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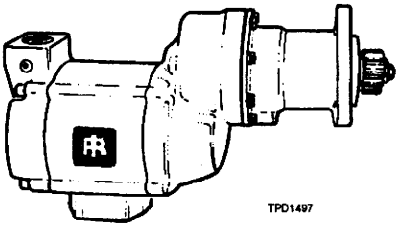
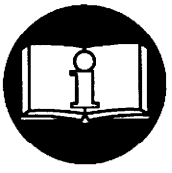
INSTALLATION AND MAINTENANCE MANUAL
for
SERIES SS815, SS825 AND SS850 STARTERS





⚠ WARNING

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

FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.

- For safety, top performance, and maximum durability of parts, do not operate Series SS815, SS825 and SS850 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 supply hose before installing, removing or adjusting any accessory on this starter, or before performing any maintenance on this starter.
- Series SS815, SS825 and SS850 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 it in accordance with the procedures outlined in this manual. Never install a reassembled starter that has not been tested in accordance with the procedures in this manual
- Operate this starter only when properly installed on the engine.
- Do not lubricate starters with flammable or volatile liquids such as kerosene or jet fuel.
- Do not remove any labels. Replace any damaged label.
- Use accessories recommended by Ingersoll–Rand.

NOTICE

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

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

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

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

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

Printed in U.S.A.

INGERSOLL-RAND®
ENGINE STARTING SYSTEMS

WARNING LABEL IDENTIFICATION

⚠ WARNING

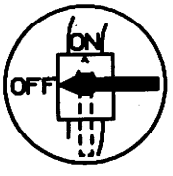
FAILURE TO OBSERVE THE FOLLOWING WARNINGS COULD RESULT IN INJURY.

⚠ WARNING

Always wear eye protection when performing maintenance on this starter.

⚠ WARNING

Always wear hearing protection when testing this starter.



⚠ WARNING

Always turn off the air supply and disconnect the air supply hose before installing, removing or adjusting any accessory on this starter, or before performing any maintenance on this starter.

⚠ WARNING

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

NOTICE

For natural gas operation, starter main exhaust must be piped away.

To pipe the drive housing vent, remove the drive housing plug and replace it with a suitable tubing line. The tubing must vent at a safe location and must not be interconnected with any other exhaust lines which might introduce a back pressure on the drive housing vent.

PLACING STARTER IN SERVICE

LUBRICATION

Proper lubrication is essential for top performance and maximum durability of a Starter.

Two lubrication systems are recommended:

Ingersoll–Rand No. HDL2 Lubricator: For Starter installations with cranking cycles of less than 10 seconds. Install as shown in Dwg. TPB978. (See **Installation of HDL2 Lubricator** on Page 5.) Lubricate with diesel fuel or 10W non–detergent motor oil.

CAUTION

When an HDL2 Lubricator is used, make certain that the oil supply line pressure is no greater than 5 psi. If there is pressure on the line, the Lubricator will continuously leak lubricant through the Starter and out the exhaust.

Ingersoll–Rand No. NL–24–8 In–Line Lubricator:

For Starter installations with cranking cycles more than 10 seconds. Install as shown inPiping Diagrams. Lubricate with a good quality 10W non–detergent motor oil. Adjust the Lubricator to flow 1 to 3 drops per second.

INSTALLATION

NOTICE

For maximum performance, read this manual prior to the installation or operation of Series SS815, SS825 and SS850 Starters.

General Information

1. We recommend that on all vehicular installations and on stationary engines subject to vibration that hoses of the specified diameter be used instead of rigid pipe connections to the starter. 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. Allpiping, hoses and fittings must be clean and free of dirt and foreign material during installation.
3. In the actual mounting of an Air Starter, it is best to have the hose connections already made at the receiver, and to have the starter end of the hose handy for attaching to the Starter.
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: a 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" #24 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 liens means that the system will drain overnight and will have to be re–pressurized the next morning by use of another vehicle or compressor. Make your connections bubble tight to avoid unnecessary costs and delays. On all threaded connections throughout the system, use Ingersoll–Rand No. SMB–441 Sealant, non–hardening No. 2 Permatex or Loctite®* Pipe Sealant. Always run your air supply line from the side or top of the receiver, never at or near the bottom. Moisture in the air collects at the bottom of the receiver 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.

Orientation of the Air Starter

If the factory orientation will not fit your engine due to radial location of the Drive Housing or location of the inlet and/or exhaust ports, reorient the Starter as follows:

1. Look at the dimension illustration and note that the Drive Housing (30) can be located in any one of sixteen radial positions relative to the Gear Case (58). The exhaust port (Motor Housing)(1) can be located in any one of four radial positions relative to the Gear Case and the air inlet (Motor Housing Cover) can be located in any one of four radial positions relative to the exhaust port. Also, the Drive Housing can be installed on the engine bell housing in any one of three radial positions.

NOTICE

Do not separate the Drive Housing from the Gear Case during orientation or installation.

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 (28) and rotate the drive housing to its required position. Reinstall the Drive Housing Cap Screws and tighten them to 28 ft–lb (38) Nm) of torque.

* Registered trademark of Loctite Corporation.

PLACING STARTER IN SERVICE

NOTICE

Do not separate the Motor Housing from theMotor Housing Cover during orientation or installation.

3. Now that you have the Drive Housing properly oriented relative to the Gear Case, notice whether or not the exhaust port will be at the bottom and whether or not the inlet port will be favorably located for hose installation. If either or both of these members must be reoriented, remove the four Motor Housing Cover Cap Screws (4) and rotate the Motor Housing and/or Motor Housing Cover to its desired position. Reinstall the Motor Housing Cover Cap Screws and alternately tighten them to 60 ft–lb (81.4 Nm) of torque.

Mounting the Air Starter

1. Study the Piping Diagram. We strongly recommend that the Starter be connected exactly as shown.
2. The air receiver tank for a Starter installation must have a working pressure capability equal to or greater than the maximum pressure at which the Starter will be operated.

⚠ 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.

3. If you are going to connect to a receiver tank that is already in service, bleed off the air pressure by opending the drain valve. Drain off any water that may have accumulated in the bottom of the tank.

NOTICE

Make certain the connection between the SRV150 Starter Relay Valve and the Receiver Tank is made to the inlet side of the Relay Valve indicated by the word "IN" cast on the valve body.

4. Using a 1–1/2" short nipple, install the SRV150 Starter Relay Valve on the end of the receiver tank as shown in Dwg. TPC444–3 on page 7.
5. Install the No. SMB–618 Starter Control Valve on the dash panel (for vehicular installations) or some other appropriate panel (for stationary installations).
6. Attach No. TA–STR–100 Starter Instruction Label to the control panel adjacent to the Starter Control Valve.
7. Mount the No. 150BMP–1064 Air Pressure Gauge on or adjacent to the control panel. It should be located where it is readily visible to the operator of the Control Valve.

NOTICE

When connecting the Starter Control Valve to the Relay Valve, make certain the hose is connected to the "SUP" side of the Starter Control Valve.

8. Connect the Starter Control Valve to the Relay Valve with 1/4" #4 hose. Install a Tee in this line with a short feeder hose to the Pressure Gauge.
9. Run a piece of heavy duty garden hose, or some other similar large diameter hose from the Relay Valve on the receiver to the starter location on the engine to determine the exact length of 1–1/2" #24 air hose required.
10. Attach the 1–1/2" #24 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 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. Liberally grease the teeth on the ring gear with a good, sticky gear grease or motorcycle chain lubricant. This will help promote the life of the ring gear and the Starter Pinion.
13. Place the Starter into position and mount it on the flywheel bell housing. Tighten the mounting bolts to 100 ft–lb (136 Nm) of torque.
14. Install a 1/4" #4 hose line from the "**DEL**" side of the Starter Control Valve to the "**IN**" port on the Starter Drive Housing.
15. Install a 1/4" #4 hose line from the "**OUT**" port on the Starter Drive Housing to the small pipe tapped port on top of the Starter Relay Valve.
16. If the exhaust is not to be piped away, install a No. SS660–A674 Muffler or No. SM450–A735 Road Splash Deflector in the exhaust port on the Motor Housing of the Starter.
17. If the engine on which the Starter is mounted does not have a bellhousing with a standard starter mounting, and a bracket had to be manufactured for mounting, we recommend that you add an additional support bracket at the motor end of the Starter. There are four holes in the Motor Housing Cover for this purpose. They are tapped M10–1.50 to accommodate metric cap screws.
18. Mount an HDL2 Lubricator on or near the Starter as shown in Dwg. TPB978 on Page 5.

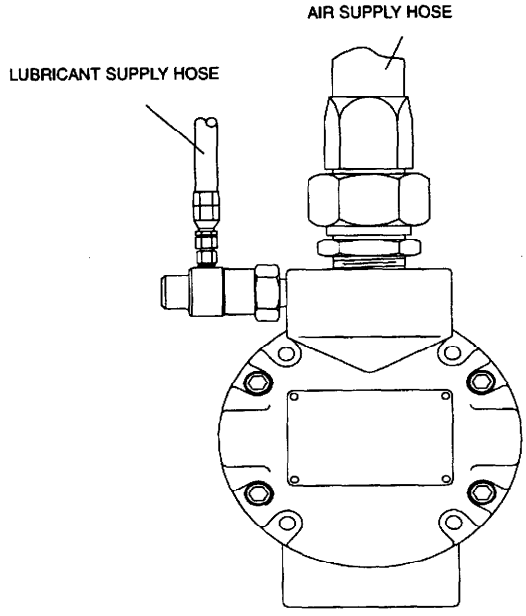
19. Pressurize the complete starting system and check every connection with a soap bubble test. **There must be no leaks.**

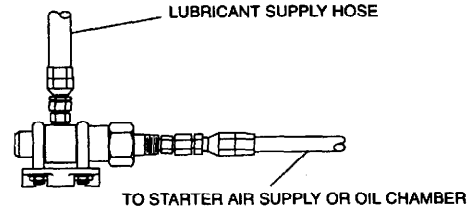
BARRING OVER THE ENGINE

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 SS815, SS825 or SS850 Starter.

1. Disconnect the 1/4" #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. Remove the 3/8" pipe plug from the center of the Motor Housing Cover.
3. Engage the Drive Pinion with the flywheel by applying pressure to the "**IN**" port on the Drive Housing.
4. Insert a 3/8" square drive wrench through the hole in the Motor Housing Cover to engage the square drive recess the rear of the Rotor.
5. Manually rotate the Rotor until the engine is cranked to its desired position.

Installation of HDL2 Lubricator





REMOTE INSTALLATION OF HDL2 LUBRICATOR

(Dwg. TPB978)

The HDL2 Lubricator is self–priming and may be installed directly on the Starter or located remotely. Although the Lubricator is capable of drawing lubricant from a source 4 ft (1.2 m) lower than the point of installation, Ingersoll–Rand recommends installing the Lubricator as close as possible to the oil source.

We recommend using the unpressurized fuel return line as the source of lubricant. However, oil may be supplied from a separate receiver or the diesel fuel tank. When the diesel fuel tank is the lubricant source, install a 10 micron to 50 micron fuel filter in the oil supply line at the fuel tank. The lubricant supply line should be fed into the fuel return line with the leg of the tee going to the lubricator directed in the down direction to insure that the lubricator does not draw air instead of oil.

Mount the HDL2 Lubricator as follows:

1. If you are going to mount the HDL2 Lubricator on the Starter, remove one of the 3/8" pipe plugs from the inlet boss on the Starter and replace it with the HDL2.

If you are going to mount the HDL2 at a remote location, use two U–bolts and base clamp available for the Lubricator.

2. If you mounted the HDL2 at a remote location, install a 1/4" #4 hose from the end of the Lubricator having both a male and female thread to one of the 3/8" pipe tapped holes on the Starter inlet boss.
3. Install a 1/4" hose from the 1/8" NPTF oil inlet in the side of the HDL2 to the unpressurized fuel line, diesel fuel tank or separate oil reservoir. Tighten the fitting at the Lubricator to 15 to 36 ft–lb (20.3 to 40.8 Nm) torque. The threads on the fitting must be clean; assemble it without sealing compound or Teflon®* tape. Connection must be vacuum tight.

NOTICE

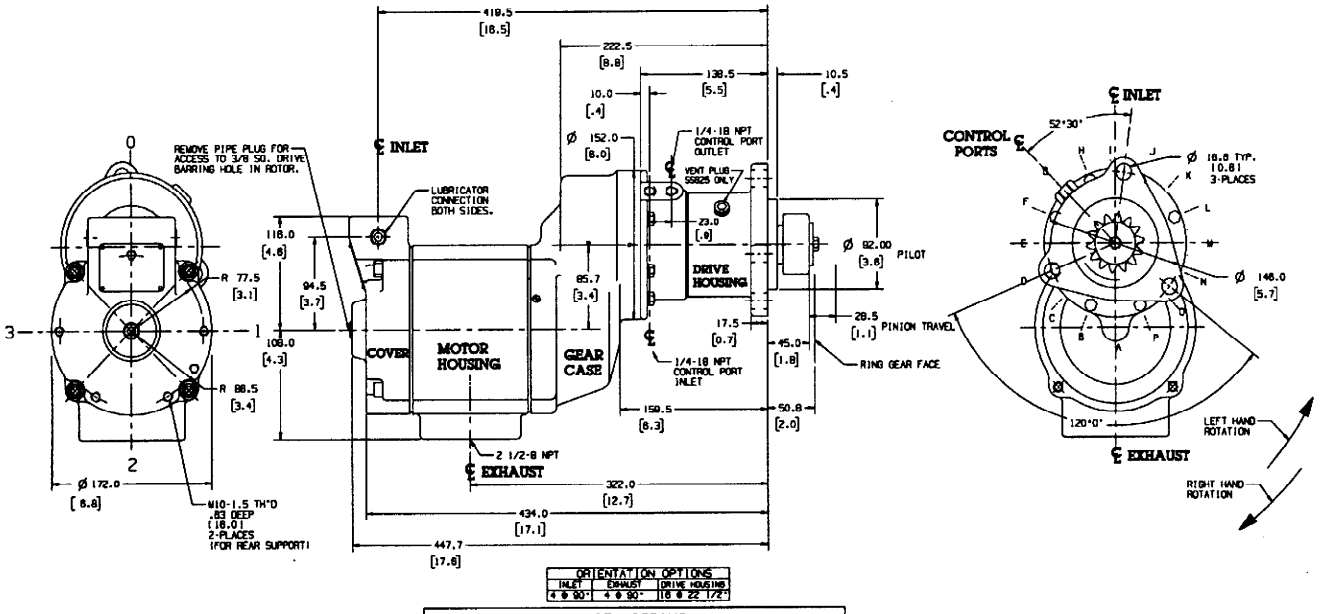
Before initial operation, manually fill the oil supply line.

4. If a separate lubrication reservoir is used, fill it with diesel fuel or a light motor oil such as SAE 10 or 10W.

* Registered trademark of E.I. Dupont de Nemans and Co., Inc.

PLACING STARTER IN SERVICE

Mounting Dimensions for Series SS815 and SS825 Starters



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

-MODEL CODING-

SS815 G B 09 R 51- 0 2 G

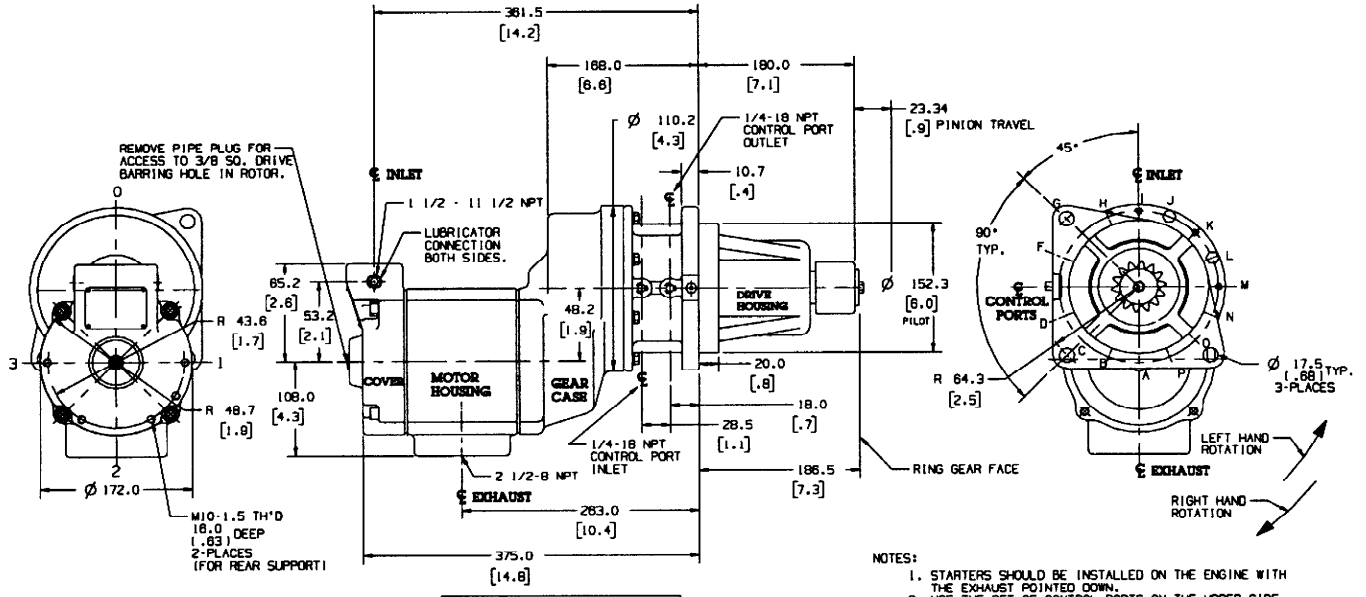
SIZE STARTER
TYPE STARTER
GEARING
DRIVE HOUSING ROTATION
DRIVE HOUSING
EXHAUST
ORIENTATION CODE
INLET
TYPE PINION
DRIVE

NOTES:
1. STARTERS SHOULD BE INSTALLED ON THE ENGINE WITH THE EXHAUST POINTED DOWN.
2. USE THE SET OF CONTROL PORTS ON THE UPPER SIDE OF THE DRIVE HOUSING.
3. THESE MODELS ARE NOT APPROVED FOR APPLICATIONS WHERE THE STARTER IS EXPOSED TO THE TRANSMISSION FLUID.
4. DRIVE HOUSING ORIENTATION CODE IS BASED ON POSITION OF MOUNTING HOLE OPPOSITE THE PINION OPENING.
5. STANDARD ORIENTATION SHOWN (02E) WILL BE SHIPPED UNLESS OTHERWISE SPECIFIED.
6. PLEASE READ THE INSTRUCTIONS BEFORE ATTEMPING TO REORIENT.
7. STARTER WEIGHT = 43.1 Kg (95 lbs.)

DUAL DIMENSIONS [MM] [INCH]

(Dwg. TPA1325–1)

Mounting Dimensions for Series SS850 Starters



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

-MODEL CODING-

SS850 G D 09 R 51- 0 2 E

SIZE STARTER
TYPE STARTER
GEARING
DRIVE HOUSING ROTATION
DRIVE HOUSING
EXHAUST
ORIENTATION CODE
INLET
TYPE PINION
DRIVE

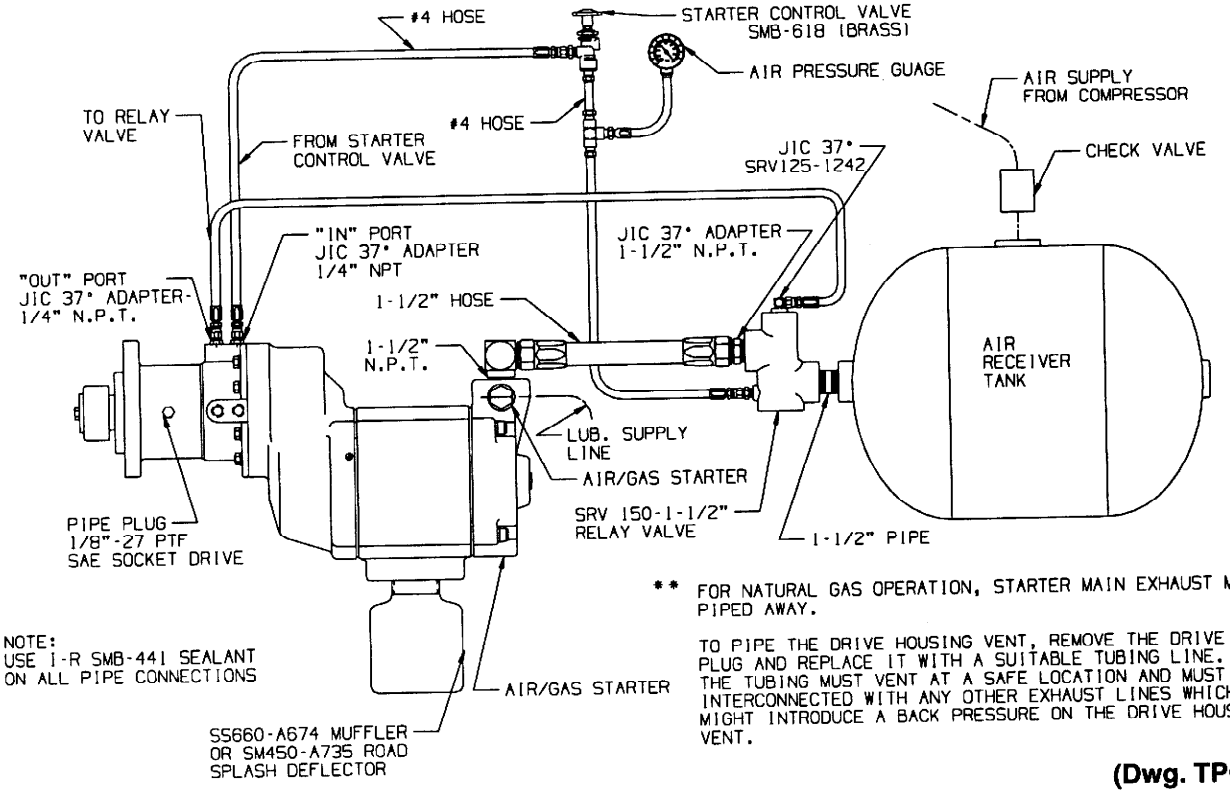
NOTES:
1. STARTERS SHOULD BE INSTALLED ON THE ENGINE WITH THE EXHAUST POINTED DOWN.
2. USE THE SET OF CONTROL PORTS ON THE UPPER SIDE OF THE DRIVE HOUSING.
3. THESE MODELS ARE NOT APPROVED FOR APPLICATIONS WHERE THE STARTER IS EXPOSED TO THE TRANSMISSION FLUID.
4. DRIVE HOUSING ORIENTATION CODE IS BASED ON POSITION OF MOUNTING HOLE OPPOSITE THE PINION OPENING.
5. STANDARD ORIENTATION SHOWN (02E) WILL BE SHIPPED UNLESS OTHERWISE SPECIFIED.
6. PLEASE READ THE INSTRUCTIONS BEFORE ATTEMPING TO REORIENT.
7. STARTER WEIGHT = 25.4 Kg (56 lbs.)

DUAL DIMENSIONS [MM] [INCH]

(Dwg. TPA832–5)

PLACING STARTER IN SERVICE

Typical Vehicular Installation (Shown with SS815 Starter)

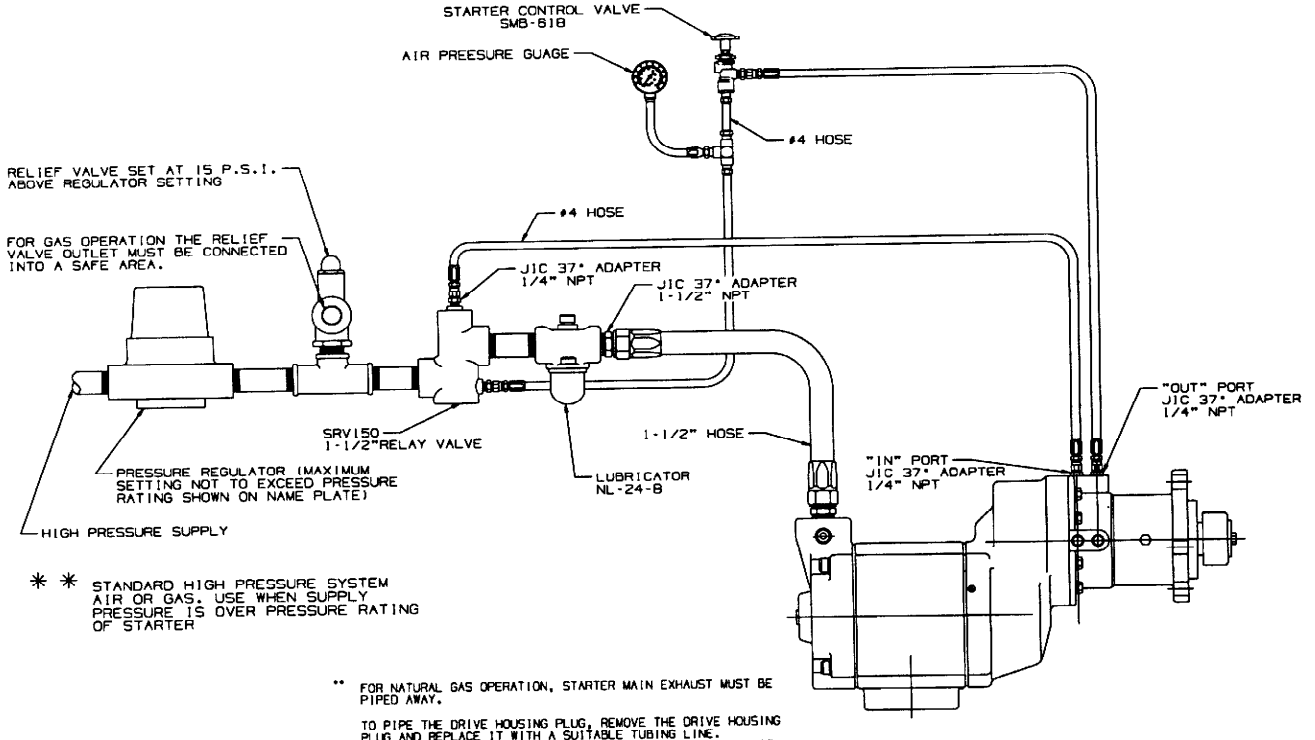


** FOR NATURAL GAS OPERATION, STARTER MAIN EXHAUST MUST BE PIPED AWAY.

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. TPC444–4)

Typical Stationary Installation (Shown with SS815 Starter)



** STANDARD HIGH PRESSURE SYSTEM AIR OR GAS. USE WHEN SUPPLY PRESSURE IS OVER PRESSURE RATING OF STARTER

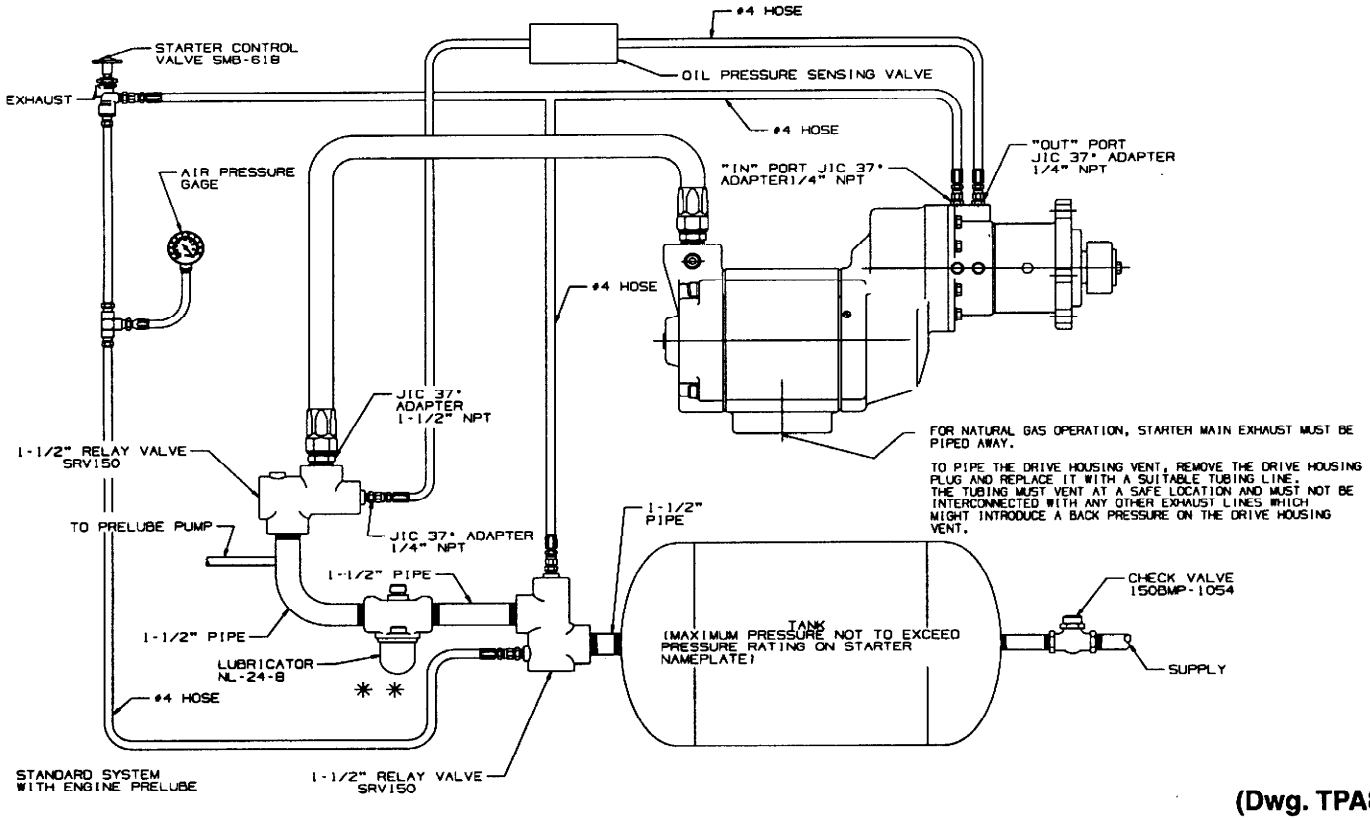
** FOR NATURAL GAS OPERATION, STARTER MAIN EXHAUST MUST BE PIPED AWAY.

TO PIPE THE DRIVE HOUSING PLUG, 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. TPA842–2)

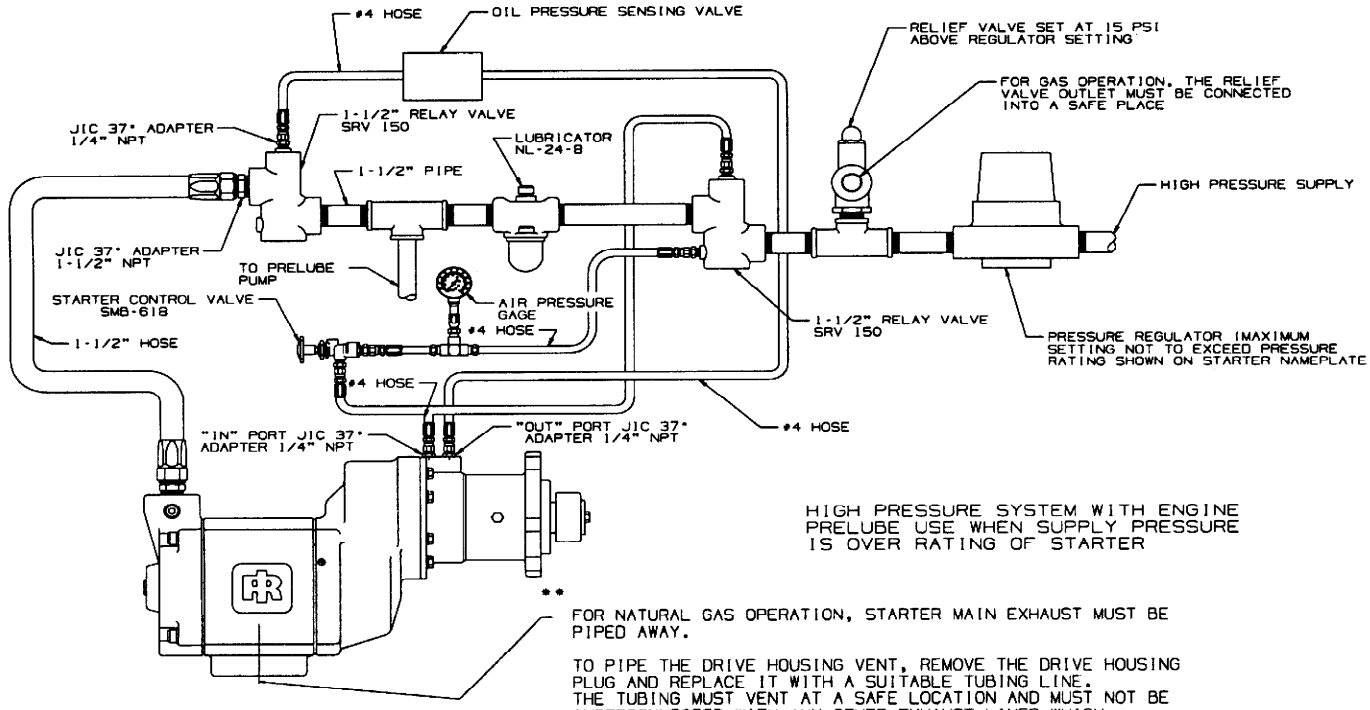
PLACING STARTER IN SERVICE

Typical Installation with Engine Prelube System



(Dwg. TPA843–2)

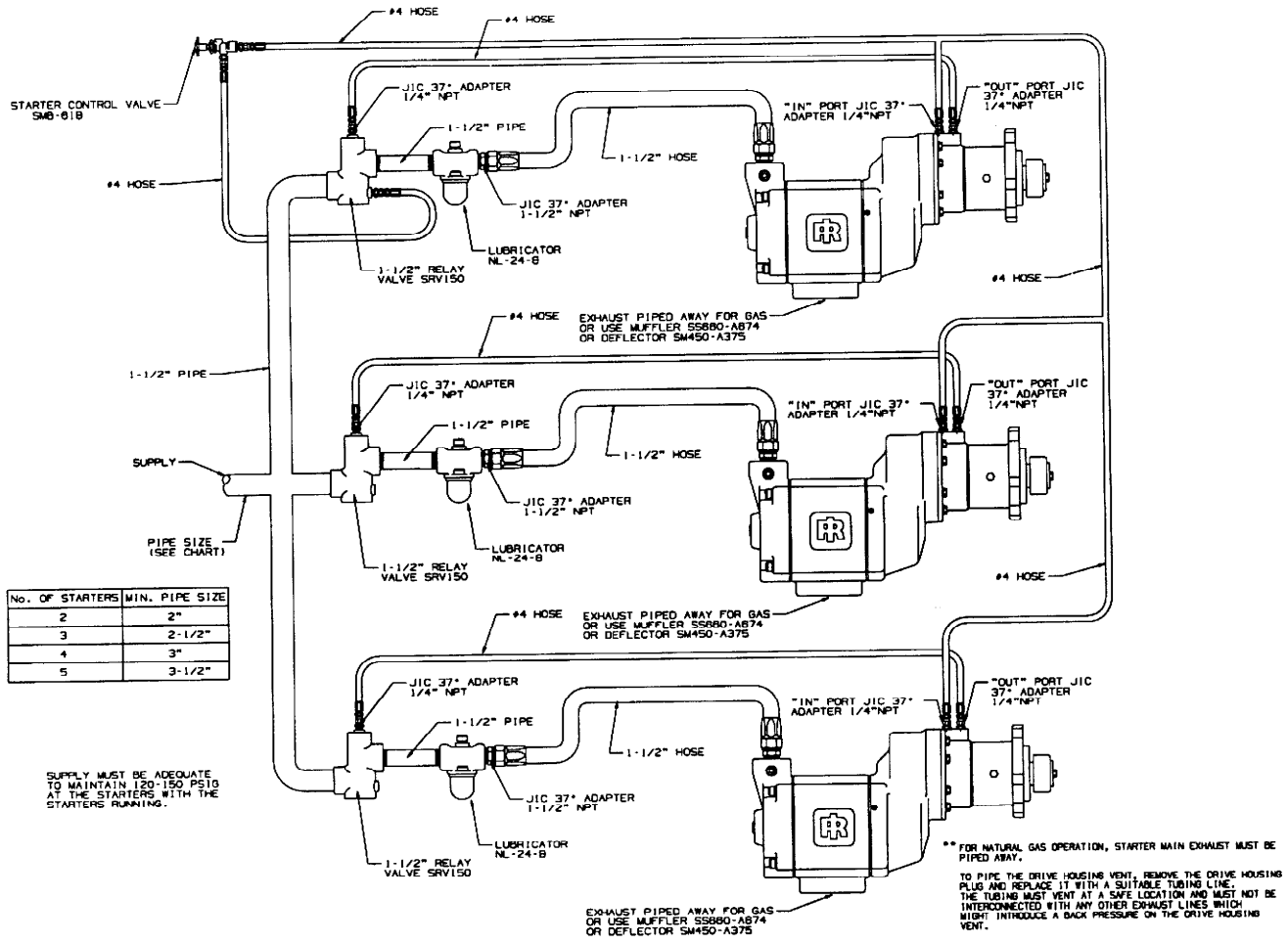
Typical Installation with Engine Prelube System when Supply Pressure is over Rated Starter Pressure



(Dwg. TPA844–2)

PLACING STARTER IN SERVICE

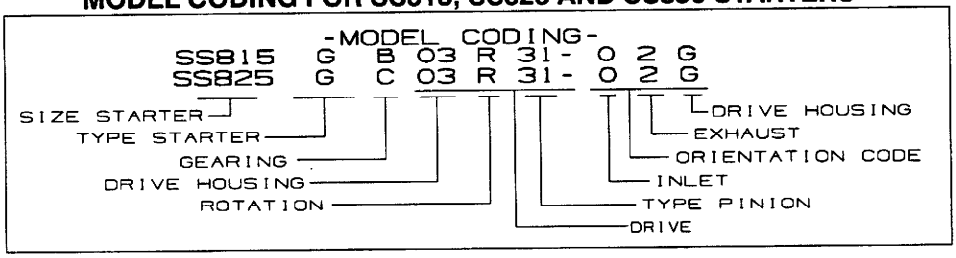
Typical Multiple Starter Installation

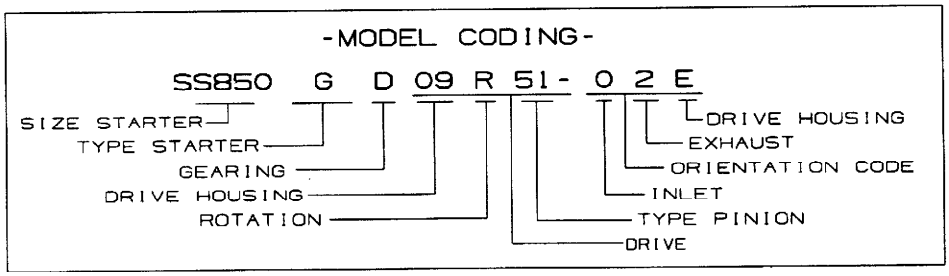


(Dwg. TPA847–2)

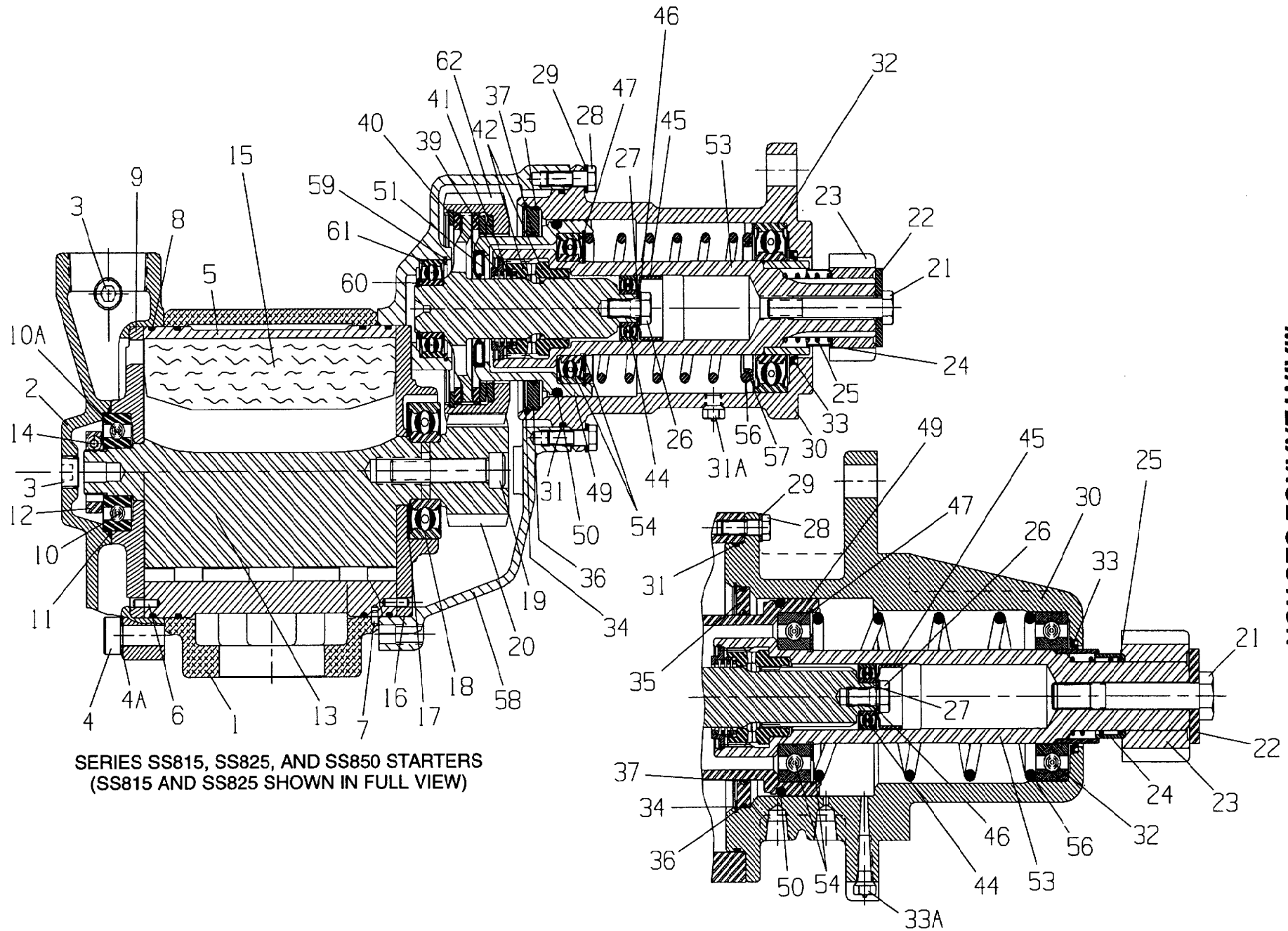
HOW TO ORDER A STARTER

MODEL CODING FOR SS815, SS825 AND SS850 STARTERS





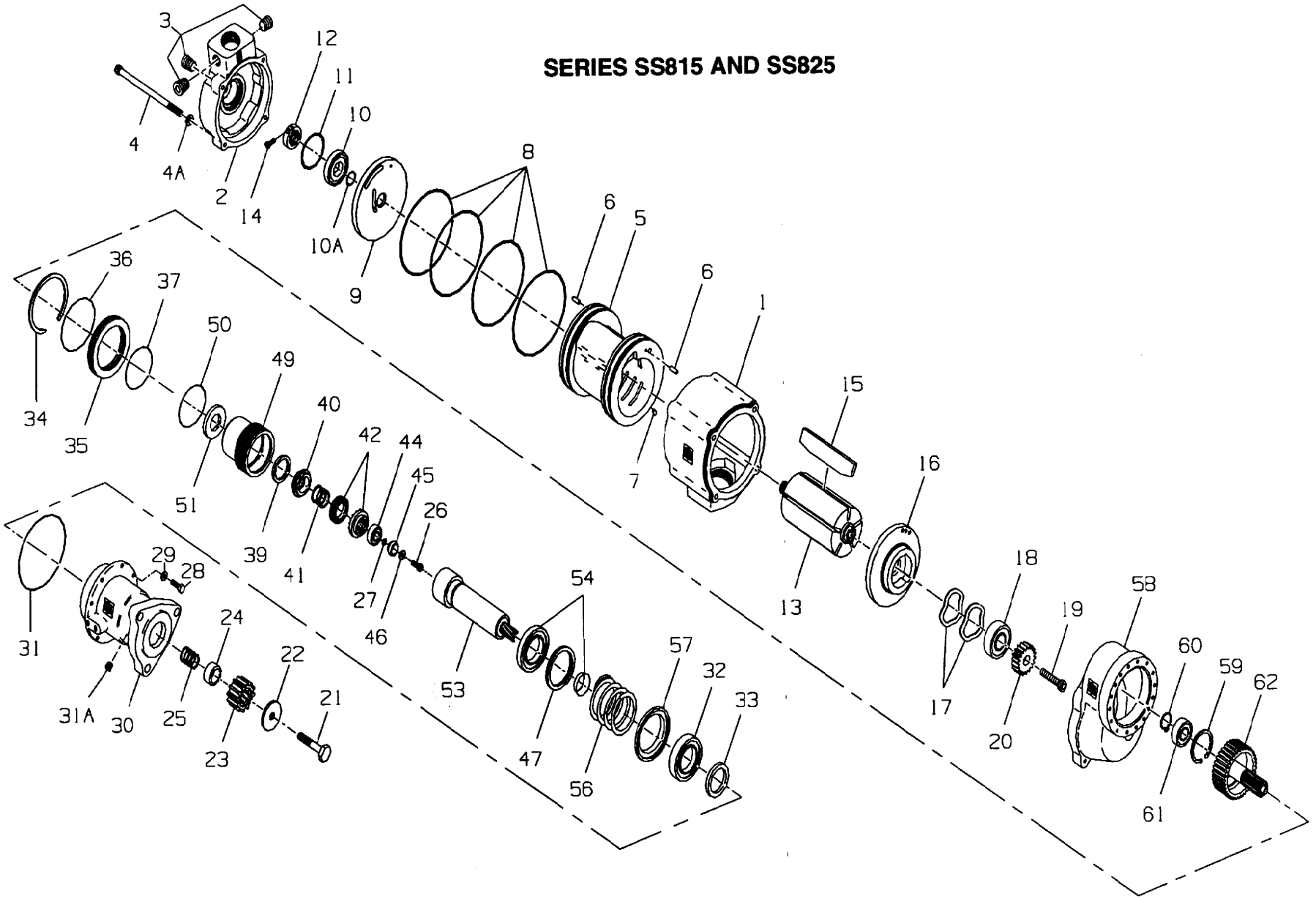
(Dwg. TPD1495)



SERIES SS815, SS825, AND SS850 STARTERS
(SS815 AND SS825 SHOWN IN FULL VIEW)

FRONT END CONSTRUCTION OF SERIES SS850 **(Dwg. TPA853–4)**

SERIES SS815 AND SS825



(Dwg. TPA778–6)

			PART NUMBER FOR ORDERING
	1	Motor Housing	
		with 2–1/2" Tapped Exhaust	SS800–40
		with 2–1/2" SAEJ518C Flanged Exhaust	SS800–140
	2	Motor Housing Cover Assembly	
		with 1–1/2" Tapped Inlet	SS800–A102
		with 1–1/2" SAEJ518C Flanged Inlet	SS800–A202
	3	Housing Cover Plug (3)	HSSPPS–3
	4	Motor Housing Cover Cap Screw (4)	SS800–25
	4A	Motor Housing Cover Cap Screw Washer (4)	SS800–26
	5	Cylinder Kit	SS800–K3
♦	6	End Plate Alignment Pin (2)	510–669A
♦	7	Cylinder Alignment Pin	SS800–99
♦•	8	Cylinder 0–ring (4)	SS800–67
	9	Rear End Plate	
		for SS815RB or SS825RC Models	SS800R–12
		for SS800LB, SS815LB or 5S825LC Models	SS800L–12
♦	10	Rear Rotor Bearing	SS800–24
♦•	10A	Rotor Shaft 0–ring	C321–606
♦•	11	Rear Rotor Bearing 0–ring	HRA20A–990
	12	Rotor Clamp Nut	SS800–65
	13	Rotor	SS825–53
	14	Rotor Clamp Nut Screw	SS800–63
♦•	15	Vane Packet (set of 5 Vanes)	SS800–42A–5
	16	Front End Plate	SS800G–11
	17	Motor Wave Washer (2)	SS800–224
♦	18	Front Rotor Bearing	SS800–22
	19	Rotor Pinion Retaining Screw	SS800–732
	20	Rotor Pinion	
		for SS815RB, 55800LB or SS815LB Models	SS800B–17
		for SS825RC or SS825LC Models	SS825C–17
•	21	Drive Pinion Retaining Screw	
		for SS815RB or SS825RC Models	SS800R–394
		for SS815LB or S825LC Models	SS800L–394
	22	Drive Pinion Washer	SS800–725
•	23	Drive Pinion	
		for SS815GB03R31 Models	SS815R–13–31
		for SS815GB03L32 Model	SS815L–13–32
		for SS8l5GB03R91 and SS825GC03R91 Models	SS815R–13–91
		for SS8l5GB03L92, and SS825GC03L92 Models	SS815L–13–92
		for SS825GC03R25 Models	SS825R–13–25
		for SS825GC03L26 Models	SS825L–13–26

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

		PART NUMBER FOR ORDERING	
	24	Pinion Spring Sleeve	SS800–335
♦	25	Pinion Spring	
		for SS800RB, SS815RB or SS825RC Models	SS800R–419
		for SS800LB, SS815LB or SS825LC Models	SS800L–419
	26	Drive Gear Screw	SS800–179
♦•	27	Drive Gear Screw 0–ring	SS800–176
	28	Drive Housing Cap Screw (8)	SS800–744
	29	Drive Housing Cap Screw Lock Washer (8)	CE210–605
	30	Drive Housing Kit	SS825–K300
♦•	31	Drive Housing 0–ring	SS800–244
	31A	Drive Housing Vent Plug	P250–546
	32	Front Drive Shaft Bearing	
		for SS815B Models	SS800–363
		for SS825C Models	SS850–363
♦	33	Drive Housing Seal	SS800–271
♦	34	Bulkhead Retainer	SS800–181
	35	Bulkhead Kit	SS800–K150
♦•	36	Outer Bulkhead 0–ring	SS800–152
♦•	37	Inner Bulkhead 0–ring	SS800–151
♦	39	Clutch Spring Cup Retainer	SS800–366
	40	Clutch Spring Cup	SS800–367
♦	41	Clutch Spring	SS800–583

		PART NUMBER FOR ORDERING	
	42	Clutch Jaw Kit	
		for SS815RB or SS825RC Models	SS800R–K587
		for SS815LB or SS825LC Models	SS800L–K587
	44	Front Drive Gear Bearing	SS800–278
	45	Drive Gear Cup	SS800–177
	46	Drive Gear Lock Washer	SS800–180
	47	Large Drive Shaft Bearing Retainer	SS800–107
	49	Piston Kit	SS800–K703
♦•	50	Piston 0–ring	SS800–337
♦•	51	Piston Seal	SS800–272
	53	Drive Shaft Kit	
		for SS815RB or SS825RC Models	SS800R–K8
		for SS815LB or SS825LC Models	SS800L–K8
	54	Rear Drive Shaft Bearing Kit (includes bearing and retainer)	SS800–K399
	56	Piston Return Spring	SS800–700
	57	Piston Return Spring Seat	SS800–191
	58	Gear Case	SS800–37
	59	Drive Gear Bearing Retainer	SS800–361
	60	Drive Gear Shaft Bearing Retainer	SS800–632

♦ Indicates Tune–up Kit part.

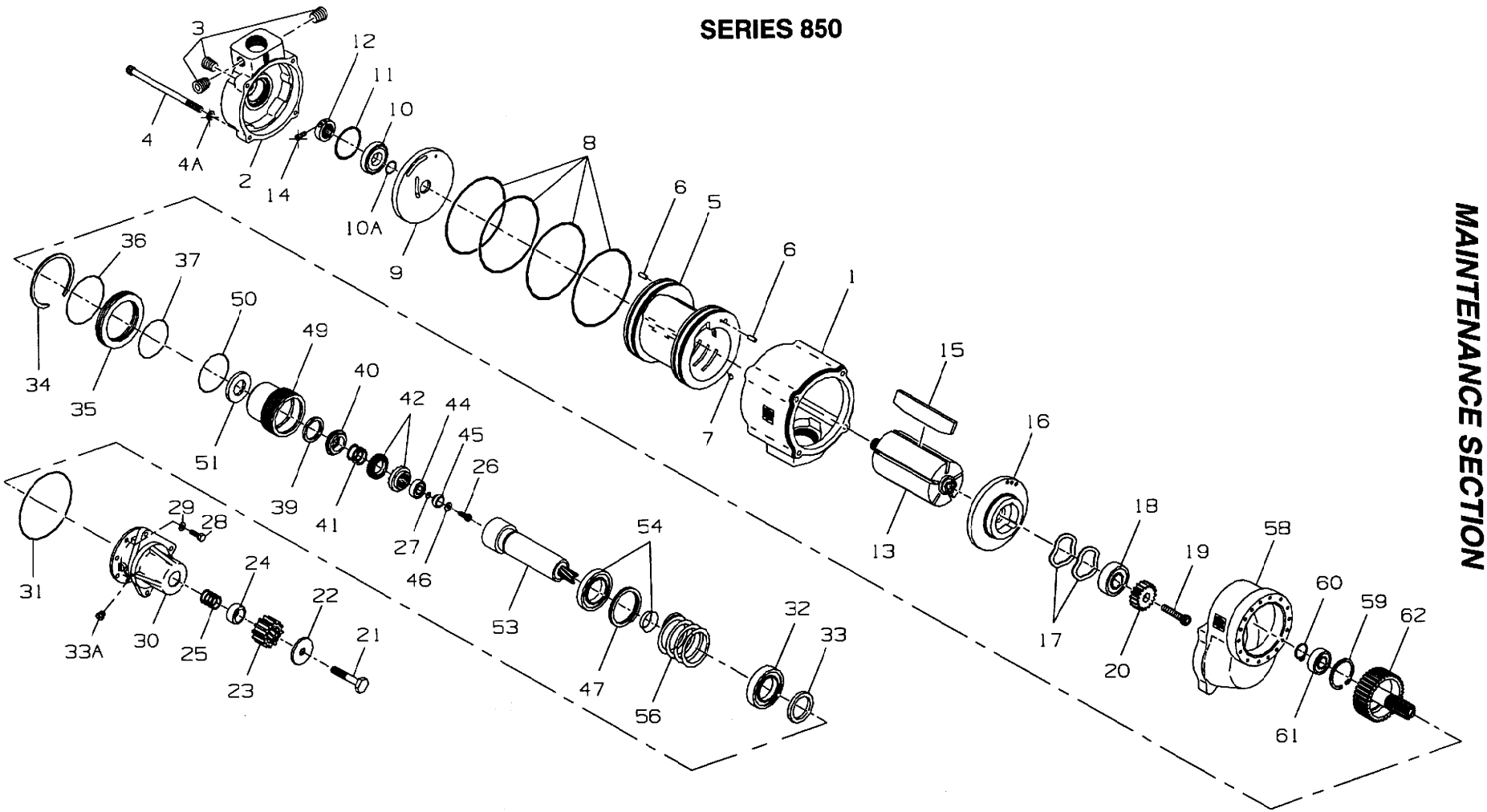
• To keep downtime to a minimum, it is desirable to have on hand certain repair parts. We recommend that you stock one (pair or set) of each part indicated by a bullet (•) for every four tools in service.

		PART NUMBER FOR ORDERING			PART NUMBER FOR ORDERING
♦ 61	Rear Drive Gear Bearing	SS800–632	*	Muffler	SS660–A674
62	Drive Gear	SS800–359	*	Road Splash Deflector	SM450–A735
	for SS815108 or		*	Air Strainer	SM450–A267AT
	SS815LB Models	SS815B–9	*	Lubricator	HDL2
	for SS825RC or		*	In–Line Lubricator	NL–24–8
	SS825LC Models	SS825C–9	*	Tune–up Kit (includes illustrated parts	
*	Nameplate	SS800–301		6[2], 7, 8, 10, 10A[4], 11, 15, 18, 24, 25,	
*	Nameplate Screw (4)	R4K–302		27, 31, 33, 34, 36, 37, 39, 50,	
*	Relay Valve	SRV150		51, 60 and 61)	SS800–TK2

* Not illustrated.

♦ Indicates Tune–up Kit part.

SERIES 850



Series SS850

(Dwg. TPA820–3)

			PART NUMBER FOR ORDERING				PART NUMBER FOR ORDERING
	1	Motor Housing			14	Rotor Clamp Nut Screw	SS800–63
		with 2–1/2" Tapped Exhaust	SS800–40	♦•	15	Vane Packet (set of 5 Vanes)	SS800–42A–5
		with 2–1/2" SAEJ518C Flanged Exhaust	SS800–140		16	Front End Plate	SS800G–11
	2	Motor Housing Cover Assembly			17	Motor Wave Washer (2)	SS800–224
		with 1–1/2" Tapped Inlet	SS800–A102	♦	18	Front Rotor Bearing	SS800–22
		with 1–1/2" SAEJ518C Flanged Inlet	SS800–A202		19	Rotor Pinion Retaining Screw	SS800–732
	3	Housing Cover Plug (3)	HSSPPS–3		20	Rotor Pinion (for SS850RD or SS850LD Models)	SS850D–17
	4	Motor Housing Cover Cap Screw (4)	SS800–25	•	21	Drive Pinion Retaining Screw	
	4A	Motor Housing Cover Cap Screw Washer (4)	SS800–26			for SS850RD Models	SS850R–394
	5	Cylinder Kit	SS800–K3			for SS850LD Models	SS850L–394
♦	6	End Plate Alignment Pin (2)	510–669A		22	Drive Pinion Washer	SS800–725
♦	7	Cylinder Alignment Pin	SS800–99	•	23	Drive Pinion	
♦•	8	Cylinder 0–ring (4)	SS800–67			for SS850GD09R51 and SS850FGD09R51 Models	SS850R–13–51
	9	Rear End Plate				for SS850GD09L52 and SS850FGD09L52 Models	SS850L–13–52
		for SS850RD Models	SS800R–12	♦	24	Pinion Spring Sleeve	SS800–335
		for SS850LD Models	SS800L–12	♦	25	Pinion Spring	
♦	10	Rear Rotor Bearing	SS800–24			for SS850RD Models	SS850R–419
♦•	10A	Rotor Shaft 0–ring	C321–606			for SS850LD Models	SS850L–419
♦•	11	Rear Rotor Bearing 0–ring	HRA20A–990		26	Drive Gear Screw	SS800–179
	12	Rotor Clamp Nut	SS800–65	♦•	27	Drive Gear Screw 0–ring	SS800–176
	13	Rotor	SS825–53		28	Drive Housing Cap Screw (8)	SS800–744

♦ Indicates Tune–up Kit part.

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

			PART NUMBER FOR ORDERING
	29	Drive Housing Cap Screw Lock Washer (8)	CE210–605
	30	Drive Housing Kit	SS850–K300
♦•	31	Drive Housing 0–ring	SS850–244
	32	Front Drive Shaft Bearing	SS850–363
♦	33	Drive Housing Seal	SS850–271
	33A	Drive Housing Vent Plug	P250–546
♦	34	Bulkhead Retainer	SS500–181
	35	Bulkhead Kit	SS850–K150
♦•	36	Outer Bulkhead 0–ring	SS850–152
♦•	37	Inner Bulkhead 0–ring	SS850–151
♦	39	Clutch Spring Cup Retainer	SS850–366
	40	Clutch Spring Cup	SS850–367
♦	41	Clutch Spring	SS850–583
	42	Clutch Jaw Kit	
		for SS850RD Models	SS800R–K587
		for SS850LD Models	SS800L–K587
	44	Front Drive Gear Bearing	SS800–278
	45	Drive Gear Cup	SS800–177
	46	Drive Gear Lock Washer	SS800–180
	47	Large Drive Shaft Bearing Retainer	SS850–107
	49	Piston Kit	SS850–K703
♦•	50	Piston 0–ring	SS850–337
♦•	51	Piston Seal	SS800–272

			PART NUMBER FOR ORDERING
	53	Drive Shaft Kit	
		for SS850RD Models	SS850R–K8
		for SS850LD Models	SS850L–K8
	54	Rear Drive Shaft Bearing Kit	
		(includes bearing and retainer)	SS850–K399
	56	Piston Return Spring	SS850–700
	58	Gear Case	SS850–37
	59	Drive Gear Bearing Retainer	SS800–361
	60	Drive Gear Shaft Bearing Retainer	SS800–632
♦	61	Rear Drive Gear Bearing	SS800–359
	62	Drive Gear	SS850D–9
	*	Nameplate	SS800–301
	*	Nameplate Screw (4)	R4K–302
	*	Relay Valve	SRV150
	*	Muffler	SS660–A674
	*	Road Splash Deflector	SM450–A735
	*	Air Strainer	SM450–A267AT
	*	In–Line Lubricator	NL–24–8
	*	Lubricator	HDL2
	*	Tune–up Kit (includes illustrated parts 6[2], 7, 8, 10, 10A[4], 11, 15, 18, 24, 25, 27, 31, 33, 34, 36, 37, 39, 50, 51, 60 and 61)	SS850–TK2

* Not illustrated.

♦ Indicates Tune–up Kit part.

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

MAINTENANCE SECTION

⚠ WARNING

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

Always turn off the air supply and disconnect the air supply hose before installing, removing or adjusting any accessory on this starter or before performing any maintenance on this starter.

LUBRICATION

Each time a Series SS815, SS825 or SS850 Starter is disassembled for maintenance or repair, lubricate the starter as follows

For temperatures above 32°F (0°C), use a good quality SAE 10 non–detergent motor oil.

For temperatures below 32°F (0°C), use diesel fuel.

1. Lubricate all O–rings with O–ring lubricant.
2. Lubricate the Drive Gear (62) with 8 oz. of Ingersoll–Rand No. 130 Grease.
3. Lubricate the Vanes (15) with 10W non–detergent oil.
4. Lubricate the inside diameter of the Drive Shaft (53) with Ingersoll–Rand No. 130 Grease.
5. Lubricate the Front Drive Gear Bearing (44) with Ingersoll–Rand No. 130 Grease.
6. Lubricate the pinion end of the Drive Shaft with Ingersoll–Rand No. 11 Grease.
7. Wipe a thin film of Ingersoll–Rand No. 130 Grease in the bore of the Drive Housing (58).
8. Roll the Piston Return Spring (56) in Ingersoll–Rand No. 130 Grease.
9. Coat the outside of the Piston (49) with Ingersoll–Rand No. 130 Grease.

DISASSEMBLY

General Information

1. Do not disassemble the starter any further than necessary to replace worn or damaged parts.
2. When grasping a part in a vise, always use leather–covered or copper–covered vise jaws to protect the surface of the part and help prevent distortion. This is particularly true of threaded members.
3. Do not remove any part which is a press fit in or on a subassembly unless the removal of that part is necessary for replacement or repairs.
4. Always have a complete set of seals and O–rings on hand before starting any overhaul of a starter. Never reuse old seals or gaskets.
5. Always mark adjacent parts on the Motor Housing Cover (2), Motor Housing (1), Gear Case (58) and Drive Housing (30) so these members can be located in the same relative position when the Starter is reassembled.

Drive Housing

1. Remove the rear Motor Housing Cover Plug (3) from the rear of the Motor Housing Cover (2).
2. Grasp the Drive Pinion (23) in a vise with the Starter supported on the workbench.

NOTICE

Models SS815RB, SS825RC and SS850RD have a left–hand thread; Models SS815LB, SS825LC and SS85OLD have a right hand thread.

3. Using a wrench, remove the Drive Pinion Retaining Screw (21).
4. Remove the starter from the vise.
5. Remove the Drive Pinion Washer (22) and the Drive Pinion (23).
6. Slide the Pinion Spring Sleeve (24) and the Pinion Spring (25) off the Drive Shaft.
7. Insert a 3/8" square drive extension through the Motor Housing Cover to hold the Rotor (13) from turning. Using a 5/16" (8 mm) x 8" (203 mm) long hex wrench inserted into the end of the Drive Shaft, unscrew the Drive Gear Screw (26).
8. Unscrew and remove the Drive Housing Cap Screws (28) and Lock Washers (29).
9. Tap the Drive Housing (30) with a plastic hammer to help dislodge it from the Gear Case (58).

⚠ WARNING

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

10. Place the Drive Housing in an arbor press, piston end up. Apply pressure to the Piston (49) to compress the Piston Return Spring (56) before removing the Bulkhead Retainer (34).
11. Using a screwdriver, remove the Bulkhead Retainer. Ease 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.

12. Remove the Bulkhead (35) from the Piston.
13. Remove the Outer Bulkhead 0–ring (36) and the Inner Bulkhead 0–ring (37).
14. Slide the Drive Shaft (53) from the Drive Housing.
15. Pull the Piston Return Spring (56) off the Drive Shaft.

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NOTICE

Do not remove the Front Drive Shaft Bearing (32) or the Drive Housing Seal (33) 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 0–ring (50) from the Piston.

NOTICE

The following operation will damage the Piston Seal (51). Therefore, always have a replacement Seal on hand.

16. Insert a large screwdriver blade through the Piston Seal so that it rests on top of the Clutch Spring Cup. Pry the Seal out of the Piston.
17. Press the Clutch Spring Cup (40) down and remove the Clutch Spring Cup Retainer (39).
18. Remove the Clutch Spring Cup and Clutch Spring (41).
19. Remove the two Clutch Jaws (42).
20. Remove the Front Drive Gear Bearing (44), Drive Gear Cup (45), Drive Gear Lock Washer (46), Drive Gear Screw 0–ring (27) and Drive Gear Screw (26).
21. Using a screwdriver, remove the Large Drive Shaft Bearing Retainer (47).
22. Press the Rear Drive Shaft Bearing and Drive Shaft (53) out of the Piston. If the Rear Drive Shaft Bearing needs to be replaced, proceed as follows:
    a. Using a small chisel, cut and remove the small drive shaft bearing retainer on the Drive Shaft.
    b. Press the Rear Drive Shaft Bearing (54) off the Drive Shaft.

Motor Housing

1. Unscrew and remove the Motor Housing Cover Cap Screws (4).
2. Pull the Motor Housing Cover (2) from the Motor Housing (1). It may be necessary to dislodge the Motor Housing Cover by tapping it with a plastic hammer.
3. Tap the Gear Case (58) with a plastic hammer to dislodge it from the Motor Housing.
4. Grasp the Rotor Pinion in a vise and using a wrench, remove the Rotor Pinion Retaining Screw (19).
5. Remove the Rotor Pinion (20) from the rotor shaft.
6. Slide the Front End Plate (16), Front Rotor Bearing (18) and Motor Wave Washers (17) off the rotor shaft.
7. Remove the Rotor (13) and Rear End Plate (9) from the Cylinder.
8. Remove and examine each Vane (15). Install a new set of Vanes if any Vane is cracked, spalled or worn to the extent that its width is 15/16" (24 mm) or less at either end.
9. Grasp the Rotor in a vise. Using a 5/32" (4 mm) hex wrench, loosen the Rotor Clamp Nut Screw (14). Unscrew and remove the Rotor Clamp Nut (12).
10. Remove the Large Rear Rotor Bearing 0–ring (11).
11. Remove the Rear End Plate (9) from the rotor shaft.
12. Remove the Small Rear Rotor Bearing 0–ring (10A) from the rotor shaft.
13. If the Rear Rotor Bearing (10) needs to be replaced, remove it from the Rear End Plate.
14. Push the Cylinder (5) out of the Motor Housing.
15. Remove the Cylinder 0–rings (8) from the Cylinder.

Gear Case

1. Place the Gear Case (58) on a workbench.
2. Using retaining ring pliers and working through the access holes in the gear web, remove the Drive Gear Bearing Retainer (59).
3. Pull the Drive Gear (62) out of the Gear Case.
4. Do not disassemble the Drive Gear of Series SS815, SS825 or SS850. If the Drive Gear is defective, install a new or factory rebuilt unit.
5. Using retaining ring pliers, remove the Drive Gear Shaft Bearing Retainer (60).
6. Remove the Rear Drive Gear Bearing (61) 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.

Gear Case

1. Place the Drive Gear Bearing Retainer (59) over the rear end of the Drive Gear.
2. Using an arbor press, press the Rear Drive Gear Bearing (61) onto the rear end ofthe Drive Gear.
3. Using retaining ring pliers, install the Drive Gear Shaft Bearing Retainer (60).

4. Position the Gear Case on a workbench. Using a plastic hammer, seat the Rear Drive Gear Bearing into the Gear Case by tapping the opposite end of the Drive Gear.
5. Using retaining ring pliers and working through the access holes in the gear web, install the Drive Gear Bearing Retainer (59).
6. Lubricate the Drive Gear with approximately 8 oz. (240 mL) of Ingersoll–Rand No. 130 Grease.

Motor Housing

1. Clamp the Rotor in a vise threaded end up.
2. Install the Rear Rotor Bearing (10) into the Rear End Plate.
3. Using O–ring lubricant, lubricate and install the Small Rear Rotor Bearing O–ring (10A) onto the rotor shaft until it butts against the rotor shaft shoulder.
4. Install the Rear End Plate (9), bearing end up, onto the rotor shaft.
5. Screw the Rotor Clamp Nut (12) onto the rotor shaft with the shoulder toward the bearing. Tighten the nut until there is .001" (.02 mm) to .003" (.07 mm) clearance between the Rear End Plate and Rotor.
6. Using a 5/32" (4 mm) hex wrench, tighten the Rotor Clamp Nut Screw (14). After tapping the End Plate away from the rotor face with a plastic hammer, recheck the clearance between the Rear End Plate and Rotor.
7. Check the two End Plate Alignment Pins (6). If they are bent or broken, remove them from the Cylinder and press in a new pin or pins.
8. Check the Cylinder Alignment Pin (7). If it is bent or broken, remove it from the Cylinder and press in a new pin.
9. Using O–ring lubricant, lubricate and install the two inside Cylinder O–rings (8).
10. Position the Motor Housing (1) vertically, on two blocks of wood, locating slot up.
11. Using a plastic hammer, tap the Cylinder (5) into the Motor Housing making sure the Cylinder Alignment Pin (7) seats into the slot of the Motor Housing.
12. Using O–ring lubricant, lubricate and install the two outside Cylinder O–rings (8).
13. **For Right–Hand Rotation Starter:** Insert the Rotor (13) into the Cylinder, pinion end toward the Cylinder Alignment Pin.

NOTICE

Make sure the protruding End Plate Alignment Pin (6) in the Cylinder aligns with the dowel hole in the Rear End Plate (9) numbered SS800R–12. Make sure the air ports of both the Cylinder and the Rear End Plate align.

For Left–Hand Rotation Starter:
Insert the Rotor (13) into the Cylinder, pinion end away from the Cylinder Alignment Pin.

NOTICE

Make sure the protruding End Plate Alignment Pin (6) in the Cylinder aligns with the dowel hole in the Rear End Plate (9) numbered SS800L–12. Make sure the air ports of both the Cylinder and the Rear End Plate align.

14. Lightly lubricate each Vane (15) and insert one in each of the rotor vane slots.
15. Slide the Front End Plate (16) over the pinion end of the Rotor. The other protruding End Plate Alignment Pin (6) in the face of the Cylinder should align with the dowel hole in the Front End Plate.
16. Insert the two Motor Wave Washers (17) into the Front End Plate well.
17. Install the Front Rotor Bearing (18) into the Front End Plate well.
18. Install the Rotor Pinion (20) on the rotor shaft so that the lugs on the Pinion engage those on the shaft.
19. Screw the Rotor Pinion Retaining Screw (19) into the rotor shaft and tighten to 90 ft–lb (122 Nm) torque.
20. Using O–ring lubricant, lubricate and install the Rear Rotor Bearing O–ring (11) onto the Rear Rotor Bearing.
21. Check freeness of the motor by turning the Rotor Pinion. If necessary, tap the Front End Plate with a soft hammer to align the motor.
22. Align the punch marks on the Gear Case (58), Motor Housing (1) and Motor Housing Cover (2) and assemble as follows:
    a. Grasp the Gear Case (58) in a vise by the Drive Gear Shaft.
    b. Insert the pinion end of the motor into the Gear Case. Using a soft hammer, tap the Motor Housing (1) until it seats.
    c. Position the Motor Housing Cover (2) on the Motor Housing. Using a soft hammer, tap the Motor Housing Cover until it is seated on the Motor Housing.

    NOTICE

    Screw a 12" (305 mm) piece of 1–1/2" (38 mm) pipe into the air inlet to act as a handle to help align the Motor Housing with the Motor Housing Cover and Gear Case.

    d. Lubricate the threads and install the Motor Housing Cover Cap Screws (4) and Lock Washers (4A), alternately tightening each a little at a time to a final torque of 60 ft–lb (81.4 N m).
23. Install two of the Housing Cover Plugs (3) into the Motor Housing Cover inlet boss and tighten securely.

Drive Housing

1. Press the Rear Drive Short Bearing (54) onto the Drive Shaft.
2. 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.
3. Assemble the Drive Gear Screw (26), Drive Gear Lock Washer (46), Drive Gear Cup (45) and Drive Gear Screw O–ring (27).
4. Grasp the Drive Shaft (53) in a vise, pinion end down. Place assembled Drive Shaft Screw Unit into the Drive Shaft, screw head down. Lubricate the inside diameter of the Drive Shaft with Ingersoll–Rand No. 130 Grease.
5. Slide the Front Drive Gear Bearing (44) into the Drive Shaft.
6. 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.
7. Insert the Clutch Spring (41) into the Drive Shaft.
8. Insert the Clutch Spring Cup (40) into the Drive Shaft.
9. Press the inserted parts into the Drive Shaft, and install the Clutch Spring Cup Retainer (39).
10. Using an arbor press, press the Piston Seal (51), cover side out, into the Piston until it is flush with the piston face.
11. Install the Piston (49) onto the Drive Shaft until the Rear Drive Shaft Bearing seats into the Piston.
12. Using a thin flat blade screwdriver to assist in this operation, coil the Large Drive Shaft Bearing Retainer (47) into the groove of the Piston to retain the outer race of the Drive Shaft Bearing.
13. Lubricate the Piston O–ring (50) and install it in the groove of the Piston.
14. Position the Drive Housing in an arbor press, pinion end down and install the Drive Housing Seal (33) into the Drive Housing.

NOTICE

Press the Seal into the Drive Housing so that the lip of the Seal faces away from the Drive Pinion.

15. Using a sleeve that contacts the outer race of the Front Drive Shaft Bearing (32), press the Bearing into the Drive Housing until it seats. **For Models SS815 and SS825,** drop the Piston Return Spring Seat (57) on top of the Front Drive Shaft Bearing.
16. Slide the Piston Return Spring (56) onto the Drive Shaft and snap it into the front of the Piston so that it is against the Large Drive Shaft Bearing Retainer (47).
17. Lubricate and insert the assembled Drive Shaft into the Drive Housing.
18. Using O–ring lubricant, lubricate and install the Outer Bulkhead O–ring (36) and the Inner Bulkhead O–ring (37) on the Bulkhead (35).
19. Slide the Bulkhead onto the Piston.
20. 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. Using a screwdriver, install the Bulkhead Retainer (34).

⚠ WARNING

Make sure the Bulkhead Retainer is properly seated in the Motor Housing groove before easing off the arbor press.

21. Remove the Drive Housing from the arbor press.
22. Using O–ring lubricant, lubricate and install the Drive Housing O–ring (31) in the groove of the Drive Housing.
23. Position the assembled Motor Housing and Gear Case on a workbench. Assembled unit must be upright to accept the Drive Housing.
24. Carefully position the assembled Drive Housing (30) onto the Gear Case so as not to damage the Piston Seal. Align the punch marks of the Gear Case and Drive Housing.
25. Install the Drive Housing Cap Screw Lock Washers (29) and the Drive Housing Cap Screws (28) and tighten to 28 ft–lb (38 Nm)torque.
26. Insert a 3/8" (10 mm) square drive extension bar through the hole in the Motor Housing Cover to prevent the Rotor from turning. Using a 5/16" (8 mm) x 8" (203 mm) long hex wrench inserted into the end of the Drive Shaft, tighten the Drive Gear Screw (26) to 57 ft–lb (77.3 N m) torque.
27. Using Ingersoll–Rand No. 11 Grease, Lubricate and slide the Pinion Spring (25) and the Pinion Spring Sleeve (24) over the Pinion end of the Drive Shaft.
28. Lubricate the pinion end of the Drive Shaft with Ingersoll–Rand No. 11 Grease and install the Drive Pinion (23).

29. Grasp the Drive Pinion in a vise with the Starter supported on a workbench.
30. Place the Drive Pinion Washer (22) onto the Drive Pinion Retaining Screw (21). 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 SS815 and SS825 Starters, and 125 ft–lb (169.5 Nm) torque for SS850 Starters.

NOTICE

Models SS815RB, SS825RC and SS850RD have a left–hand thread; Models SS815LB, SS825LC and SS850LD have a right–hand thread.

Remove the Starter from the vise.

31. Install the rear Motor Housing Cover Plug (3) and tighten securely.

TEST AND INSPECTION PROCEDURE

1. **Clutch Ratcheting:** Turn the Drive Shaft Pinion (23) 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 (23) opposite the direction of Starter rotation. The Drive Shaft Pinion should turn by hand.
3. **Pinion Engagement:** Apply 50 psig (3.4 bar/345 kPa) pressure to the engagement "In" Port. Drive Shaft Pinion (23) should move outward and air or gas should escape from the "Out" Port. Plug the "Out" Port and apply 150 psig (10.3 bar/I 034 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 (23) to the face of the mounting flange. It should be 2–23/32" (69.0 + 2.0 mm) for Models SS815, SS825 and 8–3/4" (222 + 2.0 mm) for Model SS850. Remove the pressure from the "In" Port. Measure the distance from the face of the Drive Shaft Pinion (23) to the face of the mounting flange. It should be 1–25/32" 45.0 + 2.0 mm) for Models SS815, SS825 and 7–3/32" (180 + 2.0 mm) for Model SS850.
4. **Motor Vane Action:** 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 apply 20 psig (1.4 bar/138 kPa) pressure to the inlet of the motor. Immerse the Starter for 30 seconds in a nonflammable solvent. If the Starter is properly sealed, no bubbles, will appear.

TROUBLESHOOTING GUIDE

Trouble	Probable Cause	Solution
Motor will not run	No air supply.	Check for blockage or damage to air supply linesor tank.
	Damaged Motor Assembly	Inspect Motor Assembly and power train and repair or replace if necessary.
	Foreign material in Motor and/or piping.	Remove Motor Assembly and/or piping and remove blockage.
	Blocked exhaust system.	Remove Housing Exhaust Cover and check for blockage.
	Defective Control Valve or Relay Valve.	Replace Control Valve or Relay Valve.
Loss of Power	Low air pressure to Starter.	Check air supply.
	Restricted air supply line.	Check for blockage or damage to air lines.
	Relay Valve malfunctioning.	Clean or replace lines or Relay Valve. Lube Relay Valve.
	Exhaust flow 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.
	Foreign material in Starter Drive.	Remove obstruction.
	Damaged or worn Drive parts.	Check Drive components and replace if necessary.
	Inadequate lubrication.	Check the lubricator, inlet hose, fitting, and oil supply hose to make sure they are vacuum tight and free of leaks. Tighten all joints and replace lubricator if necessary.
Starter drive does notengage ring gear or engages and disengages ring gear very slowly.	Clogged control hoses	Remove the control hoses attached to the Drive Housing and clean them by blowing compressed air through them. **⚠ WARNING** **Firmly secure the hose end before turning on the air. Make certain no one is in line with the discharge end of the control hose.**
	Clogged or faulty Control Valve	Remove and inspect the Control Valve or install a new Control Valve if necessary.
	Broken Clutch Jaws or other parts.	Disassemble Drive Housing and replace broken parts.
Motor runs, pinion engages but does not rotate	Broken Shaft, Gearing, or Clutch Jaws.	Disassemble Drive Housing and replace broken parts.
Excessive butt engagements.	Dry Drive Pinion Spline	Remove Drive Pinion and lubricate the Drive Pinion and the helical spline of the Drive Shaft. Refer to **Disassembly of the Drive Housing.**

NOTICE

SAVE THESE INSTRUCTIONS. DO NOT DESTROY.