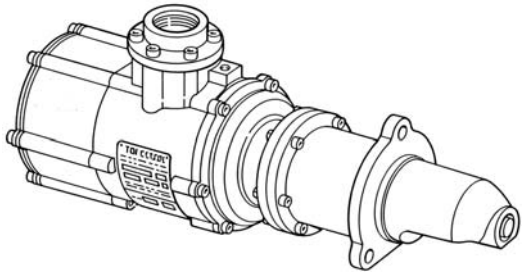
TECH DEVELOPMENT

Publication T1-701, Rev. 1
Dated: April 15, 2006

SERVICE MANUAL



T100 Series (T112B/T121B, T112D/T121D, T106F/T112F, T109P/T115P)

TURBOTWIN ENGINE AIR STARTERS

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SECTION 1.0 INTRODUCTION

1.1 GENERAL INFORMATION

This manual provides information for servicing, disassembly, and reassembly of the TDI Turbotwin T100 series 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 series of 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 motor speed.

The Turbotwin T100 series 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 series 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 TDI Turbotwin T100 series 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 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 T100 series starters are powered by a pair of axial flow turbines coupled to a simple planetary gear reduction set. The T100 series 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 planetary gear speed reducer results in a very efficient and compact unit. The Turbotwin T100 series starters can be used over a wide range of drive pressures from 30 psig (2 BAR) to 150 psig (10 BAR) and are suitable for operation on either air or natural gas.

The Turbotwin T106F & T112F weighs approximately 47 pounds (21 KG) and each is capable of delivering over 44 HP (33 kW) of cranking power at their maximum pressure of either 150 psig (10 BAR) or 90 psig (6 BAR) respectively.

The Turbotwin T112B & T121B weighs approximately 55 pounds (25 KG) and each is capable of delivering over 80 HP (60 kW) of cranking power at their maximum pressure of either 150 psig (10 BAR) or 90 psig (6 BAR) respectively.

The Turbotwin T112D &T121D weighs approximately 70 pounds (32 KG) and each is capable of delivering over 80 HP (60 kW) of cranking power at their maximum pressure of either 150 psig (10 BAR) or 90 psig (6 BAR) respectively.

The Turbotwin T109P & T115P weighs approximately 59 pounds (27 KG) and is capable of delivering over 60 HP (41 kW) of cranking power at their maximum pressure of either 150 psig (10 BAR) or 90 psig (6 BAR) respectively.

1.4 INSTALLATION AND SERVICE

It is important to properly install and operate the TDI Turbotwin T100 series 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 ATTACHED TO AN ENGINE.

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.

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 series starters, refer to *Figure* 1. The part number coding explanation, refer to *Figure 2*, can help you when talking to your distributor.

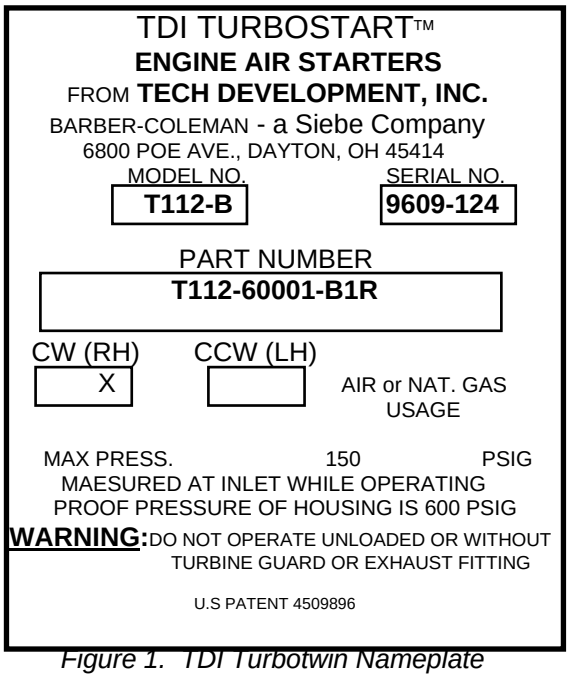

Figure 1. TDI Turbotwin Nameplate

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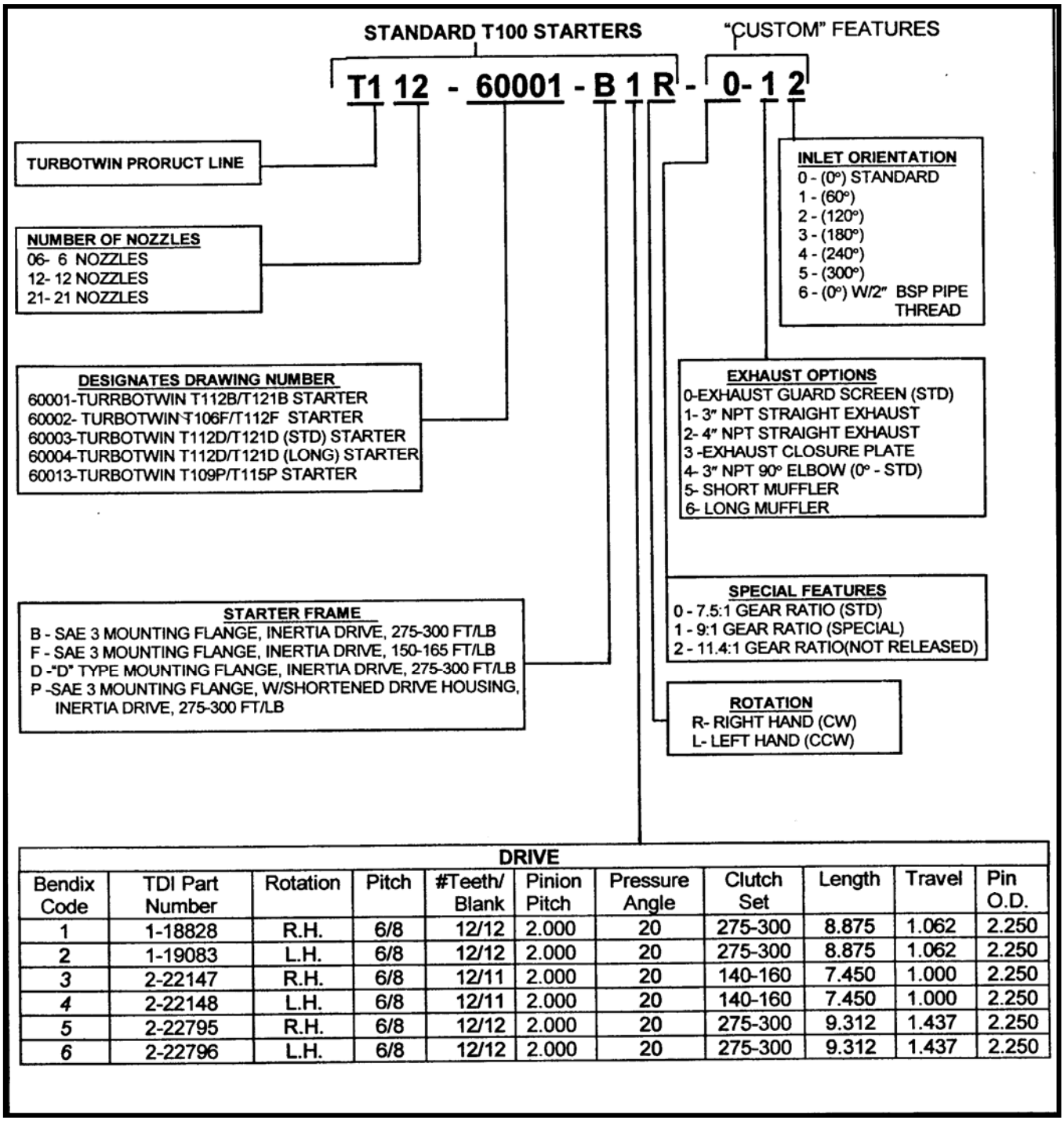


DRIVE

Bendix Code	TDI Part Number	Rotation	Pitch	#Teeth/ Blank	Pinion Pitch	Pressure Angle	Clutch Set	Length	Travel	Pin O.D.
1	1-18828	R.H.	6/8	12/12	2.000	20	275-300	8.875	1.062	2.250
2	1-19083	L.H.	6/8	12/12	2.000	20	275-300	8.875	1.062	2.250
3	2-22147	R.H.	6/8	12/11	2.000	20	140-160	7.450	1.000	2.250
4	2-22148	L.H.	6/8	12/11	2.000	20	140-160	7.450	1.000	2.250
5	2-22795	R.H.	6/8	12/12	2.000	20	275-300	9.312	1.437	2.250
6	2-22796	L.H.	6/8	12/12	2.000	20	275-300	9.312	1.437	2.250

Figure 2. Part Number Coding

SECTION 2.0 DESCRIPTION OF BASIC GROUPS

2.1 GENERAL

The TDI Turbotwin T100 Series 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 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 wheel mounted on sungear shaft (33) . The front bearing (10) is secured by a retainer plate (32). The aft bearing is preloaded by wavy spring (12).

The ring gear (29) is heat shrunk into the front of the turbine housing (26) and secured by a setscrew (25).

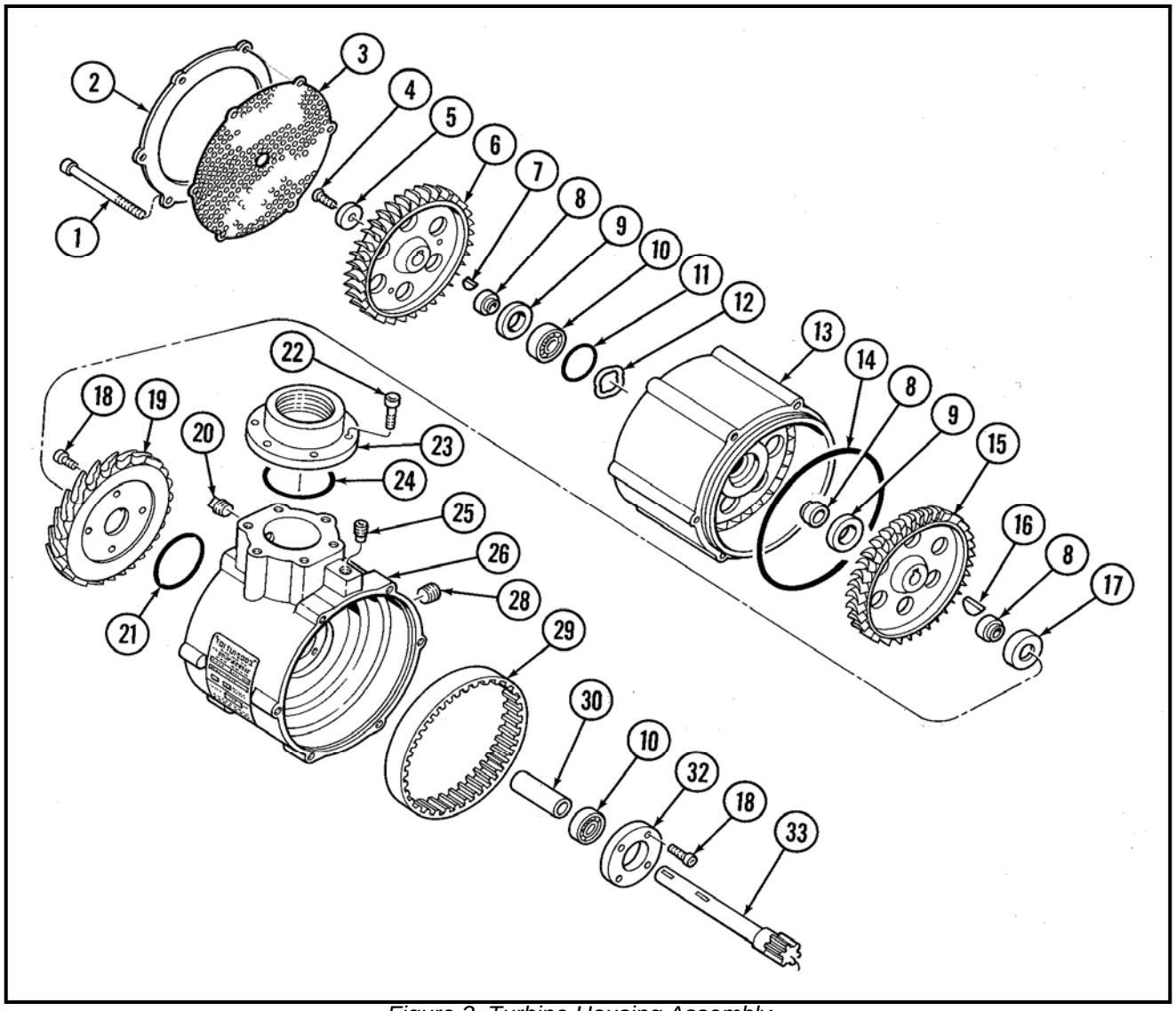


Figure 3. Turbine Housing Assembly

2.3 GEARBOX HOUSING ASSEMBLY

The gearbox housing assembly, refer to figures 4, consist of a planet gear carrier and output shaft (35), three planet gears (37), needle bearings (38), spacers (36), and bearing pins (39).

The carrier shaft is mounted on two ball bearings (41) in the gearbox housing (58). The retainer nut (48) secures the carrier shaft in the gearbox housing. The front bearing (41) is secured by a retainer plate (46). The back bearing is preloaded by use of a spring washer (42).

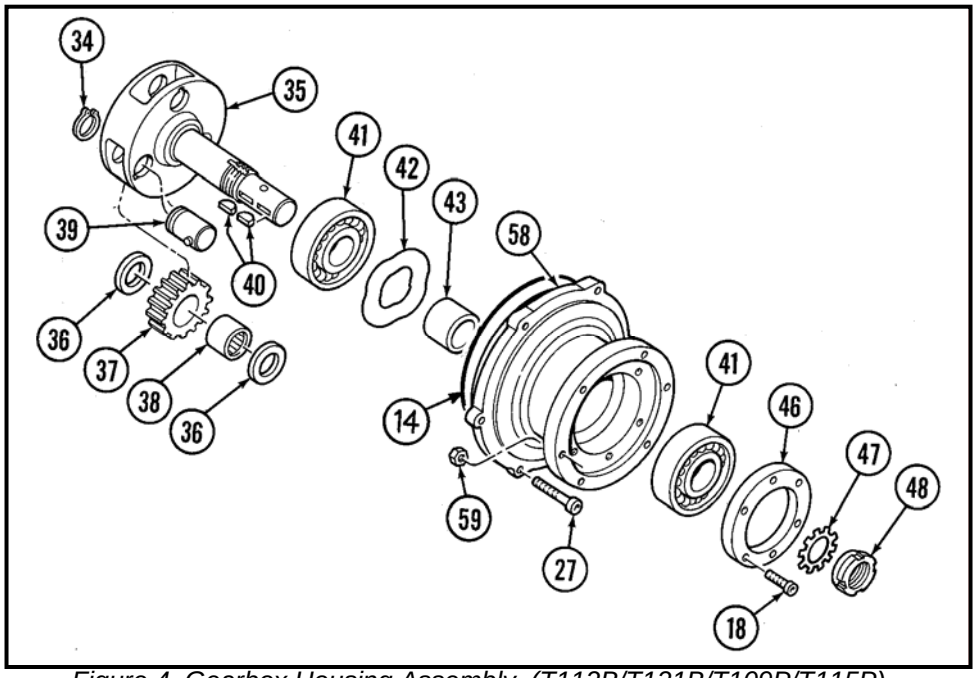


Figure 4. Gearbox Housing Assembly (T112B/T121B/T109P/T115P)

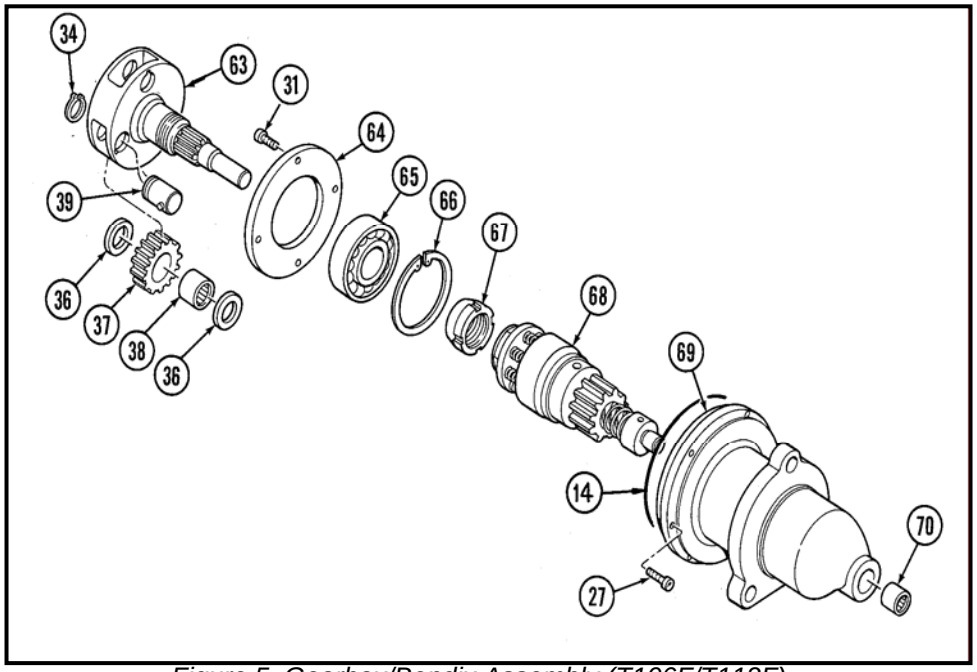


Figure 5. Gearbox/Bendix Assembly (T106F/T112F)

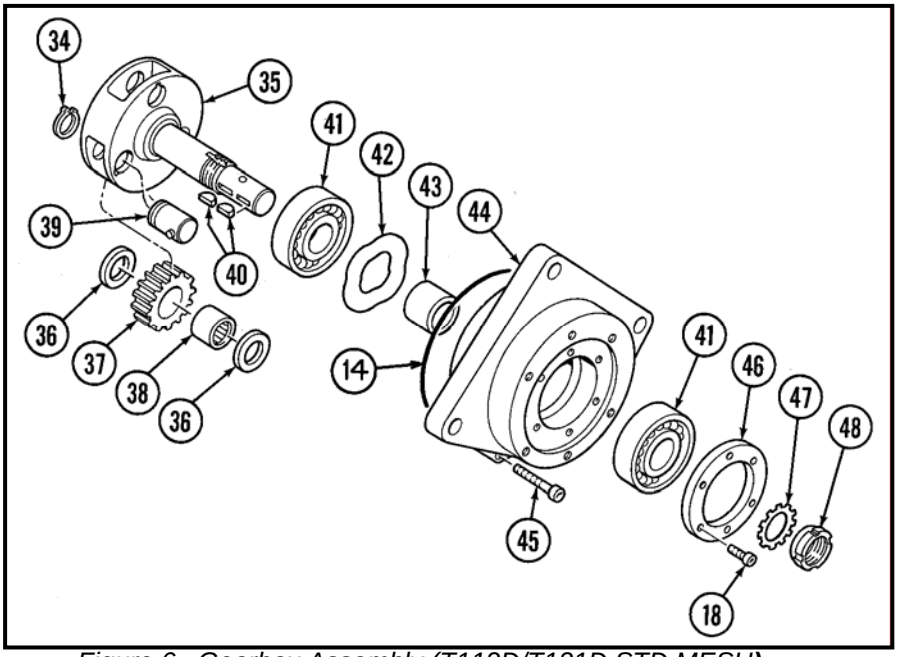


Figure 6. Gearbox Assembly (T112D/T121D STD MESH)

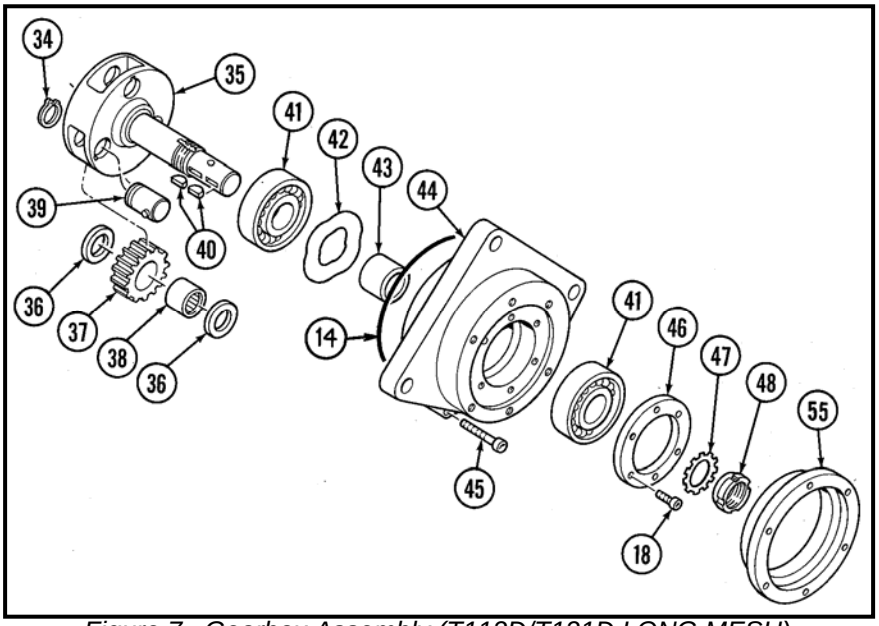


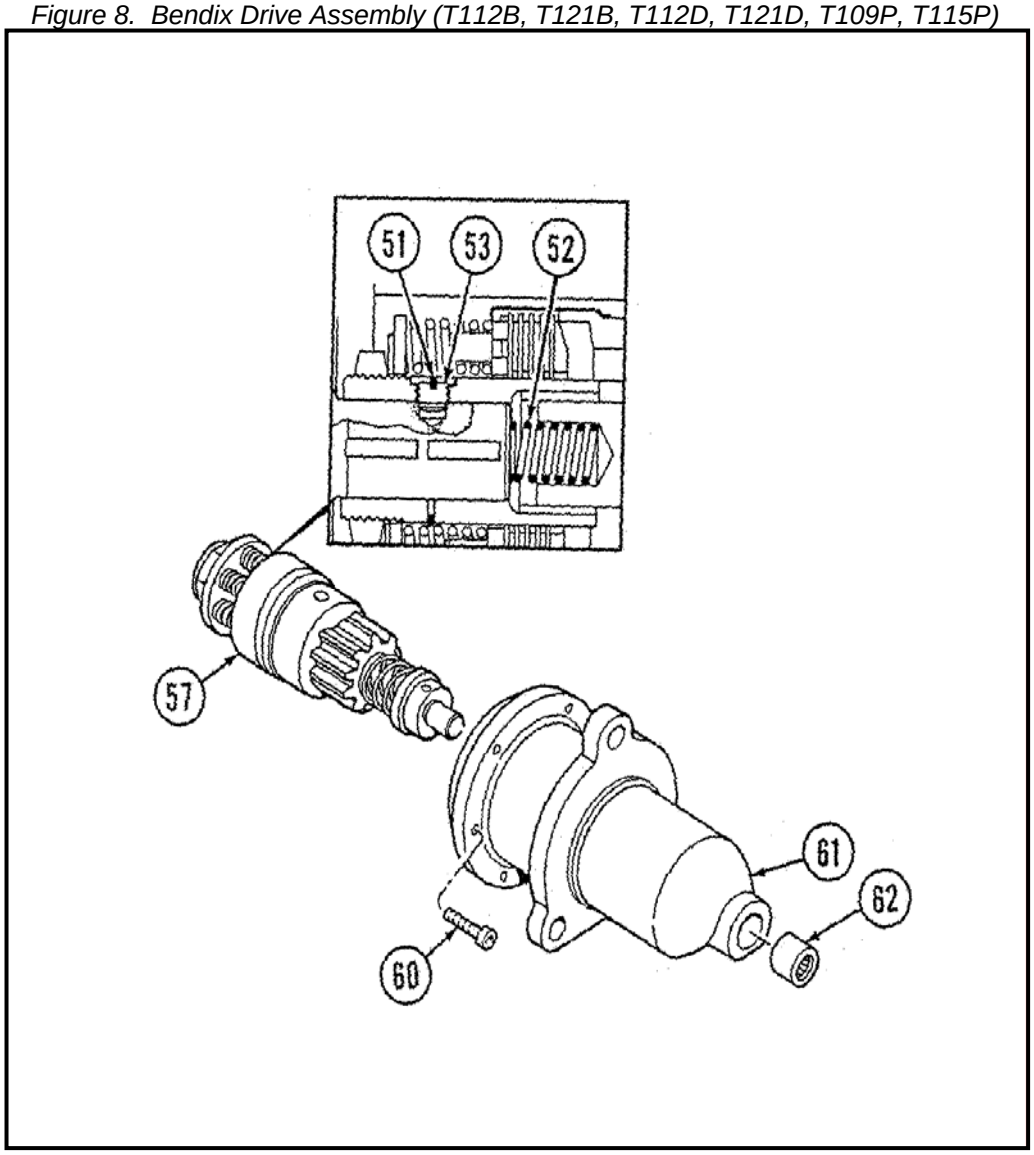
Figure 7. Gearbox Assembly (T112D/T121D LONG MESH)

2.4 BENDIX DRIVE ASSEMBLY

The Bendix drive assembly, refer to figure 8, consists of an inertial engagement drive or “bendix” (57) and drive housing (61). The bendix is mounted to the output shaft with two keys and a retaining set screw (53).

The other end of the drive unit is mounted into a needle bearing (54), which is installed in the nose of the drive housing.

Figure 8. Bendix Drive Assembly (T112B, T121B, T112D, T121D, T109P, T115P)



SECTION 3.0 DISASSEMBLY

3.1 GENERAL

Always mark adjacent parts on the starter housing; Nozzle 2/ Containment Ring (13), Turbine Housing (26), Gearbox Housing (58), and Bendix Drive Housing (61) 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 series starter. Never use old seals or o-rings.

The tools listed in *Table 1* are suggested for use by technicians servicing the Turbotwin T100 series starters. 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	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 Series Service Tools

3.2 DRIVE HOUSING
(T112B,T121B,T109P,T115P)

3.2.1 Removal of Drive Housing

Mark position of bendix pinion opening relative to gearbox housing for reference during reassembly. Remove the six bolts (60) and lock nuts (59). Pull drive housing (61) from gearbox housing (58). If drive housing is too tight, tap it with a mallet to loosen.

3.2.2 Removal of Bendix Drive

In loaded spring area of drive (57) remove retaining ring (51) from set screw (53) slot.

Remove set screw using a flat head screwdriver, *Figure 9* and pull the bendix assembly from the starter carrier shaft. Remove spring (52). This spring fits loosely between the bendix assembly and carrier shaft. Remove the needle bearing (62), if necessary, by simply tapping out the “welch” plug from the front of the drive housing and press bearing out.

3.3 DRIVE HOUSING
(T112D/T121D)

3.3.1 Removal of Drive Housing

Remove the six screws (22). Mark position of bendix pinion opening relative to gearbox housing for reference during reassembly. Pull drive housing (49) from gearbox housing (44). If drive housing is too tight, tap it with a mallet to loosen.

3.3.2 Removal of Bendix Drive

In loaded spring area of drive (57) remove retaining ring (51) from set screw (53) slot.

Remove set screw using a flat head screwdriver, *Figure 9, and* pull the bendix assembly from the starter carrier shaft.

Remove spring (52). This spring fits loosely between the bendix assembly and carrier shaft. Remove the needle bearing (62), if necessary, by simply tapping out the “welch” plug from the front of the drive housing and press bearing out.

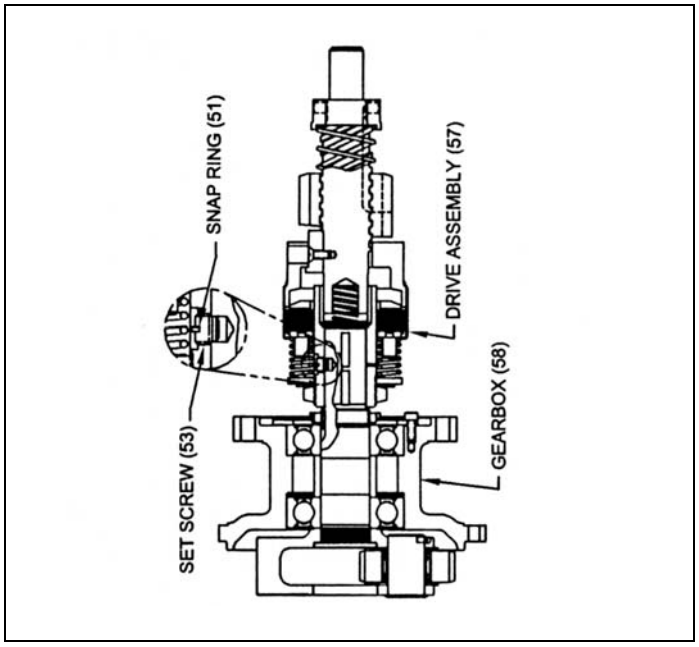


Figure 9. Bendix Drive Removal

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3.4 DRIVE/GEARBOX HOUSING
(*T106F/T112F)*

3.4.1 Removal of Drive Housing

Mark position of bendix pinion opening relative to turbine housing (26) for reference during reassembly. Per *Figure 10,* remove the six screws (27). Pull drive housing (69) from turbine housing. If drive housing is too tight, tap it with a mallet to loosen.

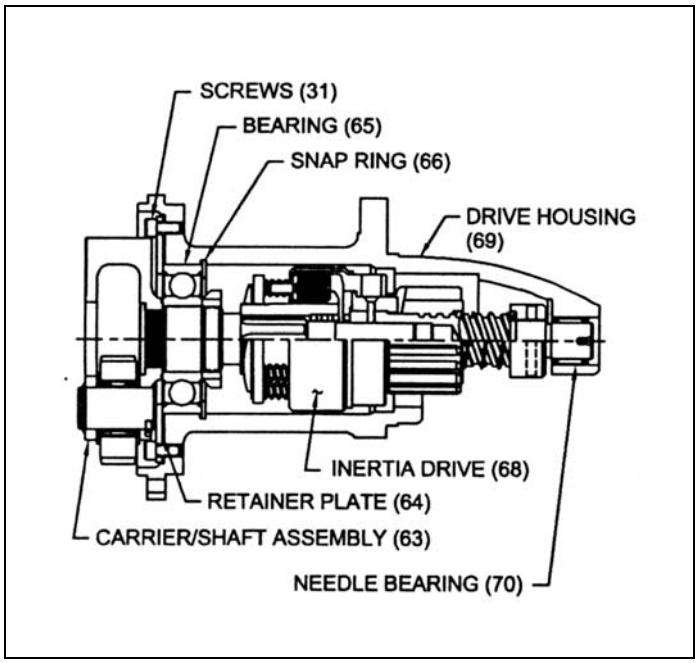

Figure 10. Bendix Drive Removal (T106F/T112F)

3.4.2 Removal of Bendix Drive

Remove four screws (31). Pull carrier shaft assembly (63) from drive housing (69). The bendix (68) will remain in the drive housing. With snap ring tool, remove snap ring (66) and bendix drive (68)from drive housing.

If it is necessary to remove needle bearing (70) from drive housing, simply press bearing out.

Mount the carrier shaft assembly on the TDI holding tool P/N 52-20202 placing the three holes on the gearbox over the dow pins. *Refer to Figure11*.

Place TDI tool P/N 52-21345 (Spanner Wrench) over shaft and into slots of retainer nut (67). Hold down carrier shaft and remove nut.

Remove bearing (65) from shaft by pressing shaft while supporting inner race of bearing. Remove bearing retainer plate (64).

3.4.3 Planet Gear Disassembly

Remove snap ring (34) from planet shaft (39) using snap ring pliers and push shaft through holes in assembly.

Slide the planet gear (37) out from the carrier shaft and remove the two nylon spacer (36). Unless the needle roller bearings 38) are damaged, do not remove. If removal is necessary, simply press bearing out.

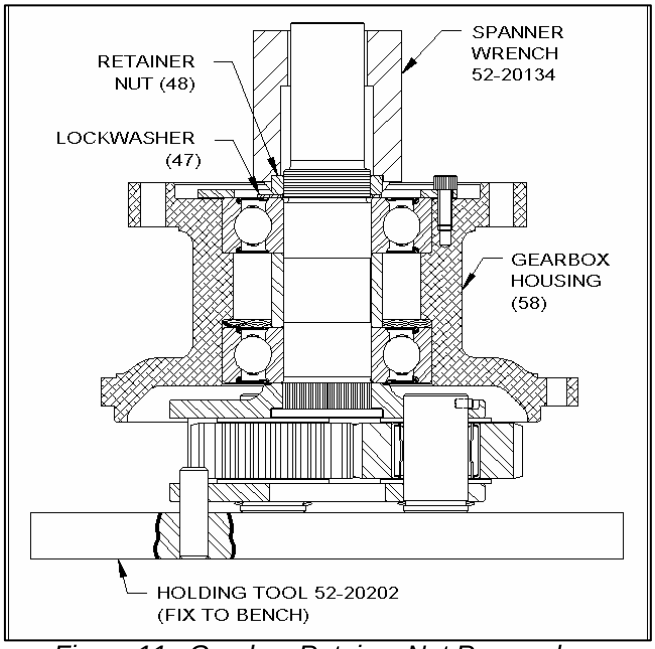

Figure 11. Gearbox Retainer Nut Removal

3.5 GEARBOX HOUSING
(*T112B/T121B,T112D/T121D,T109P/T115P)*

* The drive housing removal procedure should be performed before performing this procedure.

3.5.1 Removal of Gearbox Housing

Remove the six screws (27) and lift the gearbox assembly from the turbine assembly. If the gearbox assembly is too tight, tap it with a mallet to loosen).

3.5.2 Gearbox Disassembly

Mount the gearbox on the TDI holding tool P/N 52-20202 placing the three holes on the gearbox over the dow pins. *Refer to Figure 11*.

Remove woodruff keys (40) from shaft by tapping them with a chisel and hammer

With screwdriver remove tang of lockwasher (47) from slot of retainer nut (48).

Place TDI tool P/N 52-20134 (Spanner Wrench) over shaft and into slots of retainer nut. Hold gearbox down and remove nut.

In most cases the gearbox housing (58, D-44) can be removed from the carrier shaft (35) by holding shaft down and pulling directly up on housing. If this is not the case, press carrier shaft from housing per *Figure 12*.

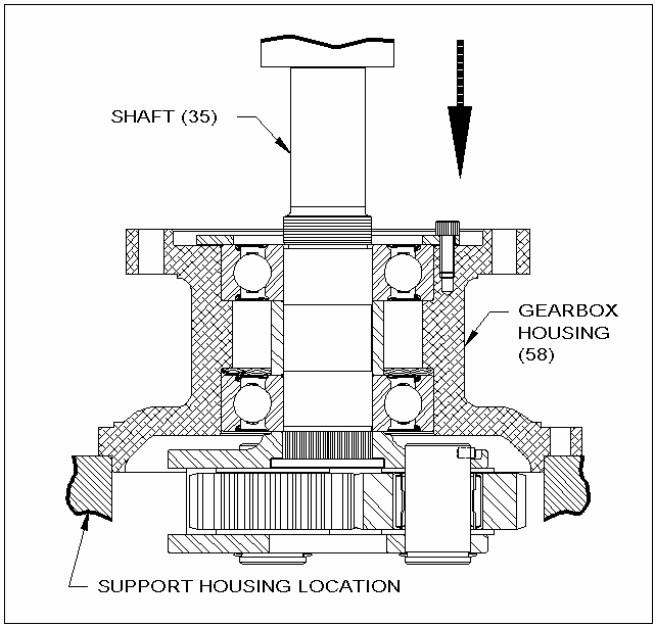

Figure 12. Pressing Out Carrier Shaft

The aft bearing (41), spring washer (42), and bearing spacer (43) will come out with the shaft. Remove aft bearing (41) from shaft by pressing shaft while supporting bearing.

If the aft bearing (41) is retained in the gearbox housing when the carrier shaft is removed, apply pressure through housing to the bearing to remove it. It will be necessary to elevate the housing with a brace to remove the bearing completely.

Remove the six screws (18) and retainer plate (46). The front bearing may then be removed by lightly tapping.

3.5.3 Planet Gear Disassembly

Remove snap ring (34) from planet shaft (39) and push shaft through holes in assembly.

Slide the planet gear (37) out from the carrier shaft and remove the two nylon spacer (36). Unless the needle roller bearings 38) are damaged, do not remove. If removal is necessary, simply press bearing out.

3.6 TURBINE HOUSING

3.6.1 Stage 2 Rotor Removal

Remove the six screws (27) that connect the gearbox assembly to the turbine housing and separate the two assemblies. Remove the four screws (18) and the clamping plate (32).

Turn the turbine to the (exhaust) end up and remove the six screws (1), screen support ring (2), and the screen (3). For the T109P, remove six screws (74) and Exhaust Cover Housing (75).

Hold the stage 2 rotor (6) and remove the turbine screw (4) and washer (5).

Install the rotor puller tool P/N 52-20076 and remove the stage 2 rotor per *Figure 13*.

Remove the woodruff key (7) using a hammer and chisel.

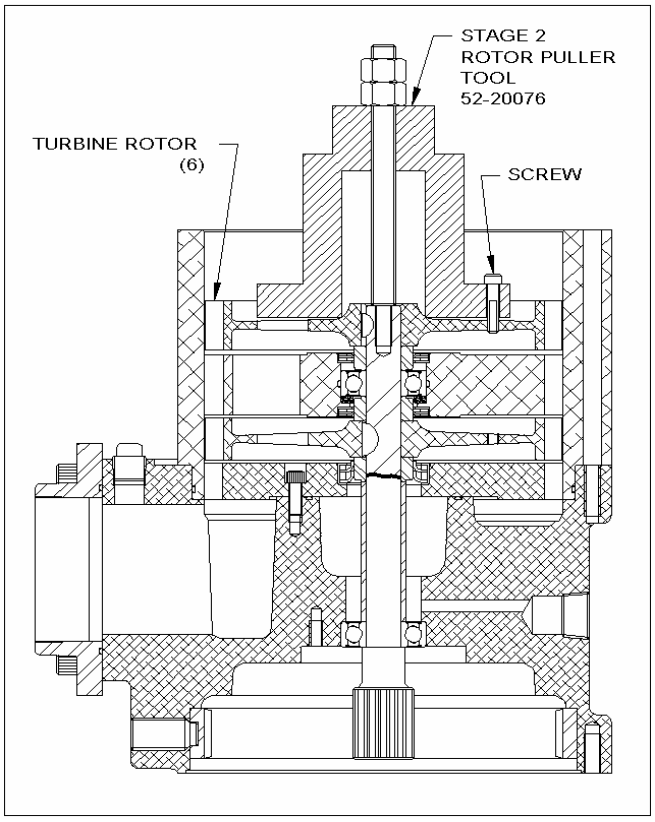

Figure 13. Turbine Rotor Removal

3.6 Turbine Shaft Removal

Using the shaft removal tool P/N 2-26945 per figure 14, press on the turbine shaft (33) while supporting the turbine housing.

Press the shaft assembly (33) through the aft bearing (10) and continue pressing until the shaft assembly is completely out of the housing (26).

Remove the woodruff key (16), seal spacer (8), bearing spacer (30), and bearing (10) from the shaft. The bearing can be removed from the shaft by pressing the shaft through the bearing. Note that if T100 is the original design *(SN: 9501-239 to9611-191),* the bearing will be pressed inside a spacer.

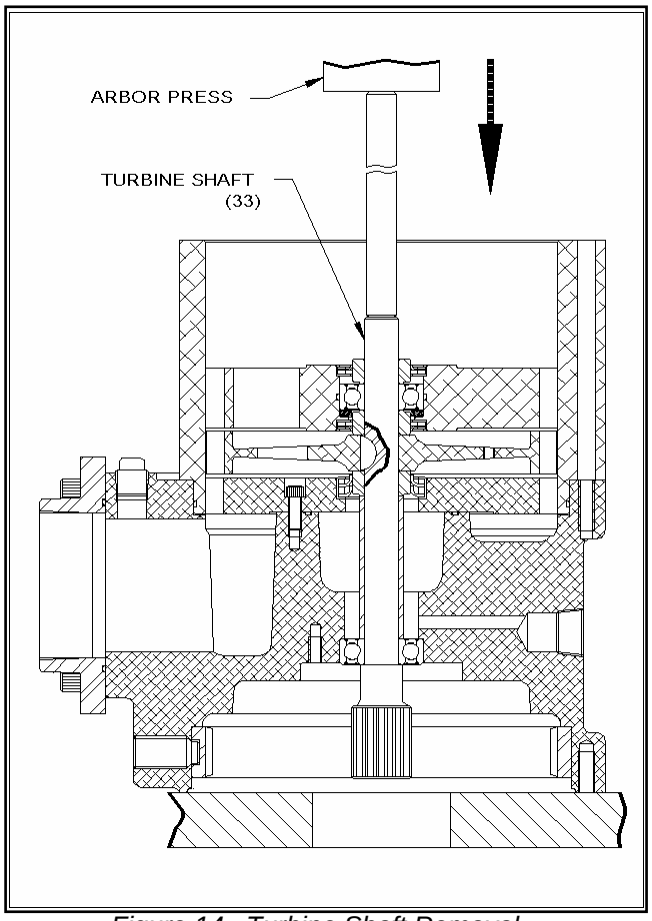

Figure 14. Turbine Shaft Removal

Separate the stage 2 nozzle assembly (13) from the turbine assembly (26) 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. Refer to *Figure 15*.

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 them while removing nozzle 2.

The stage 1 rotor (15) may now be removed.

Remove the four screws (18) and nozzle 1 (19) from the turbine assembly. It may be necessary to tap the screws with a hammer and chisel to loosen.

On the stage 2 nozzle (13), remove the seal spacer (8) from the forward side of the nozzle. Place the stage 2 nozzle on the exhaust end. Press through the lip seal onto the bearing until it, including the 2nd lip seal and seal spacer disengages from the nozzle. Turn the nozzle over and press on the lip seal to remove.

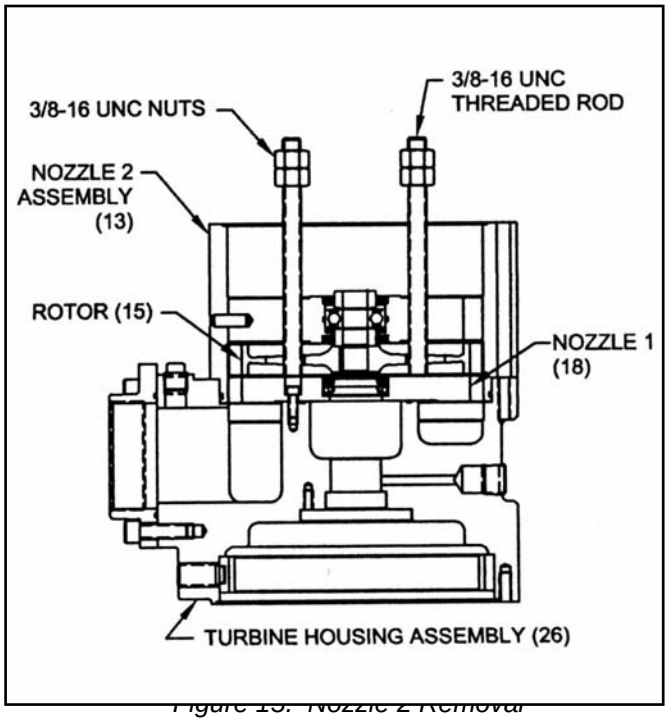

Figure 15. Nozzle 2 Removal

SECTION 4.0 CLEANING and INSPECTION

4.1 CLEANING

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

NOTE

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

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 (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 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)
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 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

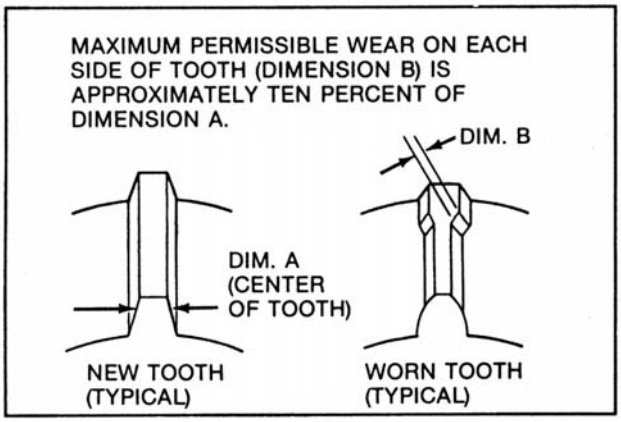

Figure 16. Gear Teeth Wear Allowances

SECTION 5.0 ASSEMBLY

5.1 GENERAL

The tools listed in *Table 1* are suggested for use by technicians servicing the T100 Series 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 Series starter is reassembled. These parts are included in the overhaul kits 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 Series 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 (10) onto the shaft (33) until seated. Support the shaft and press on the inner race only with press tool P/N 2-26943 per *Figure 17.* Note that if

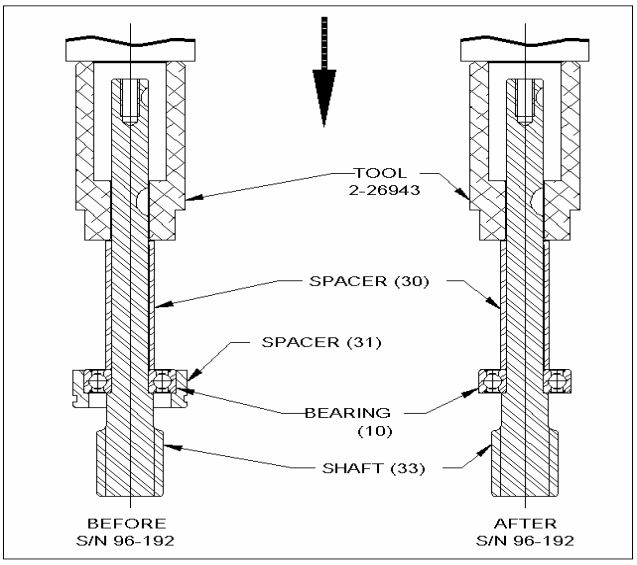

Figure 18. *Pressing Spacer onto Bearing*

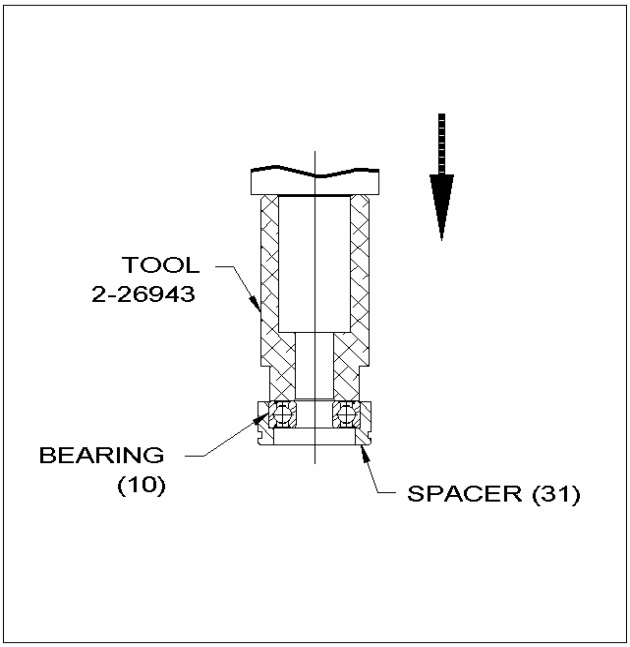

Figure 17. Pressing Front Turbine Bearing

T100 is the original design (SN: 9501-239 to 9611-191), press the spacer (31) onto the outer race of the bearing (10) per *Figure 18* by supporting the bearing outer race, and then press the bearing/spacer (10, 31) onto the shaft.

Press the bearing/shaft assembly, keyway end first, into bearing housing of the turbine housing. Use press tool P/N 2-26943 if required per *Figure 19. D*o not press on the end of the shaft because the load could damage the balls of the bearing.

Install bearing retainer plate (32) and secure with four screws (18). Torque screws to 30 in-lbs.

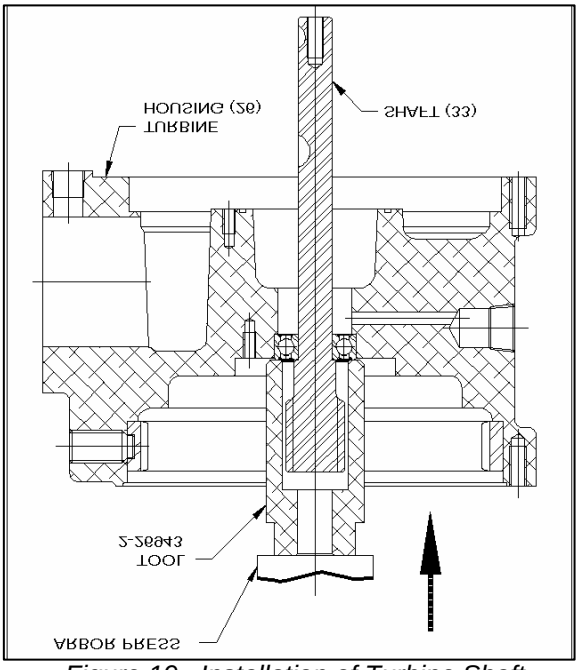

Figure 19. Installation of Turbine Shaft

Place turbine housing front surface (sungear end) on flat surface. Install long bearing space (30) over shaft.

Install the seal spacer (8) onto the shaft. Note the small end of the spacer faces the long bearing spacer.

Install the O-ring (21) into the aft face of the turbine housing (26).

5.2.2 Nozzle 1 Installation

Press the aft seal (17) into nozzle 1 (19) using press tool P/N 2-26943 per *Figure 20* with the lips facing up.

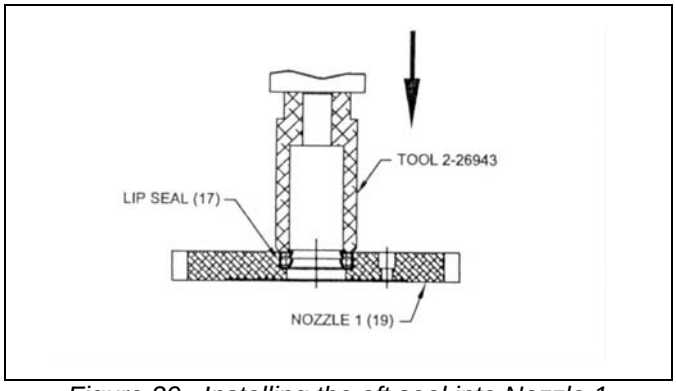

Figure 20. Installing the aft seal into Nozzle 1

Install nozzle 1 onto the turbine housing (26). Orient the nozzles facing the air inlet (23). Install four screws (18) to secure the nozzle. Do not tighten the screws at this time.

5.2.3 Rotor 1 Installation

Install the woodruff key (large key) (16) for stage 1 rotor into the shaft (33).

Install the stage 1 rotor (15), 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.

Temporarily install Nozzle 2 on the turbine housing. Tighten the four screws that secure nozzle 1 (18) to 30 in-lb. The four screws can be accessed via the holes in nozzle 2 and the first stage turbine rotor. Remove Nozzle 2 when the four screws are tight.

5.2.3 Nozzle 2 Installation

Press the lip seal (9) into the forward side of nozzle 2 with seal lip facing up. Use press tool P/N 2-26943.

Install the O-ring (11) into the bearing bore of nozzle 2 (13). DO NOT LUBRICATE THIS O-RING.

Install O-ring (14) onto the outer diameter of nozzle 2.

Install nozzle 2 (13) onto the turbine housing (26). The three flats of nozzle 2 are always oriented opposite the turbine housing air inlet (SN 9505-213 to 9611-191).

Install the seal spacer (8) onto the shaft with the small end facing the aft bearing (10).

Install the wavy spring washer (12) into the bearing bore of the stage 2 nozzle.

Support the sun gear end of the shaft. Press the aft bearing (10) onto the shaft by pressing onto the inner and outer race simultaneously. Use press tool per *Figure 21*. Press until bearing is seated.

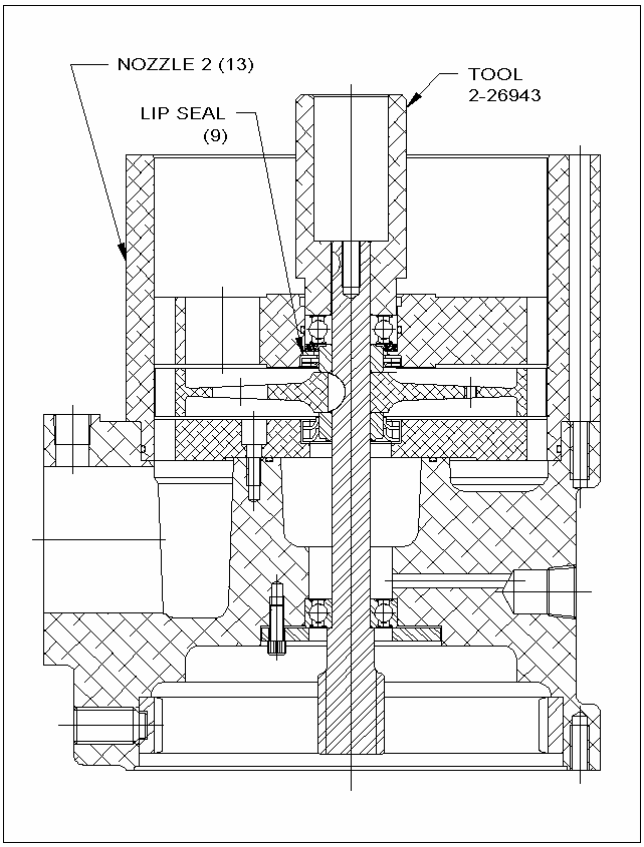

Figure 21. Pressing Aft Bearing onto Shaft

Install the seal spacer (8) with the small end facing the aft bearing (10).

Press the lip seal (9) into the stage 2 nozzle using press tool P/N 2-26943 with lip seal facing up.

Install the stage 2 woodruff key (7) into the shaft (33).

5.2.4 Stage 2 Rotor Installation

Install the stage 2 rotor (6) onto the shaft. 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 can be installed backwards.

Install the rotor washer (5) and secure with screws (4). Tighten screw to 100 in-lb.

Install the exhaust screen (3) and back plate (2). Secure with six screws (1). Tighten the screws to 80 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 170 in-lb.

Mark the number of stage 1 nozzles (usually 6, 12,or 21) onto the O.D. of the unit for identification of the unit prior to name plate installation.

5.3 GEARBOX HOUSING

(T112B/T121B, T112D/T121D, T109P/T115P)

5.3.1 Planetary Gear Carrier Reassembly

If disassembled, press needle bearing (38) into planet gears (37). 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 (36) on each side of gear, slide gear into carrier shaft slots (35), and align with pin holes.

Lightly slide plant shafts into aligned holes, making sure snap ring groove on end of pins goes in first per *Figure* 22.

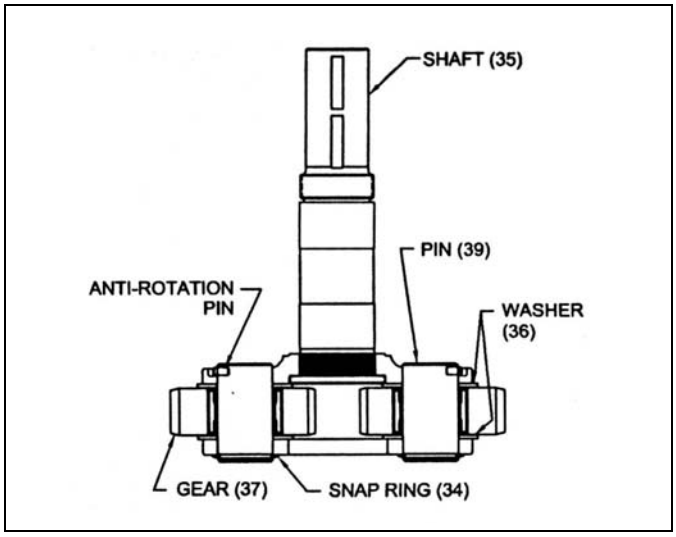

Figure 22. Planet Gear Carrier Shaft Assembly

NOTE

Make sure that anti-rotation pins on shafts are properly located in retaining slots of carrier shaft (35).

Install snap ring (34) with a snap ring tool.

5.3.2 Gearbox Reassembly

Press the bearing (41) into the forward side of the gearbox housing (58, D-44). Pressing force should be on the outer race only.

Install retainer plate (46) and secure with six screws (18).

Press rear bearing (41) onto carrier shaft (35) using TDI Tool P/N 52-20143 per *Figure 23*. Pressing force should be on the inner race of bearing.

Install spring washer (42) and bearing spacer (43) onto shaft and locate against bearing.

Position carrier shaft assembly (35,41,42,43) into bearing bore of the gearbox housing (58). Lift up on housing and slide shaft down. If shaft will not slide into bearing bore, press housing per *Figure 24* until bearing is seated (41).

Place gearbox assembly on TDI Tool P/N 2-20202 per *Figure 25*. Install lockwasher (47) and then retainer nut (48). Torque to 600-800 in-lb. Tang lockwasher into retainer nut slot.

Place O-ring (14) onto outer diameter of gearbox assembly.

Thoroughly grease planet gears, ring gear and sun gear using the grease specified in *Table 5* and pack the center of the gears with grease.

5.3.3 Gearbox to Turbine Housing Assembly

Rotate carrier shaft (35) slightly, and at the same time, align gearbox into the front of turbine housing (26).

Install six screws and torque 90-120 in-lbs.

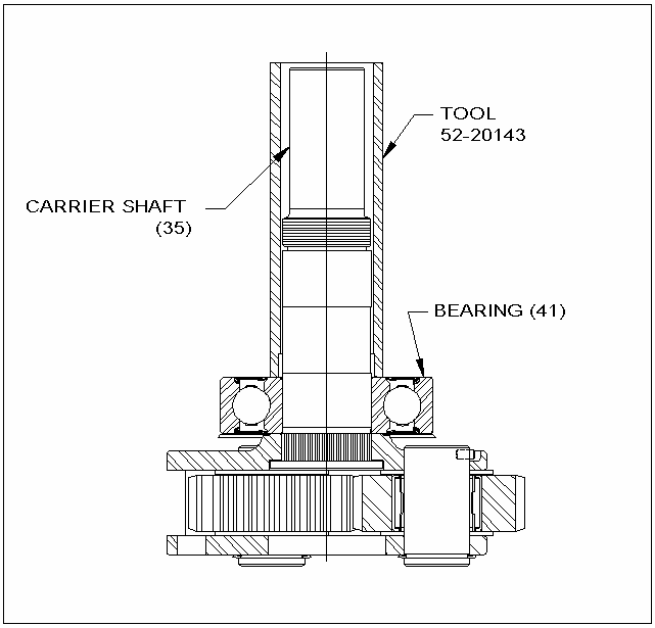

Figure 23. Pressing Rear Bearing onto Carrier Shaft

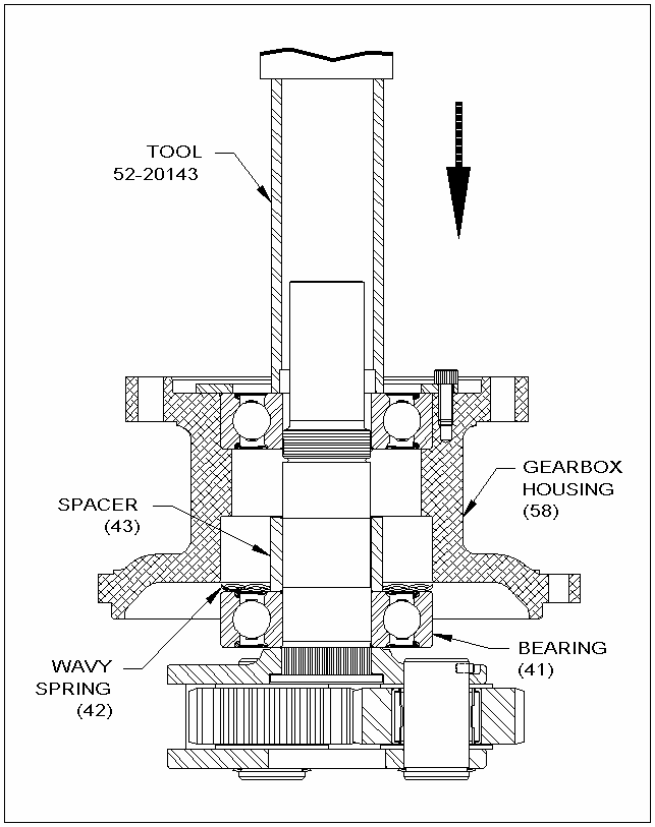

Figure 24. Installing Carrier Shaft into Gearbox Housing

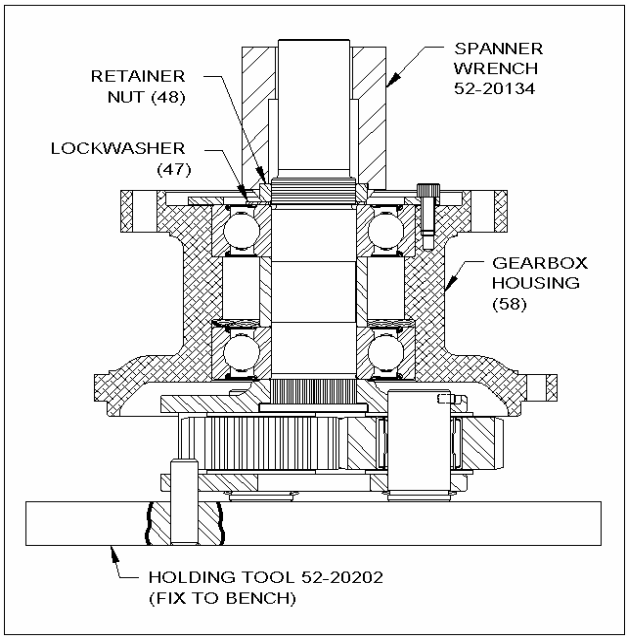

Figure 25. Tightening Retainer Nut

5.4 DRIVE HOUSING
(T112B/T121B, T112D/T121D, T109P/T115P)

5.4.1 Bendix Drive Installation

Install two woodruff keys (40). Ensure keys are properly installed per *Figure 26*.

Position bendix assembly (57) on shaft with retainer set screw (53) removed. Install spring (52) between bendix cavity and end of output shaft. Slide bendix over shaft until set screw hole aligns with set screw hole in shaft.

Install set screw and tighten firmly. Slip retainer (51) ring into set screw slot.

5.4.2 Bendix Drive Housing Installation

If disassembled, press needle bearing (62, P-80) into drive housing (61) until flush with bottom surface.

Mount drive housing over bendix drive, and align holes for desired bendix opening orientation with starter inlet connection. Torque bolts and nuts to 90-120 in-lbs.

5.5. DRIVE/GEARBOX HOUSING
(T106F/T112F)

5.5.1 Planetary Gear Carrier Reassembly

If disassembled, press needle bearing (38) into planet gears (37). 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 (36) on each side of gear, slide gear into carrier shaft slots (63), and align with pin holes.

Lightly slide plant shafts (39) into aligned holes, making sure snap ring groove on end of pins goes in first.

NOTE

Make sure anti-rotation pins on shafts are properly located in the retaining slots of the carrier shafts (63).

5.5.2 Planetary Carrier Bearing Installation

Install bearing retainer plate (64) over carrier shaft (63)

Press bearing (65) onto shaft making sure pressing force is on inner race of bearing only.

Place carrier shaft assembly onto TDI Tool P/N 52-20202, see Figure 27. Thread retainer nut (67) onto shaft (63). Hold carrier assembly down and torque nut to 600-800 lb.-in. with spanner wrench, TDI Tool P/N 52-21345.

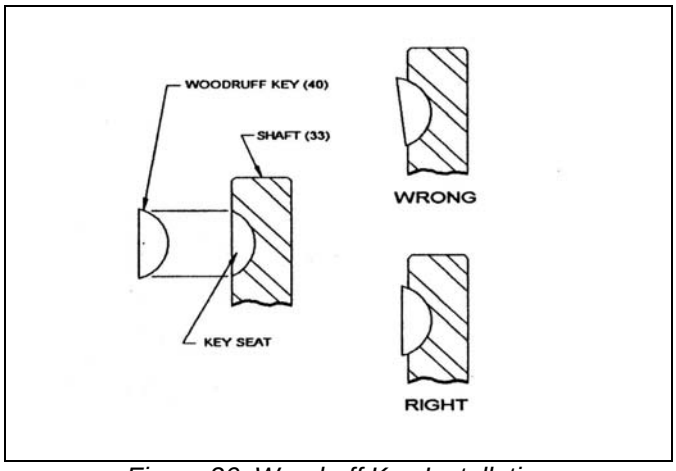

Figure 26. Woodruff Key Installation

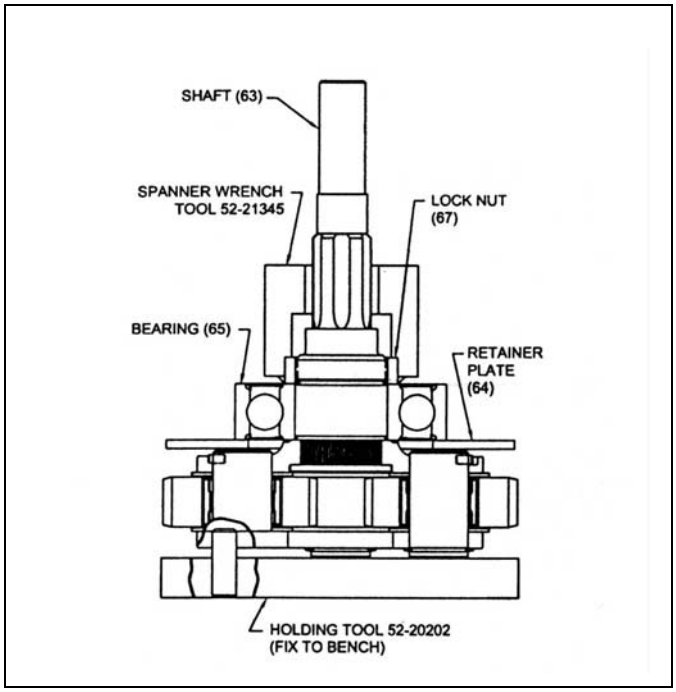

Figure 27. Tightening Retainer Nut (T106F, T112F)

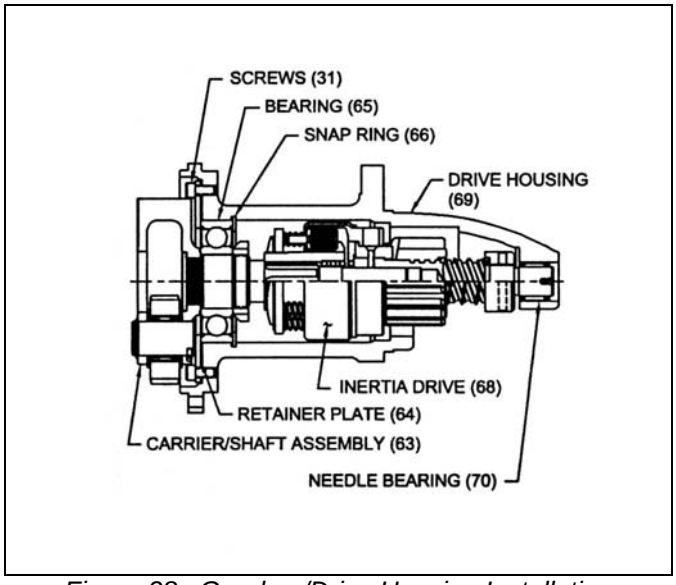

Figure 28. Gearbox/Drive Housing Installation (T106F/T112F)

5.5.3 Bendix Drive Installation

Install bendix drive (68) into drive housing (69), aligning bendix shaft into front needle bearing (70).
With snap ring tool, install snap ring (66)into drive housing (69).

Align carrier shaft assembly (63) into bendix drive and push assembly until seated against snap ring (66) per *Figure 28*.

Install six screws (27) and torque 90 to 120 lb.-in.

SECTION 6.0 PARTS LIST

The components illustrated and/or described in this section are for the Turbotwin T100 series air starters. When rebuilding a T100 series starter, it is recommended to purchase, and completely install the appropriate service kit(s).

Key No.	Description	Part Number	B	D	F	P
1	Screw (6)	11F- 25020-072	✓	✓	✓	
2	Screen Support Ring	2-20831				
3	Screen	2-26148				
4	Screw	19F- 25028-012	✓	✓	✓	✓
5	Washer	9-93047				
6	Rotor 2	2-26604				
7	Woodruff Key	9-90211-006				
8	Seal Spacer (3)	9-93083-001	✓	✓	✓	✓
9	Seal, Lip (2)	2-26719	✓	✓	✓	✓
10	Bearing (2)	9-91224	✓	✓	✓	✓
11	O-ring (2)	9-90001-027	✓	✓	✓	✓
12	Wave Spring Washer	9-90439	✓	✓	✓	✓
13i	Nozzle 2/Containment Ring R.H.	2-27333-00R				
13ii	Nozzle 2/Containment Ring L.H.	2-27333-00L				
14	O-ring	9-90001-050	✓	✓	✓	✓
15	Rotor 1	2-26603				
16	Woodruff Key	9-90211-009				
17	Lip Seal	2-22376	✓	✓	✓	✓
18	Screw (14)	14F-19024-008	✓	✓	✓	✓
19i	Nozzle 1, R.H. 21 Noz	2-26718-21R				
19ii	Nozzle 1, L.H. 21 Noz	2-26718-21L				
19iii	Nozzle 1, R.H. 12 Noz	2-26718-12R				
19iv	Nozzle 1, L.H. 12 Noz	2-26718-12L				

Key Number	Description	Part Number	B	D	F	P
19v	Nozzle 1, R.H. 6 Noz	2-26718-06R				
19vi	Nozzle 1, L.H. 6 Noz	2-26718-06L				
20	Pipe Plug	9-93556-004				
21	O-ring	9-90001-034	✓	✓	✓	✓
22	Screw (6) or (12 for T112D/T121D std)	14F-31218-016	✓	✓	✓	✓
23	Inlet Flange	1-18967				
24	O-ring	9-90001-037	✓	✓	✓	✓
25	Set Screw (See Note 1)	52F-50013-016				
26	Turbine Housing (See Note 1)	2-27045				
27	Screw (6)	14F-25020-016	✓		✓	✓
28	Pipe Plug	9-93501-004				
29	Ring Gear (See Note 1)	1-18780				
30	Bearing Spacer	9-93091-001				
31	Screw (4)	14F-25020-008			✓	
32	Clamping Plate	2-26750				
33	Turbine Shaft	2-26554				
34	Retainer Ring (3)	9-92001-001				
35	Planet Gear Carrier Shaft	2P-20156-006				
36	Washer (6)	9-93004				
37	Planet Gear (3)	1-19441				
38	Needle Roller Bearing (3)	9-91004-001	✓	✓	✓	✓
39	Planet Shaft (3)	2P-20182				
40	Woodruff Key (2)	9-90211-019				
41	Bearing (2)	9-91351	✓			

Key	Description	Part Number	B	D	F	P
42	Wave Spring Washer	9-90402-025				
43	Bearing Spacer	9-93007				
44	Gearbox Housing	2-22226				
45	Screw (6)	14F-25020-028		✓		
46	Retainer Plate	1-18817				
47	Lockwasher	9-93061-007				
48	Retainer Nut	9-92127-007				
49	Drive Housing	2-22301				
50i	Inertia Drive Assembly, R.H.	2-22795				
50ii	Inertia Drive Assembly, L.H.	2-22796				
51	Retaining Ring	Included with item 50 or 57				
52	Spring	Included with item 50 or 57				
53	Set Screw	Included with item 50 or 57				
54	Needle Bearing	9-91393				
55	Adapter Plate	2-22794				
56	Screw	14F-31218-020		✓		
57i	Inertia Drive Assembly, R.H.	1-18828				
57ii	Inertia Drive Assembly, L.H.	1-19083				
58	Gearbox Housing	1-18810				
59	Lock Nut (6)	9-92107-015	✓			✓
60	Screw (6)	11F-31218-024	✓			
61	Drive Housing	1-18822				
62	Needle Bearing	9-91005	✓	✓		
63	Carrier Shaft	3P-20858-006				
64	Retainer Plate	2-20855				
65	Bearing	9-91356			✓	

Key	Description	Part Number	B	D	F	P
66	Snap Ring	9-92001-006				
67	Lock Nut	9-92105-008				
68i	Inertia Drive Assembly, R.H.	2-22147				
68ii	Inertia Drive Assembly, L.H.	2-22148				
69	Drive Housing	2-20826				
70	Needle Bearing	9-91380			✓	
71	Washer, Flat	9-93018-011				
72	Nut, Hex	9-92108-003				
73	Cover, Plate	2-20192				
74	Screw (6)	11F-25020-072				✓
75	Housing, Exhaust Cover	2-27069				
76	Spring, Compression	9-90408-016				
77	Post	2-27223				
78	Drive Housing	2-25617				
79	Screw (12)	11F-31218-024				✓
80	Needle Bearing	9-91423				✓

Model	Overhaul Kit for S/N's before: 9611-191	Overhaul Kit for S/N's after: 9611-192
B	T10B-27618	T10B-27634
D	T10D-27619	T10D-27635
F	T10F-27617	T10F-27633
P	T10P-27620	T10P-27636

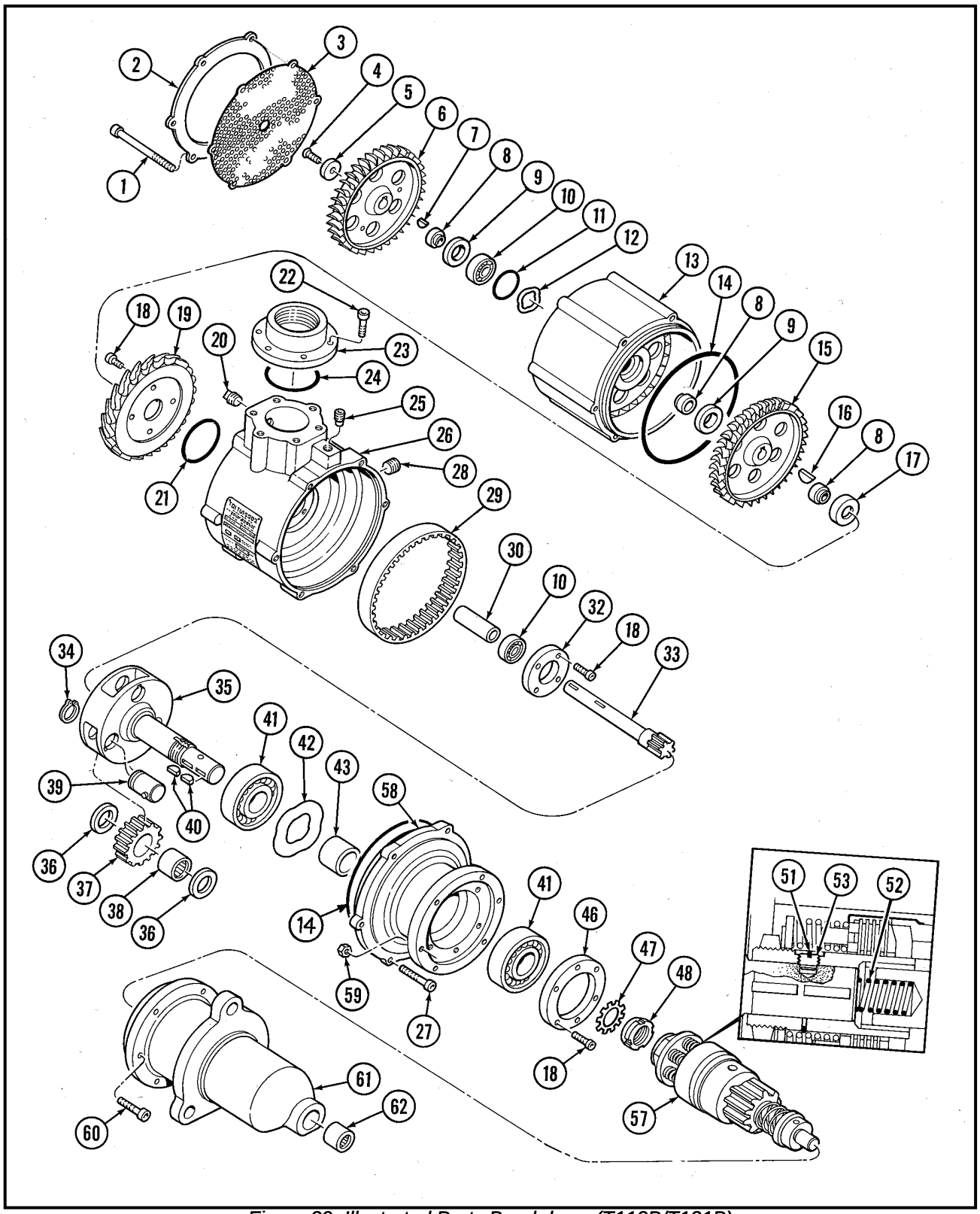

Figure 29. Illustrated Parts Breakdown (T112B/T121B)

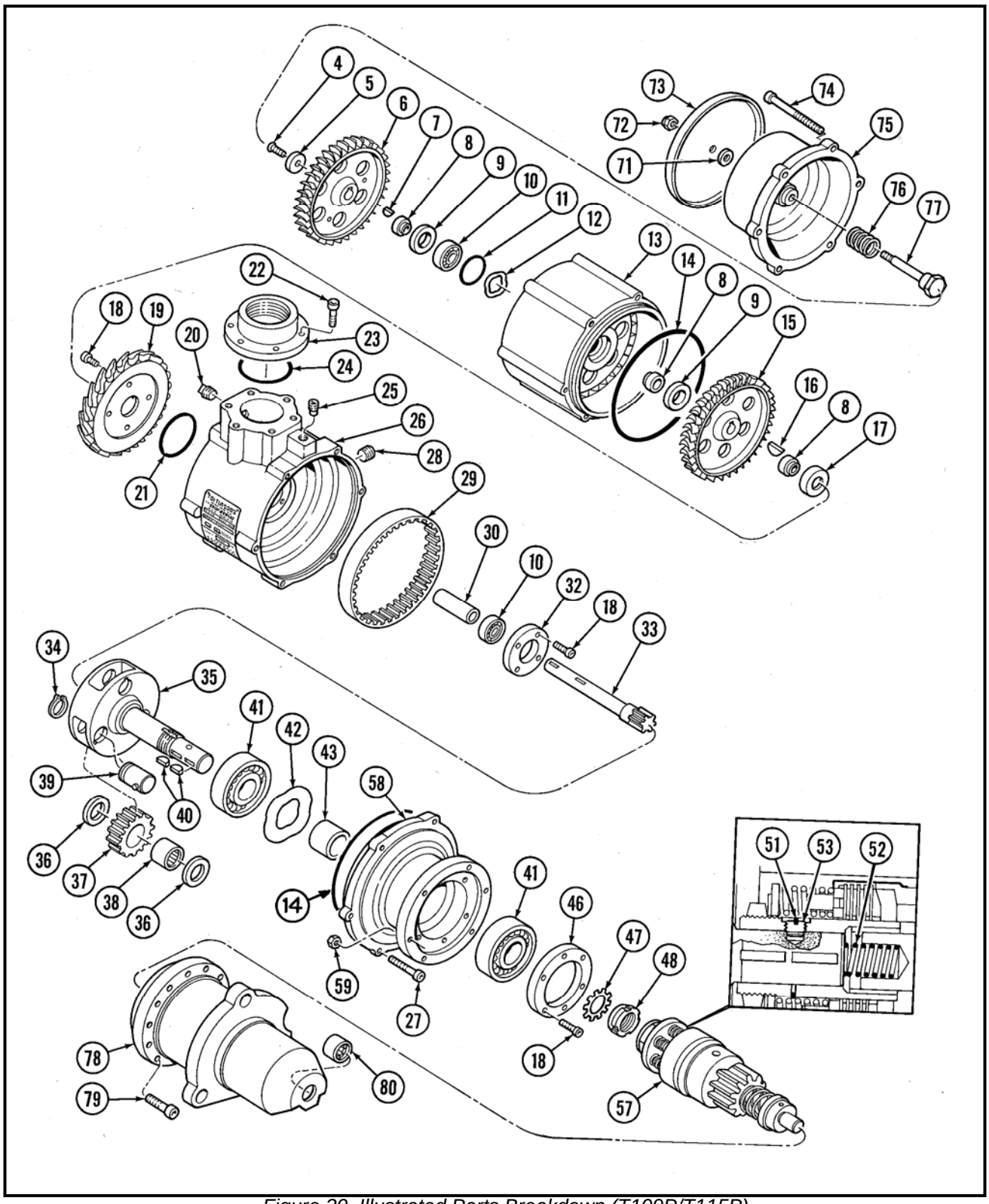

Figure 30. Illustrated Parts Breakdown (T109P/T115P)

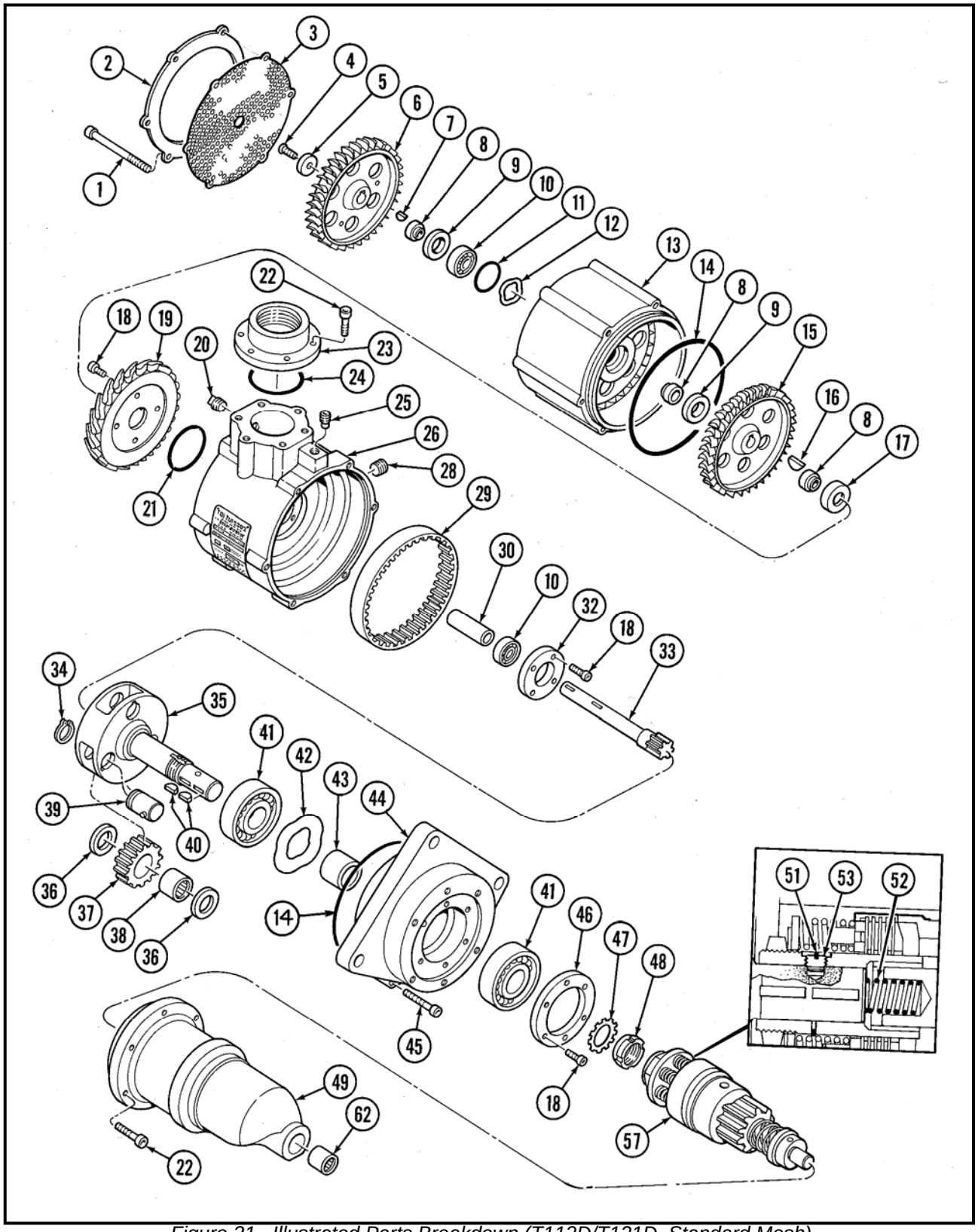

Figure 31. Illustrated Parts Breakdown (T112D/T121D, Standard Mesh)

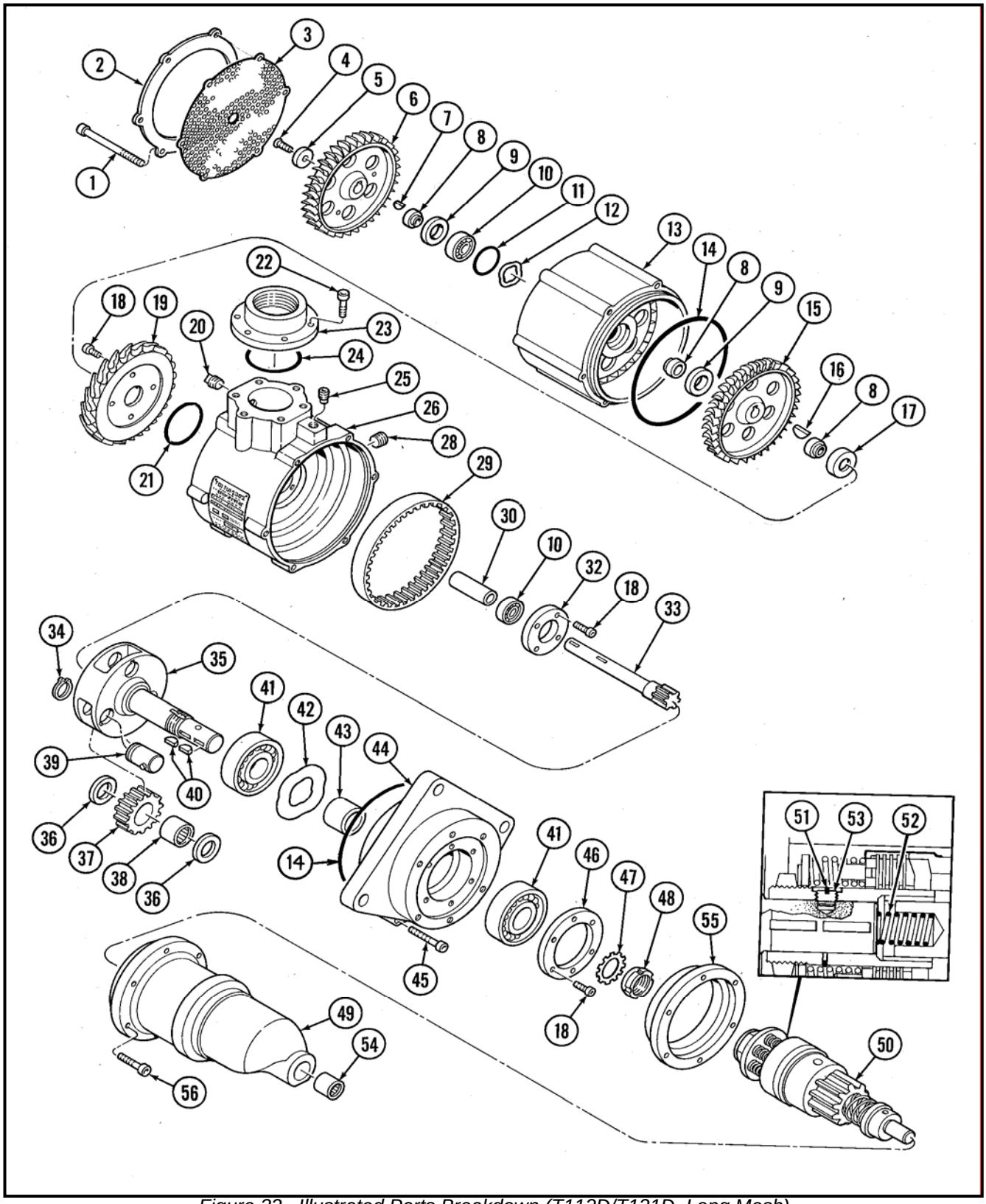

Figure 32. Illustrated Parts Breakdown (T112D/T121D, Long Mesh)

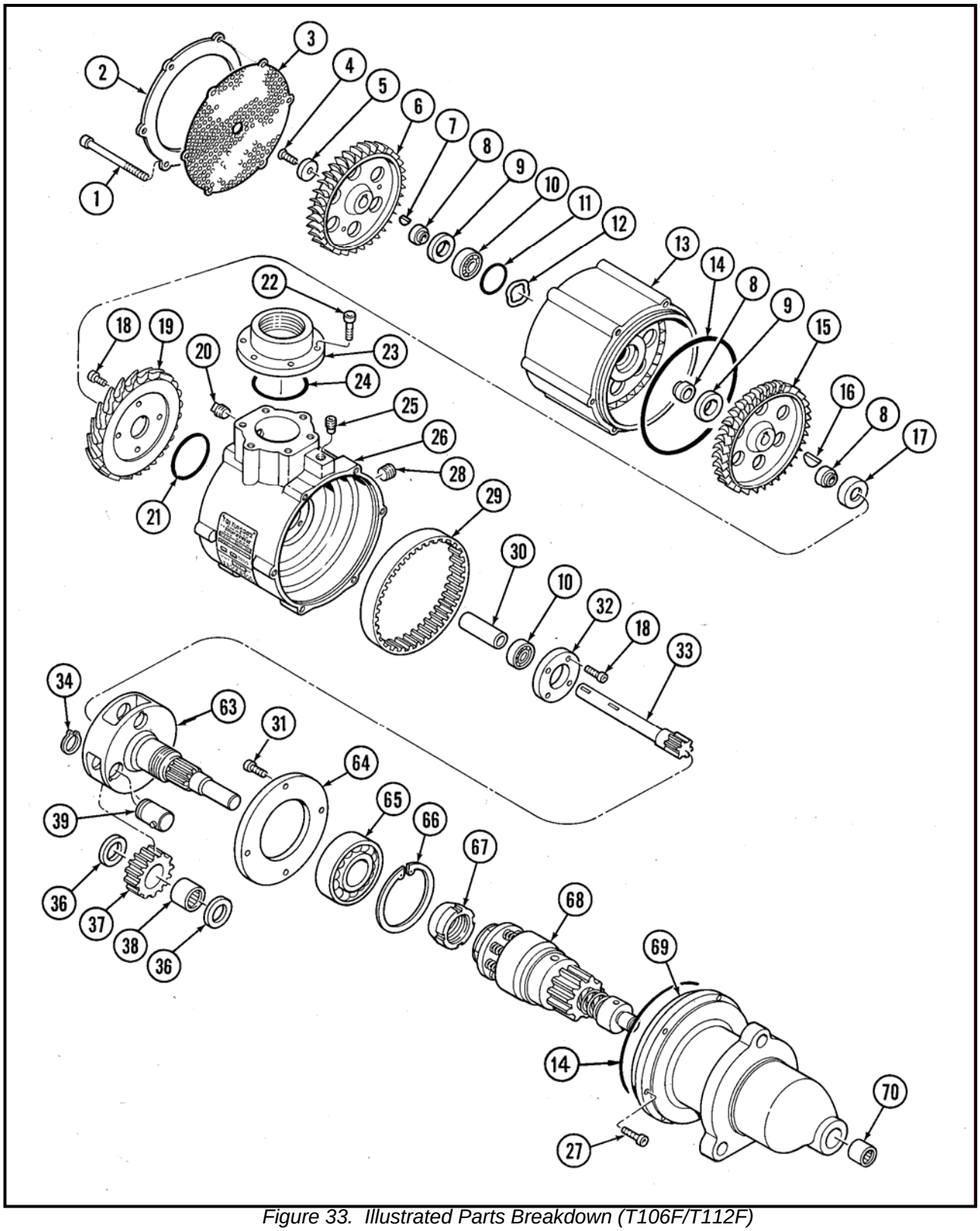

Figure 33. Illustrated Parts Breakdown (T106F/T112F)

SECTION 7.0 ACCESSORIES

SIZE	PART NUMBER
RELAY VALVES	
1½" STAINLESS STEEL (AMOT)	52-93505
2" STAINLESS STEEL (AMOT)	52-93505-100
1½" 316 SST MANUALLY OPERATED	52-93508-300
2" 316 SST MANUALLY OPERATED	52-93508-400
1¼" NPT; BUNA N	RLVA-25683-001-1
1½" NPT; BUNA N	RLVA-25683-001-1-01
1¼" NPT; VITON	RLVA-25683-001-2
1½" NPT; VITON	RLVA-25683-001-2-01
12VDC; 1¼"; BUNA N	RLVA-25683-012-1
12VDC; 1½"; BUNA N	RLVA-25683-012-1-01
12VDC; 1¼"; VITON	RLVA-25683-012-2
12VDC; 1½"; VITON	RLVA-25683-012-2-01
24VDC; 1¼"; BUNA N	RLVA-25683-024-1
24VDC; 1½"; BUNA N	RLVA-25683-024-1-01
24VDC; 1¼"; VITON	RLVA-25683-024-2
24VDC; 1½"; VITON	RLVA-25683-024-2-01
110VDC; 1½"; VITON	RLVA-25683-110-2-01
120VAC; 1½"; VITON	RLVA-25683-120-2-01

PRESSURE REGULATORS	
2" GAS 300	52-93552
2" GAS 125	52-93553
1½" AIR; MAX 1200 SCFM	52-20724-100
2" AIR; MAX 1600 SCFM	52-20724-200

Y-STRAINERS	
1½" CARBON STEEL BODY, #40 MESH, SST SCREEN	52-93549-100
2" CARBON STEEL BODY, #40 MESH, SST SCREEN	52-93549-200
1½" CAST IRON BODY, #40 MESH, SST SCREEN	52-93550-100
2" CAST IRON BODY, #40 MESH, SST SCREEN	52-93550-200

SIZE	PART NUMBER
GAUGES	
REAR CENTER MOUNT	52-21982
U-CLAMP REAR CENTER MOUNT	52-21982-100
BOTTOM MOUNT	52-21982-200

EXHAUST	
3" ELBOW KIT	T100-27015
ECP KIT	T100-27068
MUFFLER KIT (21 NOZ)	T100-27074
MUFFLER KIT (6/12 NOZ)	T100-27075
3" NPT ADAPTER KIT - FEMALE	T100-27651
4" NPT ADAPTER KIT - FEMALE	T100-27652
4" STRAIGHT PIPE KIT	T100-27791
3" ELBOW KIT	T100-27900
EXHAUST ELBOW W/ 3" PIPE WELD FLANGE	T100-28182-001
EXHAUST ELBOW W/OUT WELD FLANGE	T100-28182-002

CONTROL & SOLENOID VALVES	
1/8" NPT STR CONROL VALVE	52-93504
1/4", 24 VDC, CONDUIT	52-21981
1/4", 12 VDC, GROMMET	52-21981-002
1/4", 120 VAC, CONDUIT	52-93506-100
1/4", 120 VAC, GROMMET	52-93506-200
1/4", 24 VDC, CONDUIT	52-93506-300
1/4", 24 VDC, GROMMET	52-93506-400
1/4" 72 VDC	52-93506-500