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Turbine Powered Starters

Series ST700

Installation and Maintenance Information

Save These Instructions

Ingersoll-Rand

⚠ WARNING

General Product Safety Information

- **Read and understand this manual before operating this starter.**
- **It is your responsibility to make this safety information available to others that will operate this starter.**
- **Failure to observe the following warnings could result in injury.**

⚠ WARNING

- **For safety, top performance, and maximum durability of parts, do not operate Series ST700 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 ST700 Starters are designed for gas operation. They are not totally sealed in dynamic operation since the exhaust must be vented or piped away and there is a possibility of leakage around the output shaft when rotating.**
- **Caution should be taken when operating these starters on gas because of the danger of fire, explosion, or inhalation. After assembling a starter, always test in accordance with the procedures outlined in this manual. Never install a reassembled starter that has not been tested in accordance with the procedures in this manual.**
- **Operate this starter only when properly installed on the engine.**
- **Do not lubricate starters with flammable or volatile liquids such as kerosene or jet fuel.**
- **For personal protection, do not remove any labels. Replace any damaged label.**
- **Do not use damaged, frayed or deteriorated air hoses and fittings.**
- **Always wear eye protection when operation or performing maintenance on this starter.**
- **Always wear hearing protection when operating this starter.**
- **Use only recommended Ingersoll-Rand accessories.**

NOTICE

- It is the responsibility of the employer to place the information in this manual into the hands of the operator.
- 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.
- ST900-267 Strainer or equivalent is required for all starters used in GAS applications.

Safety Symbol Identification

Wear Respiratory Protection | Wear Eye Protection | Wear Hearing Protection | Read Manuals Before Operating Product

(Dwg. MHP2598)

Safety Information - Explanation of Safety Signal Words

⚠ DANGER	Indicates an imminently hazardous situation which, if not avoided, will result in death or serious injury.
⚠ WARNING	Indicates a potentially hazardous situation which, if not avoided, could result in death or serious injury.
⚠ CAUTION	Indicates a potentially hazardous situation which, if not avoided, may result in minor or moderate injury or property damage.
NOTICE	Indicates information or a company policy that relates directly or indirectly to the safety of personnel or protection of property.

Placing the Starter in Service

Installation

NOTICE

For maximum performance, read this manual prior to the installation or operation of Series ST700 Turbine-Powered Starters.

General Information

1. It is strongly recommended 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. Vehicle and engine vibration will soon 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 remains free of dirt and foreign material during installation.
3. In the actual mounting of a starter, it may be best to have the hose connections already made at the receiver and to have the starter end of the hose handy for attaching to the starter.
4. Engine design often demands that the starter be mounted 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 a single or double-end box wrench.
5. The efficiency of an Air Starter can be greatly impaired by an improper hook-up. Hoses smaller than those recommended will reduce the volume of air to the motor and the use of reducers for piped-away applications in the exhaust port will restrict the exhaust causing back pressure to the motor resulting in reduced performance. The number of tees and elbows, and the length of the supply line should be kept 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. A leak in any of the connections in live air lines means that the system will drain overnight and will have to be repressurized 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 Loctite®* Pipe Sealant.
   After all connections have been made, check each joint with a soap bubble test. There must be no leaks in live air lines. The slightest leak will cause the system to lose pressure overnight. 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.
7. Whenever a hazardous gas is being used to operate the starter, **there must be no leaks in inlet or exhaust piping or from any other starter joints. All discharges should be piped away to a safe area**.
8. 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.
9. It is **required** that a strainer be installed in the inlet line for each starter.
   Ingersoll-Rand offers 5 strainers:
   ST900-267-24 for 1-1/2 inch lines,
   ST900-267-32 and ST900-267-32F for 2 inch lines,
   ST900-267-48 for 3 inch lines and
   ST900-267-64 for 4 inch lines.
   These 300 mesh strainers provide 50 micron filtration and offer significant protection against supply line contaminates which could damage the turbine components. Replacement elements are:
   ST900-266-24 for 1-1/2 inch,
   ST900-266-32 for 2 inch pipe thread,
   ST900-266-32F for 2 inch flange,
   ST900-266-48 for 3 inch flange and
   ST900-266-64 for 4 inch lines.

Orientation of the Starter

It is recommended that starters be ordered to proper orientation for your specific mounting to the required engine or for your specific installation. However, if the starter must be reoriented for installation, proceed as follows:

1. Refer to the dimension illustration on page 5, 6 and 7and note that the Drive Housing can be located in any one of sixteen 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 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 (38 Nm) torque.
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 (81.4 Nm) torque in 20 ft-lb (27 Nm) increments.

Mounting the Starter

1. Study the appropriate piping diagrams on page 8 through 11 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 pressured.

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

4. Using a 1-1/2” short nipple, install the SRV150 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 (150BMP-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 Nm) torque.
14. **For Pre-Engaged Models**, 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 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 ST700 Turbine Starter. Remove the Deflector Retaining Screw (5), the Deflector Return Spring (4) and the Splash Deflector (3). If piped-away exhaust is being used, remove piping so that you can gain access to the hole at the center of the Housing Exhaust Cover. Remove the 1/4” pipe plug.

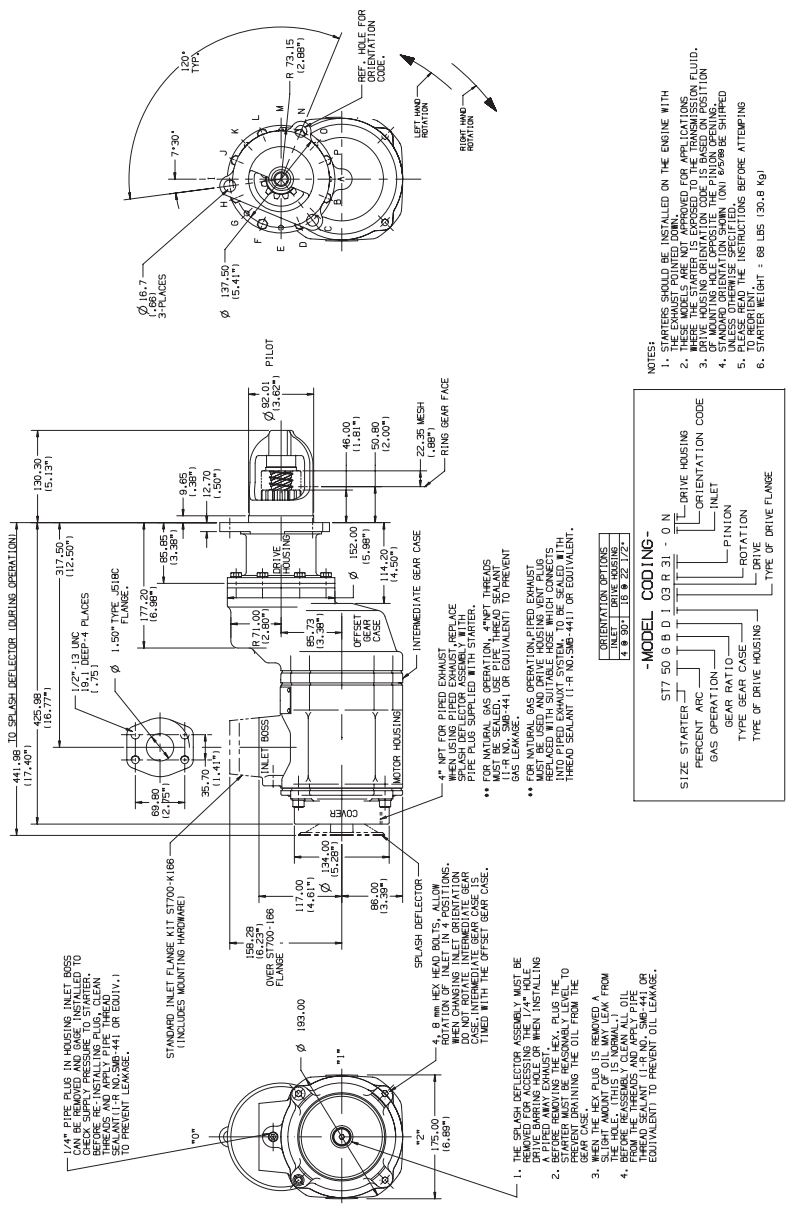
For Models with Inertia Drive:

1. Manually engage pinion and insert a 1/4” hex wrench through the hole in the Housing Cover to engage the hex drive recess at the rear of the Motor Assembly.
2. Manually rotate the Motor Assembly until the engine is cranked to the desired position.

For Models with Pre-Engaged Drive

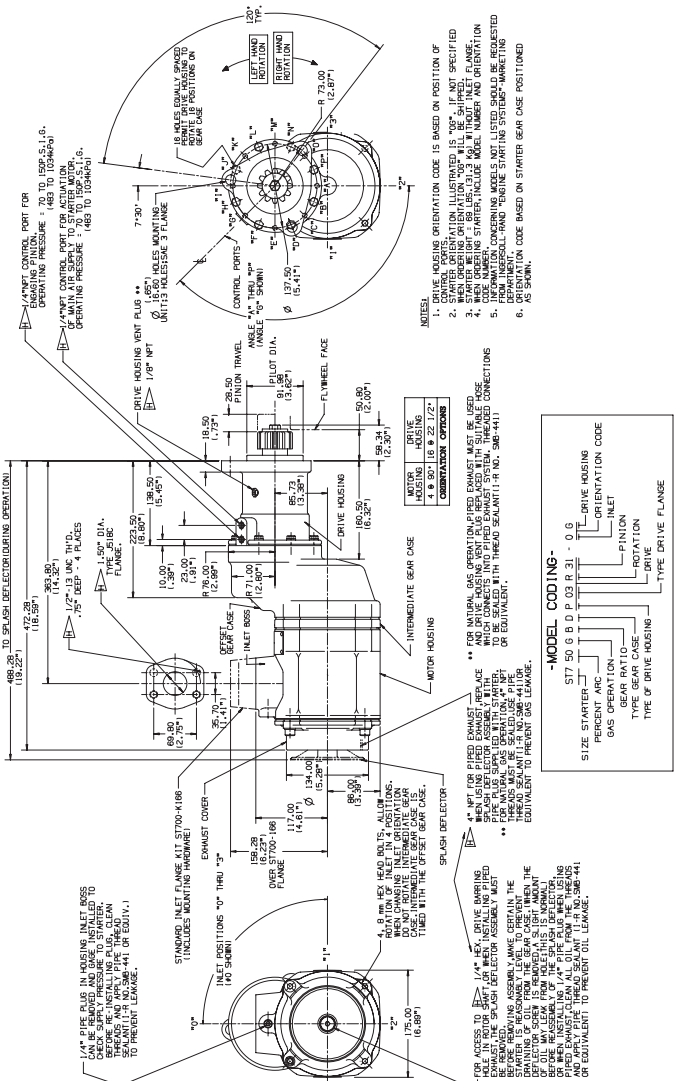
1. Disconnect the 1/4” hose at the “OUT” port on the Drive Housing, and plug the hole in the Drive Housing with a 1/4” pipe plug.
2. Engage the Drive Pinion with the flywheel by applying a minimum of 70 psig (4.8 bar/483 kPa) to the “IN” port on the Drive Housing.
3. Insert a 1/4” hex wrench through the hole in the Housing Exhaust Cover to engage the hex drive recess in the rear of the Motor Assembly.
4. Manually rotate the Motor Assembly until the engine is cranked to the desired position.

ST700 Inertia Mounting Dimensions



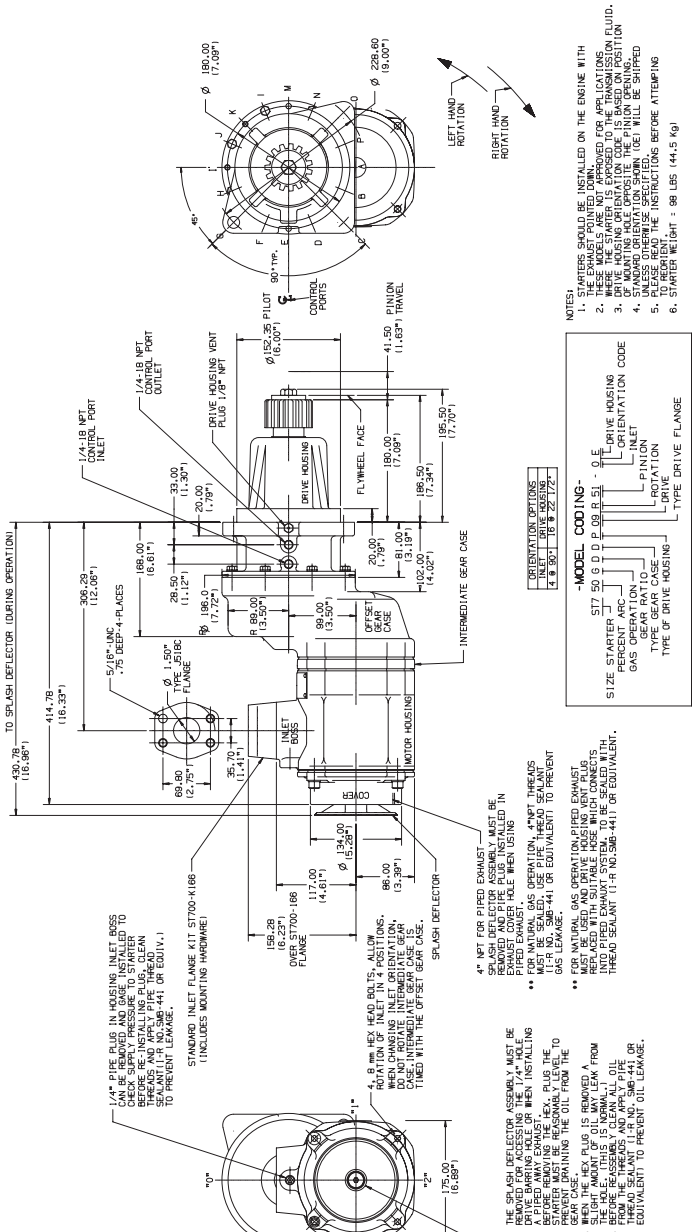
(Dwg. TPA1276-4)

Mounting Dimensions



(Dwg. TPA1277-5)

ST700 Pre-Engaged Mounting Dimensions

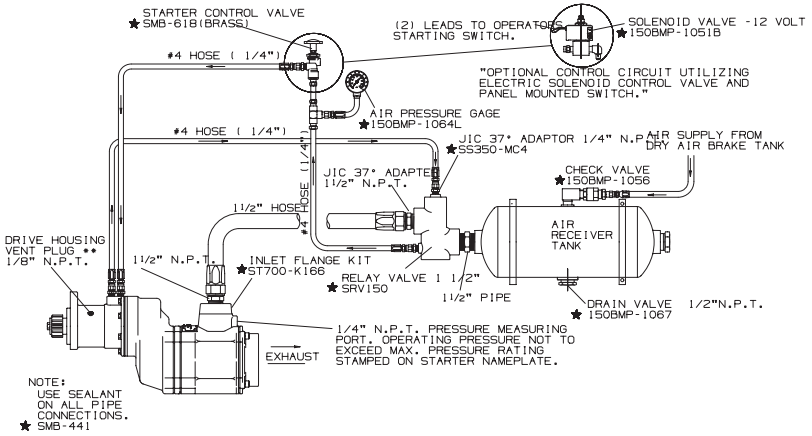


(Dwg. TPA1278-4)

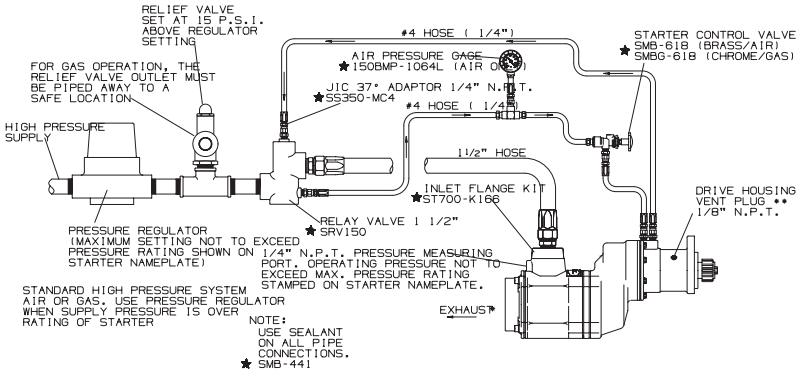
Piping Diagrams

Pre-Engaged System (Series ST700 Shown)

Typical Vehicular Installation



Typical Stationary Installation



★ INGERSOLL-RAND PART NUMBER

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

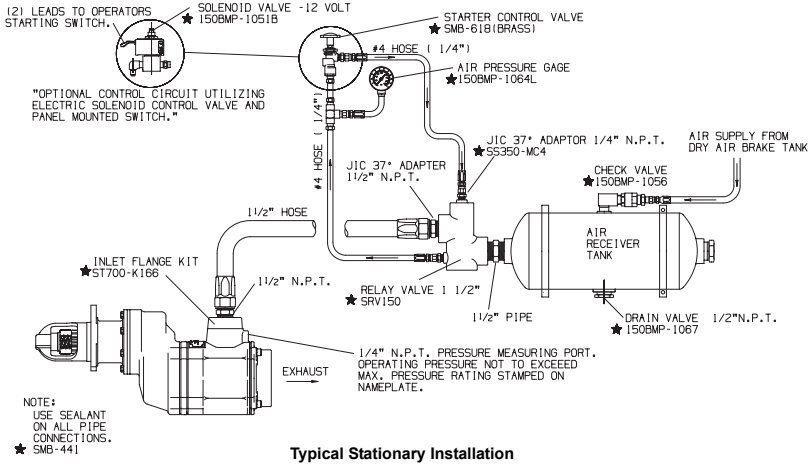
TO PIPE THE DRIVE HOUSING VENT, REMOVE THE DRIVE HOUSING PLUG AND REPLACE IT WITH A SUITABLE TUBING LINE. THE TUBING MUST VENT AT A SAFE LOCATION AND MUST NOT BE INTERCONNECTED WITH ANY OTHER EXHAUST LINES WHICH MIGHT INTRODUCE A BACK PRESSURE ON THE DRIVE HOUSING VENT.

(Dwg. TPA1282-3)

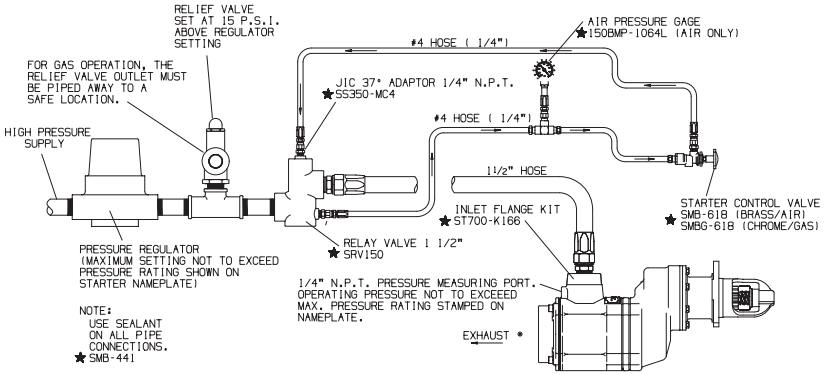
Piping Diagrams

Inertia Type System (Series ST700 Shown)

Typical Vehicular Installation



Typical Stationary Installation

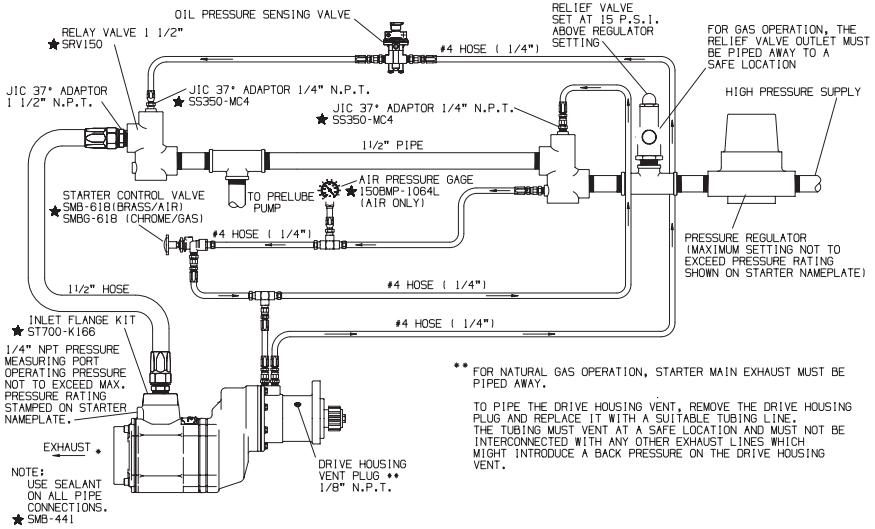


(Dwg. TPA1283-3)

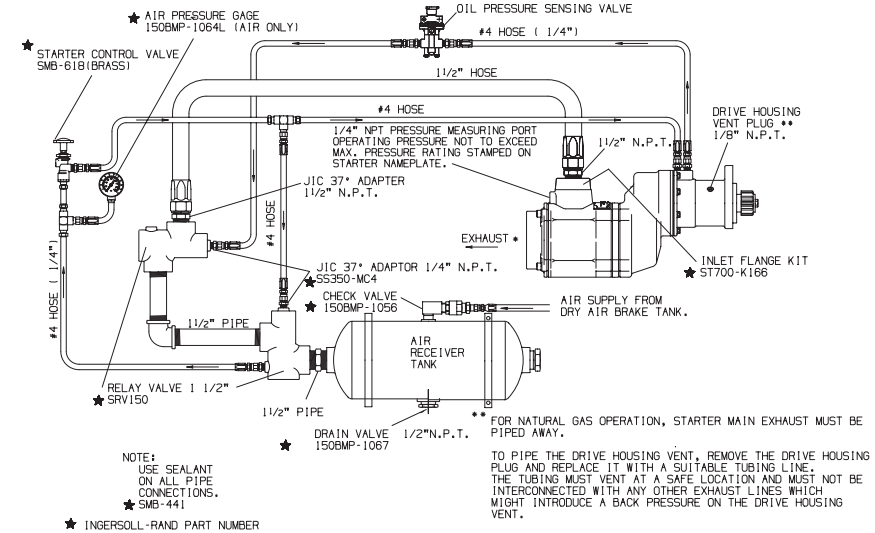
Piping Diagrams

Pre-Engaged System (Series ST700 Shown)

Typical Installation with Engine Prelube System when Supply Pressure is over Rated Starter Pressure



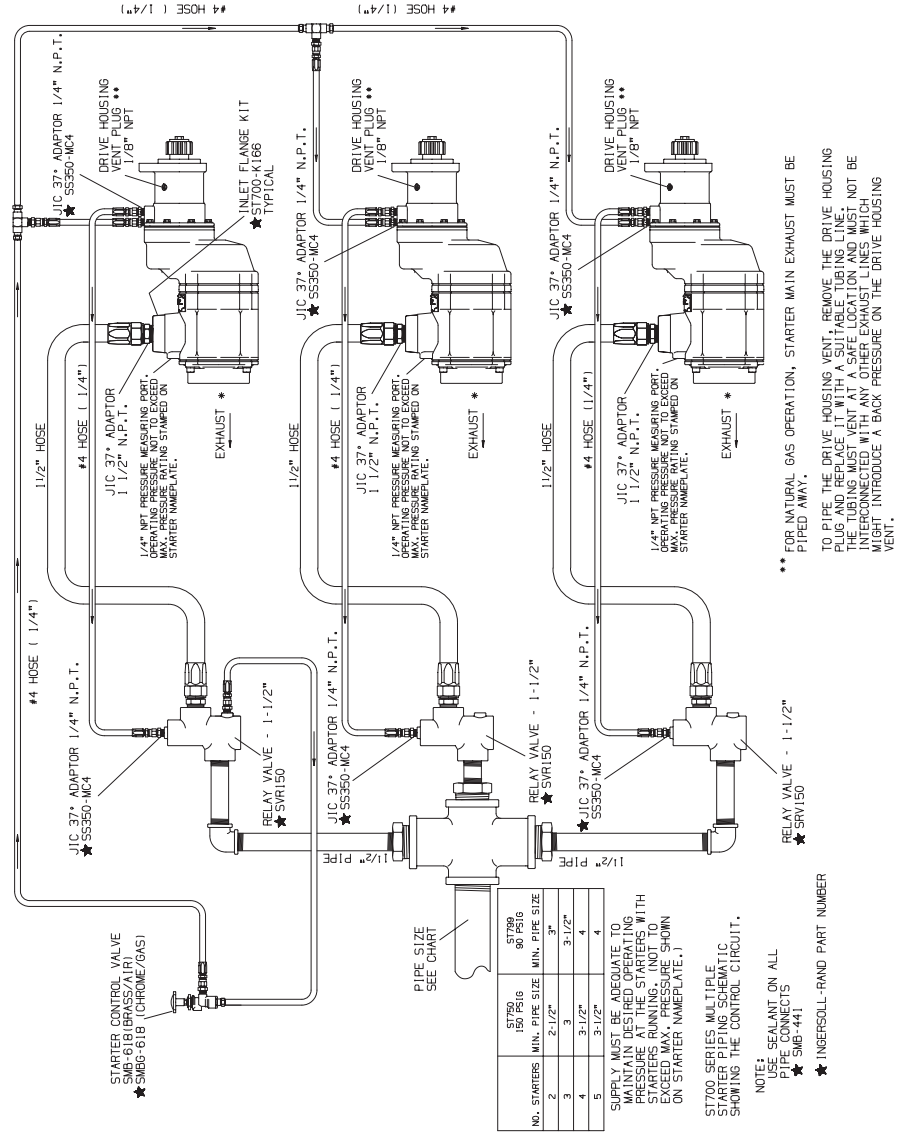
Typical Installation with Engine Prelube System



(Dwg. TPA1281-3)

Piping Diagrams

Typical Multiple Starter Installation



NO. STARTERS	ST750 150 PSIG MIN. PIPE SIZE	ST750 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

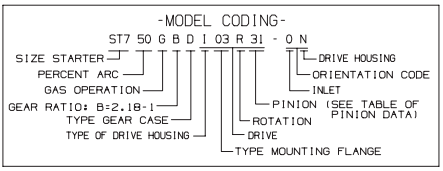
(Dwg. TPA1284-4)

Product Information

Intended Use:

Series ST700 Turbine Powered Starters are designed for air or gas operation in off-highway, marine and stationary applications.

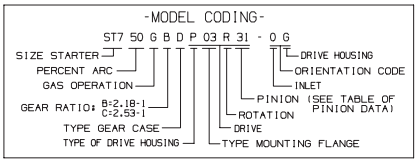
How to order a Starter



MODEL		SUPPLY PRESSURE PSIG/KPa MAX. *	DRIVE	PINION DATA			
			I-R NO.	NO. OF TEETH	D.P.	P.D.	PA
ST750GBDI03R31	ORIENTATION CODE	150/1034	20BM-299-1	12/12	6/8	2.00"	20°
ST750GBDI03L32		150/1034	20BM-299-3	12/12	6/8	2.00"	20°
ST799GBDI03R31		90/621	20BM-299-1	12/12	6/8	2.00"	20°
ST799GBDI03L32		90/621	20BM-299-3	12/12	6/8	2.00"	20°

MUST BE SPECIFIED WHEN ORDERING

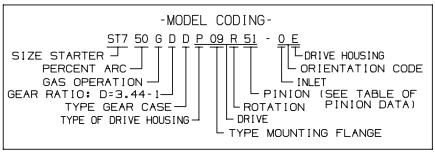
(Dwg. TPD1176)



MODEL		SUPPLY PRESSURE PSIG/KPa MAX. *	PINION DATA			
			NO. OF TEETH	D.P.	P.D.	PA
ST750GBDP03R31	ORIENTATION CODE	150/1034	12/12	6/8	2.00"	20°
ST750GBDP03L32		150/1034	12/12	6/8	2.00"	20°
ST750GCDP03R25		150/1034	11/12	6/8	2.00"	20°
ST750GBDP03L26		150/1034	12/12	6/8	2.00"	20°
ST799GBDP03R31		90/621	12/12	6/8	2.00"	20°
ST799GBDP03L32		90/621	12/12	6/8	2.00"	20°
ST799GCDP03R25		90/621	11/12	6/8	2.00"	20°
ST799GBDP03L26		90/621	12/12	6/8	2.00"	20°

MUST BE SPECIFIED WHEN ORDERING

(Dwg. TPD1177)



MODEL		SUPPLY PRESSURE PSIG/KPa MAX. *	PINION DATA			
			NO. OF TEETH	D.P.	P.D.	PA
ST750GDDP09R51	ORIENTATION CODE	150/1034	15	6/8	2.50"	20°
ST750GDDP09L52		150/1034	15	6/8	2.50"	20°
ST799GDDP09R51		90/621	15	6/8	2.50"	20°

MUST BE SPECIFIED WHEN ORDERING

(Dwg. TPD1178)

For different models or special applications, contact your nearest Ingersoll-rand Distributor or SALES HEADQUARTERS, Engine Starting Systems, P.O. Box 1776, Liberty Corner, NJ 07938, Phone (908) 647 - 6000.

Product Parts Information

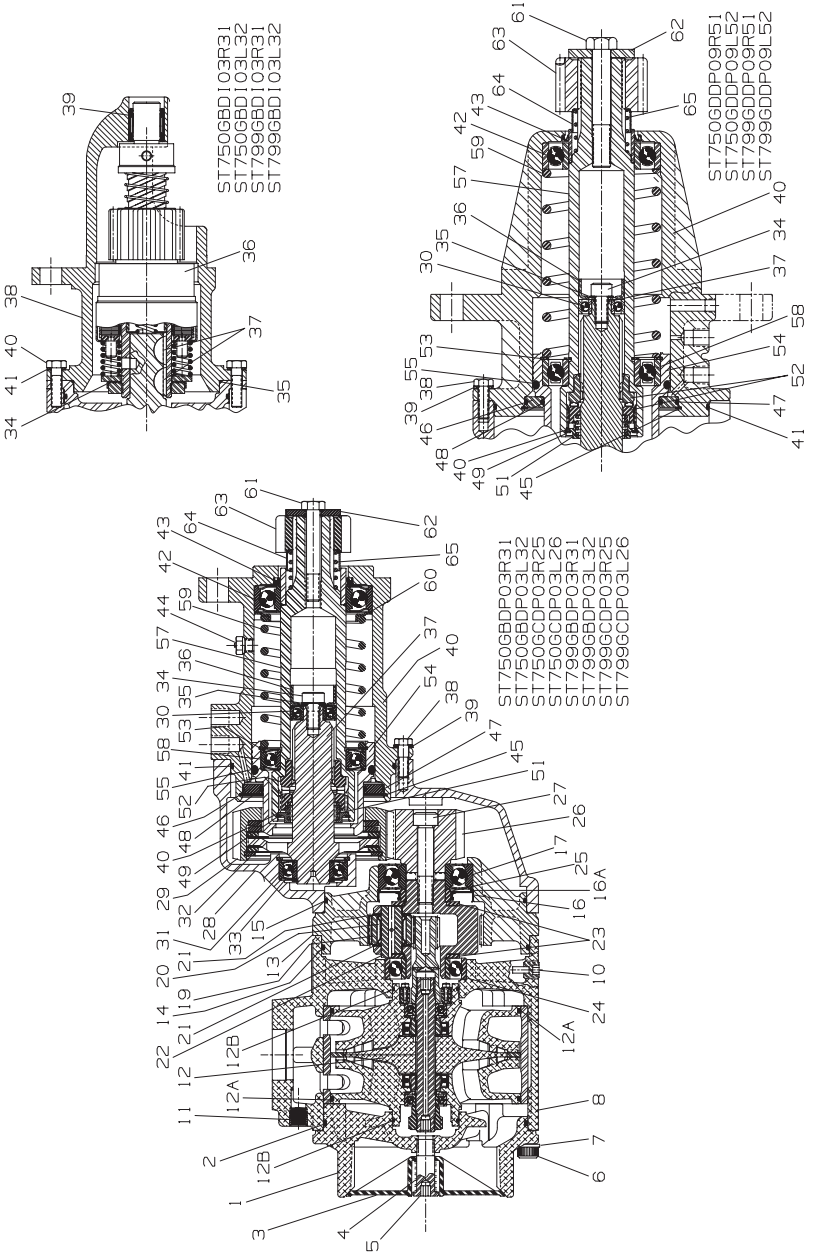
CAUTION

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.

Manuals can be downloaded from www.irtools.com
Refer all communications to the nearest **Ingersoll-Rand** Office or Distributor.

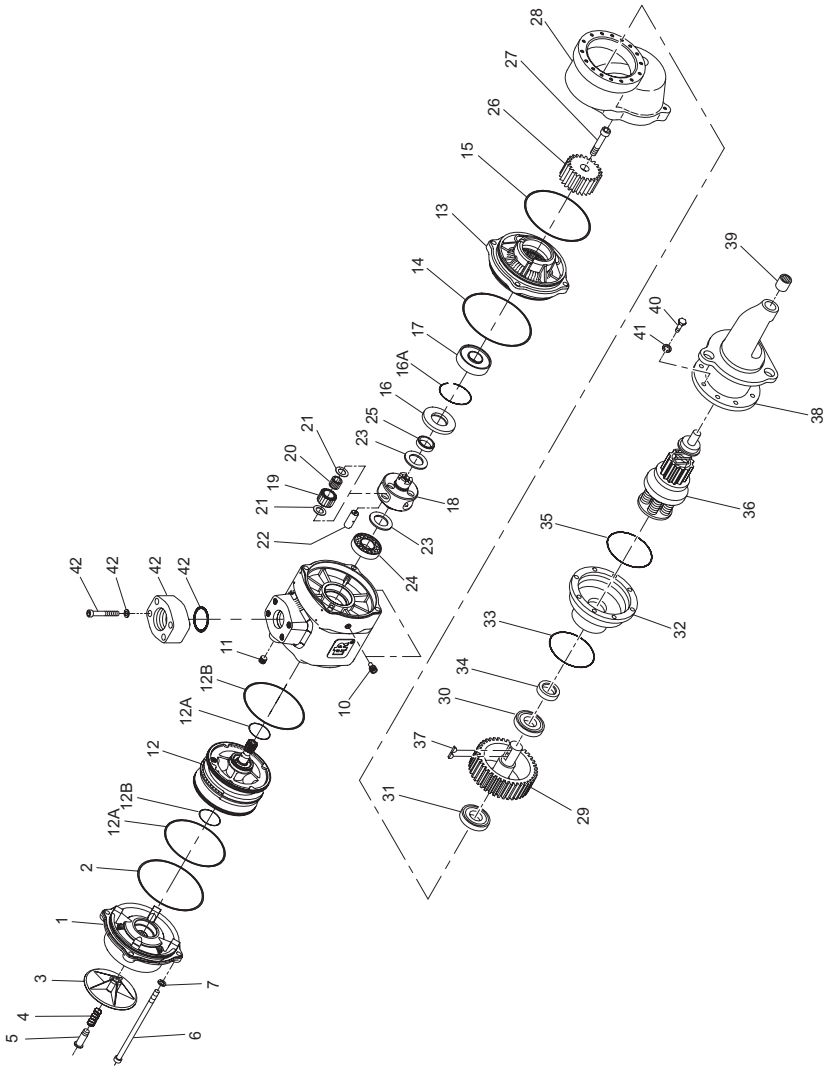
Parts Information

Cross Section Diagram, ST700 Turbine Powered Starter



(Dwg. TPA1275-2)

Exploded Diagram, ST750 Turbine Powered Starter (Inertia)



(Dwg. TPA1272-2)

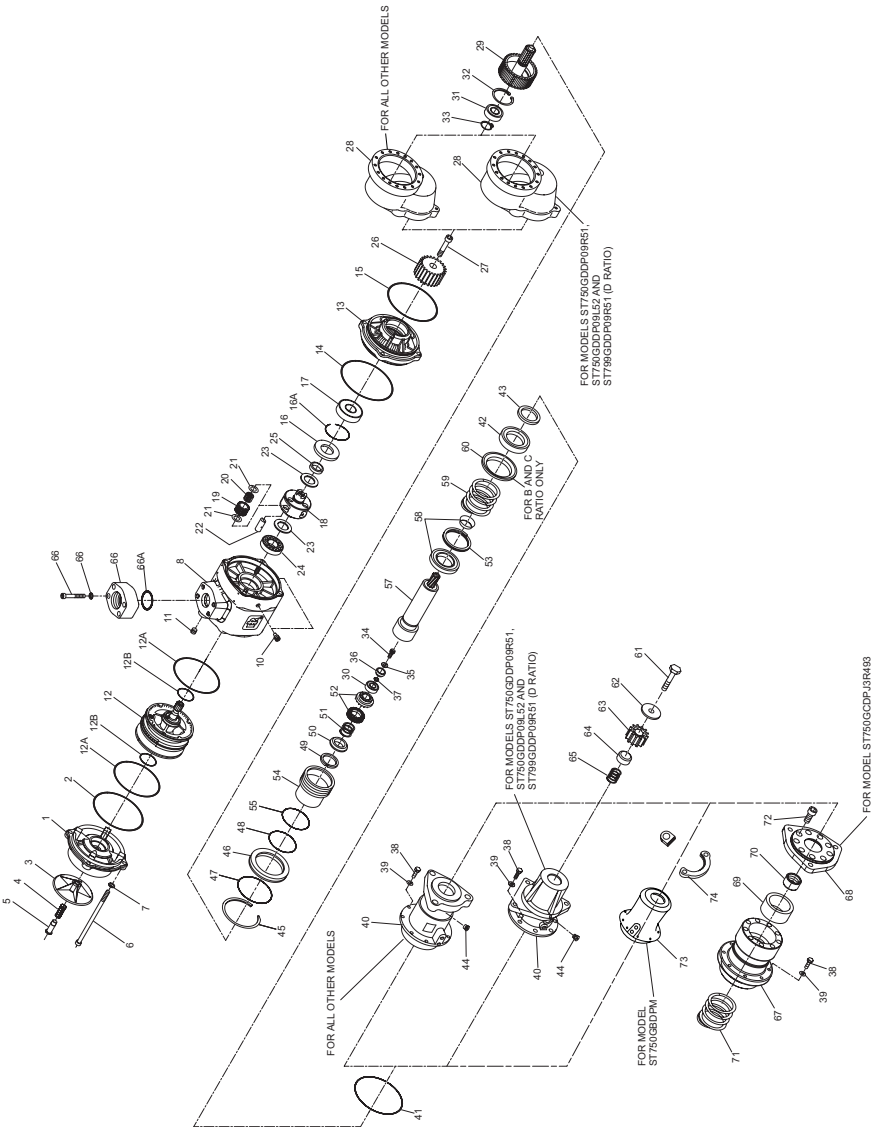
Parts List, ST750 Turbine Powered Starter (Inertia)

Item	Part Description	Part Number
	Housing Exhaust Cover Assembly	ST700-A562
1	Housing Exhaust Cover	ST700-562
2	Exhaust Cover Seal	SS800-67
*	Exhaust Cover Plug	ST700-K37
3	Splash Deflector	ST700-735
4	Deflector Return Spring	D10-275
5	Deflector Retaining Screw	ST700-737
6	Starter Assembly Cap Screw (4)	ST900-2574
7	Cap Screw Washer (4)	SS800-26
	Motor Housing Assembly	ST700-A40
8	Motor Housing	ST700-40
10	Housing Plug (2)	CE110-29
11	Housing Plug Inlet Boss	R0H-377
*	Nameplate	ST700-301
*	Nameplate Screw (4)	R4K-302
† 12	Motor Assembly	
	for Model ST750GBDI03R31	ST750R-A53
	for Model ST750GBDI03L32	ST750L-A53
	for Model ST799GBDI03R31	ST799R-A53
	for Model ST799GBDI03L32	ST799L-A53
12A	Cylinder O-Ring Seal (2)	ST700-67
12B	Housing O-Ring Seal (2)	Y327-032
	Intermediate Gear Case Assembly	ST700-A37
13	Intermediate Gear Case	ST700-37
† 14	Rear Gear Case O-Ring	Y327-163
† 15	Front Gear case O-Ring	Y327-162
† 16	Planet Gear Frame Shaft Seal	ST700-272
† 16A	Spacer Ring	ST700-323
† 17	Front Gear Frame Bearing	SS800-22
	Planet Gear Frame Assembly	ST700-A108
18	Planet Gear Frame	ST700-108
† 19	Planet Gear (3)	ST700-10
† 20	Planet Gear Needle Roller Bearing (3)	ST700-363
*	Planet Gear Needle (18)	ST700-363-R
† 21	Bearing Spacer (6)	ST700-364
† 22	Planet Gear Shaft (3)	ST700-191
23	Gear Shaft Retaining Washer (2)	ST700-100
† 24	Rear Gear Frame Bearing	TA-22
25	Front Bearing Spacer	ST700-90
26	Intermediate Pinion	SS800B-17
27	Intermediate Retaining Screw	SS800-732
28	Gear Case	SS800-37
29	Drive Gear	SS810-9
† 30	Front Drive Gear Bearing	BU-359
† 31	Rear Drive Gear Bearing	SS800-359

Item	Part Description	Part Number
32	Gear Case Cover	SS810-678
† 33	Gear Case Cover O-Ring	SS800-244
† 34	Drive Gear Shaft Seal	SS810-272
† 35	Drive Housing O-Ring	SS800-152
36	Starter Drive	
	for Models ST750GBDI03R31 and ST799GBDI03R31	20BM-299-1
	for Models ST750GBDI03L32 and ST799GBDI03L32	20BM-299-3
37	Drive Gear Key (2)	20BM-610
38	Drive Housing	SS810-300
† 39	Drive Housing Bearing	SS660-363-13
40	Drive Housing Cap Screw (8)	SS810-744
41	Drive Housing Cap Screw Lock Washer (8)	TE223A-415
† 42	Inlet Flange Kit (Includes Inlet Flange, Flange Mounting Bolts and Lock Washers)	ST700-K166
43	Flange Mounting Hardware Kit (includes Flange Mounting Bolts and Lock Washers)	ST700-K167
*	Planet Gear Kit (includes illustrated parts 14, 19 [3], 20 [54], 21 [6], and 22 [3])	ST700-K10
*	Tune-up Kit (included illustrated parts 14, 15, 16, 16A, 17, 19, 20, 21, 22 and 42	ST700-TK1
*	Tune-up Kit (for ST750 models with right hand rotation) includes illustrated parts 12, 14, 16, 16A, 17, 19, 20, 21, 22, 24 and 42	ST750R-TK2
*	Tune-up Kit (for ST750 models with left hand rotation) includes illustrated parts 12, 14, 16, 16A, 17, 19, 20, 21, 22, 24 and 42	ST750L-TK3
*	Tune-up Kit (for ST799 models with right hand rotation) includes illustrated parts 12, 14, 16, 16A, 17, 19, 20, 21, 22, 24 and 42	ST799R-TK4
*	Tune-up Kit (for ST799 models with left hand rotation) includes illustrated parts 12, 14, 16, 16A, 17, 19, 20, 21, 22, 24 and 42	ST799L-TK5
	Tune-up Kit (for Inertia Drive models includes illustrated parts 30, 31, 33, 34 35 and 39	ST700I-TK6

* Not Illustrated
† Tune-up Kit Parts

Exploded Diagram, Series ST700 Turbine Starter (Pre-Engaged)



(Dwg. TPA1273-5)

Parts List, Series ST700 Turbine Starter (Pre-Engaged)

Item	Part Description	Part Number
	Housing Exhaust Cover Assembly	ST700-A562
1	Housing Exhaust Cover	ST700-562
2	Exhaust Cover Seal	SS800-67
*	Exhaust Cover Plug	ST700-K37
3	Splash Deflector	ST700-735
4	Deflector Return Spring	D10-275
5	Deflector Retaining Screw	ST700-737
6	Starter Assembly Cap Screw (4)	ST700-2574
7	Cap Screw Washer (4)	SS800-26
	Motor Housing Assembly	ST700-A40
8	Motor Housing	ST700-40
10	Housing Plug (2)	CE110-29
11	Housing Plug Inlet Boss	R0H-377
*	Nameplate	ST700-301
*	Nameplate Screw (4)	R4K-302
† 12	Motor Assembly	
	for Models ST750GBDP03R31 ST750GCDP03R25 and ST750GDDP09R51	ST750R-A53
	for Models ST750GBDP03L32, ST750GCDP03L26 and ST750GDDP09L52	ST750L-A53
	for Models ST799GBDP03R31, ST799GCDP03R25 and ST799GDDP09R51	ST799R-A53
	for Models ST799GBDPO3L32, ST799GBDP03L26 and ST799GDDP09L52	ST799L-A53
12A	Cylinder O-ring Seal (2)	ST700-67
12B	Housing O-ring Seal (2)	Y327-032
	Intermediate Gear Case Assembly	ST700-A37
13	Intermediate Gear Case	ST700-37
† 14	Rear Gear Case O-ring	Y327-163
† 15	Front Gear Case O-ring	Y327-162
† 16	Planet Gear Frame Shaft Seal	ST700-272
† 16A	Spacer Ring	ST700-323
† 17	Front Gear Frame Bearing	SS800-22
	Planet Gear Frame Assembly	ST700-A108
18	Planet Gear Frame	ST700-108
† 19	Planet Gear (3)	ST700-10
† 20	Planet Gear Needle Roller Bearing (3)	ST700-363
*	Planet Gear Needle Roller (18)	ST700-363-R
† 21	Bearing Spacer (6)	ST700-364
† 22	Planet Gear Shaft (3)	ST700-191
23	Gear Shaft Retaining Washer (2)	ST700-100
† 24	Rear Gear Frame Bearing	TA-22
25	Front Bearing Spacer	ST700-90
26	Intermediate Pinion	
	for Models ST750GBDP03R31, ST750GBDP03L32, ST799GBDP03R31 and ST799GBDP03L32	SS800B-17
	for Models ST750GCDP03R25, ST750GCDP03L26, ST799GCDP03R25 and ST799GCDP03L26	SS825C-17
	for Models ST750GDDP09R51, ST750GDDP09L52,ST799GDDP09R51 and ST799GDDP09L52	SS850-17
27	Intermediate Pinion Retaining Screw	SS800-732
28	Gear Case	
	for Models ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09R51 and ST799GDDP09L52	SS850-37
	for all other models	SS800-37
29	Drive Gear	
	for Models ST750GBDP03R31, ST750GBDP03L32, ST799GBDP03R31 and ST799GBDP03L32	SS815B-9
	for Models ST750GCDP03R25, ST750GCDP03L26, ST799GCDP03R25 and ST799GCDP03L26	SS825C-9
	for Models ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09R51 and ST799GDDP09L52	SS850D-9
30	Front Drive Gear Bearing	SS800-278
† 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 ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09R51 and ST799GDDP09L52	SS850-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	SS850-363
43	Drive Housing Seal	SS800-271
44	Drive Housing Vent Plug	P250-546
† 45	Bulkhead Retainer	
	for Models ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09R51 and ST799GDDP09L52	SS850-181
	for all other models	SS800-181
46	Bulkhead Kit	
	for Models ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09R51 and ST799GDDP09L52	SS850-K150
	for all other models	SS800-K150
† 47	Outer Bulkhead O-ring	
	for Models ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09R51 and ST799GDDP09L52	SS850-152
	for all other models	SS800-152
† 48	Inner Bulkhead O-ring	
	for Models ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09R51, ST799GDDP09R51, and ST799GDDP09L52	SS850-151
	for all other models	SS800-151

* Not illustrated

† Indicates Tune-up Kit parts

Parts List, Series ST700 Turbine Starter (Pre-Engaged) - *Continued*

Item	Part Description	Part Number
49	Clutch Spring Cup Retainer	SS800-366
50	Clutch Spring Cup	SS800-367
51	Clutch Spring	SS800-583
52	Clutch Jaw Kit	
	for Models ST750GBDP03R31, ST750GCDP03R25, ST750GDDP09R51, ST799GBDP03R31, ST799GCDP03R25 and ST799GDDP09R51	SS800R-K587
	for Models ST750GBDP03L32, ST750GCDP03L26, ST750GDDP09L52, ST799GBDP03L32, ST799GCDP03L26 and ST799GDDP09L52	SS800L-K587
53	Large Drive Shaft Bearing Retainer	
	for Models ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09RS1 and ST799GDDP09L52	SS850-107
	for all other models	SS800-107
54	Piston Kit	
	for Models ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09R51 and ST799GDDP09L52	SS850K-703
	for all other models	SS800K-703
† 55	Piston O-ring	
	for Models ST750GDDP09R51 ST750GDDP09L52, ST799GDDP09R51 and ST799GDDP09L52	SS850-337
	for all other models	SS800-337
57	Drive Shaft Kit	
	for Models ST750GBDP03R31, ST750GCDP03R25, ST799GBDP03R31 and ST799GCDP03R25	SS800R-K8
	for Models ST750GBDP03L32, ST750GCDP03L26, ST799GBDP03L32 and ST799GCDP03L26	SS800L-K8
	for Models ST750GDDP09R51 and ST799GDDP09R51	SS850R-K8
	for ST750GDDP09L52 and ST799GDDP09L52	SS850L-K8
58	Rear Drive Shaft Bearing (includes bearing and retainer)	
	for Models ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09R51 and ST799GDDP09L52	SS850-K399
	for all other models	SS800-K399
59	Piston Return Spring	
	for Models ST750GDDP09R51, ST750GDDP09L52 and ST799GDDP09R51	SS850-700
	for all other models	SS800-700
60	Seat (for all B and C ratio Models only)	SS800-191

Item	Part Description	Part Number
61	Drive Pinion Retaining Screw	
	for Models ST750GBDP03R31, ST750GCDP03R25, ST799GBDP03R31 and ST799GCDP03R25	SS800R-394
	for Models ST750GBDP03L32 ST750GCDP03L26,ST799GBDP03L32 and ST799GCDP03L26	SS800L-394
	for ST750GDDP09R51 and ST799GDDP09R51	SS850R-394
	for ST750GDDP09L52 and ST799GDDP09L52	SS850L-394
62	Drive Pinion Washer	
	for Models ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09R51 and ST799GDDP09L52	SS850-725
	for all other models	SS800-725
63	Drive Pinion	
	for ST750GBDP03R31 and ST799GBDP03R31	SS815R-13-31
	for ST750GBDP03L32 and ST799GBDP03L32	SS815L-13-32
	for ST750GCDP03R25 and ST799GCDP03R25	SS825R-13-25
	for ST750GCDP03L26 and ST799GCDP03L26	SS825L-13-26
	for ST750GDDP09R51 and ST799GDDP09L52	SS850R-13-51
	for ST750GDDP09L52 and ST799GDDP09L52	SS850L-13-52
64	Pinion Spring Sleeve	
	for Models ST750GDDP09R51, ST750GDDP09L52, ST799GDDP09R51 and ST799GDDP09L52	SS850-335
	for all other models	SS800-335
65	Pinion Spring	
	for Models ST750GBDP03R31, ST750GCDP03R25, ST799GBDP03R31 and ST799GCDP03R25	SS800R-419
	for Models ST750GBDP03L32, ST750GCDP03L26, ST799GBDP03L32 and ST799GCDP03L26	SS800L-419
	for ST750GDDP09R51 and ST799GDDP09R52	SS850R-419
	for ST750GDDP09L52 and ST799GDDP09L52	SS850L-419
66	Inlet Flange Kit (includes Inlet Flange, O-ring, Mounting Bolts and Lock Washers)	ST700-K166
67	Drive Housing Kit	ST700-K300
68	Flange	ST700-212A
69	Ring	ST700-694Y
70	Bearing	ST700-693
71	Spring	SS800-700LP
72	Cap Screw (9)	SS800-179
73	Drive Housing	04331328
74	Flange	04331310

* Not illustrated

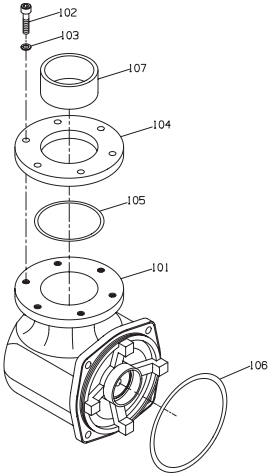
† Indicates Tune-up Kit parts

Parts List, Series ST700 Turbine Starter (Pre-Engaged) - *Kits*

Item	Part Description	Part Number
*	Flange Mounting Hardware Kit (includes O-ring, Mounting Bolts and Lock Washers)	ST750-K167
*	Planet Gear Kit (includes illustrated parts 14, 19 [3], 20 [54], 21 [6] and 22 [3])	ST700-K10
*	Tune-up Kit (includes illustrated parts 14, 15, 16, 16A, 17, 19, 20, 21, 22, 24 and 66A	ST700-TK1
*	Tune-up Kit (for ST750 models with right hand rotation) includes illustrated parts 12, 14, 16, 16A, 17, 19, 20, 21, 22, 24 and 66A	ST750R-TK2
*	Tune-up Kit (for ST799 models with left hand rotation) includes illustrated parts 12, 14, 16, 16A, 17, 19, 20, 21, 22, 24 and 66A	ST750L-TK3
*	Tune-up Kit (for ST799 models with right hand rotation) includes 12, 14, 16, 16A, 17, 19, 20, 21, 22, 24 and 66A	ST799R-TK4
*	Tune-up Kit (for ST799 models with left hand rotation) includes 12, 14, 16, 16A, 17, 19, 20, 21, 22, 24 and 66A	ST799R-TK5
*	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

* Not illustrated

ST700K-350 Exhaust Kit (*Available at extra cost)*



(Dwg. TPC540-1)

Item	Description	Part Number
	Exhaust Kit	ST700K-350
101	Directional Housing Exhaust Cover	ST700-350
102	Capscrew (6)	ST700-703
103	Lockwasher (6)	845-58
104	Exhaust Adapter	ST700-351
105	Exhaust Adapter Seal	ST700-103
106	Exhaust Cover Seal	SS800-67
107	Weld Sleeve	ST700-352
*	Plug	R0H-377

* Not illustrated.

Installation of Exhaust Kit

NOTICE

To aid in installation of ST700K-350 Exhaust Kit, refer to Drawings TPA1272-2 and TPA1273-2 in this manual.

⚠ WARNING

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.

1. Using an 8 mm hex-head wrench, remove Starter Assembly Cap Screws (6) and Cap Screw Washers (7).
2. Pull the Housing Exhaust Cover (1) from the Motor Housing (8). To dislodge the Housing Exhaust Cover, rotate it until it clears the Motor Housing. Using a plastic hammer, tap the ears alternately until the Housing Exhaust Cover can be removed from the Motor Housing.

NOTICE

If Exhaust Cover Seal (106) was removed or damaged, replace it with a new Seal.

3. Coat the Exhaust Cover Seal with O-ring lubricant and install in the groove in the Directional Housing Exhaust Cover (101).
4. 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.
5. 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.
6. Lubricate Exhaust Adapter Seal (105) with O-ring lubricant and install in groove in Exhaust Adapter (104).
7. Install Exhaust Adapter with Exhaust Adapter Seal down on Directional Housing Exhaust Cover. Align holes and secure Adapter with Cap Screws (102) and Lock Washers (103). Tighten each Cap Screw a little at a time to a final torque of 48 ft-lb (65 Nm torque) in 20 ft-lb (27 Nm) increments.

Maintenance

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 a Series ST700 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.

For All Models

1. Lubricate all O-rings with O-ring lubricant.
2. Lubricate the Front Drive Gear (29) with 8 oz. (240 ml) of **Ingersoll-Rand** No. 130 Grease.
3. Coat the Front Bearing Spacer (25) with gear lube before installing.
4. Add 175 ml (approximately 1/3 pint) of Dexron®** II Automatic Transmission Fluid through the side plug hole in the Motor Housing (8).

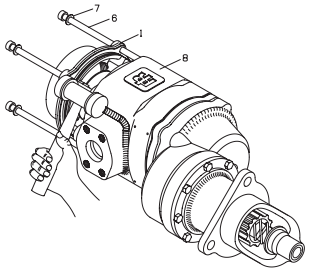
Disassembly

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 copper-covered vice jaws to protect the surface of the part and help prevent distortion. This is particularly true of threaded and die cast 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 ST700 Turbine Starter. Never reuse old seals or O-rings.
5. Always mask adjacent parts on the Housing Exhaust Cover (1), Motor Housing (8), Intermediate Gear Case (13), Gear Case (28) and Drive Housing (38) so these members can be located in the same relative position when the Starter is reassembled.
6. Never wash the Inertia Drive 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.

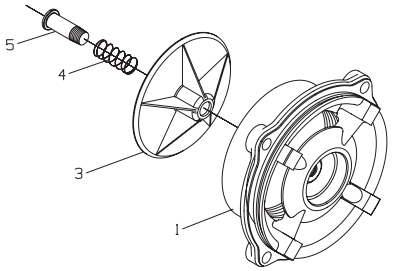
Disassembly of the Housing Exhaust Cover, Motor Assembly, and Motor Housing

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. Inspect the Magnetic Housing Plugs (10) for metal particles. Very fine metal particles are normal. Remove particles and reinstall plugs. Large particles or chips are an indication of a problem. Disassemble Gear Case (28) and inspect.
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 Cover (1) from the Motor Housing (8). To dislodge the Housing Exhaust Cover, rotate it until the ears clear the Motor Housing. Using a plastic hammer, tap the ears alternately until the Housing Exhaust Cover can be removed from the Motor Housing. Refer to Dwg. TPD1159.



(Dwg. TPD1159)

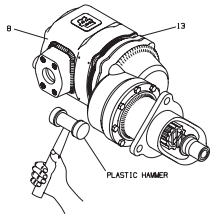
4. Remove the Deflector Retaining Screw (5), Deflector Retaining Spring (4) and the Splash Deflector (3) from the Housing Exhaust Cover. Refer to Dwg. TPD1160.



(Dwg. TPD1160)

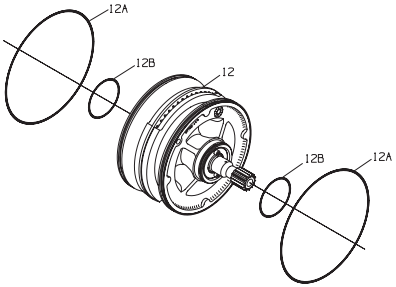
** Registered trademark of Exxon Corporation.

5. Tap the Motor Housing with a plastic hammer to dislodge it from the Intermediate Gear Case (13). Refer to Dwg. TPD1162.



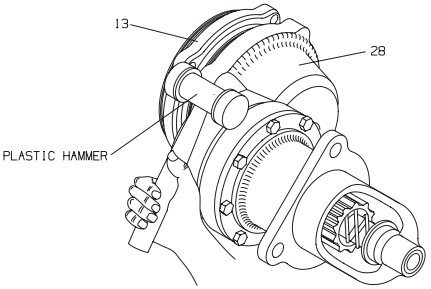
(Dwg. TPD1162)

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. 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. TPD1164.



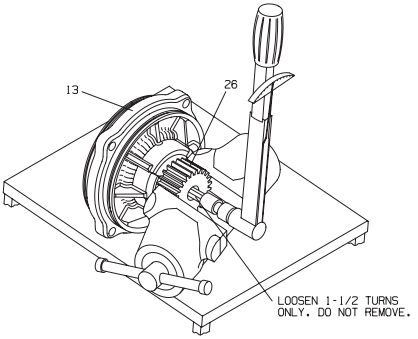
(Dwg. TPD1164)

8. Position the Intermediate Gear Case on a bench in a copper-faced vise so that the Intermediate Pinion (26) 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 (27) 1-1/2 turns only. **Do not remove**.

WARNING

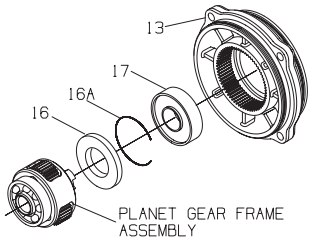
If the Intermediate Gear Case is not supported on a bench and if the Intermediate Pinion Retaining Screw is completely removed, the Intermediate Gear Case and components could fall causing injury.

Tap the Intermediate Pinion lightly to back the Planet Gear Frame Assembly out of the Intermediate Gear Case. Refer to Dwg. TPD1169.



(Dwg. TPD1169)

10. Remove the Intermediate Gear Case Assembly from the vise and remove the Intermediate Pinion. Remove the Rear Gear Case O-ring (14) and Front Gear Case O-ring (15) from the Intermediate Gear Case.
11. Remove the Planet Gear Frame Assembly from the Intermediate Gear Case. Using a sleeve that contacts the outer race of the Front Gear Frame Bearing (17), press the Planet Gear Frame Shaft Seal (16) and the Front Gear Frame Bearing (17) from the front end and out of the rear of the Intermediate Gear Case. Refer to Dwg. TPD1166.

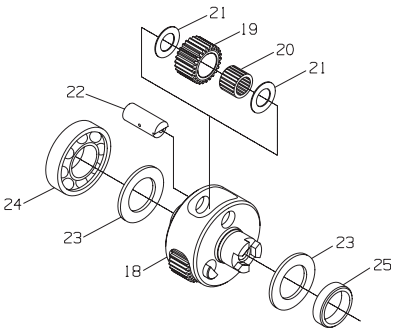


(Dwg. TPD1166-1)

12. Using a bearing puller, remove the Rear Gear Frame Bearing (24) from the Planet Gear Frame (18) and remove the Gear Shaft Retaining Washer (23).
13. Remove the Planet Gear Shafts (22), Planet Gears (19), Planet Gear Bearings (20) and Bearing Spacers (21).
14. Using a bearing puller, remove the Front Bearing Spacer (25) and the Gear Shaft Retaining Washer (23) from the front of the Planet Gear Frame by pressing on the front of the Planet Gear Frame Shaft. Refer to Dwg. TPD1167.

WARNING

Remove the Gear Shaft Retaining Washer only if the Washer or Front Bearing Spacer is damaged.

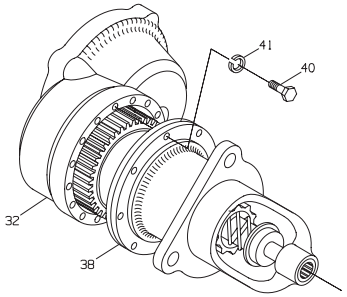


(Dwg. TPD1167)

Disassembly of the Drive Housing

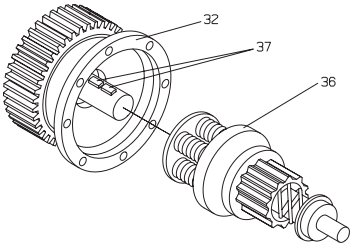
Inertia Models:

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) 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 from the Gear Case.
8. Remove the Drive Housing G-ring (35) and the Gear Case Cover Seal (33) from the Gear Case Cover.
9. Pull the Drive Gear (30) out of the Gear Case.
10. Remove the Rear Drive Gear Bearing (31) and the Front Drive Gear Bearing (30) from the Drive Gear.

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 Screws (38) and Lock Washers (39).
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). **Do not use compressed air to load the Piston.**
10. Using a screwdriver, remove the Bulkhead Retainer. Use off the arbor press.

⚠ 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.

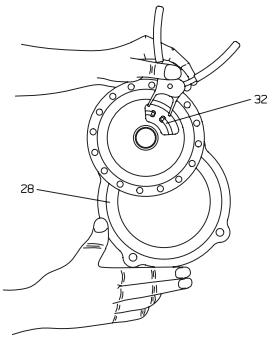
15. Remove the Piston Ring (55) from the Piston.
16. Insert a large screwdriver blade through the Piston Seal (56) so that it rests on top of the Clutch Spring Cup (50). Pry the Seal out of the Piston.

NOTICE

This operation will damage the Piston Seal. Therefore, a replacement Piston Seal must be on hand.

17. Press the Clutch Spring Cup (50) down and remove the Clutch Spring Cup Retainer (49).

18. Remove the Clutch Spring Cup and Clutch Spring (51).
19. Remove the two Clutch Jaws (52).
20. 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).
21. Using a screwdriver, remove the large Drive Shaft Bearing Retainer (53).
22. 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 retained in the Drive Shaft.
    b Press the Rear Drive Shaft Bearing (58) off the Drive Shaft.
23. Place the Gear Case (28) on a workbench.
24. Using retaining ring pliers and working through the access holes in the gear web, remove the Drive Gear Bearing Retainer (32). Refer to Dwg. TPD1170.



(Dwg. TPD1170)

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

NOTICE

Do not disassemble the Drive Gear and Clutch parts of Series ST700 Turbine-Powered Starters. If the Drive Shaft is defective, install a new or factory-rebuilt unit.

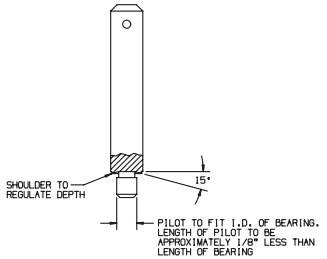
26. Using retaining ring pliers, remove the Drive Gear Shaft Bearing Retainer (33).
27. Remove the Rear Drive Gear Bearing (31) from the Drive Gear.

Assembly

General Instructions

1. Always press on the inner ring of a ball-type bearing when installing the bearing on a shaft.
2. Always press on the outer ring of a ball-type bearing when pressing the bearing into a bearing recess.
3. Whenever grasping a starter or part in a vise, always use leather-covered or copper-covered vise jaws. Take extra care with threaded parts or housings.
4. Except for bearings, always clean every part and wipe every part with a thin film of oil before installation.
5. Check every bearing for roughness. If an open bearing must be cleaned, wash it thoroughly in a 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.
7. Unless otherwise noted, always press on the stamped end of a needle bearing when installing the needle bearing in a recess. Use a bearing inserting tool similar to the one shown in Dwg. TPD786.

Needle Bearing Inserting Tool



(Dwg. TPD786)

Assembly of the Gear case and Drive Housing

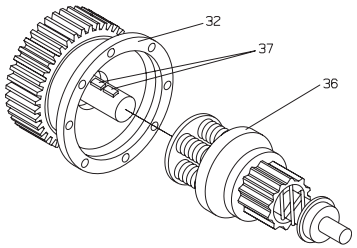
Inertia Drive Models:

NOTICE

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

Gear Case

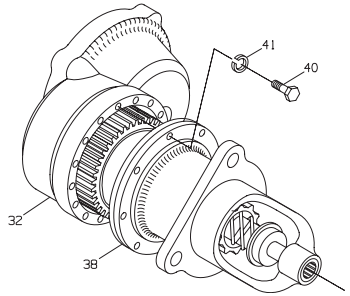
1. Install the Rear Drive Gear Bearing (31) and Front Drive Gear Bearing (30) onto the Drive Gear (29).
2. Install the two Drive Gear Keys (37) into the drive gear shaft. Refer to Dwg. TPD1171.



(Dwg. TPD1171)

3. Slide the Rear Drive Gear Bearing into the Gear Case.
4. Lubricate the Drive Gear with approximately 8 oz. (240 ml) 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 ring and screw securely.
9. Press the Drive Housing Bearing (39) into the Drive Housing (38) and lubricate with **Ingersoll-Rand** No. 130 Grease. See 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.



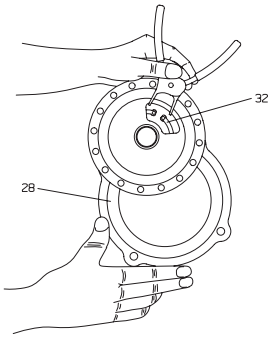
(Dwg. TPD1168)

Assembly of the Gear case and Drive Housing

Pre-Engaged Models:

Gear Case

1. Place the Drive Gear Bearing Retainer 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 pliers, 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 Grease.
7. Press the Rear Drive Shaft Bearing (58) onto the Drive Shaft.
8. Slide the small 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. 130 Grease.
11. Slide the Drive Gear Bearing (30) into the Drive Shaft.
12. Lubricate with**Ingersoll-Rand** No. 130 Grease 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. (See illustration TPA1273-5 on page 16.)
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 (45).
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).

NOTICE

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 29 ft-lb (39.3 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

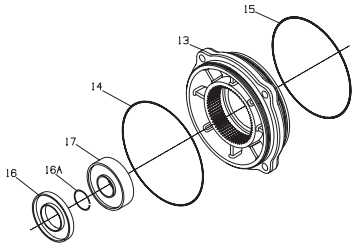
Models ending in R25, R31 and R51 have a left-hand thread; models ending in L26, L32 and L52 have a right-hand thread. Install the Drive Pinion Retaining Screw into the end of the Drive Shaft and tighten it to 80 ft-lb (108.5 Nm) torque for models with "B" and "C" gear ratios and to 125 ft-lb (169.5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

Assembly of the Intermediate Gear Case, Motor Housing, Motor Assembly and Housing Exhaust Cover

1. Using a bearing pressing tool of the proper size, press the Front Gear Frame Bearing (17) into the rear of the Intermediate Gear Case (13). Place Spacer Ring (16A) on Bearing.
2. Using a sleeve which contacts the outer ring of the seal, press the Planet Gear Frame Shaft Seal (16) into the rear of the Intermediate Gear Case over the Front Gear Frame Bearing. Refer to Dwg. TPD1172-1.

NOTICE

Make sure the flat side of the Seal is installed against the Bearing.



(Dwg. TPD1172-1)

3. Install the Rear Gear Case O-ring (14) in the groove at the rear of the Intermediate Gear Case and the Front Gear Case O-ring (15) in the groove at the front of the Intermediate Gear Case. Coat both O-rings with O-ring lubricant.
4. Install one Gear Shaft Retaining Washer (23) on the front of the Planet Gear Frame (18). Press the Front Bearing Spacer (25) on the front shaft of the Planet Gear Frame to hold the Gear Shaft Retaining Washer snugly in position.

NOTICE

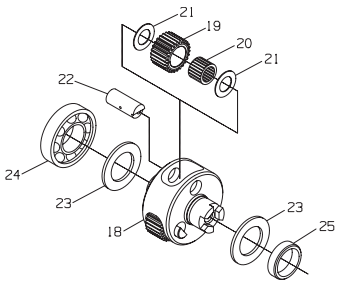
Coat the Front Bearing Spacer with Gear Lube before installing it. Be careful not to gouge or scratch the Front Bearing Spacer during installation as this could result in leakage between the Planet Gear Frame and Gear Case.

5. Place Planet Gear Frame on a bench, shaft side down. Place the Planet Gear Bearing (20) inside of Planet Gear (19). Place Bearing Spacers (21) on top and bottom of Bearing and Gear. Slide the components into the slots in the side of the Planet Gear Frame. Align holes in Spacers and Bearing with holes in Planet Gear Frame and insert Planet Gear Shaft (22), integral keyed end down, through the Spacers and Bearing so that the larger portion of the keyed end of the Shaft contacts the Planet Gear Shaft Retaining Washer. Repeat the procedure for the two remaining Planet Gears and Components.

NOTICE

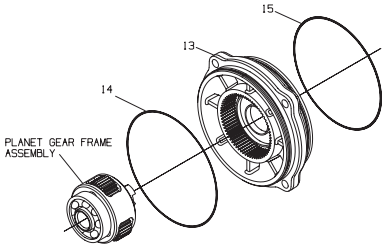
Do not move or turn over the Planet Gear Frame until steps 6 and 7 have been completed. Movement of the Planet Gear Frame Assembly could dislodge assembled components, making it necessary to repeat Step 5.

6. Install the other Planet Gear Shaft Retaining Washer over the shaft at the rear of the Planet Gear.
7. Using the proper size bearing inserting tool, press the Rear Gear Frame Bearing (24) on the shaft at the rear of the Planet Gear Frame. Refer to Dwg. TPD1167.



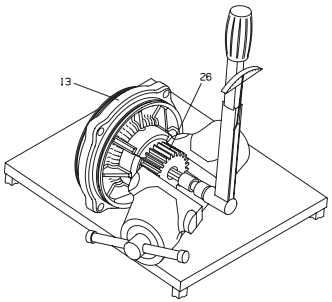
(Dwg. TPD1167)

8. Slide the Planet Gear Frame Assembly, coupling end first, into the rear of the Intermediate Gear Case (13), making sure that the Planet Gears mesh with the ring gear. Use care so as to not damage the seal. Refer to Dwg. TPD1173.



(Dwg. TPD1173)

9. Install the Intermediate Pinion (26) making sure that the notches at the rear of the Pinion align with the notches and tangs in the shaft of the Planet Gear Frame.
10. Clean the threads of the Intermediate Pinion Retaining Screw (27) 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.
11. 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. TPD1204.



(Dwg. TPD1204)

12. Remove the Intermediate Gear Case from the vise and set it on a bench.

NOTICE

The Intermediate Gear Case will work in only one orientation.

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. TPD1165.

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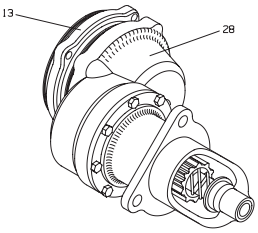
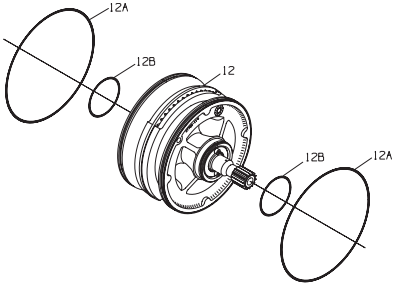


(Dwg. TPD1165)

13. Before installing the Motor Assembly, coat the O-rings on the Motor Assembly and the inside of the Cylinder with O-ring lubricant. Install the Motor Assembly through the rear of the Motor Housing with the geared end of the rotor toward the front. Refer to Dwg. TPD1161.

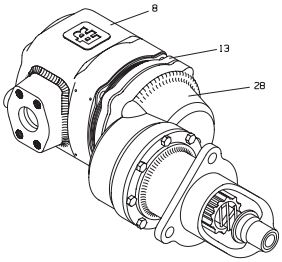


(Dwg. TPD1161)

NOTICE

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

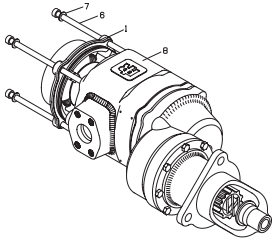
14. Align the punch marks on the Motor Housing with the punch marks on the Intermediate Gear Case and using a plastic hammer, tap the Motor Housing until it seats on the rear of the Intermediate Gear Case. Refer to Dwg. TPD1163.



(Dwg. TPD1163)

15. Coat the Exhaust Cover Seal (2) with O-ring lubricant and install in the groove on the Housing Exhaust Cover.
16. Align the punch marks on the Housing Exhaust Cover with the punch marks on the Motor Housing and using a plastic hammer, tap the Housing Exhaust Cover until it seats.

17. Install the Housing Exhaust Cover on the rear of the Motor Housing using the Starter Assembly Cap Screws (6) and Cap Screw Washers (7). Use an 8 mm hex-head wrench to tighten each a little at a time to a final torque of 45 to 50 ft-lb (61 to 68 Nm). Refer to Dwg. TPD1183.



(Dwg. TPD1183)

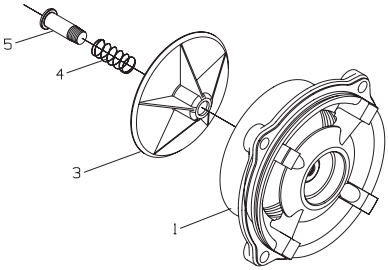
NOTICE

When assembling the exhaust cover to the starter, add 15 ml of Dextron®*II Automatic Transmission Fluid through the pipe plug hole in the Exhaust Cover.**

18. Install the Splash Deflector (3), Deflector Retaining Spring (4) and Deflector Retaining Screw (5) in the rear of the Housing Exhaust Cover. Refer to Dwg. TPD1160.

NOTICE

Coat the threads of the Deflector Retaining Screw with Ingersoll-Rand SMB-441 Sealant.



(Dwg. TPD1160)

NOTICE

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

19. 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).

⚠ 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.

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 (21). Also, loosen Housing Plugs (10) and (11) to vent Motor.

3. **Pinion Engagement:** Apply 50 psig (3.4 bar/345 kPa) pressure to the engagement "IN" Port. Drive Shaft Pinion (63) should move outward and air or gas should escape from the "Out" Port. Plug the "Out" Port and apply 150 psig (10.3 bar/1034 kPa) pressure to the "IN" Port. Check and make sure no air or gas is escaping. Measure the dimension from the face of the Drive Shaft Pinion (63) to the face of the mounting flange. It should be 2-23/32" (69.0 + 2.0 mm) for models with "B" and "C" ratio gearing and 8-3/4" (222 + 2.0 mm) for models with "D" ratio gearing. Remove the pressure from the "IN" Port. Measure the distance from the face of the Drive Shaft Pinion to the face of the mounting flange. It should be 1-25/32" (45.0 + 2.0 mm) for models with "B" and "C" ratio gearing and 7-3/32" (180 + 2.0 mm) for models with "D" ratio gearing.
4. **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.
5. **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.
6. **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.
7. **Confirm Motor Rotation:** Remove Housing Plug (10). Use a 1/4" hex drive to rotate the motor to verify proper motor adjustment. Intermediate Gearing output should rotate opposite the required Starter rotation while observing from the pinion side. Replace Housing Plug.
8. **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 page 5, 6 and 7.
9. **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.
10. **Bendix Drive Function-Inertia Models Only:** Install Starter on testing fixture. Apply low pressure air to motor. Bendix must engage according to specified rotation.
11. **Drive Housing Function-Pre-Engaged Models Only:** Apply 120 psig (8.27 bar/8.27 kPa) to "IN" port of Drive Housing (40). Cycle five times. Air should exhaust through "OUT" port during each cycle.
12. **Free Speed (All Models):** Install the Starter on a testing fixture with proper containment system. Apply 90 psig (6.2 bar/ 620 kPa) to motor inlet.

Free speed specifications should be as follows:

	MAXIMUM	MINIMUM
“B” ratio	4600 rpm	4500 rpm
“C” ratio	4130 rpm	3660 rpm
“D” ratio	3100 rpm	2870 rpm

13. **Exhaust Deflector Operation:** Install Starter on testing fixture. Apply low air pressure to motor and observe. Deflector must return to its normal position tier operation of the Starter.
14. **Concentricity and Squareness of Shaft to Housing “D” Ratio Only:** Assemble indicator on shaft. Indicate pilot diameter. Check squareness of face at mounting surface. Pilot diameter must be concentric within 0.008 max. T.I.R. Mounting face must be square with shaft within 0.004 T.I.R. max.
15. **Drive Housing Leakage-P-Engaged Models Only:** Plug Drive Housing (40) “OUT’ port and apply 50 psig (3.45 bar/345 kPa) to “IN” port to extend Drive Shaft (57). There should be no leakage.
16. **Test Pinion Engagement-P-Engaged Models Only:** Plug “OUT” port in Drive Housing (40). Apply 50 psig (3.45 bar/345 kPa) as needed. In its normal position, the distance from the mounting flange to the end of the Drive Shaft (57) should be1-3/4”. 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 Drive Pinion (63) back on helical splined shaft. Rear face of Drive Pinion must move back 0.47” ± 0.035”.

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 the 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. Lubricate 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.
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	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.
	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 Starter Assembly Cap Screws are tightened to 60 ft-lb (81 Nm) torque. Make sure all seals and O-Rings fit and seal properly at their perimeters. If they do not, replace with new seals and O-Rings.
	Excessive high-speed operation	Operate according to recommendations.
	High number of start cycles	Replace worn components.
	Loose or leaking Pipe Plugs	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 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.
	Splash Deflector Retaining Screw loose or pipe plug missing	Tighten Splash Deflector Retaining Screw or replace pipe plug.

Notes

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