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Edition 6
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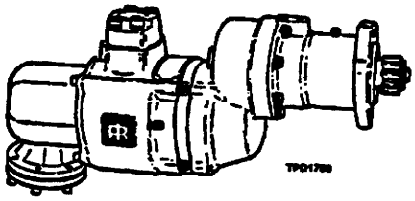
INSTALLATION AND MAINTENANCE MANUAL
for
SERIES ST900 TURBINE-POWERED STARTERS



⚠ 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 ST900 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 ST900 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.
- Do not remove any labels. Replace any damaged label.
- Use accessories recommended by Ingersoll-Rand

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 Service center.
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.

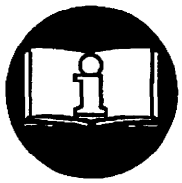
Printed in the U.S.A

INGERSOLL-RAND®
ENGINE STARTING SYSTEMS

WARNING LABEL IDENTIFICATION

⚠ WARNING

FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.



⚠ WARNING

Important information contained in installation and Maintenance Manual for safe starter operation.

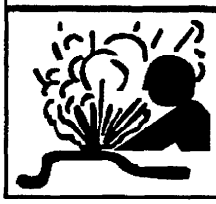
This material must be read prior to installing or operating the starter.

⚠ WARNING

Always wear hearing protection when operating this starter.

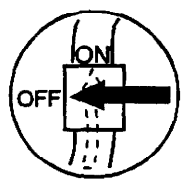
⚠ WARNING

Always wear eye protection when operating or performing maintenance on this starter.



⚠ WARNING

Do not use damaged, frayed or deteriorated air hoses and fittings.



⚠ WARNING

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.

MODEL ST900 TURBINE-POWERED STARTER OPERATING GUIDELINES

⚠ WARNING

- Never exceed the Nameplate operating pressure rating.

⚠ WARNING

- Always release the start button immediately after the engine starts.

NOTICE

- If the engine has not started after 30 seconds of cranking, refer to the engine maintenance guides for information on starting, ignition, and fuel systems.

NOTICE

- When using the starter for dynamic timing measurements, rest the starter for 2-½ minutes between 30 second measuerments.

NOTICE

- ST900-267 Strainer or equivalent is required for all starters used in stationary applacations.

- Supply must be free of contaminants. New piping must be free of scale.

NOTICE

- **For natural gas operation, starter main exhaust must be piped away.**
  To pipe the drive housing vent, remove the drive housing plug and replace it with a suitable tubing line. The tubing must vent at a safe location and must not be interconnected with any other exhaust lines which might introduce a back pressure on the drive housing vent.

NOTICE

- **The ST900 series starter is designed for long crank heavy duty applications. When cranking attempts fail to start the engine in 30 seconds, stop and allow the starter to cool for 2-½ minutes before attempting to start the engine.**

CONTENTS

PLACING THE STARTER IN SERVICE

INSTALLATION

For maximum performance, read this manual prior to the installation or operation of Series ST900 Turbine-Powered Starters.

General Information

1. We recommend that on all vehicular installations and on stationary engines subject to vibration that hoses of the specified diameter be used instead of rigid pipe connections to the starter. Engine vibration will loosen rigid pipe connections, whereas hoses will absorb the vibration, and connections will remain tight.
2. This starter is designed for flange mounting at the inlet. The furnished Flange Mounting Kit is required for installation. All piping, hoses and valving must be clean prior to installation. Make sure that the starter inlet is free of dirt and foreign material during installation.
3. In mounting a starter, have the hose connections already made at the receiver and have the starter end of the hose handy for attaching to the starter.
4. Engine design often requires mounting the starter underneath in extremely close quarters, and even though two of the mounting bolt holes are easy to reach, the third one is often less accessible. To install a starter, the following tools are required: regular ratchet wrench, sockets, universal joint, socket extension and single or double-end box wrench.
5. Improper hook-up impairs the efficiency of an Air Starter. Hoses smaller than those recommended will reduce the volume of air to the motor and the use of reducers for piped-away applications in the exhaust port will restrict the exhaust causing back pressure to the motor resulting in reduced performance. Keep the number of tees and elbows, and the length of the supply line to a minimum. Use 1-1/2" hose or pipe for supply lines up to 15 feet long: use 2" hose or pipe if the supply line is over 15 feet long.
6. We recommend that you install a strainer in the inlet line for each starter. These 150 mesh strainers provide 100 micron filtration and offer significant protection against supply line contaminants which could damage the turbine components. Ingersoll-Rand offers 3 sizes: ST900-267-24 for 1-1/2 inch lines, ST900-267-32 for 2 inch lines, and ST900-267-64 for 4 inch lines. Replacement elements are: ST900-266-24 for 1-1/2 inch, ST900-266-32 for 2 inch, and ST900-266-64 for 4 inch lines.
7. A leak in any live air line connections means that the system will drain overnight and will have to be re-pressurized the next morning by use of another vehicle or compressor. **Make your connections bubble tight to avoid unnecessary costs and delays.** On all threaded connections throughout the system, use Ingersoll-Rand No. SMB-441 Sealant, non-hardening No. 2 Permatex or Always run the 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 resulting in damage which could cause the valves to become inoperative. Periodically, open the petcock at the bottom of the tank to drain the water.
8. Whenever using a hazardous gas to operate the starter, there must be no leaks in inlet or exhaust piping or from any other starter joints. Pipe away all discharges to a safe area.
9. We recommend installation of a "glad hand" for emergency re-pressurizing of the system. To keep the "glad hand" clean and free of dirt, and to protect it from damage, a second "glad hand" closed by a pipe plug can be mated to it, or a "glad hand" protector bracket can be used.

Orientation of the Starter

We recommend that starters be ordered to proper orientation for your specific mounting or installation requirements. However, if the starter must be reoriented for installation, proceed as follows:

1. Refer to the dimension illustration on pages 7 and 8 and note that the Drive Housing can be located in any one of sixteen radial positions relative to the Gear Case. The air inlet can be located in any one of four radial positions relative to the Gear Case. The air inlet can be located in any one of four radial positions relative to the Drive Housing.
2. Study the engine mounting requirements, and determine the required orientation of the Drive Housing relative to the Gear Case. If the Drive Housing has to be reoriented, remove the eight Drive Housing Cap Screws and rotate the Drive Housing to its required position. Separation of the Drive Housing from the Gear Case is not required. Reinstall the Drive Housing Cap Screws and tighten to 28 ft-lb (38Nm) torque.

NOTICE

During field orientation do not change the relationship between the offset housing (28) and the intermediate housing (13). It is important that the cut out section of the bearing boss on the intermediate housing (13) aligns with the drive gear (24).

3. After the Drive Housing is properly oriented relative to the Gear Case, determine if the inlet port will be favorably located for hose installation. If either or both of these members must be reoriented, use an 8 mm hex-head wrench to remove the four motor housing cover cap screws, and rotate the motor housing and/or motor housing cover to its desired position.

NOTICE

Do not separate the Motor Housing from the Intermediate Gear case as gear lubrication oil will be lost.

Reinstall the motor housing cover cap screws and alternately tighten them to 60 ft-lb (81.4Nm).

PLACING THE STARTER IN SERVICE

Mounting the Air Starter

1. Study the appropriate piping diagrams and install as indicated.
2. The air receiver tank for a starter installation must have a working pressure rating equal to or greater than the maximum pressure at which the starter will be operated.
3. When connecting the starter to a receiver tank that is already in service, bleed off the air pressure in the tank prior to installing the starter.

⚠ WARNING

Bleed off the air pressure through a valve or petcock. Do not remove a plug from the tank while the tank is still pressurized.

Drain off any water that may have accumulated in the bottom of the tank.

4. Using a 1-1/2" short nipple, install the SRV 150 Starter Relay Valve on the end of the receiver tank as shown in the piping diagram.

NOTICE

Make certain the connection is made to the inlet side of the Relay Valve indicated by the word "IN", cast on the valve body.

5. For air installations, install the Starter Control Valve (SMB-618) on the dash panel (for vehicular installations) or some other appropriate panel (for stationary installations). An optional control circuit utilizing an electric solenoid control valve and a panel mounted switch are available. Mount the 12V Solenoid Valve (150BMP-1051B) securely and preferably in a vertical position away from any concentration of heat, vibration or contamination. Connect the leads to the operator's starting switch which should be located on the dashboard or control panel.
6. Attach Starter Instruction Label (TA-STR-100) to the control panel adjacent to the Starter Control Valve.
7. Mount the Air Pressure Gauge (150-BMP-1064) on or adjacent to the control panel. It should be located where it is readily visible to the operator.
8. Connect the Starter Control Valve to the Relay Valve with 1/4" 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 supply side (marked "SUP") of the Starter Control Valve.

9. To determine the exact length of 1-1/2" air hose required, run a piece of heavy duty hose or some other flexible tubing of the same diameter from the Relay Valve on the receiver to the starter location on the engine.
10. Attach the 1-1/2" air hose to the outlet side of the Relay Valve, and run the hose through the frame, etc. to its final position at the starter location.
11. At this point determine whether or not it is feasible or practical to attach the hose to the starter before or after the starter is actually mounted . In many cases it may be necessary to attach the hose to the starter before mounting.
12. If possible, liberally grease the teeth on the ring gear with a good quality sticky gear grease. This will help promote the life of the ring gear and the starter Pinion.
13. Move the starter into position, and mount it on the flywheel housing. Tighten the mounting bolts to 100 ft-lb (136 ft-lb Nm) torque.
14. **For Pre-Engaged Models only,** Install a 1/4" hose line from the delivery side (marked "DEL") of the starter Control Valve or Solenoid Valve to the "IN" port on the Starter Drive Housing.

NOTICE

Inadvertent application of air pressure to the "OUT" port will result in Drive malfunction (Pinion will fail to retract). If this condition occurs, loosen Drive Housing Cap Screws (38) to vent Gear Case (28). Also, loosen Housing Plugs (10) and (11) to vent Motor.

15. Install a 1/4" hose line from the "OUT" port on the Starter Drive Housing to the small pipe tapped portion top of the Starter Relay Valve or Solenoid Valve.
16. If the exhaust is to be piped away, remove the standard Splash Deflector which is located at the rear of the Housing Exhaust Cover and replace the Assembly with the 1/4" N.P.T. pipe plug supplied with the starter.
17. Pressurize the complete starting system and check every connection with a soap bubble test. **There must be no leaks in the live air lines or other connections.**

Barring Over the Engine

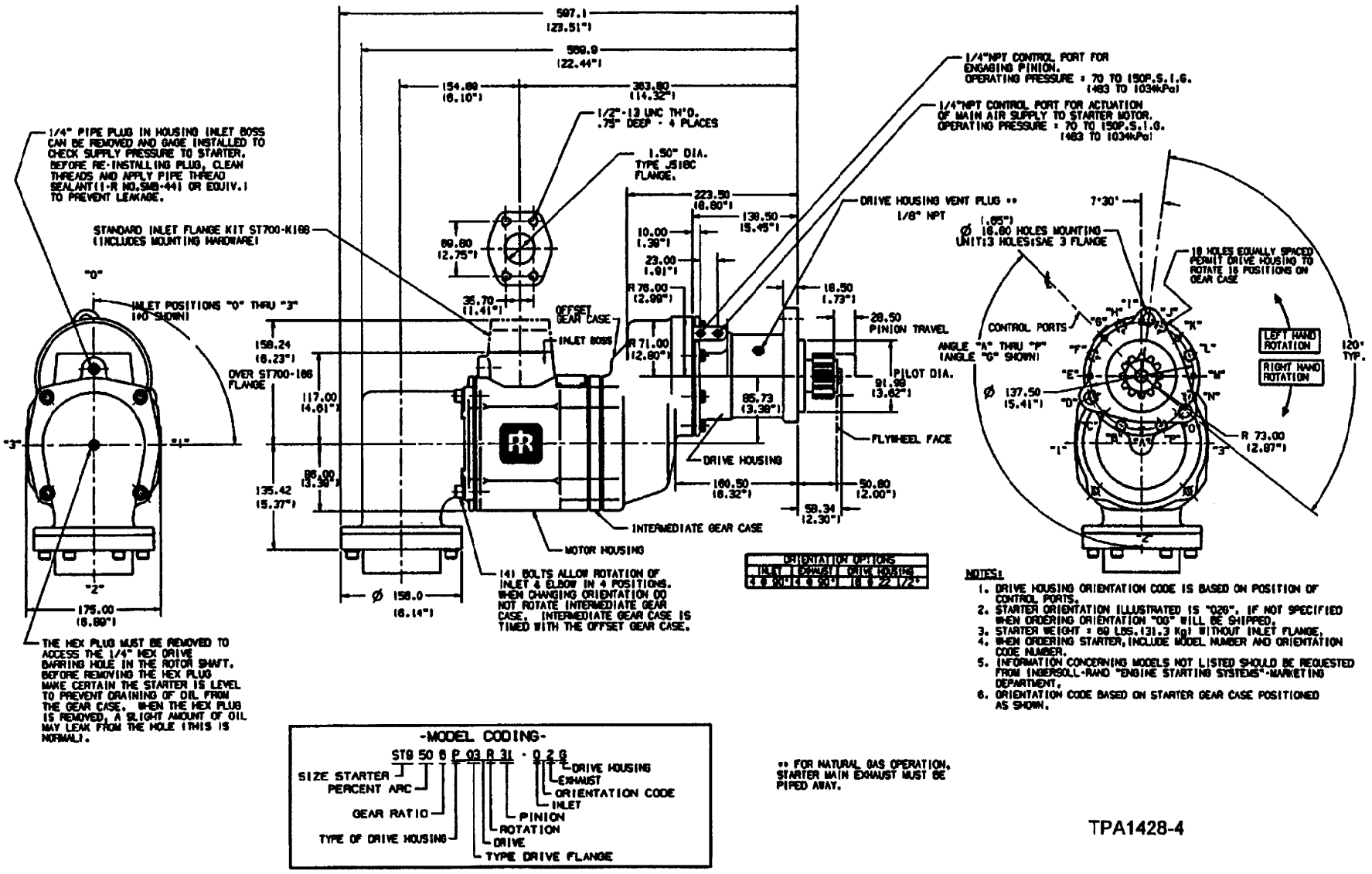
Occasionally, for setting injectors and/or for timing purposes, it may be desirable to bar over the engine in such a manner that any given piston can be stopped at any given location. This is very easily done with a Series ST900 Turbine Starter.

1. Remove the 1/4" pipe plug located on the exhaust.
2. Manually rotate the Motor Assembly until the engine is cranked to the desired position.

For Pre-Engaged Models

1. Disconnect the 1/4" hose at the "OUT" port on the Drive Housing, and plug the hole in the Drive Housing with a 1/4" pipe plug.
2. Engage the Drive Pinion with the flywheel by applying a minimum of 70 psig (4.8 bar/483 kPa) to the "IN" port on the Drive Housing.
3. Using a 6" long hex wrench, manually rotate the Motor Assembly until the engine is cranked to the desired position.

MOUNTING DIMENSIONS (Pre-Engaged)



ORIENTATION OPTIONS		
INLET	EXHAUST	DRIVE HOUSING
4 @ 90°	4 @ 90°	18 @ 7 1/2°

NOTES:
1. DRIVE HOUSING ORIENTATION CODE IS BASED ON POSITION OF CONTROL PORTS.
2. STARTER ORIENTATION ILLUSTRATED IS "028". IF NOT SPECIFIED WHEN ORDERING ORIENTATION "00" WILL BE SHIPPED.
3. STARTER WEIGHT = 69 LBS.(31.3 Kg) WITHOUT INLET FLANGE.
4. WHEN ORDERING STARTER, INCLUDE MODEL NUMBER AND ORIENTATION CODE NUMBER.
5. INFORMATION CONCERNING MODELS NOT LISTED SHOULD BE REQUESTED FROM INGERSOLL-RAND "ENGINE STARTING SYSTEMS"-MARKETING DEPARTMENT.
6. ORIENTATION CODE BASED ON STARTER GEAR CASE POSITIONED AS SHOWN.

-MODEL CODING-

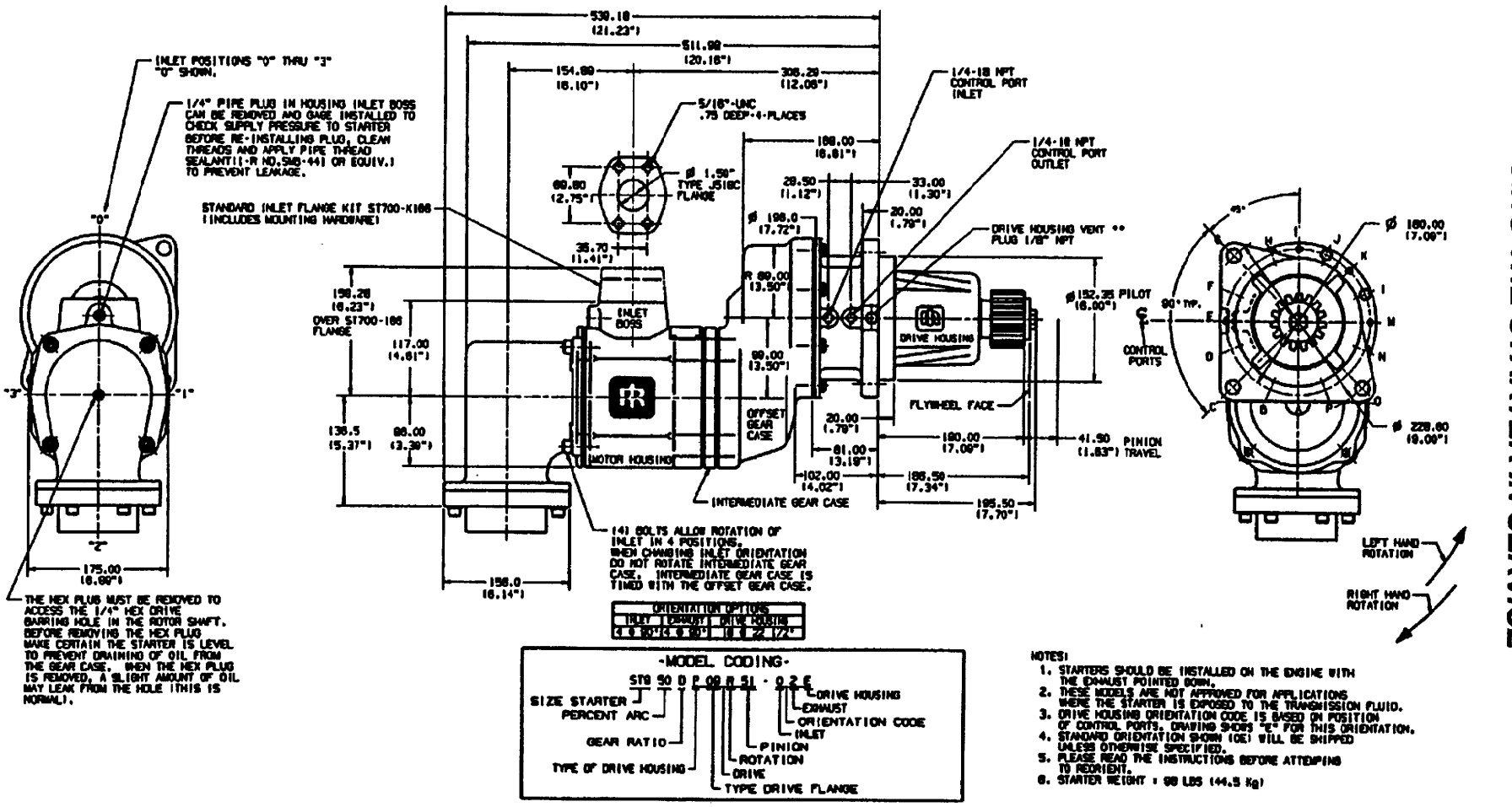
ST8 50 8 P 03 R 3L - 0 2 8
- ST8: SIZE STARTER
- 50: PERCENT ARC
- 8: GEAR RATIO
- P: TYPE OF DRIVE HOUSING
- 03: TYPE DRIVE FLANGE
- R: DRIVE
- 3L: PINION ROTATION
- 0 2 8: ORIENTATION CODE (INLET, EXHAUST, DRIVE HOUSING)

** FOR NATURAL GAS OPERATION, STARTER MAIN EXHAUST MUST BE PIPED AWAY.

TPA1428-4

PLACING THE STARTER IN SERVICE

MOUNTING DIMENSIONS (Pre-Engaged)
"D" RATIO DRIVE HOUSING

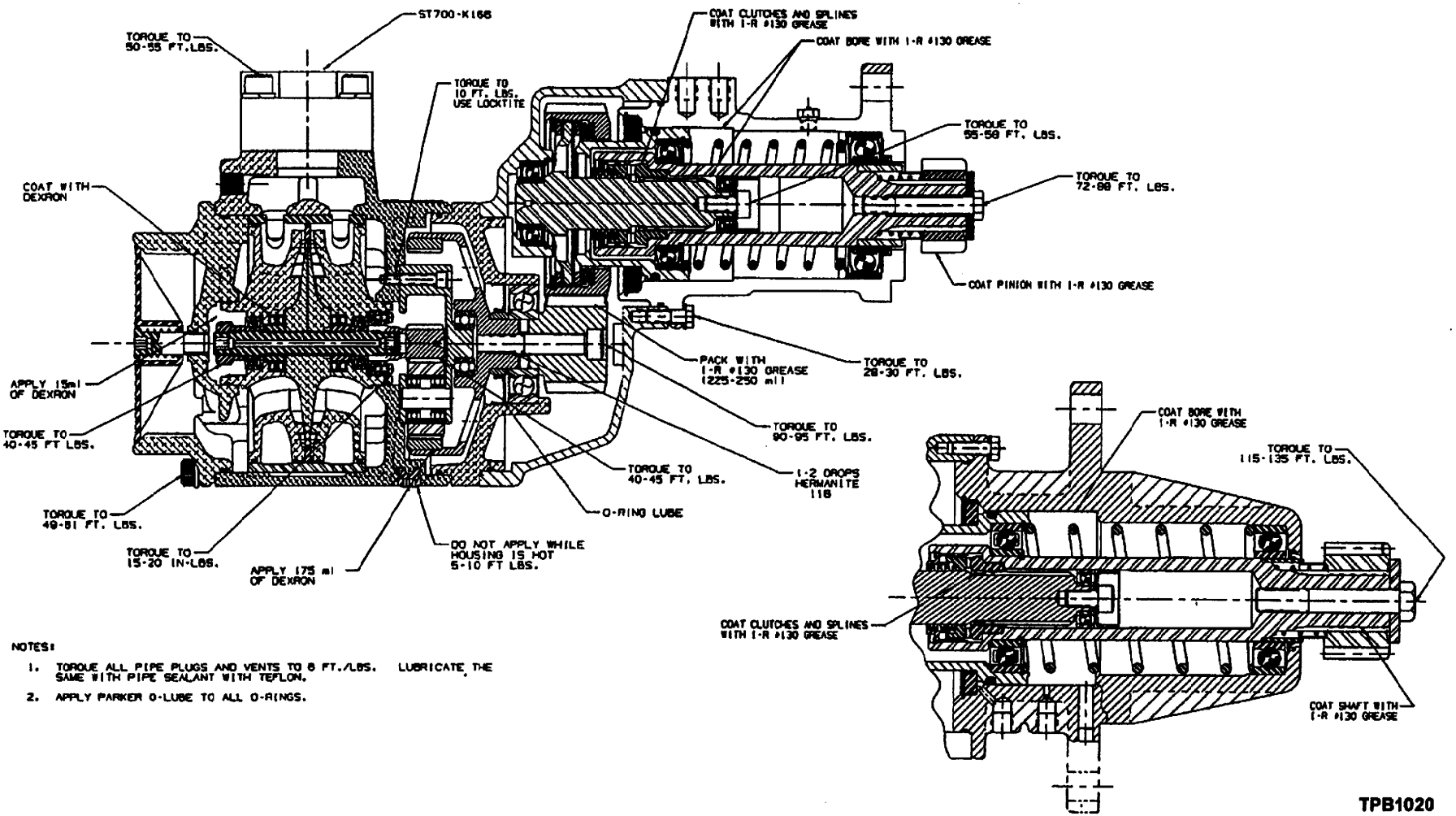


NOTES:
1. STARTERS SHOULD BE INSTALLED ON THE ENGINE WITH THE EXHAUST POINTED DOWN.
2. THESE MODELS ARE NOT APPROVED FOR APPLICATIONS WHERE THE STARTER IS EXPOSED TO THE TRANSMISSION FLUID.
3. DRIVE HOUSING ORIENTATION CODE IS BASED ON POSITION OF CONTROL PORTS. DRAWING SHOWS "E" FOR THIS ORIENTATION.
4. STANDARD ORIENTATION SHOWN (OE) WILL BE SHIPPED UNLESS OTHERWISE SPECIFIED.
5. PLEASE READ THE INSTRUCTIONS BEFORE ATTEMPING TO REORIENT.
6. STARTER WEIGHT = 98 LBS (44.5 Kg)

DUAL DIMENSIONS , (INCH) / (MM)

TPA1446-3

ST900 LUBE AND TORQUE SPECIFICATIONS

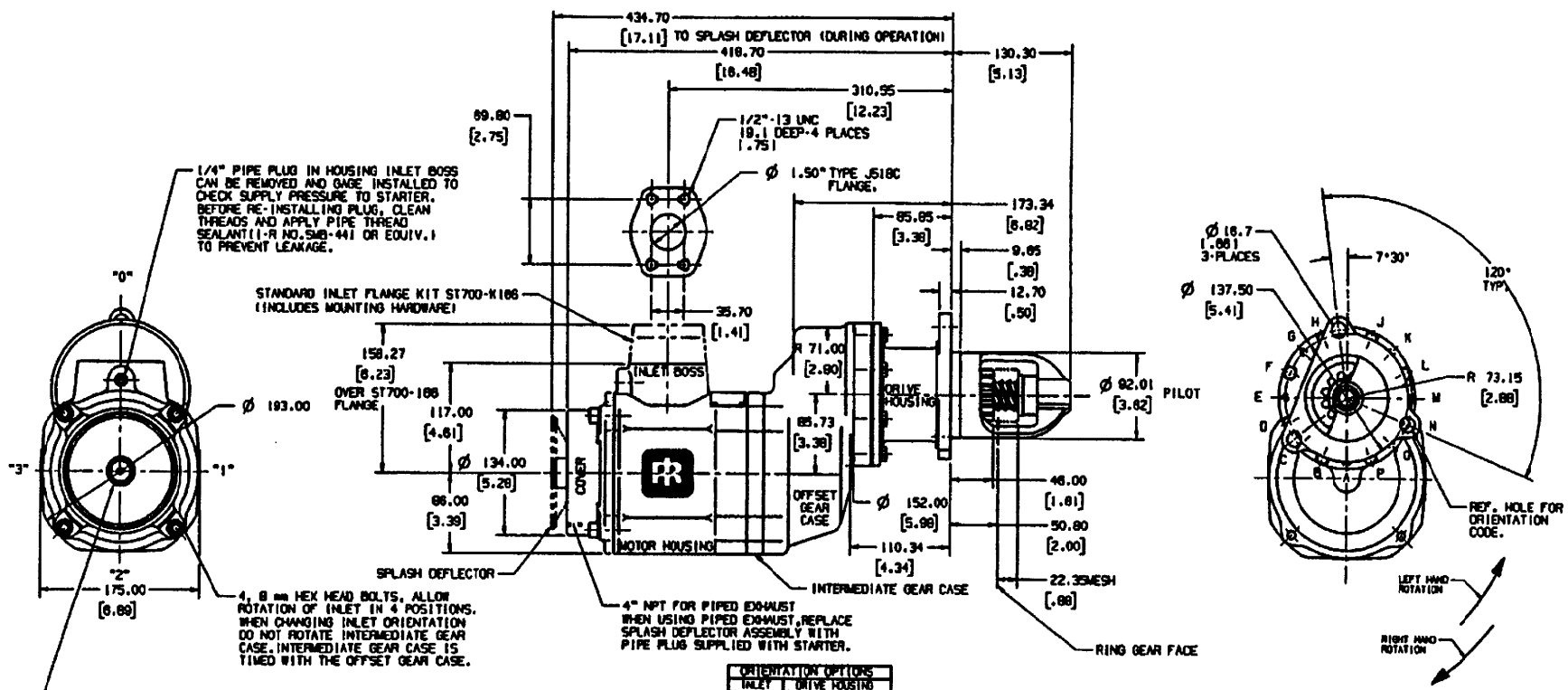


NOTES:

1. TORQUE ALL PIPE PLUGS AND VENTS TO 8 FT./LBS. LUBRICATE THE SAME WITH PIPE SEALANT WITH TEFLON.
2. APPLY PARKER O-LUBE TO ALL O-RINGS.

TPB1020

MOUNTING DIMENSIONS
ST900 TURBINE STARTER (INERTIA)



1. THE SPLASH DEFLECTOR ASSEMBLY MUST BE REMOVED FOR ACCESSING THE 1/4" HOLE DRIVE BARRING HOLE OR WHEN INSTALLING A PIPED AWAY EXHAUST.
2. BEFORE REMOVING THE HEX. PLUG THE STARTER MUST BE REASONABLY LEVEL TO PREVENT DRAINING THE OIL FROM THE GEAR CASE.
3. WHEN THE HEX PLUG IS REMOVED A SLIGHT AMOUNT OF OIL MAY LEAK FROM THE HOLE. (THIS IS NORMAL.)
4. BEFORE REASSEMBLY CLEAN ALL OIL FROM THE THREADS AND APPLY PIPE THREAD SEALANT (I-R NO. SMB-441 OR EQUIVALENT) TO PREVENT OIL LEAKAGE.

ORIENTATION OPTIONS	
INLET	DRIVE HOUSING
4 @ 90°	16 @ 22 1/2°

-MODEL CODING-

ST9 00 G B 0 1 03 R 31 - 0 N

- SIZE STARTER
- PERCENT ARC
- GAS OPERATION
- GEAR RATIO
- TYPE GEAR CASE
- TYPE OF DRIVE HOUSING
- TYPE DRIVE FLANGE
- DRIVE
- ROTATION
- PINION
- INLET
- ORIENTATION CODE
- DRIVE HOUSING

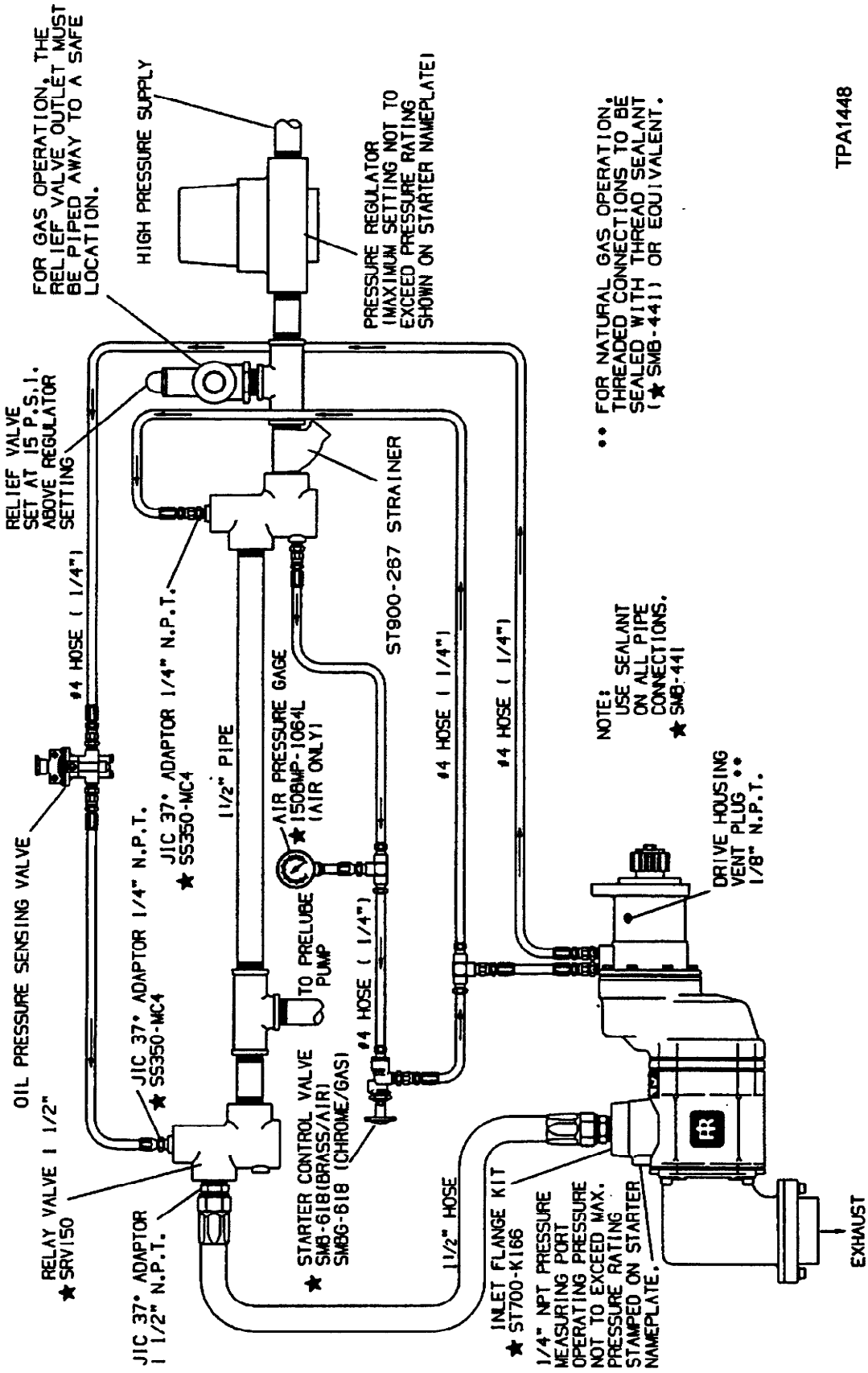
NOTES:
1. STARTERS SHOULD BE INSTALLED ON THE ENGINE WITH THE EXHAUST POINTED DOWN.
2. THESE MODELS ARE NOT APPROVED FOR APPLICATIONS WHERE THE STARTER IS EXPOSED TO THE TRANSMISSION FLUID.
3. DRIVE HOUSING ORIENTATION CODE IS BASED ON POSITION OF MOUNTING HOLE OPPOSITE THE PINION OPENING.
4. STANDARD ORIENTATION SHOWN (0N) WILL BE SHIPPED UNLESS OTHERWISE SPECIFIED.
5. PLEASE READ THE INSTRUCTIONS BEFORE ATTEMPING TO REORIENT.
6. STARTER WEIGHT = 68 LBS (30.8 Kg)

DUAL DIMENSIONS — MM (INCH)

TPA1503

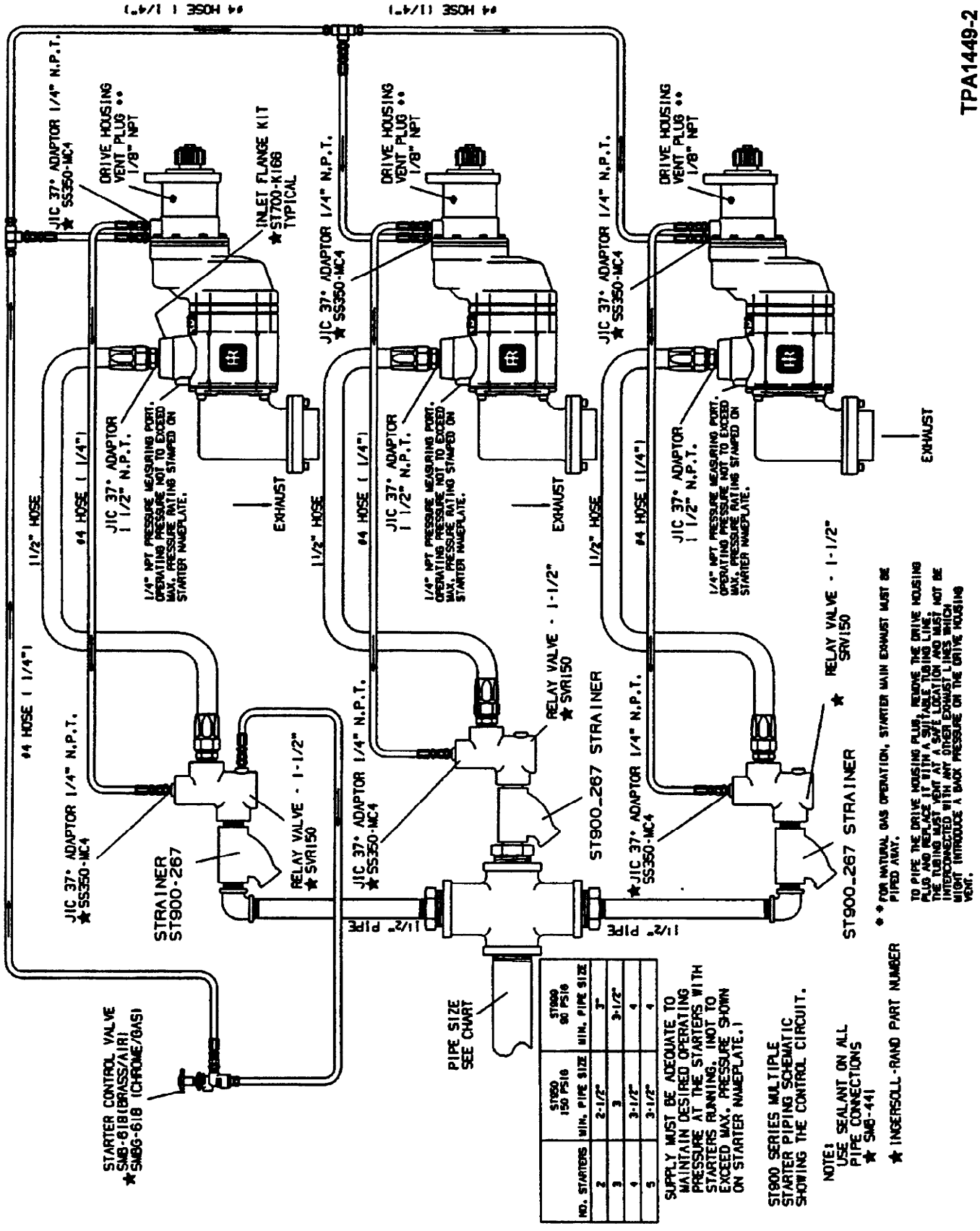
PLACING STARTER IN SERVICE

PIPING DIAGRAM WITH ENGINE PRELUBE SYSTEM FOR A STANDARD HIGH PRESSURE SYSTEM WHEN SUPPLY PRESSURE IS OVER PRESSURE RATING OF STARTER.



PLACING STARTER IN SERVICE

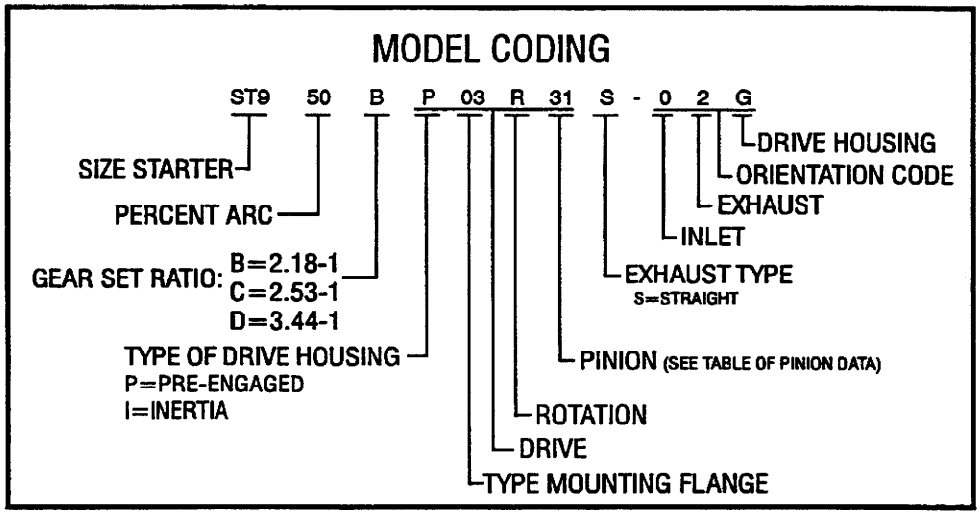
PIPING DIAGRAM FOR A TYPICAL MULTIPLE STARTER INSTALLATION PRE-ENGAGED



PLACING THE STARTER IN SERVICE

Series ST900 Turbine-Powered Starters are designed for air or gas operation in off-highway, marine and stationary applications.

HOW TO ORDER A STARTER



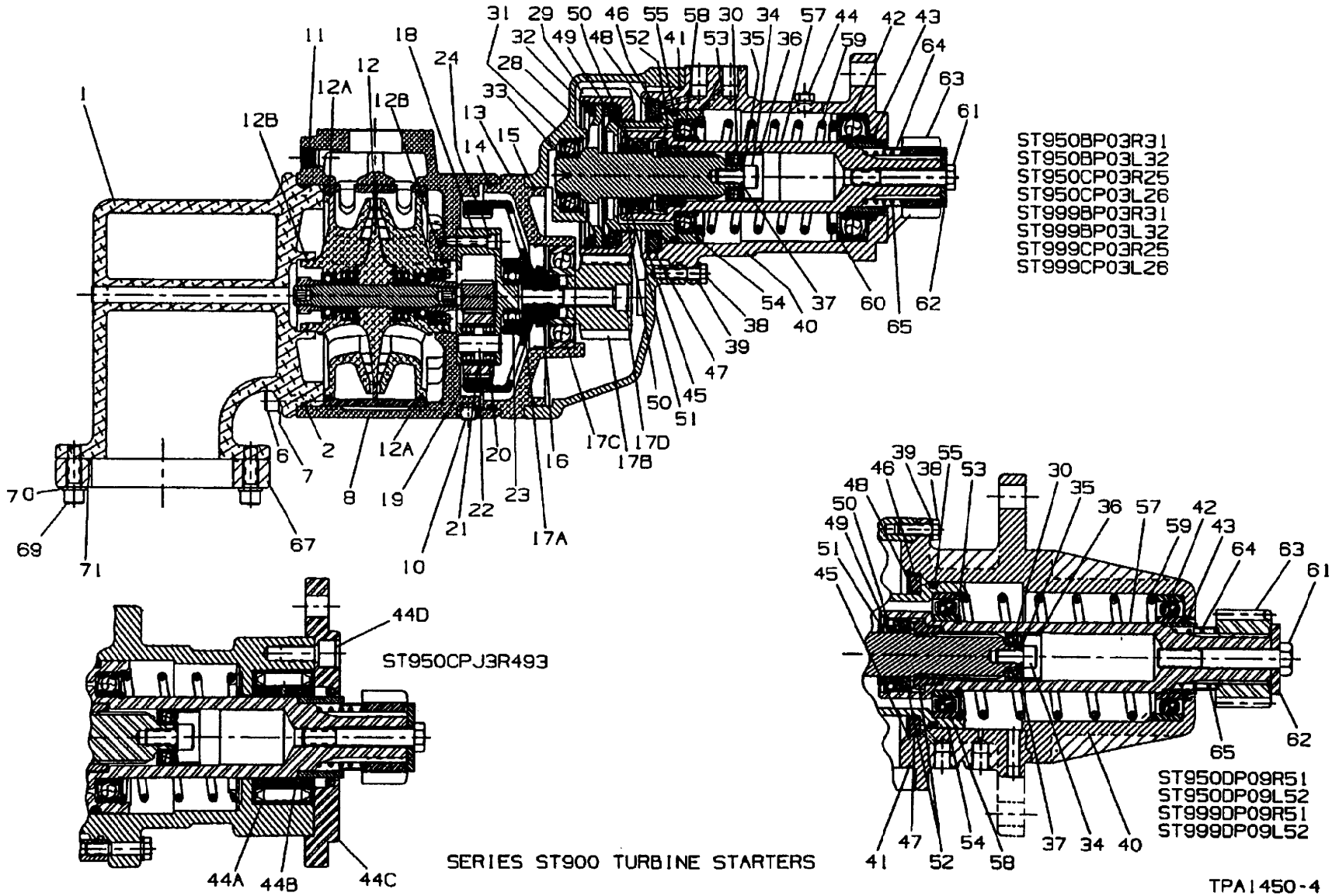
MODEL	SUPPLY PRESSURE PSIG/KPa MAX. *	PINION DATA			
		NO. OF TEETH	D.P.	H P.D.	P.A.
ST950BP03R31	150/1034	12/12	6/8	2.00"	20°
ST950BP03L32	150/1034	12/12	6/8	2.00"	20°
ST950CPJ3R493	150/1034	15	4.0 MOD	162.6mm	15°
ST950CP03R25	150/1034	11/12	6/8	2.00"	20°
ST950CP03L26	150/1034	11/12	6/8	2.00"	20°
ST999BP03R31	90/621	12/12	6/8	2.00"	20°
ST999BP03L32	90/621	12/12	6/8	2.00"	20°
ST999CP03R25	90/621	11/12	6/8	2.00"	20°
ST999CP03L26	90/621	11/12	6/8	2.00"	20°
ST950DP09R51	150/1034	15	6/8	2.50"	20°
ST950DP09L52	150/1034	15	6/8	2.50"	20°
ST999DP09R51	90/621	15	6/8	2.50"	20°
ST999DP09L52	90/621	15	6/8	2.50"	20°

MUST BE SPECIFIED WHEN ORDERING

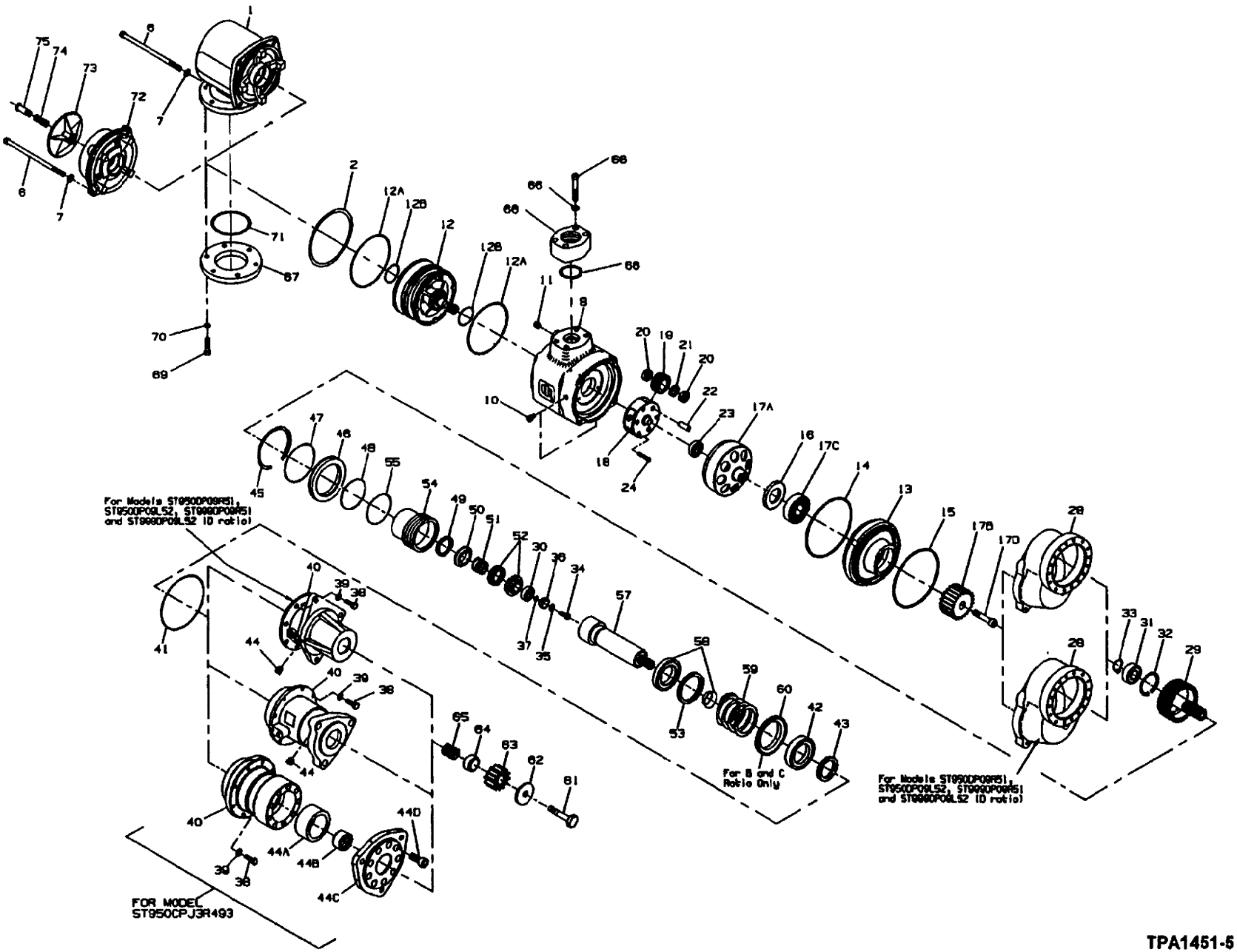
(Dwg. TPD1808)

For different models or special applications, contact your nearest Ingersoll-Rand Distributor or Ingersoll-Rand Engine Starting Systems, Box 8000, Southern Pines, NC 28387 (910) 692-8700.

ST900 TURBINE STARTER (Pre-Engaged)



ST900 TURBINE STARTER (Pre-Engaged)



TPA1451-5

PRE-ENGAGED DRIVE

		PART NO. FOR ORDERING
	Exhaust Kit	ST700K-350
1	Directional Housing Exhaust Cover	ST700-350
2	Exhaust Cover Seal	SS800-67
*	Plug	R0H-377
6	Starter Assembly Cap Screw (4)	ST700-2574
7	Cap Screw Washer (4)	SS800-26
	Motor Housing Assembly	ST900-A40
8	Motor Housing	ST900-40
10	Housing Plug (2)	CE110-29
11	Housing Plug Inlet Boss	ROH-377
*	Nameplate	ST900-301
*	Nameplate Screw (4)	R4K-302
12	Motor Assembly	
	for Models ST950CPJ3R493, ST950BP03R31, ST950CP0325, and ST950DP09R51	ST750L-A53A
	for Models ST950BP03L32 ST950CP03L26 and ST950DP09L52	ST750R-A53A
	for Models ST999BP03R31, ST999CP03R25 and ST999DP09R51	ST799L-A53A
	for Modesl ST999BP03L32 ST999CP03L26 and ST999KP09L52	ST799R-A53A
12A	Cylinder O-ring Seal (2)	ST700-67
12B	Housing O-ring Seal (2)	Y327-32
	Intermediate Gear Case Assembly	ST900-A37
13	Intermediate Gear Case	ST900-37
14	Rear Gear Case O-ring	Y327-163
15	Front Gear Case O-ring	Y327-162
16	Seal	ST700-272
17A	Ring Gear	04324596
17B	Intermediate Pinion	
	for Model ST950BP03R31, ST950BP03L32, ST999BP03R31, and ST999BP03L32	SS800B-17
	for Models ST950CPJ3R43 ST950CP03R25, ST950CP03L26, ST999CPO3R25 and ST999CP03L26	SS825C-17
17C	Bearing	SS800-22
17D	Screw	SS800-732
	Idler Gear Frame Assembly	ST900-A108
18	Idler Gear Frame	ST900-108
19	Idler Gear (3)	ST900-10
20	Idler Gear Bearing (6)	ST900-24
21	Idler Gear Bearing Spacer (3)	ST900-91
22	Idler Gear Shaft (3)	ST900-191
23	Gear Frame Bearing	T06-24
24	Cap Screw (3)	R3F-7
28	Gear Case	
	for Models ST950DP09R51, ST950DP09L52, ST999DP09R51 and ST999GDP09L52	SS850-37
	for all other models	SS800-37
29	Drive Gear	
	for Models ST950BP03R31, ST950BP03L32, ST999BP03R31, and ST999BP03L32	SS815B-9
	for Models ST950CPJ3R493, ST950CP03R25, ST950CP03L26, ST999CP03R25 and ST999CP03L26	SS825C-9
	for Models ST950DP09R51, ST950DP09L52,ST999DP09R51, and ST999DP09L52	SS850D-9
30	Front Drive Gear Bearing	SS800D-278
◆31	Rear Drive Gear Bearing	SS800-359
32	Drive Gear Bearing Retainer	SS800-361
33	Drive Gear Shaft Bearing Retainer	SS800-632
34	Drive Gear Screw	SS800-179
35	Drive Gear Lock Washer	SS800-180
36	Drive Gear Cup	SS800-177
37	Drive Gear Screw O-ring	SS800-176
38	Drive Housing Cap Screw (8)	SS800-744
39	Drive Housing Cap Screw Lock Washer (8)	TE223A-415
40	Drive Housing Kit	
	for Models ST950DP09R51, ST950DP09L52, ST999DP09R51 and ST999GDDP09L52	SS850-K300
	for Model ST950GCDPJ3R493	ST700-K300
	For all other Models	SS825-K300
◆41	Drive Housing O-ring	
	for B & C ratio	SS800-244
	for D ratio	SS850-244
42	Front Drive Shaft Bearing	SS800-363
43	Drive Housing Seal	SS800-271
44	Drive Housing Vent Plug	P250-546
44A	Ring (for Model ST950CPJ3R493)	ST700-693
44B	Bearing (for Model ST950CPJ3R493)	ST700-694Y
44C	Flange (for Model ST950CPJ3R493)	ST700-212A

* Not illustrated.

◆ Indicates Tune-up Kit part.

PRE-ENGAGED DRIVE (continued)

		PART NO. FOR ORDERING
44D	Cap Screw (for Model ST950GCDPJ3R493)	SS800-179
◆45	Bulkhead Retainer	
	for Models ST950DP09R51, ST950DP09L52, ST999DP09R51 and ST999GD9P09L52	SS850-181
	for all other models	SS800-181
46	Bulkhead Kit	
	for Models ST950DP09R51, ST950DP09L52, ST999DP09R51 and ST999DP09L52	SS850-K150
	for all other models	SS800-K150
◆47	Outer Bulkhead O-ring	
	for Models ST950DP09R51, ST950DP09L52, ST999DP09R51 and ST999DP09L52	SS850-152
	for all other models	SS800-152
◆48	Inner Bulkhead O-ring	
	for Models ST950DP09R51 ST950DP09L52, ST999DP09R51 and ST999DP09L52	SS850-151
	for all other models	SS800-151
49	Clutch Spring Cup Retainer	SS800-366
50	Clutch Spring Cup	SS800-367
51	Clutch Spring	SS800-583
52	Clutch Jaw Kit	
	for Models ST950CPJ3R493, ST950BP03R31, ST950CP03R25, ST950DP09R51, ST999BP03R31, ST999CP03R25, and ST999DP09R51	SS800R-K587
	for Models ST950BP03L32, ST950CP03L26, ST950DP09L52, ST999BP03L32, ST999CP03L26 and ST999DP09L52	SS800L-K587
53	Large Drive Shaft Bearing Retainer	
	for Models ST950DP09R51, ST950DP09L52, ST999DP09R51 and ST999DP09L52	SS850-107
	for all other models	SS800-107
54	Piston Kit	
	for Models ST950DP09R51, ST950DP09L52, ST999DP09R51 and ST999DP09L52	SS850K-703
	for all other models	SS800K-703
◆55	Piston O-ring	
	for Models ST950DP0R51, ST950DP09L52, ST999DP09R51 and ST999DP09L52	SS850-337
	for all other models	SS800-337
57	Drive Shaft Kit	
	for Models ST950CPJ3R493, ST950BP03R31, ST950CP03R25, ST999BP03R31 and ST999CP03R25	SS800R-K8
	for Models ST950BP03L32, ST950CP03L26, ST999BP03L32 and ST999CP03L26	SS800L-K8
	for Models ST950DP09R51 and ST999DP09R51	SS850R-K8
	for ST950DP09L52 & ST999DP09L52	SS850L-K8
58	Rear Drive Shaft Bearing (includes bearing retainer)	
	for Models ST950DP09R51, ST950DP09L52, ST999DP09R51, and ST999DP09L52	SS850-K399
	for all other models	SS800-K399
59	Piston Return Spring	
	for Models ST950DP09R51, ST950DP09L52 and ST999DP09R51	SS850-700
	for all other models	ST700-700
◆60	Seat (for all "B" and "C" ratio Models only)	SS800-191
61	Drive Pinion Retaining Screw	
	for Models ST950CPJ3R493, ST950BP03R31, ST950CP03R25, ST999BP03R31 and ST999CP03R25	SS800R-394
	for Models ST950BP03L32 ST950CP03L26, ST999BP03L32 and ST999CP03L26	SS800L-394
	for ST950DP09R51 and ST999DP09R51	SS850R-394
	for ST950DP09L52 and ST999DP09L52	SS850L-394
62	Drive PinionWasher	
	for Models ST950DP09R51, ST950DP09L52, ST999DP09R51, and ST999DP09L52	SS850-725
	for all other models	SS800-725

* Not illustrated.

◆ Indicates Tune-up Kit part.

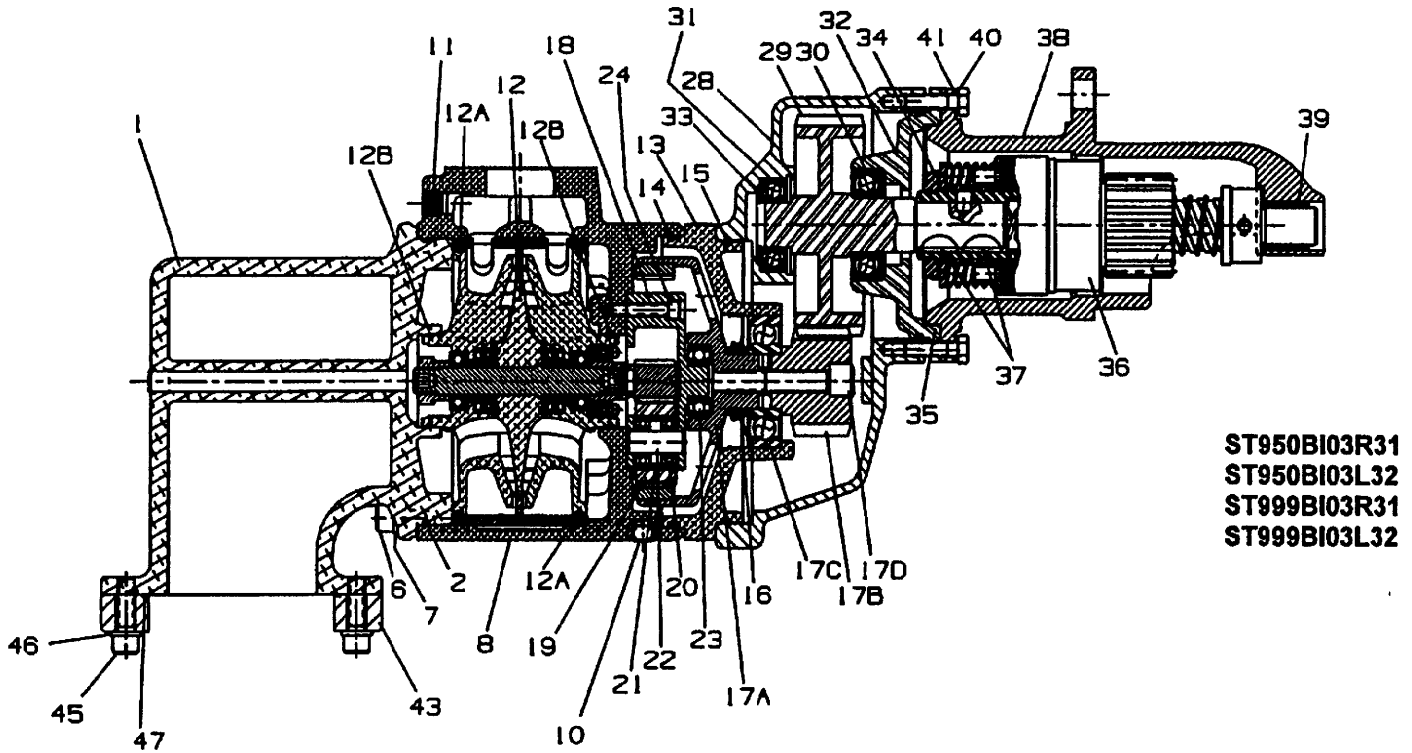
PRE-ENGAGED DRIVE (continued)

		PART NO. FOR ORDERING
63	Drive Pinion	
	for ST950BP03R31 and	
	ST999BP03R31	SS815R-13-31
	for ST950BP03L32 and ST999BP03L32	SS815L-13-32
	for 950CP03R25 and ST999CP03R25	SS825R-13-25
	for ST950CP03L26 and ST999CP03L26	SS825L-13-26
	for ST950DP09R51and ST999DP09R51	SS850R-13-51
	for ST950DP09L52 and ST999DP09L52	SS850L-13-52
	for ST950CPJ3R493	SS815R013-493
64	Pinion Spring Sleeve	
	for Models ST950DP09R51	
	ST950DP09L52, ST999DP09R51	
	and ST999DP09L52	SS850-335
	for all other models	SS800-335
65	Pinion Spring	
	for Models ST950CPJ3R493	
	ST950BP03R31, ST950CP03R25,	
	ST999BP03R31 and ST999CP03R25	SS800R-419
	for Models ST950BP03L32,	
	ST950CP03L26, ST999BP03L32 and	
	ST999CP03L26	SS800L-419
	for ST950DP09R51 and ST999DP09R51	SS850R-419
	ST999DP09L52 and ST950DP09L52	SS850L-419
66	Inlet Flange Kit (includes Inlet Flange,O-ring, Mounting Bolts and Lock Washers)	ST700-K166
	Exhaust Flange Kit (includes illustrated parts 67, 68, 69, 70, and 71)	ST700-K351
67	Exhaust Flange	ST700-351
68	Weld Sleeve	ST700-352
69	Cap Screws (6)	ST700-703
70	Lockwashers (6)	845-58
71	Exhaust Adapter Seal	Y327-46
*	Flange Mounting Hardware Kit (includes O-ring, Mounting Bolts and Lockwashers)	ST750-K167
*	Tune-up Kit (for Pre-engaged drive models) (includes illustrated parts 31,41,45,47,48,55 and 60	ST700P-TK7
*	Tune-up Kit (for D ratio models) includes illustrated parts 41,45,47,48 and 55	ST700D-TK8
72	Housing Exhaust Cover	ST700-562
73	Splash Deflector	ST700-735
74	Deflector Return Spring	D10-275
75	Deflector Return Screw	ST700-737
*	Gear Kit (includes parts 14,15,16,17A,17C,19 20,21,22,23)	ST900-GK1
*	Seal Kit (includes parts 2,12A,12B,14,15,16, 37,41,43,47,48,55,71)	ST900-SK1

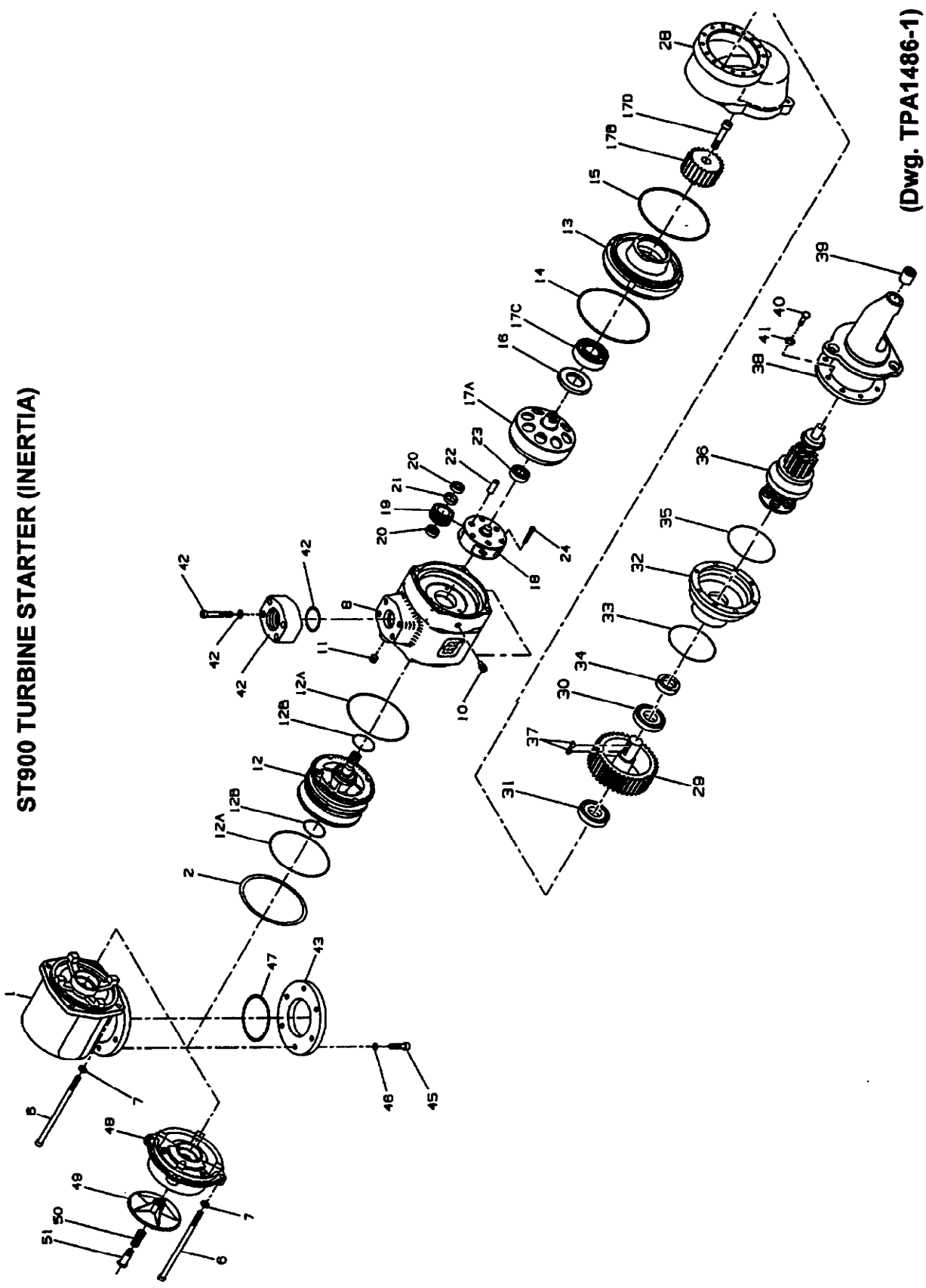
* Not illustrated.

◆ Indicates Tune-up Kit part.

ST900 TURBINE STARTER (INERTIA)



ST950BI03R31
ST950BI03L32
ST999BI03R31
ST999BI03L32


ST900 TURBINE STARTER (INERTIA)
(Dwg. TPA1486-1)

		PART NO. FOR ORDERING			PART NO. FOR ORDERING
	Exhaust Kit	ST700K-350	28	Gear Case	SS800-37
1	Directional Housing Exhaust Cover	ST700-350	29	Drive Gear	SS810-9
2	Exhaust Cover Seal	SS800-67	•30	Front Drive Gear Bearing	BU-359
*	Plug	R0H-377	•31	Rear Drive Gear Bearing	SS800-359
6	Starter Assembly Cap Screw(4)	ST700-2574	32	Gear Case Cover	SS810-678
7	Cap Screw Washer (4)	SS800-26	•33	Gear Case Cover O-ring	SS800-244
	Motor Housing Assembly	ST900-A40	•34	Drive Gear Shaft Seal	SS810-272
8	Motor Housing	ST900-40	•35	Drive Housing O-ring	SS800-152
10	Housing Plug (2)	CE110-29	36	Starter Drive	
11	Housing Plug Inlet Boss	R0H-377		For RH Models	20BM-299-1
*	Nameplate	ST900-301		For LH Models	20BM-299-3
*	Nameplate screw (4)	R4K-302	37	Drive Gear Key (2)	20BM-610
12	Motor Assembly		38	Drive Housing	SS810-300
	For Models ST950BI03	ST950G-RC350	•39	Drive Housing Bearing	SS660-363-13
12A	Cylinder O-ring Seal (2)	ST700-67	40	Drive Housing Cap Screw (8)	SS810-744
12B	Housing O-ring Seal (2)	Y327-32	•41	Drive Housing Cap Screw Lock Washer(8)	TS223A-415
	Intermediate Gear Case Assembly	ST900-A37	42	Inlet Flange Kit (includes Inlet Flange,	
13	Intermediate Gear Case	ST900-37		O-ring, Mounting Bolts and Lock Washers)	ST700-K166
14	Rear Gear Case O-ring	Y327-163		Exhaust Flange Kit (includes illustrated	
15	Front Gear Case O-ring	Y327-162		parts 43,44,45,46, and 47)	ST700-K351
16	Seal	ST700-272	43	Exhaust Flange	ST700-351
17A	Carrier/Ring Gear	ST900-500	45	Cap Screws (6)	ST700-703
17B	Intermediate Pinion	SS800B-17	46	Lockwashers (6)	845-58
17C	Bearing	SS800-22	47	Exhaust Adapter Seal	Y327-46
17D	Screw	SS800-732	*	Flange Mounting Hardware Kit (includes	
	Idler Gear Frame Assembly	ST900-A108		O-ring, Mounting Bolts and Lock Washers)	ST750-K167
18	Idler Gear Frame	ST900-108	*	Tune-up Kit (for Inertia Drive Models)	
19	Idler Gear (3)	ST900-10		includes illustrated parts 30,31,33,34,35,	
20	Idler Gear Bearing (6)	ST900-24		and 39	ST700I-TK6
21	Idler Gear Bearing Spacer (3)	ST900-91	48	Housing Exhaust Cover	ST700-562
22	Idler Gear Shaft (3)	ST900-191	49	Splash Deflector	ST700-735
23	Gear Frame Bearing	T06-24	50	Deflector Return Spring	D10-275
24	Cap Screw (3)	R3F-7	51	Deflector Return Screw	ST700-737

*** Not Illustrated**

• To keep downtime to a minimum, it is desirable to have on hand certain repair parts. We recommend that you stock one (pair or set) of each part indicated by a bullet (•) for every four starters in service.

Always wears 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.

LUBRICATION

Each time a Series ST900 Starter is disassembled for maintenance or repair, lubricate the starter as follows:

For Models with Inertia Drive

NOTICE

On models with inertia drive, do not lubricate the threaded area of the Drive Shaft as it could collect dirt and foreign material which will prevent efficient operation.

For Models with Pre-Engaged Drive

1. Lubricate the inside diameter of the Drive Shaft (57) with Ingersoll-Rand No. 130 Grease.
2. Lubricate the Pinion end of the Drive Shaft with Ingersoll-Rand No. 11 Grease.
3. Wipe a thin film of Ingersoll-Rand No. 130 Grease in the bore of the Drive Housing (40).
4. Roll the Piston Return Spring (59) in Ingersoll-Rand No. 130 Grease.
5. Coat the outside of the Piston (54) with Ingersoll-Rand No. 130 Grease.
6. Lubricate the Drive Gear (29) with 8 oz. (240ml) of Ingersoll-Rand No. 130 Grease.

For All Models (refer to Lubrication and Torque drawing)

1. Lubricate the O-rings with O-ring lubricant.
2. Add 175 ml (approximately 1/3 pint) of Dexron®** II Automatic Transmission Fluid through the side plug hole in the Motor Housing (8).
3. Add 15ml of Dexron®** II Automatic Transmission Fluid to exhaust pipe plug hole (see page 7 left end view).

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 vise 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 ST900 Turbine Starter. Never reuse old seals or gaskets.
5. Always mark adjacent parts on the Housing Exhaust Cover (1), Motor Housing (8), Intermediate Gear Case (13), Gear Case (28) and Drive Housing (40) so these members can be located in the same relative position when the Starter is reassembled.
6. Never wash inertia drive models in a solvent.
7. Do not press any needle bearing from a part unless you have a new needle bearing on hand for installation. Needle bearings are always damaged during the removal process.

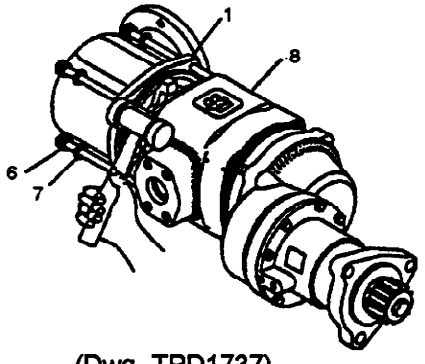
Disassembly of the Exhaust Elbow, Motor Assembly, and Motor Housing and Intermediate Gear Case

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.

NOTICE

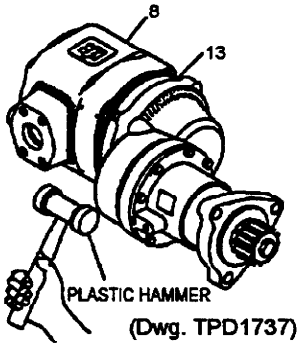
Removing Exhaust Cover Pipe Plug prior to dislodging Housing Exhaust allows easier dissassembly.

2. Using an 8 mm hex-head wrench, unscrew and remove the Starter Assembly Cap Screws (6) and Washers (7).
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, tap the ears alternately until the Housing Exhaust Elbow can be removed from the Motor Housing. Refer to Dwg. TPD1736.



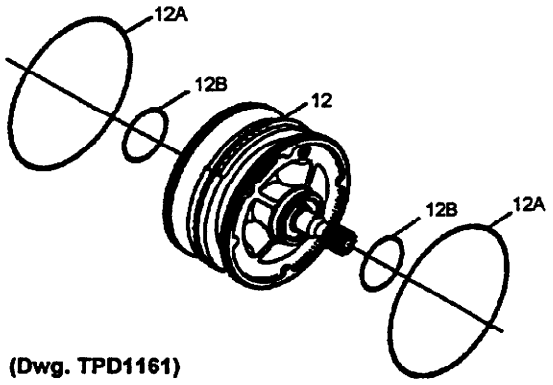
(Dwg. TPD1737)

4. To disassemble the Housing Exhaust Elbow and components, refer to Dwg. TPA1451-3.
5. Tap the Motor Housing with a plastic hammer to dislodge it from the Intermediate Gear Case (13). Refer to Dwg. TPD1737.



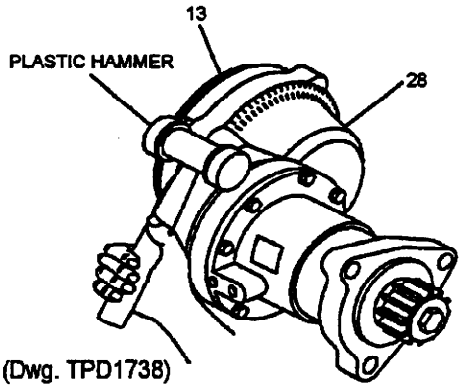
(Dwg. TPD1737)

6. 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 after step 14. Refer to Dwg. TPD1161.



(Dwg. TPD1161)

7. Tap the Intermediate Gear Case with a plastic hammer to dislodge it from the Gear Case (28). Refer to Dwg. TPD1738.

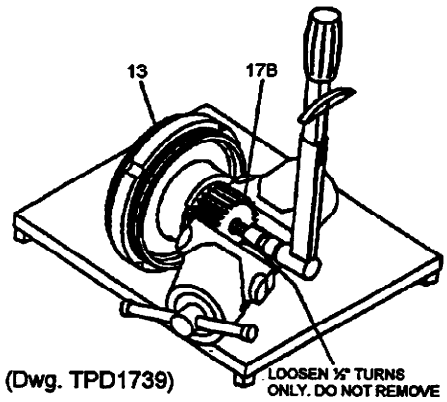


(Dwg. TPD1738)

8. Support the Intermediate Gear Case on a bench and position it in a copper-faced vise so that the Intermediate Pinion (17B) is secured in the jaws of the vise. Tighten the vise only enough to hold the Intermediate Pinion securely.
9. Loosen the Intermediate Pinion Retaining Screw (17D) 1-1/2 turns only. **Do not remove.**

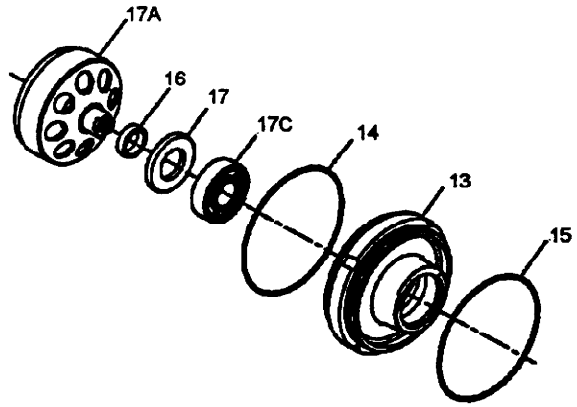
⚠ WARNING

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. Refer to Dwg. TPD1739.



(Dwg. TPD1739)

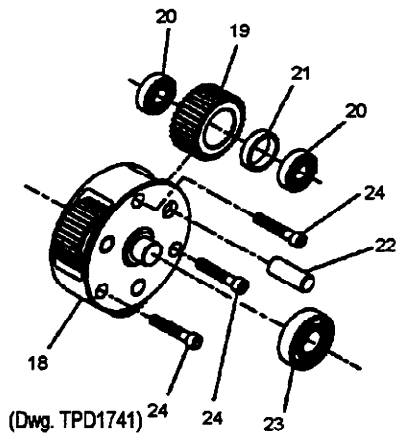
10. Remove the Intermediate Gear Case Assembly from the vise and remove the Intermediate Pinion. Remove the Rear Gear Case O-ring and Front Gear Case O-ring from the Intermediate Gear Case.
11. Remove the Carrier/Ring Gear (17A).
12. Remove Seal (16) and Spacer (17).
13. Remove Bearing (17C) by pressing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



(Dwg. TPD1743)

14. Remove the Cap Screws (24) from the Idler Gear Frame (18) and remove the Idler Gear Frame from the front of the Motor Housing.
    If the Idler Gear Frame will not come out of the Motor Housing easily, use a wooden dowel to tap the Idler Gear Frame from inside the rear of the Motor Housing.
15. If the Gear Frame Bearing (23) needs to be replaced, press it off of the shaft of the Idler Gear Frame.
16. Press the Idler Gear Shafts (22) out of the Gear Frame and remove the Idler Gears (19).

17. Press one of the Idler Gear Bearings (20) out of the 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)

Disassembly of the Drive Housing

Pre-Engaged Models:

1. Grasp the Drive Pinion (63) in a copper-faced vise with the Starter supported on the workbench.
2. Remove the Drive Pinion Retaining Screw (61).

NOTICE

Models ending in R25, R31, and R51 have a left-hand thread. Models ending in L26, L32 and L52 have a right-hand thread.

3. Remove the Starter from the vise.
4. Remove the Drive Pinion Washer (62) and the Drive Pinion.
5. Slide the Pinion Spring Sleeve (64) and the Pinion Spring (65) off the Drive Shaft.
6. Using an impact wrench with a 5/16" (8 mm) x 8" (203 mm) long hex inserted into the end of the Drive Shaft, unscrew the Drive Gear Screw (34).
7. Unscrew and remove the Drive Housing Cap.
8. Tap the Drive Housing (40) with a plastic hammer to help dislodge it from the Gear Case (28).

⚠ WARNING

Failure to follow this procedure could result in injury to personnel.

9. Place the Drive Housing in an arbor press, piston end up. Apply a load to the Piston (54) using the arbor press to compress the Piston Return Spring (59) before removing the Bulkhead Retainer (45).
10. Using a screwdriver, remove the Bulkhead Retainer. Use the arbor press. **Do not use compressed air to load the piston.**

CAUTION

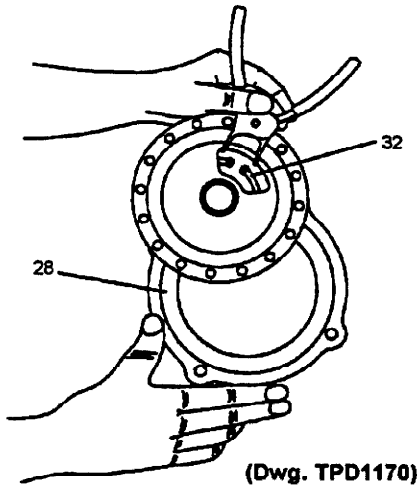
Make sure the tension of the spring pushes the Bulkhead out of the Drive Housing before removing the Drive Housing from the arbor press.

11. Remove the Bulkhead (46) from the Piston.
12. Remove the Outer Bulkhead Ring (47) and the Inner Bulkhead Ring (48).
13. Slide the Drive Shaft (57) from the Drive Housing.
14. Pull the Piston Return Spring (59) off the Drive Shaft.

NOTICE

Do not remove the Front Drive Shaft Bearing (42) or the Drive Housing Seal (43) unless replacement is necessary and new parts are available. The Bearing and/or the Seal will always be damaged when removed from the Drive Housing.

15. Remove the Piston Ring (55) from the Piston.
16. Press the Clutch Spring Cup (50) down and remove the Clutch Spring Cup Retainer (49).
17. Remove the Clutch Spring Cup and Clutch Spring (51).
18. Remove the two Clutch Jaws (52).
19. Remove the Front Drive Gear Bearing (30), Drive Gear Cup (46), Drive Gear Lock Washer (35), Drive Gear Screw Ring (37) and Drive Gear Screw (34).
20. Using a screwdriver, remove the large Drive Shaft Bearing Retainer (53).
21. Press the Rear Drive Shaft Bearing and Drive Shaft (57) out of the Piston. If the Rear Drive Shaft Bearing needs to be replaced, proceed as follows:
    a. Using a small chisel, cut and remove the small drive shaft bearing retainer (53) in the Drive Shaft.
    b. Press the Rear Drive Shaft Bearing (58) off the Drive shaft.
22. Place the Gear Case (28) on a workbench.
23. Using retaining right pliers and working through the access holes in the gear web, remove the Drive Gear Bearing Retainer (32). Refer to Dwg. TPD1170.



(Dwg. TPD1170)

24. Pull the Drive Gear (29) out of the Gear Case.

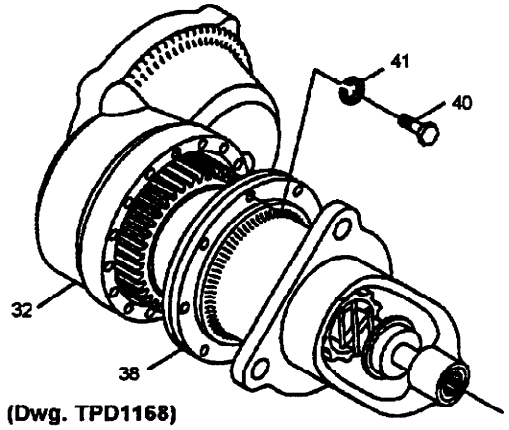
NOTICE

Do not disassemble the Drive Gear and Clutch parts of Series ST900 Turbine-Powered Starters. If the Drive Gear Shaft is defective, install a new or factory-rebuilt unit.

25. Using retaining ring pliers, remove the Drive Gear Shaft Bearing Retainer (33).
26. Remove the Rear Drive Gear Bearing (31) from the Drive Gear.

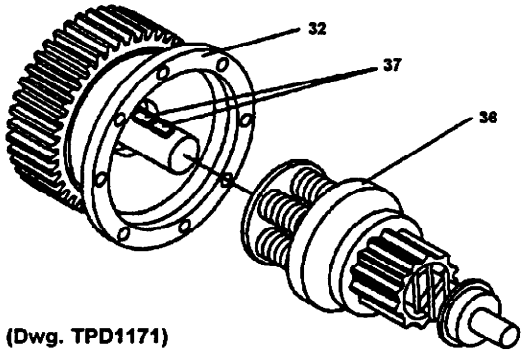
Inertia Models:

1. Remove the eight Drive Housing Cap Screws (40) and Lock Washers (41).
2. Tap the Drive Housing (38) with a plastic hammer to help dislodge it from the Gear Case Cover (32). Remove the Drive Housing (38) from the Starter Drive (36). Refer to Dwg. TPD1168.



(Dwg. TPD1168)

3. Place the Drive Housing in an arbor press, bearing end up. Using a pressing bar, remove the Drive Housing Bearing (39) from the Drive Housing.
4. Using a screwdriver, displace the locking spring and remove the screw holding the Starter Drive (36) to the Drive Gear Shaft.
5. Slide the Starter Drive off the Drive Gear Shaft.
6. Remove the two Drive Gear Keys (37) from the Drive Gear Shaft. Refer to Dwg. TPD1171.



(Dwg. TPD1171)

7. Remove the Gear Case Cover (32) from the Gear Case (38).
8. Remove the Drive Housing O-ring (35) and the Gear Case Cover O-ring (33) from the Gear Case Cover.
9. Pull the Drive Gear (29) out of the Gear Case.
10. Remove the Rear Drive Gear Bearing (31) and the Front Drive Gear Bearing (30) from the Drive Gear.

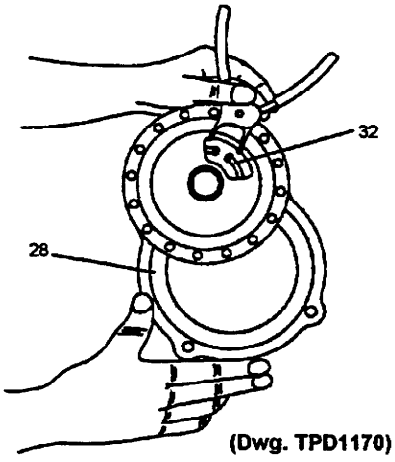
ASSEMBLY

General Instructions (refer to lubrication and torque drawing)

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 Gear Case and Drive Housing Pre-Engaged Models:

1. Place the Drive Gear Bearing Retainer (32) over the rear end of the Drive Gear.
2. Using an arbor press, press the Rear Drive Gear Bearing (31) onto the rear end of the Drive Gear.
3. Using a plastic Hammer, seat the Rear Drive Gear Bearing into the Gear Case by tapping the opposite end of the Drive Gear.
4. Using retaining ring install the Drive Gear Shaft Bearing Retainer (33).
5. Using retaining ring pliers and working through the access holes in the gear web, install the Drive Gear Bearing Retainer. Refer to Dwg. TPD1170.



(Dwg. TPD1170)

6. Lubricate the Drive Gear with approximately 8 oz. (240 ml) of Ingersoll-Rand No. 130 Lubricant.
7. Press the Rear Drive Shaft Bearing (58) onto the Drive Shaft.
8. Slide the rear bearing retainer convex side first, onto the Drive Shaft. Press it into position in accordance with the instructions packaged with the new Retainer.
9. Assemble the Drive Gear Screw (34), Drive Gear Lock Washer (35), Drive Gear Cup (36) and Drive Gear Screw O-ring (37).
10. Grasp the Drive Shaft (57) in a vise, external splined end down. Place assembled Drive Shaft Screw Unit into the Drive Shaft, screwhead down. Lubricate the inside diameter of the Drive Shaft with Ingersoll-Rand No. 28 Lubricant.
11. Slide the Drive Gear Bearing (30) into the Drive Shaft.
12. Lubricate with Ingersoll-Rand No. 130 Lubricant and install the Driving Clutch Jaw teeth facing up and Driven Clutch Jaw teeth facing down into the Drive Shaft.
13. Insert the Clutch Spring (51) into the Drive Shaft.
14. Insert the Clutch Spring Cup (50) into the Drive Shaft.
15. Press the inserted parts into the Drive Shaft, and install the Clutch Spring Cup Retainer (49).

NOTICE

If it is necessary to replace the Drive Housing (40) and drive components, make sure that the Piston Seal (part number SS800-272) has been removed from the rear of the new Piston (54). The Piston Seal must be removed to prevent pressure build-up which will cause movement of the Planet Gear Frame Shaft Seal (16). If this condition occurs, the Piston cannot retract and the Drive Pinion (63) will remain in engagement with the flywheel, causing damage to the Starter drive train and/or Starter motor. To remove the Piston Seal, insert a screwdriver inside the lip of the Seal and pry it loose from the Piston.

16. Install the Piston (54) onto the Drive Shaft until the Rear Drive Shaft Bearing seats into the Piston.
17. Using a thin, flat blade screwdriver to assist in this operation, coil the Large Drive Shaft Bearing Retainer (53) into the groove of the Piston to retain the outer race of the Drive Shaft Bearing.
18. Using o-ring lubricant, lubricate the Piston O-ring (55) and install it in the groove of the Piston.
19. Position the Drive Housing in an arbor press, pinion-end down and install the Drive Housing Seal (43) into the Drive Housing. Using a pressing sleeve of the proper size, press the Seal into the Drive Housing so that the lip of the seal faces away from the Drive Pinion.
20. Using a sleeve that contacts the outer race of the Front Drive Shaft Bearing (42), press the Bearing into the Drive Housing until it seats. For "B" and "C" ratio models only, drop the Piston Return Spring Seat (60) on top of the Front Drive Shaft Bearing.
21. Slide the Piston Return Spring (59) onto the Drive Shaft and snap it into the front of the Piston so that it is against the Large Drive Shaft Bearing Retainer (53).
22. Lubricate and insert the assembled Drive Shaft into the Drive Housing.
23. Using o-ring lubricant, lubricate and install the Outer Bulkhead O-ring (47) and the Inner Bulkhead O-ring (48) on the Bulkhead (46).
24. Slide the Bulkhead onto the Piston.
25. With the Drive Housing in the arbor press, press down on the rear face of the Piston.

NOTICE

Feel the underside of the Drive Housing to make sure the Drive Shaft passes through the Bearing.

26. Using a screwdriver, install the Bulkhead Retainer (45).

⚠ WARNING

Make sure the Bulkhead Retainer is properly seated in the Motor Housing groove before easing off the arbor press. Failure to do so will allow improperly retained parts to separate when removed from the arbor press resulting in injury to personnel.

27. Remove the Drive Housing from the arbor press.
28. Using o-ring lubricant, lubricate and install the Drive Housing O-ring (41) in the groove of the Drive Housing.
29. Position the assembled Gear Case on a workbench. The assembled unit must be upright to accept the Drive Housing.
30. Carefully position the assembled Drive Housing (40) onto the Gear Case so as not to damage the Piston Seal. Align the punch marks of the Gear Case and Drive Housing.
31. Install the Drive Housing Cap Screw Lock Washers (39) and the Drive Housing Cap Screws (38) and tighten to 28 ft-lb (38 Nm) torque.
32. Using an impact wrench with a 5/16" (8 mm) x 8" (203 mm) long hex inserted into the end of Drive Shaft, tighten the Drive Gear Screw (34) to 57 ft-lb (77.3 Nm) torque.
33. Lubricate using Ingersoll-Rand No. 11 Grease and slide the Pinion Spring (65) and the Pinion Spring Sleeve (64) over the Pinion end of the Drive Shaft.
34. Lubricate the Pinion end of the Drive Shaft with Ingersoll-Rand No. 11 Grease and install the Drive Pinion (63).
35. Grasp the Drive Pinion in a leather-covered or copper-covered vise with the starter supported on a workbench.
36. Place the Drive Pinion Washer (62) onto Drive Pinion Retaining Screw (61).

NOTICE

Models ending in R25, R31 and R51 have a left-hand thread; models ending in L26, L32 and L52 have a right-hand thread. Install the Drive Pinion Retaining Screw into the end of the Drive Shaft and tighten it to 80 ft-lb (108.5 Nm) torque for models with "B" and "C" gear ratios and to 125 ft-lb (169.5 Nm) torque for models with "D" gear ratio.

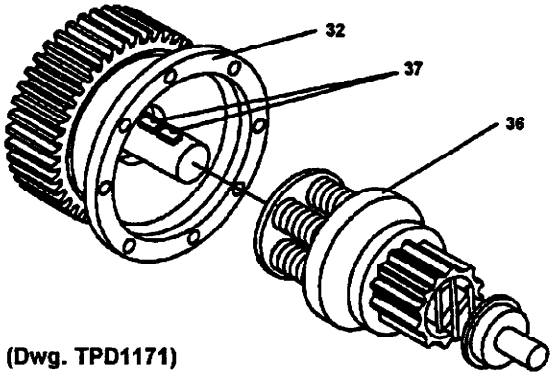
Inertia Drive Models:

NOTICE

On models with Inertia Drive, do not lubricate the threaded area of the Drive Shaft as it could collect dirt and foreign material which will hinder efficient operation.

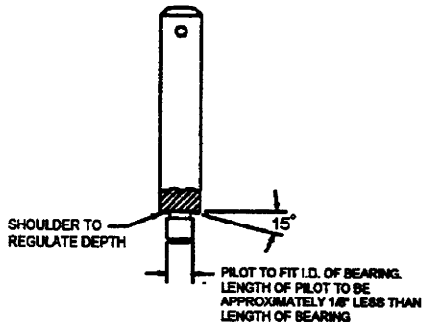
Gear Case

1. Install the Rear Drive Gear Bearing (31) and Front Drive Gear Bearing (30) onto the Drive Gear (29).
2. Install the two Drive Gear keys (37) into the drive gear shaft. Refer to Dwg. TPD1171.



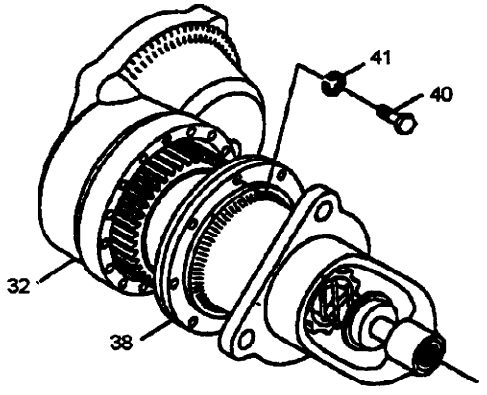
(Dwg. TPD1171)

3. Slide the Rear Drive Gear Bearing into the Gear Case.
4. Lubricate the Drive Gear with approximately 8 oz. (240ml) of Ingersoll-Rand No. 130 Grease.
5. Press the Drive Gear Shaft Seal (34) down into the Gear Case Cover (32). lip facing upward.
6. Install the Gear Case Cover O-ring (33) onto the Gear Case Cover.
7. Install the Gear Case Cover into the Gear Case.
8. Slide the Starter Drive (36) onto the drive gear shaft and tighten the Starter drive locating the ring and screw securely.
9. Press the Drive Housing Bearing (39) into the Drive Housing (38) and lubricate it with Ingersoll-Rand No. 130 Grease. See Dwg. TPD786.



(Dwg. TPD786)

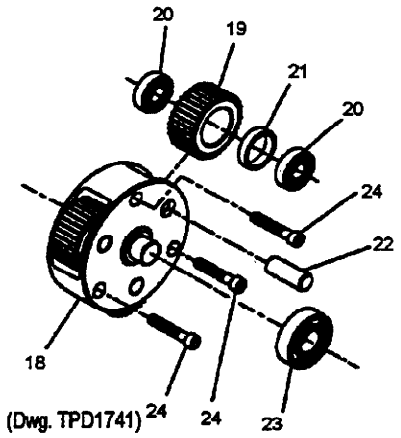
10. Install the Drive Housing O-ring (35) onto the Drive Housing.
11. Install the Drive Housing onto the Gear Case, aligning the punches.
12. Install the eight Drive Housing Cap Screws (40) and Drive Housing Cap Screw Lock Washers (41). Tighten to 28 ft-lb (38 Nm) torque. Refer to Dwg. TPD1168.



(Dwg. TPD1169)

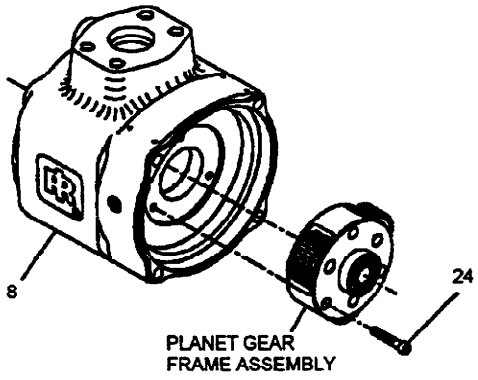
Installation of the Motor Housing, Motor Assembly and Intermediate Gear Case

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 Gears and 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.



(Dwg. TPD1741)

6. Install the Idler Gear Frame Assembly in the front of the Motor Housing and secure it with Loctite and torque to 10 ft-lb with Cap Screws (24). Refer to Dwg. TPD 1745.



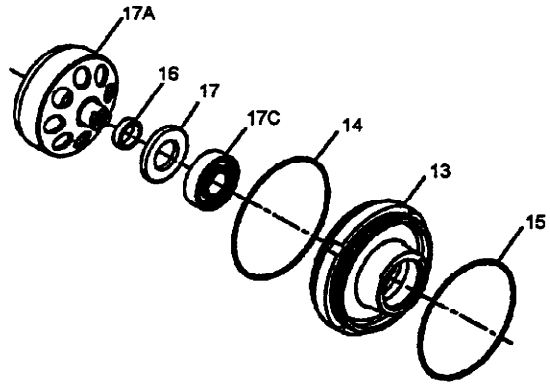
(Dwg. TPD1745)

7. Install the Spacer (17) on the shaft of 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

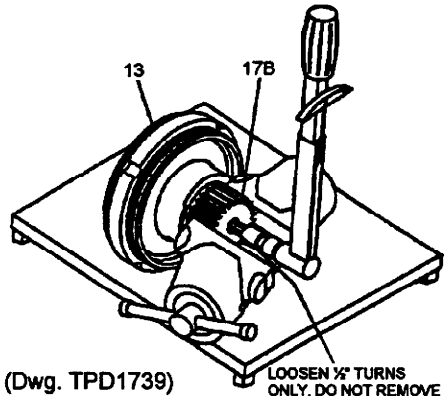
Make sure that the flat side of the seal will be installed against the Bearing.

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



(Dwg. TPD1743)

11. Install the Intermediate Pinion (17B) making sure that the notches at the rear of the Pinion align with the notches and tangs in the shaft of the Idler Gear Frame.
12. Clean the threads of the Intermediate Pinion Retaining Screw (17D) and apply 2-3 drops of Permabond HM118® *** to the threads approximately 3 mm from the end of the Screw. Install Screw and tighten enough to hold assembly together.
13. For final tightening, position the Intermediate Gear Case so 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 (122 Nm) torque. Refer to Dwg. TPD1739.

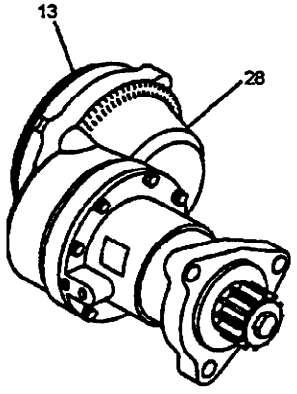


(Dwg. TPD1739)

14. Remove the Intermediate Gear Case from the vise and set it on a bench.
Align the punch marks on the Intermediate Gear Case and Gear Case and using a plastic hammer, tap the Intermediate Gear Case until it seats in the rear of the Gear Case. Make sure the Intermediate Pinion meshes with Drive Gear. Refer to Dwg. TPD1746.

NOTICE

During field orientation do not change the relationship between the offset housing (28) and the intermediate housings (13). It is important that the cut out section of the bearing boss on the intermediate housing (13) aligns with the drive gear (29).

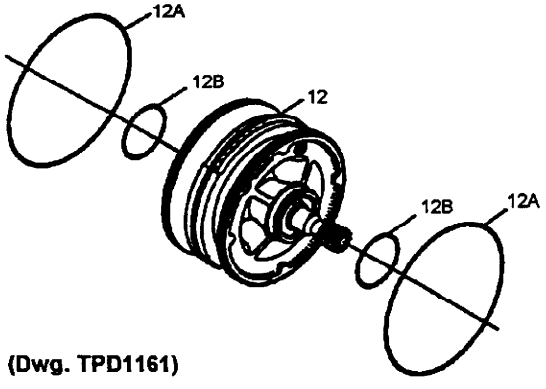


(Dwg. TPD1746)

15. 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.
16. 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.

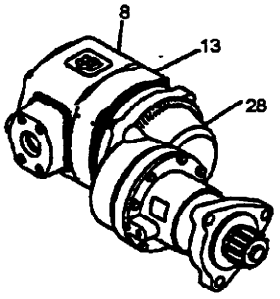
NOTICE

Turn the Intermediate Pinion so that the gear on the rotor meshes with the Idler Planet Gears. Make sure the rear of the Motor Assembly is installed flush with the rear of the Cylinder.



(Dwg. TPD1161)

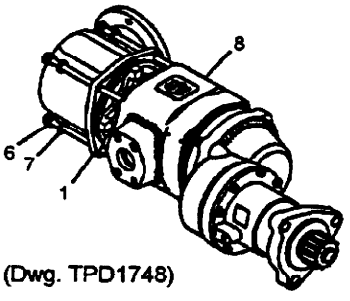
17. Align the punch marks on the Motor Housing with the punch marks on the Intermediate Gear Case and using a plastic hammer, tap the Motor Housing until it seats on the rear of the Intermediate Gear Case. Refer to Dwg. TPD1747.



(Dwg. TPD1747)

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 and Cap Screw Washers. Using an 8 mm 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. TPD1748.



(Dwg. TPD1748)

4. Lubricate Exhaust Adapter Seal (71) with o-ring lubricant and install in groove in Exhaust Flange (67).
5. Install Exhaust Flange with Exhaust Adapter Seal down on Directional Housing Exhaust Cover. Align holes and secure Adapter with Cap Screws (69) and Lock Washers (70). Tighten each Cap Screw a little a time to a final torque of 48 ft-lb (65 Nm torque) in 20 ft-lb (27 Nm) increments.

NOTICE

Whenever assembling the Exhaust Cover to the starter, be sure to add 15ml of Dexron®II Automatic Transmission Fluid to the pipe plug hole marked "OIL HERE".**

Use Ingersoll-Rand SMB-441 Pipe Sealant on all plugs.

6. 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 1/3 pint) of Dexron®** II Automatic Transmission Fluid through the side plug hole in the Motor Housing (8).

Turbine Module Change-Out

NOTICE

These instructions will ensure a successful change-out of a turbine module (Motor Assembly) on an Ingersoll-Rand starter.

These instructions will cover starters with and without Directional Housing Exhaust and cover mechanical components, plumbing, lubrication and disposition of leftover components.

Definitions

1. **Turbine Module.** The turbine module consists of the Motor Rotor Assembly (12), Exhaust Kit (1 or 72), the Motor Housing (8), the Intermediate Gear Case (13) and included parts.
2. **Gear Case (28).** The Gear Case is of an offset shape and has four long socket head Cap Screws (6). The heads of the Cap Screws are seen from the rear of the starter.
3. **Drive Housing Kit.** The Drive Housing Kit contains the 3-bolt Flange (44C) that attaches the starter to the engine or the drive housing (40) and included parts.
4. **Housing Exhaust Cover Assembly (72).** The Housing Exhaust Cover Assembly consists of the Cover and its associated parts found on the rear end of starters.
5. **Directional Housing Exhaust Cover (1).** The Directional Housing Exhaust Cover consists of a 90, 3-1/2 inch flanged elbow located on the rear end of starters equipped with the Housing Exhaust Cover Assembly.
6. **Starter Assembly Cap Screw (6).** The Starter Assembly Cap Screws are 1.5 x 10 mm socket head cap screws. Four Cap Screws are required on each starter. Their heads are seen on the rear end of the starter.

Procedure

For Starters Without Directional Housing Exhaust:

1. Tag off the starter control to prevent inadvertent use of the starter.
2. Remove the four Cap Screws (66) that attach the Inlet Flange (66) to the side of the Motor Housing (8). Save the O-ring (66) found under the Inlet Flange.
3. Remove the four Starter Assembly Cap Screws (6) found on the rear end of the starter.
4. Remove the turbine module and the Housing Exhaust Cover Assembly (72) as a unit from the Gear Case (28) and set aside.
5. Insert the replacement turbine module into the Gear Case making sure that the cutout portion of the front of the turbine module is facing the large Drive Gear (29) inside the Gear Case.
6. Install the four Starter Assembly Cap Screws and torque them each to 45-50 ft-lb torque in 20 ft-lb increments.
7. Apply some grease to the O-ring saved from the Inlet Flange. Push the O-ring into the groove on the Inlet Flange and reinstall the Flange. Remove the tag from the starter control and test the starter.
8. Place the leftover turbine module into the box and ship it to Ingersoll-Rand using the return goods authorization and shipping label provided with the replacement turbine module.

For Starters With Directional Housing Exhaust:

1. Tag off the starter control to prevent inadvertent use of the starter.
2. Remove the four Cap Screws (66) that attach the Inlet Flange (66) to the side of the Motor Housing (8). Save the O-ring (66) found under the Inlet Flange.
3. Remove the four Starter Assembly Cap Screws (6) found on the rear end of the starter.
4. Disconnect the Directional Housing Exhaust Cover (1) from the exhaust piping.
5. Remove the turbine module and Directional Housing Exhaust Cover as a unit from the Gear Case (28). Remove the Directional Housing Exhaust Cover from the turbine module. Set the turbine module aside.
6. Remove the Directional Housing Exhaust Cover Assembly from the replacement turbine module.

NOTICE

Hold the turbine module in the vertical position (with the gear end down) to save the Dexron® II covering the rear turbine bearing.**

Replenish the Dexron®** II if necessary. Install the Directional Housing Exhaust Cover (1) onto the turbine module.

7. Install the turbine module and Directional Housing Exhaust Cover as a unit into the Gear Case. Make sure that the cutout portion on the front of the turbine module is facing the large Drive Gear (29) inside of the Gear Case (Figure 1).

8. Install the four Starter Assembly Cap Screws and torque them to 55 ft-lb torque in 20 ft-lb increments
   Apply some grease to the O-ring saved from the Inlet Flange. Push it into the groove on the Inlet Flange and reinstall the Flange. Attach the Directional Housing Exhaust Cover to the exhaust piping.
10. Remove the tag from the starter control and test the starter.
11. Place the leftover turbine module and Directional Housing Exhaust Cover Assembly into the box and ship it to Ingersoll-Rand using the return goods authorization and shipping label provided with the replacement turbine module.

Completion of Turbine Module Change-Out

NOTICE

Before connecting the gas supply connection to the side of the turbine module (Motor Assembly), make sure that no loose solids are inside the supply piping.

1. No loose solids should be inside the supply piping. If it is possible to blow out the disconnected gas supply line without exposing the work space to free natural gas, tap the line with a metal hammer to dislodge loose material. Apply around 50 psig partial pressure to the gas supply line to sweep out dislodged material. If not already in use, install a 100 micron filter (Ingersoll-Rand Part No. ST900-267-24) in the gas supply line immediately before the turbine module supply inlet.
2. Finish connecting the turbine module (Motor Assembly) gas supply connections.

NOTICE

Before returning starter to service, make sure that the rear bearing of the turbine (Motor Assembly) has an adequate amount (15 mm) of Dexron® II lubricant.**

For Starters Without the Directional Housing Exhaust Cover:

1. Remove the Deflector Return Screw (75) at the center of the Splash Deflector (75) at the rear of the starter.
2. Using a lube injector, squirt some Dexron®** II into the Cap Screw hole. Reinstall the Deflector Return Screw.

For Starters With the Directional Housing Exhaust Cover:

1. Remove the 1/4 inch Plug on the outside and back of the Directional Housing Exhaust Cover.
2. Using a lube injector, squirt Dexron®** II into the hole until it begins to flow back out. Reinstall the Plug.
   Before the job is completed, verify that the starter is receiving the proper gas supply pressure while running. The desired pressure is printed on the nameplate of the starter. Measurement of this pressure should be taken at the motor inlet of the starter. Before turning on the starter, a 0-160 psig gage may be connected to the inlet of the starter by first removing a 1/4 inch NPT plug at the starter motor inlet. Return the starter to operation and adjust gas supply to proper pressure.

CAUTION

Do not overfill. Install the side Housing Plug (10) and tighten all plugs to 5 to 10 ft-lb (6.8 to 13.6 Nm) torque.

TEST AND INSPECTION PROCEDURE

1. **Clutch Ratcheting:** Turn the Drive Shaft Pinion (63) by hand in the direction of Starter rotation. The clutch should ratchet smoothly with a slight clicking action.
2. **Motor and Gearing Freeness:** Turn the Drive Shaft Pinion (63) opposite the direction of Starter rotation. The Drive Shaft Pinion should turn by hand.
3. **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.
4. **Motor Seals:** Plug the exhaust and slowly apply 20 psig (1.38 bar/138 kPa) pressure to the inlet of the motor. Immerse the Starter for 30 seconds in a nonflammable, bubble-producing liquid. If the Starter is properly sealed, no bubbles will appear.
5. **Gear Case Seals:** Plug the exhaust and slowly apply 20 psig (1.38 bar/138 kPa) pressure to the inlet of the motor. Immerse the Starter for 30 seconds in a nonflammable, bubble-producing liquid. 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, no bubbles will appear.
6. **Confirm Motor Adjustment:** Remove Housing Plug (10). Use a 1/4" hex drive to rotate the motor to verify proper motor adjustment. Motor should rotate freely.
7. **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 pages 7, 8, and 10.
8. **Confirm Drive Rotation:** Apply low pressure to motor and observe rotation. Drive Pinion (63) must rotate in the direction stamped on the nameplate. Chamfer on pinion teeth should be on trailing edge of gear tooth.
9. **Bendix Drive Function - Inertia Models Only:** Install Starter on testing fixture. Apply low pressure air to motor. Bendix must engage according to specified rotation.
10. **Drive Housing Function - Pre-Engaged Models Only:** Apply 120 psig (8.2 bar/827 kPa) to "IN" port of Drive Housing (40). Cycle five times. Air should exhaust through "OUT" port during each cycle.

11. **Exhaust Deflector Operation:** Install the Starter on testing fixture. Apply low air pressure to motor and observe. The Deflector must return to its normal position after operation of the Starter.
12. **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 with .008 max. T.I.R. Mounting face must be square with shaft within .004 T.I.R. max.
13. **Drive Housing Leakage - Pre-Engage Models Only:** Plug Drive Housing (40) "OUT" port and apply 150 psig (3.45 bar/344 kPa) to "IN" port to extend Drive Shaft (57). There should be no leakage.
14. **Test Pinion Engagement - Pre-Engaged Models Only:** Plug "OUT" port in Drive Housing (40). Apply 50 psig (3.45 bar/344 kPa) as needed. In its normal position, the distance from the mounting flange to the end of the Drive Shaft (57) should be 1-3/4". In its extended position, the distance from the mounting flange to the end of the Drive Shaft should be 2-7/8". While the Drive Shaft is extended, push the Drive Pinion (63) back on helical splined shaft. Rear face of Drive Pinion must move back .47" +/- .035".

TROUBLESHOOTING GUIDE

Touble	Probable Cause	Solution
Motor will not run	No air supply	Check for blockage or damage to air supply lines or tank.
	Damaged Motor Assembly	Inspect Motor Assembly and power train and repair or replace if necessary.
	Foreign material in Motor and /or piping.	Remove Motor Assembly and/or piping and remove blockage.
	Blocked exhaust system	Remove Housing Exhaust Cover and check for blockage.
	Defective Control Valve 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.
	Relay Valve malfunctioning	Clean or replace lines or Relay Valve. Lube Relay Valve.
	Exhaust flow restriced	Check for blocked 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.

For Models with Inertia Drive:

Drive will not engage	Foreign material in Starter Drive	Remove obstruction.
	Damaged or worn Drive Parts	Check Drive components and replace if necessary.

For Models with Pre-Engaged Drive:

Drive will not engage	No pressure to Drive Housing port	Check air supply.
	Internal Drive Housing ports blocked	Remove blockage.
	Fluid in drive unit components	Remove fluid.
	Damaged or worn Piston Assembly, O-rings or seals	Replace damaged or worn parts.
	O-rings and seals dry	Re-lube O-rings and seals.
Motor runs, Pinion engages, but does not rotate flywheel	Damaged or broken drive train	Disassemble drive train and replace worn or damaged parts.
Excessive butt engagement	Damaged Drive Pinion or flywheel	Inspect Drive Pinion and flywheel and replace if necessary.
	Damaged Starter Drive or components	Inspect Drive components and replace worn or damaged parts.
	Low air pressure	Chech air supply.
	Wrong Drive Pinion	Replace with proper Drive Pinion.

TROUBLESHOOTING GUIDE *(Continued)*

Oil blowing out of exhaust	Oil in air supply line	Inspect air line and remove source of oil.
	Splash Deflector Retaining Screw or pipe plug missing	Install Splash Deflector 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 from Gear Case	Worn or damaged O-rings	Replace O-rings.
	Loose joints	Make sure that joints fit properly and that Starter Assembly Cap Screws are tightened to 60 ft-lb (81 Nm). Make sure that 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 using Ingersoll-Rand SMB-441 Pipe Sealant.
	Splash Deflector Retaining Screw or pipe plug missing	Tighten Splash Deflector Retaining Screw or replace pipe plug.
Air or gas leakage	Loose Joints	Make sure that joints fit properly and that Starter Assembly Cap Screws are tightened to 60 ft-lb (81 Nm.) torque. Make sure that all seals and O-rings fi' and seal properly at their perimeters. I. 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.
	Splash Deflector Retaining Screw loose or pipe plug missing	Tighten Splash Deflector Retaining Screw or replace pipe plug.

NOTICE

SAVE THESE INSTRUCTIONS. DO NOT DESTROY.

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