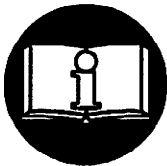


# INSTALLATION AND MAINTENANCE MANUAL

## for

# SERIES TS1401 TURBINE-POWERED STARTERS



### ▲ WARNING

**IMPORTANT SAFETY INFORMATION ENCLOSED.  
READ THIS MANUAL BEFORE OPERATING TOOL.**

**FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.**

- For safety, top performance, and maximum durability of parts, do not operate Series TS1401 Starters at air pressures over the pressure rating stamped on the nameplate. Use supply lines of adequate size as directed in the installation instructions in this manual.
- Always turn off the air or gas supply and disconnect the air or gas supply hose before installing, removing or adjusting any accessory on this starter, or before performing any maintenance on this starter.
- Series TS1401 Starters are designed for gas operation. They are not totally sealed in dynamic operation since the exhaust must be vented or piped away and there is a possibility of leakage around the output shaft when rotating.
- Caution should be taken when operating these starters on gas because of the danger of fire, explosion, or inhalation. After assembling a starter, always test in accordance with the procedures outlined in this manual. Never install a reassembled starter that has not been tested in accordance with the procedures in this manual.
- Operate this starter only when properly installed on the engine.
- Do not lubricate starters with flammable or volatile liquids such as kerosene or jet fuel.
- For personal protection, do not remove any labels. Replace any damaged label.
- Use only recommended Ingersoll-Rand accessories.

### NOTICE

The use of other than genuine Ingersoll-Rand replacement parts may result in safety hazards, decreased starter performance, and increased maintenance, and may invalidate all warranties.

Ingersoll-Rand is not responsible for customer modification of starters for applications on which Ingersoll-Rand was not consulted.

Repairs should be made only by authorized trained personnel. Consult your nearest Ingersoll-Rand Authorized Servicenter.

It is the responsibility of the employer to place the information in this manual into the hands of the operator.

Refer All Communications to the Nearest  
Ingersoll-Rand Office or Distributor.

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**ENGINE STARTING SYSTEMS**

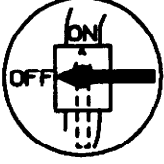
## WARNING LABEL IDENTIFICATION


### ⚠ WARNING

FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.

	<b>⚠ WARNING</b>
	Always wear eye protection when performing maintenance on this starter.

	<b>⚠ WARNING</b>
	Always wear hearing protection when testing this starter.

	<b>⚠ WARNING</b>
	Always turn off the air supply and disconnect the air supply hose before installing, removing or adjusting any accessory on this starter, or before performing any maintenance on this starter.

	<b>⚠ WARNING</b>
	Do not use damaged, frayed or deteriorated air hoses and fittings.

## MODEL TS1401 TURBINE-POWERED STARTER OPERATING GUIDELINES

### ⚠ WARNING

Never exceed the Nameplate pressure rating.

### ⚠ WARNING

Always release the start button immediately after the engine starts.

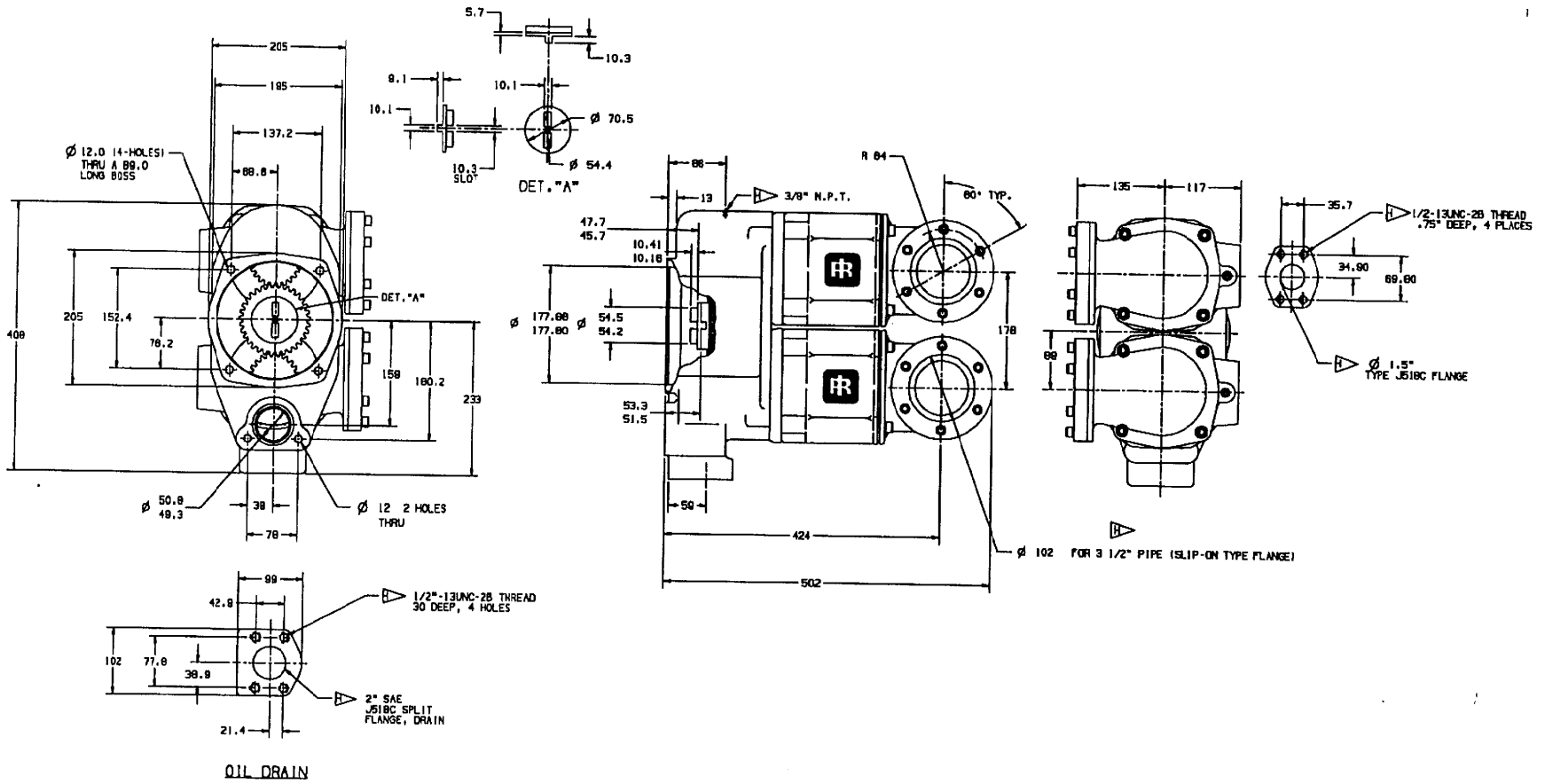
### NOTICE

(2) ST900-267-24 Strainer or equivalent is required for all turbine starters.

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4



(Dwg. TPA1470-1)

## PLACING STARTER IN SERVICE

The Ingersoll-Rand Starter is a precision piece of equipment intended to give efficient, economical performance over a long period of time. However, as with any product, performance, economy and durability are determined for the most part by a few simple common sense procedure that can be recommended only by the manufacturer and adhered to only by the customer.

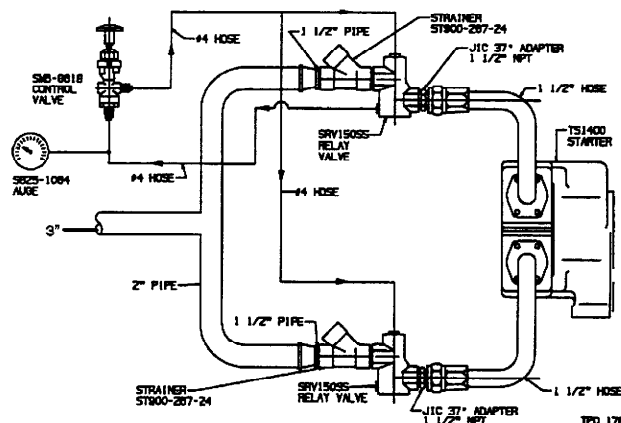
The recommendations outlined in this manual are based on 30 years of experience in the air and gas starter field. Study these recommendations and follow them. They can save you considerable time and expense.

### INSTALLATION

#### General Information

1. Always make certain your starter is properly installed. A little extra time and effort spent in doing a top quality job will contribute considerably toward a reliable starting system that does a superior job of starting your engine quickly under all conditions.
2. We strongly recommend that on all turbine engine installations, and on stationary engines subject to vibration, you use hoses of the specified diameter instead of rigid pipe connections. Turbine engine vibration will soon loosen rigid pipe connections, whereas hoses will absorb the vibration, and connections will remain tight.
3. In the actual mounting of a starter, it is best to have the hose connections already made at the receiver, and to have the starter end of the hose handy for attaching to the starter. Wherever possible, attach the air hoses to the starter before mounting the starter on the engine housing. The reason for following this procedure is twofold:
  - a. After mounting the starter, it is often impossible to make hose connections due to space limitations.
  - b. Once the hoses are attached, they carry some of the weight of the starter and make it easier to complete the mounting.
4. A strainer must be installed in the inlet line for each starter. These 150 mesh strainers provide 100 micron filtration and offer significant protection against supply components. Ingersoll-Rand offers 3 sizes: ST900-267-24 for 1 inch lines, ST900-267-32 for 2 inch lines and ST900-267-64 for 4 inch lines. Replacement elements are: ST900-266-24 for 1 inch, ST900-266-32 for 2 inch, and ST900-266-64 for 4 inch lines.

5. When installing the starter, you will usually need a regular ratchet wrench, sockets, socket extension, Allen wrenches, and a torque wrench.
6. The efficiency of a starter can be greatly impaired by an improper hook-up. Hoses smaller than those recommended will reduce the volume of air to the motor, and the use of reducers in the exhaust port will restrict the exhaust and choke the motor. The number of tees and elbows, and the length of the supply line should be kept to a minimum. Use 2" hose or pipe for supply lines up to 15 feet long; use 2-1/2" hose or pipe if the supply line is over 15 feet long.



(Dwg. TPD1786)

7. A leak in any of the connections is hazardous. **Make your connections right the first time to avoid unnecessary costs and delays.** On all threaded connections throughout the system, use Loctite®\* 56747 Sealant. Always run your air supply line from the side or top of the receiver—never at or near the bottom. Moisture in the air collects at the bottom of the receiver and could cause corrosion in the starter motor or, worse yet, freeze solid in cold weather so that the starter would be inoperative.
8. Whenever a flammable gas is being used to operate the Starter, all discharges should be piped away to a safe area.
9. Whenever possible, always mount the starter so that the exhaust port is downward. This will help prevent any accumulation of water in the starter motor.

\* Registered trademark of Loctite Corporation.

## PLACING STARTER IN SERVICE

10. Maximum allowable pressures are:

MODEL	SUPPLY PRESSURE PSI/KPI MAX
TS1400	225/1551
190475-101	225/1551
TS1435	195/1343
190475-300	195/1343
TS1450	150/1034
TS1475	120/827
TS1499	90/620

### MOUNTING THE STARTER

1. Study the piping diagram above.
2. Grease the O-ring with Parker O-ring lubricant and set in the Gear Case.
3. Place the coupling (supplied by customer) on the Drive Clutch Jaw.
4. Mount the Gear Case onto the engine.
5. Check for proper alignment of the lugs on the gear and driven jaw with the coupling.
6. Tighten the mounting nuts to the recommended torque.
7. Insert one motor assembly into the Gear Case, meshing motor pinion with Drive Gear. Check for proper orientation.
8. Alternately tighten the motor bolts to 55 ft-lb (74.5 Nm) torque.
9. Repeat Steps 8 and 9 for the other motor.
10. Using a 1- NPT Close Nipple, install the SRV150SS Relay Valve just after the strainer at each motor.

#### NOTICE

**Make certain the connection is made to the outlet side of the Relay Valve indicated by the word "OUT" cast on the valve body.**

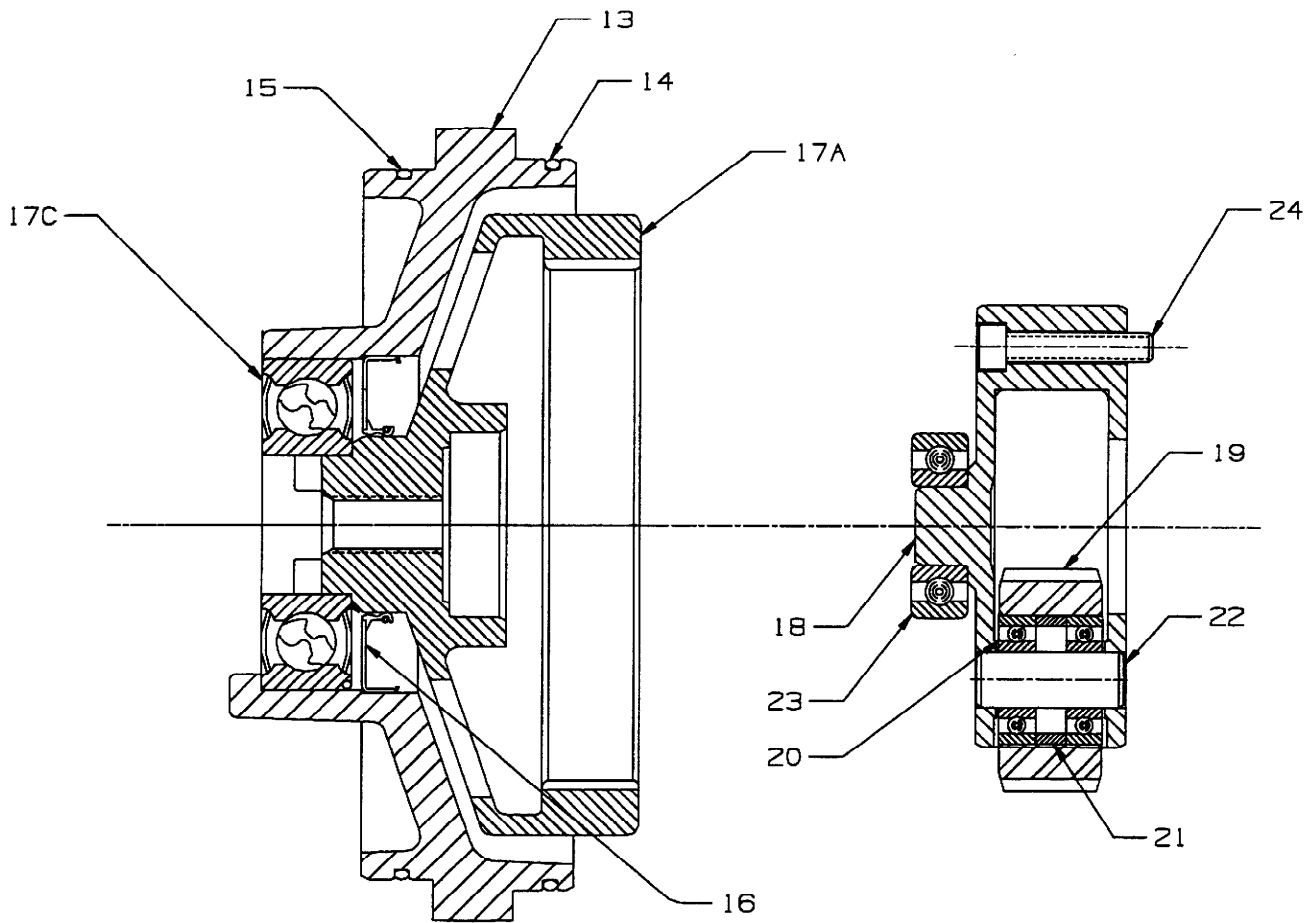
11. Install the No. SMB-G618 Starter Control Valve on an appropriate panel.
12. Mount an SS825-1064 Pressure Gauge on, or adjacent to, the control panel. It should be located where it is readily visible to the operator of the control valve.
13. Connect the Control Valve to the Relay Valve with " hose. Install a Tee in this line with a short feeder hose to the Pressure Gauge.

#### NOTICE

**Make certain the hose is connected to the "SUP" side of the Control Valve.**

14. Attach the required 1- hose, 2" pipe and lubricator/relay valve assembly.
15. Install a " hose line from the "DEL" side of the Starter Control Valve to the top of the Relay Valve. Install a Tee in this line and a short length of hose to the top of the other Relay Valve.
16. Install the required Exhaust System.
17. Pressurize the complete system and check every connection with a soap bubble test. **There must be no leaks.**

# MAINTENANCE SECTION



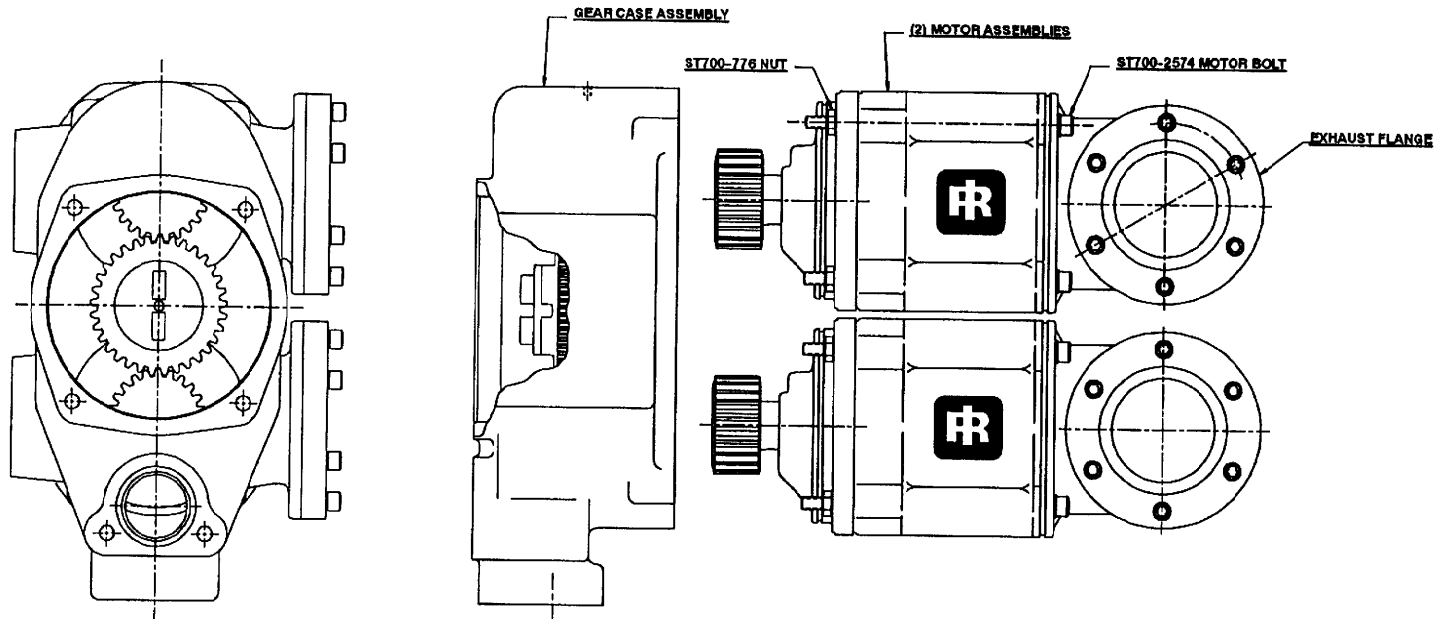
**ST999-A37  
INT. GEAR CASE ASSEMBLY**

ITEM	PART NO.	NAME	QTY.
17C	SS800-22	BEARING	1
13	ST900-37	GEAR CASE	1
15	Y327-162	O-RING	1
14	Y327-163	SEAL	1
16	ST700-272	SEAL	1
17A	04324596	RING GEAR	1

**ST900-A108  
PLANET GEAR FRAME ASSEMBLY**

ITEM	PART NO.	NAME	QTY.
18	ST900-108	FRAME	1
23	T06-24	BEARING	1
20	ST400-24	BEARING	6
22	ST900-191	PIN	3
19	ST900-10	GEAR	3
24	R3F-7	SCREW	3
21	ST900-91	SPACER	3

(Dwg. TPA1473-2)



### ASSEMBLY INSTRUCTIONS

THIS TS1400 STARTER IS BEING SHIPPED AS THREE SUB-ASSEMBLIES TO FACILITATE ITS ASSEMBLY ONTO THE TURBINE, TO FACILITATE THIS FINAL ASSEMBLY WE OFFER THE FOLLOWING RECOMMENDATIONS.

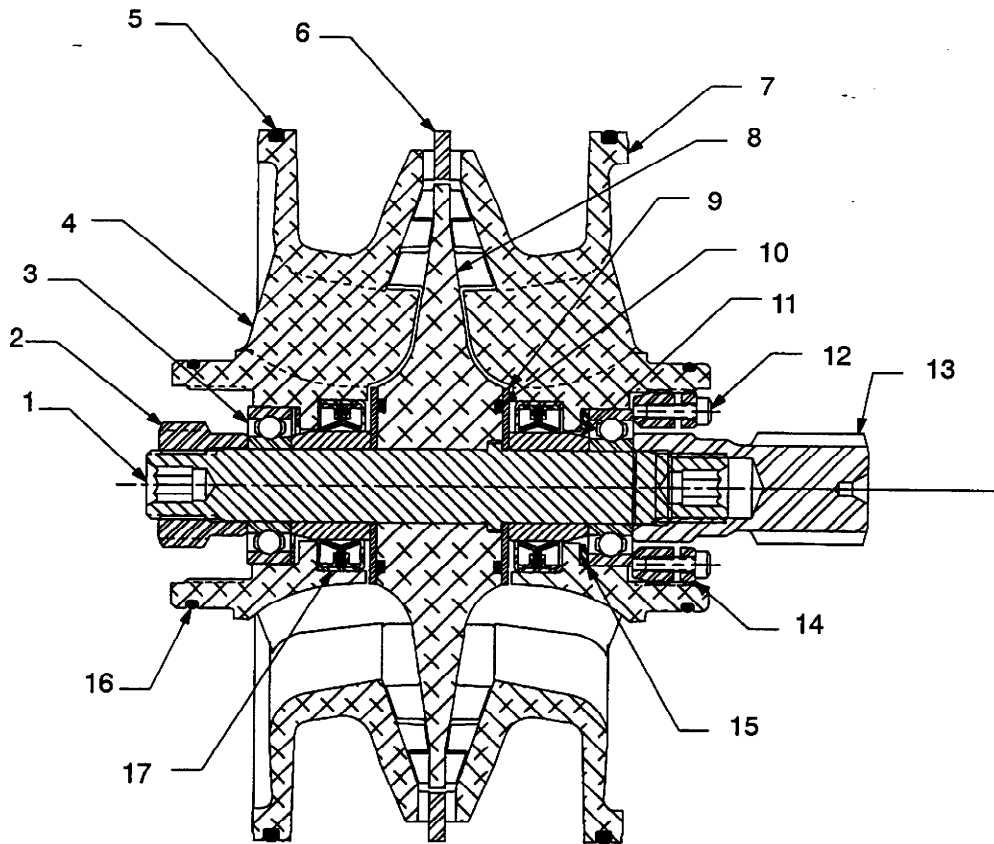
1. REMOVE THE PROTECTIVE PAPER AND TAPE FROM THE GEAR CASE. INSPECT FINISHED SURFACES TO ASSURE THAT THEY ARE CLEAN AND FREE OF ADHESIVE, NICKS AND BURRS.
2. THE GEAR CASE SHOULD BE READY FOR ASSEMBLY ONTO THE TURBINE. VISUALLY CHECK THE INSIDE OF THE GEAR CASE TO CONFIRM THAT THERE IS NO CONTAMINATION, AND THE GEAR COUPLING PARTS ARE FREE AND SECURE.
3. AFTER ASSEMBLY OF THE GEAR CASE ONTO THE TURBINE, REMOVE THE PROTECTIVE TAPE FROM THE MOTOR ASSEMBLY.
4. REMOVE THE SHIPPING NUT ST700-776 BY HOLDING IT WITH A WRENCH AND TURNING THE MOTOR BOLTS. POSITION THE MOTOR ASSEMBLY TO MINIMIZE HANDLING. SOME OF THE PARTS WILL BE LOOSE AFTER REMOVING THE NUTS.
5. INSPECT THE FINISH SURFACES TO ASSURE THEY ARE CLEAN AND FREE OF ADHESIVE NICKS, AND BURRS.
6. INSPECT THE O-RINGS TO ASSURE THAT THEY ARE FREE OF ADHESIVE, CUTS, TEARS OR ABRASIONS.
7. WORK O-RING LUBE INTO O-RINGS AND GROOVES.
8. WHILE HOLDING PARTS IN PLACE, INSERT THE MOTOR ASSEMBLY INTO THE GEAR CASE, ASSURE THE CORRECT ROTATIONAL ORIENTATION OF THE INLET AND EXHAUST AND ALTERNATELY IN STEPS, TIGHTEN THE MOTOR BOLTS TO 55 FT. LBS.
9. REPEAT STEPS 3 THRU 8 WITH THE OTHER MOTOR ASSEMBLY.

(Dwg. TPA1472)



# MAINTENANCE SECTION

## MOTOR ASSEMBLY

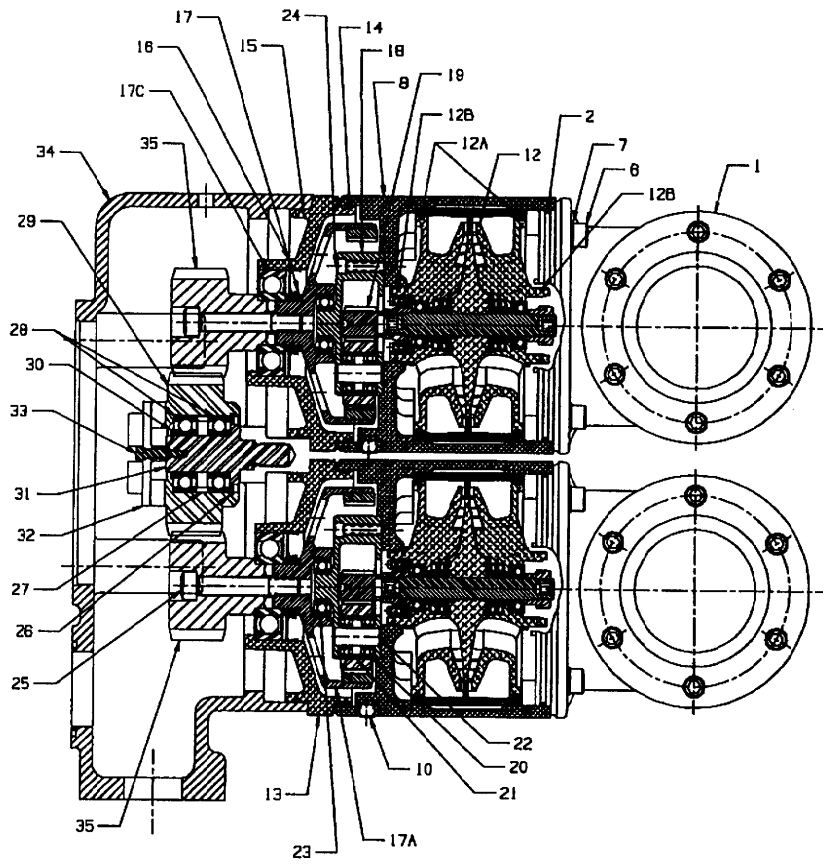
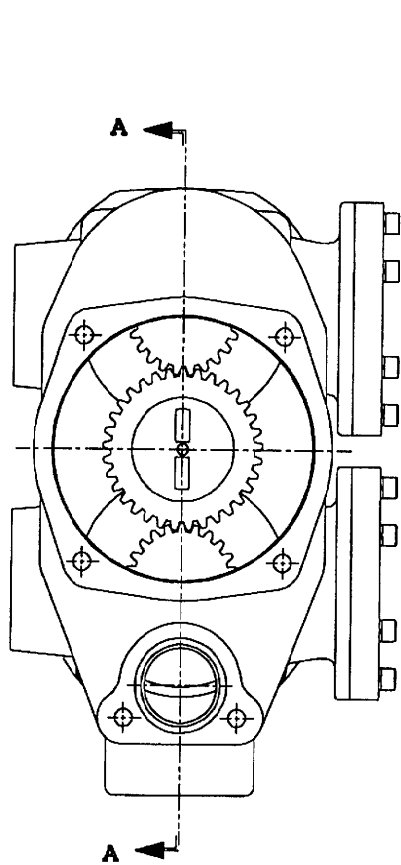


ITEM	PART NO.	NAME	QTY.
1	*	SHAFT	1
2	*	NUT	1
3	*	BEARING	2
4	*	END PLATE	1
5	*	O-RING	2
6	*	SPACER	1
7	*	END PLATE	1
8	*	ROTOR	1
9	*	SPACER	2
10	*	SEAL	2
11	*	SPACER	2
12	*	SCREW	2
13	*	PINION	1
14	*	NUT	1
15	*	WASHER	1
16	*	O-RING	2
17	*	SPRING	2

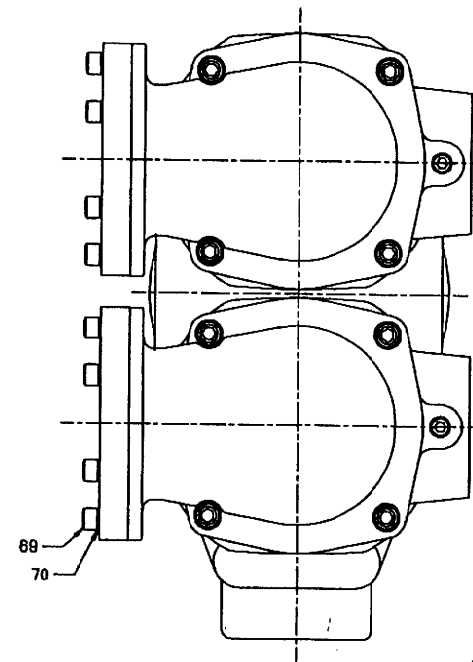
\* THESE PARTS ONLY AVAILABLE AS AN ASSEMBLY.

(Dwg. TPD1795)

10

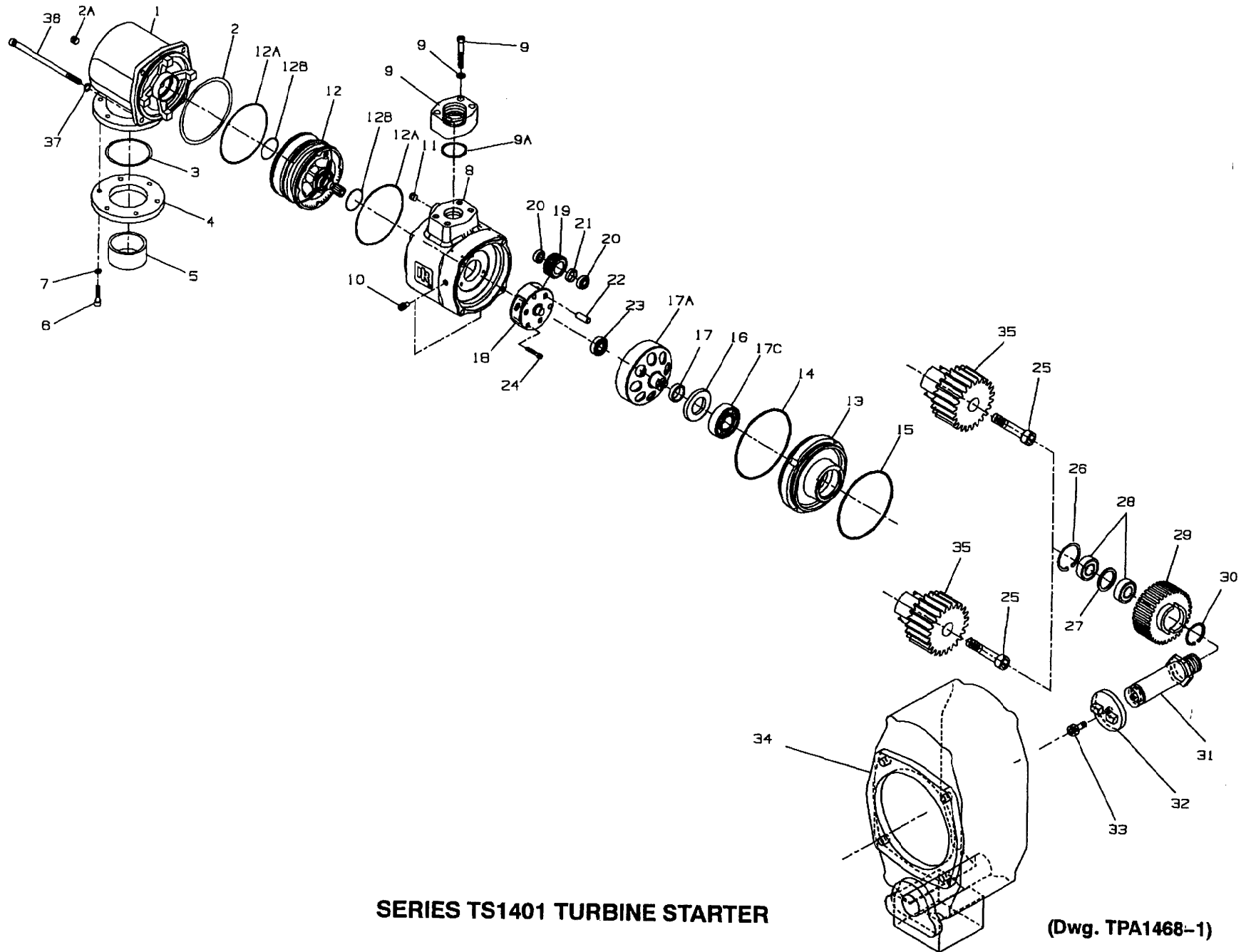


SEC. A-A



MAINTENANCE SECTION

(Dwg. TPA1469)



SERIES TS1401 TURBINE STARTER

(Dwg. TPA1468-1)

PART NUMBER FOR ORDERING

PART NUMBER FOR ORDERING

12

	Exhaust Kit .....	ST700K-350	17A	Carrier/Ring Gear .....	04324596
1	Directional Housing Exhaust Cover .....	ST700-350	17C	Bearing .....	SS800-22
2	Exhaust Cover Seal .....	Y327-162	18	Idler Gear Frame .....	ST900-108
2A	Exhaust Elbow Plug .....	ROH-377	19	Idler Gear (3) .....	ST900-10
3	Exhaust Adapter Seal .....	Y327-46	20	Idler Gear Bearing (6) .....	ST900-24
4	Exhaust Flange .....	ST700-351	21	Idler Gear Bearing Spacer .....	ST900-91
5	Weld Sleeve .....	ST700-352	22	Idler Gear Shaft (3) .....	ST900-191
6	Cap Screw (6) .....	ST700-703	23	Gear Frame Bearing .....	T06-24
7	Lock Washers (6) .....	845-55	24	Cap Screw (3) .....	R3F-7
	Motor Housing Assembly .....	ST900-A40	25	Screw (2) .....	WE205-817
8	Motor Housing .....	ST900-40	26	Bearing Retaining Ring .....	SS1600-265
9	Inlet Flange Kit (includes Inlet Flange, O-ring, Mounting bolts and Lock Washers) .....	ST700-K166	27	Bearing Spacer .....	SS1600-366
10	Housing Plug (3) .....	CE110-29	28	Drive Gear Bearing (2) .....	G7-24
11	Housing Plug Inlet Boss (2) .....	ROH-377	29	Drive Gear .....	SS1600K-9
*	Nameplate .....	ST900-301		For B ratio models .....	SS1600K-9B
*	Nameplate Screw (4) .....	R4K-302	30	For C ratio models .....	SS1600K-9C
12	Motor Assembly		31	Shaft Retaining Ring .....	SS1600-179
	For 925 RH rotation models .....	ST725R-A53A	32	Drive Gear Shaft .....	SS1600-8
	For 925 LH rotation models .....	ST725L-A53A	33	Coupling .....	SS1600-181
	For 935 LH rotation models .....	ST735R-A53A	34	Shoulder Screw .....	SS1600-182
	For 935 RH rotation models .....	ST735L-A53A	35	Gear Case .....	SS1600-37
	For 950 RH rotation models .....	ST750R-A53A		Rotor Pinion (2) .....	SS1600K-17
	For 950 LH rotation models .....	ST750L-A53A		For A ratio models .....	SS1600K-17A
	For 999 RH models .....	ST799R-A53A		For B ratio models .....	SS1600K-17B
	For 999 LH models .....	ST799L-A53A		For C ratio models .....	SS1600K-17C
				For D ratio models .....	SS1600K-17D
12A	Cylinder O-ring Seal (2) .....	ST700-67	36	Starter Assembly Cap Screw (4) .....	ST900-2574
12B	Housing O-ring Seal (2) .....	Y327-32	37	Cap Screw Washer (8) .....	SS800-26
	Intermediate Gear Case Assembly .....	ST999-A37	*	Tune Up Kit .....	TS1401-TK1
13	Intermediate Gear Case .....	ST900-37	*	Rebuild Kit	
14	Rear Gear Case O-ring .....	Y327-163		For 25% ARC .....	TS1401-RM1
15	Front Gear Case O-ring .....	Y327-162		For 35% ARC .....	TS1401-RM3
16	Seal .....	ST700-272		For 99% ARC .....	TS1401-RM2
17	Spacer .....	ST900-90		For 50% ARC .....	TS1401-RM4
			*	Gear Kit .....	SS1600-APF-C-1329

MAINTENANCE SECTION

\* Not illustrated.

## MAINTENANCE SECTION

### ▲ WARNING

Always wear eye protection when operating or performing any maintenance on this starter. Always turn off the air or gas supply and disconnect the air or gas supply hose before installing, removing or adjusting any accessory on this starter or before performing any maintenance on this starter.

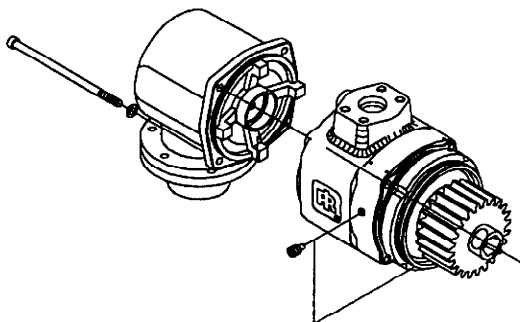
### DISASSEMBLY

#### General Information

1. Do not disassemble the starter any further than necessary to replace worn or damaged parts.
2. When grasping a part in a vise, always use leather-covered or copper-covered vice jaws to protect the surface of the part and help prevent distortion. This is particularly true of threaded members.
3. Do not remove any part which is a press fit in or on a subassembly unless the removal of that part is necessary for replacement or repairs.
4. Always have a complete set of seals and O-rings on hand before starting any overhaul of a Series TS1401 Turbine Starter. Never reuse old seals or gaskets.
5. Always mask adjacent parts on the Housing Exhaust Cover (1) and Motor Housing (8), so these members can be located in the same relative position when the Starter is reassembled.

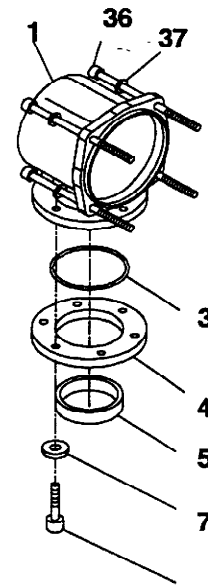
#### Disassembly of the Exhaust Elbow, Motor Assembly, and Motor Housing and Intermediate Gear Case

1. If replacing the Motor Assembly (12), remove both Housing Plugs (10) and drain the oil from the gearing before beginning disassembly of the Starter.
2. Using an 8 mm hex-head wrench, unscrew and remove the Starter Assembly Cap Screws (36) and Washers (37).
3. Pull the Housing Exhaust Elbow (1) from the Motor Housing (8). To dislodge the Housing Exhaust Elbow, rotate it until the ears clear the Motor Housing. Using a plastic hammer, tip the ears alternately until the Housing Exhaust Elbow can be removed from the Motor Housing. Refer to Dwg. TPA1791.



(Dwg. TPA1791)

4. To disassemble the Housing Exhaust Elbow and components. Refer to Dwg. TPA1784.



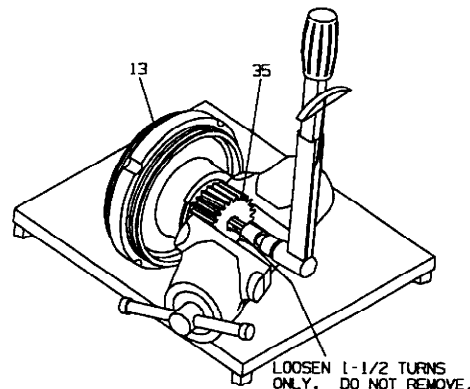
6 (Dwg. TPD1784)

5. Grasp the rear of the Motor Assembly (12) and pull it from the rear of the Motor Housing. If the Motor Assembly is difficult to remove, lightly push the motor pinion which is on the front of the Motor Assembly toward the exhaust side of the Motor Housing in order to free the Motor Assembly.

### NOTICE

Do not attempt to separate the Motor Housing (8) from the Intermediate Gear Case (13). This is a press fit and requires special bolts and air pressure to separate. This only should be done at an authorized Ingersoll-Rand repair facility.

6. Support the Intermediate Gear Case on a bench and position it in a copper-faced vise so that the Intermediate Pinion (35) is secured in the jaws of the vise. Tighten the vise only enough to hold the Intermediate Pinion securely. Refer to Dwg. TPD1785



(Dwg. TPD1785)

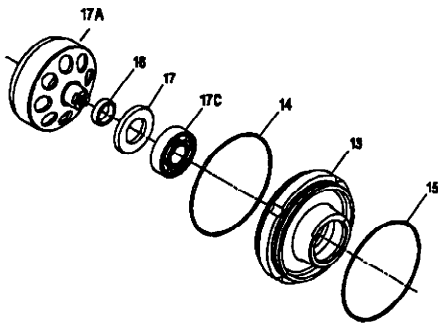
## MAINTENANCE SECTION

7. Loosen the Intermediate Pinion Retaining Screw (25)  
1- turns only. Do not remove.

### ⚠ WARNING

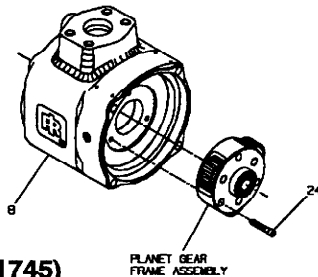
If the Intermediate Gear Case is not supported on a bench and if the Intermediate Pinion Retaining Screw is completely removed, the Intermediate Gear Case and components could fall causing injury.

8. Remove the Intermediate Gear Case Assembly from the vise and remove the Intermediate Pinion. Remove the Rear Gear Case O-ring and Front Gear Case.  
9. Remove the Carrier/Ring Gear (17A).  
10. Remove Seal (16) and spacer (17).  
11. Remove Bearing (17C) by pressing from front of Intermediate Gear Case. Refer to Dwg. TPD1743.



(Dwg. TPD1743)

12. Remove the Cap Screws (24) from the Idler Gear Frame (18) and remove the Idler Gear Frame from the front of the Motor Housing. Refer to Dwg. TPD1745

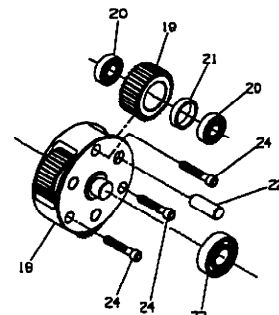


(Dwg. TPD1745)

### NOTICE

If the Idler Gear Frame will not come out of the Motor Housing easily, use a wooden dowel and tap the Idler Gear Frame from inside the rear of the Motor Housing.

13. If the Gear Frame Bearing (23) needs to be replaced, press it off of the shaft of the Idler Gear Frame.  
14. Press the Idler Gear Shafts (22) out of the Gear Frame and remove the Idler Gears (19).  
15. Press one of the Idler Gear Bearings (20) out of an Idler Gear, remove the Spacer (21), and press out the other Idler Gear Bearing. Repeat this process for the other two Idler Gears. Refer to Dwg. TPD1741.



(Dwg. TPD1741)

### Gear Case

1. With the Gear Case (34) facing up, the Drive Gear (29) should be visible.
2. Remove the Retaining Ring (26) from the Shaft (31).
3. Using a gear puller, remove the Drive Gear.
4. Remove the Retaining Ring (26) from the Drive Gear.
5. Remove the Bearings (28) and Spacer (27).
6. Using a hex socket, remove the Shaft from the Gear Case.

### NOTICE

These are left-hand threads.

### TORQUE CHART

ILLUSTRATION NO.	PART NUMBER	ASSEMBLY TORQUE	SEALANT REQUIRED
10	CE110-29	8 ft-lb (10.8 Nm)	YES
6	ST700-2579	55 ft-lb (74.5 Nm)	NO
24	R3 F-7	8 ft-lb (10.8 Nm)	YES
33	SS1600-182	45 ft-lb (5.1 Nm)	NO
25	WE205-817	90 ft-lb (122 Nm)	Yes; under head
31	SS1600-8	150 ft-lb (203 Nm)	NO
36	ST900-2574	55 ft-lb (74.5 Nm)	NO

\* IR SMB-441

# MAINTENANCE SECTION

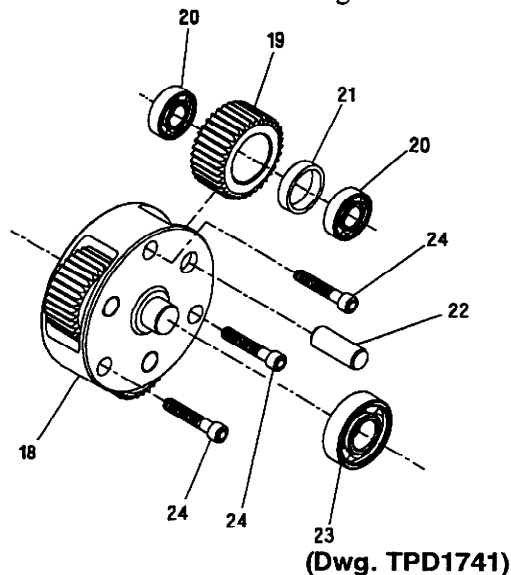
## ASSEMBLY

### General Instructions

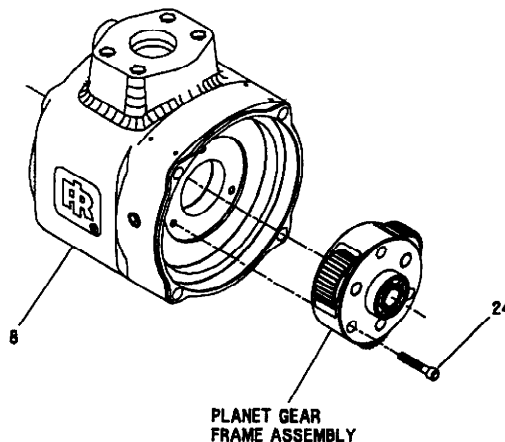
1. Always press on the **inner ring** of a ball-type bearing when installing the bearing on a shaft.
2. Always press on the **outer ring** of a ball-type bearing when pressing the bearing into a bearing recess.
3. Whenever grasping a starter or part in a vise, always use leather-covered or copper-covered vise jaws. Take extra care with threaded parts or housings.
4. Except for bearings, always clean every part and wipe every part with a thin film of oil before installation.
5. Check every bearing for roughness. If an open bearing must be cleaned, wash it thoroughly in a clean, suitable, cleaning solution and dry with a clean cloth. **Sealed or shielded bearings should never be cleaned.** Work grease thoroughly into every open bearing before installation.
6. Apply a film of o-ring lubricant to all O-rings before final assembly.

### Assembly of the Exhaust Elbow, Motor Assembly, Motor Housing and Intermediate Gear Case

1. Press one Idler Gear Bearing (20) into a Idler Gear (19).
2. Press Idler Gear Spacer (21) into the Idler Gear until it seats against the Bearing.
3. Press the other Idler Gear Bearing into the Idler Gear until it seats against the Spacer. Repeat this procedure for the other two Idler Gears.
4. Install the assembled Idler Gears in the Idler Gear Frame (18) by aligning the holes in the Bearings with the holes in the Idler Gear Frame and pressing in the Idler Gear Shafts.
5. Press the Gear Frame Bearing (23) on the shaft of the Idler Gear Frame. Refer to Dwg. TPD1741.



6. Install the Idler Gear Frame Assembly in the front of the Motor Housing and secure it with Cap Screws (24). Torque to 8 ft-lb (10.8 Nm) use Loctite Sealant. Refer to Dwg. TPD1745.

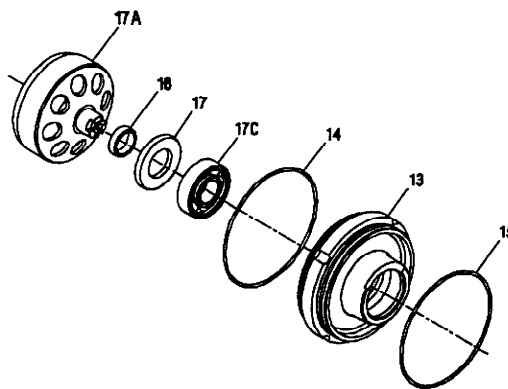


(Dwg. TPD1745)

7. Install the Spacer (17) on the shaft on the Carrier/Ring Gear (17A).
8. Using a bearing pressing tool of the proper size, press the Bearing (17C) into the rear of the Intermediate Gear Case (13).
9. Using a sleeve which contacts the outer ring of the Seal (16), press the Seal over the Spacer, flat side first.

### NOTICE

**Make sure that the flat side of the seal will be installed against the Bearing.**

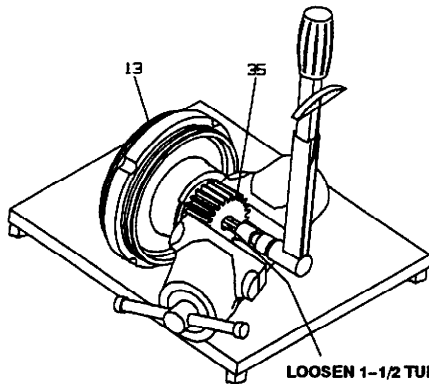


(Dwg. TPD1743)

10. Install the shaft of the Carrier through the Spacer until the shoulder of the Carrier seats against the Spacer. Refer to Dwg. TPD1743

## MAINTENANCE SECTION

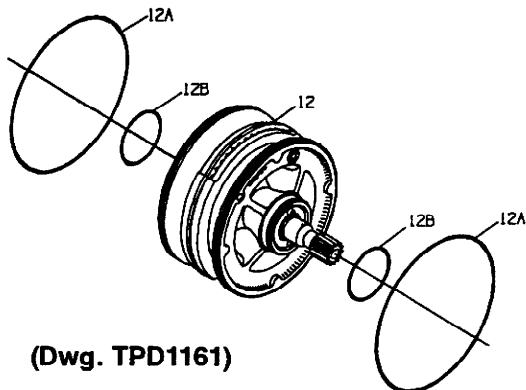
11. For final tightening, position the Intermediate Gear Case so that the Intermediate Pinion is secured in the jaws of a leather-covered or copper-faced vise. Tighten the Intermediate Pinion Retaining Screw to 90 ft.-lb. (122Nm) torque. Refer to Dwg. TPD1785



LOOSEN 1-1/2 TURNS ONLY.  
DO NOT REMOVE.

(Dwg. TPD1785)

12. Remove the Intermediate Gear Case from the vise and set it in a bench.
13. Install the Rear Gear Case O-Ring (14) in the groove at the rear of the Intermediate Gear Case and the Front Gear Case B-ring (15) in the groove at the front of the Intermediate Gear Case. Coat both O-rings with O-ring lubricant.
14. Before installing the Motor Assembly, coat the O-rings on the Motor Assembly and the inside of the Cylinder with O-ring lubricant. Install the Motor Assembly through the rear of the Motor Housing with the geared end of the rotor toward the front. Refer to Dwg. TPD1161.



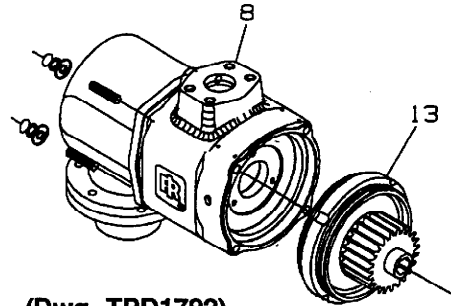
(Dwg. TPD1161)

### NOTICE

Turn the Rotor Pinion so that the gear on the rotor meshes with the Idler Planet Gears. Make sure that the rear of the Motor Assembly is installed flush with the rear of the Cylinder. Motor should be replaced every 1000 starts.

15. Align the punch marks on the Motor Housing with the punch marks on the Intermediate Gear Case and using a plastic hammer, tap the Motor Housing until it seats on the rear of the Intermediate Gear Case. Refer to Dwg. TPD1792.

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(Dwg. TPD1792)

### Assembly of the Directional Housing Exhaust Cover

1. Coat the Exhaust Cover Seal (2) with O-ring lubricant and install in the groove in the Directional Housing Exhaust Cover (1).
2. Install Directional Housing Exhaust Cover on the rear of the Motor Housing in the desired orientation and using a plastic hammer, tap the Directional Housing Exhaust Cover until it seats.
3. Secure the Directional Housing Exhaust cover on the rear of the Motor Housing using the Starter Assembly Cap Screws (36) and Cap Screw Washers (37). Using an 8mm hex-head wrench, tighten each Cap Screw a little at a time to a final torque of 55 ft.-lb. (74.5 Nm) in 20 ft.-lb. (27 Nm) increments. Refer to Dwg. TPD1791.
4. Lubricate Exhaust Adapter Seal (3) with O-ring lubricant and install in groove in Exhaust Flange (4).
5. Install Exhaust Flange with Exhaust Adapter Seal down on Directional Housing Exhaust Cover. Align holes and secure Adapter with Cap Screws (6) and Lock Washers (7). Tighten each Cap Screw a little at a time to a final torque of 55 ft.-lb. (74.5 Nm torque) in 20 ft.-lb. (27 Nm) increments. Refer to Dwg. TPD1784.

### NOTICE

Use Loctite® 56747 \*\*Pipe Sealant on all plugs.

6. Position the Starter vertical with the Exhaust Elbow Plug up (2A). Pour 15 ml of C32 Grade Turbine Oil into hole. Replace the Plug.
7. Install the **bottom** Housing Plug (10) and the Housing Plug Inlet Boss (11). Put the Starter on its side with the side plug hole upward. Add 175 ml (approximately pint) C32 Grade Turbine Oil through the side plug hole in the Motor Housing (8).

### NOTICE

This oil should be changed every 500 starts.



## MAINTENANCE SECTION

### Gear Case

1. With the Gear Case (34) facing up (the large single bore), install the Drive Gear Shaft (31). Tighten to 150 ft-lb (203 Nm) torque.

#### NOTICE

**These are left-hand threads.**

2. Insert one Drive Gear Bearing (28), Spacer (27) and the other Drive Gear Bearing (28) into the Drive Gear (29).
3. Install the Retaining Ring (26).
4. Press the Drive Gear Assembly onto the Drive Gear Shaft and install the Retaining Ring (30).

### - TEST AND INSPECTION PROCEDURE -

**Do not overfill.**

Install the side Housing Plug (10) with Loctite® 56747 sealant and tighten all plugs to 5 to 10 ft.-lb. (6.8 to 13.6 Nm) torque.

1. **Motor and Gearing Freeness:** Turn the Drive Shaft Pinion (35). The Drive Shaft Pinion should turn by hand.
2. **Motor Action:** Secure Starter in a vise and apply 90 psig (6.2 bar/620 kPa) pressure using a 3/8" (9 mm) supply line to the inlet of the motor. Starter should run smoothly.
3. **Motor Seals:** Plug the exhaust and slowly apply 20 psig (1.38 bar/138 kPa) pressure to the inlet of the motor. Pressure should hold within 5 psi for 30 seconds.

4. **Gear Case Seals:** Plug the exhaust and slowly apply 20 psig (1.38 bar/138 kPa) pressure to the inlet of the motor. There should be no leakage in the housing joints in the Gear Case area or in the shaft seal in the Intermediate Gear System. If the Starter is properly sealed, pressure should hold within 5 psi for 30 seconds.
5. **Confirm Motor Rotation:** Remove Housing Plug (10). Use a 1/4" hex drive to rotate the motor to verify proper motor adjustment. Intermediate Gearing output should rotate same as the required Starter rotation while observing from the pinion side. Replace Housing Plug.
6. **Orientation:** Drive Housing must be assembled to customer orientation or per engineering drawing. If orientation is not specified by customer, standard orientation will be supplied. Check dimension prints on TPA1470.
7. **Confirm Drive Rotation:** Apply low pressure to motor and observe rotation. Drive Pinion (35) must rotate in the direction stamped on the nameplate. Chamfer on pinion teeth should be on trailing edge of gear tooth.
8. **Concentricity and Squareness of Shaft to Housing "D" Ratio Only:** Assemble indicator on shaft. Indicate Pilot diameter. Check squareness of face at mounting surface. Pilot diameter must be concentric within .008 max. T.I.R. Mounting face must be square with shaft within .004 T.I.R. max.

## MAINTENANCE SECTION

### TROUBLESHOOTING GUIDE

Trouble	Probable Cause	Solution
Motor will not run	No air supply	Check for blockage or damage to air supply lines or tank
	Damaged Motor Assembly (12)	Inspect Motor Assembly and power train and repair power train or replace Motor Assembly if necessary
	Foreign material in Motor and/or piping	Remove Motor Assembly and piping and remove the blockage
	Blocked exhaust system	Remove Housing Exhaust Cover (1) and check for blockage
	Defective Control or Relay Valve	Replace Control Valve or Relay Valve
Loss of Power	Low air pressure to Starter	Check air supply
	Restricted air supply line	Check for blockage or damage to air lines. Check Filters.
	Relay Valve malfunctioning	Clean or replace lines or Relay Valve. Lubricate Relay Valve
	Exhaust flow restricted	Check for blockage or damaged piping. Clean or replace piping. Check for dirt or foreign material and clean or remove. Check for ice build-up. Melt ice and reduce moisture build-up to Starter
	Damaged Motor Assembly	Replace Motor Assembly
Motor runs, but does not rotate turbine	Damaged or broken drive train	Disassemble drive train and replace worn or damaged parts.
Oil blowing out of exhaust	Oil in air supply line	Replace with proper Drive Pinion.
	Retaining Screw (6) or pipe plug missing.	Inspect air line and remove source of oil. Install Retaining Screw or Pipe Plug.
	Worn or damaged rotor seals or static O-rings	Replace static seals on outside of Motor or send Motor to Ingersoll-Rand to be rebuilt.
Oil leaking	Worn or damaged O-rings	Replace O-rings
	Loose joints	Make sure that joints fit properly and Starter Assembly Cap Screws are tightened to 55 ft-lb (74.5 Nm) torque. Make sure all seals and O-rings fit and seal properly at their perimeters. If they do not replace with new seals and O-rings.
	Excessive high speed operation	Operate according to recommendations.
	High number of start cycles	Replace worn components
	Loose or leaking Pipe Plugs (10)	Tighten or replace Pipe plugs using Ingersoll-Rand No. SMB-441 Pipe Sealant.
Air or gas leakage	Loose joints	Make sure that joints fit properly and Starter Assembly Cap Screws are tightened to 55 ft-lb (74.5 Mn) torque. Make sure all seals and O-rings fit and seal properly at their perimeters. If they do not replace with new seals and O-rings.
	Excessive high-speed operation	Operate according to recommendations.
	High number of start cycles.	Replace worn components.
	Loose or leaking Pipe Plugs.	Tighten or replace Pipe Plugs

#### NOTICE

**SAVE THESE INSTRUCTIONS. DO NOT DESTROY.**

# MAINTENANCE SECTION

## TS1401 MAINTENANCE SCHEDULE

STARTS	COMPONENTS	RECOMMENDATION
500	C3 TURBINE OIL	REPLACE
500	ALL EXTERNAL CAP SCREWS	CHECK TORQUE
500	STRAINER	CHECK ELEMENT
1000	C3 TURBINE OIL	REPLACE
1000	ALL EXTERNAL CAP SCREWS	CHECK TORQUE
1000	MOTOR ASSEMBLY	REPLACE
1000	ALL BEARINGS & SEALS	REPLACE
1000	STRAINER	CHECK ELEMENT
1500	C3 TURBINE OIL	REPLACE
1500	ALL EXTERNAL CAP SCREWS	CHECK TORQUE
1500	STRAINER	CHECK ELEMENT
2000	C3 TURBINE OIL	REPLACE
2000	MOTOR ASSEMBLY	REPLACE
2000	ALL BEARINGS & SEALS	REPLACE
2000	ALL EXTERNAL CAP SCREWS	CHECK TORQUE
2000	STRAINER	CHECK ELEMENT
2500	C3 TURBINE OIL	REPLACE
2500	ALL EXTERNAL CAP SCREWS	CHECK TORQUE
2500	STRAINER	CHECK ELEMENT
3000	C3 TURBINE OIL	REPLACE
3000	MOTOR ASSEMBLY	REPLACE
3000	ALL BEARINGS & SEALS	REPLACE
3000	ALL EXTERNAL CAPS SCREWS	CHECK TORQUE
3000	STRAINER	CHECK ELEMENT
3500	C3 TURBINE OIL	REPLACE
3500	ALL EXTERNAL CAP SCREWS	CHECK TORQUE
3500	STRAINER	CHECK ELEMENT

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