



45544103
Edition 7
January 2019

Turbine Powered Starters

Series ST1000

Installation and Maintenance Information



Save These Instructions

IR *Ingersoll Rand*

Product Safety Information

Intended Use:

The ST1000 Series air starters are intended for use in starting reciprocating internal combustion engines. These starters are designed to be operated from a remote location after proper installation on the engine requiring starting.

For additional information refer to Air Starters for Internal Combustion Engines Product Safety Information Manual Form 45558624.

Manuals can be downloaded from ingersollrandproducts.com.

Operating Guidelines



WARNING

- Never exceed the nameplate operating pressure rating.
- Always release the start button immediately after the engine starts.
- 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

- 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.
 - When using the starter for dynamic timing measurements, rest the starter for 2 ½ minutes between 30 second measurements.
 - An ST1000-267 strainer or equivalent 40 mesh strainer is recommended to maximize the durability of the starter.
 - Supply must be free of contaminants. New piping must be free of scale and welding slag.
 - The ST1000 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.
 - Allow 30 seconds "wind down" time between any two successive starting attempts.
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Placing Starter in Service

NOTICE

For maximum performance, read this manual prior to the installation or operation of ST1000 series turbine-powered starters. All parts references are for pre-engaged starters unless otherwise noted.

General Installation 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 ST700-K166 flange mounting kit is available 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 to 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 1.5" 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 40 mesh strainers provide 420 micron filtration and offer significant protection against supply line contaminants which could damage the turbine components. **Ingersoll Rand** offers 2 sizes; ST1000-267-24 for 1 1/2" lines and ST1000-267-32 for 2" lines. Replacement 40 mesh elements are: ST1000-266-24 for 1 1/2" lines and ST1000-266-32 for 2" lines.

7. A leak in any live air line connections means that the system will drain overnight and will have to be repressurized the next morning by use of another vehicle or compressor.
Make connections bubble tight to avoid unnecessary costs and delays. On all threaded connections throughout the system, use **Ingersoll Rand** No. SMB-441 sealant or non-hardening No.2 Permatex. 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.

Orientation of the Starter

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

1. Refer to the orientation illustrations under "How to order a starter" and note that the drive housing (79) can be located in any one of sixteen radial positions relative to the gear case (49). The air inlet can be located in any one of four radial positions relative to the gear case. And 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 (87) 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 28-30 lb-ft (38-41 Nm) of torque.

NOTICE

During field orientation, do not change the relationship between the offset gear case and the intermediate gear case (45). It is important that the cut out section of the bearing boss on the intermediate gear case aligns with the drive gear (54). See Dwg. 45548500 SH7 in "Intermediate Gear Housing – Assembly and Installation".

- After the drive housing is properly oriented relative to the gear case, determine if the inlet port will be favourably located for hose installation. If either or both of these members must be reoriented, remove the four 5/8 in motor housing cover cap screws (33) and rotate the motor housing (1) and/or exhaust housing (16) to its desired position.

NOTICE

Do not separate the motor housing (1) from the intermediate gear case (45) as gear lubrication oil will be lost.

- Reinstall the starter assembly cap screws (33) and lock washers (32) and alternately tighten them to 49-61 lb-ft (66-83 Nm) of torque in 20 lb-ft (27 Nm) increments.

Mounting the Starter

- Study the appropriate piping diagrams and install as indicated.
- 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.
- 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.
- Using a 1½" short nipple, install the starter relay valve SRV150 for air applications SRV150S5 for gas on the end of the receiver tank as shown in the appropriate piping diagram.

NOTICE

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

- Install the starter control valve SMB-618 for air applications or SMB-G618 for gas 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 solenoid valve 150-BMP-1051B (12V) or 150BMP-2451B (24V) 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.
- Attach starter instruction label TA-STR-100 to the control panel adjacent to the starter control valve.

- Mount the 150 psi air pressure gauge 150BMP-1064 on or adjacent to the control panel. It should be located where it is readily visible to the operator.
- Connect the starter control valve to the starter relay valve with ¼" 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 "SUPP") of the starter control valve.

- To determine the exact length of 1½" air hose required, run a piece of heavy duty hose or some other flexible tubing of the same diameter from the starter relay valve on the receiver to the starter location on the engine.
- Once the 1½" hose of correct length has been obtained, attach the air hose to the outlet side of the starter relay valve and run the hose through the frame, etc. to its final position at the starter location.
- 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.
- 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.
- Move the starter into position and mount it on the flywheel housing. Tighten the mounting bolts to 100 ft-lb (136 Nm) of torque or to engine manufacturer's recommended torque settings.
- For Pre-Engaged Models only:** Install a ¼" 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.
- Install a ¼" hose line from the "OUT" port on the starter drive housing to the top of the starter relay valve or solenoid valve.
- For straight exhaust models if the exhaust is to be piped away, remove the standard splash deflector (20), spring (21), and splash deflector screw (22) which are located at the rear of the exhaust housing and replace the splash deflector screw with a ¼"NPT pipe plug.
- 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

Ingersoll Rand offers a line of pendant controlled barring motors for safe and efficient barring of engines for use with reciprocating gas engines up to 1000 liters (500 liters for diesel). Visit ingersollrandproducts.com for more information on **Ingersoll Rand** barring motors.

Performance Data**ST1060 B Ratio**

Pressure (psig)	Breakaway Torque (lbf-ft)	Speed @ Max. Power (rpm)	Max. Power (hp)	Flow @ Max. Power (scfm)
30	50	1560	8	370
60	120	2000	23	590
90	190	2270	40	820
120	257	2460	55	1050
150	321	2540	70	1290

ST1099 B Ratio

Pressure (psig)	Breakaway Torque (lbf-ft)	Speed @ Max. Power (rpm)	Max. Power (hp)	Flow @ Max. Power (scfm)
30	82	1425	13	540
60	200	1850	36	890
90	347	2060	68	1240

ST1060 C Ratio

Pressure (psig)	Breakaway Torque (lbf-ft)	Speed @ Max. Power (rpm)	Max. Power (hp)	Flow @ Max. Power (scfm)
30	60	900	8	370
60	135	1290	23	590
90	215	1515	40	820
120	295	1675	55	1050
150	372	1780	70	1290

ST1099 C Ratio

Pressure (psig)	Breakaway Torque (lbf-ft)	Speed @ Max. Power (rpm)	Max. Power (hp)	Flow @ Max. Power (scfm)
30	98	1225	13	540
60	234	1580	36	890
90	400	1770	68	1240

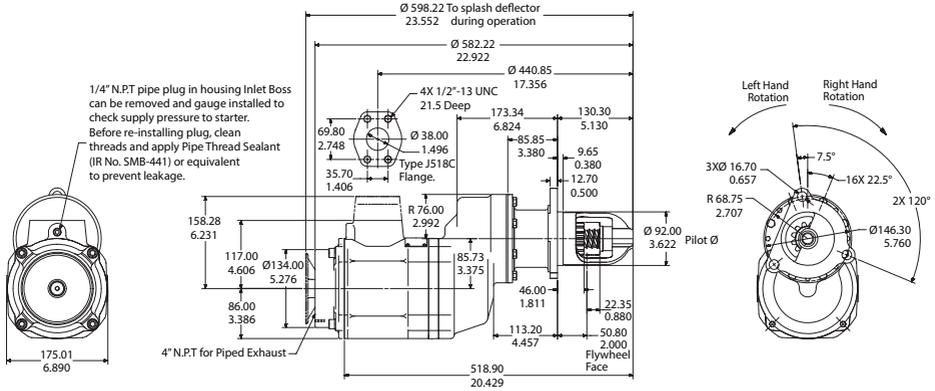
ST1060 D Ratio

Pressure (psig)	Breakaway Torque (lbf-ft)	Speed @ Max. Power (rpm)	Max. Power (hp)	Flow @ Max. Power (scfm)
30	80	663	8	370
60	183	860	23	590
90	292	1440	40	820
120	405	1560	55	1050
150	507	1650	70	1290

ST1099 D Ratio

Pressure (psig)	Breakaway Torque (lbf-ft)	Speed @ Max. Power (rpm)	Max. Power (hp)	Flow @ Max. Power (scfm)
30	132	900	13	540
60	318	1170	36	890
90	540	1305	68	1240

Inertia:



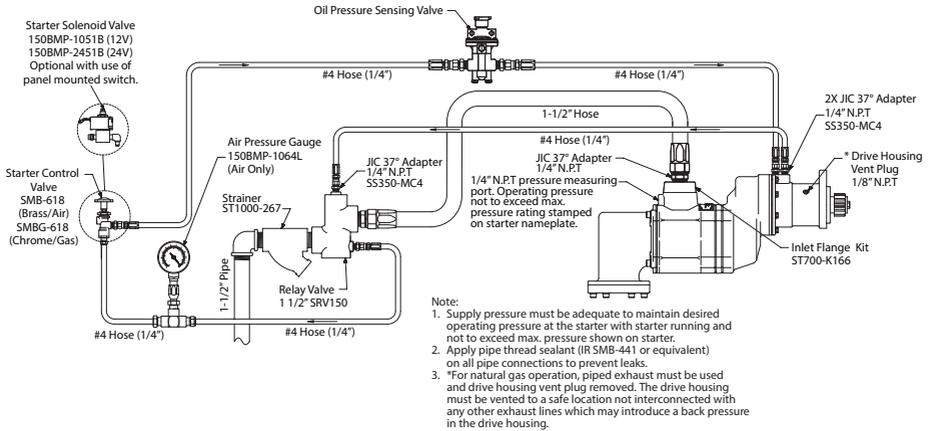
- Note:
1. For orientation information, see starter orientation method section.
 2. Starter weight: Approximately 71 LBS.
 3. Apply pipe thread sealant (IR SMB-441 or equivalent) on all pipe connections to prevent leaks.
 4. *For natural gas operation, piped exhaust must be used.

Dual Dimension MM
 Dimension IN

(Dwg. 45552197 SH3)

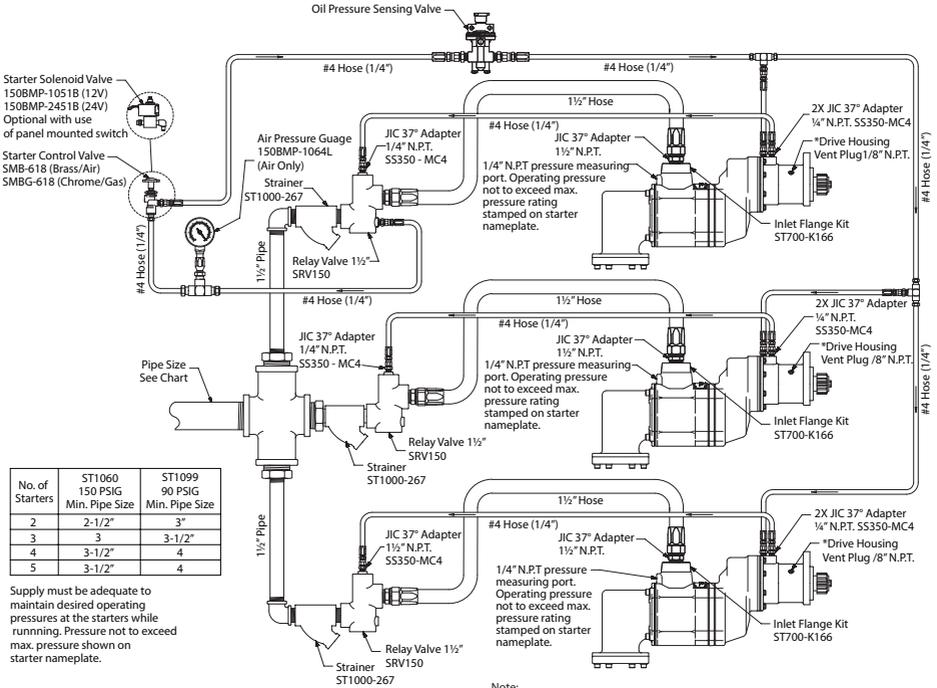
Piping Diagrams

Typical Single Starter Installation, Pre-engaged.



(Dwg. 45552197 SH4)

Typical Multiple Starter Installation, Pre-engaged.



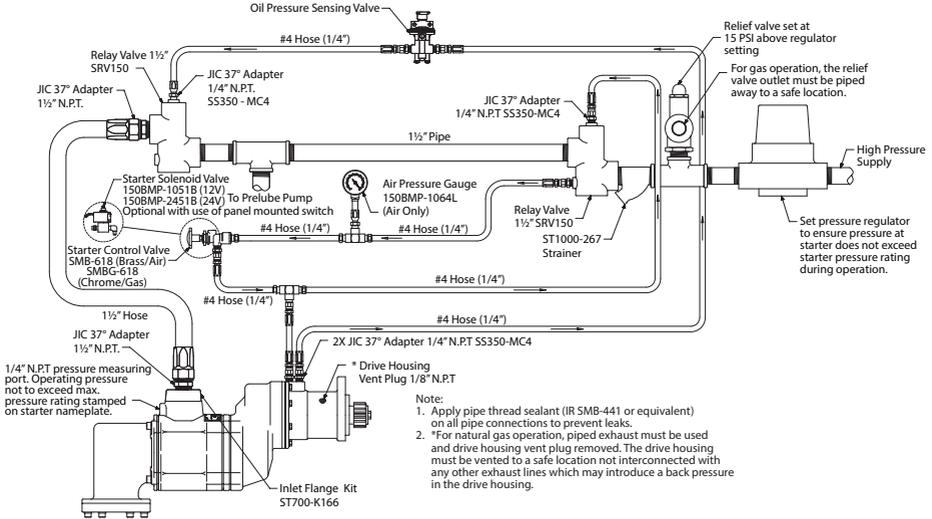
No. of Starters	ST1060 150 PSIG Min. Pipe Size	ST1099 90 PSIG Min. Pipe Size
2	2-1/2"	3"
3	3	3-1/2"
4	3-1/2"	4
5	3-1/2"	4

Supply must be adequate to maintain desired operating pressures at the starters while running. Pressure not to exceed max. pressure shown on starter nameplate.

- Note:
1. Apply pipe thread sealant (IR SMB-441 or equivalent) on all pipe connections to prevent leaks.
 2. *For natural gas operation, piped exhaust must be used and drive housing vent plug removed. The drive housing must be vented to a safe location not interconnected with any other exhaust lines which may introduce a back pressure in the drive housing.

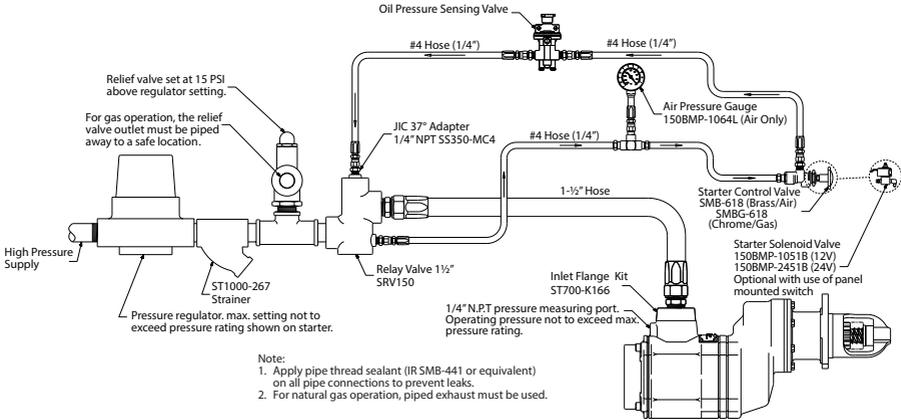
(Dwg. 45552197 SH5)

Standard High Pressure System when Supply Pressure is over Pressure Rating of Starter, Pre-Engaged.



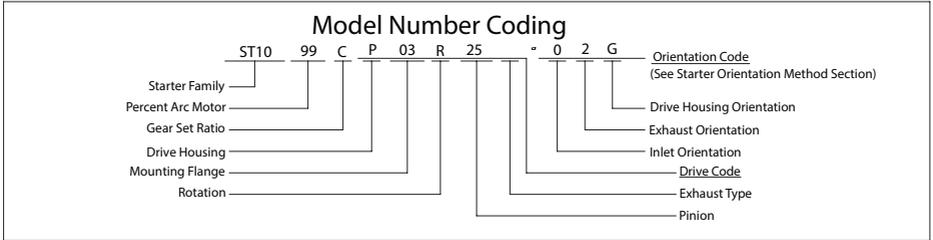
(Dwg. 45552197 SH6)

Standard High Pressure System when Supply Pressure is over Pressure Rating of Starter, Inertia.



(Dwg. 45552197 SH7)

How to Order a Starter



Percent Arc Motor*
60 : 60% Arc Motor
99 : 100% Arc Motor

Gear Set Ratio
B : 2.18 : 1
C : 2.53 : 1
D : 3.44 : 1

Drive Housing
I : Inertia
P : Pre Engaged

Mounting Flange
03 : SAE 03 Flange
09 : SAE 09 Flange

Rotation
L : Left Hand
R : Right Hand

Pinion
See Pinion Selection Chart

Exhaust Type
No Letter : Directional
S : Straight

Inlet Orientation
0 - 3

Exhaust Orientation
If Exhaust Type is Directional : 0-3
If Exhaust Type is Straight: No Number

Drive Housing Orientation
A - P

(Dwg. 45548500 SH4)

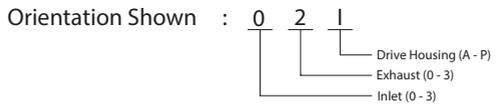
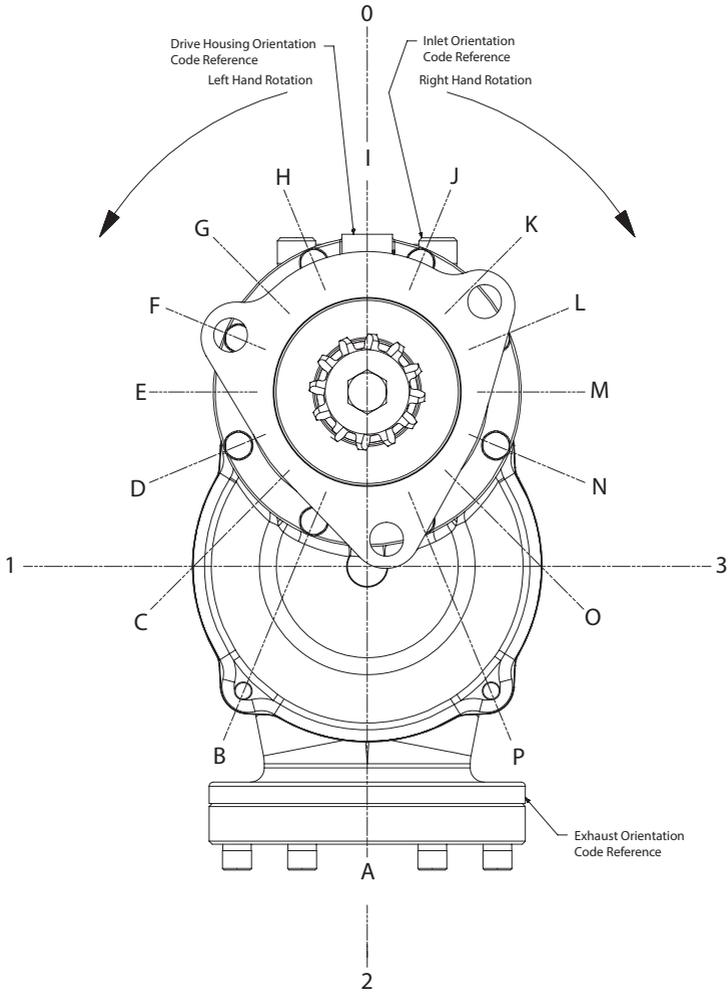
* For available arc percentages, visit ingersollrandproducts.com or contact your nearest **Ingersoll Rand** distributor or **Ingersoll Rand** Engine Starting Systems.

For different models or special applications, contact your nearest **Ingersoll Rand** distributor or **Ingersoll Rand** Engine Starting Systems at:

1-888-STARTAIR
1-888-78278247

Orientation

Pre-Engaged Starter Orientation Method



(Dwg. 45548500 SH5)

Pinion Selection Table

Gear Set Ratio	Rotation	# Teeth	Outer Diameter (mm)	Diametral Pitch	Pressure Angle	Pinion Code (from model number)	Part Number
B or C	Right	11	57.15	6/8	20°	25	SS825R-13-25
B or C	Right	11	57.15	6/8	20°	25	SS825R-13SR-25*
B or C	Right	12	57.15	6/8	20°	31	SS815R-13-31
B or C	Right	14	62.00	3.5 MOD	15°	91	SS815R-13-91
B or C	Right	14	65.61	6/8	20°	45	SS800R-13-45
B or C	Right	14	58.50	3.5 MOD	20°	32	SS825R-13-932
B or C	Right	15	69.85	6/8	20°	51	SS800R-13-51
B or C	Right	15	70.60	4 MOD	14.5°	493	SS815R-13-493
B or C	Left	11	57.15	6/8	20°	26	SS825L-13-26
B or C	Left	11	57.15	6/8	20°	26	SS825L-13SR-26*
B or C	Left	12	57.15	6/8	20°	32	SS815L-13-32
B or C	Left	14	62.00	3.5 MOD	15°	92	SS815L-13-92
B or C	Left	14	58.50	3.5 MOD	20°	42	SS825L-13-942
B or C	Left	15	69.85	6/8	20°	52	SS800L-13-52
B or C	Left	15	69.85	6/8	20°	52	SS825L-13-52
D	Right	15	69.85	6/8	20°	51	SS850R-13-51
D	Right	15	69.85	6/8	20°	51	SS850R-13SR-51*
D	Right	17	66.50	3.5 MOD	20°	952	SS850R-13-952
D	Left	15	69.85	6/8	20°	52	SS850L-13-52
D	Left	17	66.50	3.5 MOD	20°	962	SS850L-13-962

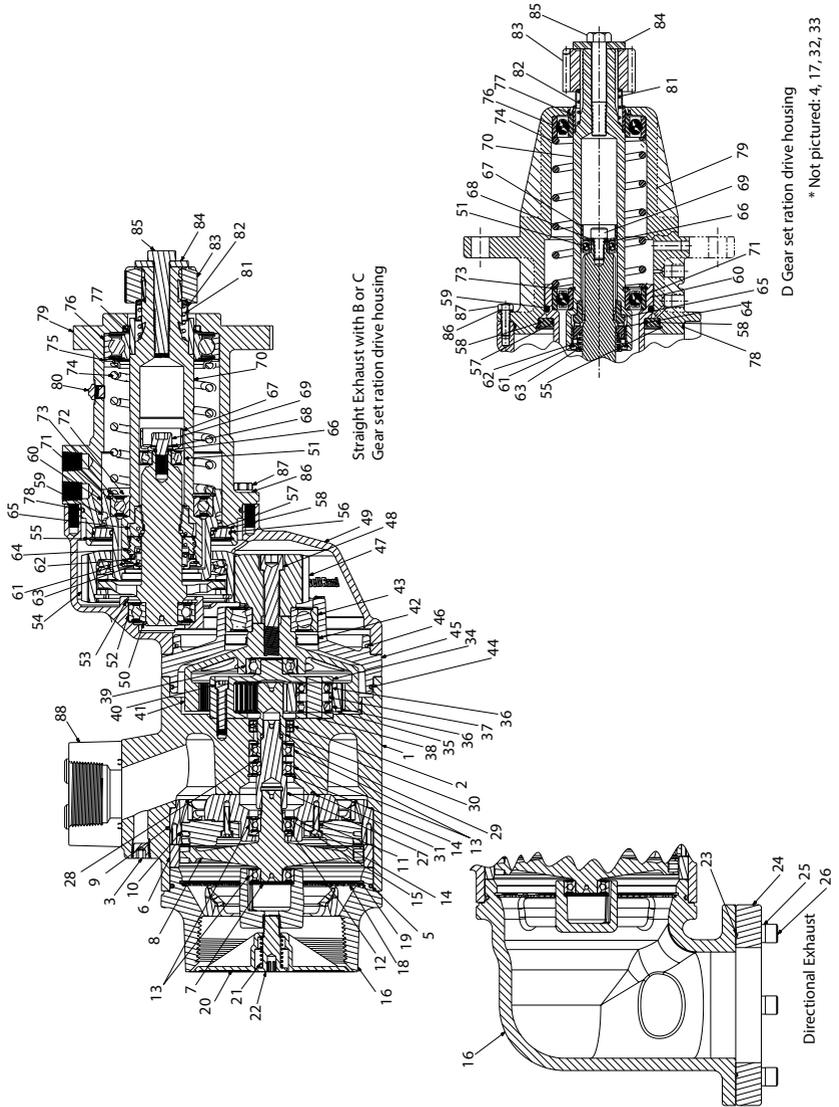
*Spark resistant pinions.

For special applications, contact your nearest **Ingersoll Rand** distributor or **Ingersoll Rand** Engine Starting Systems at:

1725 US 1 North
 Southern Pines, NC 28387
 (910) 692-8700

Construction - Pre-Engaged

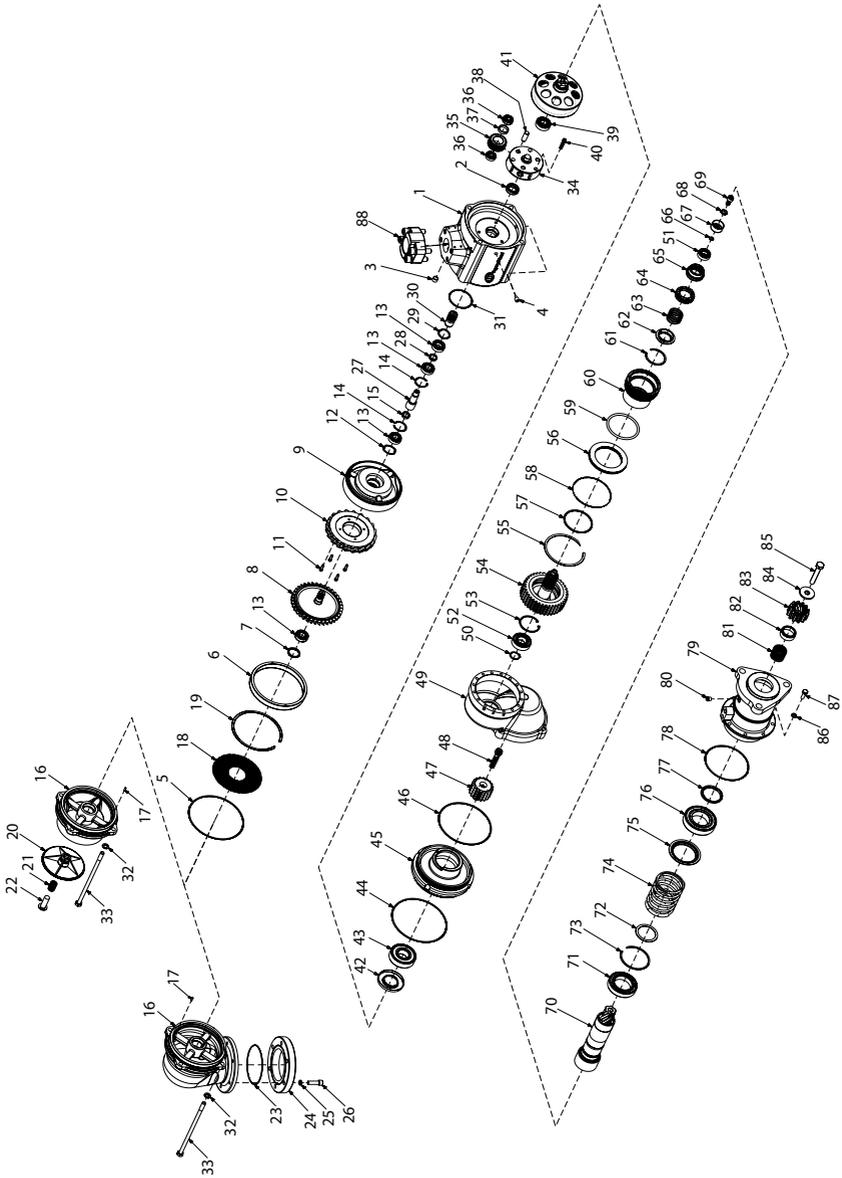
ST1000 Turbine Starter (Pre-Engaged)



D Gear set rattron drive housing
* Not pictured: 4, 17, 32, 33

(Dwg. 45548500 SH1)

ST1000 Turbine Starter (Pre-Engaged) Exploded Diagram



(Dwg. 45548500 SH2)

ST1000 Turbine Starter (Pre-Engaged) Parts List

Item	Part Description	Part Number	Item	Part Description	Part Number
	Motor module		30	Rotor pinion	
	Right Hand Rotation, Straight Exhaust	ST10__R-375*		Right Hand Rotation	ST1000L-17
	Right Hand Rotation, Directional Exhaust	ST10__R-37D*		Left Hand Rotation	ST1000R-17
	Left Hand Rotation, Straight Exhaust	ST10__L-375*	31	O-ring	SRV150-604
	Left Hand Rotation, Directional Exhaust	ST10__L-37D*	32	Lock washer (4)	SS800-26
---	Motor housing assembly	ST1000-A40	33	Screw (4)	45518586
1	Motor housing	45491289	---	Idler gear frame assembly	ST1000-A108
2	Seal	ST700-708	34	Idler gear frame	ST900-108
3	Plug	ROH-377	35	Idler gear (3)	ST900-10
4	Magnetic plug (2)	150T-29	36	Idler gear bearing (6)	ST400-24
**	Nameplate	ST1000-301	37	Idler gear bearing spacer (3)	ST900-91
**	Nameplate	ST700-301	38	Idler gear shaft (3)	ST900-191
**	Nameplate screw (8)	R4K-302	39	Gear frame bearing	T06-24
5	Exhaust housing o-ring	Y327-163	40	Cap Screw (3)	47497436001
6	Containment ring	45491057	---	Intermediate gear case assembly	
7	Wave spring	45485174		B Ratio Gear Set	ST900-A37
	Motor assembly			C Ratio Gear Set	ST900-A37C
	Right hand rotation	ST10__R-37*		D Ratio Gear Set	ST900-A37D
	Left hand rotation	ST10__L-37*	41	Ring gear	04324596
8	Rotor		42	Seal	ST700-272
	Right Hand Rotation	ST1000R-53-37	43	Bearing	SS800-22
	Left Hand Rotation	ST1000L-53-37	44	Rear gear case o-ring	Y327-162
9	Nozzle housing	45491271	45	Intermediate gear case	ST900-37
10	Nozzle		46	Front gear case o-ring	Y327-163
	Right Hand Rotation	ST1000R-19__*	47	Intermediate pinion	
	Left Hand Rotation	ST1000L-19__*		B Ratio Gear Set	SS800B-17
11	Screw (4)	47499619001		C Ratio Gear Set	SS825C-17
12	Wave spring	45480068		D Ratio Gear Set	SS850D-17
13	Bearing (2)	ST1000-24	48	Intermediate pinion screw	SS800-732
14	Retaining ring	95223673	49	Intermediate gear case	
15	Retaining collar	45514213		B or C Ratio Gear Set	SS800-37
---	Exhaust housing kit			D Ratio Gear Set	SS850-37
	Straight Exhaust	ST1000K-562	50	Drive gear shaft retaining ring	SS800-632
	Directional Exhaust	ST1000K-350	51	Front drive gear bearing	SS800-278
16	Exhaust housing		52	Rear drive gear bearing	SS800-359
	Straight Exhaust	45542339	53	Drive gear bearing retaining ring	SS800-361
	Directional Exhaust	45542594	54	Drive gear	
17	Pin	Y178-37		B Ratio Gear Set	SS815B-9
18	Screen	45491032		C Ratio Gear Set	SS825C-9
19	Retaining ring	45491040		D Ratio Gear Set	SS850D-9
20	Splash deflector		55	Retaining ring	
	Straight Exhaust	ST700-735		B or C Ratio Gear Set	SS800-181
	Directional Exhaust	N/A		D Ratio Gear Set	SS850-181
21	Deflector return spring			Bulkhead Kit	
	Straight Exhaust	D10-275		B or C Ratio Gear Set	SS800-K150
	Directional Exhaust	N/A		D Ratio Gear Set	SS850-K150
22	Deflector return screw		56	Bulkhead	
	Straight Exhaust	ST700-737		B or C Ratio Gear Set	SS800-150
	Directional Exhaust	N/A		D Ratio Gear Set	SS850-150
---	Exhaust flange kit		57	Inner bulkhead o-ring	
	Straight Exhaust	N/A		B or C Ratio Gear Set	SS800-151
	Directional Exhaust	ST700-K351		D Ratio Gear Set	SS850-151
23	Exhaust adapter seal	Y327-46	58	Outer bulkhead o-ring	
24	Exhaust flange	ST700-351		B or C Ratio Gear Set	SS800-152
25	Lock washers (6)	845-58		D Ratio Gear Set	SS850-152
26	Cap screws (6)	ST700-703	---	Piston kit	
27	Adapter			B or C Ratio Gear Set	SS800-K703
	Right Hand Rotation	ST1000L-212		D Ratio Gear Set	SS850-K703
	Left Hand Rotation	ST1000R-212	59	O-ring	
14	Retaining ring	95223673		B or C Ratio Gear Set	SS800-337
13	Bearing (2)	ST1000-24		D Ratio Gear Set	SS850-337
28	Spacer	45478443	60	Piston	
29	Wave spring	45516911		B or C Ratio Gear Set	SS800-703
				D Ratio Gear Set	SS850-A703

Item	Part Description	Part Number	Item	Part Description	Part Number		
42	Seal		75	Piston return spring seat			
	B or C Ratio Gear Set	ST700-272		B or C Ratio Gear Set	SS800-191		
	D Ratio Gear Set	N/A		D Ratio Gear Set	N/A		
61	Retaining ring	SS800-366	---	Drive housing kit			
62	Cup	SS800-367		B or C Ratio Gear Set	SS825-K300		
63	Spring	SS800-583		D Ratio Gear Set	SS850-K300		
---	Clutch jaw kit		76	Front drive shaft bearing	SS800-363		
	Right Hand Rotation	SS800R-K587	77	Drive housing seal	SS800-273		
	Left Hand Rotation	SS800L-K587	78	Drive housing O-ring			
64	Jaw Clutch			B or C Ratio Gear Set	SS800-244		
	Right Hand Rotation	SS800R-586		D Ratio Gear Set	SS850-244		
	Left Hand Rotation	SS800L-586	79	Drive housing			
65	Jaw			B or C Ratio Gear Set	SS825-300		
	Right Hand Rotation	SS800R-585		D Ratio Gear Set	SS850-300		
	Left Hand Rotation	SS800L-585	80	Drive housing vent plug	P250-546		
66	Drive gear screw o-ring	SS800-176	81	Pinion spring			
67	Drive gear cup	SS800-177		B or C Ratio Gear Set, Right Hand Rotation	SS800R-419		
68	Drive gear lock washer	SS800-180		B or C Ratio Gear Set, Left Hand Rotation	SS800L-419		
69	Drive gear screw	SS800-179		D Ratio Gear Set, Right Hand Rotation	SS850R-419		
	Drive shaft kit			D Ratio Gear Set, Left Hand Rotation	SS850L-419		
	B or C Ratio Gear Set, Right Hand Rotation	SS800R-K8	82	Pinion spring sleeve			
B or C Ratio Gear Set, Left Hand Rotation	SS800L-K8	B or C Ratio Gear Set		SS800-335			
D Ratio Gear Set, Right Hand Rotation	SS850R-K8	D Ratio Gear Set		SS850-335			
70	D Ratio Gear Set, Left Hand Rotation	SS850L-K8	83	Drive pinion	See "Drive Pinion Selection Chart"		
	Drive shaft			84	Drive Pinion (R) Washer	SS800-725	
	B or C Ratio Gear Set, Right Hand Rotation	SS800R-8			Drive Pinion (L) Washer	SS800-725-1	
	B or C Ratio Gear Set, Left Hand Rotation	SS800L-8			D Ratio Gear Set	SS850-725	
	D Ratio Gear Set, Right Hand Rotation	SS850R-8			85	Drive pinion screw	
D Ratio Gear Set, Left Hand Rotation	SS850L-8	B or C Ratio Gear Set, Right Hand Rotation	SS800R-394				
71	Rear drive shaft bearing		B or C Ratio Gear Set, Left Hand Rotation	SS800L-394			
	B or C Ratio Gear Set	SS800-399	D Ratio Gear Set, Right Hand Rotation	SS850R-394			
	D Ratio Gear Set	SS850-399	D Ratio Gear Set, Left Hand Rotation	SS850L-394			
72	Drive shaft retainer	SS800-209	86	Drive housing lock washer (8)	TE223A-415		
	73	Large drive shaft bearing retaining ring			87	Drive housing cap screw (8)	SS800-744
		B or C Ratio Gear Set		SS800-107	88	Inlet flange kit	ST700-K166
D Ratio Gear Set		SS850-107					
74	Piston return spring						
	B or C Ratio Gear Set	SS800-700					
	D Ratio Gear Set	SS850-700					

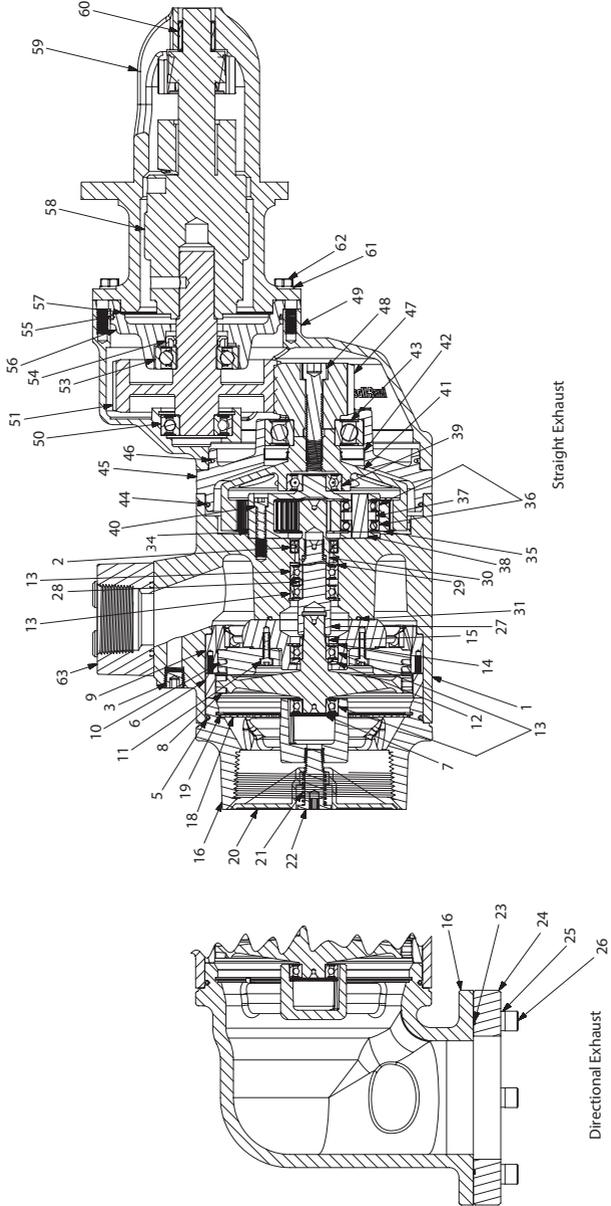
* Blanks are for motor arc percentage. Refer to the starter model code and the "How to Order a Starter" section for correct part selection.

** Indicates not shown.

Description of Part	Part Number	
	Right Hand Rotation	Left Hand Rotation
Seal Kit (includes items 2, 5, 23, 42, 44, 46, 57, 58, 59, 66, 77, 78)	ST1000-SK1	
Gear Kit (includes items 35, 36, 37, 38, 39, 41, 42, 43, 44, 46)	ST1000-GK1	
Rotor Bearing Kit (includes items 7, 12, 13, 14, 15)	ST1000-K24	
	Right Hand Rotation	Left Hand Rotation
Rotor replacement Kit (includes items 7, 8, 12, 13, 14, 15)	ST1000R-K53-37	ST1000L-K53-37
Motor Adapter Kit (includes items 2, 13, 14, 27, 28, 29, 30)	ST1000R-K212	ST1000L-K212
	B or C Ratio Gear Set	D Ratio Gear Set
Bearing Kit (includes items 71, 72.)	SS800-K399	SS850-K399
Tune up Kit (includes items 52, 55, 57, 58, 59, 75, 78)	ST700P-TK7	ST700D-TK8

Construction - Inertia

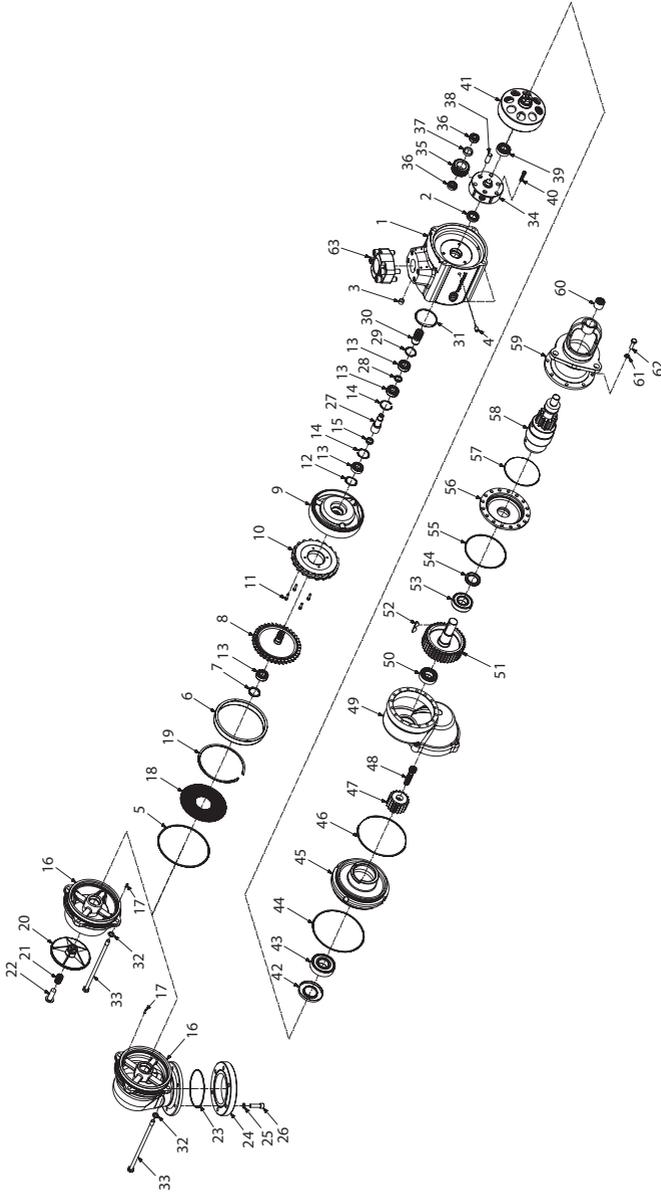
ST1000 Turbine Starter (Inertia)



*Not Shown : 4, 17, 32, 33

(Dwg. 45551009 SH1)

ST1000 Turbine Starter (Inertia) Exploded Diagram



(Dwg. 45551009 SH2)

ST1000 Turbine Starter (Inertia) Parts List

Item	Part Description	Part Number	Item	Part Description	Part Number
---	Motor module		23	Exhaust adapter seal	Y327-46
	Right Hand Rotation, Straight Exhaust	ST10__R-37S*	24	Exhaust flange	ST700-351
	Right Hand Rotation, Directional Exhaust	ST10__R-37D*	25	Lock washers (6)	845-58
	Left Hand Rotation, Straight Exhaust	ST10__L-37S*	26	Cap screws (6)	ST700-703
	Left Hand Rotation, Directional Exhaust	ST10__L-37D*	27	Adapter	
	Motor housing assembly	ST1000-A40		Right Hand Rotation	ST1000L-212
1	Motor housing	45491289		Left Hand Rotation	ST1000R-212
2	Seal	ST700-708	28	Spacer	45478443
3	Plug	ROH-377	29	Wave spring	45516911
4	Magnetic plug (2)	150T-29	30	Rotor pinion	
**	Nameplate	ST1000-301		Right Hand Rotation	ST1000R-17
**	Nameplate	ST700-301		Left Hand Rotation	ST1000L-17
**	Nameplate screw (8)	R4K-302	31	O-ring	SRV150-604
5	Exhaust housing o-ring	Y327-163	32	Lock washer (4)	S5800-26
6	Containment ring	45491057	33	Screw (4)	45518586
7	Wave spring	45485174	---	Idler gear frame assembly	ST1000-A108
	Motor assembly		34	Idler gear frame	ST900-108
	Right hand rotation	ST10__R-37*	35	Idler gear (3)	ST900-10
	Left hand rotation	ST10__L-37*	36	Idler gear bearing (6)	ST400-24
8	Rotor		37	Idler gear bearing spacer (3)	ST900-91
	Right Hand Rotation	ST1000R-53-37	38	Idler gear shaft (3)	ST900-191
	Left Hand Rotation	ST1000L-53-37	39	Gear frame bearing	T06-24
9	Nozzle housing	45491271	40	Cap Screw (3)	47497436001
10	Nozzle		---	Intermediate gear case assembly	ST900-A37
	Right Hand Rotation	ST1000R-19-__*	41	Ring gear	04324596
	Left Hand Rotation	ST1000L-19-__*	42	Seal	ST700-272
11	Screw (4)	47499619001	43	Bearing	S5800-22
12	Wave spring	45480068	44	Rear gear case o-ring	Y327-162
13	Bearing (2)	ST1000-24	45	Intermediate gear case	ST900-37
14	Retaining ring	95223673	46	Front gear case o-ring	Y327-163
15	Retaining collar	45514213	47	Intermediate pinion	S5800B-17
---	Exhaust housing kit		48	Intermediate pinion screw	S5800-732
	Straight Exhaust	ST1000K-562	49	Intermediate gear case	S5800-37
	Directional Exhaust	ST1000K-350	50	Rear drive gear bearing	S5800-359
16	Exhaust housing		51	Drive gear	S5810-9
	Straight Exhaust	45542339	52	Drive gear key (2)	20BM-610
	Directional Exhaust	45542594	53	Front drive gear bearing	BU-359
17	Pin	Y178-37	54	Drive gear shaft seal	S5810-272
18	Screen	45491032	55	Gear case cover o-ring	S5800-244
19	Retaining ring	45491040	56	Gear case cover	S5810-678
20	Splash deflector		57	Drive housing o-ring	S5800-152
	Straight Exhaust	ST700-735	58	Starter drive	
	Directional Exhaust	N/A		Right Hand Rotation	20BM-299-1
21	Deflector return spring			Left Hand Rotation	20BM-299-3
	Straight Exhaust	D10-275	59	Drive housing	S5810-300
	Directional Exhaust	N/A	60	Drive housing bearing	S5660-363-13
22	Deflector return screw		61	Drive housing lock washer	TE223A-415
	Straight Exhaust	ST700-737	62	Drive housing cap screw	S5810-744
	Directional Exhaust	N/A	63	Inlet flange kit	ST700-K166
---	Exhaust flange kit				
	Straight Exhaust	N/A			
	Directional Exhaust	ST700-K351			

* Blanks are for motor arc percentage. Refer to the starter model code and the "How to Order a Starter" section for correct part selection.

** Indicates not shown.

Description of Part	Part Number	
Tune up Kit (includes items 50, 53, 54, 55, 57, 60)	ST700I-TK6	
Gear Kit (includes items 35, 36, 37, 38, 39, 41, 42, 43, 44, 46)	ST1000-GK1	
Rotor Bearing Kit (includes items 7, 9)	ST1000-K24	
	Right Hand Rotation	Left Hand Rotation
Rotor replacement Kit (includes items 7, 8, 9, 11, 12)	ST1000R-K53-37	ST1000L-K53-37
Motor Adapter Kit (includes items 2, 9, 12, 27, 28, 29, 30)	ST1000R-K212	ST1000L-K212

Maintenance, Disassembly / Assembly Instructions



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.

Lubrication

Each time an ST1000 series starter is disassembled for maintenance or repair, lubricate the starter as follows:

For Models with Pre-Engaged Drive

- Lubricate the inside diameter of the drive shaft (70) with **Ingersoll Rand** No. 130 Grease.
- Lubricate the pinion end of the drive shaft with **Ingersoll Rand** No. 11 grease.
- Wipe a thin film of **Ingersoll Rand** No. 130 grease in the bore of the drive housing (79).
- Roll the piston return spring (74) in **Ingersoll Rand** No. 130 grease.
- Coat the outside of the piston (60) with **Ingersoll Rand** No. 130 grease.
- Lubricate the drive gear (54) with 8 oz. (240 ml) of **Ingersoll Rand** No. 130 grease.

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.

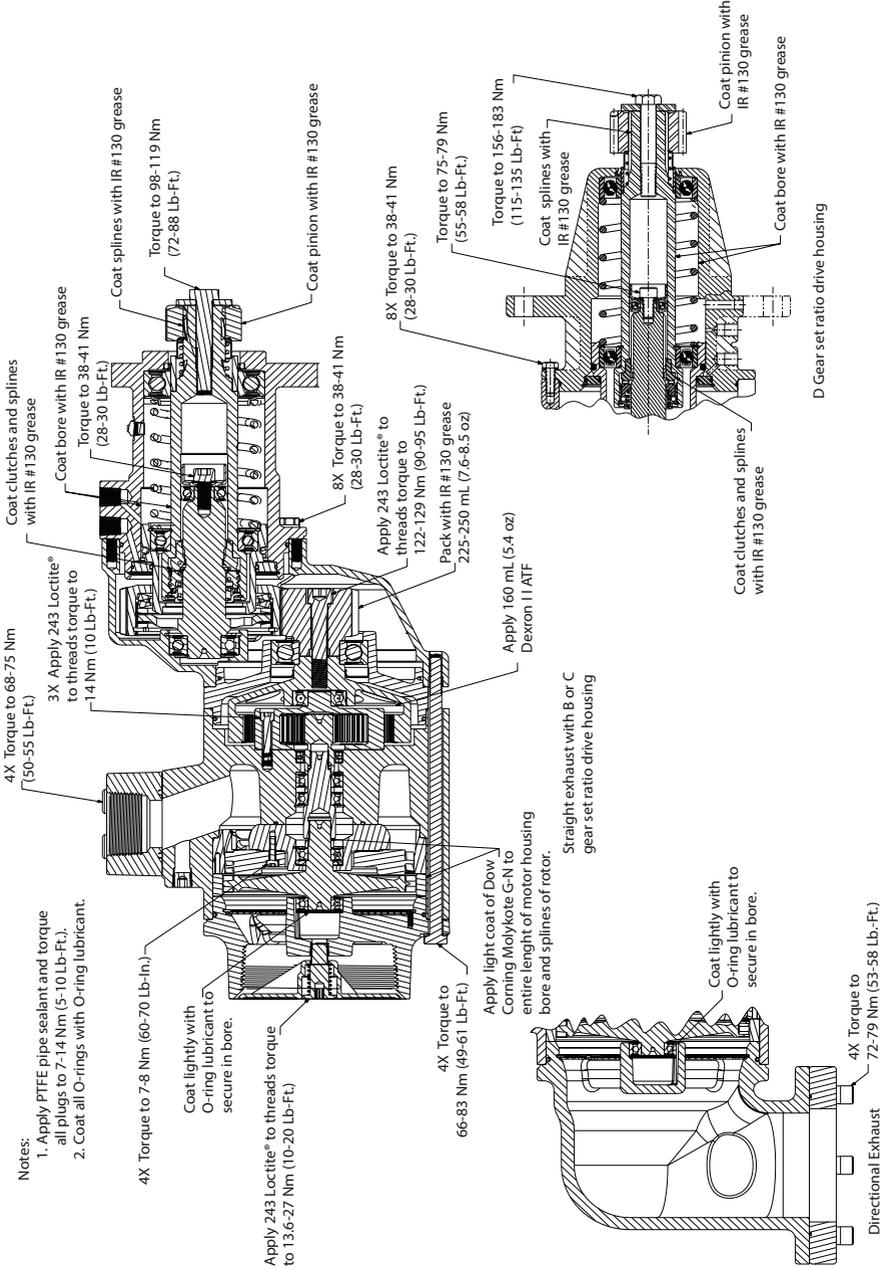
For all models (refer to "Lubrication and Torque Specifications")

- Lubricate all o-rings with o-ring lubricant.
- Add 5.4 oz (160 mL) of Dexron® II Automatic Transmission Fluid through the side plug hole in the motor housing (1).

Lubrication and Torque Specifications

Notes:

1. Apply PTFE pipe sealant and torque all plugs to 7-14 Nm (5-10 Lb-Ft.).
2. Coat all O-rings with O-ring lubricant.



(Dwg. 45548500 SH3)

General Assembly and Disassembly Instructions

- Always press on the bearing race or seal diameter that makes contact with the wall of the bore or shaft in which the bearing is being pressed in or on.
- Whenever grasping the starter or any parts in a vise, use leather or copper covered vise jaws and take extra care with threaded parts and housings.
- Excluding bearings, always clean every part and wipe each part with a thin film of oil before installing.
- Clean all threads and ensure they are free of any foreign matter before reusing.
- Check every bearing for roughness. If an open bearing must be cleaned, wash it thoroughly in a suitable clean 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.
- Apply o-ring lubricant to all o-rings prior to assembly.

NOTICE

These steps outline the complete disassembly of each module that makes up an ST1000 series starter. It is not always necessary to completely disassemble the components listed in the instructions. Only disassemble as far as necessary to perform the appropriate maintenance or repairs.

Exhaust Housing

Removal and Disassembly

1. Secure the starter assembly in a vertical position with the exhaust housing (16) oriented upwards.
2. If directional exhaust is used, make note of the orientation of the exhaust housing. If orientation is lost, refer to the model number and the appropriate orientation method instruction page in this manual.
3. Remove the starter assembly cap screws (33) and lock washers (32) from the starter assembly.
4. Rotate the exhaust housing approximately 45° and using a plastic hammer, gently tap the exhaust housing ears to remove it from the motor housing (1).
5. Remove the wave spring (7) from the exhaust housing.
6. Remove the exhaust housing o-ring (5) from the exhaust housing.
7. If necessary, remove the retaining ring (19) followed by the screen (18).
8. For models with straight exhaust and if necessary, remove the splash deflector screw (22), deflector return spring (21) and splash deflector (20).

2. Coat the exhaust housing o-ring (5) with o-ring lubricant and install it into the exhaust housing.
3. If removed, insert the retaining ring (19) into the exhaust housing to secure the screen.
4. Secure the assembled motor housing (1) in a vertical position with the inlet port facing upward.
5. Lightly coat the wave spring (7) with o-ring lubricant in order to assist in holding the wave spring in place during assembly. Place the wave spring in the appropriate bore in the exhaust housing.
6. Install the exhaust housing into the motor housing taking note of the orientation for directional exhaust models.
7. With the motor housing installed onto the intermediate gear case (45) and gear case (49), insert the starter assembly cap screws (33) and lock washers (32) and tighten to 49-61 lb-ft (66- 83 Nm) of torque in 20 lb-ft (27 Nm) increments.

Assembly and Installation

1. For models with straight exhaust, install the splash deflector (20) into the back of the exhaust housing (16). Coat the splash deflector screw (22) threads with **Ingersoll Rand** SMB-441 sealant and insert the screw along with the deflector return spring (21) into the splash deflector bore. Tighten the splash deflector screw to 10-20 lb-ft (14-27 Nm) of torque.

Motor Module

Removal and Disassembly

1. Remove both magnetic plugs (4) and drain the fluid from the motor housing (1).
2. After drained, secure the starter assembly vertically and reinstall one of the magnetic plugs.
3. If necessary, remove the exhaust housing. See "Exhaust Housing - Removal and Disassembly".
4. Slowly apply air to the location of the absent magnetic plug using a blow gun to separate the motor housing from the intermediate gear case (45). Remove the motor housing.
5. Using the ST1000 motor removal tool ST1000-TL1, remove the containment ring (6) followed by the nozzle housing (9) and motor assembly from the motor housing. Take extra caution to not damage the rotor blades or grab them with unprotected hands as they are delicate and can be very sharp.
6. Remove the cap screws (40) from the idler gear frame (34) and remove the idler gear frame from the motor housing. For idler gear assembly and disassembly instructions, see the "Idler Gear Set" section.
7. Secure the motor housing in a vise while maintaining easy access to the adapter (27) and rotor pinion (30).

NOTICE

The direction of the rotor pinion and adapter threads can be read from the face of the rotor pinion. If "ST1000R-17" is stamped on the face of the rotor pinion, the rotor pinion and adapter have right hand threads. Likewise if "ST1000L-17" is stamped on the face of the rotor pinion, the rotor pinion and adapter have left hand threads. Left hand rotation starters have right hand threads whereas right hand rotation starters have left hand threads.

8. Using the rotor pinion and adapter tools ST1000-TL2 and ST1000-TL1, separate the rotor pinion from the adapter.
9. Remove the rotor pinion.
10. From the motor housing, remove the retaining ring (14) which secures the adapter (27).
11. Remove the adapter by pushing from the threaded end.
12. Remove the wave spring (12), inlet plug (3), and the remaining magnet plug from the motor housing.
13. Remove the o-ring (31) from the motor housing and if necessary pull the seal (2) from the motor housing. The seal is not re-useable if removed.
14. If necessary, press the two bearings (13) and spacer (28) from the adapter.

Assembly and Installation

1. Press the seal (2) into the motor housing taking care to not damage the seal surfaces.
2. Using the punch ST1000-TL3, press one bearing (13) onto the adapter (27), slide the spacer (28) over the adapter, then press the other bearing (13) onto the adapter.
3. Place the wave spring (29) into the motor housing (1) bore.
4. Slide the adapter threaded end first into the motor housing bore.
5. Compress the wave spring by pushing the adapter down and insert the retaining ring (14) into the motor housing.
6. Secure the motor housing in a vice with easy access to both ends of the adapter.
7. Apply 243 Loctite® to the adapter threads.
8. Thread the rotor pinion (30) onto the adapter. Using the rotor pinion and adapter tools ST1000-TL2 and ST1000-TL1 tighten the rotor pinion to 40-45 lb-ft (54-61 Nm) of torque.

NOTICE

The direction of the rotor pinion and adapter threads can be read from the face of the rotor pinion. If "ST1000R-17" is stamped on the face of the rotor pinion, the rotor pinion and adapter have right hand threads. Likewise if "ST1000L-17" is stamped on the face of the rotor pinion, the rotor pinion and adapter have left hand threads. Left hand rotation starters have right hand threads whereas right hand rotation starters have left hand threads.

9. Install the inlet pipe plug (3) into the motor housing along with each magnetic plug (4). Coat all threads with **Ingersoll Rand SMB-441** sealant. Tighten to 7-14 Nm (5-10 lb-ft) of torque.
10. Coat the o-ring (31) with o-ring lubricant and install it into the motor housing.
11. Install the idler gear set assembly by placing it over the rotor pinion. Coat the threads of the three cap screws (40) with 243 Loctite® and secure the idler gear assembly to the motor housing. Tighten the cap screws to 14 Nm (10 lb-ft) of torque.
12. Lightly coat the inside diameter of the motor housing bore in which the motor assembly, containment ring, and exhaust housing are installed as well as the splines of the rotor (8) with Dow Corning Molykote® G-N Metal Assembly Paste.
13. Slide the motor assembly into the motor housing. Rotate the rotor to assist in meshing with the adapter.
14. Slide the containment ring (6) into the motor housing.
15. Coat the rear gear case o-ring (44) with o-ring lubricant and place the motor housing onto the intermediate gear case (49) allowing the rotor pinion to mesh with the idler gears (35).
16. Align the assembled exhaust housing (16) See "Exhaust housing assembly" with the motor housing in the desired orientation.
17. Install the starter assembly cap screws (33) and lock washers (32) and tighten to 49-61 lb-ft (66-83 Nm) of torque in 20 lb-ft (27 Nm) increments.
18. Remove one of the magnetic plugs (4) and add 5.4 oz (160 mL) of Dexron® II Automatic Transmission Fluid to the motor housing.
19. Coat the threads with SMB-441 and reinstall the magnetic plug. Tighten to 7-14 Nm (5-10 lb-ft) of torque.

Motor Assembly

Removal and Disassembly

1. Remove the motor assembly from the motor housing. Refer to steps 3-5 in the "Motor Module - Removal and Disassembly" section.
2. With the motor assembly removed from the motor housing, press the rotor (8) and bearing (13) opposite the splined shaft from the nozzle housing (9). The retaining collar (15) will also become loose from the splined end of the rotor.
3. If necessary, remove the press fit bearing (13) from the rear of the rotor.
4. Remove the retaining ring (14) from the nozzle housing followed by the bearing (13) and wave spring (12).
5. Remove the nozzle cap screws (11) from the nozzle housing and remove the nozzle (10).

Assembly and Installation

1. Fasten the nozzle (10) to the nozzle housing (9) using nozzle cap screws (11). Orient the nozzle so that the counterbores of the screw holes face outward. Tighten the cap screws to 60-70 lb-in (7-8 Nm) of torque.

Idler Gear Set

Removal and Disassembly

1. Remove the motor housing (1) from the intermediate gear case (45) and the idler gear set from the motor housing. See "Motor housing removal and disassembly."
2. With the idler gear set removed from the motor housing, press the gear frame bearing (39) off of the shaft of the idler gear frame (34).
3. Press the idler gear shafts (38) out of the gear frame and remove the idler gears (35).
4. Press one of the idler gear bearings (36) out of the idler gear, remove the spacer (37), and press out the other idler gear bearing. Repeat this process for the other two idler gears.

Assembly and Installation

1. Press one idler gear bearing (36) into an idler gear (35) followed by an idler gear spacer (37) and another idler gear bearing. Repeat for the remaining two idler gears.

2. Insert the assembled idler gear into the idler gear frame (34) and align the gear with one of the holes in the idler gear frame. Press an idler gear shaft (38) into the gear frame and idler gear assembly. Repeat for the remaining two idler gear assemblies.
3. Press the gear frame bearing (39) onto the idler gear frame.
4. Place the idler gear set assembly over the rotor pinion in the motor housing and secure it using the three cap screws (40). Coat the threads of the screws with 243 Loctite® and tighten to 14 Nm (10 lb-ft) of torque.

Intermediate Gear Case Removal and Disassembly

1. Remove the motor housing (1) from the intermediate gear case (45). See steps 1-4 "Motor Module-Removal and Disassembly".
2. Separate the intermediate gear case assembly from the gear case (49).
3. Support the intermediate gear case assembly on a bench and position it in a copper-faced vise so that the intermediate pinion (47) is secured in the jaws of the vise. Tighten the vise only enough to hold the intermediate pinion securely.

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.

4. Loosen the intermediate pinion retaining screw (48) 1.5 turns. Do not remove.
5. Remove the intermediate gear case assembly from the vise and remove the intermediate pinion. Remove the rear gear case o-ring (44) and front gear case o-ring (46) from the intermediate gear case (45).
6. Remove the ring gear (41) and seal (42).
7. Remove the bearing (43) by pressing from the front of the intermediate gear case.

Assembly and Installation

1. Press the bearing (43) followed by the seal (42) with flat side against the bearing into the intermediate gear case (45).

NOTICE

Make sure that the flat side of the seal is installed against the bearing.

2. Position the intermediate gear case over the gear frame (41) and slide it onto the notched shaft.
3. Place the intermediate pinion (47) into the intermediate gear case and rotate until the notches of the pinion and gear frame mesh.
4. Apply 243 Loctite® to the threads of the intermediate pinion screw (48) approximately 3 mm from the end of the screw and tighten the screw hand tight.

Drive Housing (Pre-Engaged)

Removal and Disassembly

1. Mark the orientation between the gear case (49) and drive housing (79). If orientation is lost, refer to the model number and the appropriate orientation method instruction page in this manual.
2. Support the starter assembly on a bench and position it in a copper-faced vise so that the drive pinion (83) is secured in the jaws of the vise. Tighten the vise only enough to hold the pinion securely.
3. Remove the drive pinion screw (85), drive pinion washer (84), drive pinion (83), pinion spring sleeve (82), and pinion spring (81).

NOTICE

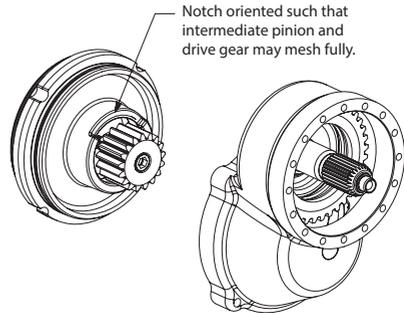
Left hand rotation starters have drive pinion screws with right hand threads. Right hand rotation starters have drive pinion screws with left hand threads. See "How to Order a Starter" if rotation is unknown.

4. Using a 5/16" (8 mm) x 8" (203 mm) long hex inserted through the threaded hole of the drive shaft, remove the drive gear screw (69) from the drive gear (54).
5. Separate the drive housing from the gear case by removing the drive housing cap screws (87) and lock washers (86).

WARNING

Failure to adhere to the following procedure could result in injury to personnel.

5. Support the intermediate gear case assembly on a bench and position it in a copper-faced vise so that the intermediate pinion is secured in the jaws of the vise. Tighten the vise only enough to hold the intermediate pinion securely.
6. Tighten the intermediate pinion screw to 90 lb-ft (122 Nm) of torque.
7. Lubricate the rear gear case o-ring (44) and front gear case o-ring (46) and install them on the intermediate gear case. The front gear case o-ring is installed on the intermediate gear case side with the pinion on it.
8. Pack the intermediate pinion (47) with 225-250 mL (7.6-8.5 oz) **Ingersoll Rand** No. 130 grease.
9. Place the intermediate gear case assembly with intermediate pinion end first into the gear case assembly in such a way that the notch in the intermediate gear case faces the drive gear (54) located in the gear case. See Dwg. 45548500 SH7.



NOTICE

Failure to align the intermediate gear case notch and drive gear will result in damage to the starter and if attempted to put into service will require disassembly and repair.

6. Place the drive housing in a press with the piston (60) end up. Apply a load to the piston in order to compress the piston return spring (74). While the spring is compressed, remove the bulkhead retainer (55). Do not use compressed air to load the piston in order to remove the bulkhead retainer.

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.

7. Remove the bulkhead (56) from the piston.
8. Remove the outer bulkhead o-ring (58) and inner bulkhead o-ring (57).
9. Remove the drive shaft (70) from the drive housing.
10. Remove the piston return spring and the piston return spring seat (75) (for B and C ratio drive models only).
11. Remove the piston o-ring (59) from the piston.
12. Compress the clutch spring (63) by pressing the clutch spring cup (62) and remove the clutch spring cup retainer (61).
13. Remove the clutch spring cup, clutch spring, and both clutch jaws (64) (65) from the drive shaft.

- Remove the front drive gear bearing (51), drive gear cup (67), drive gear lock washer (68), drive gear screw o-ring (66), and drive gear screw (69) from the inside of the drive shaft.
- Press the drive shaft along with the drive shaft bearing (71) and drive shaft retainer (72). If drive shaft bearing replacement is necessary, use a small chisel to cut and remove the drive shaft retainer and press the drive shaft bearing off of the drive shaft.
- Press the front drive shaft bearing (76) from the drive housing and pull the drive housing seal (77) from the drive housing. Only remove each part if replacement is necessary as they are damaged upon disassembly.

Assembly and Installation

- Press the drive housing seal (77) into the drive housing (79) so that the lip of the seal faces the exterior of the drive housing followed by the front drive shaft bearing (76).
- For B and C drive gear ratio models, insert the piston return spring seat (75) so that the flat edge rests against the front drive shaft bearing.
- Press the rear drive shaft bearing (71) onto the drive shaft (70).
- Slide the rear bearing retainer (72) convex side first onto the drive shaft. Press it into position according to the instructions (S5800-110) included with the new retainer.
- Gather the drive gear screw o-ring (66), drive gear cup (67), drive gear lock washer (68), and drive gear screw (69) and assemble such that the drive gear screw head rests inside the drive gear cup.
- Secure the drive shaft in a vise with externally splined end downwards.
- Insert the drive gear screw assembly into the drive shaft with screw head facing downwards.
- Lubricate the inside diameter of the drive shaft with **Ingersoll Rand** No. 28 lubricant.
- Insert the drive gear bearing (51) into the drive shaft.
- Lubricate the driven clutch jaw (64) and driving clutch jaw (65) with **Ingersoll Rand** No. 130 lubricant. Install the driving clutch jaw into the drive shaft with jaw teeth facing upwards. Install the driven clutch jaw into the drive shaft with the jaw teeth facing downwards.
- Place the clutch spring (63) into the drive shaft on top of the driven clutch jaw.
- Place the clutch spring cup (62) on the clutch spring.
- Press the clutch spring cup down and install the clutch spring cup retaining clip (61) into the drive shaft.

NOTICE

If it is necessary to replace the drive housing and drive components, make sure that the piston seal (S5800-272) has been removed from the rear of the new piston (60). The piston seal must be removed to prevent pressure build-up which will cause movement of the planet gear frame shaft seal (42). If this condition occurs, the piston cannot retract and the drive pinion (83) 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.

- Lubricate the piston o-ring (59) with o-ring lubricant and install it in the groove on the piston 60.

Drive Housing (Inertia)

Removal and Disassembly

- Mark the orientation between the gear case (49) and drive housing (59). If orientation is lost, refer to the model number and the appropriate orientation method instruction page in this manual.
- Remove the drive housing cap screws (62) and lock washers (61).
- Tap the drive housing with a plastic hammer to help dislodge it from the gear case cover (56).

- Install the piston onto the drive shaft until it seats against the rear drive shaft bearing.
- Install the large drive shaft bearing retaining ring (73) into the interior of the piston.
- Remove the drive shaft from the vise and slide the piston return spring (74) over the drive shaft. Snap the end coil of the spring into the piston so that it rests on the large drive shaft bearing retaining ring.
- Lubricate the assembled drive shaft and insert it into the drive housing.
- Lubricate the outer bulkhead o-ring (56) and inner bulkhead o-ring (57) and install each onto the bulkhead (58).
- Slide the bulkhead over the piston and into the drive housing.
- Place the drive housing assembly in a press and press the piston down.

NOTICE

Feel the underside of the drive housing to make sure the drive shaft passes through the bearing.

- Install the bulkhead retaining ring (55) into the drive housing.

WARNING

Make sure the bulkhead retainer is properly seated in the drive 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.

- Remove the drive housing from the press.
- Lubricate the drive housing o-ring (78) with o-ring lubricant and install it onto the drive housing.
- Insert the drive housing into the gear case in the same orientation as previously noted. If orientation is lost, refer to the model number and the appropriate orientation method instruction page in this manual.
- Secure the drive housing to the gear case using the drive housing lock washers and cap screws. Tighten to 28-30 lb-ft [38-41 Nm] of torque.
- Using a 5/16" (8 mm) x 8" (203 mm) long hex inserted through the threaded hole of the drive shaft, tighten the drive gear screw to the drive gear (54) shaft. Tighten to 55-58 lb-ft [75-79 Nm] of torque.
- Slide the pinion return spring (81) over the helical splines of the drive shaft and the pinion spring sleeve (82) over the pinion return spring.
- Coat the splines of the drive pinion (83) with **Ingersoll Rand** No. 28 grease and slide the pinion onto the drive shaft compressing the pinion return spring.
- Secure the drive pinion using the drive pinion washer (84) and drive pinion screw (85). Tighten the drive pinion screw to 72-88 lb-ft (98-119 Nm) of torque for B and C ratio models and 115-135 lb-ft (156-183 Nm) of torque for D ratio models.

NOTICE

Right hand rotation starters have left hand threads. Left hand rotation starters have right hand threads.

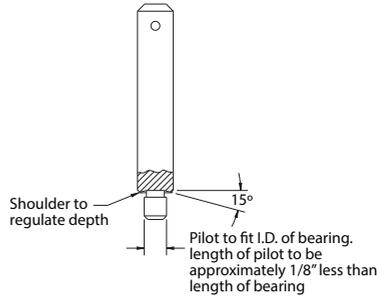
- Place the drive housing in an arbor press with the bearing end up. Press the drive housing bearing (60) from the drive housing.
- Displace the locking spring on the starter drive (58) and remove the screw securing it to the drive gear (51) shaft and slide the starter drive off of the drive gear shaft.
- Remove the two drive gear keys (52) from the drive gear shaft.
- Remove the gear case cover from the gear case.
- Remove the drive housing o-ring (57) and gear case cover o-ring (55) from the gear case cover.
- Remove the drive gear from the gear case.

- Remove the rear drive gear bearing (50), drive gear shaft seal (54) and front drive gear bearing (53) from the drive gear.

Assembly and Installation

- Install the rear drive gear bearing (50) onto the shorter drive gear (51) shaft.
- Install the front drive gear bearing (53) onto the longer drive gear shaft.
- Install the two drive gear keys (52) into the key slots in the drive gear shaft.
- Press the drive gear shaft seal (54) onto the longer drive gear shaft with the lip facing upward.
- Lubricate the drive gear with approximately 8 oz. (240mL) of **Ingersoll Rand** No. 130 grease.
- Slide the drive gear into the gear case (49) seating the rear drive gear bearing into the corresponding bore in the gear case.
- Lubricate with o-ring lubricant and install the gear case cover o-ring (55) in the groove on the gear case cover.
- Lubricate with o-ring lubricant and place the drive housing o-ring (57) on the lip of the gear case cover located opposite the side which encases the front drive gear bearing.
- Install the gear case cover onto the gear case.
- Slide the starter drive (58) onto the drive gear shaft. Tighten the starter drive locating the ring and screw securely.

- Press the drive housing bearing (60) into the drive housing (59) and lubricate it with **Ingersoll Rand** No. 130 grease. See Dwg. TPD786 for recommended needle bearing punch size.



(Dwg. TPD786)

- Install the drive housing onto the gear case cover. Make sure the orientation is the same as initially marked.
- Install the drive housing cap screws (62) and lock washers (61) and torque to 28 lb-ft (38 Nm) of torque.

Gear Case

Removal and Disassembly

- Separate the motor housing and intermediate gear case (45) from the gear case (49). See steps 1-2 in "Intermediate Gear Housing - Removal and Disassembly".
- Remove the drive housing assembly from the gear case (49). See steps 1-5 in "Drive Housing pre-engaged) - Removal and Disassembly" for pre-engaged starters and steps 1-3 in "Drive Housing (inertia) - Removal and Disassembly" for inertia starters.
- Remove the drive gear bearing retaining ring (53). Rotate the drive gear until the retaining ring can be accessed through the access holes in the drive gear web.
- Remove the drive gear from the gear case.

NOTICE

Do not disassemble the drive gear (54) and clutch parts. If the drive gear shaft is defective, install a new or factory-rebuilt unit.

- Remove the drive gear shaft retaining ring (50) and the rear drive gear bearing (52) from the drive gear.

Assembly and Installation

- Slide the rear drive gear bearing retaining ring (53) over the short shaft of the drive gear.
- Press the rear drive gear bearing (52) onto the short shaft of the drive gear.
- Install the drive gear shaft retaining ring (50) to secure the rear drive gear bearing.
- Insert the drive gear into the gear case (49) aligning the rear drive gear bearing with the appropriate bore in the gear case. Seat the bearing against the gear case using a plastic hammer to tap against the drive gear.
- Rotate the drive gear until the drive gear shaft retaining ring is accessible and insert it into the groove in the gear case.
- Install the drive housing onto the gear case See steps 26-31 in "Drive Housing (pre-engaged) - Assembly and Installation" for pre-engaged starters and steps 12-13 in "Drive Housing (inertia) - Assembly and Installation" for inertia starters.

Retrofit Installation

The following instructions outline the necessary steps required to convert an ST900 or SS800 series starter to an ST1000 series starter.

ST900 Retrofit

NOTICE

To convert an ST900 series starter to an ST1000 series starter, the appropriate motor module must be purchased from an authorized Ingersoll Rand distributor or Ingersoll Rand Engine Starting Systems.

- Make note of the orientation of the exhaust housing and motor housing. If orientation is lost, refer to the model number and the appropriate orientation method instruction page in this manual.
- Consult the ST900 manual (accessible from ingersollrandproducts.com) for instructions on removing the motor housing assembly including the exhaust housing from the intermediate gear case and remainder of the starter assembly.
- Coat the rear gear case o-ring (44) with o-ring lubricant and install the motor housing (1) assembly onto the intermediate gear case (49) in the correct orientation.
- Verify that the wave spring (7) is in the appropriate bore in the exhaust housing. If needed, coat the wave spring lightly with o-ring lubricant to assist in securing the wave spring in place. Install the exhaust housing (16) assembly into the motor housing

in the correct orientation.

- Install the starter assembly cap screws (33) and lock washers (32) and alternately tighten them to 49-61 lb-ft (66-83 Nm) of torque in 20 lb-ft (27 Nm) increments.
- Remove one of the magnetic plugs (4) and add 5.4 oz (160 mL) of Dexron® II Automatic Transmission Fluid to the motor housing.
- Coat the threads with SMB-441 and reinstall the magnetic plug. Tighten to 5-10 lb-ft (7-14 Nm) of torque.

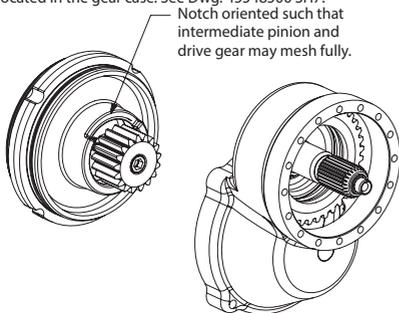
SS800 Retrofit

NOTICE

To convert an SS800 series starter to an ST1000 series starter, the appropriate motor module (see the "Parts List" section in this manual), idler gear set assembly (ST1000-A108) and intermediate gear case assembly (ST900-A37, ST900-A37C, or ST900-A37D) must be purchased. For B ratio starters an ST900-A37 intermediate gear case assembly is required. For C ratio starters an ST900-A37C intermediate gear case assembly is required. For D ratio starters an ST900-A37D intermediate gear case assembly is required.

- Make note of the orientation of the exhaust housing and motor housing. If orientation is lost, refer to the model number and the appropriate orientation method instruction page in this manual.

- Consult the 5S800 manual (accessible from ingersollrandproducts.com) for instructions on separating the motor housing from the gear case.
- Pack the intermediate pinion (47) with 7.6-8.5 oz (225-250 mL) **Ingersoll Rand** No. 130 grease.
- Coat the rear gear case o-ring (44) and front gear case o-ring (46) with o-ring lubricant.
- Place the intermediate gear case assembly with intermediate pinion end first into the gear case assembly in such a way that the notch in the intermediate gear case faces the drive gear (54) located in the gear case. See Dwg. 45548500 SH7.



(Dwg. 45548500 SH7)

NOTICE

Failure to align the intermediate gear case notch and drive gear will result in damage to the starter and if attempted to put into service will require disassembly and repair.

- Install the idler gear set assembly by placing it over the rotor pinion (30). Coat the threads of the three cap screws (40) with 243 Loctite® and secure the idler gear assembly to the motor housing. Tighten the cap screws to 14 Nm (10 lb-ft) of torque.
- Place the motor housing onto the intermediate gear case (49) allowing the pinion to mesh with the idler gears (35).
- Align the exhaust housing (16) assembly with the motor housing in the desired orientation.
- Install the starter assembly cap screws (33) and lock washers (32) and tighten to 49-61 lb-ft (66-83 Nm) of torque in 20 lb-ft (27 Nm) increments.
- Remove one of the magnetic plugs (4) and add 5.4 oz (160 mL) of Dexron® II Automatic Transmission Fluid to the motor housing.
- Coat the threads with SMB-441 and reinstall the magnetic plug. Tighten to 7-14 Nm (5-10 lbf) of torque.

Testing and Inspection

- Clutch ratcheting:** Turn the drive shaft pinion (83) by hand in the direction of starter rotation. The clutch should ratchet smoothly with a slight clicking action.
- Motor and gearing freeness:** Turn the drive shaft pinion (83) opposite the direction of starter rotation. The drive shaft pinion should turn by hand.
- Motor action:** Secure the 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. The starter should run smoothly.
- 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.
- 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.
- Orientation:** Drive housing (79) must be assembled to customer orientation or per engineering drawing. If orientation is not specified by customer, standard orientation will be supplied. Check appropriate Orientation Method section in this manual.
- Confirm drive rotation:** Apply low pressure to motor and observe rotation. The drive pinion (83) must rotate in the direction stamped on the nameplate. The chamfer on the pinion teeth should be on trailing edge of gear tooth.
- Bendix drive function - inertia models only:** Install the starter on testing fixture. Apply low pressure air to motor. The bendix must engage according to specified rotation.
- Drive housing function - pre-engaged models only:** Apply 120 psig (8.2 bar/827 kPa) to the "I" (in) port of drive housing (79). Cycle five times. Air should exhaust through the "O" (out) port during each cycle.
- Exhaust deflector operation:** Install the starter on testing fixture. Apply low air pressure to motor and observe. The deflector (20) must return to its normal position after operation of the starter.
- 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.

- Drive housing leakage - pre-engage models only:** Plug the drive housing (79) "O" (out) port and apply 150 psig (3.45 bar/344 kPa) to the "I" (in) port to extend drive shaft (57). There should be no leakage.
- Test pinion engagement - pre-engaged models only:** Plug the "O" (out) port in the drive housing (79). 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 (70) 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 (83) back on the helical splined shaft. The rear face of drive pinion must move back .47" +/- .035".

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	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.
	Low air signal pressure to start valve.	Check air supply.
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 restricted.	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.
	Motor turning in wrong rotation.	Wrong combination of clutch jaws and motor. Replace with correct rotation parts.

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.
	Defective control valve.	Replace control valve.
Motor runs, pinion engages, but does not rotate flywheel	Damaged or broken drive train.	Disassemble drive train and replace worn or damaged parts.
	Motor turning in wrong rotation.	Wrong combination of clutch jaws and motor. Replace with correct rotation 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.	Check air supply.
	Wrong drive pinion.	Replace with proper drive pinion.
Oil blowing out of exhaust	Oil in air supply line.	Inspect air line and remove source of oil including inline lubricators.
	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). 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.

Parts and Maintenance



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

Ingersoll Rand is not responsible for customer modification of motors for applications in which Ingersoll Rand was not consulted. Repairs should be made only by authorized trained personnel. Consult your nearest Ingersoll Rand Authorized Service center.

When tool life has expired, it is recommended that the tool be disassembled, degreased and parts separated by material for proper recycling.

Manuals can be downloaded from ingersollrandproducts.com.

Refer all communications to the nearest **Ingersoll Rand** office or distributor.

Notes:

Notes:
