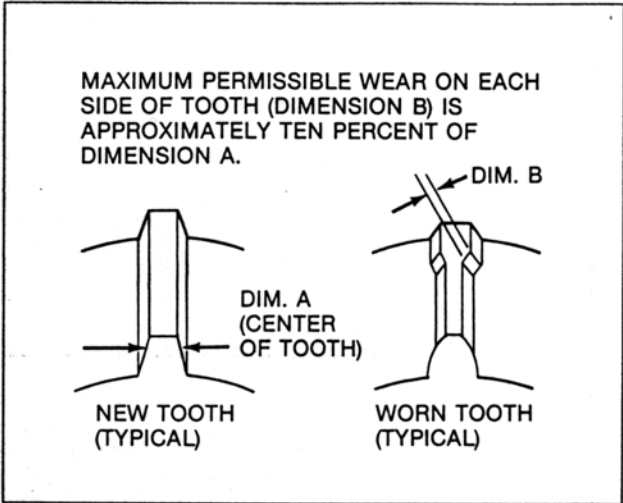


Figure 11. Gear Teeth Wear Allowances

ITEM NUMBER *	TORQUE	
	In-lbs	Nm
1 (Screw)	50	68
4 (Screw)	180	245
14 (Screw)	75	102
21 (Screw)	113	154
33 (Screw)	113	154
35 (Retainer Nut)	125	170
37 (Screw)	113	154

* Refer to section 6 for part number identification.

Table 5. Torque Values

SECTION 5.0 ASSEMBLY

5.1 GENERAL INFORMATION

The tools listed in *Table 1* are suggested for use by technicians servicing the Turbotwin T30-I air starter. The best results can be expected when these tools are used, however, the use of other tools is acceptable.

CAUTION

Replace all screws, o-rings, lip seals, and bearings when the T30-I starter is assembled. These parts are included in the overhaul kit shown in the Parts List, Section 6.0.

NOTE

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

Lubricate all o-rings with petroleum jelly or Parker O-ring Lube before assembly. Refer to *Table 6* for a list of materials to be used 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 6. Materials for Assembly

5.2 TURBINE HOUSING

5.2.1 TURBINE BEARING INSTALLATION

Press the lip seal (16) onto the large end of the bearing spacer (17) with the lips facing up.

Hand press the lip seal/bearing assembly (16,17) into the stage 1 turbine housing (19).

Press the turbine bearing (8) onto the turbine shaft (22) until seated.

Press the turbine bearing/shaft assembly (8,22) into the turbine housing (19). Use press tool P/N 2-26943 if required per figure 12. Do not press on the end of the shaft because the load could damage the balls of the bearings.

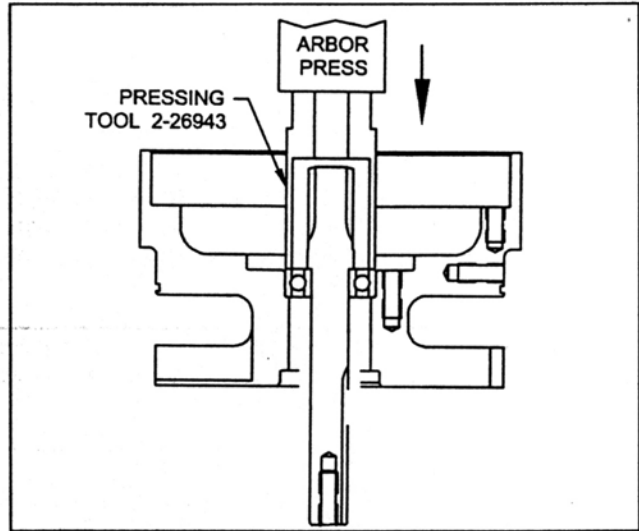


Figure 12. Turbine Shaft Installation

Install the bearing retainer (20) onto the turbine housing (19) and secure with four screws (21) Torque to 113 in-lbs.

5.2.2 ROTOR 1 INSTALLATION

Turn the turbine nozzle over (exhaust end up) and press the square key (7) into the turbine shaft (22) until seated.

Install stage 1 rotor (15) by sliding over turbine shaft (22), while simultaneously aligning the key with the keyway in the rotor.

5.2.3 STAGE 2 NOZLE INSTALLATION

Slip o-ring (18) over stage 1 rotor and into the groove of the turbine housing (19).

Install the stage 2 nozzle (13) over the turbine housing (19) and secure with five (14) pan head screws. Torque to 75 in-lb.

NOTE

The air inlet port on nozzle 2 must be aligned with the casting indentation on the turbine housing.

5.2.4 ROTOR 2 INSTALLATION

Slide bearing spacer (10) over turbine shaft (22). Place pre-load spring (9) into bearing bore.

Apply a light coating of oil to the bearing bore in the nozzle 2 containment assembly and press the bearing over the turbine shaft and into the bearing bore.

Insert key (7) into turbine shaft keyway and install stage 2 rotor (6) onto shaft, while simultaneously aligning the key with the keyway in the rotor.

Secure stage 2 rotor with rotor washer (5) and rotor screw (4). Torque to 180 in-lb.

Install plug (11) into nozzle 2 containment assembly.

Hand press ring (23) gear into turbine housing.

5.3 GEAR BOX ASSEMBLY

5.3.1 PLANETARY GEAR CARRIER ASSEMBLY

If disassembled, press needle bearings (28) into planet gear (27) using arbor press.

Place thrust washer (26) on each side of planet gear (27) and install into carrier shaft (24) slot.

Press planet shaft (25) into the carrier weldment using an arbor press.

5.3.2 CARRIER SHAFT INSTALLATION

Press ball bearing (29) onto carrier shaft using the arbor press.

Apply a light coating of oil to both bearing counter bores and place pre-load spring (30) in carrier side bearing bore.

Slide carrier shaft assembly through the gearbox housing, and place spacer (31) over the shaft.

Press second bearing (29) over carrier shaft and into gearbox housing using arbor press.

Place bearing retainer (36) over bearing and fasten with four screws. Torque to 113 in-lb.

Place carrier shaft assembly on holding tool. Install lock washer and thread locknut (35) onto carrier shaft. Tighten locknut using spanner wrench as shown in figure 13. Torque to 125 in-lb.

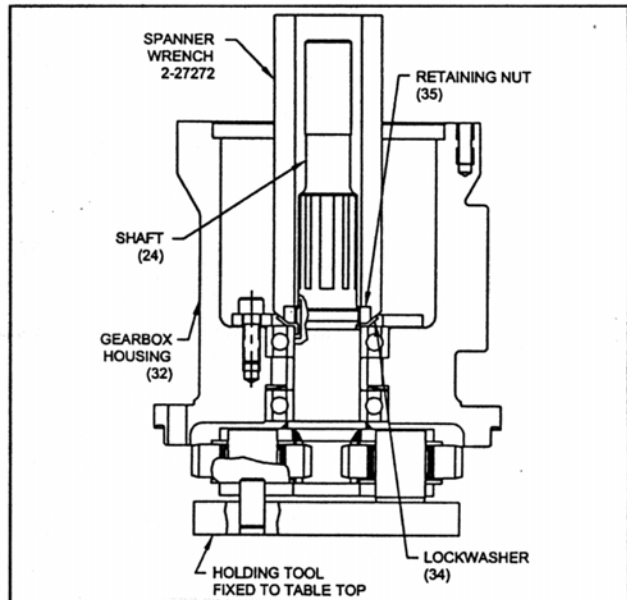


Figure 13. Tightening Retainer Nut

5.3.3 BENDIX DRIVE INSTALLATION

Slide drive spacer (38) over shaft and place bendix drive onto carrier shaft.

5.4 FINAL ASSEMBLY

Temporarily install one screw (33) into ring gear (23) to prevent it from rotating while applying grease. Remove screw after grease is applied to ring gear.

Apply liberal amounts of grease (approximately 100-115 grams) to planet gears (27), turbine shaft sun gear (22), and ring gear (23).

Align gearbox assembly with turbine assembly and secure with four screws (33).

Install drive housing onto gearbox housing using four screws (37). Torque to 113 in-lb.

Install exhaust screen (3) and support ring (2) using eight screws (1). Torque to 50 in-lb.

SECTION 6.0 PARTS LIST

The components illustrated and/or described in this section are for the Turbotwin T30-I air starter. When rebuilding a T30-I air starter, it is recommended to purchase and completely install the appropriate service kit(s).

KEY #	DESCRIPTION	PART NUMBER	QTY.	OVERHAUL KIT T30I-27624-001
1	Screw	14F-16432-008	8	✓
2	Exhaust Support	2-27475	1	
3	Exhaust Screen	2-27239	1	
4	Screw, Rotor Attachment	14F-25028-012	1	✓
5	Rotor Washer	9-93047	1	
6	Stage 2 Rotor	2-27232	1	
7	Square Key (1/8")	9-90220-050	2	
8	Turbine Bearing	9-91224	2	✓
9	Bearing Pre-Load Spring	9-90439	1	✓
10	Bearing Spacer	9-93091-003	1	✓
11	Hollow Hex Plug	9-93501-002	1	
12	1" NPT Caplug	9-93502-006	1	
13	Stage 2 Noz/ Containment (RH)	2-27405-00R	1	
13	Stage 2 Noz/ Containment (LH)	2-27405-00L	1	
14	Screw	24F-25020-012	5	✓
15	Stage 1 Rotor	2-27225	1	
16	Lip Seal	2-26719	2	✓
17	Spacer/SealBearing	9-93114	1	✓
18	O-Ring	9-90001-047	1	✓
19	Turbine Hsg. / Stage 1 (3 Noz. RH)	2-27389-03R	1	
19	Turbine Hsg. / Stage 1 (3 Noz. LH)	2-27389-03L	1	
19	Turbine Hsg. / Stage 1 (6 Noz. RH)	2-27389-06R	1	
19	Turbine Hsg. / Stage 1 (6 Noz. LH)	2-27389-06L	1	
19	Turbine Hsg. / Stage 1 (12 Noz. RH)	2-27389-12R	1	
19	Turbine Hsg. / Stage 1 (12 Noz. LH)	2-27389-12L	1	
20	Bearing Retainer	2-27406	1	
21	Screw	14F-25020-012	4	✓
22	Turbine Shaft	2-27391-002	1	
23	Ring Gear	2-27395	1	
24	Carrier Shaft Weldment (6/8P)	2-27402-001	1	
24	Carrier Shaft Weldment (8/10P)	2-27608	1	
25	Planet Shaft	2-22051	3	
26	Planet Gear Spacer	9-93065	6	✓
27	Planet Gear (11.4:1)	2-21988	3	
28	Planet Bearing	9-91389	3	✓
29	Gearbox Bearing	9-91037	2	✓
30	Bearing Pre-Load Spring	9-90442-009	1	✓
31	Bearing Spacer (Gearbox)	2-27140	1	✓

TDI TURBOTWIN™
FROM TECH DEVELOPMENT, INC.

KEY #	DESCRIPTION	PART NUMBER	QTY.	OVERHAUL KIT T30I-27624-001
32	Gearbox Housing	2-27386-001	1	
33	Hex Bolts (Gearbox Attachment)	71F-25020-024	4	✓
34	Bearing Lockwasher	9-93061-006	1	✓
35	Bearing Retainer Nut	9-92127-006	1	✓
36	Bearing Retainer	2-27407	1	
37	Screw	14F-25020-012	12	✓
38	Drive Spacer	2-27141	1	✓
39	Drive Bendix 6/8P, 11T, RH	2-22147	1	
39	Drive Bendix 6/8P, 11T, LH	2-22148	1	
39	Drive Bendix 8/10P, 12T, RH	2-20927	1	
39	Drive Bendix 8/10P, 12T, LH	2-20926	1	
40	Nose Bearing (6/8P)	9-91408	1	✓
40	Nose Bearing (8/10P)	9-91395	1	✓
41	Drive Housing (6/8P)	2-27113	1	
41	Drive Housing (8/10P)	2-27113-001	1	
42	O-Ring	9-90001-049	1	✓

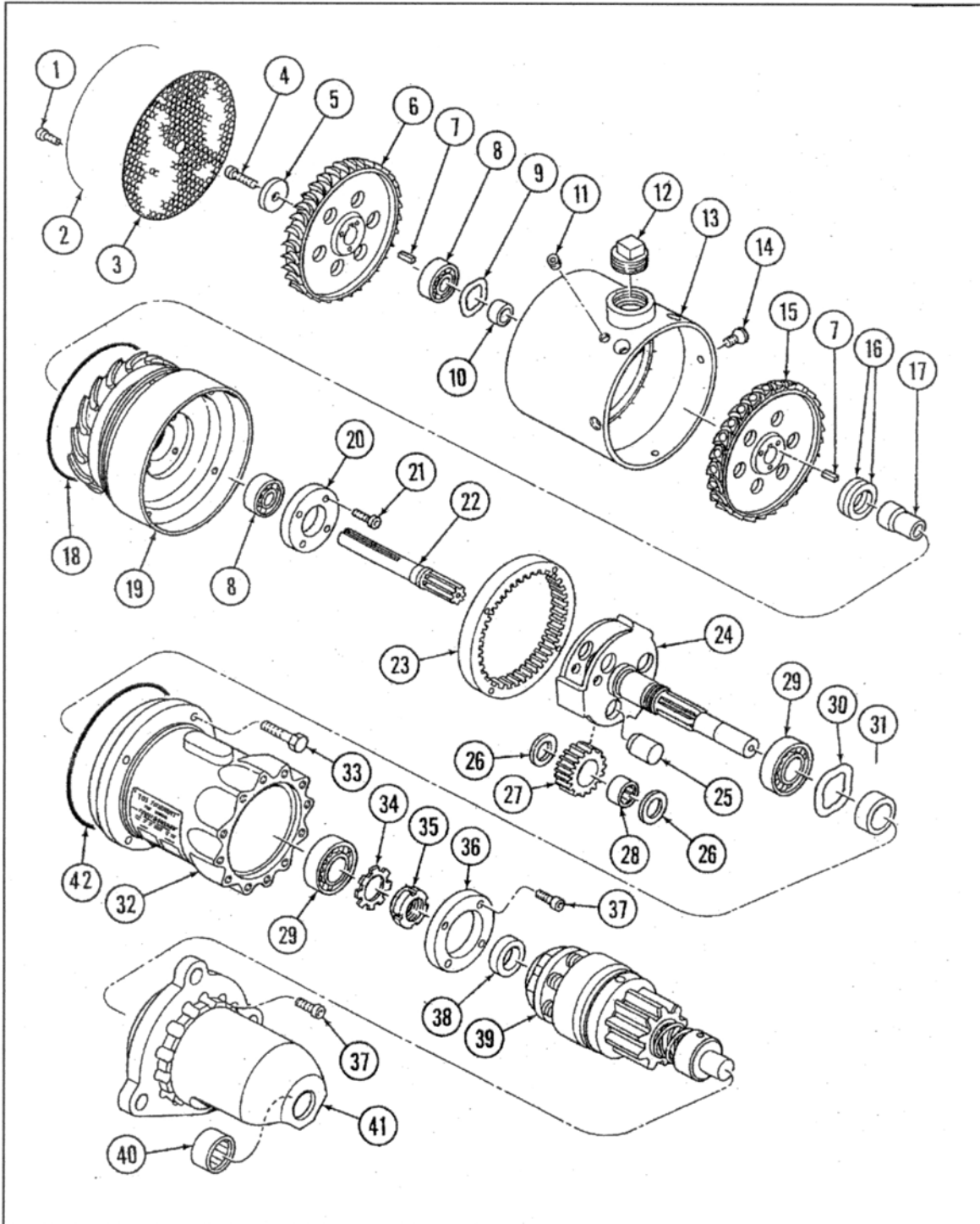


Figure 14. T30-I Illustrated Parts Breakdown