Cata-Dyne™

STANDARD HEATER APPLICATIONS

INSTALLATION & OPERATION INSTRUCTIONS

⚠ WARNING: Improper installation, adjustment, alteration, excessive vibration, service or maintenance can cause property damage, injury or death. Read the installation, operating and maintenance instructions thoroughly before installation or servicing this equipment.

FM APPROVED

BKI

CE 1418

The Cata-Dyne™ heater can be used in all industrial indoor locations where a source of infrared radiant heat is required, providing adequate ventilation is available.

CERTIFICATION

Model WX (Series X) & MKII Cata-Dyne™ Explosion-proof, flameless infrared catalytic gas heaters are certified by the Canadian Standards Association (CSA) for use in Class I, Divisions 1 and 2, Group D hazardous (classified) locations and FM Approvals, for use in Class I, Division 1, Group D hazardous (classified) locations, temperature code T2C at an ambient temperature of 40ºC (104ºF). WXS models are suitable for Class I, Division I, Group D, temperature code T2B at an ambient temperature of 40°C (104°F). Models WX & MKII are certified ATEX/CE for use in gas environments, Category 2, Zone 1 & 2, Group IIA.

The Model BX (Series G) Cata-Dyne™ heater is certified by CSA and FM for use in general industrial non-hazardous locations. Models listed are certified for industrial use only, for either natural gas or propane gas. CSA approved models are equipped for high altitudes: 0 - 4,500 ft. (0-1,370 m) above sea level.

INSTALLATION

To ensure maximum efficiency of your Cata-Dyne™ heater, it should be installed with the heating surface positioned plus or minus 45° from the vertical plane at a height of no more than 8 ft. (2.44 m). All heaters must be installed in accordance with the latest revisions of the codes described in table 4 and in accordance with any local codes and regulations. Before installing the heater, all information on the heater nameplate must be carefully reviewed. The nameplate lists all the fuel and electrical requirements for the heater.

Table 1

CATA-DYNE™ HEATER- MODELS AVAILABLE FOR FM, CE, ATEX

WX Model (Series X)

Approved for use in Class I, Division 1 and 2, Group D hazardous (classified) locations by both FM and CSA T-Code T2C @ 40°C Ambient

Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas		Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas	
	Max. Btu/hr	Max. kW		Max. Btu/hr	Max. kW
WX 6 x 6	1,250	0.366	WX 18 x 24	15,000	4.393
WX 6 x 12	2,500	0.732	WX 18 x 30	18,750	5.491
WX 6 x 24	5,000	1.464	WX 18 x 36	22,500	6.590
WX 6 x 60	12,500	3.661	WX 18 x 48	30,000	8.786
WX 8 x 8	2,222	0.651	WX 18 x 60	37,500	10.983
WX 10 x 12	4,167	1.220	WX 18 x 72	45,000	13.179
WX 12 x 12	5,000	1.464	WX 24 x 24	20,000	5.857
WX 12 x 24	10,000	2.929	WX 24 x 30	25,000	7.322
WX 12 x 36	15,000	4.393	WX 24 x 36	30,000	8.786
WX 12 x 48	20,000	5.857	WX 24 x 48	40,000	11.715
WX 12 x 60	25,000	7.322	WX 24 x 60	50,000	14.644
WX 12 x 72	30,000	8.786	WX 24 x 72	60,000	17.572

MK II Model (Series X)

Approved for use in Class I, Division 1 and 2, Group D hazardous (classified) locations by both FM and CSA T-Code T2C @ 40°C Ambient

Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas	
	Max. Btu/hr	Max. kW
MKII12x12	5,000	1.464
MKII12x24	10,000	2.929
MKII18x24	15,000	4.393
MKII18x48	30,000	8.786
MKII24x24	20,000	5.857
MKII24x48	40,000	11.715

BX Model (Series G)

Approved for use in general industrial non-hazardous locations by both FM and CSA

Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas		Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas	
	Max. Btu/hr	Max. kW		Max. Btu/hr	Max. kW
BX6x6	1,500	0.439	BX18x24	18,000	5.272
BX6x12	3,000	0.879	BX18x30	22,500	6.590
BX6x24	6,000	1.757	BX18x36	27,000	7.908
BX8x8	3,500	1.025	BX18x48	36,000	10.543
BX10x12	5,000	1.464	BX18x60	45,000	13.179
BX12x12	6,000	1.757	BX18x72	54,000	15.815
BX12X24	12,000	3.514	BX24x24	24,000	7.029
BX12x36	18,000	5.272	BX24x30	30,000	8.786
BX12x48	24,000	7.029	BX24x36	36,000	10.543
BX12x60	30,000	8.786	BX24x48	48,000	14.058
BX12x72	36,000	10.543	BX24x60	60,000	17.572
			BX24x72	72,000	21.087

WXS Model (Series X)

Approved for use in Class I, Division 1, Group D hazardous (classified) locations by FM, T-code T2B at 40°C ambient

Model Number	Max. Gas Input		Max. Gas Input	
	Nat. Gas Btu/hr	Propane Btu/hr	Nat. Gas kW	Propane kW
WXS 6 x 6	1,750	1,750	0.513	0.513
WXS 6 x 12	3,500	3,500	1.025	1.025
WXS 6 x 24	7,000	7,000	2.050	2.050
WXS 8 x 8	3,111	3,111	0.911	0.911
WXS 10 x 12	5,833	5,833	1.708	1.708
WXS 12 x 12	7,000	7,000	2.050	2.050
WXS 12 x 24	14,000	14,000	4.100	4.100

The WX Series Cata-Dyne™ features an improved efficiency catalyst pad that required nearly 20% less fuel to generate the same value as our BX Series Cata-Dyne™ heater.

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Table 2

CATA-DYNE™ HEATER- MODELS AVAILABLE FOR CSA ONLY

WX Model (Series X)

Approved for use in Class I, Division 1 and 2, Group D hazardous (classified) locations by both FM and CSA T-Code T2C @ 40°C Ambient

Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas				Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas			
	Max. Btu/hr		Max. kW			Max. Btu/hr		Max. kW	
	LPG	NAT	LPG	NAT		LPG	NAT	LPG	NAT
WX 6 x 6	1,000	1,250	0.293	0.366	WX 18 x 24	12,000	15,000	3.514	4.393
WX 6 x 12	2,000	2,500	0.586	0.732	WX 18 x 30	15,000	18,750	4.393	5.491
WX 6 x 24	4,000	5,000	1.171	1.464	WX 18 x 36	18,000	22,500	5.272	6.590
WX 6 x 60	10,000	12,500	2.929	3.661	WX 18 x 48	24,000	30,000	7.029	8.786
WX 8 x 8	1,778	2,222	0.521	0.651	WX 18 x 60	30,000	37,500	8.786	10.983
WX 10 x 12	3,333	4,167	0.976	1.220	WX 18 x 72	36,000	45,000	10.543	13.179
WX 12 x 12	4,000	5,000	1.171	1.464	WX 24 x 24	16,000	20,000	4.686	5.857
WX 12 x 24	8,000	10,000	2.343	2.929	WX 24 x 30	20,000	25,000	5.857	7.322
WX 12 x 36	12,000	15,000	3.514	4.393	WX 24 x 36	24,000	30,000	7.029	8.786
WX 12 x 48	16,000	20,000	4.686	5.857	WX 24 x 48	32,000	40,000	9.372	11.715
WX 12 x 60	20,000	25,000	5.857	7.322	WX 24 x 60	40,000	50,000	11.715	14.644
WX 12 x 72	24,000	30,000	7.029	8.786	WX 24 x 72	48,000	60,000	14.058	17.572

MK II Model (Series X)

Approved for use in Class I, Division 1 and 2, Group D hazardous (classified) locations by both FM and CSA T-Code T2C @ 40°C Ambient

Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas			
	Max. Btu/hr		Max. kW	
	LPG	NAT	LPG	NAT
MKII 12x12	4,000	5,000	1.171	1.464
MKII 12x24	8,000	10,000	2.343	2.929
MKII 18x24	12,000	15,000	3.514	4.393
MKII 18x48	24,000	30,000	7.029	8.786
MKII 24x24	16,000	20,000	4.686	5.857
MKII 24x48	32,000	40,000	9.372	11.715

BX Model (Series G)

Approved for use in general industrial non-hazardous locations by both FM and CSA

Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas		Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas	
	Max. Btu/hr	Max. kW		Max. Btu/hr	Max. kW
BX 6x6	1,500	0.439	BX 18x24	18,000	5.272
BX 6x12	3,000	0.879	BX 18x30	22,500	6.590
BX 6x24	6,000	1.757	BX 18x36	27,000	7.908
BX 8x8	3,500	1.025	BX 18x48	36,000	10.543
BX 10x12	5,000	1.464	BX 18x60	45,000	13.179
BX 12x12	6,000	1.757	BX 18x72	54,000	15.815
BX 12X24	12,000	3.514	BX 24x24	24,000	7.029
BX 12x36	18,000	5.272	BX 24x30	30,000	8.786
BX 12x48	24,000	7.029	BX 24x36	36,000	10.543
BX 12x60	30,000	8.786	BX 24x48	48,000	14.058
BX 12x72	36,000	10.543	BX 24x60	60,000	17.572
			BX 24x72	72,000	21.087

WXS Model (Series X)

Approved for use in Class I, Division 1, Group D hazardous (classified) locations by FM, T-code T2B at 40°C ambient

Model Number	Specifications (Btu/hr Input Ratings) For Both Natural and Propane Gas	
	Max. Btu/hr	Max. kW
WXS 6 x 6	1,750	0.513
WXS 6 x 12	3,500	1.025
WXS 6 x 24	7,000	2.050
WXS 8 x 8	3,111	0.911
WXS 10 x 12	5,833	1.708
WXS 12 x 12	7,000	2.050
WXS 12 x 24	14,000	4.100

Table 3

All Cata-Dyne™ Heaters Installed In Canada	*All Cata-Dyne™ Heaters Installed In the USA*	*All Cata-Dyne™ Heaters Installed Internationally*
CSA/CAN – C22.1-02, Canadian Electrical Code	NFPA 70, National Electrical Code	Install according to local and national/international fuel and electrical codes.
CSA/CAN – B149.1-00, Natural Gas and Propane Installation Code	NFPA 54, National Fuel Gas Code	

NOTE: Ensure that the heater is not operational in an excessive vibration environment or premature failure of the heater may occur.

SPECIFICATIONS

Clearances

Appropriate clearances from the heating surface must be observed during the installation of the Cata-Dyne™ heaters (See Figure 1 & Table 4). Maintain nameplate clearances from combustible materials such as wood, cloth, paper, etc.

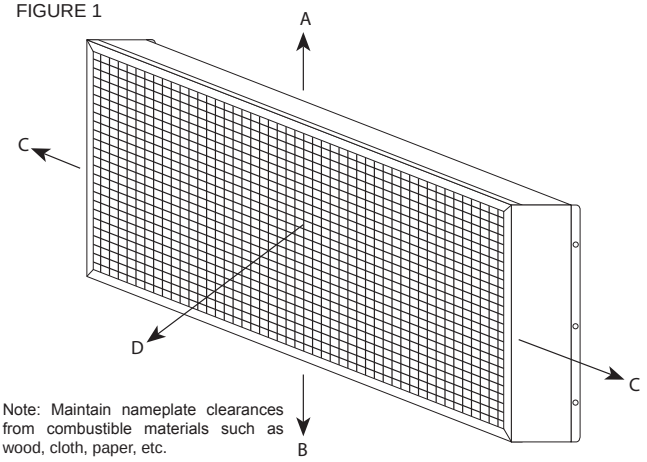
Fuels

The Cata-Dyne™ flameless gas heater is designed to operate on clean, dry natural gas or propane as specified on the heater nameplate.

Natural Gas - these heaters are designed to use natural gas (1,000 Btu/ft^3, 37 MJ/m^3) at 7 in. w.c. (1.73 kPa), 4.5 in. w.c. (1.12 kPa), or 3.5 in. w.c. (0.86 kPa).

Propane - these heaters are designed to use propane gas (2,500 Btu/ft^3, 92 MJ/m^3) at 11 in. w.c. (2.72 kPa).

FIGURE 1



Note: Maintain nameplate clearances from combustible materials such as wood, cloth, paper, etc.

Table 4

HEATER CLEARANCE

	D - Radiant Surface			C - Sides	A - Top			B - Bottom		
Radiant Surface Position	Heaters Up To 12,000 Btu/hr (3.514 kW)	Heaters Up To 48,000 Btu/hr (14.058 kW)	Over 48,000 Up To 72,000 Btu/hr (21 kW)	All Heaters Up To 72,000 Btu/hr (21 kW)	Heaters Up To 12,000 Btu/hr (3.514 kW)	Over 12,000 Up To 48,000 Btu/hr (14.058 kW)	Over 48,000 Up To 72,000 Btu/hr (14.058 kW)	Heaters Up To 12,000 Btu/hr (3.514 kW)	Over 12,000 Up To 48,000 Btu/hr (3.514 kW)	Over 48,000 Up To 72,000 Btu/hr (21 kW)
Vertical (0°)	28 in. (711 mm)	42 in. (1067 mm)	60 in. (1524 mm)	12 in. (305 mm)	18 in. (457 mm)	18 in. (457 mm)	42 in. (1067 mm)	7 in. (178 mm)	12 in. (305 mm)	18 in. (457 mm)
0-45° up	28 in. (711 mm)	42 in. (1067 mm)	60 in. (1524 mm)	12 in. (305 mm)	18 in. (457 mm)	32 in. (813 mm)	54 in. (1372 mm)	0 in. (0 mm)	12 in. (305 mm)	18 in. (457 mm)
0-45° down	28 in. (711 mm)	42 in. (1067 mm)	60 in. (1524 mm)	12 in. (305 mm)	18 in. (457 mm)	18 in. (457 mm)	18 in. (457 mm)	22 in. (559 mm)	24 in. (610 mm)	42 in. (1067 mm)

Piping

1. A main shut-off valve must be installed upstream of all auxiliary heater controls.

2. The 100% safety shut-off valve and appliance regulator (natural gas heaters only) must be installed in the upright position (horizontally).

3. The thermostatic temperature controller should be installed with the dial shaft in the horizontal position.

4. The maximum inlet pressure to the 100% safety shut-off valve, thermostatic temperature control and appliance regulator is 1/2 psi (3.4 kPa). If the inlet pressure is higher than this, a low-pressure service regulator must be installed upstream of these components.

5. The maximum inlet pressure to the low-pressure service regulator (available from CCI Thermal) is 250 psi (1.7 MPa). If the inlet pressure is higher than this, a high-pressure regulator must be installed upstream.

6. All components should be installed as indicated in Figure 2 (WX and BX models only) or Figure 3 (MKII model only).

FIGURE 2

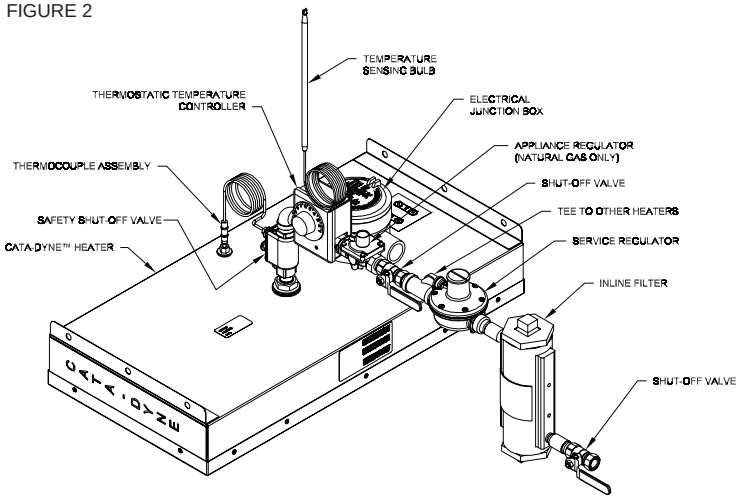


Diagram illustrates typical Natural Gas installation.

Gas appliance regulators and manual shut off valves are required standard components for all CSA approved heaters; they are available as optional accessories for FM approved heaters.

FIGURE 3

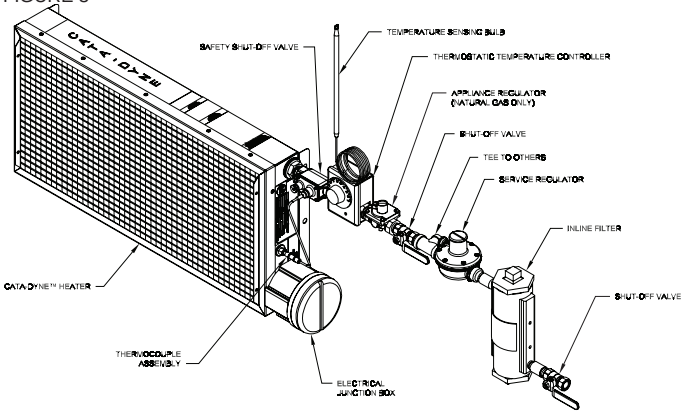


Diagram illustrates typical Natural Gas installation.

Gas appliance regulators and manual shut off valves are required standard components for all CSA approved heaters; they are available as optional accessories for FM approved heaters.

CAUTION:
Install MKII series heaters with controls on sides or bottom of heater only.

Electrical

1. All wiring is to be installed in accordance with the latest revisions of the Canadian Electrical Code (CEC)/ National Electrical Code (NEC) and/or any applicable local codes.

2. It is desirable to install an indicating light on all starting systems. This will reduce the possibility of the power being left on once the heater is started, which can severely reduce the lifespan of the heater.

3. Ground connections for 120 V and higher voltage heaters are required as indicated in Figures 4 and 5.

4. The number of terminals in the junction box can be two of four depending on the number of elements used in the fabrication of the heater. All MKII models incorporate a single element and therefore have only two terminals. The connection procedure for the different combinations is as described in Figures 4 and 5:

FIGURE 4

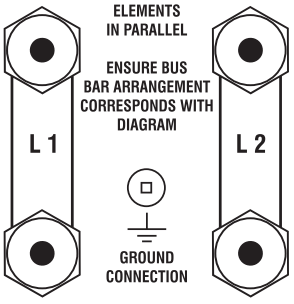
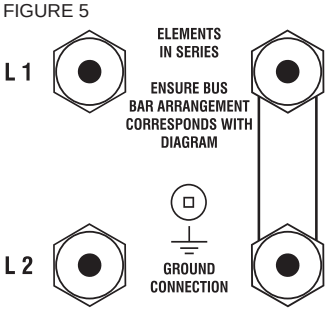


FIGURE 5



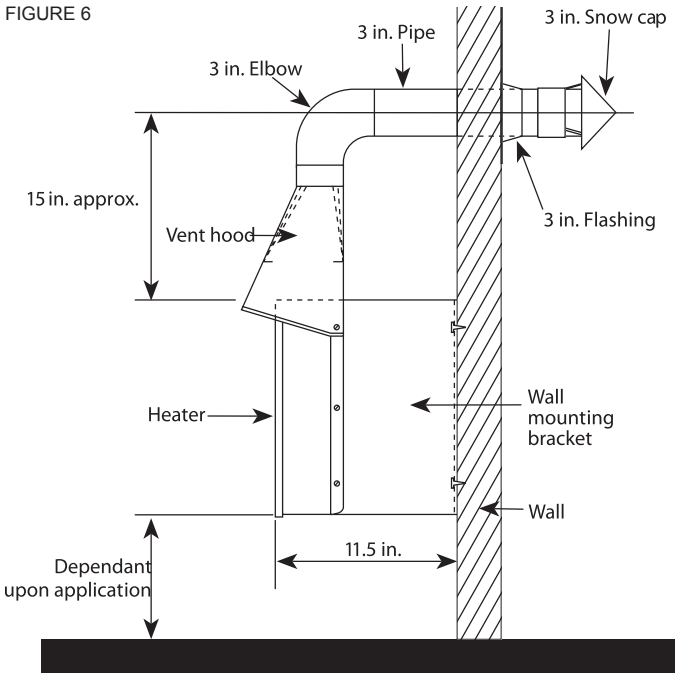
Ventilation

The catalytic reaction in Cata-Dyne™ heaters occurs when natural gas or propane reacts with oxygen to produce water vapor, carbon dioxide and infrared energy. Ventilation must be provided to allow adequate supply of oxygen for the reaction.

For every 1.0 ft^2 (0.093 m^2) of heater surface, 50 ft^3/hr (1.42 m^3/hr) of air supply is required. For example, a WX 24 x 24 heater (20,000 Btu/hr / 5.857 kW) would require 200 ft^3/hr (5.66m^3/hr) of air to ensure proper operation of the Cata-Dyne™ heater.

To reduce the carbon dioxide and water vapor concentrations in the building, a vent hood assembly can be installed to provide positive ventilation from the heater (See Figure 6).

FIGURE 6



OPERATION

All Cata-Dyne™ heaters are supplied with a Safety Shut-Off Valve (SSOV)/Thermocouple assembly to ensure the safe operation of the heater. Under no circumstances should the reset button be held or locked into the depressed position by use of a mechanical restraint. A tamper resistant model SSOV is available if desired.

Start-up

1. Ensure the heater has been installed according to all instructions and relevant codes.

2. Turn on the main gas supply to the system.

3. If the heater is equipped with a thermostatic temperature controller, rotate the dial completely clockwise to the fully open position.

4. Turn on the power to the electrical elements.

5. After 15 minutes, depress the reset button on the top of the 100% safety shut-off valve. The button should return to the original position and internally open the valve and allow gas to flow to the heater. If the valve does not stay open when the reset button is released, it may be necessary to wait an additional few minutes and then depress the reset button again. This will allow the electrical elements additional time to warm up.

6. When the catalytic reaction is well established, turn off the electrical power to the elements.

7 If the heater is equipped with a thermostatic temperature controller, it can be set to the desired setting after the catalytic reaction has been established for at least one hour.

Shut Down

Turn off the gas supply to the heater.

Multi-Heater Start-up

Cata-Dyne™ heaters can also be purchased/installed in multi-heater assemblies. If these assemblies are 12 V, each heater must be started individually. This ensures the correct voltage and current will be reaching the heater from the power supply.

12 V HAZARDOUS ELECTRICAL INSTALLATIONS

Most oil and gas production buildings have an area classification as follows:

1. Class I, Division 1, within the building. Refer to figures 7 and 8.

2. Class I, Division 2, up to 10 ft. (3 m.) from the building in any direction. Refer to figures 7 and 8.

3. Class I, Division 2, between 10 ft. (3 m.) and 25 ft. (7.6 m.) from the building in all directions at an elevation of 18 in. (0.45 m.) above the ground. Refer to figures 7 and 8.

Connection to the power supply must be outside of the Class I, Division 2 location. (refer to Figure 9). All electrical apparatus and wiring within this area must conform to the appropriate codes.

SPACE HEATING

A separate heat load calculation should be done for each building in which a Cata-Dyne™ heater will be installed for space heating purposes.

The heatload calculation determines the building heat losses through the structure and allows for air infiltration (refer to the Cata-Dyne™ catalog or visit www.ccithermal.com for the sample Heat Load Calculation).

Cata-Dyne™ heaters produce low intensity infrared heat that is absorbed by objects within the range of the heat source. The closer the object is to the source of heat the more heat the object will absorb. Cata-Dyne™ heaters should be placed close to the floor level within the building to heat objects close to the floor.

Ideally, Cata-Dyne™ heaters should be mounted 1-3 ft. (0.3-1 m) from the floor and equally spaced around the building perimeter for space heating applications.

If low mounting is not practical, then overhead mounting may be utilized. Overhead mounted heaters should be sloped face down to a maximum 45° angle to direct the infrared energy towards the floor. Overhead mounting should be restricted to heaters of 30,000 Btu.hr (8.8 kW) capacity and larger.

If the building requires only one heater, place the Cata-Dyne™ heater as close as possible to the center of the longest wall.

For multiple heater installations, space the Cata-Dyne™ heaters as evenly as possible around the perimeter of the building.

Make sure the piping is large enough to handle the gas load (refer to the sample Piping Calculation in the Cata-Dyne™ catalog for sizing information).

Make sure the electrical starting system has sufficient current carrying capacity and conforms to all applicable electrical codes.

It is advisable to install an indicator light in the electrical circuit to reduce the possibility of the power being left on once the heater is started.

FIGURE 7

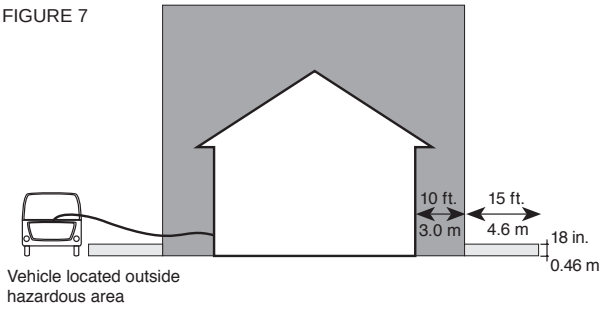
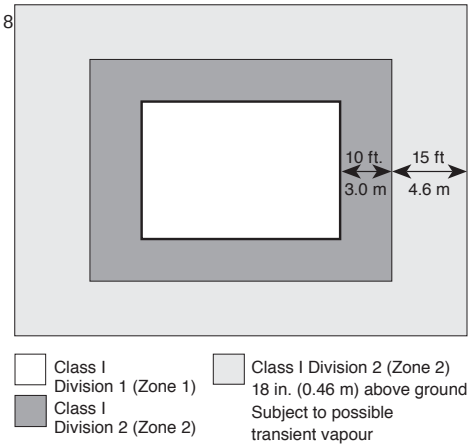


FIGURE 8



SPOT HEATING

There are several factors to consider when Cata-Dyne™ heaters are utilized for spot heating.

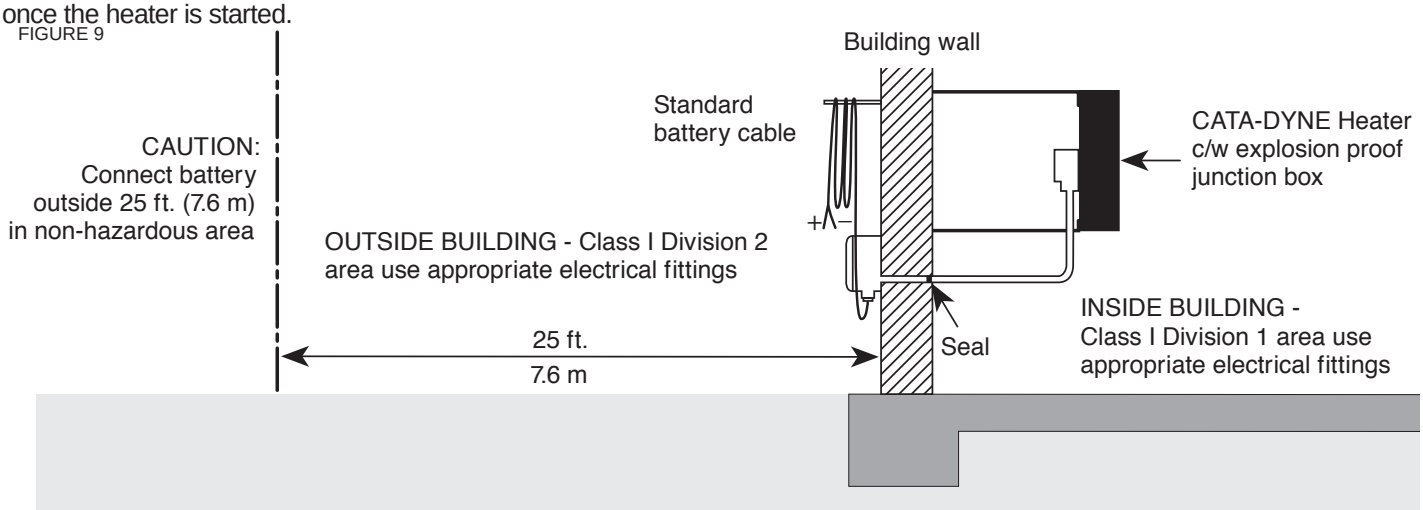
Infrared energy travels in straight lines from the face of the Cata-Dyne™ heater covering approximately 160° of an arc and is inversely proportional to the square of the distance. The heater should therefore be mounted as close as practical (min of 28 in. (71 cm)) to the object requiring heat for maximum temperature rise.

Match the shape of the object requiring heat with the appropriate Cata-Dyne™ heater, e.g. WX/BX 6 x 24 for long narrow objects or WX/BX 12 x 12 for a square object.

Objects requiring heat should be painted dull, dark colors for maximum infrared absorption and objects not requiring heat should be painted light or reflective colors.

Insulate and protect plastic, rubber and similar materials from direct intense infrared heat.

FIGURE 9



PERSONAL SAFETY

The Cata-Dyne™ flameless infrared catalytic gas heater does not produce harmful carbon monoxide gas when used with natural gas or propane. Adequate ventilation must be incorporated in any building design to ensure oxygen replenishment and removal of any carbon dioxide. Protective grills should be used on any installation where personnel may come in contact with the face of the heater.

ORDERING INFORMATION

You can order any of CCI Thermal's products by telephone, fax, mail, e-mail or directly on-line at www.ccithermal.com.

To assist us in processing your order as quickly and efficiently as possible, please provide us with the following information:

- ☐ Cata-Dyne™ product name
- ☐ Cata-Dyne™ model number
- ☐ Fuel gas - natural gas or propane
- ☐ Starting voltage - 12, 24, 120, 208, 240, 480, or 600V
- ☐ Accessories required:
  - Protection Grill
  - Wall Mount Brackets
  - Thermostat
  - Regulator
  - Start Up Leads (12 V system only)
  - Vent Hood
  - Other
- ☐ Company name and contact
- ☐ Billing address and phone number
- ☐ Shipping instructions
- ☐ Special tagging instructions
- ☐ Date required
- ☐ Method of payment:
  - on account - P.O. number required
  - credit card - VISA or Mastercard number
  - cash or cheque

RETURN GOODS POLICY

Prior written approval must be obtained from CCI Thermal for the return of any Cata-Dyne™ product(s). A restocking charge of 15% will apply. All returns must be shipped to our factory in Edmonton, freight prepaid. Final acceptance will be contingent on inspection at our factory.

GUARANTEE

CCI Thermal warrants all Cata-Dyne™ flameless infrared heaters sold to be free from defects in material or workmanship under normal use and service. The company agrees to repair or replace any Cata-Dyne™ heater which, upon examination , reveals it to have been defective due to faulty workmanship or material, if returned to our factory, transportation PREPAID, within one (1) year from date of purchase. The company does not assume responsibility for misuse or misapplication of its heaters.

Warranty is void if Cata-Dyne™ heaters are used with sour, dirty or wet gas, or where sulphur content is greater than allowable for utility gas specifications. Warranty is void if, upon our inspection, if the SSOV or thermocouple have been tampered with. Neither CCI Thermal nor the selling dealer shall be held responsible for loss of time, inconvenience, commercial loss or consequential damages relating to the use of Cata-Dyne™ heaters.

REPAIRS

Cata-Dyne™ heaters may require periodic maintenance or repair. Our factory is staffed with technicians who are qualified to perform any required repairs. The procedure to follow to have a heater repaired is as follows.

Send the heater to our factory in Edmonton. Include the following information with the heater:

- ☐ Company name and address
- ☐ Contact name
- ☐ Telephone number/fax number/e-mail
- ☐ P.O. Number
- ☐ Advise if an estimate is required prior to starting the repair
- ☐ Details on the repair or conversion required
- ☐ Return shipping instructions

NOTE: Under the terms of our certification, all repairs must be performed at our factory in Edmonton.

TROUBLE SHOOTING

1. Ensure that the fuel matches that listed on the nameplate.

2. Ensure that the voltage matches that listed on the nameplate.

3. Check for any physical damage. All signs of physical damage to the catalyst pad such as holes, tears or a general deterioration of the catalyst bed signal that it is time to have the heater repaired. Excessive vibration may cause damage to the inner catalysts structure which may cause premature failure.

4. Check the gas supply pressure at the heater – 7 in. w.c. (1.73 kPa), 4.5 in. w.c. (1.12 kPa), or 3.5 in. w.c. (0.86 kPa) for natural gas and 11 in. w.c. (2.72 kPa) for propane.

5. Check the gas orifice for obstructions or dirt and ensure the size matches that listed on the nameplate. It may be necessary to install a filter upstream of the heater or regulator if the gas supply is dirty. If the fuel supply is constantly dirty and/or wet it would be advisable to use bottled propane fuel.

6. Check the mounting position of the heater. The face of the heater should be preferably in the vertical position and should not vary more than 45° from the vertical position for maximum efficiency.

7. Check for saturation of the catalyst face caused by condensation or rain running down the face of the heater. If the heater has been exposed to water, it is advisable to place the unit in a warm area for a period of a few hours or longer if required. Once the moisture is removed, the heater can be re-installed and re-started.

8. Check the jumper cable size to ensure that the resistance of the cable is not reducing the current to the heater. This would not allow sufficient power to the electrical element to preheat the catalyst to the activity temperature. It is recommended to run the service vehicle at fast idle while starting the heater.

9. Cata-Dyne™ heaters are designed to use clean fuel and to be used in non-contaminated atmospheres. Sulphur compounds in the fuel or atmosphere will poison the catalyst bed over a period of time and render the heater inoperative. If the heater has been exposed to sulphur compounds, it should be sent to the factory for service.

10. Avoid spraying the face of the heater with high-pressure air, steam or water because this can damage the catalyst bed, if physical damage is visible, return the heater to the factory for servicing.

11. Ensure that the temperature controller is correct for the model size, fuel, and pressure specifications for the heater it is fitted to. If the temperature controller is too low, the heater will not have sufficient fuel rating to operate and will stop.

Separate Installation and Operation Instructions are available for oven and industrial heating applications.

Printed In Canada

INSTALLATION, OPERATION AND MAINTENANCE INSTRUCTIONS FOR TYPE CX & DX – IMMERSION HEATERS

ISO 9001:2000 QMI REGISTERED

CAUTION

ELECTRIC SHOCK HAZARD. All electric heating equipment installations must be performed by qualified personnel in accordance with the local electrical codes and standards and must be effectively grounded to eliminate shock hazard.

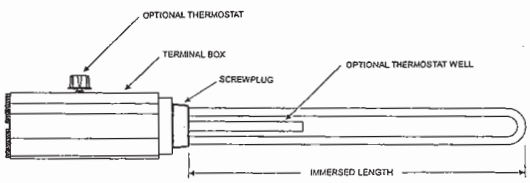
WARNING

FIRE/EXPLOSION HAZARD. Do not exceed the ratings of the flange as listed in ANSI B16.5. Do not operate the heater in the presence of combustible gases, vapours, dusts or fibres unless the heater is specifically marked for the hazardous location and heater operating temperature does not exceed the temperature code rating. Corrosion of the sheath could result in a ground fault which, depending upon the fluid being heated, could cause a fire or an explosion.

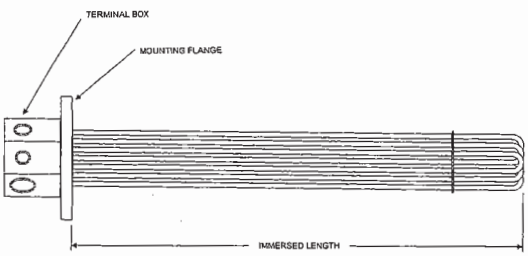
FIRE HAZARD. If a thermostat is provided, it is designed for temperature control service only. Since the thermostat does not fail safe, it should not be used for temperature limiting duty. Wiring to this device is the users responsibility.

Heaters are capable of developing high temperatures, therefore extreme care should be taken to:

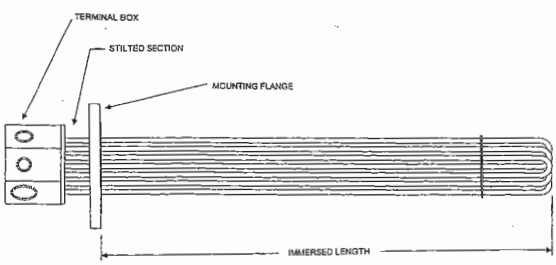
a) use explosion-proof terminal enclosures in hazardous locations;
b) maintain distance between heater and combustible materials.



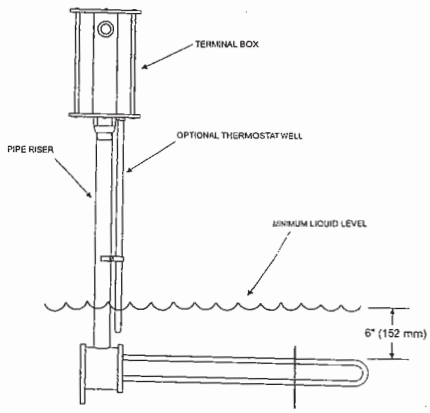
SCREWPLUG IMMERSION HEATER



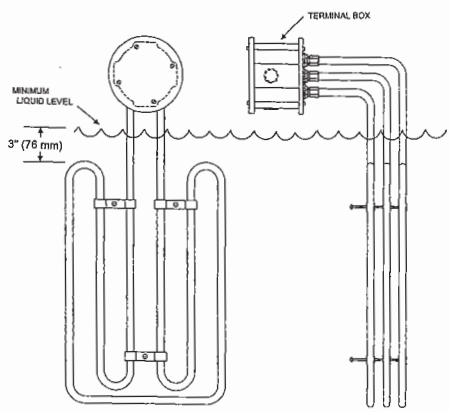
FLANGE IMMERSION HEATER



FLANGE IMMERSION HEATER
(WITH OPTIONAL STILTED TERMINAL BOX)



OVER-THE-SIDE IMMERSION HEATER (BOTTOM MOUNT)



OVER-THE-SIDE IMMERSION HEATER (SIDE MOUNT)

CCI Thermal Technologies INC.
Heating and Filtration Solutions

DESCRIPTION

1.0 Immersion heaters for liquid service are designed for operation only while completely immersed in liquids. Never allow the heating elements to be exposed while energized or failure will result.

Use the heater only in liquids and at pressures for which it was designed (unless specifically designed for non-liquid applications). Normally copper sheath is recommended in water, steel or alloy sheath in oil, and the appropriate alloy sheath for heating chemical solutions. Check factory for recommendations.

2.0 In the case of flanged (and some screwplug type) heaters where a gasket seal is required, the gasket surface should be clean and dry before the heater is seated.

DO NOT insulate over the heater flange, stilted area and terminal enclosure.

3.0 The terminals must be protected at all times from moisture or vapour. In hazardous locations, explosion resistant terminal housings must be used. In outdoor locations, moisture resistant housings are required. It is recommended to use a drip loop to prevent moisture from entering the terminal box via the wire.

4.0 Protect terminals of heating elements from drippings, condensation, fumes, spray or any other substance which could result in element contamination.

5.0 When melting solids by direct immersion, a surface vent should be provided to allow gases to escape. Operate the heater on ½ voltage until melted material completely covers the heating elements. Heaters used for this purpose may require special design features. Check factory for recommendations.

INSTALLATION

Heaters with overtemperature devices require specific installation orientation.

ELECTRIC SHOCK HAZARD. Disconnect all power before installing or servicing the heater. Failure to do so could result in personal injury and/or property damage. All maintenance and installation should be done by qualified personnel in compliance with local codes.

FIRE OR SHOCK HAZARD: Moisture accumulation on the dielectric material of the elements sheath corrosion or overtemperature on the heaters could cause a fault to ground generating arcing and molten metal. Install proper ground fault protections to prevent personal injury or property damage.

Heaters are electrical components, designers are responsible for the proper integration to the electrical systems, including protections, back-ups and controls.

6.0 Unpack and check heater for any damage that may have been caused during shipping.

7.0 Remove any protective packaging in the screw or flange connecting fitting.

8.0 Remove any dessicant material in the electrical box.

9.0 Insert heater into vessel/reservoir and verify that the heating elements are not making contact with the surface of the vessel.

10.0 Check that all terminal connections are tight.

Use copper conductors only with sufficient current carrying capacity for the heater circuit load and in accordance with the local electrical code. Check the heater nameplate for minimum conductor temperature rating. Temperature deration factors must be applied for heaters operating above 30°C(86°F).

11.0 Check supply voltage for compliance with heater nameplate voltage. DO NOT connect the heater to a voltage source other than listed on the heater nameplate.

12.0 A line voltage or pilot duty thermostat should be used to control the heater. The pilot duty thermostat must be used with a contactor and (if required) a transformer. Generally, heaters supplied with built-in thermostats will be factory prewired if suitable for line voltage operation. Integral thermostats not factory prewired are usually intended for pilot duty.

13.0 It is recommended that the control circuits be supplied from the isolated secondary windings of transformers avoiding the need for two supply circuits, or as an alternative, that mechanical or electrical interlocking be provided so that both supplies must be disconnected before live parts can be made accessible.

14.0 If there is even the slightest possibility that the liquid level may fall below the elements, a level control switch or over-temperature sensing device affixed to the uppermost heating element is required. Check factory for recommendations.

15.0 If the heater is installed in a pressurized system, a safety relief valve must be used to prevent a hazardous pressure build-up.

16.0 Horizontal element support bundles may be necessary with an immersed length over 1270 mm (50").

17.0 For flange heaters installed in a pressurized system, proper bolting hardware must be used that is suitable for the pressures and temperatures of the equipment. Use an appropriate gasket for the pressure and temperature; torque the bolts on an even clockwise or counter clockwise pattern.

18.0 Heaters with explosion resistant terminal housings must only be used in locations for which the heaters are certified.

a) Check heater nameplate information for approval code.
b) Never energize an explosion resistant heater unless the terminal housing cover is properly tightened.
c) An immersion heater for hazardous locations is approved for use only if an approved liquid level control and/or temperature limiting device is used to de-energize the heater under low liquid conditions.

OPERATION

RISK OF EXPLOSION. Do not operate heater at voltages higher than the rating specified on the nameplate. Failure to do this will cause elevated temperatures.

For metal sheathed heaters, prior to operation an insulation resistance check must be performed. Heater with values less than .5 MΩ should follow a drying process. Please contact factory for details on procedure if heater is under .5 MΩ.

FIRE HAZARD. Heater should be submersed in the fluid for proper operation and to avoid element overheating that could result in fire or damage of the heater.

When operating the heaters in a closed system or vessel, system designers must ensure that proper controls are used to maintain the temperature and pressure at normal levels.

Low megohm on heating elements with epoxy or hermetic seals cannot be serviced in the field. Typical resistance values when sealed are 1000 MΩ or greater.

19.0 Check that all connections are tight.

20.0 If a thermostat is provided, verify that it is operating properly by cycling it and verifying cutout.

21.0 Perform an IR test prior to energization and verify that levels are acceptable 500,000 ohms.

22.0 Energize the heater and check for signs of hotspots in the electrical connections or vessel.

23.0 Retorque all bolted fitting connections and all electrical connections after 10 cycles.

24.0 Always maintain a minimum of 51 mm (2") of liquid above the heated portion of the element or element failure may result.

25.0 Heating elements should be kept above sediment deposits or it may overheat and shorten life expectancy.

MAINTENANCE

Disconnect all power before installing or servicing the heater. Failure to do so could result in personal injury and/or property damage. All maintenance and installation should be done by qualified personnel in compliance with local codes.

26.0 Heaters stored for prolonged periods may absorb moisture. Using a 500VDC megger (insulation resistance tester) check the value of the insulation resistance to ground for each circuit. Initial readings of over 500,000 ohms to ground are normally acceptable. Should lower readings be observed, check factory for instructions.

27.0 Periodically check electrical connections for tightness and check wire insulation for any damage and replace if necessary.

28.0 Remove the immersion heater periodically to inspect for corrosion, sludge build-up and for scale removal. Do not continue to use a heater showing visible signs of damage.

Caloritech™
Engineered Electric Heat

5918 Roper Road, Edmonton, Alberta, Canada T6B 3E1
Phone: (780) 466-3178 Fax: (780) 468-5904 www.ccithermal.com

PLEASE ADHERE TO INSTRUCTIONS PUBLISHED IN THIS MANUAL.
Failure to do so may be dangerous and may void certain provisions of your warranty.
For further assistance, please call:

24 Hr. Hotline: 1-800-661-8529

(U.S.A. and Canada)

Please have model and serial numbers available before calling.

CCI Thermal Technologies INC.
Heating and Filtration Solutions

WARRANTY: Under normal use the Company warrants to the purchaser that defects in material or workmanship will be repaired or replaced without charge for a period of 18 months from date of shipment, or 12 months from the start date of operation, whichever expires first. Any claim for warranty must be reported to the sales office where the product was purchased for authorized repair or replacement within the terms of this warranty.

Subject to State or Provincial law to the contrary, the Company will not be responsible for any expense for installation, removal from service, transportation, or damages of any type whatsoever, including damages arising from lack of use, business interruptions, or incidental or consequential damages.

The Company cannot anticipate or control the conditions of product usage and therefore accepts no responsibility for the safe application and suitability of its products when used alone or in combination with other products. Tests for the safe application and suitability of the products are the sole responsibility of the user.

This warranty will be void if, in the judgment of the Company, the damage, failure or defect is the result of:

- vibration, radiation, erosion, corrosion, process contamination, abnormal process conditions, temperature and pressures, unusual surges or pulsation, fouling, ordinary wear and tear, lack of maintenance, incorrectly applied utilities such as voltage, air, gas, water, and others or any combination of the aforementioned causes not specifically allowed for in the design conditions or
- any act or omission by the Purchaser, its agents, servants or independent contractors which for greater certainty, but not so as to limit the generality of the foregoing, includes physical, chemical or mechanical abuse, accident, improper installation of the product, improper storage and handling of the product, improper application or the misalignment of parts.

No warranty applies to paint finishes except for manufacturing defects apparent within 30 days from the date of installation.

The Company neither assumes nor authorizes any person to assume for it any other obligation or liability in connection with the product(s).

The Purchaser agrees that all warranty work required after the initial commissioning of the product will be provided only if the Company has been paid by the Purchaser in full accordance with the terms and conditions of the contract.

The Purchaser agrees that the Company makes no warranty or guarantee, express, implied or statutory, **(INCLUDING ANY WARRANTY OF MERCHANTABILITY OR WARRANTY OF FITNESS FOR A PARTICULAR PURPOSE)** written or oral, of the Article or incidental labour, except as is expressed or contained in the agreement herein.

LIABILITY: Technical data contained in the catalog or on the website is subject to change without notice. The Company reserves the right to make dimensional and other design changes as required. The Purchaser acknowledges the Company shall not be obligated to modify those articles manufactured before the formulation of the changes in design or improvements of the products by the Company.

The Company shall not be liable to compensate or indemnify the Purchaser, end user or any other party against any actions, claims, liabilities, injury, loss, loss of use, loss of business, damages, indirect or consequential damages, demands, penalties, fines, expenses (including legal expenses), losts, obligations and causes of action of any kind arising wholly or partly from negligence or omission of the user or the misuse, incorrect application, unsafe application, incorrect storage and handling, incorrect installation, lack of maintenance, improper maintenance or improper operation of products furnished by the Company.

INSTRUCTIONS D'INSTALLATION, DE FONCTIONNEMENT ET D'ENTRETIEN DES THERMOPLONGEURS MODELÈS CX ET DX

ISO 9001:2000
QMI REGISTERED

MISE EN GARDE

RISQUE D'ÉLECTROCUTION. Toutes les installation d'équipment électrique de chauffage doivent être réalisées par un personnel qualifié, conformément aux codes et normes électriques locaux, et doivent être dûment mises à la terre afin de suppreimer les risques d'électrocution.

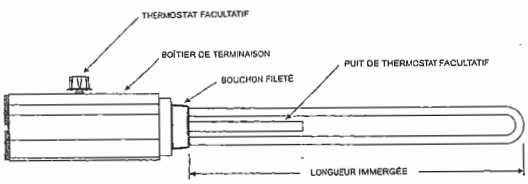
ATTENTION

RISQUE D'INCENDIE ET D'EXPLOSION. Ne depassez pas les puissances nominales de la bride figurant dans la norme B16.5 ANSI. Ne faites pas fonctionner le thermoplongeur en presence de gaz combustibles, de vapeurs combustibles, de poussieres combustibles ou de fibres combustibles, a moins que le thermoplongeur ne soit specialement prevu pour un tel emplacement dangereux, et que la temperature de fonctionnement du thermoplongeur ne depasse pas le code de temperature. La corrosion de la gaine peut resulter en un defaut a la terre, qui, selon la nature du liquide en cours de rechauffement, pourrait causer un incendie ou une explosion.

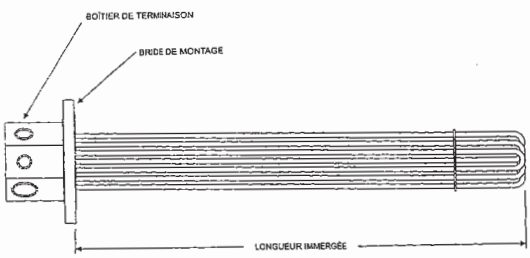
RISQUE D'ICENDIE. Si un thermostat est fourni, il est conçu uniquement à des fins de contrôle de la température. Puisque le thermostat ne dispose daucun système le protégeant des défaillances, il ne faut pas s'en servir pour limiter la température. C'est à l'utilisateur qu'il revient d'effectuer le câblage de ce dispositif.

Les thermoplongeurs peuvent atteindre des températures élevées, c'est pourquoi il faut faire extrêmement attention de prendre les mesures suivantes:

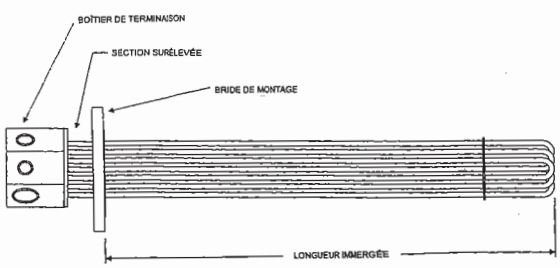
a) se servir de boîtiers de terminaison antidéflagrants dans les lieux à risques,
b) conserver une certaine distance entre le thermoplongeur et les matières combustibles.



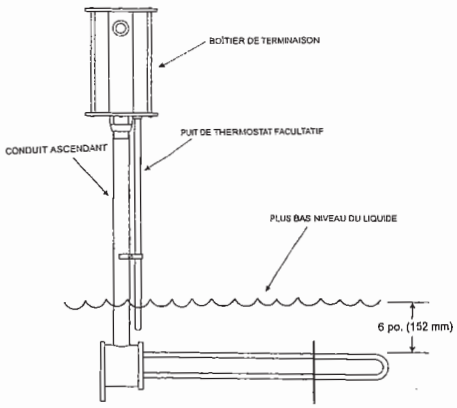
THERMOPLONGEUR À BOUCHON FILETÉ



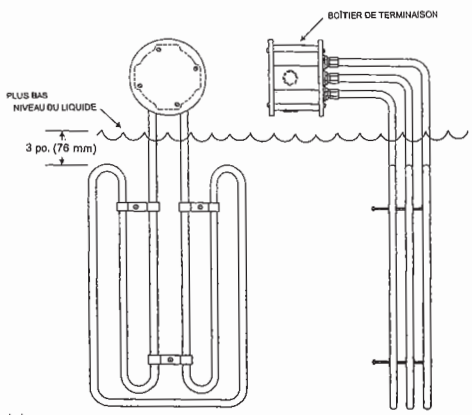
THERMOPLONGEUR À BRIDE



THERMOPLONGEUR À BRIDE
(AVEC BOÎTIER DE TERMINAISON SURÉLEVÉE FACULTATIF)



THERMOPLONGEUR AMOVIBLES POUR MONTAGE DE FOND



THERMOPLONGEUR AMOVIBLES POUR MONTAGE LATÉRAL

CCI Thermal Technologies INC.
Solutions de chauffage et de filtration

DÉSCRIPTION

1.0 Les thermoplongeurs employés pour des liquides sont conçus pour ne fonctionner que s'ils sont complètement immergés dans des liquides. Ne laissez jamais les éléments chauffants à l'air libre tandis qu'ils fonctionnent, sans quoi une panne se produira.

Ne vous servez du thermoplongeur que dans des liquides, et à des pressions pour lesquelles il a été conçu (à moins qu'il n'ait été conçu particulièrement pour des applications non liquides). Normalement, la gaine en cuivre est recommandée dans l'eau, la gaine en acier ou en alliage dans l'huile, et la gaine en alliage appropriée sert à chauffer les solutions chimiques. Demandez à l'usine de vous donner ses recommandations.

2.0 Dans le cas des thermoplongeurs à bride (et certains modèles à bouchon fileté), si un joint d'étanchéité est nécessaire, la surface du joint d'étanchéité doit être propre et sèche avant que le thermoplongeur ne soit mis en place.

DÉFENSE d'isoler par-dessus la bride, la zone surélevée et le boîtier de terminaison du thermoplongeur.

3.0 Les bornes doivent être protégées à tout moment de l'humidité et des émanations. Dans les lieux à risques, il faut employer des boîtiers de terminaison antidéflagrants. À l'extérieur, des boîtiers résistants à l'humidité sont obligatoires. Il est recommandé d'employer un anneau d'écoulement pour empêcher l'humidité de pénétrer dans le boîtier de terminaison à travers le câble.

4.0 Protégez les bornes des éléments chauffants contre les écoulements, la condensation, les émanations, les pulvérisations ou contre toute autre substance qui pourrait provoquer une contamination des éléments.

5.0 Lorsque vous faites fusionner des solides par immersion directe, il faut prévoir un orifice de ventilation à la surface, afin de laisser les gaz s'échapper. Faites fonctionner le thermoplongeur à ½ tension, jusqu'à ce que la matière fusionnée recouvre complètement les éléments chauffants. Les thermoplongeurs utilisés dans ce but peuvent nécessiter des caractéristiques de conception spéciales. Demandez à l'usine de vous donner ses recommandations.

INSTALLATION

Les thermoplongeurs dotés de dispositifs de surchauffe nécessitent une orientation particulière d'installation.

RISQUE D'ÉLECTROCUTION. Débranchez toute l'alimentation électrique avant d'installer, de réparer ou d'entretenir le thermoplongeur. Faute de quoi, il y a un risque de blessures physiques et/ou d'endommagement des lieux et objets qui s'y trouvent. L'entretien et l'installation, dans leur ensemble, doivent être effectués par un personnel qualifié et se conformer aux codes locaux.

RISQUE D'INCENDIE OU RISQUE D'ÉLECTROCUTION: L'accumulation d'humidité sur la matière diélectrique des éléments, la corrosion des gaines, ou la surchauffe des thermoplongeurs peut provoquer un défaut de la mise à la terre, ce qui produira des étincelles et la fusion du métal. Pour éviter toute blessure physique ou tout endommagement des lieux et objets qui s'y trouvent, installez des protections adéquates contre les défauts de mise à la terre.

Les thermoplongeurs sont des composants électriques. Les concepteurs sont responsables de l'intégration correcte dans les systèmes électriques, ce qui englobe les protections, les systèmes de relève et les contrôles.

6.0 Déballez le thermoplongeur. Vérifiez-le pour détecter tout dégât qui aurait pu survenir pendant le transport.

7.0 Retirez le conditionnement de protection du raccord de couplage à bouchon fileté ou à bride.

8.0 Retirez le produit dessicant situé dans le coffret électrique.

9.0 Insérez le thermoplongeur dans la cuve ou le réservoir. Vérifiez que les éléments chauffants ne sont pas en contact avec la surface de la cuve.

10.0 Vérifiez que tous les raccordements des bornes sont bien serrés.

Utilisez uniquement des conducteurs en cuivre dont l'intensité de courant admissible est suffisante pour la charge du circuit du thermoplongeur, conformément au code électrique local. Consultez la plaque signalétique du thermoplongeur pour connaître les caractéristiques thermiques minimales du conducteur. Les facteurs de réduction de la valeur nominale du courant doivent être appliqués pour les thermoplongeurs fonctionnant à plus de 30°C (soit 86°F).

11.0 Vérifiez que la tension de l'alimentation est conforme à la tension figurant sur la plaque signalétique du thermoplongeur. NE BRANCHEZ PAS le thermoplongeur à une source de tension autre que celle figurant sur la plaque signalétique du thermoplongeur.

12.0 Il faut se servir d'un thermostat de circuit de commande ou de tension de ligne pour commander le thermoplongeur. Le thermostat de circuit de commande doit être utilisé avec un contacteur et (au besoin) un transformateur. En général, les thermoplongeurs fournis avec des thermostats intégrés seront câblés d'avance à l'usine si cela convient à un fonctionnement sur tension de secteur. Les thermostats intégraux qui ne sont pas câblés d'avance à l'usine sont normalement prévus pour une fonction avec un circuit de commande.

13.0 Il est recommandé d'alimenter les circuits de commande à partir des bobinages secondaires isolés des transformateurs, en évitant le besoin de deux circuits d'alimentation. Autrement, il est recommandé de fournir l'enclenchement électrique afin que les deux alimentations soient débranchées avant que des parties électrifiées ne puissent être rendues accessibles.

14.0 S'il existe une possibilité, même faible, de voir le niveau de liquide tomber au-dessous des éléments, il est obligatoire d'avoir un commutateur de contrôle du niveau ou un dispositif de détection de surchauffe, fixé sur l'élément chauffant le plus haut. Demandez à l'usine de vous donner ses recommandations.

15.0 Si le thermoplongeur est installé dans un système pressurisé, une soupape de sûreté et de décharge doit être employée pour empêcher une accumulation dangereuse de la pression.

16.0 Des faisceaux horizontaux de soutien des éléments peuvent s'avérer nécessaires si la longueur immergée dépasse 1270 mm (50 po).

17.0 Pour les thermoplongeurs à bride installés dans un système pressurisé, la quincaillerie de boulonnage adéquate doit être employée. Elle doit convenir aux pressions et aux températures de l'équipement. Employez un joint d'étanchéité adéquat pour la pression et la temperature de l'équipment. Serrez les boulons selon un schéma uniforme, soit dans le sens des aiguilles d'une montre, soit dans le sens inverse des aiguilles d'une montre.

18.0 Les thermoplongeurs dotés de boîtiers de terminaison antidéflagrants ne doivent être employés que dans les lieux pour lesquels ces thermoplongeurs sont certifiés.

a) Voyez les renseignements figurant sur la plaque signalétique du thermoplongeur pour connaître le code d'homologation.
b) Ne mettez jamais sous tension un thermoplongeur antidéflagrant sans vous assurer que le couvercle du boîtier de terminaison est correctement serré.
c) Un thermoplongeur pour les emplacements dangereux n'est approuvé à l'utilisation que si un dispositif homologué de contrôle du niveau du liquide, et/ou un dispositif homologué de haute-limite de température sont employés pour mettre le thermoplongeur hors tension au cas où le niveau du liquide baisserait.

FONCTIONNEMENT

RISQUE D'EXPLOSION. Ne faites pas fonctionner le thermoplongeur à des tensions supérieures à la puissance nominale figurant sur la plaque signalétique. Faute de quoi, vous provoquerez des températures élevées.

Pour les thermoplongeurs à gaine de métal, il faut effectuer une vérification de la résistance de l'isolation avant le fonctionnement. Un thermoplongeur dont les valeurs sont inférieures à 0,5 MΩ doit être soumis à un processus d'assèchement. Adressez-vous à l'usine qui vous expliquera la procédure si les valeurs du thermoplongeur sont inférieures à 0,5 MΩ.

RISQUE D'INCENDIE. Pour que le thermoplongeur fonctionne bien, et pour éviter la surchauffe des éléments chauffants, qui pourrait provoquer un incendie ou endommager le thermoplongeur, il faut que le thermoplongeur soit immergé dans le liquide.

Quand on fait fonctionner les thermoplongeurs dans un système fermé ou dans une cuve, les concepteurs du système doivent faire attention que les contrôles adéquats sont employés pour conserver la température et la pression à un niveau normal.

Le problème d'un relevé faible des mégohms sur les éléments chauffants dotés de sceaux en époxy or hermétiques ne peut pas être résolu sur place. Les valeurs normales de la résistance, en présence de sceaux, sont de 1000 MΩ ou plus.

19.0 Vérifiez que tous les branchements sont serrés.

20.0 Si un thermostat est fourni, vérifiez qu'il fonctionne correctement en le faisant passer par son cycle et en vérifiant la coupure du circuit.

21.0 Effectuez un test IR avant la mise sous tension. Vérifiez que les niveaux sont acceptables, à 500,000 ohms.

22.0 Mettez le thermoplongeur sous tension. Vérifiez les signes de pointes locales de température dans les raccords électriques ou dans la cuve.

23.0 Au bout de dix cycles, resserrez toutes les raccords de coupage à boulons, et tous les raccords électriques.

24.0 Maintenez toujours un minimum de 51 mm (2 po) de liquide au-dessus de la partie chauffée de l'élément, sans quoi l'élément peut tomber en panne.

25.0 Les éléments chauffants doivent être gardés au-dessus des dépôts de sédiments, sans quoi, ils peuvent surchauffer et s'user prématurément.

ENTRETIEN ET RÉPARATION

Débranchez toute l'alimentation électrique avant d'installer, de réparer ou d'entretenir le thermoplongeur. Faute de quoi, il y a un risque de blessures physiques et/ou d'endommagement des lieux et objets qui s'y trouvent. L'entretien et l'installation, dans leur ensemble, doivent être effectués par un personnel qualifié et se conformer aux codes locaux.

26.0 Les thermoplongeurs entreposés pendant de longues périodes peuvent absorber de l'humidité. À l'aide d'un mégohmmètre 500 VDC (appareil de mesure de résistance de l'isolation), vérifiez la valeur de la résistance de l'isolation à la terre pour chaque circuit. Des relevés initiaux de plus de 500.000 ohms à la terre sont normalement acceptables. Si vous obtenez des relevés inférieurs, consultez l'usine qui vous donnera ses instructions.

27.0 De temps en temps, vérifiez que les branchements électriques sont serrés. Vérifiez que l'isolation des câbles n'est pas endommagée. Remplacez-la au besoin.

28.0 De temps en temps, retirez le thermoplongeur afin de l'inspecter et de détecter toute corrosion ou accumulation de dépôts, et de retirer le calcaire. Ne continuez pas à vous servir d'un thermoplongeur sur lequel des signes de dommages sont visibles.

Caloritech MC
Chauffage électrique sur demande

5918 Roper Road, Edmonton, Alberta, Canada T6B 3E1
Téléphone : 1 780 466-3178 Télécopie : 1 780 468-5904 www.ccithermal.com

VEUILLEZ VOUS CONFORMER AUX INSTRUCTIONS CONTENUES DANS CE MANUEL.
Tout manquement à ces dernières pourrait s'avérer dangereux et invalider certaines dispositions de votre garantie.
Pour obtenir une aide supplémentaire, veuillez appeler

l'assistance téléphonique disponible 24 heures sur 24 au 1 800 661-8529

(États-Unis et Canada)

Merci de préparer vos numéros de modèle et de série avant d'appeler.

CCI Thermal Technologies INC.
Solutions de chauffage et de filtration

GARANTIE : Dans des conditions normales d'utilisation, la Société garantit à l'acheteur que les produits ayant des défauts matériels ou de fabrication seront réparés ou remplacés sans frais pour une période de 18 mois à compter de la date d'expédition ou de 12 mois à partir de la date de début de fonctionnement, selon la date qui arrive à expiration la première. Toute réclamation dans le cadre de la garantie doit être adressée à l'agence commerciale dans laquelle le produit a été acheté afin d'obtenir une réparation ou un remplacement selon les termes de cette garantie.

Nonobstant toute loi fédérale ou provinciale au contraire, la Société ne pourra être tenue pour responsable des frais encourus pour l'installation, le retrait du service, le transport ou les dommages de quelque nature que ce soit, y compris les dommages résultant d'un manque d'utilisation, d'interruptions d'activité ou de dommages directs ou indirects.

La Société ne peut anticiper ou contrôler les conditions d'utilisation du produit et, par conséquent, décline toute responsabilité quant à l'application et l'adaptation en toute sécurité de ses produits lors de leur utilisation seuls ou en combinaison avec d'autres produits. Il est de la seule responsabilité de l'utilisateur d'effectuer des tests pour vérifier l'application et l'adaptation en toute sécurité des produits.

Cette garantie sera nulle si, à l'appréciation de la Société, le dommage, la panne ou le défaut a été causé par :

- des vibrations, des radiations, de l'érosion, de la corrosion, une contamination du processus, des conditions opératoires anormales, la température et la pression, une poussée ou une pulsation anormale, l'encrassement, une usure normale, un manque d'entretien, des services appliqués de manière inappropriée tels que le voltage, l'air, le gaz, l'eau et autres, ou toute combinaison des causes susmentionnées non autorisées par les conditions de régime; ou
- tout acte ou omission de la part de l'Acheteur, ses agents, employés ou entrepreneur indépendant, comprenant, pour une plus grande précision, mais pas au point de limiter la généralité de ce qui précède, une mauvaise utilisation physique, chimique ou mécanique, un accident, une mauvaise installation du produit, de mauvaises conditions de stockage ou de manipulation du produit, une application inappropriée ou un défaut d'alignement des pièces.

Aucune garantie ne s'applique à la finition de peinture, excepté dans le cas de défauts de fabrication apparents dans les 30 jours à compter de la date d'installation.

La Société n'assume ni n'autorise aucune personne à assumer en son nom toute autre obligation ou responsabilité en rapport avec le/les produit(s).

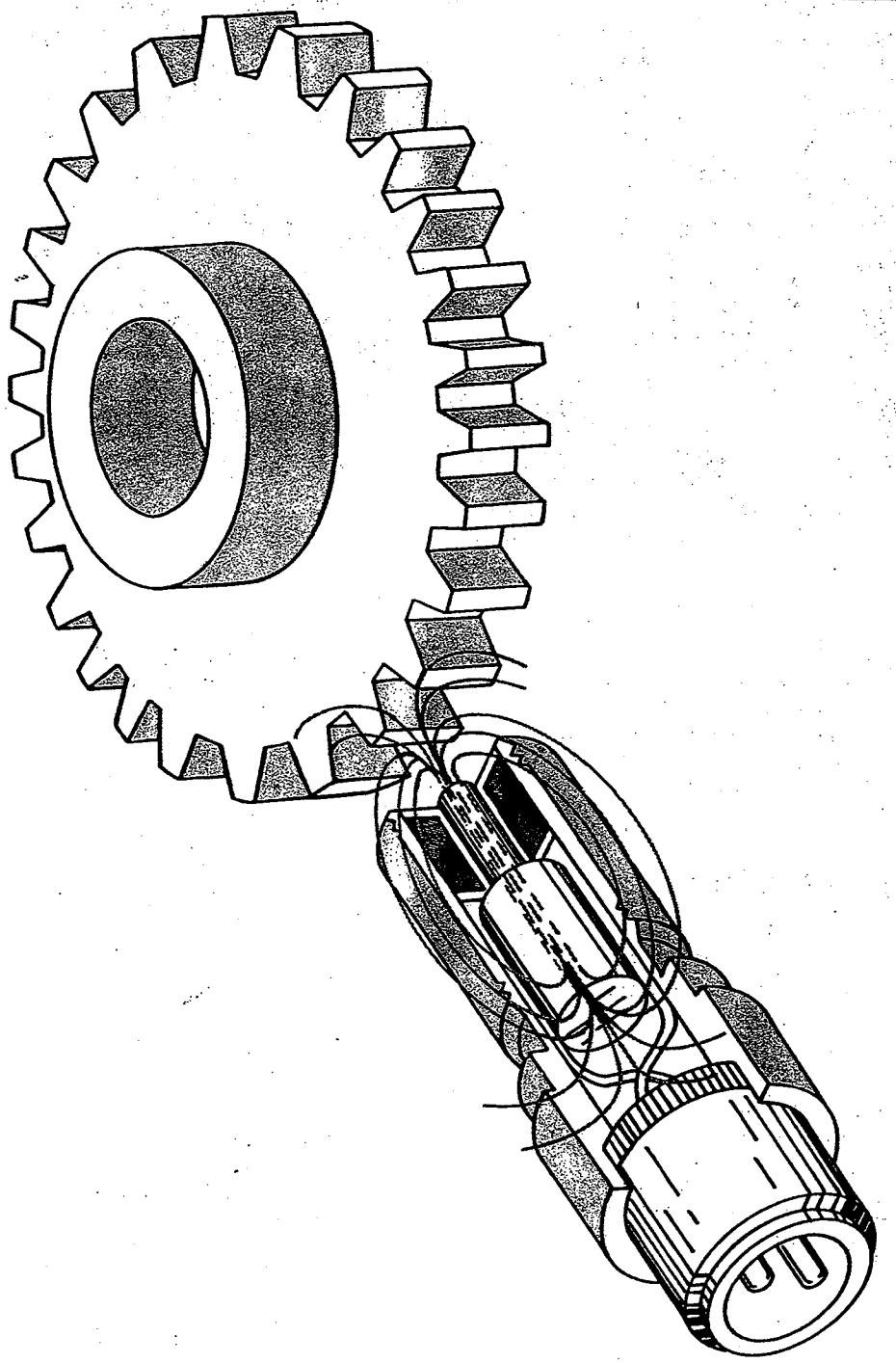
L'Acheteur accepte que tout travail relatif à la garantie, exigé après la mise en service initiale du produit soit fourni uniquement si la Société a été payée par l'Acheteur en pleine conformité avec les conditions générales du contrat.

L'Acheteur accepte que la Société ne fournisse aucune garantie, expresse, implicite ou légale (Y COMPRIS TOUTE GARANTIE DE QUALITÉ MARCHANDE OU DE CONVENANCE À DES FINS PARTICULIÈRES), écrite ou orale, du produit ou de la main-d'œuvre indirecte, à l'exception des dispositions exprimées ou contenues dans le présent accord.

RESPONSABILITÉ : Les données techniques contenues dans le catalogue ou sur le site Web sont sujettes à modification sans préavis. La Société se réserve le droit d'apporter des modifications par rapport aux dimensions ou à la conception si nécessaire. L'Acheteur reconnaît que la Société ne sera pas dans l'obligation de modifier ces articles manufacturés avant la formulation des modifications de conception ou des améliorations apportées aux produits par la Société.

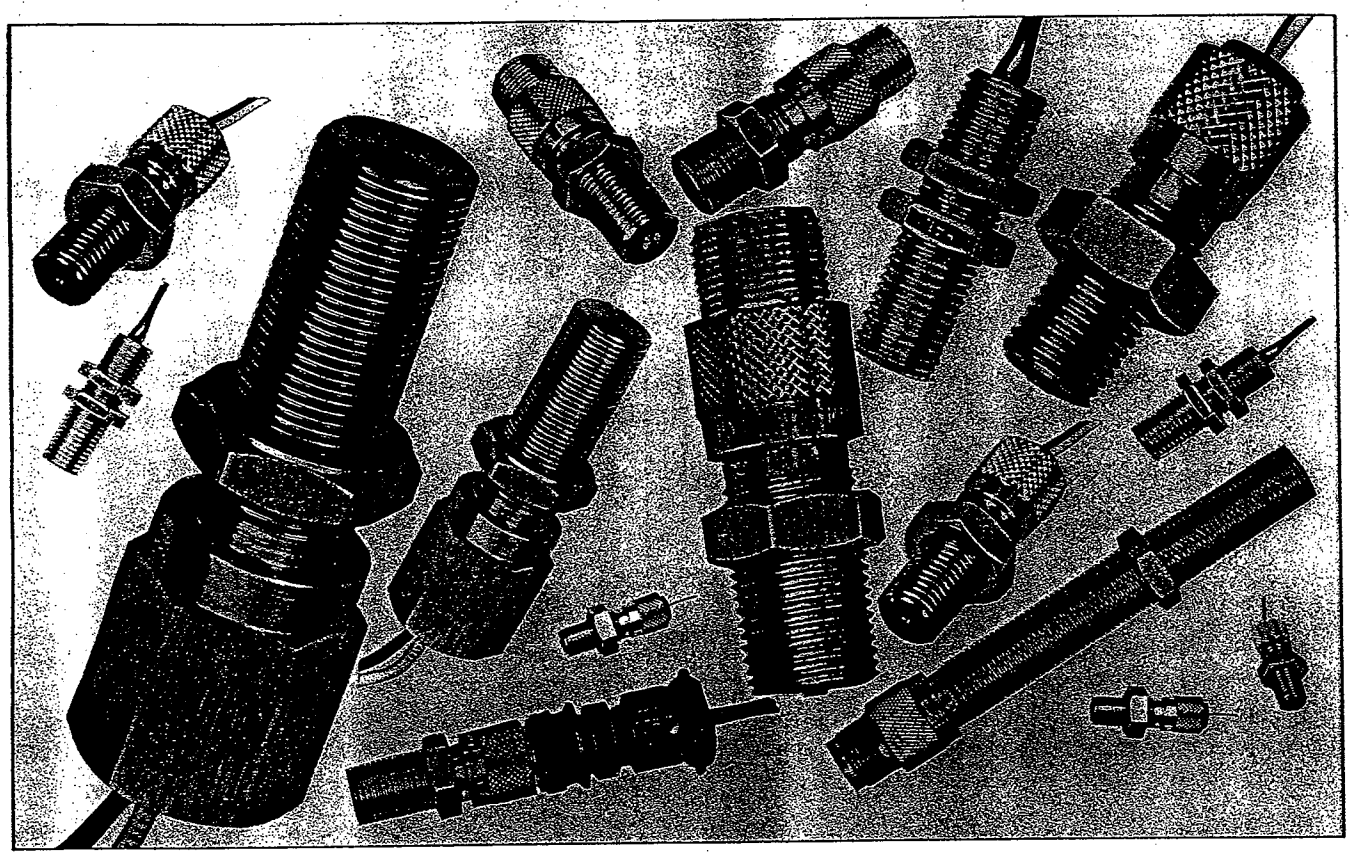
La Société ne sera pas tenue de dédommager ou d'indemniser l'Acheteur, l'utilisateur final ou toute autre partie pour les actions, les réclamations, les responsabilités, les préjudices, les sinistres, la perte d'usage, la perte d'activité, les dommages, les dommages indirects ou consécutifs, les demandes, les sanctions, les amendes, les dépenses (y compris les dépenses légales), les pertes, les obligations et les conséquences d'une action de quelque nature que ce soit découlant entièrement ou en partie de la négligence ou de l'omission de l'utilisateur ou de la mauvaise utilisation, de la mauvaise application, de l'utilisation dangereuse, de mauvaises conditions de stockage ou de manipulation, de la mauvaise installation, du manque d'entretien, du mauvais entretien ou de la mauvaise opération des produits fournis par la Société.

Dynalco Controls Division
TRW Transportation Electrical
Electronics Operations



Magnetic Pickups

GENERAL



Dynalco magnetic pickups convert mechanical motion to an AC voltage without mechanical linkage or external power. These self-contained transducers produce a magnetic field which, when altered by a moving ferrous object, generates an AC voltage. The voltage has a frequency directly proportional to RPM when the pickup is mounted in proximity to the teeth of a gear on a rotating shaft. Although a gear is preferable, a proper signal may be derived from evenly spaced screws, holes or flats on a rotating shaft.

1. MAGNETIC PICKUP APPLICATIONS

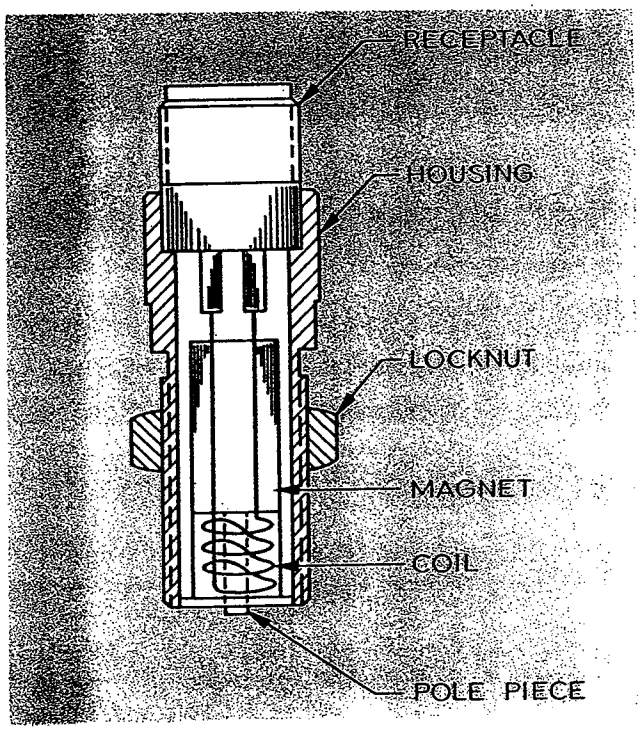
- Tachometry
- Counting
- Timing
- Synchronization
- Flowmeters
- Position Measurements
- Vibration Measurements
- Motion Study

Magnetic pickups are used in conjunction with a variety of Dynalco instruments to achieve speed monitoring, alarm and control functions. A few examples are digital and analog RPM indicators, self-powered tachometers, speed switches, speed transmitters, etc. All of the above instruments sense the number of pulses per second, not the amplitude of the generated pulses. Sufficient voltage to activate the connected instrument is all that is required.

2. MAGNETIC PICKUP ADVANTAGES

Dynalco pickups offer many advantages over mechanical and optical sensing devices. They are compact, rugged sensors that are able to withstand wide temperature extremes and endure severe shocks and vibrations.

Dynalco pickups produce lower maintenance and operating costs because they have no switches to wear out, no rotating couplings to snap, no bulbs to burn out and they do not require protection from dirty environments.



OPERATIONAL PRINCIPLES

A magnetic pickup consists of a cylindrical permanent magnet behind a soft iron pole piece wound with fine magnet wire. This basic assembly is enclosed in a housing, usually made of stainless steel, for mechanical strength and protection against corrosion. Figure 1 on page 2 shows a cut-away drawing of a standard magnetic pickup.

When a ferrous object passes in close proximity to the pole piece, the magnetic flux linking the coil increases and then decreases as the object recedes. The output voltage is proportional to the rate of change of flux through the pole piece, and therefore proportional to the speed of the ferrous mass that causes the flux to build up and collapse.

Figure 2 shows the voltage waveforms generated as a gear passes the central axis of the pole piece. The highest voltages are generated at the instant the flux is changing most rapidly in the pole piece. A gear tooth approaching the pole piece causes generation of positive voltage and leaving the pole piece causes generation of negative voltage.

When a fine tooth gear is used, the generated voltage is low because the flux leaks into adjacent teeth and there are no large fluctuations of the total flux through the pole piece. When a coarse tooth gear is used, high voltages are generated. An extremely coarse gear would generate high peak voltages separated in time by low generation periods when the pole piece dwells on top of a tooth or in-between teeth.

Figure 3 illustrates the relationship between gear tooth size and spacing to generate maximum amplitude. However, the need for "maximum" output is seldom required.

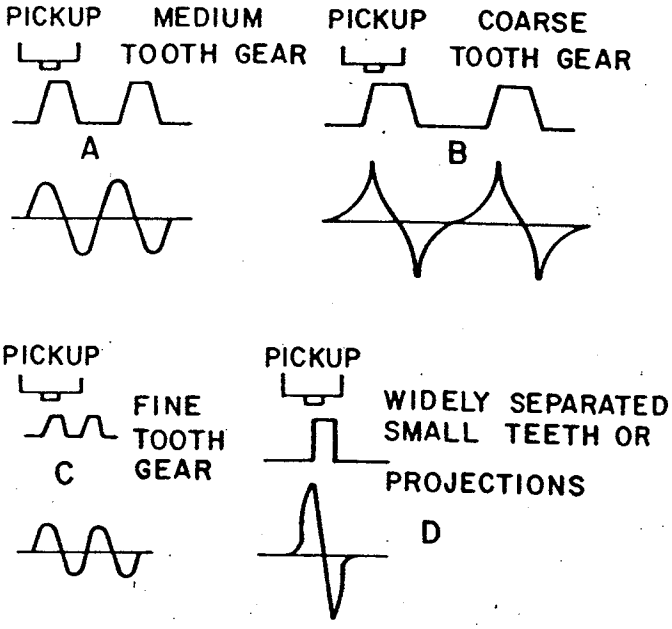
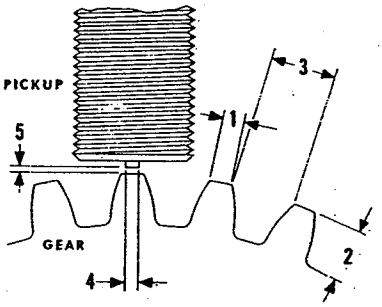


Figure 2. Generated voltage wave forms.



1 Dimension of tooth top surface
2 Tooth height
3 Space between teeth
4 Pole piece diameter
5 Air gap

For maximum output and approximately sinusoidal waveform choose:

(1) equal to or more than (4)
(2) equal to or more than (3)
(3) approximately three times (4)
(5) as small as possible, .005" typical.
Gear width equal to or more than (4)

Figure 3. Gear tooth size relationship.

DYNALCO INTRINSICALLY SAFE PICKUPS ...A NEW CONCEPT IN MAGNETIC PICKUPS

Approved Factory Mutual System

Dynalco intrinsically safe pickups are designed to meet the intrinsic safety requirements for pentane, ethylene and hydrogen groups when used with gears having a diametral pitch ranging from 4 through 20.

Dynalco models M134, M135, M139, M201, M202 M231 and M233 will not release sufficient electrical or thermal energy to cause ignition of a gas mixture in its most volatile state. These pickups are intrinsically safe only when used with Dynalco FM Approved instruments.

For example, an intrinsically safe tachometer system results when the M134, M135, M139, M201, M202, M231 or M233 magnetic pickup feeds a self-powered Dynalco speed indicator such as the digital SPD 700 or analog type SPT7000. A safe system also results when feeding the self-powered speed trip PNT 100 with pneumatic output.

DYNALCO ZERO VELOCITY PICKUPS

These pickups feature a high constant amplitude output independent of speed; the output is a function of position, not of motion. They are ideal for very low speed sensing and counting applications (refer to page 11).

The M900 is a "sensor only" pickup (no integral amplifier) that usually requires external capacitive blocking of its DC output component. The M910 features an integral amplifier with logic level output from zero to the supply. The M917 is a dual M910 without integral amplification for direction sensing applications (see Dynaform DST2000).

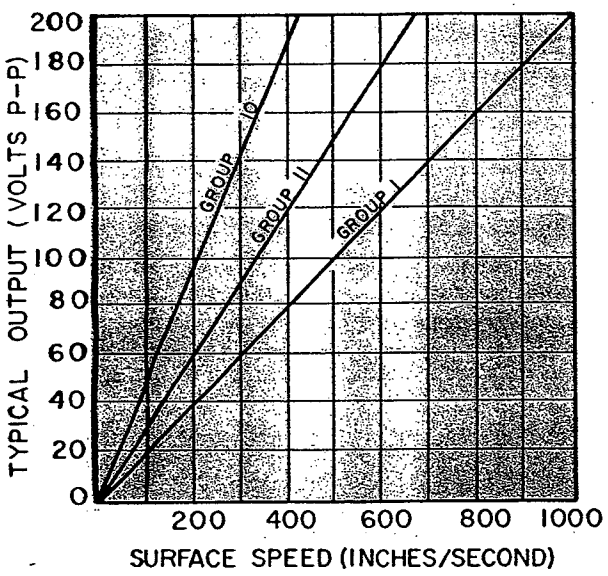


Figure 4. Output voltage vs. surface speed. (20 pitch gear, 0.005 in. gap, 100K ohm load).
(NOTE: Curves are linear to 0)

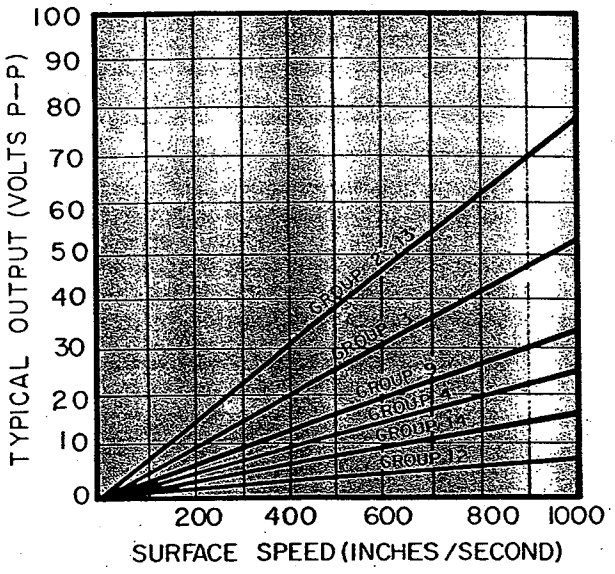


Figure 5. Output voltage vs. surface speed. (20 pitch gear, 0.005 in. gap, 100K ohm load).
(NOTE: Curves are linear to O)

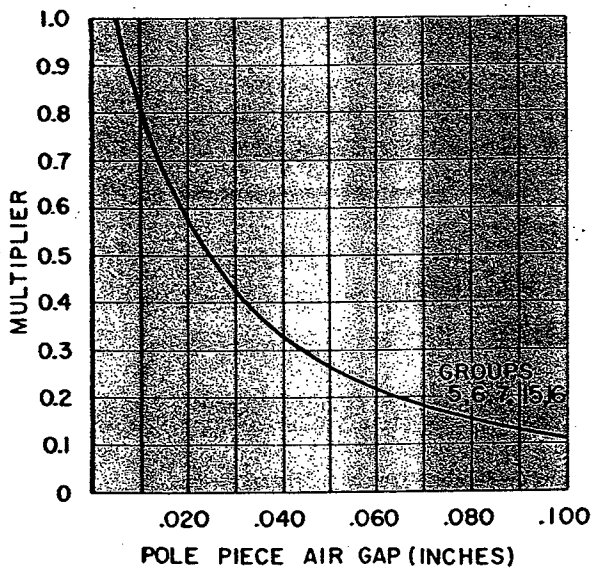


Figure 8. Output voltage vs. air gap. (1000 IPS, 8 pitch gear, 100K ohm load).

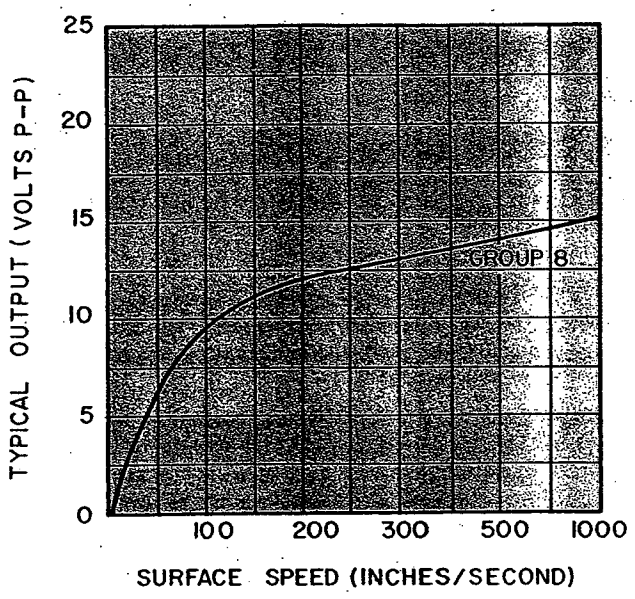


Figure 9. Output voltage vs. surface speed. (16 pitch gear, 0.005 in. gap, 100K ohm load).

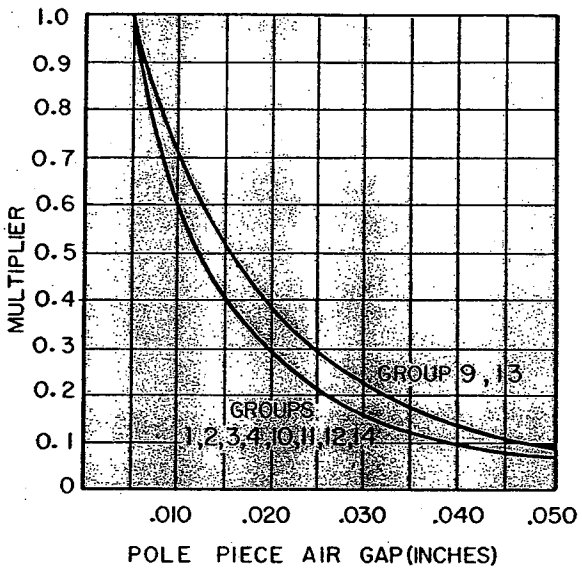


Figure 6. Output voltage vs. air gap, (1000 IPS, 20 pitch gear, 100K ohm load).

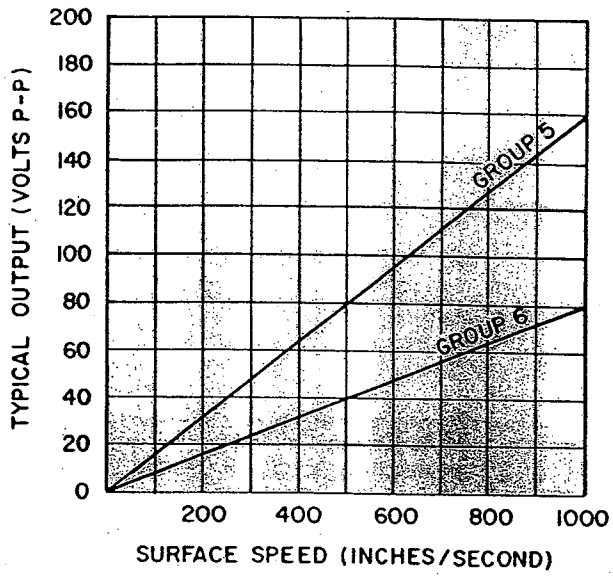


Figure 7. Output voltage vs. surface speed. (8 pitch gear, 0.005 in. gap, 100K ohm load).
(NOTE: Curves are linear to 0)

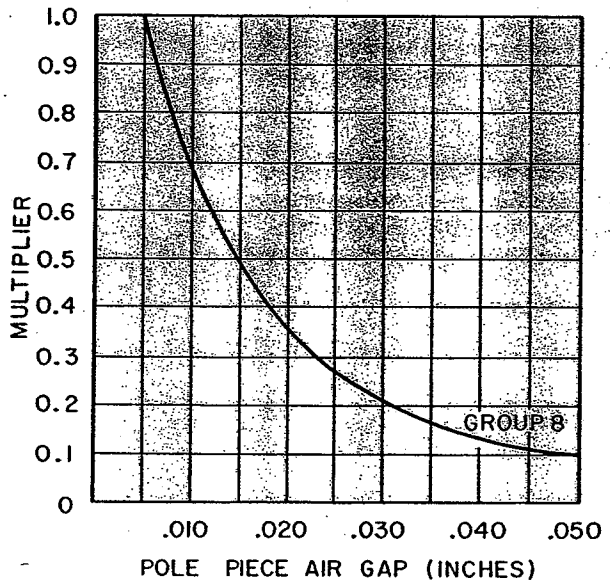


Figure 10. Output voltage vs. air gap. (100 IPS, 16 pitch gear, 100K ohm load).

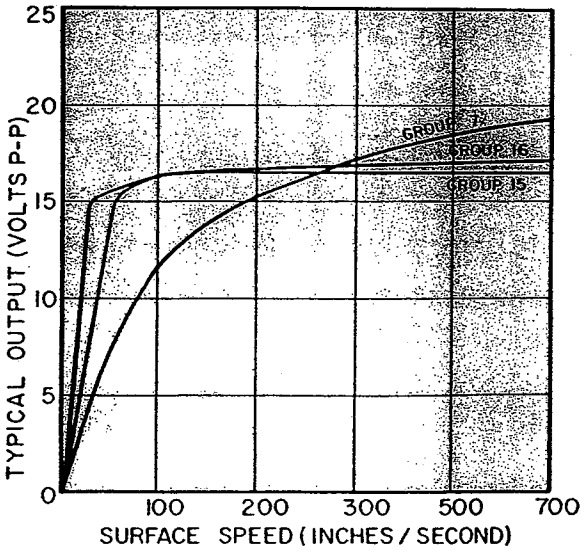


Figure 11. Output voltage vs. surface speed. (8 pitch gear, 0.005 in. gap, 100K ohm load).

Four variables determine output voltage:

(1) Surface speed of the ferrous mass.

(2) Clearance or air gap between pole piece and ferrous mass.

(3) Gear tooth size (determined by the diametral pitch).

(4) Load resistance connected to the pickups.

1. The formula for determining surface speed is:

$$\text{INCHES/SECONDS} = \frac{\text{RPM X gear dia. in inches X } 3.14}{60}$$

Refer to the selection of pickups on pages 8 thru 13 and corresponding output curves shown in Figures 4, 5, 7, 9 and 11. Typical peformance curves have been consolidated into 16 main groups that correlate with Dynalco pickups.

Group 1 - M102, M133, M202, M233, M183

Group 2 - M136, M138, M176, M177, M151, M172

Group 3 - M101, M131, M201, M231, M304

Group 4 - M105, M137

Group 5 - M107, M300

Group 6 - M104

Group 7 - M134, M135, M189

Group 8 - M139

Group 9 - M140, M180

Group 10 - M142, M184, M185

Group 11 - M155

Group 12 - M141

Group 13 - M163

Group 14 - M143

Group 15 - M203, M204

Group 16 - M205

2. Pole Piece Clearance: The AC output voltage is approximately inversely proportional to the clearance or air gap between the pickup tip and the surface of the gear. Figures 6, 8 and 10 on page 4 and 5 show relative output versus air gap. The generated output shown in Figurs 4, 5, 7, 9 must be modified by the factor (multiplier) shown in Figures 6, 8 or 10 to account for spacing other than .005" gap.

3. Gear Pitch: Obtained by dividing the total number of gear teeth by the pitch diameter of the gear in inches (i.e. number of teeth per inch of diameter). As the gear pitch number decreases, the gear tooth size increases. Table 1 on page 7 shows the correction factor (multiplier) needed to modify the voltages from steps 1 and 2 to account for the type of gear used.

4. Load Resistance: Load resistance has a negligible effect on lowering the output of a pickup unless its value becomes low enough to be comparable to the internal impedance of the pick-up coil. In that case, a voltage divider effect takes place and some of the generated voltage "is dropped" across the internal impedance of the coil. Dynalco's sensors are designed to have a low impedance, while still providing a sufficient output.

EXAMPLE

Let's calculate the nominal peak to peak output voltage of an M102 pickup facing a 16 pitch gear rotating with a peripheral surface speed of 100 inches per second, with a .007 inch gap and connected to a load of 100K ohms.

(1) Figure 4 shows 20 volts peak to peak at 100 inches/sec.
(2) Figure 6 shows a multiplier of .8 at .007" gap.
(3) Table 1 shows a multiplier of 1.27 for a 16 pitch gear.
Nominal output is: 20 X .8 X 1.27 = 20.3 volts P-P.

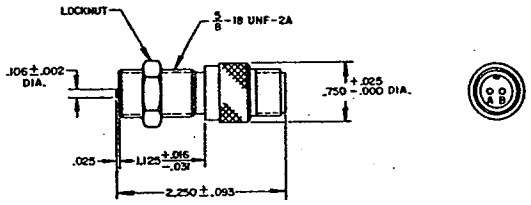
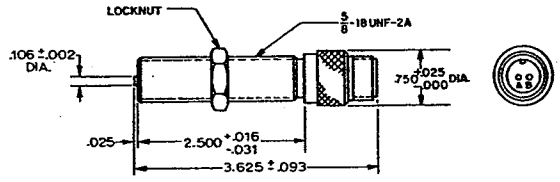
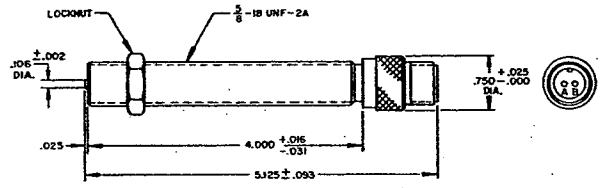
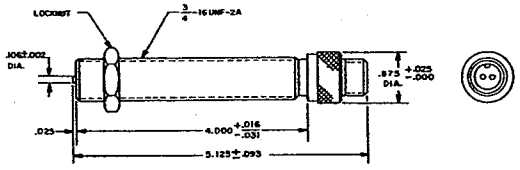
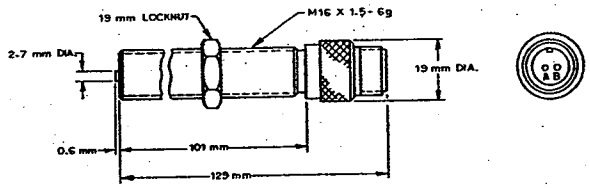
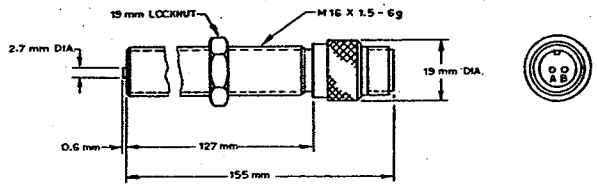
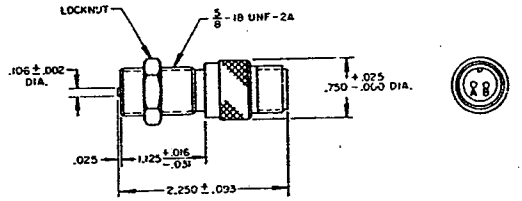
If the load resistance were 1100 ohms, the output voltage would drop to approximately 10 volts since the internal resistance of the pickup is also 1100 ohms. If the load resistance were 100 ohms, only a couple of volts of output would be obtained; most of the generated voltage would be dropped internally. At high speeds, the inductive reactance of the coil would also have to be considered as part of the internal impedance of the pickup.

If the required pickup is not available from the selection on pages 8 thru 13 please contact us for help in designing a pickup to meet your specific requirements.

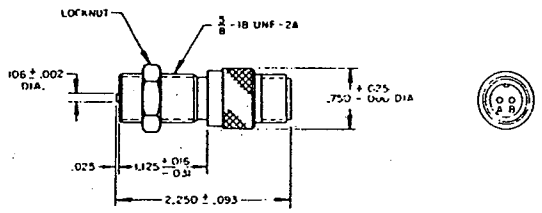
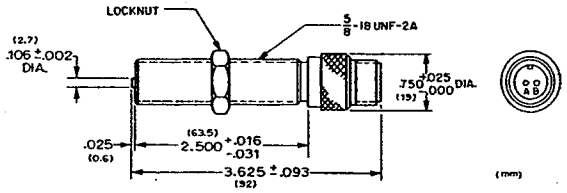
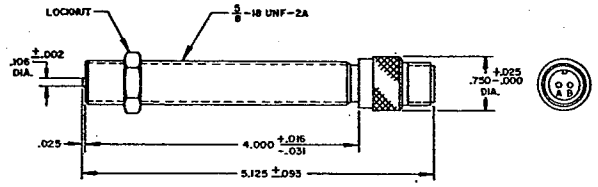
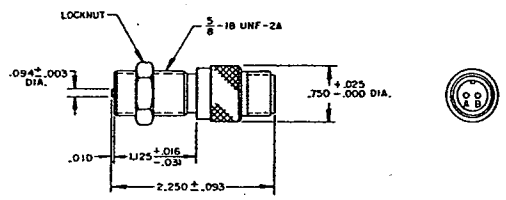
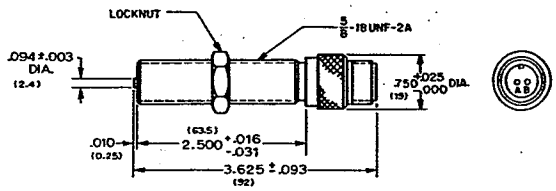
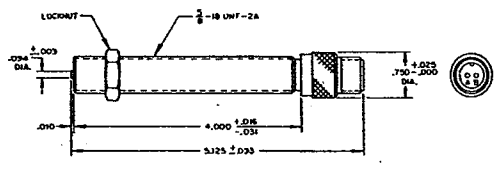
PICKUP GROUP	POLE PIECE DIAMETER	GEAR DIAMETRAL PITCH						
		8	12	16	20	24	32	48
5,6,7,15	0.187	1.00	0.83	0.39	0.22			
1,3,8,9,10,11,13	0.106	1.40	1.40	1.27	1.00	0.70	0.28	0.07
2,4	0.094	1.25	1.25	1.22	1.00	0.75	0.37	0.12
14	0.062	1.00	1.00	1.00	1.00	0.92	0.88	0.37
12	0.040	1.00	1.00	1.00	1.00	1.00	0.90	0.60

TABLE 1. Gear Pitch Multiplier

STANDARD

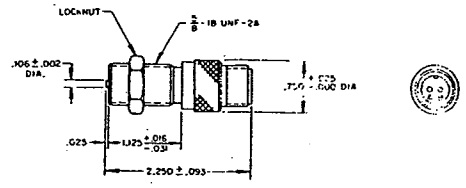
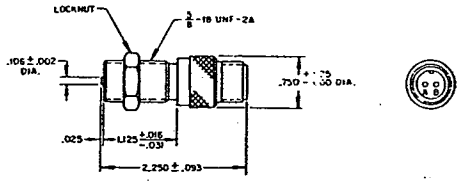
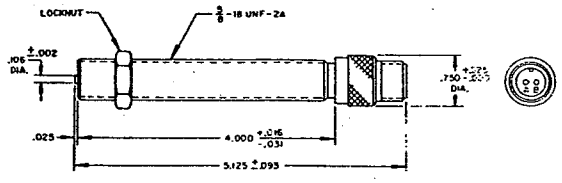
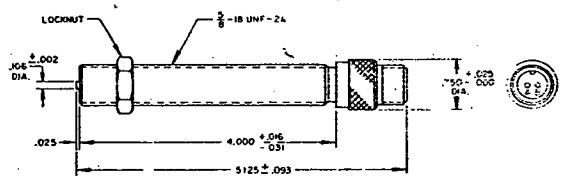
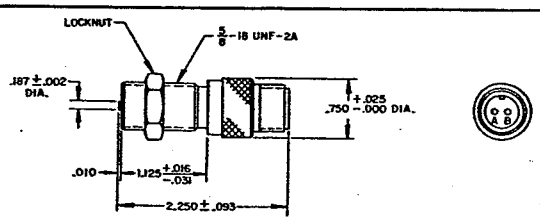
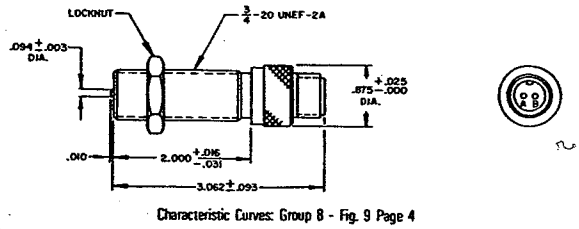
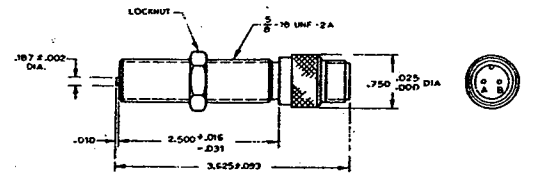
MODEL NUMBER	OUTLINE DRAWING	SPECIFICATION
MODEL M101 (STANDARD)	 Characteristic Curves: Group 3 - Fig. 5 Page 4	Temperature: −65°F to +225°F Output Voltage: 40-65 Volts P-P(2) DC Resistance: 80-110 Ohms Inductance: 30 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M151	 Characteristic Curves: Group 2 - Fig. 5 Page 4	Temperature: −65°F to +225°F Output Voltage: 63-84 Volts P-P(2) DC Resistance: 170-200 Ohms Inductance: 70 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M131 (LONG REACH-STANDARD)	 Characteristic Curves: Group 3 - Fig. 5 Page 4	Temperature: −65°F to +225°F Output Voltage: 40-65 Volts P-P(2) DC Resistance: 80-110 Ohms Inductance: 30 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M304	 Characteristic Curves: Group 3 - Fig. 5 Page 4	Temperature: −65°F to +225°F Output Voltage: 40-65 Volts P-P(2) DC Resistance: 80-110 Ohms Inductance: 30 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M176 (METRIC PICKUP)	 Characteristic Curves: Group 2 - Fig. 5 Page 4	Temperature: −65°F to +225°F Output Voltage: 63-84 Volts P-P(2) DC Resistance: 170-200 Ohms Inductance: 70 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M177 (METRIC PICKUP)	 Characteristic Curves: Group 2 - Fig. 5 Page 4	Temperature: −65°F to +225°F Output Voltage: 63-84 Volts P-P(2) DC Resistance: 170-200 Ohms Inductance: 70 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M155 FLOW METER APPLICATION	 Characteristic Curves: Group 11 - Fig. 4 Page 4	Temperature: −65°F to +225°F Output Voltage: 260-340 Volts P-P(2) DC Resistance: 2000-2300 Ohms Inductance: 850 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)

HIGH SENSITIVITY

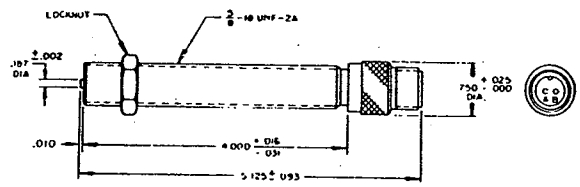
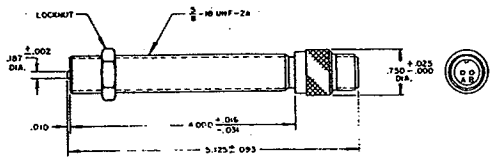
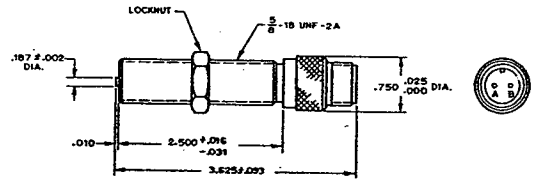
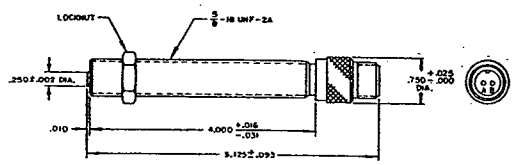
MODEL NUMBER	OUTLINE DRAWING	SPECIFICATION
MODEL M102 (HIGH SENSITIVITY)	 Characteristic Curves: Group 1 - Fig. 4 Page 4	Temperature: −65°F to +225°F Output Voltage: 160-240 Volts P-P(2) DC Resistance: 1000-1300 Ohms Inductance: 360 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M183	 Characteristic Curves: Group 1 - Fig. 4 Page 4	Temperature: −65°F to +225°F Output Voltage: 160-240 Volts P-P(2) DC Resistance: 1000-1300 Ohms Inductance: 360 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M133 (LONG REACH-HIGH SENSITIVITY)	 Characteristic Curves: Group 1 - Fig. 4 Page 4	Temperature: −65°F to +225°F Output Voltage: 160-240 Volts P-P(2) DC Resistance: 1000-1300 Ohms Inductance: 360 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M142 ULTRA HIGH SENSITIVITY	 Characteristic Curves: Group 10 - Fig. 4 Page 4	Temperature: −65°F to +225°F Output Voltage: 400-550 Volts P-P(2) DC Resistance: 1750-2250 Ohms Inductance: 700 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M184	 Characteristic Curves: Group 10 - Fig. 4 Page 4	Temperature: −65°F to +225°F Output Voltage: 400-550 Volts P-P(2) DC Resistance: 1750-2250 Ohms Inductance: 700 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL 185	 Characteristic Curves: Group 10 - Fig. 4 Page 4	Temperature: −65°F to +225°F Output Voltage: 400-550 Volts P-P(2) DC Resistance: 1750-2250 Ohms Inductance: 700 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)

(1) A 10' shielded cable assembly (type C101) with mating connector and clamp is available.
(2) Tested at 1000 inches/sec. with 20 pitch, 30 tooth gear, 0.005" clearance and 100,000 ohm load shunted by 250 picofarads.
(3) Tested at 1000 inches/sec. with an 8 pitch, 12 tooth gear, 0.005" clearance and 100,000 ohm load.
(4) Tested at 1000 inches/sec. with an 8 pitch, 12 tooth gear, 0.005" clearance and 1250 ohm load shunted by 250 picrofarads.
(5) Tested at 25°C with 12 VDC, 20 pitch, 30 tooth gear, 0.005" clearance and 100,000 ohm load. Voltage output is independent of speed.
(6) Tested at 100 inches/sec. with an 8 pitch gear, 0.005" clearance and 100,000 ohm load.
(7) Tested at 100 inches/sec. with a 16 pitch gear, 0.005" clearance and 100,000 ohm load.

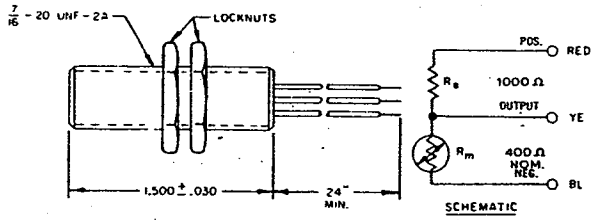
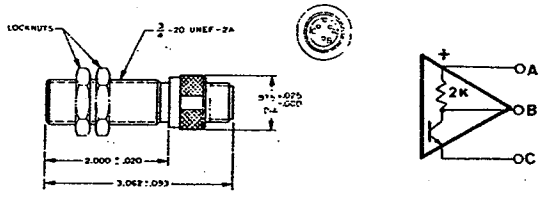
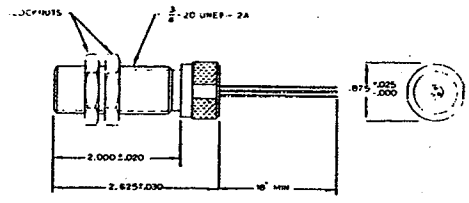
INTRINSICALLY SAFE

MODEL NUMBER	OUTLINE DRAWING	SPECIFICATION
MODEL M201 (INTRINSICALLY SAFE) FM APPROVED	 Characteristic Curves: Group 3 - Fig. 5 Page 4	Temperature: −65°F to +225°F Output Voltage: 40-65 Volts P-P(2) DC Resistance: 80-110 Ohms Inductance: 28-34 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M202 (INTRINSICALLY SAFE) FM APPROVED	 Characteristic Curves: Group 1 - Fig. 4 Page 4	Temperature: −65°F to +225°F Output Voltage: 160-240 Volts P-P(2) DC Resistance: 1000-1300 Ohms Inductance: 330-410 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M231 (INTRINSICALLY SAFE) FM APPROVED	 Characteristic Curves: Group 3 - Fig. 5 Page 4	Temperature: −65°F to +225°F Output Voltage: 40-65 Volts P-P(2) DC Resistance: 80-110 Ohms Inductance: 28-34 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M233 (INTRINSICALLY SAFE) FM APPROVED	 Characteristic Curves: Group 1 - Fig. 4 Page 4	Temperature: −65°F to +225°F Output Voltage: 160-240 Volts P-P(2) DC Resistance: 1000-1300 Ohms Inductance: 330-410 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M134 (INTRINSICALLY SAFE STANDARD) FM APPROVED	 Characteristic Curves: Group 7 - Fig. 11 Page 5	Temperature: −65°F to +225°F Output Voltage: 13 Volts P-P Typical (6) DC Resistance: 170-210 Ohms Inductance: 10 MH Max at 3K Hz Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M139 (INTRINSICALLY SAFE ¾-20 UNEF - 2A THREAD) FM APPROVED	 Characteristic Curves: Group 8 - Fig. 9 Page 4	Temperature: −65°F to +225°F Output Voltage: 9.5 Volts P-P Typical (7) DC Resistance: 230-280 Ohms Inductance: 15 MH Max at 3K Hz Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M189 (INTRINSICALLY SAFE)	 Characteristic Curves: Group 7 - Fig. 11 Page 5	Temperature: −65°F to +225°F Output Voltage: 18-23 Volts P-P(3) DC Resistance: 170-210 Ohms Inductance: 12-16 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)

(1) A 10' shielded cable assembly (type C101) with mating connector and clamp is available.
(2) Tested at 1000 inches/sec. with 20 pitch, 30 tooth gear, 0.005" clearance and 100,000 ohm load shunted by 250 picofarads.
(3) Tested at 1000 inches/sec. with an 8 pitch, 12 tooth gear, 0.005" clearance and 100,000 ohm load.

MODEL M135 (INTRINSICALLY SAFE-LONG REACH) FM APPROVED	 Characteristic Curves: Group 7 - Fig. 11 Page 5	Temperature: −65°F to +225°F Output Voltage: 13 Volts P-P Typical (6) DC Resistance: 170-210 Ohms Inductance: 10 MH Max at 3K Hz Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M203	 Characteristic Curves: Group 15 - Fig. 11 Page 5	Temperature: −65°F to +225°F Output Voltage: 15-17 Volts P-P(4) DC Resistance: 550-650 Ohms Inductance: 260 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL 204	 Characteristic Curves: Group 15 - Fig. 11 Page 5	Temperature: −65°F to +225°F Output Voltage: 15-17 Volts P-P(4) DC Resistance: 550-650 Ohms Inductance: 260 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)
MODEL M205	 Characteristic Curves: Group 16 - Fig. 11 Page 5	Temperature: −65°F to +225°F Output Voltage: 15-17 Volts P-P(4) DC Resistance: 115-140 Ohms Inductance: 37 MH Nominal Output Polarity: Pin "B" Positive Output Connector: Mates with MS3106A-10SL-4S(1)

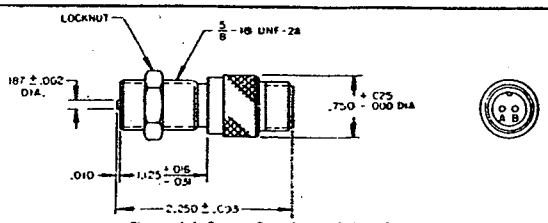
ZERO VELOCITY

MODEL M900 (ZERO VELOCITY)	 SCHEMATIC	Temperature: −40°F to +190°F Output Voltage: 1.2-2.0 VAC P-P(5) Power Supply: 1 to 18 VDC Output Leads: 3-24" #22 Awg. Leads
MODEL M910 (ZERO VELOCITY)		Temperature: −30°F to +180°F Output Voltage: 0 to supply Power Supply: 5 to 15 VDC Output Connector: Mates with MS3106A-10SL-3S(1) Usable Gears: 48 to 4 Pitch
MODEL M919 (ZERO VELOCITY)		Temperature: −30°F to +180°F Output Voltage: 50±15% Duty Cycle Power Supply: 10-15 VDC Output Leads: Shielded Cable #22 Awg. Leads Usable Gears: 48 to 4 Pitch

(4) Tested at 1000 inches/sec. with an 8 pitch, 12 tooth gear, 0.005" clearance and 1250 ohm load shunted by 250 picrofarads.
(5) Tested at 25°C with 12 VDC, 20 pitch, 30 tooth gear, 0.005" clearance and 100,000 ohm load. Voltage output is independent of speed.
(6) Tested at 100 inches/sec. with an 8 pitch gear, 0.005" clearance and 100,000 ohm load.
(7) Tested at 100 inches/sec. with a 16 pitch gear, 0.005" clearance and 100,000 ohm load.

POWER OUTPUT

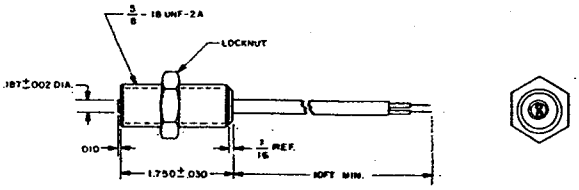
MODEL M107
(POWER OUTPUT)



Characteristic Curves: Group 5 - Fig. 7 Page 5

Temperature: −65°F to +225°F
Output Voltage: 70-110 Volts P-P(4)
DC Resistance: 170-210 Ohms
Inductance: 75 MH Nominal
Output Polarity: Pin "B" Positive
Output Connector: Mates with MS3106A-10SL-4S(1)

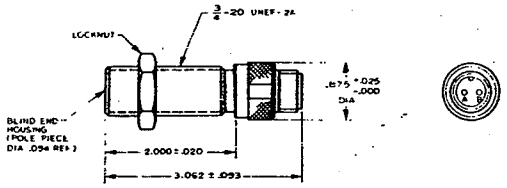
MODEL M300



Characteristic Curves: Group 5 - Fig. 7 Page 5

Temperature: −65°F to +225°F
Output Voltage: 70-110 Volts P-P(4)
DC Resistance: 170-210 Ohms
Inductance: 75 MH Nominal
Output Polarity: Red Lead Positive
Output Leads: Shielded Cable Awg No. 22

MODEL M163
(POWER OUTPUT)
BLIND END

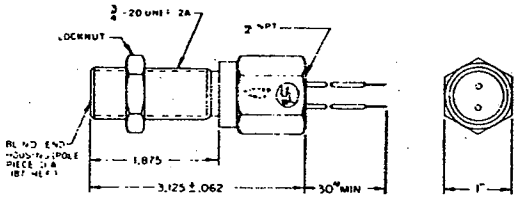


Characteristic Curves: Group 13 - Fig. 5 Page 4

Temperature: −65°F to +225°F
Output Voltage: 65-85 Volts P-P(2)
DC Resistance: 540-660 Ohms
Inductance: 230 MH Nominal
Output Polarity: Pin "B" Positive
Output Connector: Mates with MS3106A-10SL-4S(1)

UL LISTED

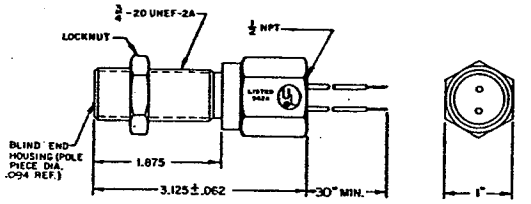
MODEL M104
(UL LISTED)
Meets Hazardous Location Requirements of Class 1, Groups A, B, C, D, Class 2, Groups E, F, G



Characteristic Curves: Group 6 - Fig. 7 Page 5

Temperature: −100°F to +200°F
Output Voltage: 60-100 Volts P-P(3)
DC Resistance: 170-210 Ohms
Inductance: 35 MH Nominal
Output Polarity: White Lead Positive
Output Leads: 2-30" #18 Awg. Leads

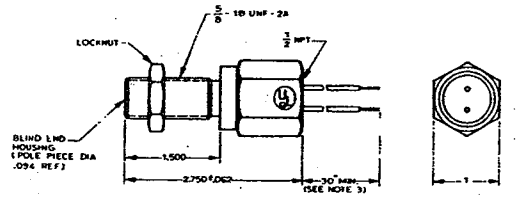
MODEL M140
(UL LISTED)
Meets Hazardous Location Requirements of Class 1, Groups A, B, C, D, Class 2, Groups E, F, G



Characteristic Curves: Group 9 - Fig. 5 Page 4

Temperature: −100°F to +200°F
Output Voltage: 23-33 Volts P-P(2)
DC Resistance: 170-210 Ohms
Inductance: 29 MH Nominal
Output Polarity: White Lead Positive
Output Leads: 30" #18 Awg Leads

MODEL M180
(UL LISTED)
Meets Hazardous Location Requirements of Class 1, Groups A, B, C, D, Class 2, Groups E, F, G

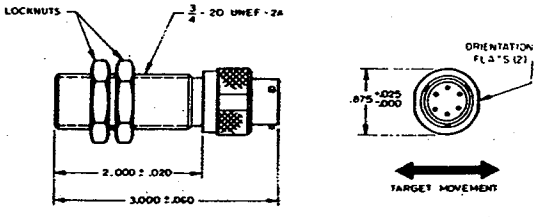


Characteristic Curves: Group 9 - Fig. 5 Page 4

Temperature: −100°F to +200°F
Output Voltage: 23-33 Volts P-P(2)
DC Resistance: 170-210 Ohms
Inductance: 29 MH Nominal
Output Polarity: White Lead Positive
Output Leads: 30" #18 Awg. Leads

DIRECTION SENSING
USED WITH DST 2000 DIRECTION SENSING MODULE

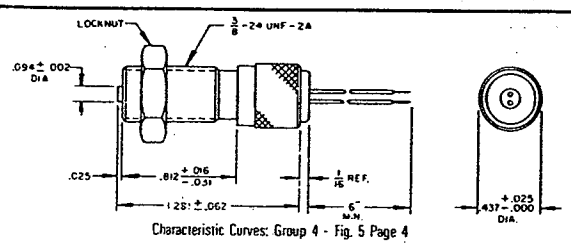
MODEL M917



Temperature: −30°F to +160°F
Power Supply: 5 to 10 VDC
Output Connector: Mates with MS3116-10-6S
Usable Gears: 4 through 12

MINIATURES

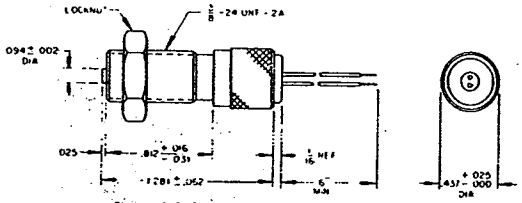
MODEL M105
(MINIATURE-STANDARD)



Characteristic Curves: Group 4 - Fig. 5 Page 4

Temperature: −65°F to +225°F
Output Voltage: 20-30 Volts P-P(2)
DC Resistance: 50-70 Ohms
Inductance: 13 MH Nominal
Output Polarity: White Lead Positive
Output Leads: 2-6" #26 Awg. Leads

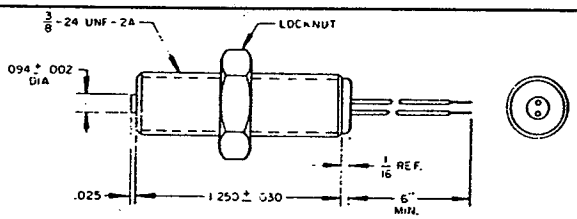
MODEL M136
(MINIATURE-HIGH SENSITIVITY)



Characteristic Curves: Group 2 - Fig. 5 Page 4

Temperature: −65°F to +225°F
Output Voltage: 60-90 Volts P-P(2)
DC Resistance: 390-530 Ohms
Inductance: 112 MH Nominal
Output Polarity: White Lead Positive
Output Leads: 2-6" #26 Awg Leads

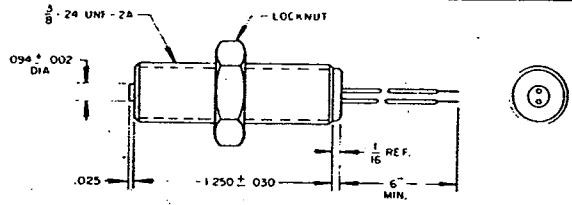
MODEL M137
(MINIATURE-STANDARD-FULLY THREADED)



Characteristic Curves: Group 4 - Fig. 5 Page 4

Temperature: −65°F to +225°F
Output Voltage: 20-30 Volts P-P(2)
DC Resistance: 50-70 Ohms
Inductance: 13 MH Nominal
Output Polarity: White Lead Positive
Output Leads: 2-6" #26 Awg. Leads

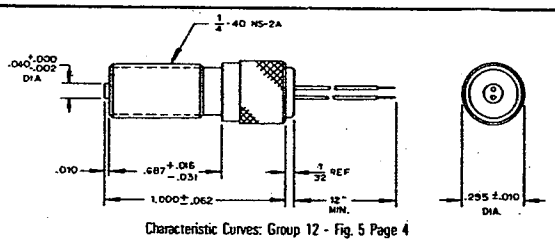
MODEL M138
(MINIATURE-HIGH SENSITIVITY-FULLY THREADED)



Characteristic Curves: Group 2 - Fig. 5 Page 4

Temperature: −65°F to +225°F
Output Voltage: 60-90 Volts P-P(2)
DC Resistance: 390-530 Ohms
Inductance: 112 MH Nominal
Output Polarity: White Lead Positive
Output Leads: 2-6" #26 Awg. Leads

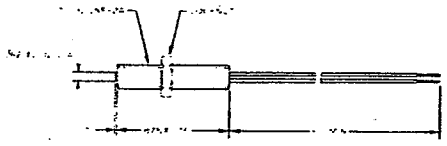
MODEL M141
SUB-MINIATURE



Characteristic Curves: Group 12 - Fig. 5 Page 4

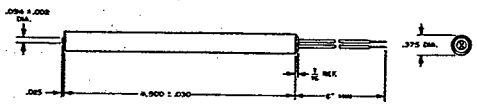
Temperature: −65°F to +225°F
Output Voltage: 5.9 Volts P-P(2)
DC Resistance: 105-130 Ohms
Inductance: 6 MH Nominal
Output Polarity: White Lead Positive
Output Leads: 2-12" #30 Awg. Leads

MODEL M143
(MICRO MINIATURE)


Characteristic Curves: Group 14 - Fig. 5 Page 4

Temperature: −65°F to +225°F
Output Voltage: 10-14 Volts P-P(2)
DC Resistance: 130-170 Ohms
Inductance: 5 MH Nominal
Output Polarity: White Lead Positive
Output Leads: 2-6" #32 Awg.

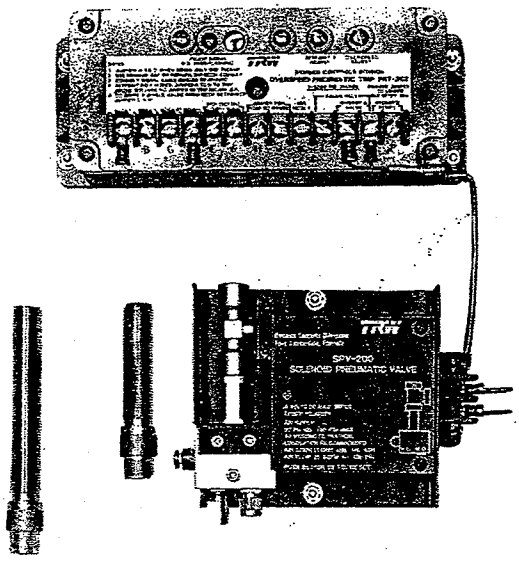
MODEL M172


Characteristic Curves: Group 2 - Fig. 5 Page 4

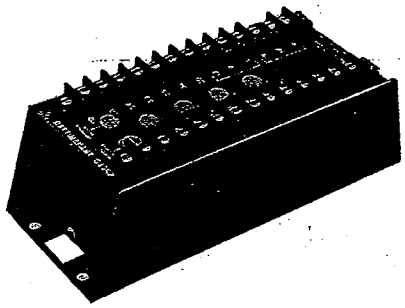
Temperature: −65°F to +225°F
Output Voltage: 60-90 Volts P-P(2)
DC Resistance: 390-530 Ohms
Inductance: 112 MH Nominal
Output Polarity: White Lead Positive
Output Leads: Awg #26

A 10' shielded cable assembly (type C101) with mating connector and clamp is available.
(2) Tested at 1000 inches/sec. with 20 pitch, 30 tooth gear, 0.005" clearance and 100,000 ohm load shunted by 250 picofarads.
(3) Tested at 1000 inches/sec. with an 8 pitch, 12 tooth gear, 0.005" clearance and 100,000 ohm load.
(4) Tested at 1000 inches/sec. with an 8 pitch, 12 tooth gear, 0.005" clearance and 1250 ohm load shunted by 250 picrofarads.
(5) Tested at 25°C with 12 VDC, 20 pitch, 30 tooth gear, 0.005" clearance and 100,000 ohm load. Voltage output is independent of speed.
(6) Tested at 100 inches/sec. with an 8 pitch gear, 0.005" clearance and 100,000 ohm load.
(7) Tested at 100 inches/sec. with a 16 pitch gear, 0.005" clearance and 100,000 ohm load.

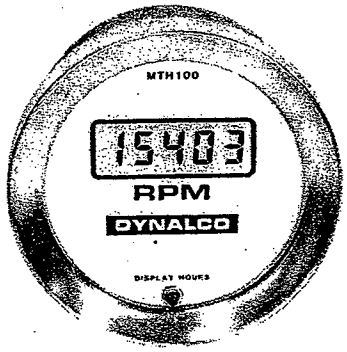
PRECISION DIGITAL AND ANALOG MEASUREMENT AND CONTROL EQUIPMENT USED WITH MAGNETIC PICKUPS



PNT201/202/SPV 200-Pneumatic, pickup powered overspeed trip, causes engine shutdown at a preset speed.

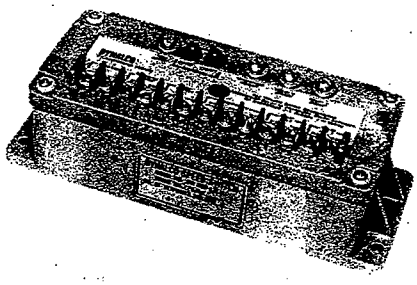


SS2000-Speed switches/transmitters to measure and control speed, flow, frequency and rate.



MTH100-Pickup powered tachometer, hourmeter with overspeed trip option. Microprocessor based.

SPD700-Pickup powered tachometer, .1% accurate, intrinsically safe. FM and CSA Approved.



SW200-Speed switch with up to three relays and one proportional DC output of 0 to 1 MA DC.

NOTES


TRW
DYNALCO® CONTROLS DIVISION
5200 N.W. 37TH AVENUE • P.O. BOX 8187
FT. LAUDERDALE, FLORIDA 33310
PHONE 305/739-4300 TELEX 514833

Spin-Clean™

OIL CLEANING CENTRIFUGE

MODEL M300

FEATURES

- True Centrifuge
- Reduces Hazardous Waste
- Reduces Engine Wear
- Extends Oil And Filter Life
- Removes Solids Below One Micron
- Diagnostic Tool
- User Friendly
- Easy Installation
- Rugged Construction

MADE IN U. S. A.

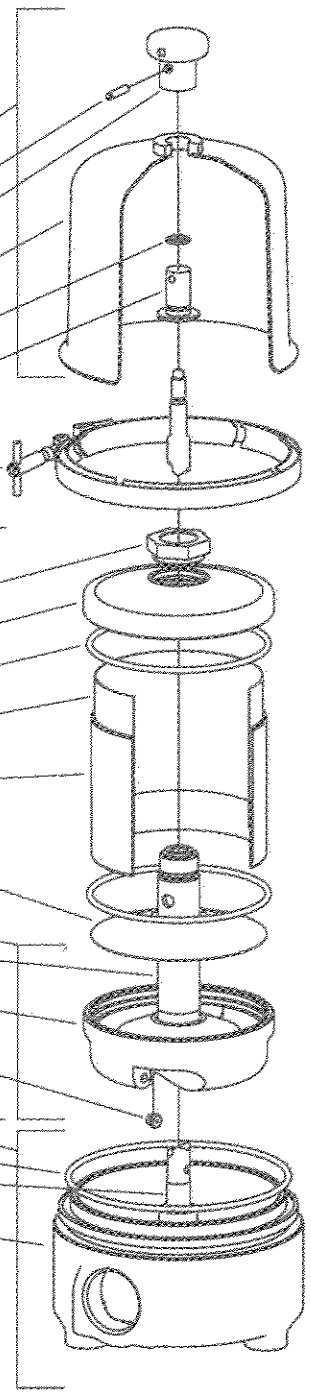
Installation • Service • Parts

PARTS LIST

Model M300

Parts List

Description	Part No.
Cover Assembly (no clamp)	**C300-CA**
Pin-Cover Nut	C300-12
Knob-Cover Nut	C300-14
Cover	C300-15
Seal-Cover Nut	C300-09
Nut-Cover	C300-13
Clamp w/ Tee Handle-Cover to Base	**C300-18**
Centrifuge Turbine Assembly	**C300-TA**
Nut-Turbine	C300-11
Cover-Turbine	C300-03
Seal-Turbine (2 req'd)	C300-10
Insert-Turbine (Package of 25)	C300-33
Bowl-Turbine	C300-02
Baffle-Turbine	C300-04
Base, Turbine Assembly (sold as assembly only)	**C300-BTA**
Bearing Tube Assembly	C300-05A
Base, Turbine	C300-01
Nozzle-Turbine (2 req'd)	C300-19-20
Base Assembly w/ Shaft (no clamp)	**C300-MBA**
Seal, Base to Cover	C300-17
Stationary Shaft	C300-06
Base	C300M-16
Model 300 Service Tool Kit	**C300-SK**



INSTALLATION AND OPERATION

Oil Supply to Centrifuge

Oil supply should be taken from a source as close to the lube oil pump discharge as possible and on the dirty side of the full flow oil filter. A 1/2" NPT pipe or #8 hose supply should be used for supply with a full-opening ball valve installed in supply line to allow the centrifuge to be isolated for cleaning without shutting the engine down. The centrifuge will operate efficiently at 30 to 90 psig with the preferred pressure of 60 to 80 psig.

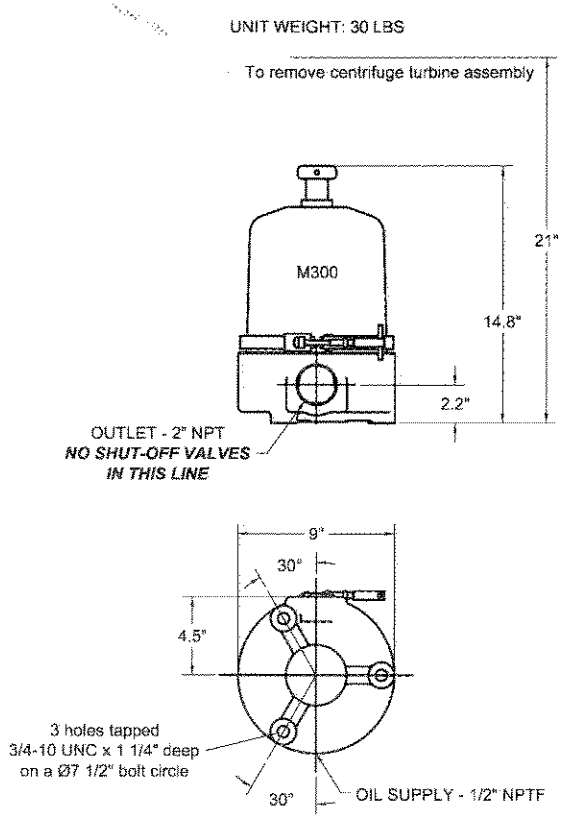
Clean Oil Return to Sump

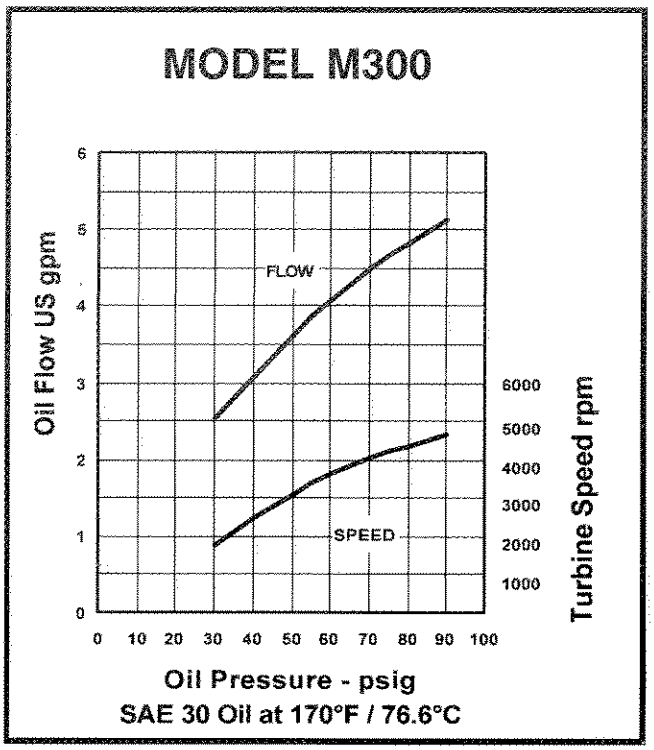
The clean oil drain line to the sump should be a 2.0" minimum diameter unrestricted hose or pipe. A 2" connection located above the oil level is required. Alternate oil fill openings or drilled-and-tapped holes in crankcase doors are options that can be used.

The drain is correct if you can drop in a 2" diameter ball and it can freely roll through the drain line into the engine.

Mounting Considerations

SPIN-CLEAN™ centrifuges are high-speed devices and should be securely mounted to prevent excessive vibration. They may be installed up to 15 degrees from vertical.





SERVICE INSTRUCTIONS

1. Shut off oil supply or stop the engine and allow centrifuge turbine assembly to come to a complete stop. **The oil drain line should be free of any shut-off valves.**

2. Remove cover clamp, unscrew cover and remove cover assembly.

3. Lift the turbine assembly a couple of inches and allow the oil to completely drain out of the nozzles before removing completely. Carefully separate the turbine assembly. **Do not strike the bushings with or against a hard surface or damage will result.** Remove lower turbine bowl seal and then remove baffle.

4. Carefully remove the solids cake from the turbine bowl, **Part No. C300-02**, taking care not to damage the turbine bowl. Thoroughly wash away all traces of the solids cake to insure maintaining turbine balance.

5. Thoroughly clean all other turbine parts. Check turbine nozzles and make sure they are unrestricted. Inspect turbine bowl seals, **Part No C300-10**, for cuts or damage; they can be used several times. Examine top and bottom bearings for excessive wear. Replace turbine base assembly, **Part No. C300-BTA**, if diameters exceed 0.503" (12.8 mm) top or 0.879" (22.3 mm) bottom.

6. Seat baffle in turbine base and install lower turbine bowl seal, **Part No. C300-10**, in the turbine base. Install turbine insert, **Part No. C300-33**, inside the turbine bowl. Reassemble the turbine assembly tightening the turbine nut securely **using finger pressure only.**

7. Examine stationary shaft journals for damage or excessive wear. Replace base assembly, **Part No. C300-MBA**, if diameter is less than 0.496"(12.6mm) top or 0.871" (22.1mm) bottom. The stationary shaft is factory installed to insure alignment and cannot be properly serviced in the field.

8. Coat the stationary shaft with clean oil. Install the turbine assembly on the stationary shaft, being careful not to damage bushings. Spin turbine assembly on the stationary shaft and make sure it spins freely and unrestricted.

9. Clean and inspect cover and make sure the cover seal is not leaking. If necessary replace the seal, **Part No. C300-09**, by removing the roll pin below the hand knob and remove the nut from the bottom.

10. Inspect the base to cover seal, **Part No. C300-17**, and replace if necessary.

11. Replace the cover assembly and tighten the cover knob by **hand pressure only**. Make sure the cover seats on the base evenly all around to insure proper crush on cover seal to prevent oil leaks. Reinstall the cover clamp and tighten securely.

12. Turn on oil supply to the centrifuge. With engine running, check complete installation for oil leaks or excessive vibration. If excessive vibration exists then disassemble, inspect and reassemble.

Note: *All centrifuge turbines are factory tested for balance before leaving the factory. An out-of-balance condition can occur as a result of uneven build up of dirt cake in the bowl or as a result of excessive bearing or stationary shaft wear. Depending on conditions, wear will eventually take place on the stationary shaft and bearings, requiring replacement of the appropriate assemblies.*

FPE

FLUID POWER ENERGY, INC.

W229 N591 Foster Court • Waukesha, WI 53186
Phone: 262-548-6220 • FAX: 262-548-6239
Website: www.fpevalves.com

ISO 9001-2000

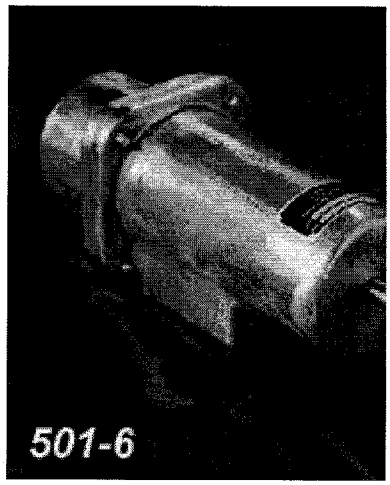
GARZO

Quality Products since 1939

4430 STEFFANI LANE
HOUSTON, TX 77041
(713) 466-8679
info@garzoproducts.com

March

MODEL 501-6 LINEAR DIAPHRAGM OPERATOR



GARZO Linear Diaphragm Operators are small diameter spring opposed rolling diaphragm operators suitable for gas compressor applications. The series 501 operators are designed specifically to be used in various industrial applications. The rolling diaphragm creates the perfect seal for friction free cylinders. It is a durable, flexible membrane shaped like a top hat with the peak of the hat resting against the end of the piston and the brim clamped between the forward and rear cylinders. Inside the cylinder this forms a long-lasting frictionless sealed cushion of air between the piston head and the cylinder wall. The fabric reinforced elastomer rolling diaphragms are produced exclusively for GARZO to our exacting standards. Standard diaphragm material design allows for operation of the cylinders in temperatures from -31°F to 248°F. Custom diaphragm material design allows for operation of the cylinders in temperatures from -121°F to 500°F.

The operators are designed to withstand many corrosive elements. The piston and body of the operators are made from 100% aluminum castings which resist galvanic corrosion and eliminate the need for painting. The diaphragm is a Dacron fabric, Buna-n impregnated, molded rolling diaphragm. The diaphragms are designed and manufactured to withstand repeated use in industrial applications, and the fabric prevents the elastomer from stretching in over pressure conditions. The spring has been electro zinc plated. The piston rod is a large diameter 300 series stainless steel. All other parts are either plated or stainless steel, making the operator si offshore salt water, natural gas, and sour gas service.

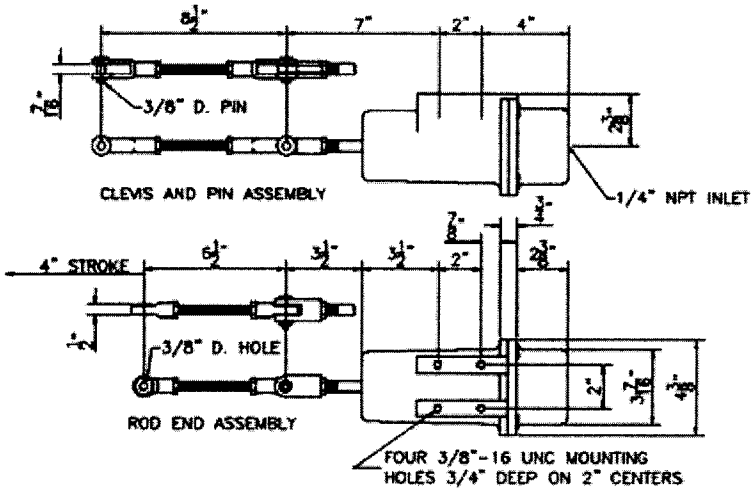
GARZO linear diaphragm operators are designed using INSTRUMENT SOCIETY of AMERICA recognized spring rates. The GARZ have strokes that follow a true linear progression. A properly sized GARZO spring opposed diaphragm operator has as much force forward stroke as it does on the return stroke.

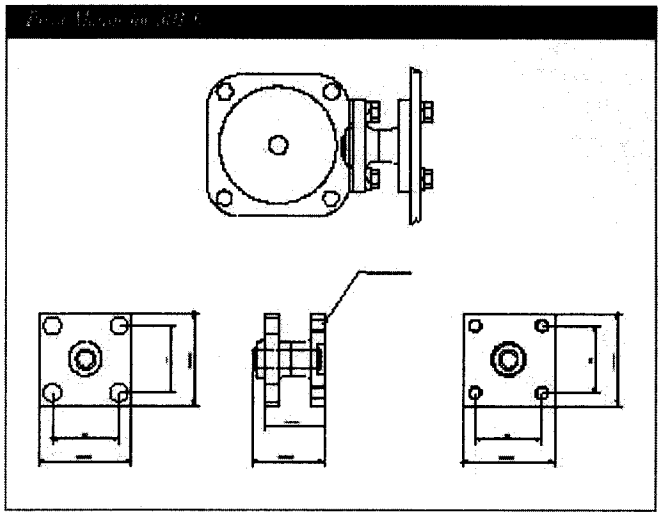
FEATURES

- Super Sensitivity
- Absolutely No Lubrication Required
- Low Hysteresis
- No Blow-By Leakage - 100% Leak Testing
- Solid Aluminum Construction
- Ease of Maintenance
- Wide Temperature Variations
- Designed For Use With Air or Sour Gas

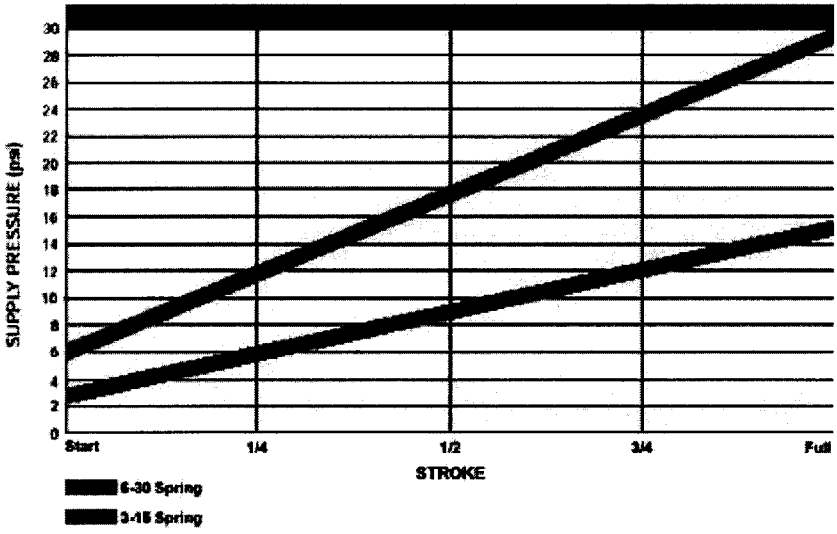
SPECIFICATIONS

- Cylinders 100% Cast Aluminum
- Piston 100% Cast Aluminum
- Rod 303 Stainless Steel
- Diaphragm Buna-N with Dacron Fabric
- Spring Zink Plated





MODEL NUMBER	EFFECTIVE AREA (IN²)	STROKE (IN)	FORCE AVAILABLE (LB)	NOMINAL SUPPLY PRESSURE	MAXIMUM SUPPLY PRESSURE
501-6-315	6	4	18	20	100
501-6-630	6	4	36	40	100



How to order.

Series **501- 4 - 315 - SUR - P - SIL**

Model

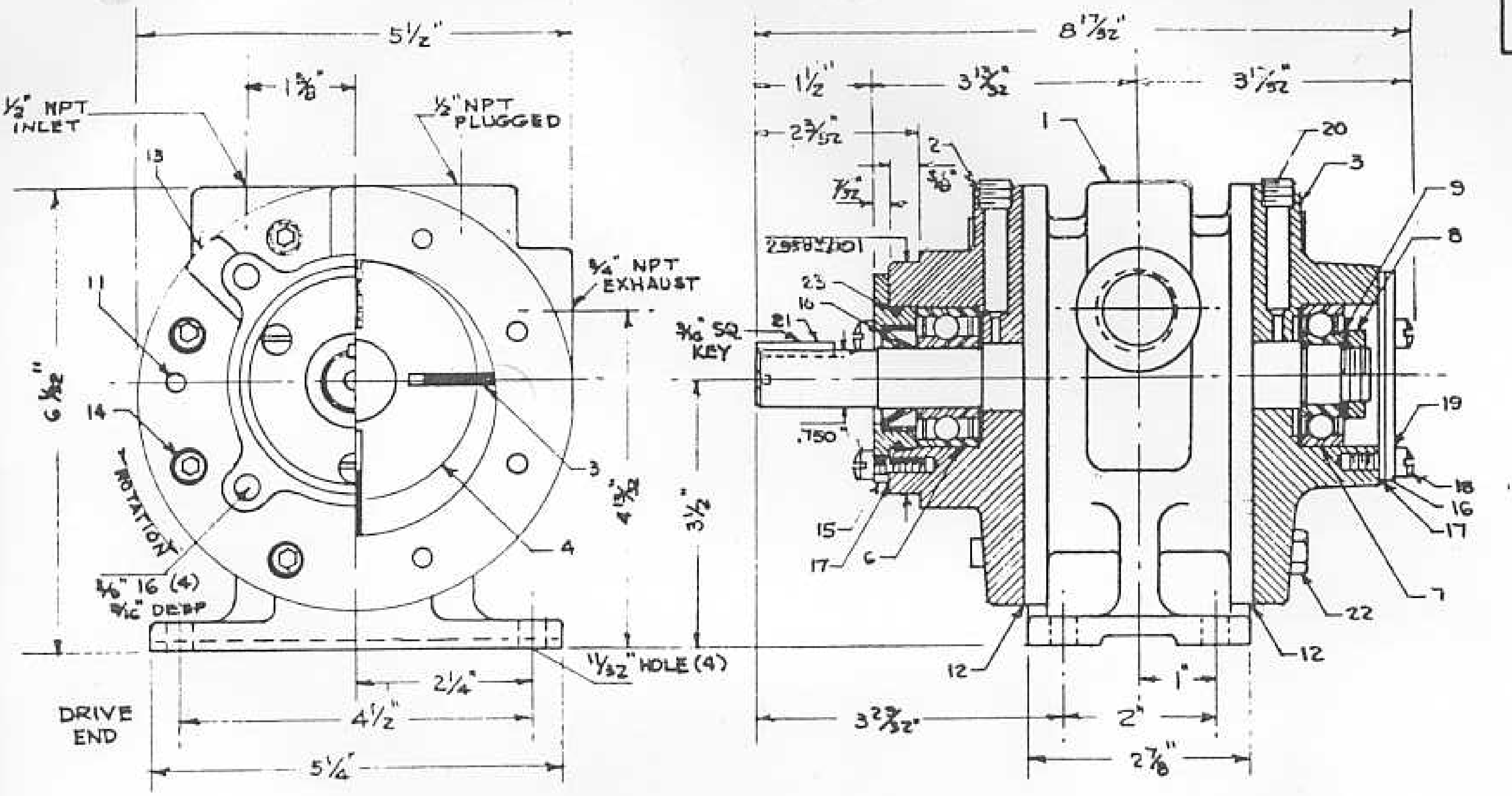
Spring Range
315-3 to 15 psig
630-6 to 30 psig

Mounting
SUR-Surface Mounting Bracket
PVT-Pivot Mounting Bracket

Positioner
O-Without Positioner
P-With Top Mounted Positioner

Diaphragm Temerature Range
Buna-N Diaphragm (Standard) -35°C to 120°C (-31°F to 248°F)
Silicone Diaphragm -85°C to 260°C (-121°F to 500°F)

Connector Assembly
Clevis & Pin Assembly (Standard)
Rod End Assembly



DWG. NO.	PART NO.	DESCRIPTION	NO. REQ.
1	C880A	Body	1
2	C882	End Plate, Drive End	1
3	C883	End Plate, Dead End	1
4	C884A	Rotor Assembly	1
5	C887A	Special Vane	4
6	C894	Bearing	1
7	D242	Bearing	1
8	B123	Locknut	1
9	B124A	Locknut Washer	1
10	C839	Shaft Seal	1
11	B162	Dowell Pin	4
12	C888	End Plate Gasket	2
13	A222	1/8" Slotted Plug	2
14	A223	5/16-24 x 3/4 AHCS	8
15	C835	End Cap, Drive End	1
16	C836	End Cap, Dead End	1
17	C837	End Cap Gasket	2
18	A224	End Cap Screw	6
19	A225	#1214 Washer	6
20	A230	Special Plug	2
21	B136	Shaft Key	1
22	A229	5/16-24 x 3/4 HHCS	8
23	C808	O Ring	1

HY-BON ENGINEERING COMPANY, INC.

MIDLAND TEXAS

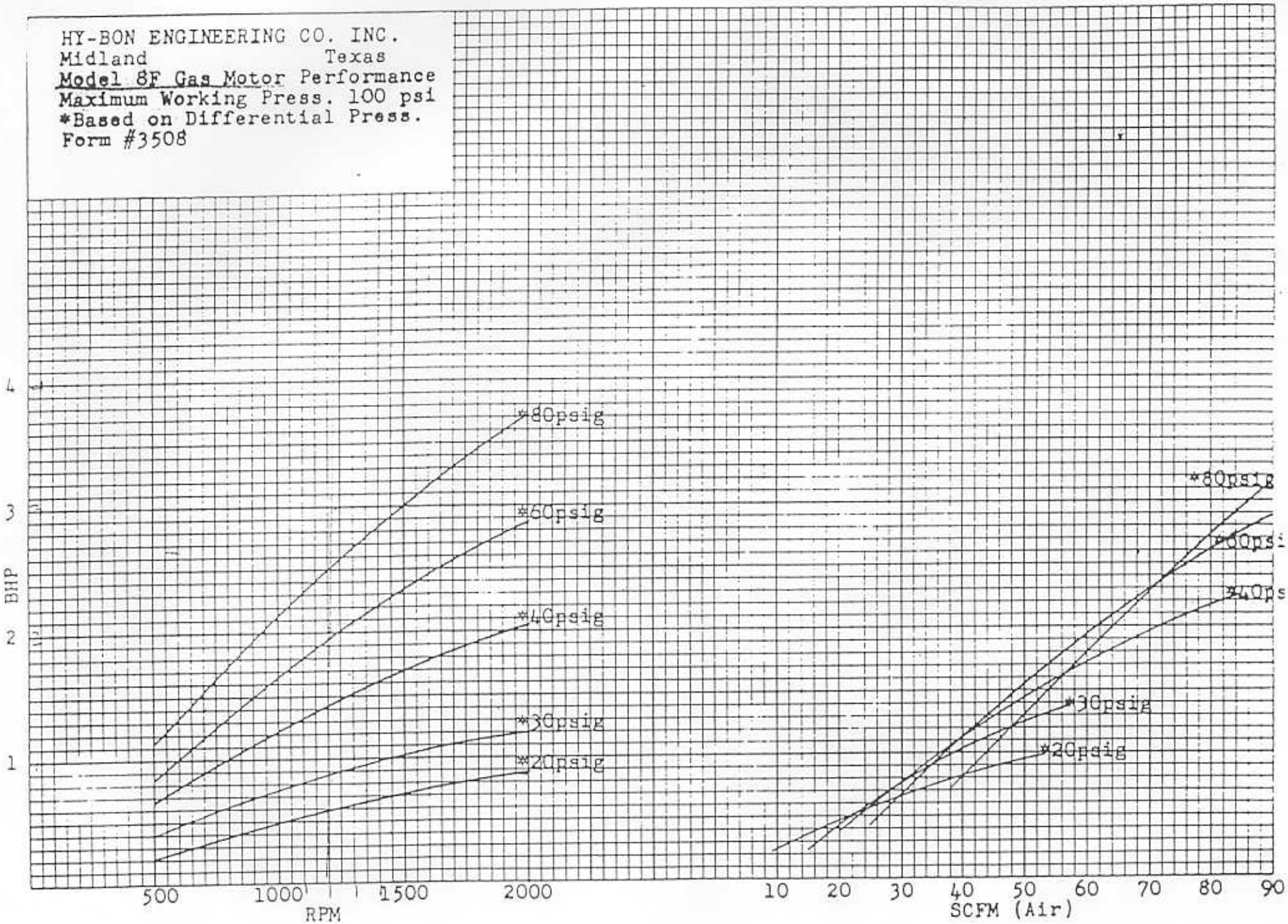
SCALE: NONE | APPROVED BY | DRAWN BY Swede

DATE: 6-24-67

PARTS LIST
MODEL 8F GAS MOTOR

DRAWING NUMBER 3725

HY-BON ENGINEERING CO. INC.
Midland Texas
Model 8F Gas Motor Performance
Maximum Working Press. 100 psi
*Based on Differential Press.
Form #3508



INSTRUCTIONS - GAS MOTOR MODEL 8F

The Model 8F is a rotary type gas motor using gas pressure differential for power. It is designed and constructed of cast iron and stainless steel for "SOUR" gas operation. The shaft bearings are permanently lubricated SEALED ball bearings requiring no further lubrication.

OPERATIONAL FAILURES ARE THE RESULT OF:

1. Rigid pipe connection to pump and gas motor causing misalignment and undue stress and wear of pump, coupling or gas motor.

2. Slugs of sand and pipe scale from the gas line plugging the gas motor causing it to stop rotating.

3. Insufficient gas pressure (differential across the gas motor) to meet the necessary pumping conditions.

CORRECTIVE MEASURES:

1. This pumping unit carries a 90 day warranty against any material defects providing the unit is connected to fluid and gas lines with flexible couplings. The warranty is not in effect if gas motor is subject to gas pressure greater than 100 PSIG. If rigid connections are used check alignment of pump, coupling and gas Motor before putting unit in operation.

2. Failure of the gas motor to rotate is the result of binding rotor or stuck rotor vanes resulting from the compaction of sand or pipe scale.

   a. Disconnect gas inlet and outlet of gas motor.

   b. Flush gas motor with KEROSENE - NO HEAVY OILS.

   c. Rotate shaft by hand several times.

   d. Repeat until rotor is free.

   e. Blow down gas supply line to clean it of sand and scale.

   f. Connect up gas inlet and outlet to gas motor.

2A. If gas blows through the motor with the shaft free and it does not rotate, the vanes are stuck in rotor.--Proceed as follows:

   a. Remove three screws and cover plate on back of gas motor. Dwg. No. 18 and No. 16.

   b. Remove locking nut and lock washer from shaft. (Right hand thread) Dwg. No. 8 and No. 9.

   c. Remove 8 cap screws in the end plate of housing, Dwg. No. 22.

   d. Remove end plate by tapping or prying lightly as the end plate is a machined casting containing the sealed ball bearing assembly. Dwg. No. 3.

   e. Remove plastic vanes from slotted rotor clean and flush with KEROSENE until vanes slide freely in the rotor slots.

   f. To assemble use a NEW end plate gasket to insure proper fit. The parts are machined to close tolerances, assemble with care for best results.

3. a. Check capacity and pump pressure - refer to your performance chart for the gas pressure required.

   b. If it requires extra gas pressure, check alignment of pump and gas motor - Misalignment makes a high frictional load.

   c. Check pump to see it is properly lubricated.

HY-BON Engineering Company, Inc.
P. O. BOX 4185 MIDLAND, TEXAS 79701

NET SAFETY MONITORING INC.

MILLENNIUM
Combustible Gas Detector

User Manual

Models:

MLP- A/AR/AD- SC1100

MLP- LP-A/AR/ARS - SC1100

ISO 9001:2000

QMI REGISTERED

Part Number: MAN-0047 Rev 12
July 24, 2009

IMPORTANT INFORMATION

This manual is for informational purposes only. Although every effort has been made to ensure the correctness of the information, technical inaccuracies may occur and periodic changes may be made without notice. Net Safety Monitoring Inc., assumes no responsibility for any errors contained within this manual.

If the products or procedures are used for purposes other than as described in the manual, without receiving prior confirmation of validity or suitability, Net Safety Monitoring Inc., does not guarantee the results and assumes no obligation or liability.

Net Safety Monitoring Inc., products are carefully designed and manufactured from high quality components and can be expected to provide many years of trouble free service. Each product is thoroughly tested, inspected and calibrated prior to shipment. Failures can occur which are beyond the control of the manufacturer. Failures can be minimized by adhering to the operating and maintenance instructions herein. Where the absolute greatest of reliability is required, redundancy should be designed into the system.

Warranty

Net Safety Monitoring Inc., warrants its sensors against defective parts and workmanship for a period of 24 months from date of purchase; other electronic assemblies for 36 months from date of purchase.

No other warranties or liability, expressed or implied, will be honoured by Net Safety Monitoring Inc.

Contact Net Safety Monitoring Inc., or an authorized representative for details.

We welcome your input at Net Safety Monitoring. If you have any comments please contact us by phone, at the address below or visit our web site and complete our on-line customer survey: www.net-safety.com.

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www.net-safety.com
E-mail: nsmsales@net-safety.com

ISO 9001:2000

Part Number: MAN-0047 Rev 12
July 24, 2009

Table of Contents

Introduction

The Millennium series is a part of Net Safety's innovation in a line of continuously evolving industrial gas detectors and sensors. The microcontroller based system provides fast, accurate and continuous monitoring of gases in extreme environments.

The Product

The Sensor

The SC1100 combustible gas sensor is a proven, poison resistant, pellistor sensor utilizing active and reference catalytic beads in a Wheatstone Bridge configuration. Its integrated design ensures accurate and repeatable response in the most severe environments.

The Controller (Transmitter)

The Millennium Controller has an Explosion-Proof Housing, rated Class 1, Division 1, Groups B, C, and D for hazardous applications. It was designed for either a 1-man, intrusive calibration or 2-man non-intrusive calibration. The Controller has convenient user interface functionality to make installation, operation and maintenance easy.

The Manual

The manual has been designed to make installation of the Millennium product easy. To ensure proper installation, follow the steps outlined in the following pages. If you encounter problems during operation, consult the troubleshooting section or contact your sales representative.

SECTION 1: PLAN

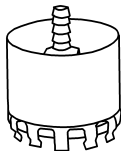
1.1 LOCATE CONTROLLER / SENSOR

Prior to the installation process, a location plan for placing the controller and sensor should be developed. Although there are no absolute rules determining the quantity and location of a sensor or controller, the following points should be considered when planning the installation.

- Locate the controller where it will be accessible and visible.
- Carefully locate sensor in an area where gases may potentially accumulate.
- Use redundant systems to enhance protection and reliability.
- Light gases tend to rise; heavy gases tend to accumulate in low areas.
- Consider the air movement patterns within the facility.
- Consider the construction of the facility (such as trenches where heavy gases may accumulate or peaks where light gases may accumulate)
- Seek advice from experts knowledgeable about the primary gas to be detected.
- Use common sense and refer to the regulatory publications that discuss guidelines for your industry. The two most common installations options are as follows.

Option 1

Locate the sensor separate from the controller using a Certified Junction Box. **If the Net Safety Multi-purpose Junction Box is being used, refer to MAN-0081 for terminal designations.**
The controller is located near eye- level. Conduit is run from the controller to the sensor. A Calibration Cup (CCS-1) can be attached to the sensor. Tubing can be run from the CCS-1 to a convenient location accessible for calibration gas to be injected.



CCS-1

Option 2

The sensor is attached directly to the controller. See "Wiring – Controller and Sensor" for details. The CCS-1 and tubing is used to facilitate calibration.

TIP: The Calibration Cup (CCS-1) allows for tubing to be affixed to a sensor mounted in remote locations. The tubing s directed to a level, usually close to the controller, for easy injection of calibration gas. The calibration cup can also act as a splash guard, protecting sensors mounted low to the ground.

Figure 1: Locate Sensor/Controller - Separated

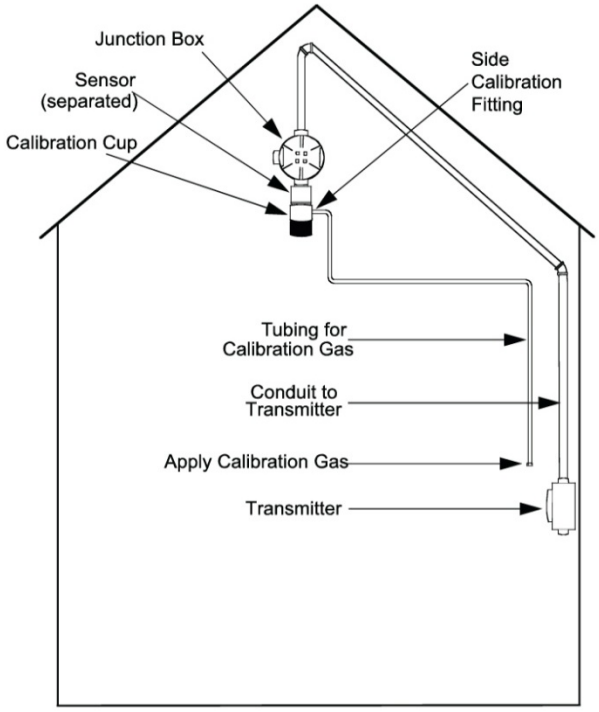
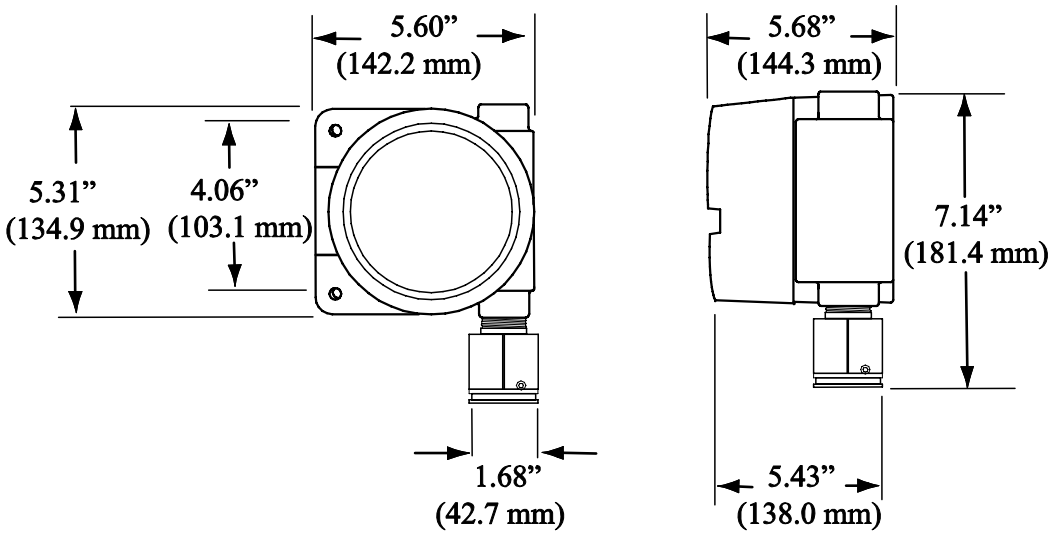


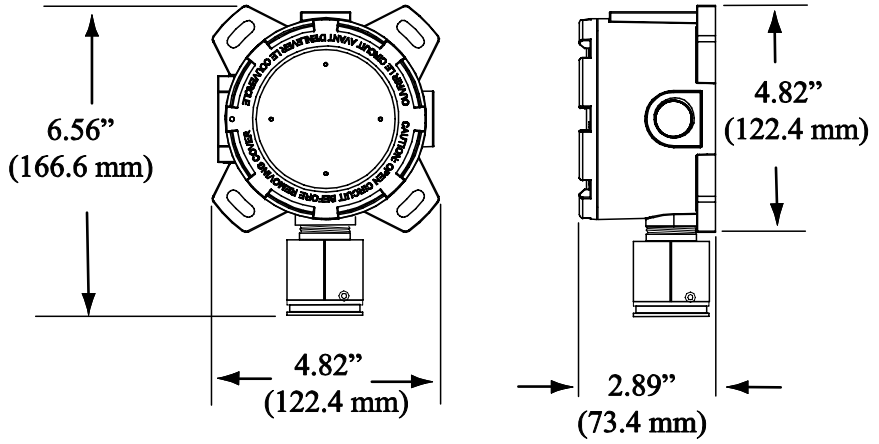
Figure 2 below shows the Controller with sensor and the Multipurpose Junction box with sensor attached.

Figure 2: Dimensional Drawing

Controller with sensor



Multi-purpose Junction box with sensor

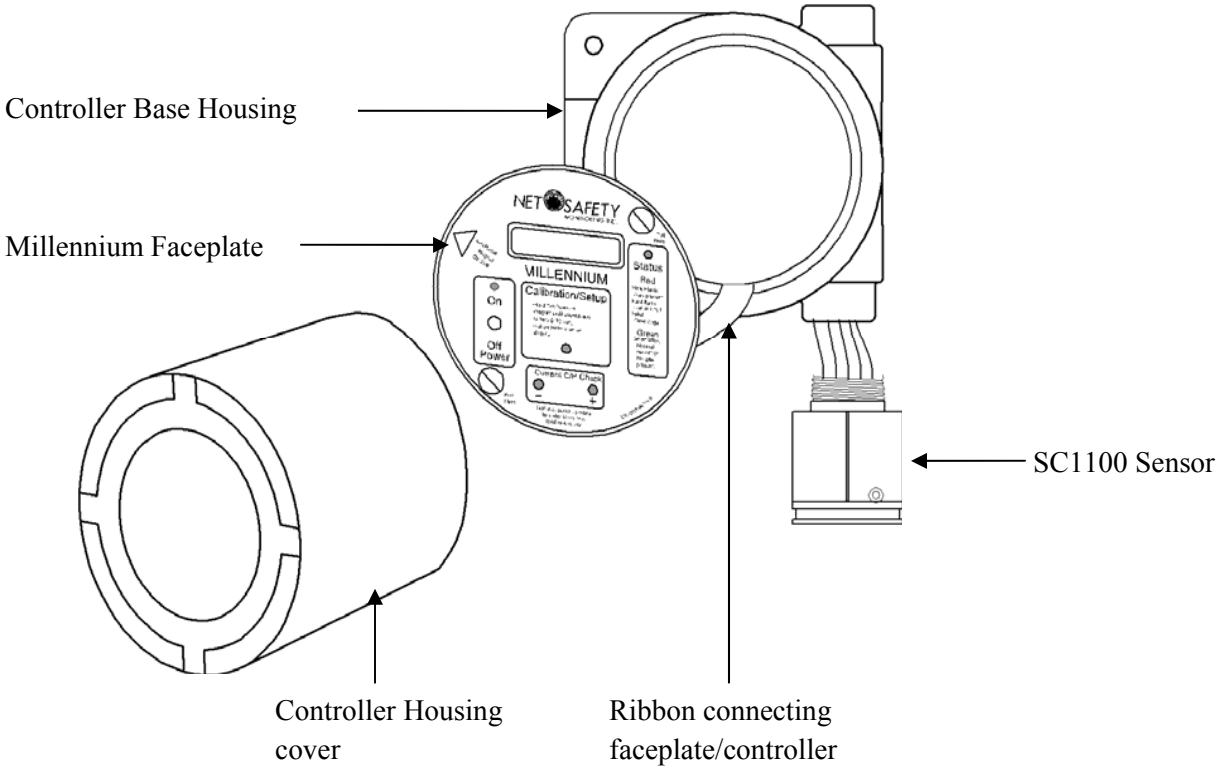


SECTION 2: Install

Unpack

Carefully remove all components from the packaging. Check components against the enclosed packing list and inspect all components for obvious damage such as broken or loose parts. If you find any components missing or damaged, notify the representative or Net Safety Monitoring immediately.

Figure 3: Components



External Equipment

It is necessary that reliable monitoring and indicating devices or systems be connected to the detector. These devices must be designed to produce clear visual and audible danger signals when high signal levels occur.

Mount

The controller should be mounted near eye-level and be easily accessible for calibration and maintenance purposes. The sensor should be placed where gas is likely to accumulate.

Ensure all devices are securely mounted, taking into consideration all requirements.

If necessary use the Face Rotation Option to mount the Millennium Controller at a different orientation. Refer to “Face Rotation Option” for detailed instructions.

SECTION 3: Wire

Field Installation

Warning Wiring codes and regulations may vary. Wiring must comply with applicable regulations relating to the installation of electrical equipment in a hazardous area and is the responsibility of the installer. If in doubt, consult a qualified official before wiring the system. See some wiring considerations below.

- If the 4-20 mA signal is not used, connect a jumper between the 4-20 mA terminal and the Common terminal.
- The use of shielded cable is highly recommended for signal, input, output and power wires to protect against interference caused by extraneous electrical or electromagnetic 'noise'.
- In applications where the wiring cable is installed in conduit, the conduit must not be used for wiring to other electrical equipment.
- The maximum distance between sensor and controller is limited by the resistance of the connecting wiring, which is a function of the gauge wire being used. See Appendix B.
- When developing a RS-485 chain of devices, the last device in the chain requires end of line termination.
- RS-485 connection 2-wire, multipoint serial line.

Seal

The use of seals is recommended to further protect the system against any unwanted water ingression, and equipment should be installed according to applicable local electrical codes. Seals are especially recommended for installations that use high-pressure or steam cleaning devices in proximity to the transmitter and/or sensor.

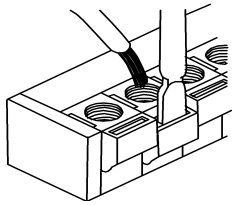
- Water-proof and explosion-proof conduit seals are recommended to prevent water accumulation within the enclosure.
- Seals should be located as close to the device as possible and not more than 18 inches (46 cm) away.
- Explosion-proof installations may require an additional seal where conduit enters a non-hazardous area. Ensure conformity with local wiring codes.
- When pouring a seal, use a fibre dam to ensure proper formation of the seal. Seals should never be poured at temperatures below freezing.
- The jacket and shielding of the cable should be stripped back to permit the seal to form around the individual wires. This will prevent air, gas and water leakage through the inside of the shield and into the enclosure.
- It is recommended that explosion-proof drains and conduit breathers be used. In some applications, alternate changes in temperature and barometric pressure can cause 'breathing' which allows moist air to enter and circulate inside the

conduit. Joints in the conduit system are seldom tight enough to prevent this 'breathing'.

Connecting Wires

1. Use a small screw driver to gently press down and hold the spring connector open.
2. Insert appropriate wire into open connector hole.
3. Release screw driver to secure wire.

Figure 4: Securing wires



Board Assembly

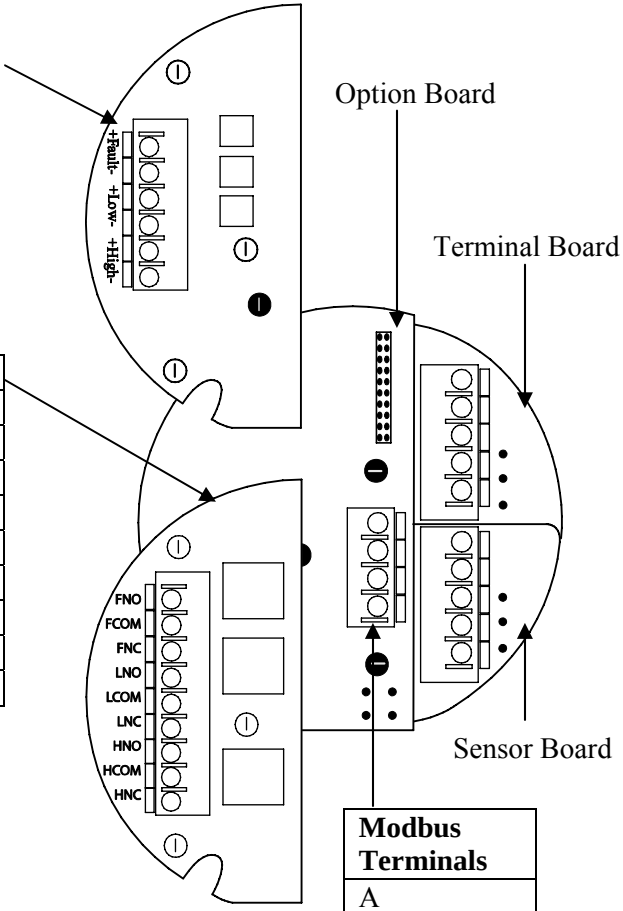
There are three different user-allowed removable boards; relay board (Solid State or Electromechanical), Option board and Modbus board. These Boards are field replaceable. Simply loosen the locking standoffs, remove one board, insert the other board and tighten screws. Depending upon requirements, either an Electromechanical or Solid State Relay Board module can be used.

Note: Boards are susceptible to ESD. Refer to Appendix A Electrostatic Sensitive Device (ESD)"

Figure 5: Millennium Module Boards

Solid State Relay Board	
Fault	+
	-
Low	+
	-
High	+
	-

Electromechanical Relay Board		
FNO	Fault	Normally open
FCOM		Common
FNC		Normally closed
LNO	Low	Normally open
LCOM		Common
LNC		Normally closed
HNO	High	Normally open
HCOM		Common
HNC		Normally closed



Modbus Terminals
A
B
COM
-

Sensor and Controller

Warning Power to the unit must be OFF before wiring. Also ensure area is de-classified before removing housing cover.

Note: The Sensor may be factory installed to the Controller. If so, you need only connect the Power Terminals.

1. Remove the Controller's Housing Cover.
2. Connect the sensor to the Sensor Terminals (if necessary) and the Power Terminals to power and output signal wires.
3. Turn controller on (put ON/OFF Switch in 'ON' position).
4. Replace Controller's Housing cover. Apply power to unit.
5. Ensure display reads **Start Delay**, Status LED is Red Slow Flash and current output displays 3.0 mA. This is the start-up delay sequence which will last approximately 90 seconds.

Refer to Tables 1and 2 along with Figure 6, for wiring.

Table 1: Sensor Terminal connection

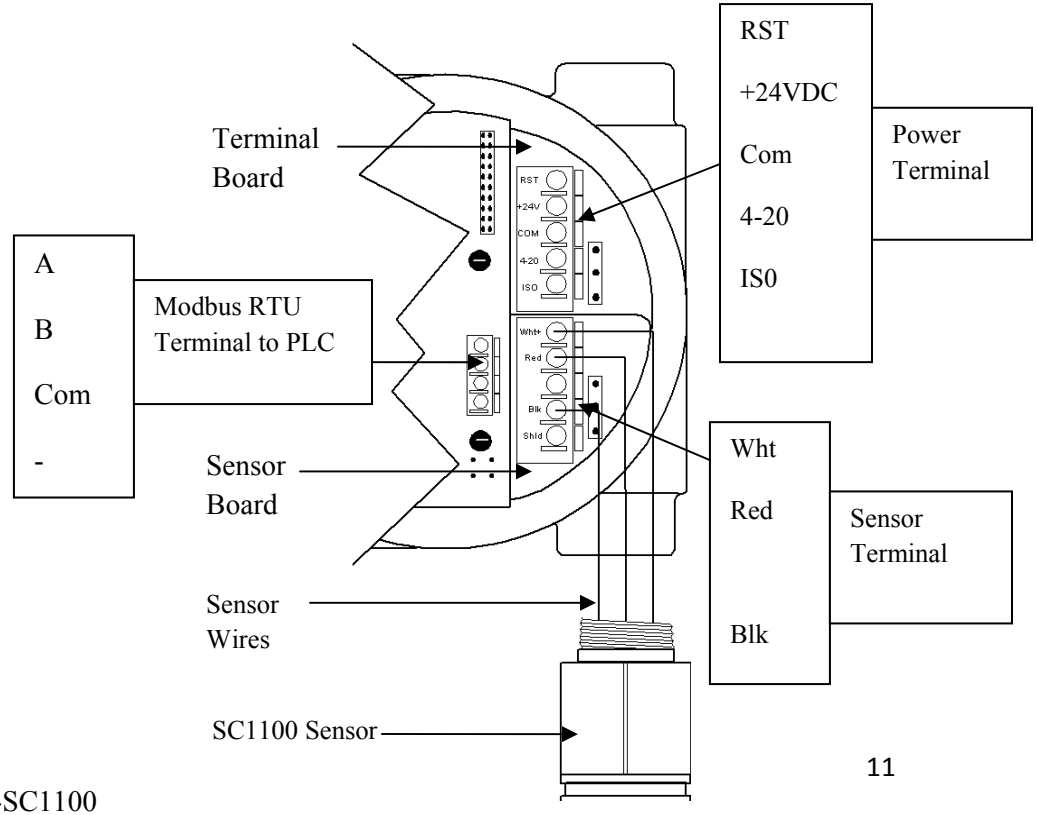
Sensor Terminals		
Sensor Wire		**Terminal designation**
White	↔	Wht(+)
Red	↔	Red
	Blank space	
Black	↔	Blk(-)
		Shld

Note the terminal designations on sensor terminal board i.e. Wht (+), Red, Blank space (no connection), Blk (-) and Shld.

Table 2: Controller Terminal connection

Power Terminals		
Controller (Terminal Board)		**Power Connections**
RST	↔	Remote Reset
+24VDC	↔	Power(+)
COM	↔	Power(-)
4-20	↔	Current loop output
ISO	↔	+24V isolated 4-20

Figure 6: Wiring - Controller and Sensor



Note: If the 4-20 mA signal is not used, connect a jumper between the 4-20 terminal and the COM terminal on the Terminal Board.

Relay Board

Refer to Figure 5, “Millennium Module Boards" for relay board location and termination.

RS-485 Communication

Connect devices in a chain via the Modbus terminals. The last device in the chain requires end of line termination. Refer to “Modbus Termination”.

Sensor Separation

Since the sensor must be located where gas is likely to accumulate and the controller where it can be easily reached, it is often necessary to “separate” the controller and sensor. This is done with the aid of the Sensor Separation kit. The Sensor Separation kit is composed of a **Net Safety Multi-purpose Junction Box** and terminal strip. **For terminal definitions refer to the Multi-purpose Junction Box manual (MAN-0081).**

Shielded copper instrument wire (minimum 18 AWG) should be used for separations up to 75 feet. Shielded copper instrument wire (minimum 16 AWG) should be used for separations up to 150 feet.

Note: Factory default for Sensor Separation is 0-75 feet.

The actual physical **distance between the sensor and controller must be defined**. See "Extend Sensor Separation for instructions on setting the sensor separation distance.

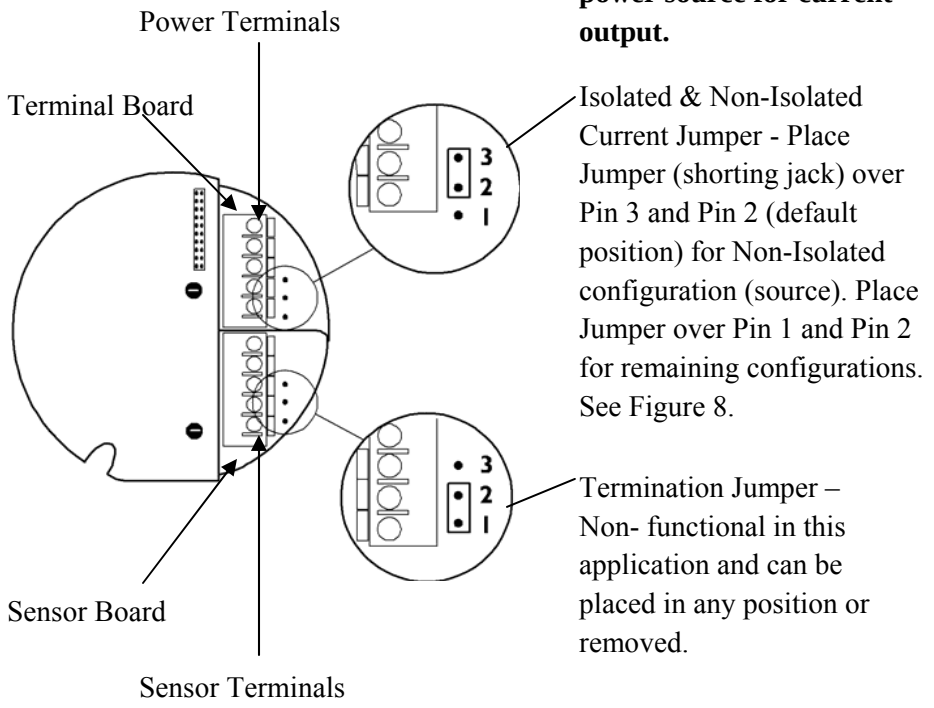
Note: If the 4-20 mA signal is not being used, connect a jumper between the 4-20 mA terminal and the COM terminal on the Terminal Board.

CURRENT OUTPUT

To set the current output, simply move the jumper located on the Terminal Board near the power terminals, to the isolated or non isolated current position. Refer to Figure 7.

Note: Unless otherwise specified, all models ship with this jumper in the non-isolated current position (Pin 2 and Pin 3 jumpered). Refer to Figure 7.

Figure 7: Jumper Position



Jumper positions to set power source for current output.

Isolated & Non-Isolated Current Jumper - Place Jumper (shorting jack) over Pin 3 and Pin 2 (default position) for Non-Isolated configuration (source). Place Jumper over Pin 1 and Pin 2 for remaining configurations. See Figure 8.

Termination Jumper – Non- functional in this application and can be placed in any position or removed.

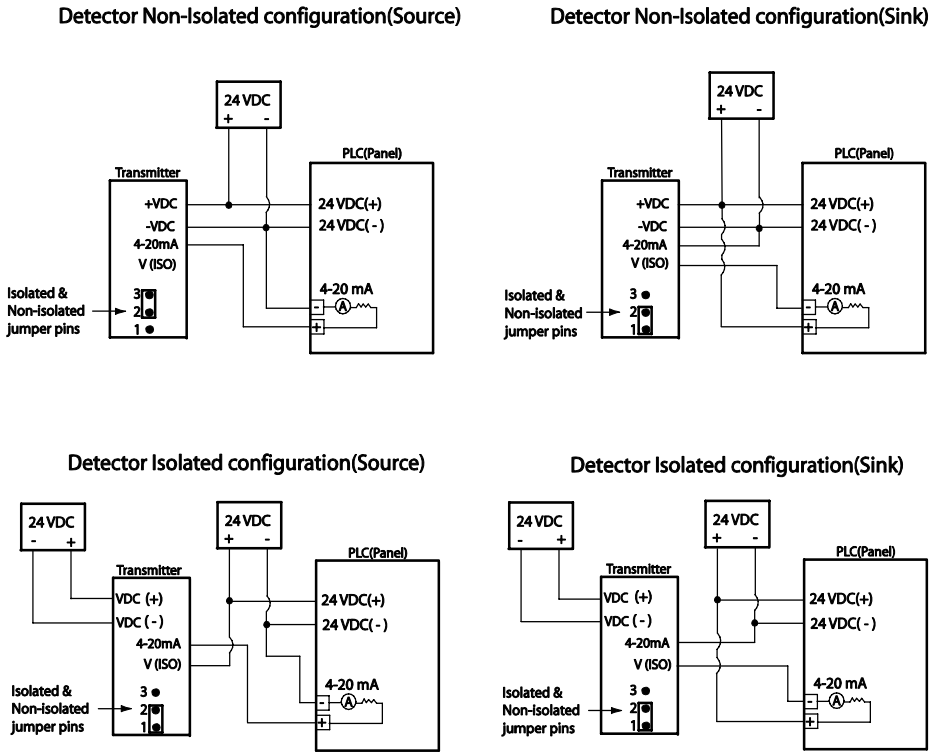
NON-ISOLATED AND ISOLATED POWER CONFIGURATIONS

For current source using Non-Isolated configuration, the jumper must remain in the default position (Pin 2 and Pin 3 jumpered). The jumper is placed over Pin1 and Pin 2 for current sink using Non-Isolated configuration.

For Isolated configuration using a separate power supply to isolate the current loop, the jumper must be placed over Pin 1 and Pin 2 for source and sink. See Figure 7 and Figure 8.

Note the Jumper position for each configuration.

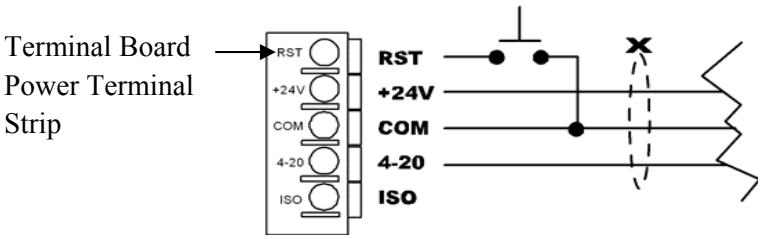
Figure 8: Current Source and Sink Drawing



Remote Reset

If the Millennium relays are set for latching a remote reset can be done to reset the relays. This is done with a normally open Push Button Switch connected between the RST and COM terminals on the Terminal Board. See Figure 9.

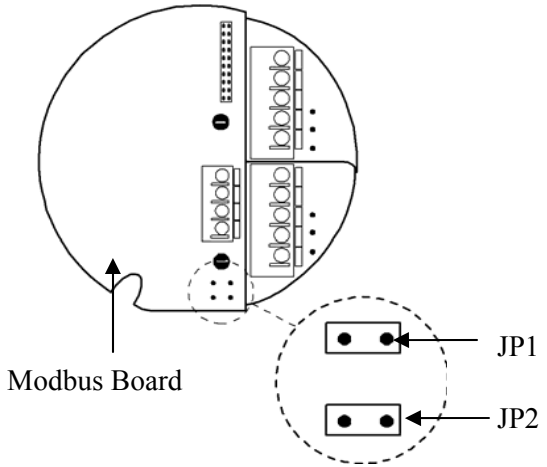
Figure 9: Remote Reset



Modbus Termination

Devices can be networked in a daisy chain. The device located at the end of the chain requires end of line termination. Place both jumpers over the pins as shown in the Figure 10 below.

Figure 10: Modbus Termination Jumpers



SECTION 4: OPERATE

Figure 11: Controller Functionality

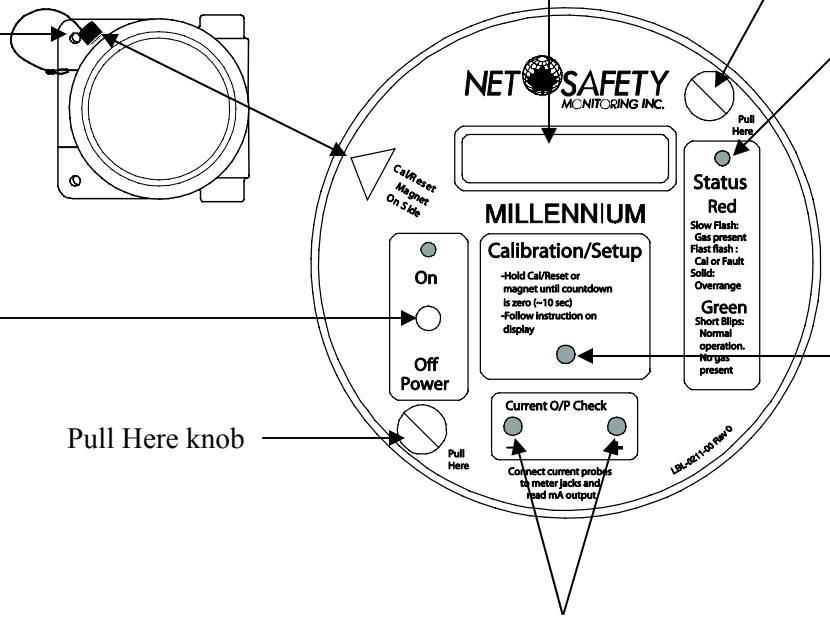
Scrolling 8 character display- provides various status messages and prompts. Refer to "Status LED's, Display Messages and Current Loop"

Pull Here knob-unscrew the two screws and pull to remove faceplate. Removal allows access to terminal boards. The face plate remains attached to the ribbon cable

Magnetic Reed Switch –provides non-intrusive access for programming, zeroing and resetting.

-Place magnet against housing as indicated for less than one second to initiate a basic system reset (clear latched alarm) and make selections.
–Place magnet against housing as indicated and hold to access, select, view settings and zero.

Status Light (flashes Red or Green) to indicate status of unit. Refer to "Status LEDs, Display Messages", for detailed explanation.



ON/OFF Switch –used to turn controller on and off. Housing must be removed to access.

Setup Button –provides intrusive access for programming, zeroing and resetting. -Push for less than one second to initiate a basic system reset (clear a latched alarm) and make selection. -Push and hold to program, view current settings and zero.

Pull Here knob

Current Output Check –test jacks to facilitate current loop measurements without breaking external current loop. To take current loop measurements ensure wiring is correct and current loop is closed, and then follow steps below

-Set meter on mA scale and insert meter leads into test jacks.

-Set external devices to bypass, if necessary, to avoid unwanted alarm response

-Perform simulated tests to check output

-Remove meter leads from test jacks and return external devices to normal

Table 3: Status LEDs, Display messages and current loop

State	Current output	Status LED Red or Green		Display
Calibrate sensor	3.0 mA	N/A		N/A
Normal operation	4.0 mA		Green blip/blink	00 %LEL
Start-up delay (90 seconds)	3.0 mA	Red Slow flash		Start delay
Access main menu & options	3.0 mA	N/A		Switch on (10→0)
Memory error	2.5 mA	Red slow flash		Memory error
Sensor lead open	2.5 mA	Red slow flash		Sensor Fault
Excess drift (>10%)	2.5 mA	Red blip/blink		Neg. drift
Auto Zero set	3.0 mA		Green Solid	Apply clean air
Apply cal. gas	3.3 mA	Red fast flash		Apply 50% span gas
Span is set, remove gas	3.6 mA		Green solid	Remove gas
Calibration successful	3.6 mA		Green solid	Cal. complete
Sensor guard	20.0 mA	Red Solid		100%LEL
Gas present	>4-20 mA	Red blip/blink		1-100% full scale
Failed calibration	3.0/3.3 mA	Red flash	Green flash	Fail cal.

Table 4: RTU Status register(40002) Read only (binary)

RTU Status Registers and meaning		
RTUstat_fault	0x0001	Fault(sensor)
RTUstat_low_alarm	0X0002	Low alarm tripped
RTUstat_high_alarm	0X0004	High alarm tripped
RTUstat_low_alarm_latched	0X0008	Low alarm latched
RTUstat_high_alarm_latched	0X0010	High alarm latched
RTUstat_lel_60_latched	0X0020	60% LEL latched
RTUstat_lel_100_latched	0x0040	100% LEL latched
RTUstat_powerUp	0x0080	Power up delay
RTUstat_cal_cycle	0X0100	Calibration cycle in progress
RTUstat_zeroing	0x0200	zeroing
RTUstat_apply_span_gas	0x0400	Apply span gas
RTUstat_calibrating	0x0800	Calibrating
RTUstat_remove_gas	0x1000	Remove gas
RTUstat_cal_complete	0x2000	Calibration complete
RTUstat_mem_error	0X4000	Memory error

Note: Register 40001 = LEL output (read only)
Register 40002 = RTU status (read only)
Register 40101 = Reset latched relays (write)

Calibration Button

The Calibration Button provides access to the Millennium's Main Menu, which in turn allows calibration and options to be reviewed and set. Refer to Figure 11, "Controller Functionality" , for more information.

- **Press and hold** the Calibration Button to calibrate and access Main Menu.
- **Briefly press** to make a selection (select **YES?**).

Warning Do not open the controller in a classified area (Do not open when an explosive atmosphere may be present). Do not power up the system with the housing cover removed unless the area has been de-classified.

Magnetic Reed Switch

The Magnetic Reed Switch is provided to avoid opening the housing in an environment where gas may be present. The Magnetic Reed Switch functions in the same manner as the Calibration Button but in a non-intrusive manner. Refer to Figure 11, "Controller Functionality", for more information.

When using the magnet:

Place and hold the magnet to the Controller's Housing (10 o'clock position) to calibrate and access Main Menu.

Briefly place the magnet to the Controller's Housing (10 o'clock position) to make a selection (select **YES?**).

Power Up

Turn the power switch on. A 90 second warm-up routine will begin. The display reads **Start Delay Millennium Net Safety**, the Status LED will flash slow red and current output displays 3.0 mA.

When power is applied, the system is automatically tested to ensure proper functionality.

After warm-up, the controller will enter normal operation, the display reads **00 %LEL**, Status LED will blip/blink Green and analog output will change to 4.0 mA.

Current Loop Measurement (Test Jacks)

Use a standard meter to measure current loop during various states. The Controller's Housing cover must be removed to access the Test Jacks.

Refer to Table 3: "Status LEDs, Display Messages and Current Loop," for a detailed list and Figure 11, "Controller Functionality", for more information.

Status LED

The Status LED will remain solid, flash, blip and/or blink, either Red or Green, to indicate various states. Refer to Table 3, "Status LEDs, Display Message".

The Main Menu

The Main Menu provides access to various functional settings and viewing of current settings.

- Calibrate Sensor.
- Review Relay Settings (optional) - Review the current Fault, Low and High alarm settings. This is a read only option.
- Set Relay Options (optional) - Set the Low and High alarm settings.
- Restricted Menu - Set the sensor separation distance and choose low power options.
- Select a display language - English, Spanish or French.
- Select Modbus Options (option only available if Modbus board is used i.e. digital model).

Note: The current output will drop to 3.0 mA while accessing the Main menu.

Accessing the Main Menu

There are two ways to access the Main Menu:

- Calibration Button found on the faceplate (the housing cover must be removed to access)
- Magnetic Reed Switch (a magnet must be used to activate)

Main Menu Functionality

1. Ensure that the controller has been turned on and no fault is present.
2. Hold the magnet against the Reed Switch or press and hold the Calibration Button until the message **Switch On** displays and the countdown (10 to 0) finishes.
3. An option will scroll across the display followed by the prompt **YES?**
4. To select an option, momentarily place the magnet to the Reed Switch or press the Calibration Button at the **YES?** prompt.
5. If you do not wish to select that option wait until the next option appears and then select **YES?**.
6. A selection is acknowledged with a flashing **YES**.
7. If no option is selected, the controller returns to **00 %LEL** (normal operation).

SECTION 5: Calibrate

Calibration Procedure

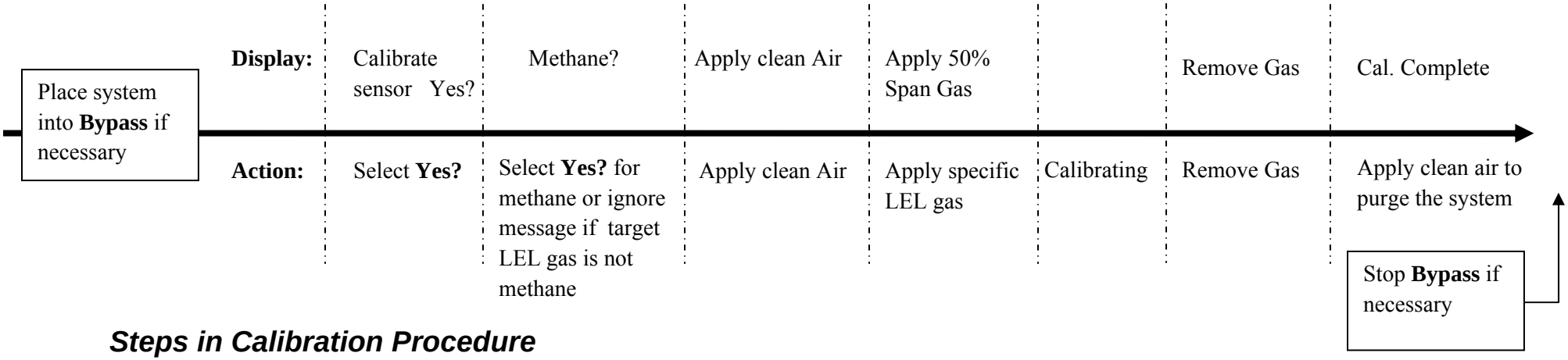
Warning The calibration procedure requires about 5 minutes to complete. If gas is not applied at the appropriate time, a calibration failure may occur. Refer to "Calibration Failure" for specific information.

For accurate performance, the Millennium should be calibrated using 50% span of the specific gas of concern. The concentration of gas, corresponding to 100% of full scale, is converted to a linear 4 to 20 mA output signal which can be powered from the primary dc supply of the instrument. **Power up the unit for at least 4 hours BEFORE the first calibration.**

The following calibration procedure should be followed to ensure an accurate correlation between the 4 to 20 mA output signal and the gas concentration.

Warning To compensate for distance when remotely calibrating (sensor wired for separation), decrease the tubing diameter or increase the calibration gas flow rate between canister and sensor. Always confirm calibration by applying gas directly at the sensor.

Figure 12: Calibration Procedure



Steps in Calibration Procedure

Refer to "Remote Calibration", if remote calibration is to be performed.

1. Confirm successful power up of controller—LED Green Blip/blink every 2 seconds; no fault indicated.
2. Flow certified Clean AIR at a rate of 0.5 litres per minute through the calibration cup for 1 minute to ensure clean air environment.
3. Press and hold the Calibration Button or use the Reed Switch to access the Main Menu and wait for countdown (10-0) to complete.
4. When **Calibrate Sensor YES?** displays, use the Calibration Button or Reed Switch to select **YES?** Selection will be confirmed by a flashing **YES**.
5. The prompt **Methane YES?** will display. If calibrating for methane use the Calibration Button or Reed Switch to select, otherwise (**for another target LEL gas**) ignore and wait for next prompt.

Note: The purpose of the prompt "**Methane YES** ?" is for activating the sensor life feature for methane gas only.

6. When **Apply Clean Air** displays apply clean air.
7. Wait for **Apply 50% Span Gas** to display and apply specific LEL gas at a rate of 0.5 litres per minute (use 1.0 litre per minute for remote calibration).
8. The display will show **Calibrating** as gas is detected.
9. Remove span gas when the message **Remove Gas** displays (Status LED Green solid and 3.6 mA output).
10. The message **Cal Complete** will display when calibration is completed.
11. Apply clean air again to purge system.

Note: Always apply test gas after calibration to verify operation.

Remote Calibration

The preferred tubing has an inside diameter of 3/16"; stainless steel tubing is excellent, plastic tubing is good. Within 10ft/35m, a flow rate of 0.5 litre per minute can be used but 1.0 litre per minute is recommended. Always use 1.0 litre per minute for distances (calibration tube lengths) between10ft to 100ft. Contact Net Safety if a remote calibration distance is greater than 100 ft/30 m is required.

Abort Calibration

The Calibration procedure can be aborted. When the display shows **Apply 50% Span Gas**, press and hold the Reed Switch or Calibration Button until the countdown '**10-0 Abort Calibration**' completes. After which the display shows **Cal. Complete** then returns to **00 %LEL**.

Sensor Life Check

Units, **calibrated for methane only**, indicate life expectancy of the sensor. Once calibration is complete, one of the following messages may display if the sensor needs replacing.

Sensor Near End of Life - indicates the sensor will reach end of life before the next calibration can be completed. Replace sensor as soon as possible. Press the Calibration Button or use the Reed Switch to clear this message.

End of Sensor Life, Replace Sensor - indicates sensor has reached end of life and needs to be replaced immediately. Press the Calibration Button or use the Reed Switch to clear this message. The unit will remain in Fault Mode until the sensor is replaced.

Calibration Failure

If the calibration procedure fails, the display shows **Fail Cal**, the Status LED alternates Red/Green flashes and the analog output changes back and forth from 3.0 to 3.3 mA.

The unit remains in a failed state until a Manual Reset. After the Manual Reset, the unit will return to normal operation based on previous calibration values.

SECTION 6: Monitor

Review Relay Settings

This is a **read-only mode**; changes cannot be made.

1. Press and hold the Calibration Button or hold the magnet to the Reed Switch to enter the Main Menu; wait for the countdown, from 10 to 0, to end.
2. When **Review Relay Settings** displays press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection.
3. The Fault Alarm is **fixed** (**Energized** / **Non-Latching**) and displays first, then the Low Alarm level, coil and latch status display, followed by the High Alarm level, coil and latch status.
4. At this point, the option to **Set Relay Options YES?** is displayed.

Set Relay Option

Use to set the alarm level, coil status and latch status for the Low and High Alarm relays (Fault Alarm is fixed).The following table describes the default settings for the relays.

Note: The High and Low relay configurations are set up independent of each other.

Table 5: Default Relay Settings

Millennium model #	Alarm levels			Coil Status			
	Low *	High *	Fault	Latching	Non-latching	Energized	De-energized
MLP-A/AR/AD-SC1100 and MLP-LP-A/AR/ARS-SC1100	20%	40%	Fixed as Energized and Non-latching		*		*

Steps in setting relay options

There are two settings for Relay Options: Low and High. The Fault Relay is fixed as Energized/Non-latching and cannot be changed. The low alarm level, coil energization and latch status are set first; high alarm level, coil energization and latch status are then set. All ranges are in %LEL. Low and High alarm levels will be displayed if reached.

1. When **Set Relay Options YES?** displays press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection. The message **Set Low** displays. Low Alarm set-points are then displayed in increments of 5 (0 to 55).
2. When the required level displays, press the Calibration Button or use the Reed Switch to select. The level selected will flash to confirm the selection.
3. The message **Coil Status** displays. The display then shows **Energized YES?** and then **De-Energized YES?**.
4. Press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection. If no selection is made, Coil Status option is repeated.
5. The message **Latch Status** displays. The display then shows **Latching YES?** and then **Non-Latching YES?**.
6. Press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection. If no selection is made, Latch Status option is repeated.
7. The message **Set High** displays. The High Alarm level cannot be set to a value lower than the Low Alarm level (as set in Step 2), nor higher than the maximum of 55% LEL. The High Alarm level is displayed in increments of 5 **greater** than the Low Alarm level (as set in Step 2).
8. Repeat Steps 3 through 6 to complete the High Alarm level, coil and latch status settings.

Note: If no selection is made, a 5 minute timer expires, in which case the unit returns to normal operation.

Enter Restricted Menu

The Restricted Menu allows you to select:

- Sensor Separation Distance (“Extend Sensor Separation”).
- Low Power Options (optional).

1. Press and hold the Calibration Button or hold the magnet to the Reed Switch to enter the Main Menu; wait for the countdown, from 10 to 0, to end.
2. When **Enter restricted menu YES?** displays press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection.
3. When **Are you sure? YES?** displays, press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection.

Extend Sensor Separation

1. Enter the Restricted Menu. Refer to "Enter Restricted Menu".
2. When **Extend Sensor Separation YES?** displays, press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection.
3. **Sensor Separation = 75 to 150 feet YES?** displays first then **Sensor Separation = 0 to 75 feet YES?**. Press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection.

Note: The **sensor separation distance**, as set for this option, **must** be the same as the physical length of sensor wiring; (within the range: 0 to 75 ft or 75 to 150ft).

Warning To avoid damaging the sensor, the factory default of 0-75 feet must be used for non-separation. If the sensor and controller are separated by a distance greater than 75 feet, 75-150 feet must be entering in the menu under "Extend Sensor Separation".

Set Low Power Options - Optional

Some Millennium versions have two optional low power features to reduce overall power consumption. Use this option to:

- Dim the LED display (display will still be visible in most lighting conditions - default setting).
- Disable the 4 to 20 mA analog output (for applications requiring only relay output - default setting).

1. Enter the Restricted Menu. Refer to "Enter Restricted Menu".
2. When **Set Low Power Options YES?** displays, press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection.
3. When **Lower Display Brightness YES?** displays, press the Calibration Button or use the Reed Switch to select or wait until **Display Full Brightness YES?** displays, then select. The flashing **YES** confirms the selection.
4. When **Disable 4 - 20mA O/P YES?** displays, press the Calibration Button or use the Reed Switch to select or wait until **Enable 4 - 20mA O/P YES?** displays, then select. The flashing **YES** confirms the selection.

Select Display Language

Display language selection appears after the Restricted Menu.

1. After the Restricted Menu the option **Select Display Language YES?** displays. Press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection.
2. When the required language displays (**English**, **Espanol**, **Francais**) press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection.

Note: The factory default language is English.

Modbus Options

Digital RS-485 Modbus RTU protocol is used. There are two Modbus options: Node Address and Baud Rate.

Node Address

Each device connected to the chain must be assigned a unique node address. The last number in the address is selected first.

1. When **Modbus Setup? YES?** displays, press the Calibration Button or use the Reed Switch to select. The flashing **YES** confirms the selection.
2. The current node address will display **Node: 000**.
3. Wait for the prompt **New Address? YES?** and press the Calibration Button or use the Reed Switch to select.

4. Use the Calibration Button or Reed Switch to select each of three numbers in the new address:
   - select the last number in the address first: **0** thru **9**.
   - select the next number in the address: **0** thru **9**.
   - select the first number in the address last, i.e. **0 1 2**.

Baud Rate

The transmission speed must be defined.

1. When **Modbus Setup? YES?** displays, press the Calibration Button or use the Reed Switch to select.
   The flashing **YES** confirms the selection.
2. After setting the Node Address, the current Baud Rate will display **XX.X BPS**.
3. Wait for the prompt **New Baud Rate? YES?** and press the Calibration Button or use the Reed Switch to select.
4. The available baud rates will display: **2400s**, **4800s**, **9600s**, **14.4s**, **19.2s**, **28.8s**, **38.4s**, **57.6s.**
5. Use the Calibration Button or use the Reed Switch to select required baud rate when it displays.
6. The flashing **YES** confirms the selection.

Alarms

Sensor Fault

Warning The fault detection circuitry does not monitor the operation of external response equipment or the external wiring to these devices. It is important that these devices be checked periodically to ensure they are operational.

Self-testing circuitry continuously checks for problems that could prevent proper response. When power is applied, the microcontroller automatically tests the system to ensure that it is functioning properly. During normal operation, it continuously monitors the signal from the internal sensor source. In addition, a "watchdog" timer is maintained to ensure the program is running correctly. When a system fault is detected, the Status LED flashes Slow Red, the display shows **Sensor Fault** and the analog output changes to 2.5 mA.

Sensor Drift

It is a normal characteristic of gas sensors to exhibit a slow drift from zero. When the amount of drift exceeds 10%, since the last calibration, the analog output switches to 2.5 mA, the Status LED Blip/blink Red and the display shows **Neg Drift**. This message will remain until a Manual Reset and the system is re-calibrated. When the analog output switches to 2.5 mA due to drift, the sensor will still respond and transmit reasonable analog output signals if gas is present.

Gas Present

When gas is present **1 to 100% Full Scale** will display, the analog output switches between 4 and 20 mA and the Status LED blips/blinks Red.

Sensor Life

Depending on various factors, sensor response may slowly deteriorate over a period of years. If calibration becomes impossible for any reason, the display will show **Fail Cal**, the analog output will switch repeatedly between 3.0 mA and 3.3 mA and the Status LED alternates Red and Green flashes.

Refer to “Sensor Life Check” if calibrating for methane gas (target gas).

Sensor Guard

SensorGuard is a proprietary firmware feature that protects the pellistor sensor from the damage and/or response shift commonly caused by exposure to high concentrations of combustible gas. With this feature, repeated or lengthy exposure to high gas concentrations has negligible effect on the sensor's performance. Sensor life is prolonged and calibration frequency is reduced. This does not eliminate the necessity of periodic sensor response checks which should be performed as part of an effective maintenance schedule.

If a gas signal exceeds 100% LEL the analog output will latch at 20 mA, the Status LED turns solid red and the display shows **100 % LEL**. At this point, power to the Sensor module will be terminated.

Simultaneously the SensorGuard feature is activated to protect the sensor from damage that can be caused by the oxidation of high gas concentrations. This protective feature extends the useful lifetime of the sensor and reduces or eliminates disruption of its calibration. As an extra safety precaution, the system should be checked for accuracy after such over-range exposure and if necessary re-calibrated. The system will need to be reset to clear the latched output. Refer to "Reset".

Flooding of pellistor sensors with high percentage levels of combustible gas results in a rapid response followed by a rapid return to zero which can be misleading and dangerous. **CSA and ISA require that a reading of at least 60% LEL is reached under such conditions. To be safe, alarm signals should latch at 60% LEL and require a manual reset action to restore normal operation.**
SensorGuard includes a unique safety feature where high alarm relays and the analog output latch when 60% LEL is exceeded. SensorGuard includes an analog ratchet so that LEL values above 60% are recorded and latched until reset manually. This encourages the acknowledgement and investigation of all high readings.

Warning Any type of gas sensor is susceptible to damage when exposed to high levels of gas, therefore, check the sensor for accurate response and if necessary perform a calibration or replace the sensor after any high level alarm.

Reset

Manual Reset

A Manual Reset is required after a calibration failure or to clear a latched relay alarm. Simply place and hold the magnet against the Reed Switch or press and hold the Calibration Button for 3-5 seconds. The unit will return to normal operation using previous calibration values.

Remote Reset

If the Relay Option is set to **Latching** (refer to "Steps in Setting Relay Options" and an open Push Button Switch is connected between the RST terminal and the COM terminal on the Terminal Board, Remote Reset is possible. Also refer to Figure 9: Remote Reset.

Outputs

Relays (Optional)

Note: The Fault relay output is not used to activate an automatic shut down procedure. The fault output indicates a potential problem with the controller.

Standard Electro-mechanical relay outputs have Form C SPDT contacts rated 5 Amps at 30 V dc/ 250 V ac. Three relay outputs are available; one for Fault, one for Low alarm and one for High alarm.

All relays have normally open and normally closed contacts available at the output terminals.

The Fault relay is set for normally energized operation and is non-latching. If a system fault is detected, the Fault relay becomes de-energized. The Fault relay is factory set and cannot be altered. The Low alarm and High alarm relays can be selected for either normally energized or normally de-energized operation and latching or non-latching.

An optional low power Solid State relay board comes with Form A contacts rated 2.5 Amps at 60 VAC/DC and selectable energized/de-energized, latching/ non-latching configurable low and high alarms. Fault relay is factory set as energized, non-latching and cannot be modified.

Modbus

Digital RS-485 Modbus RTU protocol is used.

Register 40001 = LEL output (read only)
Register 40002 = Status (read only)
Register 40101 = Reset latched alarms (write)

Note: Many registers are used by the controller. Please do not write outside the registers.

Current

A 4-20 mA dc current output is used to transmit the alarm status and fault codes to other devices. This output can be wired for isolated or non-isolated operation. A 4.0 mA output indicates normal operation; $> 4.0 \leq 20.0$ mA output indicates the presence of gas. Current output of 2.5 mA indicates the presence of a system fault.

SECTION 7: Maintain

Periodic Response Check

We recommend the Millennium be verified or calibrated every 3 months. A typical response check involves the application of calibration gas to the sensor, then the observation of the response LEDs, Analog output, display and external monitoring equipment. Be sure to prevent unwanted response of external monitoring devices and equipment during this procedure. If the Millennium response to calibration gas is within its specified accuracy then it is not necessary to perform a calibration. For example, when 50% of full scale is applied, the response is expected to be between 11.5 mA (47% of full scale) and 12.5 mA (53% of full scale). An additional consideration is the accuracy and tolerance of the calibration gas which may be + or - a few percent. If the calibration gas is + or - 10% of full scale then the reading may be from 10.7 mA (42% of full scale) to 13.3 mA (58% of full scale).

Troubleshoot

Response to the input should be checked and, if necessary, calibration should be performed whenever any of the following occur. Refer to "Calibration Procedure" for calibration instructions.

- Excess negative drift is indicated by 2.5 mA current output.
- Sensor or transmitter is connected or disconnected.
- Long term or high concentration exposure to gas.

See "Table 6: Troubleshooting guide" for assistance in troubleshooting. Also refer to "How to Return Equipment", if returning equipment.

Repairs to Net Safety products should not be performed in the field. Repairs to faulty or damaged equipment should only be performed at the factory; otherwise warranty on the product will be voided.

Table 6: Troubleshooting guide

Condition	Possible Cause	Possible Solution
Intermittent power	• Faulty power supply or /wiring. • Voltage is below operational voltage. • Failed electronic component(s).	• Correct power supply or / wiring. • Correct input voltage to unit. • Contact factory.
Unit not powering up	• Faulty wiring/power supply. • Voltage is below operational voltage. • Blown inline fuse. • Water invasion of electronics. • Failed electronic component(s).	• Correct wiring and power supply. • Correct input voltage to unit. • Replace inline fuse. • Contact factory. • Contact factory.
Unit powers up without display	• Loose electronic boards. • Water invasion of electronics. • Failed electronic component(s).	• Tightly fit electronic boards. • Contact factory. • Contact factory.
Sensor fault displays	• Faulty power supply. • Faulty sensor. • Faulty sensor wiring. • Faulty junction box wiring. • Water invasion of electronics/ junction box. • Failed electronic component(s).	• Replace or correct power supply. • Replace sensor. • Correct sensor wiring at controller. • Correct junction box wiring. • Contact factory. • Contact factory.
Unstable 4-20 mA signal	• Unshielded cables used for wiring. • Water invasion of electronics. • Failed electronic component(s)	• Use shielded cables for wiring. • Contact factory. • Contact factory.
No 4-20 mA Output Signal	• Current loop wiring is open. • Missing or incorrect placement of current output jumper. • Current output is disabled by default for Low powered Millennium units. • Failed electronic component(s)	• Close 4-20 mA signal loop. • Place current output jumper in correct position. See ‘Current Output’. • Enable 4-20 mA signal under ‘restricted menu’ option. • Contact factory.
Undesirable change in relay state	• Incorrect relay settings in menu. • Voltage applied to relay contacts outside relay ratings. • Failed electronic component(s).	• Correct relay settings in menu. • Correct voltage applied to relay dry contacts. See Appendix for specification. • Contact factory.
Chattering relays (Mechanical relay units)	• Voltage is below operational voltage. • Loose electronic boards or/ loose wiring. • Failed electronic component(s).	• Correct input voltage to unit. • Tightly fit electronic boards or/ fit wires. • Contact factory.

How to Return Equipment

A Material Return Authorization number is required in order to return equipment. Please contact Net Safety Monitoring at **(403) 219-0688** before returning equipment or consult our Service Department to possibly avoid returning equipment.

If you are required to return equipment, include the following information:

1. A Material Return Authorization number (provided over the phone to you by Net Safety).
2. A detailed description of the problem. The more specific you are regarding the problem, the quicker our Service department can determine and correct the problem.
3. A company name, contact name and telephone number.
4. A Purchase Order, from your company, authorizing repairs or request for quote.
5. Ship all equipment, prepaid to:
   Net Safety Monitoring Inc
   2721 Hopewell Place NE
   Calgary, Alberta, Canada
   T1Y 7J7
6. Mark all packages: **RETURN for REPAIR**

Waybills, for shipments from outside Canada, must state:

Equipment being returned for repair
All charges to be billed to the sender

Also, please ensure a duplicate copy of the packing slip is enclosed inside the box indicating item 1-4 along with the courier and account number for returning the goods.

All Equipment must be Shipped prepaid. Collect shipments will not be accepted.

Pack items to protect them from damage and use anti-static bags or aluminium-backed cardboard as protection from electrostatic discharge.

Spare Parts/Accessories

Table 7: Part numbering

Net Safety Part Number	Description
SC1100-R	Replacement Catalytic Bead combustible sensor
SC1100-SS	Replacement catalytic bead sensor W/Stainless Steel housing
PCBA-0252E	Terminal Connector Board
JB-MPG-A/S	Aluminum or Stainless Steel Junction box
FRO-001	90 Degrees Rotation Plate
ML7-TX200	Transmitter for MLP-XX-SC1100 series c/w display, Terminal and Input Board

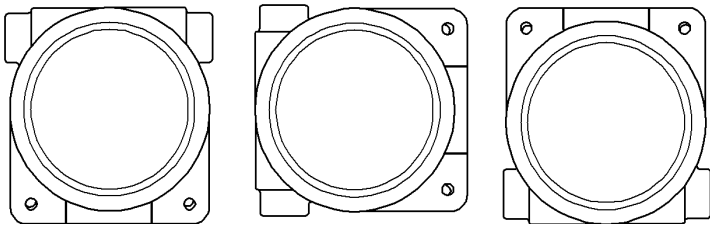
Table 7: Part numbering (cont'd)

ML7-TX400	Transmitter for MLP-LP-XX-SC1100 series c/w Display, Terminal and Input Board
ML7-RS303	Solid State Relay Board for MLP series
MLP-LP-ARS	Low Powered with Solid State Low, High and Fault Relays w/o sensor
MLP-A	Analog 4-20 mA output(isolated/non-isolated) only w/o sensor
ML7-RL305	Mechanical Relay Board for MLP series
ML7-OP100	Optional Board c/w connectors for use with ML7-303 or ML7-305 Relay Boards
ML7-ORL305	Electromechanical Relay Board(ML7-RL305) c/w Option Board(ML7-OP100)
ML7-ORS303	Solid State Relay Board (ML7-RS303 c./w Option Board(ML7-OP100)
ML7-MB100	ML7 MODBUS Output Board for MLP series
Magnet -1	Magnet assembly
CCS-1	Calibration Cup

FACE ROTATION OPTION

In some applications, it is necessary for the Millennium Controller to be mounted in a non-standard orientation. To accommodate such installations and ensure that the display will appear at the correct angle for viewing, the PCB Assembly can be rotated inside the Controller's housing.

Figure 13: Non-standard Orientation



Note: Ensure orientation allows for connections and excess wire within controller.

Rotate PCB Assembly

Warning Ensure area is declassified.

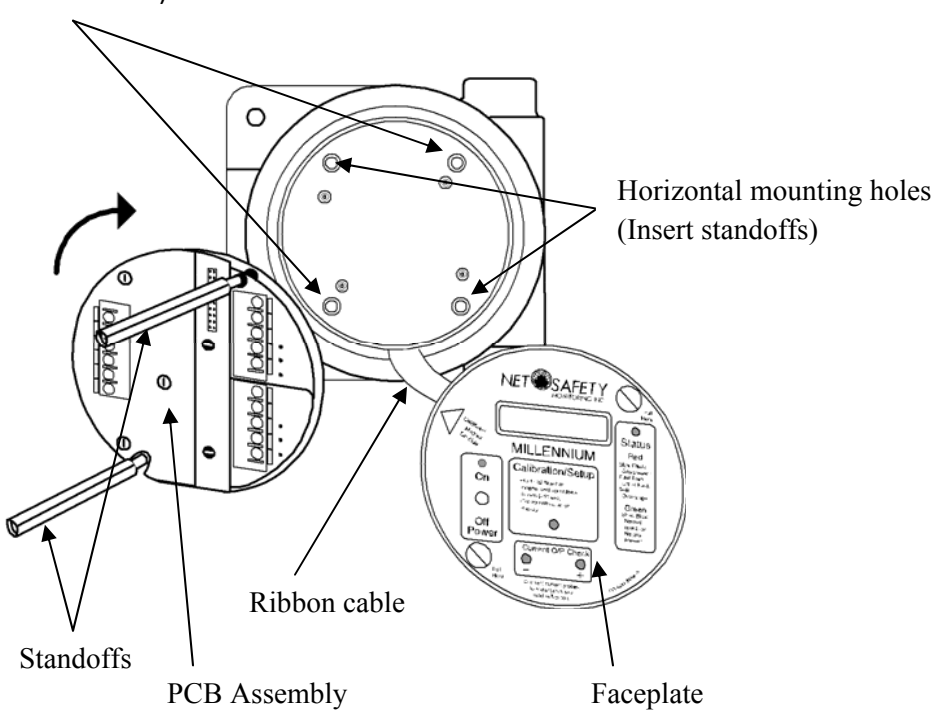
1. Remove the Controller's Housing Cover.
2. Turn the power to the detector off.
3. Unscrew both the knobs marked "Pull Here".
4. Lift Controller faceplate from housing and allow to hang from ribbon cable.
5. Unscrew the two metal standoffs.
6. Carefully remove the PCB Assembly from the housing.
7. The Rotator plate is secured to the bottom of the housing and is accessible after the PCB Assembly has been removed.
8. Rotate the PCB Assembly to desired position and line up the standoffs with the mounting holes.

9. Insert standoffs in the appropriate horizontal or vertical mounting holes.
10. Tighten standoffs to secure PCB Assembly.
11. Replace faceplate and tighten "Pull Here" knobs.
12. Return power to detector and replace housing cover.

See Figure 14: PCB Assembly Rotated.

Warning See Appendix, “Electrostatic Sensitive Device (ESD)" for handling electronic components.

Figure 14: PCB Assembly Rotated



AppendixA:

Electrostatic Sensitive Device (ESD)

Electrostatic discharge (ESD) is the transfer, between bodies, of an electrostatic charge caused by direct contact or induced by an electrostatic field.

The most common cause of ESD is physical contact. Touching an object can cause a discharge of electrostatic energy—ESD! If the charge is sufficient and occurs near electronic components, it can damage or destroy those components.

In some cases, damage is instantaneous and an immediate malfunction occurs. However, symptoms are not always immediate—performance may be marginal or seemingly normal for an indefinite period of time, followed by a sudden failure.

- To eliminate potential ESD damage, review the following guidelines:
- Handle boards by metal shields—taking care not to touch electronic components
- Wear grounded wrist or foot straps, or ESD shoes or heel grounders to dissipate unwanted static energy
- Prior to handling boards, dispel any charge in your body or equipment
- Ensure components are transported and stored in static safe packaging
- When returning boards, carefully package in the original carton and static protective wrapping
- Ensure ALL personnel are educated and trained in ESD Control Procedures

In general, exercise accepted and proven precautions normally observed when handling electrostatic sensitive devices.

A warning label is placed on the packaging, identifying product using electrostatic sensitive semiconductor devices.

AppendixB: Resistance Table

Distance (Feet)	AWG #20	AWG #18	AWG #16	AWG #14	AWG #12	AWG #10	AWG #8
100	1.02	0.64	0.40	0.25	0.16	0.10	0.06
200	2.03	1.28	0.80	0.51	0.32	0.20	0.13
300	3.05	1.92	1.20	0.76	0.48	0.30	0.19
400	4.06	2.55	1.61	1.01	0.64	0.40	0.25
500	5.08	3.20	2.01	1.26	0.79	0.50	0.31
600	6.09	3.83	2.41	1.52	0.95	0.60	0.38
700	7.11	4.47	2.81	1.77	1.11	0.70	0.44
800	8.12	5.11	3.21	2.02	1.27	0.80	0.50
900	9.14	5.75	3.61	2.27	1.43	0.90	0.57
1000	10.20	6.39	4.02	2.53	1.59	1.09	0.63
1250	12.70	7.99	5.03	3.16	1.99	1.25	0.79
1500	15.20	9.58	6.02	3.79	2.38	1.50	0.94
1750	17.80	11.20	7.03	4.42	2.78	1.75	1.10
2000	20.30	12.80	8.03	5.05	3.18	2.00	1.26
2250	22.80	14.40	9.03	5.68	3.57	2.25	1.41
2500	25.40	16.00	10.00	6.31	3.97	2.50	1.57
3000	30.50	19.20	12.00	7.58	4.76	3.00	1.88
3500	35.50	22.40	14.10	8.84	5.56	3.50	2.21
4000	40.60	25.50	16.10	10.00	6.35	4.00	2.51
4500	45.70	28.70	18.10	11.40	7.15	4.50	2.82
5000	50.10	32.00	20.10	12.60	7.94	5.00	3.14
5500	55.80	35.10	22.10	13.91	8.73	5.50	3.46
6000	61.00	38.30	24.10	15.20	9.53	6.00	3.77

Appendix B: Resistance Table (cont'd)

Distance (Feet)	AWG #20	AWG #18	AWG #16	AWG #14	AWG #12	AWG #10	AWG #8
6500	66.00	41.50	26.10	16.40	10.30	6.50	4.08
7000	71.10	44.70	28.10	17.70	11.10	7.00	4.40
7500	76.10	47.90	30.10	19.00	12.00	7.49	4.71
8000	81.20	51.10	23.10	20.20	12.70	7.99	5.03
9000	91.40	57.50	36.10	22.70	14.30	8.99	5.65
10000	102.00	63.90	40.20	25.30	15.90	9.99	6.28

Note: Resistance shown is one way. This figure should be doubled when determining closed loop resistance

AppendixC: Sensor Specifications

Sensor Specifications	
Operating Temperature Range	-40°C to + 85°C (-40F to +185F)
Weight	0.1 Kg(0.2 lb)
Enclosure Material	Powder Coated or Anodized Aluminum(optional stainless steel)
Range of Detection	0 to 100% LEL of most hydrocarbons and hydrogen
Accuracy	±3% LEL up to 50%LEL ±5% LEL above 50% LEL
Response Time	<10 seconds to T50 < 30 seconds to T90
Linearity/Repeatability	±3% LEL / ±2% LEL
Certification	CSA and NRTL/C certified for hazardous locations. Class 1, Division 1,Groups B,C and D. IEC Rating Ex d IIB+H2 T5. Performance certified to CSA C22.2 No. 152

Controller Specifications

Millennium Controller Specifications					
Millennium	**4-20mA Analog Output**	**Low Power board 4-20 mA Analog and Relay Output (Solid State) display dimmed**	**4-20mA with Relay Output module**	**Low Power board 4-20 mA Analog Output (disabled) and Relay Output (Solid State) display dimmed**	**RS-485 MODBUS RTU Digital Communications**
Power Consumption 12VDC	Maximum 1.88 W	Maximum 1.68 W	Maximum 2.42 W	Maximum 1.38 W	Maximum 2.18 W
Power Consumption 12V dc @ 50 span	Maximum 2.12 W	Maximum 1.72 W	Maximum 2.58 W	Maximum 1.41 W	Maximum 2.23 W
Power Consumption 24VDC	Maximum 2.09 W	Maximum 1.85 W	Maximum 2.54 W	Maximum 1.56 W	Maximum 2.33 W
Power Consumption 24V dc @ 50 span	Maximum 2.26 W	Maximum 1.90 W	Maximum 2.76 W	Maximum 1.59 W	Maximum 2.38 W
In-Rush Current @ 24VDC	5.0A @10µs-40µs 0.080A after 2ms	5.0A @10µs-40µs 0.040A after 2ms	5.3A @10µs-40µs 0.120A after 2ms	4.6A @10µs-40µs 0.32A after 2ms	4.8A @10µs-40µs 0.112A after 2ms
Operating voltage	10.5 to 32VDC				
Operating temp range	Operational -50°C to +85°C (-58F to + 185F) / Certified -40°C to +85°C (-40F to + 185F)				
Humidity Range	0 to 100% Relative humidity, non- condensing				
Enclosure material	Powder coated Copper Free Cast Aluminum				
Weight	3.2 kg (7.0 lb)				
Certifications	CSA and NRTL/C certified for hazardous locations. Class 1, Division1, Groups C and D. Temperature Code T6. IEC Rating Ex dIIB T6 (Class 1, Zone 1, Group IIB T6). Maximum operating ambient of 85°C. Enclosure Type 4X. Note: Electronics only- CSA and NRTL/C certified for hazardous locations Class 1, Division 2 , Groups A,B,C and D.				
	4 to 20 mA - Into a maximum loop impedance of 800 Ohms @32 VDC or 150 Ohms at 10.5 VDC. Isolated or non-isolated loop supply. **Premium version -** Form C contacts rated 5 Amps at 30 VDC / 250 VAC. Selectable energized / de-energized, latching/non-latching configurable low and high alarms. Fault relay is factory set as energized, non-latching and cannot be modified**.** **Low Power Version-**Form A contacts rated 2.5 Amps at 60 VAC/DC. Selectable energized / de-energized latching/non S latching configurable low and high alarms. Fault relay is factory set as energized, non-latching and cannot be modified. Digital RS 485 Modbus RTU Protocol.				

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http://www.net-safety.com/service/product_services.html

NET SAFETY MONITORING INC.

PHOENIX

Triple Infrared Flame Detector

User Manual

Models:

IR3S-A, IR3S-R, IR3S-D, IR3S-AD

ISO 9001:2000

QMI REGISTERED

MAN-0044 Rev 13 IR3S-XX
March 03, 2008

IMPORTANT INFORMATION

This manual is for informational purposes only. Although every effort has been made to ensure the correctness of the information, technical inaccuracies may occur and periodic changes may be made without notice. Net Safety Monitoring Inc., assumes no responsibility for any errors contained within this manual.

If the products or procedures are used for purposes other than as described in the manual, without receiving prior confirmation of validity or suitability, Net Safety Monitoring Inc., does not guarantee the results and assumes no obligation or liability.

No part of this manual may be copied, disseminated or distributed without the express written consent of Net Safety Monitoring Inc.

Net Safety Monitoring Inc., products are carefully designed and manufactured from high quality components and can be expected to provide many years of trouble free service. Each product is thoroughly tested, inspected and calibrated prior to shipment. Failures can occur which are beyond the control of the manufacturer. Failures can be minimized by adhering to the operating and maintenance instructions herein. Where the absolute greatest of reliability is required, redundancy should be designed into the system.

Warranty

Net Safety Monitoring Inc., offers a pro-rated 7 year warranty on the IR3S, from date of purchase.

No other warranties or liability, expressed or implied, will be honoured by Net Safety Monitoring Inc.

Contact Net Safety Monitoring Inc., or an authorized representative for details.

We welcome your input at Net Safety Monitoring. If you have any comments please contact us at the phone/address below or visit our web site and complete our on-line customer survey: www.net-safety.com.

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INTRODUCTION

The Phoenix, Net Safety's latest flame detection product, is a triple spectrum IR fire detector designed to respond to infrared radiation emitted by a wide range of hydrocarbon based fires.

The three IR sensors allow the Phoenix to extend detector range, reduce the number of detectors required, produce substantially fewer false alarms and draw less power than many other products on the market.

The Phoenix is suitable for indoor and outdoor applications and has been tested and proven reliable in extreme environmental conditions.

LOCATE DETECTOR

When positioning fire detectors, consider such factors as distance from the fire, type of fuel and temperature, as well as any environmental factors which may influence the detector's response to radiation.

Typical applications

- automotive-manufacturing and paint spray booths
- aircraft hangars (commercial and military)
- offshore platforms, refineries, pipelines and production ships
- printing industry facilities
- oil, gas and petrochemical refineries/production/storage/off loading/shipping
- various production, processing and storage facilities
- munitions handling
- warehouses (flammable liquids/toxic gases) and tank farms (floating/non-floating)
- power generation pumps, generators and unmanned stations

Potential Ignition Sources

The following are examples of some potential ignition sources:

- alcohol
- gasoline
- paint
- aviation fuel
- acetylene
- natural gas
- solvents
- heptane/naptha
- diesel and hydraulic fuel
- liquefied natural gas (LNG)
- liquefied petroleum gas (LPG)
- propane/methane/butane

Potential Inhibitors

A potential inhibitor is anything located between the detector and a potential fire source which could prevent the Phoenix from detecting a fire or reduce its sensitivity to fire. Possible inhibitors include but are not limited to the following:

- Solid objects such as machinery, glass or plexiglass between the detector and potential fire source
- Excess water, fog, rain, dirt or dust on the detector window or heavy smoke between the detector and potential fire source

Immune

The Phoenix exhibits excellent immunity to many conditions/activities including but not limited to the following:

- hot body radiation
- sunlight (direct/reflected)
- arc welding radiation
- lightning
- artificial lighting
- water surface flicker

Sensitivity

The practical application distance is directly related to the intensity of the IR radiation source.

Table 1: Summary of Distances

Response Testing			
Fuel	**Size**	**Distance (ft)**	**Average Response Time (Seconds)**
n-Heptane	1' x 1'	100	2.24
Methane	30" Plume	110	4.46
Methanol	1' x 1'	100	9.86
Ethanol	1' x 1'	90	1.62

NOTE: The response time is based on zero time delay and maximum sensitivity.

Field of View (As per FM and NFPA definition)

The area in front of a flame detector, where a standardized flame can be detected and which is specified by distance and angle off the central axis, is the Field of View. The referenced flame is moved to 50% of the maximum on-axis detection distance and then moved off-axis horizontally and vertically to the limit of detection. These off-axis angle limits specify Field of View.

Table 2: Field of View Testing

Field of View Testing			
Fuel	**Size**	**Horizontal Degrees**	**Vertical Degrees**
n-Heptane	1' x 1'	100 (+50, -50)	100 (+50, -50)
Methane	30" Plume	90 (+45, -45)	90 (+45, -45)
Methanol	1' x 1'	90 (+45, -45)	90 (+45, -45)
Ethanol	1' x 1'	90 (+45, -45)	90 (+45, -45)

NOTE: Data based on Maximum Sensitivity Setting.

Installation Considerations

The following should be considered when mounting the Phoenix.

- Point detector toward where the flame is expected.
- Ensure an unobstructed view of the area to be monitored.
- Employ more than one detector to ensure the hazard is fully covered.
- Mount the detector a few feet (about 1 metre) below the ceiling so it can respond before being blocked by smoke accumulation at the ceiling.
- If dense smoke is likely to accumulate prior to flame (as in an electrical fire), supplement IR detector(s) with other protection such as Net Safety Monitoring Airborne Particle Monitor.
- The detector should be accessible for cleaning.
- Tilt detector downward a minimum of 10 to 20° to reduce dirt and dust accumulation which could obscure the detector's viewing window.
- Securely mount detector so as to reduce vibration as much as possible.
- When located outside, detector sensitivity can be reduced by heavy fog, rain and/or ice.
- Consider shortening the time delay settings when smoke is expected to accumulate before or during a fire (refer to "System Sensitivity").
- Reduce sensitivity setting if false alarms, related to surrounding activities, occur (refer to "System Sensitivity").
- If a detector is located close to an intense flickering IR source, the detector's sensitivity may be affected.
- When installed near or on water (such as an off shore platform), be sure to take into account the low horizon level when tilting detector downward.

- For protection against line surge and extraneous transients, it is required to install detector wires in a braided flexible conduit less than 5 feet.

UNPACK

Carefully remove all components from the packaging. Check components against the enclosed packing list and inspect all components for obvious damage such as broken or loose parts.

If you find any components missing or damaged, notify the representative or Net Safety Monitoring immediately.

Figure 1: Detector and Swivel Mount

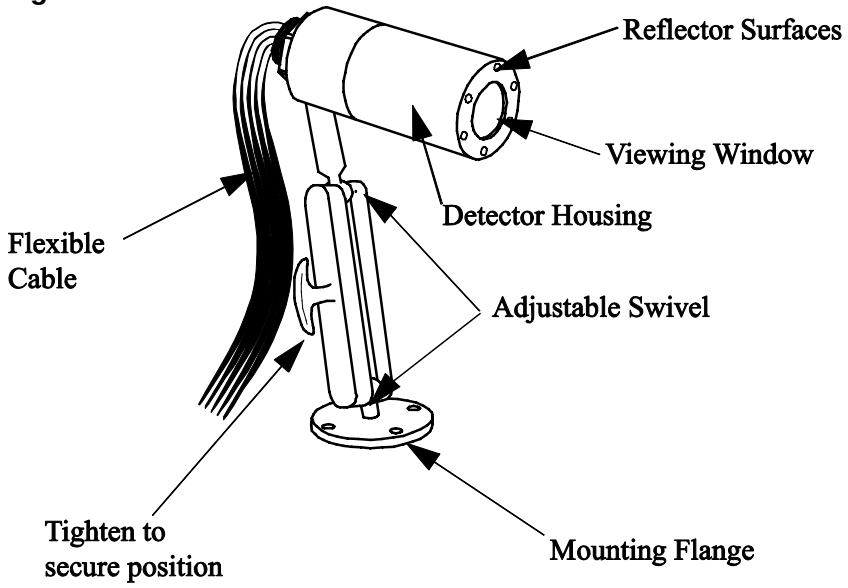
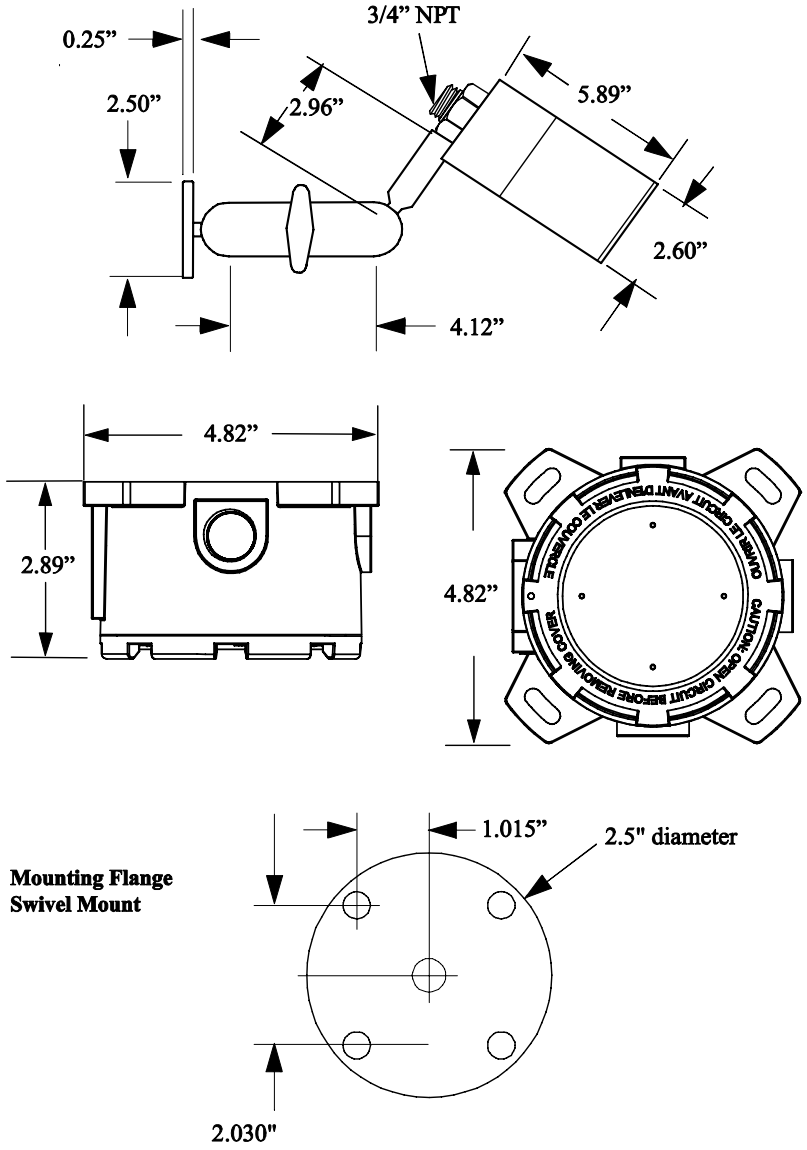


Figure 2: Dimensional Drawing



FIELD INSTALLATION

WARNING:

- Wiring codes and regulations may vary. Compliance with regulations is the responsibility of the installer. Wiring must comply with applicable regulations relating to the installation of electrical equipment in a hazardous area. If in doubt, consult a qualified official before wiring the system.
- Do not open the housing and expose the electronics in a classified area (Do not open when an explosive atmosphere may be present)

Wiring

For protection against line and extraneous transients, it is required to install detector pig tail lead wires in a braided flexible conduit less than 5 feet in length to the termination box. From the termination box to the power supply the recommended detector cable is three conductor for IR3S-A up to 6 conductor for IR3S-R, shielded 18 AWG rated 300 V for distances up to 150 feet; 16 AWG rated 300 V for distances of 150-2000 feet. When cable is installed in conduit, the conduit must not be used to support wiring to other electrical equipment. The maximum distance between the detector and the power supply is limited by the resistance of the connecting wiring, which is a function of the gauge of the wire being used. Refer to “Appendix B, Resistance Table (Ohms)".

Grounding

Proper shielding and grounding procedures, for the specific area must be followed. Consult local electrical code.

Sealing

Water-proof and explosion-proof conduit seals are always recommended to prevent the accumulation of moisture within the junction box. Seals should be located as close to the device as possible and not more than 18 inches (46 cm) away. Explosion-proof installations may require an additional seal where conduit enters a non-hazardous area. When pouring a seal, use a fibre dam to ensure proper formation of the seal. Seals should never be poured at temperatures below freezing.

The jacket and shielding of the cable should be stripped back to permit the seal to form around the individual wires. This will prevent air, gas and water leakage through the inside of the shield and into the enclosure.

It is recommended that explosion-proof drains and conduit breathers be used. Changes in temperature and barometric pressure can cause 'breathing' which allows moist air to enter the conduit. Joints are seldom enough to prevent this 'breathing'.

CONNECTING

The Phoenix can be either an Analog, Analog/Digital, Relay or Digital model. Refer to the following tables for specifics regarding connections for the various models. A termination junction box can be also be supplied by Net Safety if required.

WARNING: Prior to wiring, ensure power is disconnected. Improper wiring can cause damage to the detector.

Isolated Power Configuration (IR3S-A or IR3S-AD only)

If a separate power supply is used to isolate current output, a jumper must be placed over the two pins marked EXT. If a separate power supply is not required, the jumper must remain in the default INT position.

Figure 3: Current Output Isolated/Non-isolated Jumper Placement

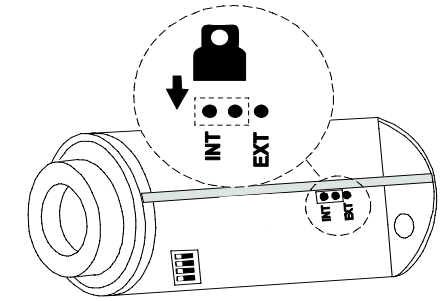


Table 3: Wire Color Coding — IR3S-A (ANALOG)

FLAME DETECTOR WIRE CODING	
Wire Color	**Function**
Green	Earth Ground (GND)
Red	10.5–32 Vdc (+)
Black	Com (-)
Purple	Isolated Power (+) (ISO)
Yellow	4-20mA Signal Output

Table 4: Wire Color Coding — IR3S-R (RELAY)

FLAME DETECTOR WIRE CODING	
Wire Color	**Function**
Green	Earth Ground (GND)
Red	10.5–32 Vdc (+)
Black	Com (-)
Orange	Alarm Relay
Orange	Alarm Relay
Violet	Fault Relay
Violet	Fault Relay

WARNING: If terminations are being done in a Net Safety Multi-Purpose Junction Box, refer to MAN-0081 for specific terminal designations.

WARNING: Analog units use the purple wire (Terminal Marked ISO) to isolate the current output when using a separate power supply (refer to Figure 3 - Isolated Power Configuration (IR3S-A or IR3S-AD only)).

Table 5: Wire Color Coding—IR3S-AD (ANALOG / DIGITAL)

FLAME DETECTOR WIRE CODING	
Wire Color	**Function**
Green	Earth Ground (GND)
Red	10.5–32 Vdc (+)
Black	Com (-)
Blue	A (Communication)
Brown	B (Communication)
Purple	Isolated Power (+) (ISO)
Yellow	4-20mA Signal Output

Table 6: Wire Color Coding — IR3S-D (DIGITAL)

FLAME DETECTOR WIRE CODING	
Wire Color	**Function**
Green	Earth Ground (GND)
Red	10.5–32 Vdc (+)
Black	Com (-)
Blue	A (Communication)
Brown	B (Communication)

NOTE: Up to 254 Analog / Digital units can be included in the chain. **An end of line Resistor (120-150 Ohms)MUST be included between the A and B Terminals in the last junction box.**

DETECTOR SETUP

SYSTEM SENSITIVITY

DIP Switch Access

DIP Switches are used to define various functional settings and are located on the internal electronics module of the Phoenix. Simply slide a DIP Switch to the ON or OFF position (as marked in Figure 4). Also refer to Table 7 for DIP Switch positioning instructions.

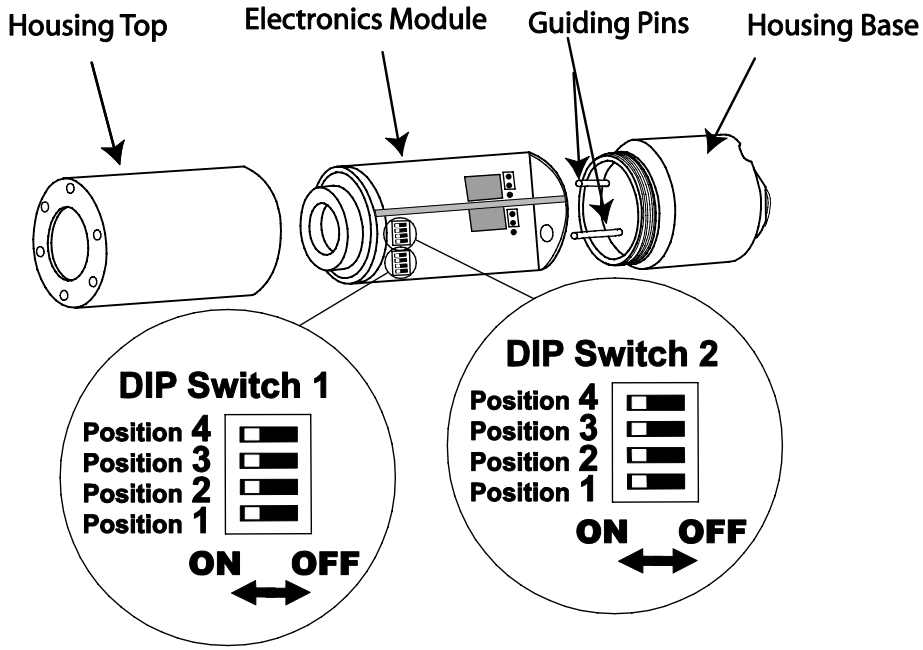
WARNING: ⚠ Do not open the fire head in a classified area. The area must be de-classified prior to opening the fire head.

WARNING: ⚠ Do not touch internal components other then the DIP Switches (refer to Appendix A, Electrostatic Sensitive Device (ESD).

Relay
The Relay Phoenix uses two sets of DIP Switches.
DIP Switch #1 is used for defining Sensitivity and Time Delay.
DIP Switch #2 is used for defining the Relay setting; it is only available for relay models and only position 2 is used.
Refer to Table 7 and 8 for dip switch positioning instructions.

Analog
The Analog Phoenix uses only DIP Switch #1 to define Sensitivity and Time Delay settings.
Refer to Table#7 for dip switch positioning instructions.

Figure 4: DIP Switch Location



Time Delay Setting

Defining a Time Delay setting allows the Phoenix to delay (for specified period) before indicating a fire alarm. This feature can be beneficial depending upon the conditions/activities surrounding the detector.

TIP: To avoid false alarms caused by momentary background IR, leave the Time Delay setting in the default position of 7 seconds. Avoid setting the Time Delay to zero.

Sensitivity Setting

The adjustable Sensitivity setting is used to optimize the Phoenix for a particular application.

When selecting Low or High Sensitivity, consider the following:

- Size of potential fire
- Distance between possible fire and detector
- Type of flammable substance to be detected
- Environmental factors

Response time can vary depending on the intensity and type of fire.

Table 7: Sensitivity and Time Delay Settings (DIP Switch #1)

DIP Switch #1	Time Delay	
	Position 1	Position 2
0 Seconds	ON	ON
3 Seconds	ON	OFF
5 Seconds	OFF	ON
7 Seconds (default)	OFF	OFF

Sensitivity	
Position 3	
ON	High
OFF	Low (default)

Note: Default settings are set for Low Sensitivity and a 7 second Time Delay.

RELAY SETTINGS (IR3S-R ONLY)

Coil Status Setting

The Fire relay can be set to normally Energized or normally De-energized using DIP Switch #2, Position 2 (refer to Figure 8).

NOTE: The Fault relay is fixed as Energized and both relays are fixed as Non-Latching.

Table 8: Relay Setting (Dip Switch #2)

DIP Switch #2	DIP Setting	Relay State	Alarm
Position 2	OFF	Normally Energized	Fire
	ON	Normally De-energized (factory default)	

Relay Contact Setting

The Fire and Fault relay contacts can be selected as Normally Open or Normally Closed using Jumpers. Simply position the Jumper over two of the pins to define the Normally Open/Closed Fire or Fault relay contacts (refer to Figure 5 and Table 9 for settings).

Fig 5: Normally Open or Normally Closed Jumpers.

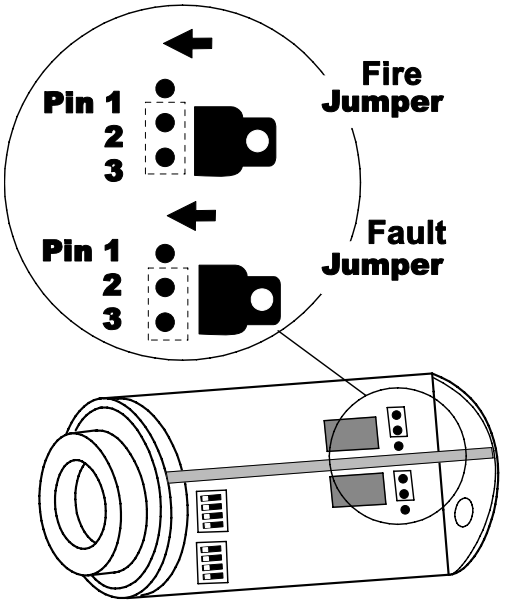


Table 9: Relays Contact

Jumper Position	Function
Pin 1 & 2	Normally closed (NC)
Pin 2 & 3	Normally Open (NO) factory default

Table 10: Fire Alarm Relay States

	Unpowered	Powered	Alarm (FIRE)
Energized/NO	OPEN	CLOSED	OPEN
Energized/NC	CLOSED	OPEN	CLOSED
De-energized/NO	OPEN	OPEN	CLOSED
De-energized/NC	CLOSED	CLOSED	OPEN

Table 11: Fault Alarm Relay States

	Unpowered	Powered	Alarm (FAULT)
Energized/NO	OPEN	CLOSED	OPEN
Energized/NC	CLOSED	OPEN	CLOSED

MODBUS RTU (IR3S-D & AD)

Install Phoenix PC Set Up Software

In order to program various settings required for the Modbus RTU protocol, user-interface software is required.

The software is available for download from Net Safety's web site: www.net-safety.com/technical_support.html.

1. The Phoenix PC Set Up folder must be copied onto the desktop.
2. Open the Phoenix PC Set Up folder and double click on dotnetfx.exe (this is a onetime only install required with Windows).
3. Double click on Setup.exe to install the Phoenix set up software. A shortcut will be placed on the desktop.

WARNING: An RS-232 to RS-485 converter is required to communicate with the detector and perform Modbus set up. An external power supply (12 V or 24 V depending on the converter used) is required to power up the detector during Modbus set up.

Table 12: Wiring for Modbus Detector Set Up

Converter	Detector
A	Blue wire
B	Brown wire
Gnd	Black wire
A+	Red wire

Note: On the Analog /Digital model (AD), ignore the yellow and purple wires for set up.

Table 13: Available Baud Rates

Baud rate 4800bps
Baud rate 9600bps
Baud rate 14_4kbps
Baud rate 19_2kbps (default)
Baud rate 28_8kbps
Baud rate 38_4kbps
Baud rate 57_6kbps

Note: Baud rate 2400 is not available at this time.

Modbus Set Up

A node address must be assigned and a baud rate specified for each Phoenix in the chain, one at a time. The baud rate is set using the Phoenix Set Up

software; the address is also set using this software and a DIP Switch must be used to confirm the address assignment.

The Modbus Phoenix uses DIP Switch #1, Position 4 to confirm the address assignment for each detector (refer to Table 14 for detailed information).

Table 14: Digital Modbus RTU Setting (DIP Switch #1, Position 4)

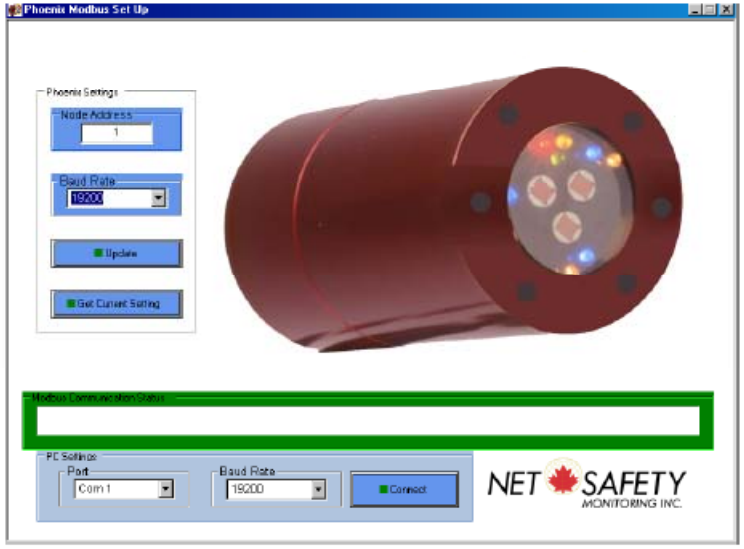
DIP Switch #1	Modbus RTU Setting	
Position 4	ON	Confirm address set up once power recycled
	OFF	Reset Node Address (default is Address 1)

1. Ensure Position 4 of DIP Switch #1, is set to OFF.
2. Connect a Phoenix using a RS-232 to RS-485 Converter.
3. Start the Phoenix Modbus Set Up program.
4. Set up the computer communication by selecting a **Port** and **Baud Rate** under the PC Settings at the bottom of the screen.
5. Click on the **Connect** button at the bottom of the screen (the button will then change to "Connected").
6. Click on the **Get Current Settings** button (if necessary, make a note of existing settings).
7. The message **OK** should appear under Modbus Communication Status.
8. Under Phoenix Settings enter the new Node Address for the detector.
9. Select the Baud Rate for the detector (refer to Table 13).
10. Click on the **Update** button under the Phoenix Settings.
11. The message **OK** should appear under Modbus Communication Status.
12. Close Phoenix Modbus Set UP software (close connection).
13. Turn off power to the detector.
14. Move Position 4 of DIP Switch #1, to the ON position (this will confirm the address set up).
15. Turn on power to the detector and repeat for all detectors in the chain.

Note: Each time a change is made to the RTU setting (DIP #1, Position 4), power to the detector must be cycled.

TIP: Make a note of the newly assigned Node Address for each unit.

Figure 6: Phoenix Modbus Set Up



Get Current Setting

Click to display the current Modbus set up of the connected Phoenix.

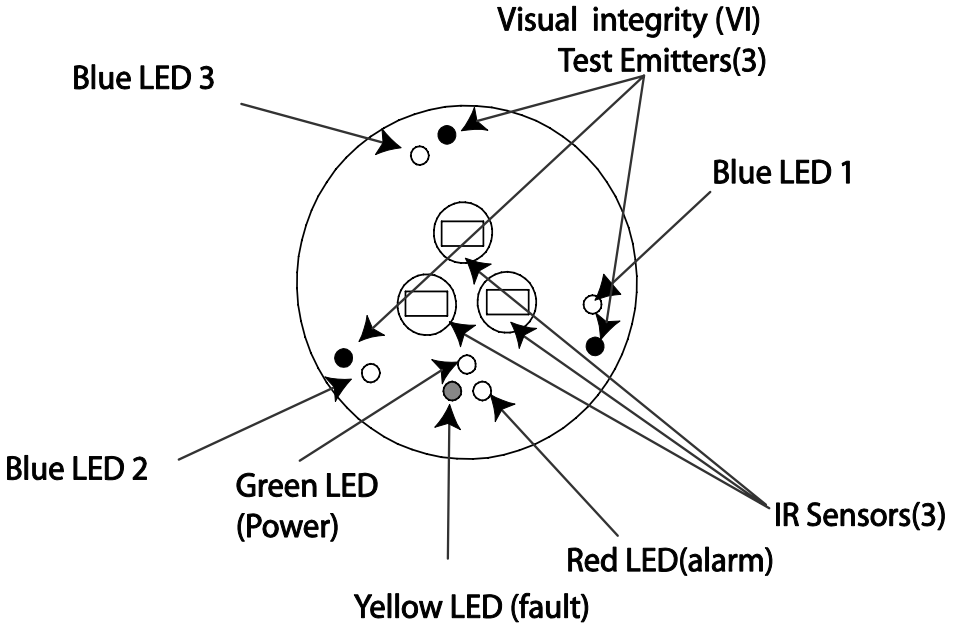
Modbus Set Up Failure/Reset

If the Modbus Set Up fails or the connected Phoenix is not recognized (the message **Failed** will appear under Modbus Communication Status when the Connect button is pressed), the connected detector needs to be reset.

1. Turn off power to the unit.
2. Move DIP Switch #1, Position 4 to OFF.
3. Turn on power to the unit.
4. The connected device(detector) returns to default Node Address 1.
5. Repeat the Modbus Set Up process.

DETECTOR FUNCTIONALITY

Figure 7: Detector Viewing Window



START UP PROCEDURE

Once powered up, the Phoenix begins a start up routine. The three Blue LEDs are Solid, and the Green LED Flashes. After approximately 30 seconds the Blue LEDs will turn off and the Green LED will turn Solid indicating normal operation. During start up, the current output is 3.0 mA for approximately 30 seconds at which time the unit begins normal operation and current output increases to 4.0 mA.

MONITOR

The Detector's status can be determined by monitoring the current loop (Table 15) and the IR sensor LEDs or coloured condition LEDs (Table 16).

Condition Status—Current Output

The following table defines the current output status for the Phoenix during various detector conditions.

Table 15: Current Output Status

Condition	Current Output
No Power Fault	0 mA
VI Test Failure - VI Testing (Warning)	2.0 mA
Start delay/Start up	3.0 mA
Normal Operation	4.0 mA
Early Warning - probable fire	16 mA
Fire confirmed	20 mA

Condition Status—LEDs

There are six (6) LEDs used to indicate the status and condition of the detector.

Note that there are three Blue LEDs—one for each IR sensor. These Blue LEDs only activate when the particular IR sensor is affected.

Table 16: Status LEDs

LED Status	IR Sensor LEDs			Condition LEDs		
	Blue 1 LED	Blue 2 LED	Blue 3 LED	Green LED (Power)	Red LED (Alarm)	Yellow LED (Fault)
Power up - >30 second start delay	Solid	Solid	Solid	Flashing	off	off
Normal Operation	off	off	off	Solid	off	off
VI Test Failure	Flashing	Flashing	Flashing	Solid	off	Flashing
VI Testing OK	off	off	off	Solid	off	off
Early Warning - probable fire	Flashing	Flashing	Flashing	Solid	off	off
Fire confirmed	Solid	Solid	Solid	Solid	Solid	off

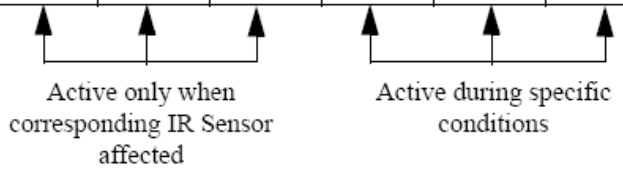


Table 17: RTU Status (Register 40001) Read Only

RTUfire_power_up	0x0001	0000 0000 0000 0001B	Power up delay
RTUfire_vi_fault	0x0002	0000 0000 0000 0010B	Failed self test
RTUfire_normal	0x0004	0000 0000 0000 0100B	Fire heads normal operation
RTUfire_fault	0x0008	0000 0000 0000 1000B	Fire heads fault
RTUfire_warning	0x0040	0000 0000 0100 0000B	Probable fire warning
RTUfire_alarm	0x0080	0000 0000 1000 0000B	Fire present

Automatic Digital Zoom (ADZ)

If a fire is located at an extreme distance, the infrared characteristics may not be at levels needed for proper detection. To accommodate this occurrence, the Phoenix measures the flicker frequency and compares it to an internal data table. If the sensor data gained is within given parameters, the Automatic Digital Zoom (ADZ) will increase the gain of the input signal until the sensors can measure the infrared wavelengths of the fire. The three detection wavelengths have been specifically selected to ensure the greatest degree of fire recognition with the least amount of false fire detection.

TESTING

Automatic Visual Integrity (VI) Test

To evaluate the cleanliness of the lens and verify the function of the detection circuits, the Phoenix performs an automatic Visual Integrity (VI) test every 3 minutes.

If accumulation of material on the surface of the lens reaches a factory calibrated preset level, which could substantially reduce flame detection sensitivity, the Phoenix will transmit a VI fault signal indicating that the cause of the fault should be investigated and, if necessary, the window cleaned. Refer to Table 18 for fault types and possible solutions

Note: Unusual heavy oil accumulations may not be easily detected by the internal VI Test, but are easily identified by an observer during regular inspections.

MAINTAIN

Monitoring the VI fault signal is only part of the necessary routine to ensure the safe operating condition of the detector. If conditions exist, whereby foreign materials could accumulate on the detector's lens, maintenance routines should include regular visual inspection of the detector and cleaning when necessary, by qualified personnel.

Clean The Window/Lens

When cleaning the window/lens, use the cloth and the cleaning solution provided with the detector. Use only the cleaning solution provided, as some cleaners may leave a residue or film that blocks IR radiation.

WARNING: Always bypass Alarm Output when performing maintenance tasks and ensure that all external equipment are disconnected/ deactivated.

O-ring

The rubber o-ring on the detector housing is used to ensure the detector is watertight. The housing should be opened periodically and the o-ring inspected for breaks, cracks or dryness. To test the o-ring, remove it from the detector housing and stretch it slightly. If cracks are visible, the o-ring should be replaced. If it feels dry to the touch, a thin coating of lubricant should be applied (such as polyalphaolefin grease). When re-installing the o-ring, be sure that it is properly seated in the groove on the housing.

The o-ring must be properly installed and in good condition to prevent water from entering the detector and causing failure. The life expectancy of rubber o- rings varies depending on the type and amount of contaminants present in the area. The person who maintains the system must rely on experience and common sense to determine how frequently the rings should be inspected. A coating of lubricant should also be applied to the enclosure threads before reassembling the detector to help prevent moisture from entering.

TROUBLE SHOOT

The occurrence of a false alarm may be due to various factors. In order to determine the source of a false alarm, keep accurate records of alarms including time, date, weather conditions, activities in area, etc. Consult the following table for possible solutions to false alarm conditions.

Table 18: Possible Problems and Solutions

Current O/P	Green	Yellow	Red	Blue 1	Blue 2	Blue 3	Possible Problem	Possible Solution
0 mA	-	-	-	-	-	-	Microprocessor Failure	Consult factory
0 mA	Off	Off	Off	Off	Off	Off	Shorted signal output ,Loss of Power or Loose Wire	Check wiring Check power source at unit. Check power supply (should be between 10.5-32 V dc)
1.0 mA	Off	Flashing	Off	-				
1.5 mA	On	Flashing	Off	Off			Temperature out of range	Environmental issue
2 mA	Solid	Flashing	Off	Affected Sensor LED will Flash			VI (visual integrity) warning	Clean Lens (use Net Safety Monitoring Lens cleaner only) Check IR source bulb(s)
Phoenix Modbus Set Up Software Error Messages								
Wr Failed							Wrong COM port or Baud rate selected for System/Detector communication DIP Switch improperly set	Change the COM or Baud rate (refer to "**Error! Reference source not found.**") Ensure DIP #1, Position 4 is set to OFF (refer to "**Error! Reference source not found.**")
Failed							Wrong COM port or Baud rate selected for Computer	Change the COM or Baud rate (refer to "**Error! Reference source not found.**" or "Modbus Set Up Failure/Reset")

HOW TO RETURN EQUIPMENT

A Material Return Authorization number is required in order to return equipment. Please contact Net Safety Monitoring at **(403) 219-0688** before returning equipment or consult our Service Department to possibly avoid returning equipment.

If you are required to return equipment, include the following information:

1. A Material Return Authorization number (provided over the phone to you by Net Safety).
2. A detailed description of the problem. The more specific you are regarding the problem, the quicker our Service department can determine and correct the problem.
3. A company name, contact name and telephone number.
4. A Purchase Order, from your company, authorizing repairs or request for quote.
5. Ship all equipment, prepaid to:

   Net Safety Monitoring Inc
   2721 Hopewell Place NE
   Calgary, Alberta, Canada
   T1Y 7J7

6. Mark all packages: **RETURN for REPAIR**

Waybills, for shipments from outside Canada, must state:

Equipment being returned for repair
All charges to be billed to the sender

Also, please ensure a duplicate copy of the packing slip is enclosed inside the box indicating item 1-4 along with the courier and account number for returning the goods.

All Equipment must be Shipped prepaid. Collect shipments will not be accepted.

Pack items to protect them from damage and use anti-static bags or aluminum- backed cardboard as protection from electrostatic discharge.

Appendix A:ELECTROSTATIC SENSITIVE DEVICE (ESD)

Electrostatic discharge (ESD) is the transfer, between bodies, of an electrostatic charge caused by direct contact or induced by an electrostatic field.

The most common cause of ESD is physical contact. Touching an object can cause a discharge of electrostatic energy—ESD! If the charge is sufficient and occurs near electronic components, it can damage or destroy those components.

In some cases, damage is instantaneous and an immediate malfunction occurs. However, symptoms are not always immediate—performance may be marginal or seemingly normal for an indefinite period of time, followed by a sudden failure.

To eliminate potential ESD damage, review the following guidelines:

- Handle boards by metal shields—taking care not to touch electronic components
- Wear grounded wrist or foot straps, or ESD shoes or heel grounders to dissipate unwanted static energy
- Prior to handling boards, dispel any charge in your body or equipment
- Ensure components are transported and stored in static safe packaging
- When returning boards, carefully package in the original carton and static protective wrapping
- Ensure ALL personnel are educated and trained in ESD Control Procedures

In general, exercise accepted and proven precautions normally observed when handling electrostatic sensitive devices.

A warning label is placed on the packaging, identifying product using electrostatic sensitive semiconductor devices.

Appendix B:RESISTANCE TABLE (OHMS)

Distance (Feet)	AWG #20	AWG #18	AWG #16	AWG #14	AWG #12	AWG #10	AWG #8
100	1.02	0.64	0.40	0.25	0.16	0.10	0.06
200	2.03	1.28	0.80	0.51	0.32	0.20	0.13
300	3.05	1.92	1.20	0.76	0.48	0.30	0.19
400	4.06	2.55	1.61	1.01	0.64	0.40	0.25
500	5.08	3.20	2.01	1.26	0.79	0.50	0.31
600	6.09	3.83	2.41	1.52	0.95	0.60	0.38
700	7.11	4.47	2.81	1.77	1.11	0.70	0.44
800	8.12	5.11	3.21	2.02	1.27	0.80	0.50
900	9.14	5.75	3.61	2.27	1.43	0.90	0.57
1000	10.20	6.39	4.02	2.53	1.59	1.09	0.63
1250	12.70	7.99	5.03	3.16	1.99	1.25	0.79
1500	15.20	9.58	6.02	3.79	2.38	1.50	0.94
1750	17.80	11.20	7.03	4.42	2.78	1.75	1.10
2000	20.30	12.80	8.03	5.05	3.18	2.00	1.26
2250	22.80	14.40	9.03	5.68	3.57	2.25	1.41
2500	25.40	16.00	10.00	6.31	3.97	2.50	1.57
3000	30.50	19.20	12.00	7.58	4.76	3.00	1.88
3500	35.50	22.40	14.10	8.84	5.56	3.50	2.21
4000	40.60	25.50	16.10	10.00	6.35	4.00	2.51
4500	45.70	28.70	18.10	11.40	7.15	4.50	2.82
5000	50.10	32.00	20.10	12.60	7.94	5.00	3.14
5500	55.80	35.10	22.10	13.91	8.73	5.50	3.46
6000	61.00	38.30	24.10	15.20	9.53	6.00	3.77
6500	66.00	41.50	26.10	16.40	10.30	6.50	4.08
7000	71.10	44.70	28.10	17.70	11.10	7.00	4.40
7500	76.10	47.90	30.10	19.00	12.00	7.49	4.71
8000	81.20	51.10	23.10	20.20	12.70	7.99	5.03
9000	91.40	57.50	36.10	22.70	14.30	8.99	5.65
10 000	102.00	63.90	40.20	25.30	15.90	9.99	6.28

Note: Resistance shown is one way. This figure should be doubled when determining closed loop resistance.

Appendix C:SPECIFICATION

Models	IR3S-A (Analog)	I3RS-R (Analog/Relay)	IR3S-AD (Analog/Digital)
Operating Voltage	10 to 32 Vdc measured at the detector		
Power Consumption (@ 24Vdc)	Nominal 30mA/ 0.72W Maximum 64mA/ 1.44W	De-Energized: Nominal 39mA/0.96W. Maximum 73mA/ 1.68W Energized: Nominal- 51mA, =1.20w). Maximum- 86mA, 2.16W	Nominal 30mA/ 0.72W Maximum 64mA/ 1.44W
Power Consumption (@ 12Vdc)	Nominal 45mA/ 0.60W Maximum 113mA/ 1.32W	De-Energized: Nominal- 66mA/0.84W. Maximum- 138mA/ 1.68W Energized: Nominal- 93mA, =1.08w) Maximum- 165mA, 2.04W	Nominal 45mA/ 0.60W Maximum 113mA/ 1.32W
In Rush Current (at 24Vdc)	Max 750 mA for 2.ms		
Output	0 to 20 mA – Into a max loop impedance of 800Ohms @ 32Vdc or 150Ohms @ 11.0Vdc. Non-Isolated loop supply	Normally open/Normally closed contacts rated for 5A @ 30Vdc/125Vac. Selectable energized/ de-energized Fire relay. Fault relay fixed as energized and both Fire & Fault relays fixed as non-latching	0 to 20 mA – Into a max loop impedance of 800Ohms @ 32Vdc or 150Ohms @ 11.0Vdc. Non-Isolated loop supply. RS-485 RTU Modbus protocol.
Field of View	100° horizontal / 100° vertical @ 50% of the on-axis detection distance.		
Spectral Range	The IR3S fire detector measures at three distinct Infrared Wavelengths		
Time Delay	DIP switch selectable 0, 3, 5, 7 seconds,		
Sensitivity Settings	Two (2) adjustable setting via DIP switch (High/Low)		
Temperature/ RH	FM Certified (-40°C to +75°C / -40°F to 167°F). Operational (-50°C to +75°C / -58°F to 167°F). 0 – 95% RH non condensing		
Metallurgy & IP/Nema Ratings	Aluminum or SS316 (factory sealed housing). IP66 and NEMA 4X		
Weight (with swivel)	2.1Kg /4.5lbs (SS316 Option @ 3.4Kg/ 7.5lbs)		
Approvals	Performance certified to: Class3260, ANSI/NEMA 250, and IEC60529. FM APPROVED C SP US Class I, Div 1, Grps BCD, T5. Ex d IIB+H2 T5. Class I, Zone 1, Grps IIB+H2, T5; Nema 4X, IP66. For **CANADA ONLY**, Class I, Div 1, Grps A (Canada ONLY – with special cementing), BCD, T5. Ex d IIB+H2 T5.		

NOTE: Performance certified by FM with maximum sensitivity setting and zero second time delay.

Appendix D:IR3S DATA

False Alarm Immunity			
Fire Alarm Source	**Distance (ft)**	**Modulated**	**Unmodulated**
Sunlight direct	--------	No Alarm	No Alarm
Sunlight indirect	--------	No Alarm	No Alarm
Arc Welder	10	No Alarm	No Alarm
1500 Watt heater	10	No Alarm	No Alarm
2 (34 Watt 4') Fluorescent Lights	10	No Alarm	No Alarm
500 Watt Halogen Light	10	No Alarm	No Alarm
400 Watt Incandescent Light	10	No Alarm	No Alarm
250 Watt Sodium Vapor Lamp	10	No Alarm	No Alarm
70 Watt Sodium Vapor Lamp	10	No Alarm	No Alarm
250 Watt Metal Halide Lamp	10	No Alarm	No Alarm
27000 Watt Propane Heater	12	No Alarm	No Alarm

Response Testing w/ Un-modulated False Alarm Stimuli Present			
False Alarm Source	**False Alarm Source Distance (ft)**	**Fire Source**	**Fire Source Distance (ft)**
Sunlight direct	----------	16" Propane Plume	25
Sunlight indirect	----------	16" Propane Plume	25
Arc Welding	10	16" Propane Plume	25
1500 Watt heater	10	16" Propane Plume	25
2 (34 Watt 4') Fluorescent Lights	10	16" Propane Plume	25
500 Watt Halogen Light	10	16" Propane Plume	25
400 Watt Incandescent Light	10	16" Propane Plume	25
250 Watt Sodium Vapor Lamp	10	16" Propane Plume	25
70 Watt Sodium Vapor Lamp	10	16" Propane Plume	25
250 Watt Metal Halide Lamp	10	16" Propane Plume	25

Response Testing w/ Modulated False Alarm Stimuli Present			
Fire Alarm Source	**Distance (ft)**	**Fire Source**	**Fire Source Distance (ft)**
Sunlight direct	----------	16" Propane Plume	25
Sunlight indirect	----------	16" Propane Plume	25
Arc Welding	10	16" Propane Plume	25
1500 Watt heater	10	16" Propane Plume	25
2 (34 Watt 4') Fluorescent Lights	10	16" Propane Plume	25
500 Watt Halogen Light	10	16" Propane Plume	25
400 Watt Incandescent Light	10	16" Propane Plume	25
250 Watt Sodium Vapor Lamp	10	16" Propane Plume	25
70 Watt Sodium Vapor Lamp	10	16" Propane Plume	25
250 Watt Metal Halide Lamp	10	16" Propane Plume	25

Net Safety Monitoring Inc.
2721 Hopewell Place NE, Calgary, AB Canada T1Y 7J7
1-866-FIREGAS (347-3427) | ph. (403) 219-0688 | fx. (403) 219-0694
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PRODUCT SERVICES CONTACT INFORMATION
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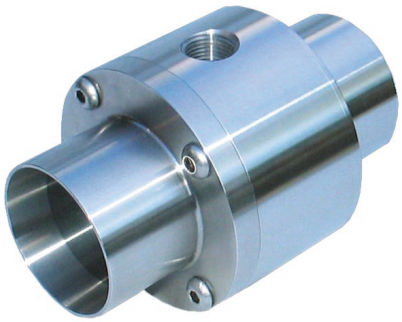
Fax: (403) 219-0694 Email: productservices@net-safety.com
http://www.net-safety.com/service/product_services.html

NET SAFETY MONITORING INC.

RING-VAC™ COMPRESSED AIR CONVEYING SYSTEM

RING-VAC™ COMPRESSED AIR CONVEYING SYSTEM



The Ring-Vac™ Compressed Air Conveying System utilizes compressed air for a powerful, efficient venturi action along its length in a compact design for high capacity conveying over large distances.

Available in both coated aluminum or high temperature stainless steel. Simply clamp a standard hose size to each end of the Ring-Vac™ Compressed Air Conveying System to create this high energy conveying system. No moving parts for maintenance free operation with capacity and flow controlled with a pressure regulator. The Ring-Vac™ Compressed Air Conveying System is available in 1" (25mm), 1-1/4" (32mm), 1-1/2" (38mm), 2" (51mm), 2-1/2" (64mm), and 3" (76mm) sizes. Any size beyond that can be prohibitive for most applications due to high compressed air requirements. In addition, beyond 3", the vacuum ability begins to drop significantly except for highly intermittent applications. For applications beyond 3", a blower system often becomes far more economical except in a rare number of possible applications. However, larger size versions are available if required as well as special sizes.

Typical applications replace expensive, high maintenance blower systems and are particularly advantageous in intermittent applications.

Automotive: Convey all sorts of items from ball bearings, screws, metal and plastic parts from machinery, moulding machines in manufacturing and in assembly operations.

Bottling: Loading and conveying caps in bottle filling lines.

Food: Convey caps, small items including food items from cheese bits to dried food. Fill or empty packaging material in shipping.

General Manufacturing: Convey all sorts of items from ball bearings, screws, metal and plastic parts. Replace costly blower systems, especially in intermittent applications.

Paper: Trim removal in paper production.

Plastic: Trim removal in converting applications.

Printing: Waste trim removal in printing applications.

Pharmaceutical: Convey pills, capsules, and tablets.

Textile: Thread conveying.

Features

- The Ring-Vac™ Air Conveying System is made of a coated aluminum body with no moving parts. Stainless steel models are available for high temperature and corrosive applications.
- Standard sizes to fit standard hose diameter for easy clamping. Threaded versions connect easily to regular pipe thread: 1" (25mm), 1-1/4" (32mm), 1-1/2" (38mm), 2" (51mm), 2-1/2" (64mm), and 3" (76mm). Special sizes can be manufactured if required.
- Utilizing a pressure regulator will control the flow material.
- Instant ON/OFF with no moving parts, no electricity or explosion hazard.

Benefits

- Longer life in difficult environments than competitive models.
- Ease of use.
- Simple and easy control of material flow.
- Maintenance free operation.

E-Mail: sales@nex-flow.com
Web Site: www.nex-flow.com

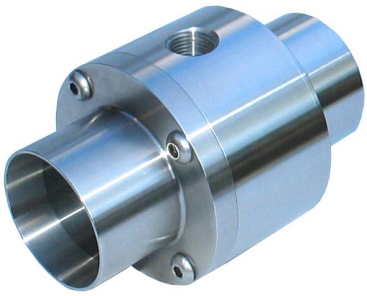
Leading Technology Into The Future
NEX FLOW™

RING-VAC™ COMPRESSED AIR CONVEYING SYSTEM

SPECIFICATIONS

Compressed Air Conveyor Systems Ring-Vac™ are available in coated aluminum and in stainless steel for high temperature applications. Special materials can be utilized for unique applications. If greater conveying force is required the conveying "generator" can be machined for higher capacities.

Outside Diameter	Model Number	Material of Construction
1"	30001	Aluminum
1-1/4"	30002	Aluminum
1-1/2"	30003	Aluminum
2"	30004	Aluminum
2-12"	30005	Aluminum
3"	30006	Aluminum
1"	30001S	High Temperature Stainless Steel
1-1/4"	30002S	High Temperature Stainless Steel
1-1/2"	30003S	High Temperature Stainless Steel
2"	30004S	High Temperature Stainless Steel
2-12"	30005S	High Temperature Stainless Steel
3"	30006S	High Temperature Stainless Steel
1"	30001T (Threaded)	Aluminum
1-1/4"	30002T (Threaded)	Aluminum
1-1/2"	30003T (Threaded)	Aluminum
2"	30004T (Threaded)	Aluminum
2-12"	30005T (Threaded)	Aluminum
3"	30005T (Threaded0	Aluminum
1"	30001TS (Threaded)	High Temperature Stainless Steel
1-1/4"	30002TS (Threaded)	High Temperature Stainless Steel
1-1/2"	30003TS (Threaded)	High Temperature Stainless Steel
2"	30004TS (Threaded)	High Temperature Stainless Steel
2-12"	30005TS (Threaded)	High Temperature Stainless Steel
3"	30006TS (Threaded)	High Temperature Stainless Steel



PERFORMANCE

MODEL	Size Outside Diameter inches (mm)	Air Consumption SCFM at 80 PSIG (SLDP at 5.5 BAR)	Vacum inches H20 (KPG))
30001/30001S/30001T/30001TS	1" (25mm)	15 (415)	-42 (-11)
30002/30002S/30002T/30002TS	1-14" (32mm)	26 (730)	-42 (-11)
30003/30003S/30003T/30003TS	1-1/2" (38mm)	33 (932)	-36 (-9)
30004/30004S/30004T/30004TS	2" ((51mm)	45 (1270)	-28 (-7)
30005/30005S/30005T/30005TS	2-1/2" (64mm)	58 (1650)	-23 (-6)
30006/30006S/30006T/30006TS	3" (70mm)	68 (1935)	-14.5 (-4)

Leading Technology Into The Future
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Fax: (416) 410-1806

INTERNET
www.nex-flow.com
sales@nex-flow.com

Flexible Connectors

Look to Silex for standard and customized flexible connectors to cover all your needs.

Most engine installations require that all piping to and from the engine be supplied with flexible connectors to absorb the vibration. Manufactured from T321 stainless steel convoluted metal hose and your choice of connection ends, Silex flexible connectors maintain the life expectancy of your exhaust system and your equipment. For connectors that compensate for thermal growth or allow motion, please refer to our expansion joint page.

Features and Benefits

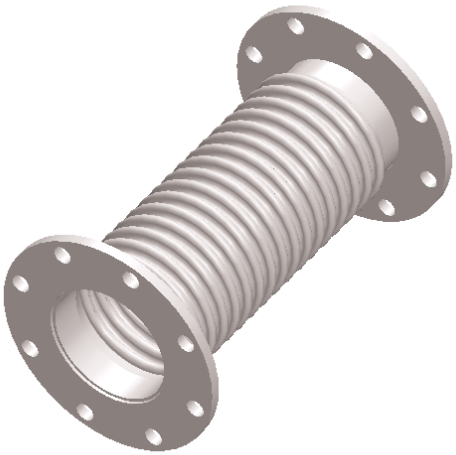
Silex offers both standard and custom connection ends to suit your specific application.

Engine specific flexible connectors are available for most OEMs including Caterpillar, Cummins, Kohler, Detroit Diesel, Mitsubishi, Generac.

Flexible connectors available wtih different size connector ends in an effort to eliminate the need for expanders when accomodating larger piping

Various lengths available to suit different applications. Standard length recommended by Silex is 18" OAL.

The result? The right flexible connector for your specific application. Tell us what you need and we can design a connector to fit. That's the Silex advantage.



Flexible Connectors

Features

- T321 Stainless steel annular corrugated hose
- Braided hose also available for higher pressure ratings
- Various connector ends available to suit specific application
- Sizes 1 1/2" & up
- Designed up to 1500 degrees F
- Stainless steel connector ends available upon request.

Benefits

- Leakproof and pressure tight
- Vibration Control
- Can resolve misalignment problems if sized correctly.

Connector Ends

- ANSI Flange 125/150#
- Male NPT
- Female Coupling (FNPT)
- Sch 40 Pipe
- I.D. Slipon
- O.D. Tubing
- OEM Specific Flanges/connectors
- Elbows
- Custom flanges

Flex Connector Types

Here are a few examples of flex connectors manufactured by Silex

ID Slipon x ID Slipon (OO)

Flared Tube x Female Coupling (CJ)

Male NPT x Elbow 90 degree w/Flange (NB)

ANSI Flange x OEM Specific Flange (FF)

Call Us

For more information on our flex connectors - as well as our complete line of exhaust products, simply give us a call.

Silex Innovations Inc.
6659 Ordan Drive, Mississauga
Ontario L5T 1K6

Phone 905 612 4000
Fax 905 612 8999
Email info@silex.com
Web www.silex.com

Lit-0032 04-10
Printed in Canada

JDDS Series

35 - 40 dBA

Silencer Selection

Call a Silex Application Engineer for immediate assistance in sizing and selecting the optimum solution for your application or use the *Silencer Selection Guide* on the reverse page to determine the appropriate silencer series based on the acoustic performance required for your application. Then choose the model in the series based on the silencer's inlet diameter. Finish by selecting the orientation from the silencer illustrations on the right.

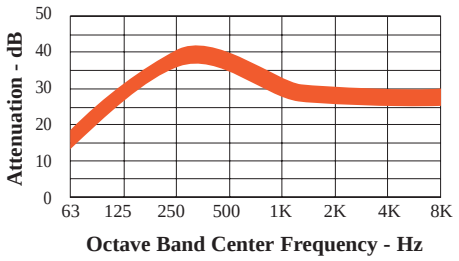
Design & Manufacturing

Silex silencers are designed and manufactured to the highest standard in the industry. In the design process, proprietary mathematical models generate predictive insertion loss levels for each unit and then each model's acoustic performance is validated empirically. Each design is then solid modeled in order to parametrically generate custom production drawings for each order. The result is application-engineered production silencers manufactured from state of the art engineering technologies. These advanced design capabilities, higher standard material specifications and exclusive *auto*WELD technology delivers silencers that are unequalled in the industry.

Acoustical Performance

The JDDS series is a standard *Hospital Grade* silencer with the insertion loss specified above. The frequency breakdown is given in the following graph.

Typical Attenuation Curve



Dimensions

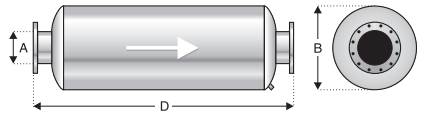
Model	A	B	C	D	F	G	H	Wt.
JDDS-1.5	1.5	9	30	36	3.5	7.5	33	49
JDDS-2	2	10	34	40	4.5	8	37	62
JDDS-2.5	2.5	12	40	46	5.5	9	43	87
JDDS-3	3	14	44	50	6	10	47	112
JDDS-3.5	3.5	16	48	54	7	11	51	139
JDDS-4	4	18	56	64	7	13	60	192
JDDS-5	5	22	64	72	9	15	68	325
JDDS-6	6	26	77	85	11	17	81	452
JDDS-8	8	30	95	103	12	19	99	701
JDDS-10	10	36	110	118	14	22	114	1020
JDDS-12	12	36	124	132	14	22	128	1357
JDDS-14	14	40	135	145	17	25	140	1655
JDDS-16	16	45	154	164	19	27.5	159	2076
JDDS-18	18	50	178	188	21	30	183	2809
JDDS-20	20	54	207	217	22	32	212	3519
JDDS-22	22	60	220	230	24	35	225	4470
JDDS-24	24	64	248	258	26	37	253	5376
JDDS-26	26	68	273	283	27	39	278	6264
JDDS-28	28	72	305	315	29	41	310	7372
JDDS-30	30	78	316	326	32	44	321	8322

Dimensions in inches, weight in pounds.

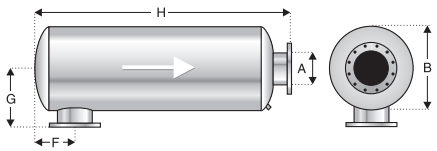
Dimensions and weights are nominal and may vary slightly in production models. Request a certified drawing of a specific model for exact dimensions.

The inlet and discharge on silencers up to 3½" are Sch. 40 NPT pipe. On silencers 4" and larger the inlet and discharge are flanged, manufactured from minimum ½" thick plate and drilled to ANSI 150 lb.

JDDS-ST



JDDS-SI



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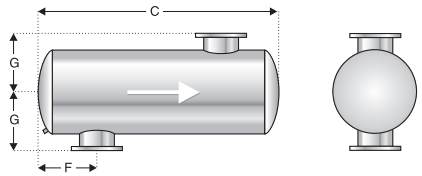

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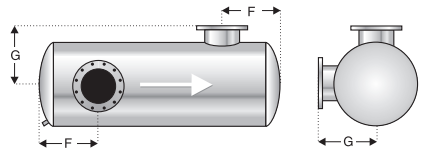
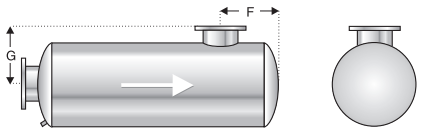
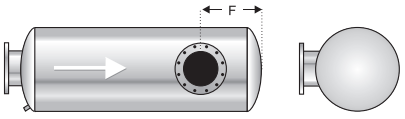


JDDS-SO12



JDDS-SO9



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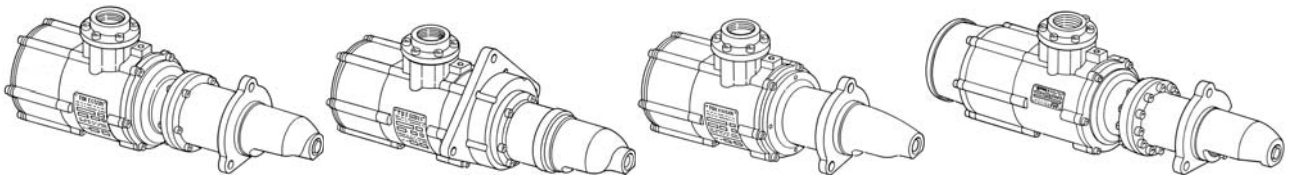
TECH DEVELOPMENT

Publication T1-702, Rev. 2
Dated: April 15, 2006

INSTALLATION AND OPERATING MANUAL



MODELS: T100-B, T100-D, T100-F, T100-P

TURBOTWIN Engine Air Starters

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KEEP IT REAL

AN 95-414

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TABLE OF CONTENTS

LIST OF FIGURES

1.0 GENERAL INFORMATION

This manual provides instructions for the installation and operation of the TDI T100 *TURBOTWIN* Starters (Series: B,D,F,P). If there are questions not answered in this manual, please contact your TDI *TURBOTWIN* distributor or dealer for assistance.

The T100 *TURBOTWIN* models are turbine driven starters with an inertially engaged starter drive. Depending on the starter model and engine installation, the *TURBOTWIN* starters have applications ranging from 1200 CID (20 Liters) on diesel engines and up to 15000 CID (250 Liters) on gas engines. The *TURBOTWIN* models are suited to operate within a wide range of inlet pressures and ambient temperatures. The engine size and parasitic loading will determine the exact minimum pressure that will assure reliable starting.

The T100 *TURBOTWIN* starters are designed for operation with compressed air or natural gas; materials used are compatible with “sour” natural gas and marine environments. Small amounts of foreign matter or liquid in the air stream will not adversely affect *TURBOTWIN* starters. As with all other TDI starters, no lubrication is required in the air supply.

Please review the rest of this manual before installing the T100 *TURBOTWIN* series air starter.

WARNINGS, CAUTIONS AND NOTES

Certain types of information are highlighted in this manual for your attention:

WARNING - used where injury to personnel or damage to the equipment is likely.

CAUTION - used where there is the possibility of damage to the equipment.

NOTE - used to point out special interest information.

NOTE

Throughout this manual, the term “air” is used to designate the starter drive medium. Unless other wise stated, air “ means either compressed air or natural gas.

1.1 DESCRIPTION

All models feature three basic subassemblies: a unique two stage turbine motor section, a planetary gearbox section and an inertia drive assembly.
The two stage motor section features greater stall torque than a single stage turbine plus aerodynamic speed control. This aerodynamic speed control helps protect the *TURBOTWIN* starter from damage caused by starter motor over speed.

The T100 *TURBOTWINS* employ a 7.5:1 or 9:1 ratio planetary gearbox. This low gear ratio allows the turbine motor to spin at low speeds for long bearing life. At a typical 3000 rpm pinion speed, the turbine is cruising at a low 22500 rpm (7.5:1 ratio). Reliability and part commonality are designed into all *TURBOTWINS*.

A simple and reliable inertia drive delivers the torque to the pinion. The pinion is thrown out to engage the engine's ring gear by the turbine motor's acceleration. Lighter weight rotating parts used in the *TURBOTWIN* provide low inertia and even "softer" engagement. In the event of over-pressure, the friction clutch used in every *TURBOTWIN* protects ring gear teeth from static torque overloads. In addition, an inertia engaged starter eliminates the need for complex pre-engagement control plumbing...and is easier to install and maintain than pre-engaged type starters.

Compressed air or natural gas is used to power T100 *TURBOTWIN* air starters through the inlet port. The air or gas is expanded through the first nozzle or stators. The high velocity gas impinges on the first stage rotor to yield torque to the gearbox. The gas is further expanded through the second stage stators, which impart additional torque to the second stage rotor.

1.2 PRODUCT IDENTIFICATION

The starter nameplate which is attached to the turbine housing contains the following information: model number, serial number, part number, direction of rotation and the maximum rated operating pressure.

The directions of rotation are either right hand or left hand rotation as shown in Figure 1. Right Hand rotation is defined as clockwise rotation as viewed from the pinion end of the starter, and Left Hand rotation is counter clockwise rotation viewed from the pinion end of the starter.

The maximum operating pressure is also stamped on the nameplate. This pressure is measured at the check port on the starter inlet with the starter in operation.

CAUTION

Exceeding the maximum pressure shown on the nameplate may result in drive failure, damage to the starter, or damage to the engine.

The housing proof pressure is 600 psig and is also shown on the nameplate. This means the turbine housing will not burst when subjected to a static pressure of 600 psig.

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Issued April 15, 2006

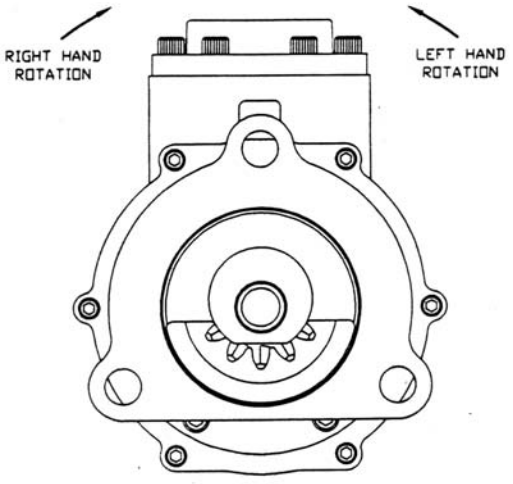

Figure 1. Direction of Rotation viewed from Pinion End.

1.3 PERFORMANCE

Graphs of the performance curves feature pinion torque versus pinion speed (rpm) at constant drive air pressures and shaft horsepower versus pinion speed at constant drive air pressures. Pinion speed is shown on the horizontal axis. The pinion torque is shown along the left edge vertical axis. The shaft horsepower is shown along the right edge vertical axis. Air consumption rates are given for the various drive pressure lines. These performance curves feature air as the drive gas and have open exhaust (standard exhaust guard) which have no back pressure.

2.0 ORIENTATION OF THE STARTER

2.1 GENERAL

If the factory orientation of the starter's pinion housing assembly in relation to the inlet port does not fit your engine installation, these components can easily be re-oriented.

All ***TURBOTWINS*** have the capability to rotate the inlet port relative to the drive opening for the optimum inlet port location. The number of different positions is 6 to 12 depending on model.

3.0 INSTALLING THE STARTER

A turbine air starter does not require lubrication in the supply air. Therefore, if a vane type starter motor is being replaced, TDI recommends that all lubrication devices and lines removed to minimize flow restrictions.

WARNING

If a fuel (pulse) lubricator has previously been installed in the system, disconnect and plug the line to eliminate spraying diesel fuel on the engine.

The starter should be installed with the inlet in a position between horizontal and straight down. Any condensation will be restricted to the air lines and not in the starter.

WARNING

Do not operate this starter unless it is properly connected to an engine.

3.1 SUPPLY LINE INSTALLATION

WARNING

Be sure to either bleed the pressurized air reservoir and/or safety the system such as closing all valves prior to installing starter supply line.

The *T100 TURBOTWIN series* air starters come standard with a 2" NPT female pipe thread for the inlet connection port**.** The supply line consists of the line from the air source, a pressure regulator (when necessary), a manual or relay valve, and the connection to the starter inlet. Hard piping may be used, but a section of flexible tubing should be installed at the starter to prevent leaks due to engine vibration.

Care must be taken to ensure that all inlet supply line piping is no less than 1.5" and all components used are capable of passing the required air flow.

NOTE

Valves with a Cv of 40 or higher are recommended.

If the supply line must be longer than 20 feet, the inlet supply line piping should be increased to 2" in diameter to ensure proper performance by your ***TURBOTWIN***.

Because turbine starters such as the ***T100 TURBOTWIN*** *series* are sensitive to flow restrictions, care must be taken to use uniform hose or tubing and fittings for connection of the supply line. Tees, elbows and line length must be kept to a minimum. TDI recommends that hose or flex couplings are installed to eliminate possible leakage caused by strain on the supply line.

Normally, an air strainer is not required. However, in dirty environments use of a #40 mesh Y-strainer is recommended. The ***T100 TURBOTWIN*** *series* is highly tolerant of dirt in the air line, however, starter life can be increased with the use of an air strainer.

A pressure regulator is required when the air supply pressure is great enough to exceed the starter operating pressure (at the inlet port) and/or the maximum torque.

A manual ball valve may be used to admit drive air/gas to the starter. The manual valve should be located in a safe position away from the engine.

A preferred valve is pilot-operated, which can be pneumatically or electrically actuated. The valve should be located close to or even on the starter inlet for best performance. Pneumatic or electrical control lines may be routed virtually anywhere for the customer's preferred operating station. This type of valve actuates from a fully closed to a fully open position very rapidly. TDI offers a variety of relay valves such as P/N RLVA-25683-001-2-01, which is a 1-1/2" port, pneumatically actuated valve.

The supply line should be dry-fitted for proper alignment /location prior to final assembly. All pipe threaded joints should be sealed with Loctite Pipe Thread Sealant (TDI P/N 9-94085) or equivalent for leak tight joints prior to final assembly. Be sure to tighten all joints to proper torque after final assembly.

CAUTION

In cold weather climates, care should be taken while designing your installation to prevent condensation from developing in the starter system. In systems with a regulator valve or relay valve, there is the possibility of freeze-ups.

A tee connection with a quick disconnect can be added to the inlet. This will allow an external air source to be used to accomplish a “blow start” if the system freezes. Once the engine has been started, the other system components may be thawed.

CAUTION

On new installations, it is strongly recommended to blow out the supply line with air to remove possible dirt and welding slag prior to final connection to the *TURBOTWIN* starter. Be sure to secure the free end of the supply line prior to blowing out the line.

3.2 INLET PRESSURE PORT

A 1/4" NPT port is located on the air inlet. This port may be used to check the supply pressure at the starter when the starter is operating. Remove the 1/4" NPT pipe plug and save for later use. Install a 1/4" minimum size tubing to the port. Route the tubing away from the starter to a safe location away from the engine. Install a pressure gauge on the tubing. This pressure monitoring line/gauge may be permanently installed. Use Loctite Pipe Thread Sealant or equivalent. Alternately, a pressure transducer may be installed at the pressure check port and electrical lines routed to a digital display at the operator's station.

This pressure port is invaluable in diagnosing air starter and/or installation problems.

3.3 EXHAUST PIPING

The turbine exhaust may be plumbed away from the starter area. All starters using natural gas must be piped according to industry codes and local regulations.

The performance of a turbine starter will be decreased because of back pressure when smaller than recommended exhaust piping is installed. If back pressure hampers starter performance, compensation can be made by increasing the supply pressure. Consult your TDI distributor for advice.

Exhaust piping should be routed downward to help prevent any accumulation of condensation in the starter motor.

If the overhung section of the starter is not otherwise supported, TDI recommends supporting the exhaust piping with a suitable bracket(s).

Exhaust piping should be routed downward to help prevent any accumulation of condensate in the starter motor.

3.4 NATURAL GAS INSTALLATION

The installation of the starter using natural gas is similar to the air installation except all fittings, piping, valves and regulators must be compatible with natural gas.

Proper control of natural gas is a major consideration when used in the starter system. All starters using natural gas must pipe the exhaust according to industry codes and local regulations.

There is a natural gas vent port in the turbine housing that is plugged for compressed air use. This vent is used to remove any natural gas that could leak past the primary turbine shaft seal. Remove this 3/8"NPT plug and install a line to carry gas away from the starter area.

WARNING

Do not connect the turbine housing vent line to the turbine exhaust line. Exhaust gas can pressurize the housing.

3.5 PIPING SYSTEM

Only type approved metallic hose assemblies are approved in permanently pressurized compressed air lines of starters. Non-metallic hose assemblies are allowed only in case the piping system will be emptied after the starting procedure.

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Pipe unions must be type approved by GL. Downstream of the pressure regulator a pressure relief valve is to be provided.

3.6 BACKLASH

Backlash is the "free play" between the mesh of two gears. Figure 15 shows the backlash between two gears. Maintaining the proper gear backlash setting allows the gears to mesh smoothly. Proper backlash and alignment allows smooth engagement/disengagement of the pinion gear and loads the tooth face surfaces evenly producing longer gear life. The correct backlash setting for 6/8 diametral pitch gearing used on larger engines is as follows:

Minimum backlash	.015 inch
Maximum backlash	.025 inch

To check the backlash, the pinion will need to be rolled out onto the end of the drive prior to starter installation. This can be accomplished by using a hex drive wrench to rotate the turbine end of the starter while holding the pinion from rotating. The pinion will simply walk to the end of the shaft. An access hole to reach the turbine screw is provided in the turbine exhaust guard. The starter must then be installed on the engine. Checking backlash can be accomplished using a dial indicator or a simple blade-type feeler gauge. Because ring gears are not usually perfectly round, it is necessary to

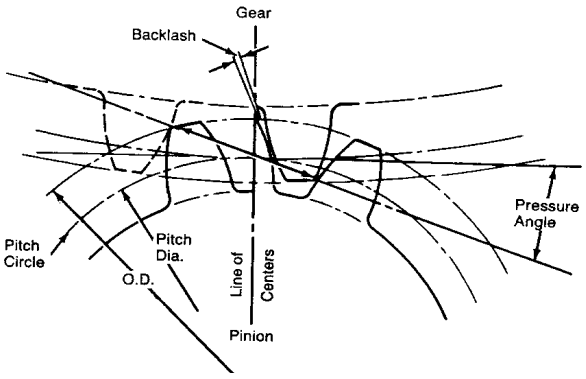

Figure 2. Checking Backlash

check backlash at several (six or more) points around the circumference of the ring gear. Average the highs and lows to allow a setting that is in the range cited above.

Setting the correct backlash may involve "shimming" and/or moving the starter bracket(s). An adjustable starter bracket design will simplify this procedure. Always re-check the backlash after a ring gear replacement.

Liberally grease the starter's drive teeth with chassis lube and then mount the ***TURBOTWIN*** starter on the engine. Tighten all mounting hardware as appropriate. Make sure to use Loctite Threadlocker #290 or equivalent on the starter mounting bolts. Torque the three 5/8" screws to 100 lb-ft.

4.0 STARTER OPERATION

Prior to operation, check that all connections are tight and free from leaks. Check the 1/4" NPT pipe plug or a pressure gauge/transducer that may be connected to the pressure port on the starter inlet.

WARNING

Do not operate the TDI *TURBOTWIN* starter with air pressure greater than the pressure rating on the nameplate. This pressure is measured at the starter inlet while the starter is running.

The maximum operating pressure limit is the inlet pressure measured at the starter's inlet pressure check port. In order to check the starter, a 1/4"NPT pipe tap connection is provided in the inlet housing to attach a pressure gauge/transducer). The maximum pressure assumes an open exhaust (standard turbine exhaust guard). The standard exhaust guard causes no back pressure.

The static non-flowing supply pressure will always be higher than the operating (dynamic) pressure. The maximum pressure limit (proof pressure) that the TDI *TURBOTWIN* starter housings may be subjected to is 600 PSIG (42 BAR). System pressure that exceeds the maximum operating limit must use a pressure reducing device to ensure that the operating pressure limit to the TDI *TURBOTWIN* starter is maintained.

System static pressure that exceeds the 600 PSIG (42 BAR) limit must, in addition to pressure reducer devices incorporate a pressure relief valve set below 600 PSIG (42 BAR) in the supply air line.

NOTE

For maximum life of the starter pinion and for the protection of the engine ring gear, limit the operating pressure to that necessary to start the engine at its most difficult starting conditions.

All appropriate local pressure codes and pressure limitations on other system components must be adhered to and supersede the guidelines given in this manual.

Consult your TDI distributor if you have exhaust plumbing that creates back pressure and reduces starter performance. You may be able to increase the supply pressure to restore the lost power.
Follow the engine manufacturer's instructions for starting the engine.

4.1 BASIC OPERATION

The basic operation of the starter is as follows:

Pressurized air or natural is admitted to the starter by opening of the manual or relay valve. The air expands through the turbine, which produces shaft rotation and torque. The acceleration of the drive assembly causes the pinion to advance and engage the ring gear of the engine.

The starter motor torque causes the engine to accelerate. This acceleration causes the pinion to be disengaged from the ring gear. The fuel and ignition systems now fire the engine. Closing the relay valve stops the starter.

The operator may decrease starter life by the continual operation of the starter after the engine has started. Upon a successful engine start, turn the air off to the starter immediately. Minimizing the time the starter is operating unloaded (i.e. the engine is running) will maximize starter life. If a start is aborted, a restart may be attempted after the engine and the starter has come to rest.

CAUTION

Do not engage the starter while the engine is running.

The drive air pressure is the primary starter control parameter**.** It is important, especially on new installations, to measure this pressure during several engine starts. The secondary parameter is the starter pinion speed. This speed is usually measured by knowledge of the engine starting speed and the starter cranking ratio. The cranking ratio is the number of ring gear teeth divided by the number of pinion teeth. The starter pinion speed is then found by multiplying the engine speed by the cranking ratio. The pinion speed is usually 2000-3500 rpm at typical engine starting speed.

4.2 AUTOMATED START PANEL

The starter drive pressure measured at the starter inlet must be set. As noted above, for maximum life of the starter pinion and for the protection of the engine ring gear, limit the operating pressure to that necessary to start the engine at its most difficult starting conditions.

The speed control parameter will then need to be set. Engine starting speed along with the cranking ratio number can be used to determine starter pinion speed. The pinion speed is usually 2000-3500 rpm for a typical engine starting speed. Once the start sequence has begun, the air is admitted to the starter. The starter begins to accelerate the engine. Once the firing speed of the engine is reached, the automated start panel may deliver fuel to the engine. The engine will begin to accelerate under its own power. The starter should be dropped out of the sequence at a rpm higher than the firing speed, but less than the engine idle speed.

The automated start panel should monitor engine speed to determine air on and air off. Do not simply use time as a control parameter. Avoiding excessive operation of the starter after the engine is firing will maximize the starter life.

5.0 PREVENTIVE MAINTENANCE

The TDI ***TURBOTWIN*** starters provide distinct advantages of size and efficiency as compared to electric motor, vane-type or other turbine-type starters. It is important to properly install the starter to receive full benefit of these advantages. Repair technicians or service organizations without turbine starter experience should not attempt to repair this machine until they receive factory approved training from TDI, or its representatives.

Proper operation and repair of your TDI TURBOTWIN starter will assure continued reliable and superior performance for many years.

5.1 Every Six (6) Months

Perform the following procedures at six(6) months intervals if the normal cranking cycle is 0 - 10 seconds.

5.1.1 Check the amount and condition of grease in the planetary gearbox. If gearbox requires re-greasing, only use TDI grease. Approximately one (1) pint of grease is needed to repack the gearbox.

5.1.2 Check the turbine bearing and carrier output bearings for freedom of rotation without excessive play between races. If bearings are damaged, replace them with genuine TDI parts. Refer to TDI Service Manual for part numbers.

5.1.3 Place a small amount of chassis lube on the starter's pinion teeth.

5.2 Every Three (3) Months

Follow the six (6) month procedures if there is severe starter loading or extended duration crank cycles. Also perform these procedures every three (3) months when starter is used for motoring the engine for maintenance or valve adjustments.

Motoring Crank Cycle: 10 -60 seconds

Extended Crank Cycle: 60 seconds or longer

starter, use only genuine TDI replacement parts. The

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component part numbers are found in the Illustrated Parts Breakdown.

CAUTION

The grease used in the planetary system has a shelf life of 2 years. Therefore, if the starter is NOT installed and operated on the engine for 2 years after the starter is manufactured, the grease should be replaced prior to starter operation. The manufactured date is reflected in the starter serial number. (Ex: 0602-0567 has a manufactured date of February 2006).

6.0 TROUBLESHOOTING CHART

TROUBLE	PROBABLE CAUSE	SOLUTION
1. Starter does not run; small air flow from exhaust.	A. Relay valve not fully open.	A. Repair or replace relay valve.
	B. Nozzle blockage.	B. Remove blockage or obstruction from nozzles.
2. Starter does not run; normal air flow from exhaust.	A. Broken turbine rotor.	A. Replace all damaged parts.
	B. Broken gear train.	B. Repair or replace geartrain.
	C. Damaged starter drive.	C. Repair or replace starter drive.
3. Reduced Starter output power.	A. Inlet air pressure too low.	A. Increase air pressure in 10 PSIG (0.6 BAR) increments; DO NOT EXCEED OPERATING LIMIT.
	B. Inlet supply piping too small.	B. Supply piping must be a minimum of 1.5" diameter.
	C. Pressure regulator orifice too small.	C. Increase orifice size or replace pressure regulator
	D. Inlet supply line valve (ball, gate, relay, plug) too small.	D. Install larger valve.
	E. In line lubricator installed in supply line.	E. Remove lubricator.
	F. Y-Strainer in supply line clogged.	F. Clean strainer.
	G. Excessive back pressure; exhaust restricted.	G. Clean exhaust piping or increase size to at least the minimum diameter recommended.
	H. Damaged turbine nozzle.	H. Replace turbine nozzle.
	I. Broken started drive.	I. Repair or replace starter drive.
	J. Wrong rotation starter.	J. Replace with starter or proper rotation.
	K. Wrong size starter.	K. Check the Application Guide for the correct starter.
4. Engine cranks too quickly.	A. Inlet air pressure too high.	A. Decrease air pressure in 10 PSIG (0.6 BAR) increments. OR If there is a manual shut-off valve in the supply line, partially close it. OR Install a restriction orifice in the inlet supply line.
	B. Wrong size starter.	B. Check the Application Guide for the correct starter.

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7.0 WARRANTY

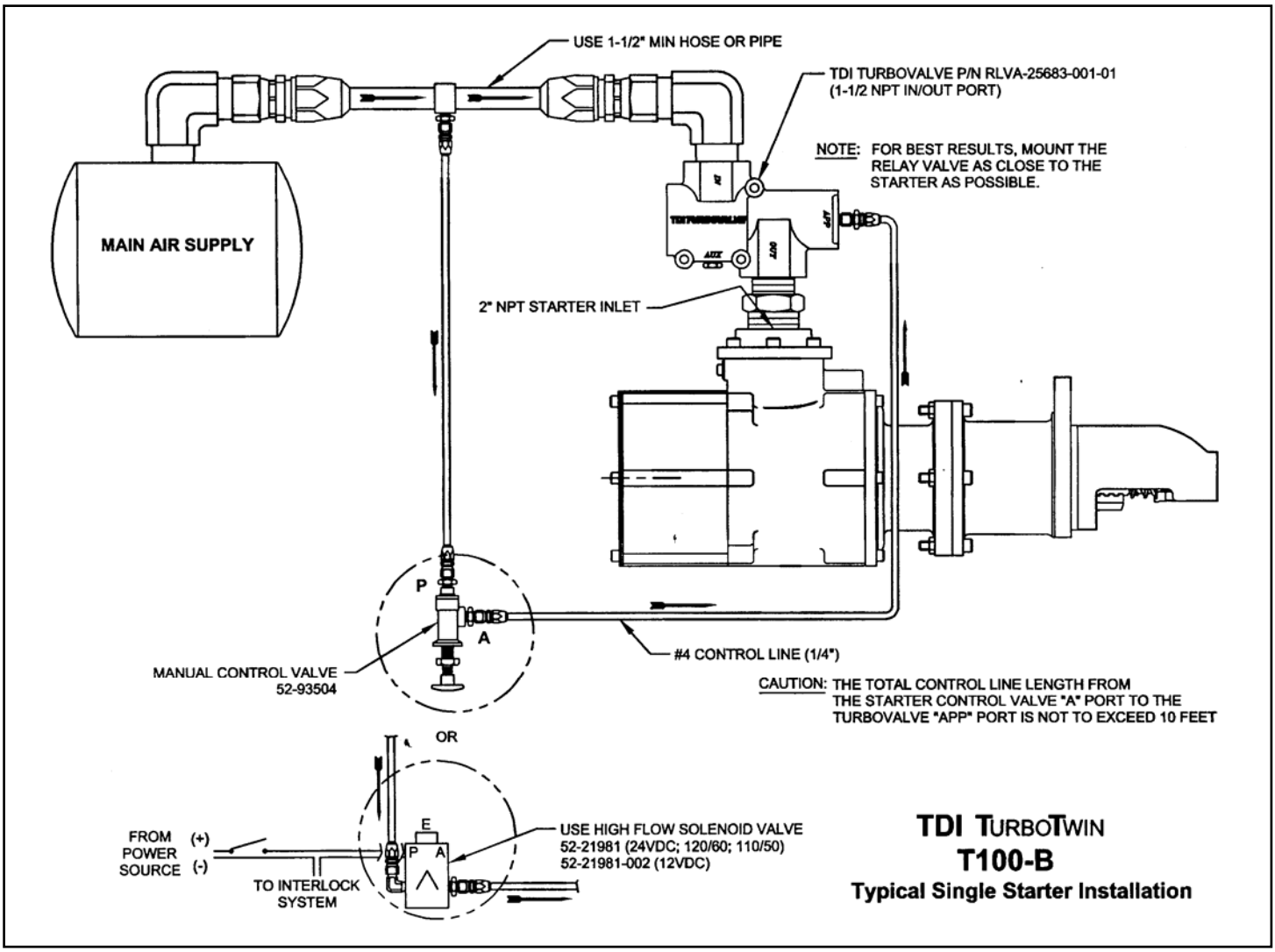
TDI TURBOTWIN ENGINE STARTER WARRANTY

Tech Development Inc. (TDI) warrants to the original user of the TDI TurboTwin™ Model T30 Series air starters to be free from defects in material and workmanship for a period of one year from date of purchase by such user. The warranty period shall begin on the actual delivery date to the original user or twelve (12) months from the date of shipment from TDI, whichever comes first. The conditions of this warranty are: **a)** TDI is notified within this period by return of such product to TDI or its authorized distributor or dealer, transportation prepaid by user; **b)** such product has been installed according to TDI's specifications; **c)** such product has not been misused, abused or improperly maintained by user; **d)** the defect is not the result of normal wear and tear; and **e)** such starter product has not been repaired with parts not manufactured or authorized by TDI, and TDI installation and repair procedures as outlined in the appropriate manual were properly followed.

Tech Development Inc. shall, at its option, either repair or replace, without charge, any such starter product found by TDI's examination to be defective, or by mutual agreement, refund the user's purchase price in exchange for such starter product. Repairs or replacements are warranted for the remainder of the original warranty period.

Tech Development Inc. makes no other warranty, and IMPLIED WARRANTIES INCLUDING ANY WARRANTY OR MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED.

This warranty constitutes the entire obligation of Tech Development Inc. relating to the sale and use of such product, and TDI's maximum liability is limited to the purchase price of such product at the date of purchase. In no event shall TDI be liable for incidental, indirect, consequential or special damages of any nature arising from the sale or use of such engine starter product.



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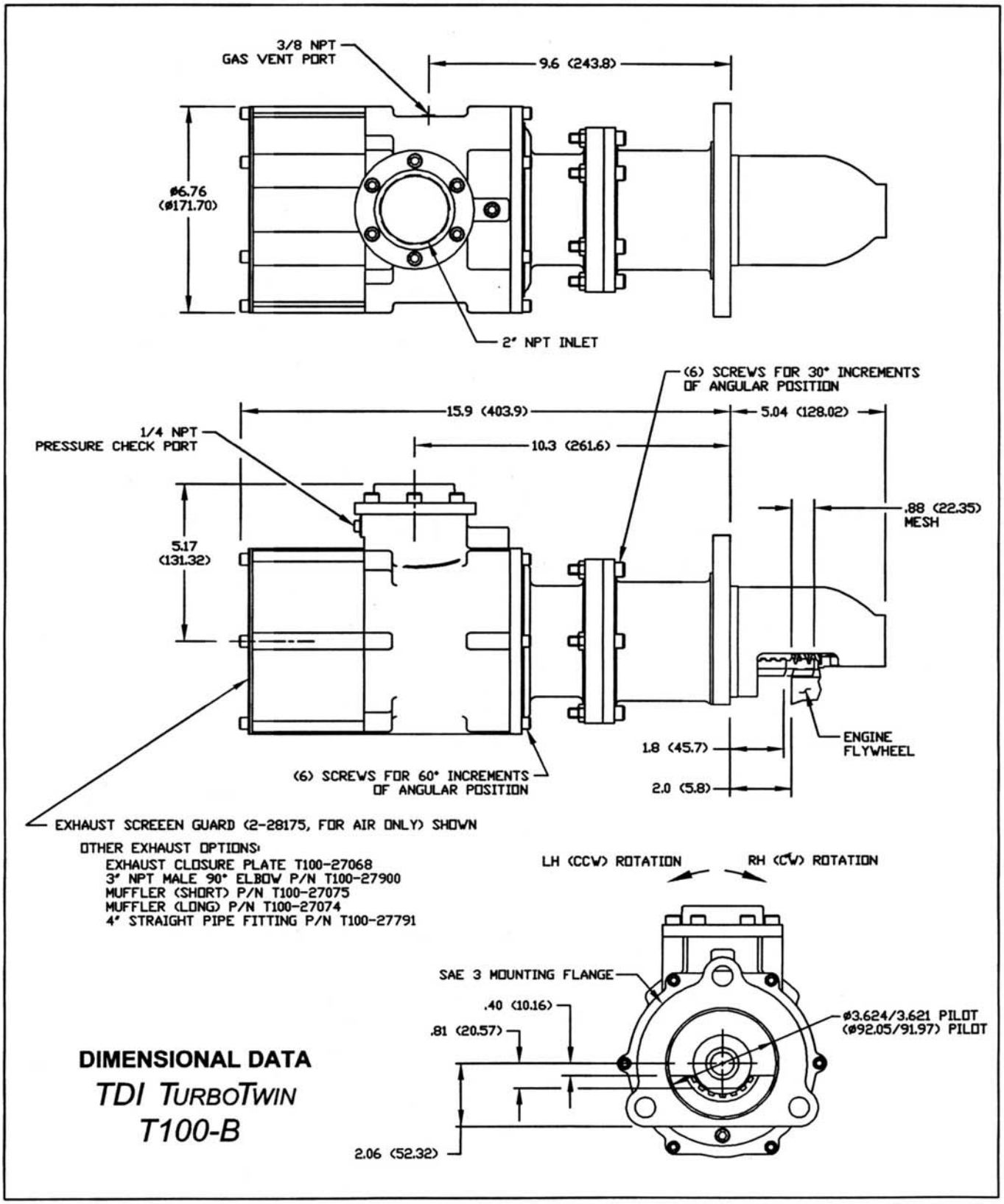
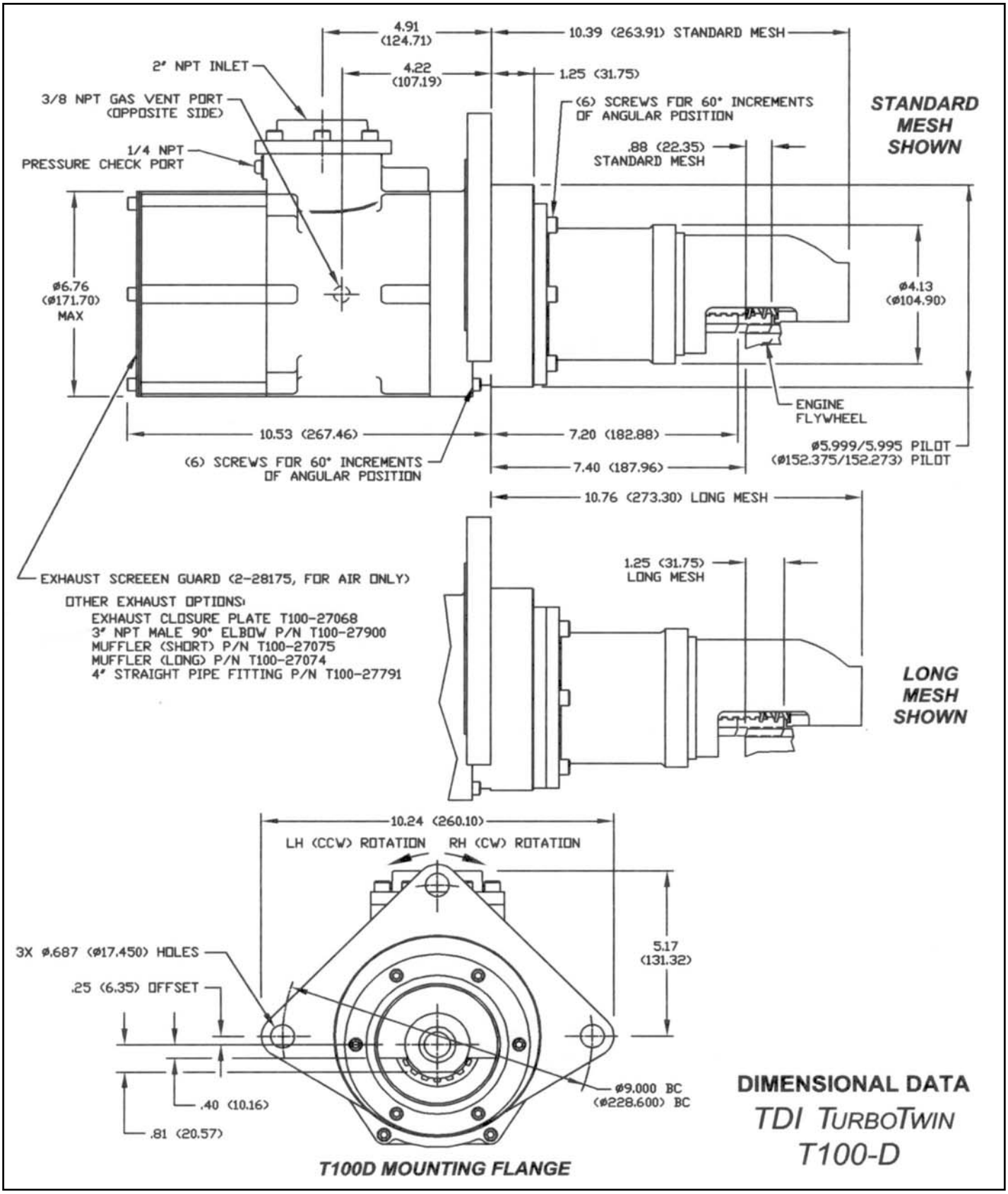

3/8 NPT
GAS VENT PORT
9.6 (243.8)
ø6.76
(ø171.70)
2" NPT INLET
(6) SCREWS FOR 30° INCREMENTS
OF ANGULAR POSITION
15.9 (403.9)
5.04 (128.02)
1/4 NPT
PRESSURE CHECK PORT
10.3 (261.6)
.88 (22.35)
MESH
5.17
(131.32)
ENGINE
FLYWHEEL
1.8 (45.7)
2.0 (5.8)
(6) SCREWS FOR 60° INCREMENTS
OF ANGULAR POSITION
EXHAUST SCREEEN GUARD (2-28175, FOR AIR ONLY) SHOWN
OTHER EXHAUST OPTIONS:
EXHAUST CLOSURE PLATE T100-27068
3" NPT MALE 90° ELBOW P/N T100-27900
MUFFLER (SHORT) P/N T100-27075
MUFFLER (LONG) P/N T100-27074
4" STRAIGHT PIPE FITTING P/N T100-27791
LH (CCW) ROTATION
RH (CW) ROTATION
SAE 3 MOUNTING FLANGE
.40 (10.16)
.81 (20.57)
ø3.624/3.621 PILOT
(ø92.05/91.97) PILOT
2.06 (52.32)
DIMENSIONAL DATA
TDI TURBOTWIN
T100-B



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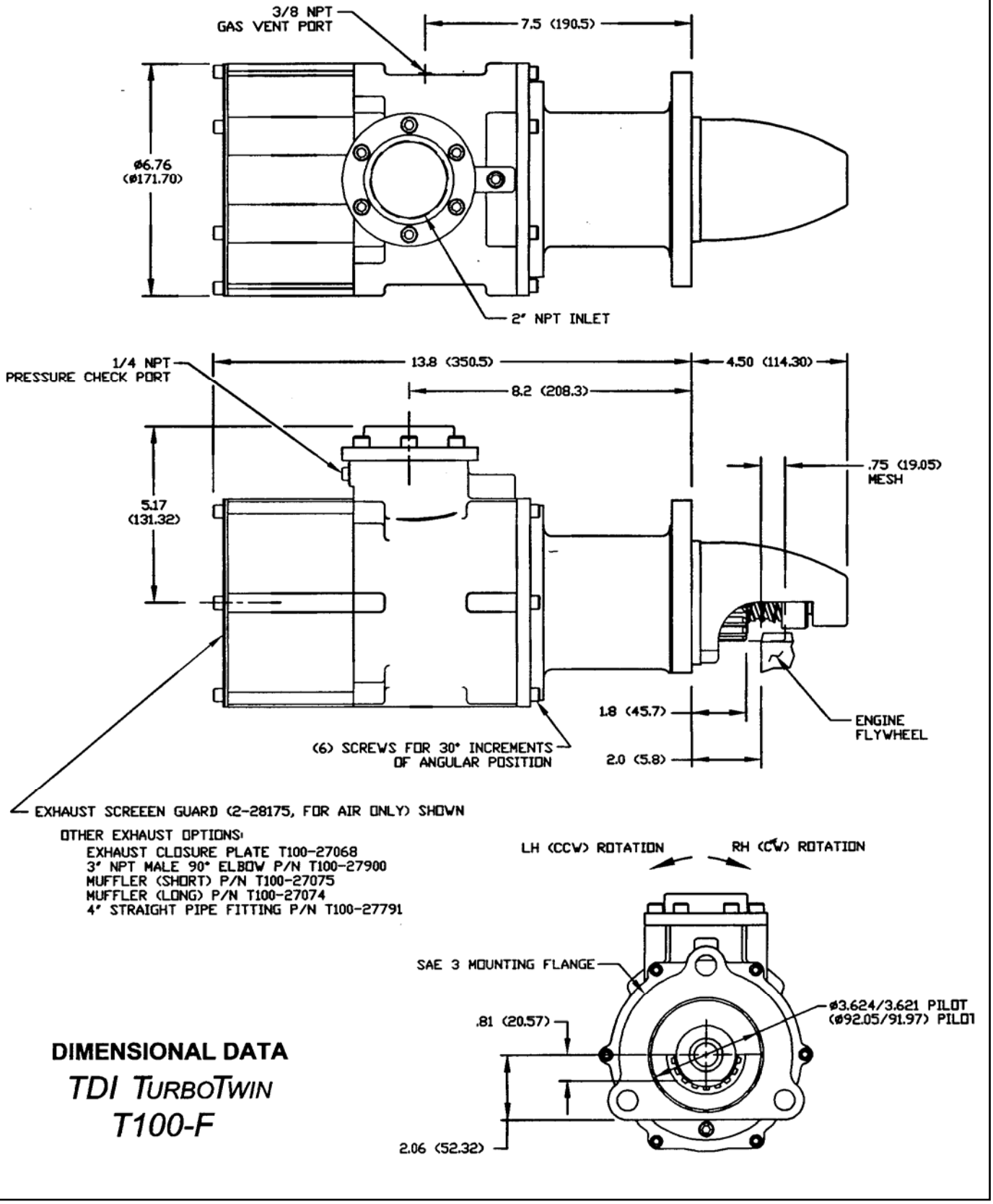
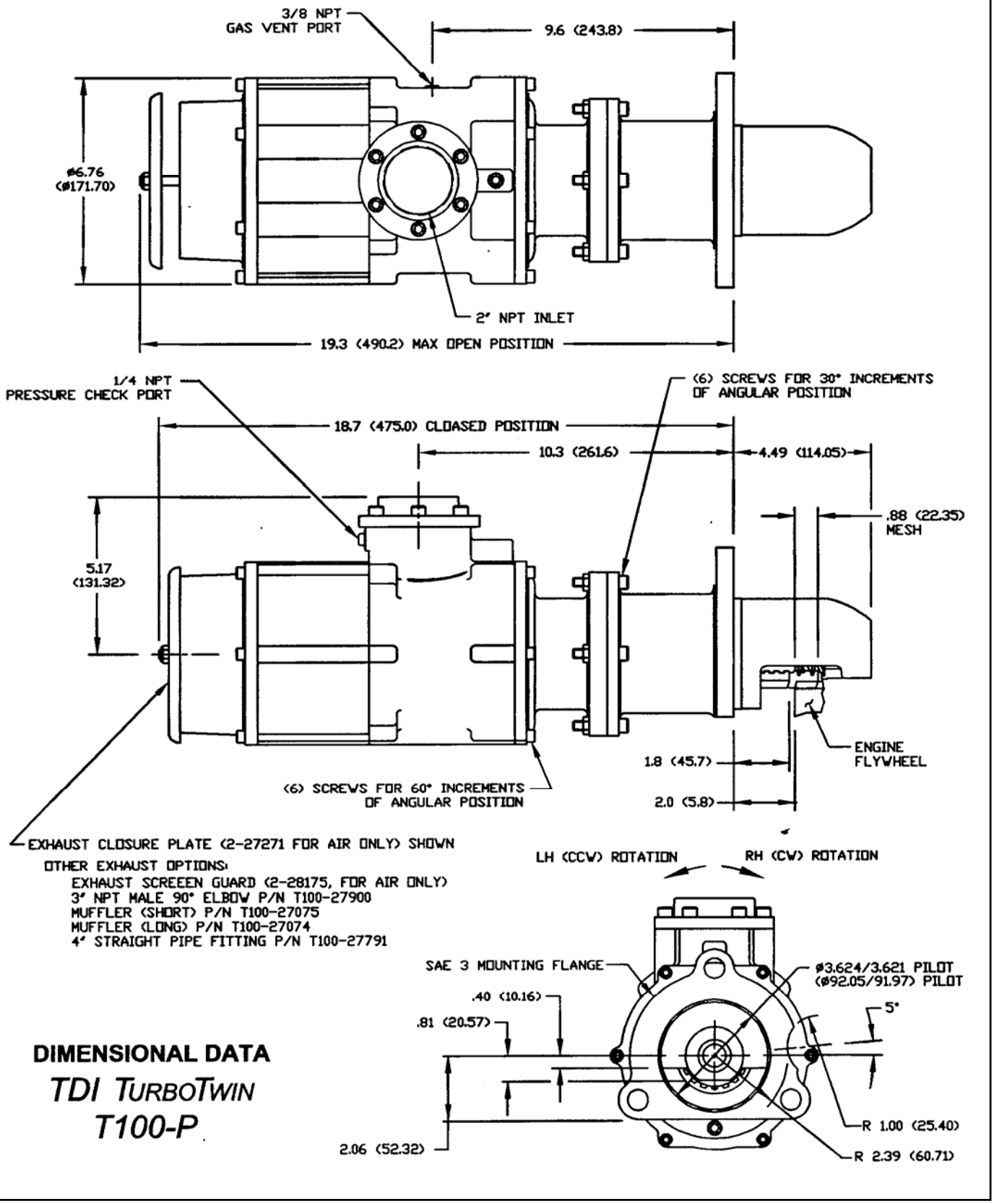


DIMENSIONAL DATA

TDI TURBOTWIN

T100-F



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TDI TURBOTWIN
T100-P

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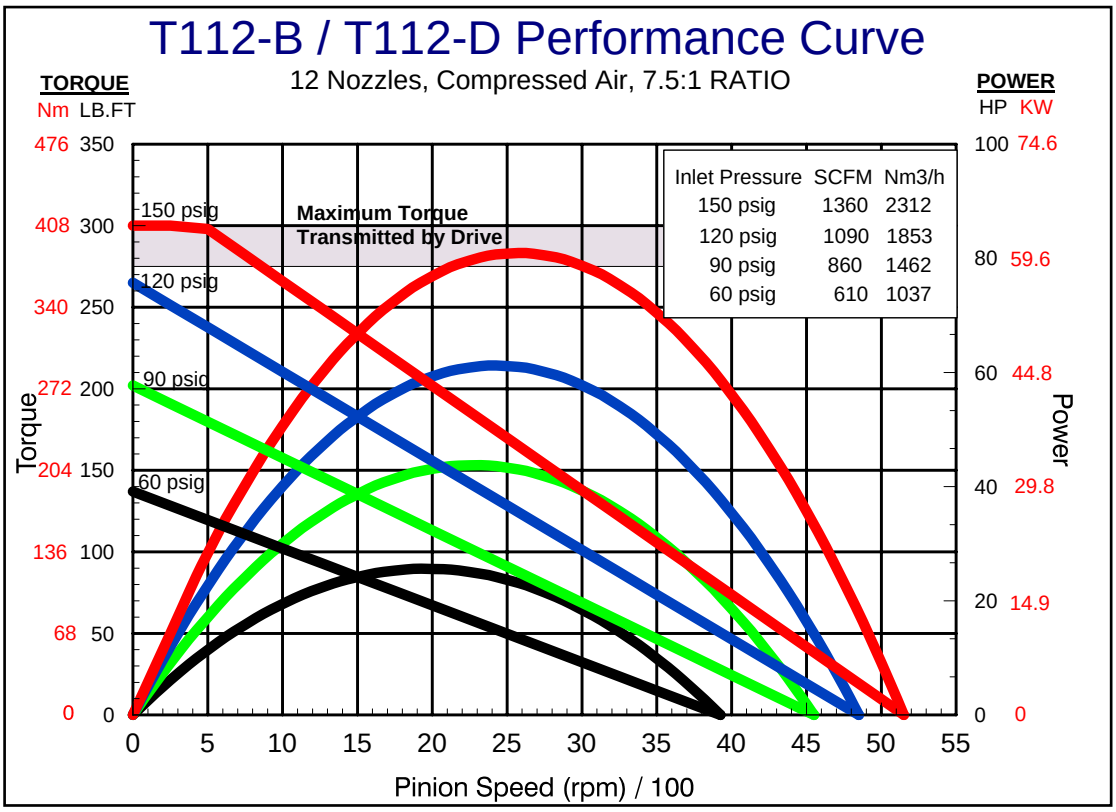
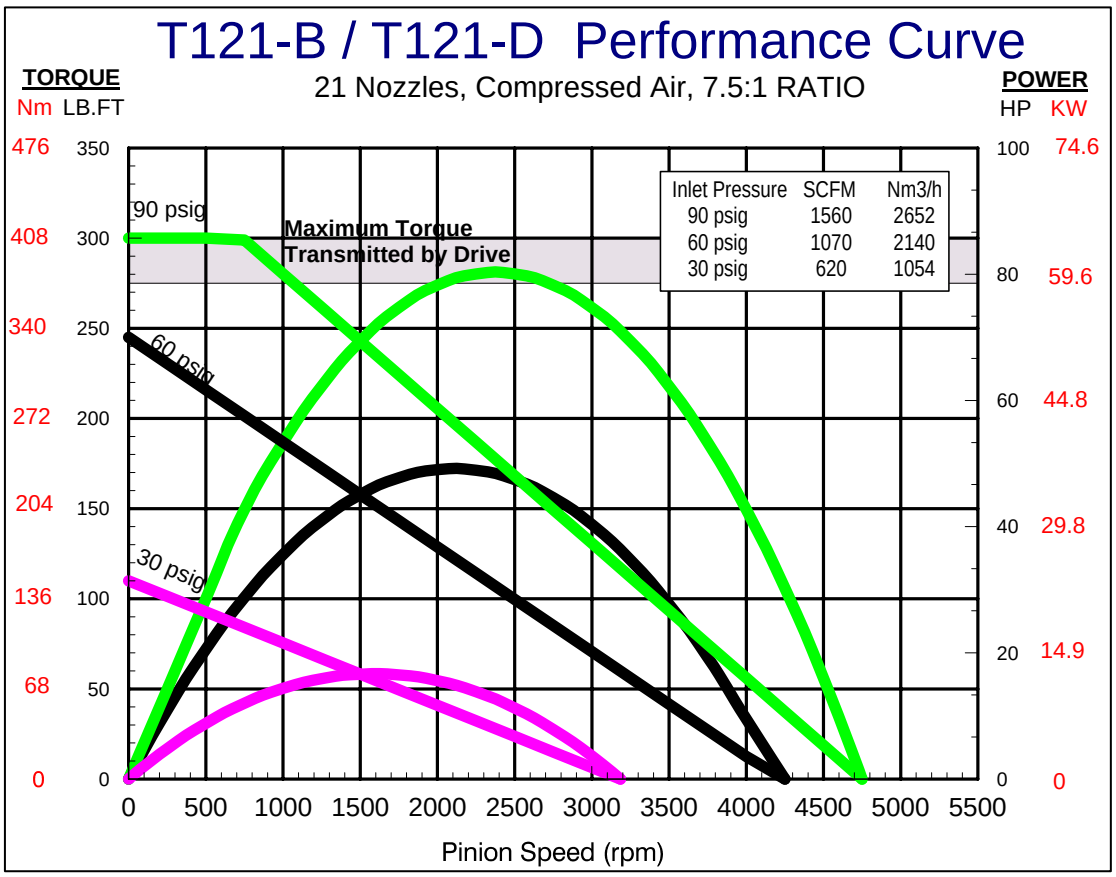
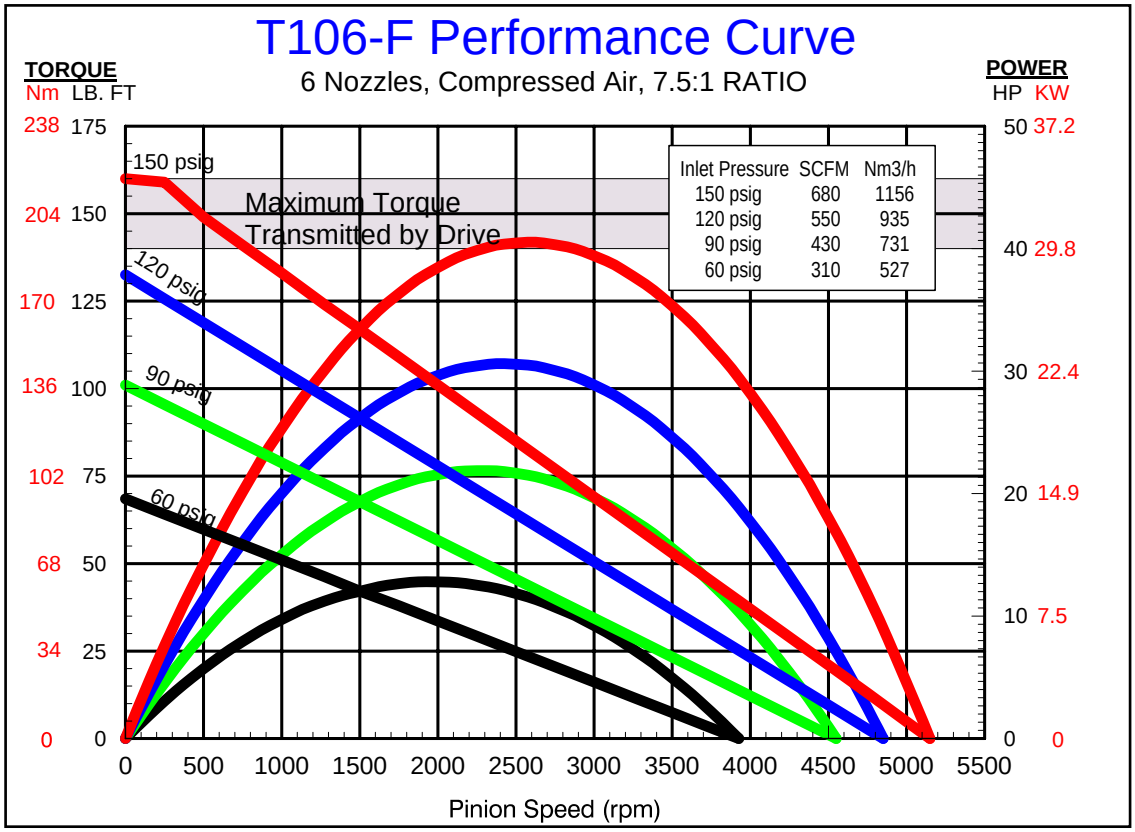
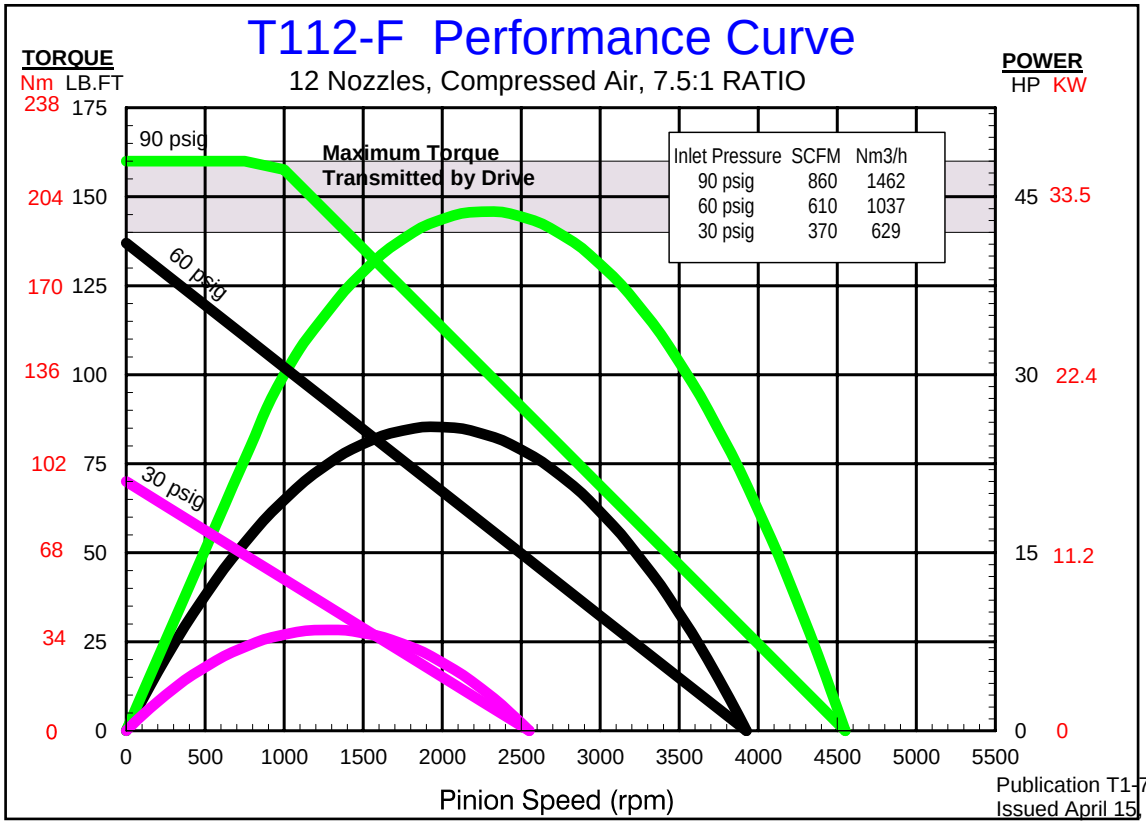

T112-B / T112-D Performance Curve
12 Nozzles, Compressed Air, 7.5:1 RATIO
TORQUE
Nm LB.FT
476 350
408 300
340 250
272 200
204 150
136 100
68 50
0 0
POWER
HP KW
100 74.6
80 59.6
60 44.8
40 29.8
20 14.9
0 0
Inlet Pressure SCFM Nm3/h
150 psig 1360 2312
120 psig 1090 1853
90 psig 860 1462
60 psig 610 1037
150 psig
120 psig
90 psig
60 psig
Maximum Torque
Transmitted by Drive
Torque
Power
0 5 10 15 20 25 30 35 40 45 50 55
Pinion Speed (rpm) / 100


T121-B / T121-D Performance Curve
21 Nozzles, Compressed Air, 7.5:1 RATIO
TORQUE
Nm LB.FT
476 350
408 300
340 250
272 200
204 150
136 100
68 50
0 0
POWER
HP KW
100 74.6
80 59.6
60 44.8
40 29.8
20 14.9
0 0
Inlet Pressure SCFM Nm3/h
90 psig 1560 2652
60 psig 1070 2140
30 psig 620 1054
90 psig
60 psig
30 psig
Maximum Torque
Transmitted by Drive
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500
Pinion Speed (rpm)





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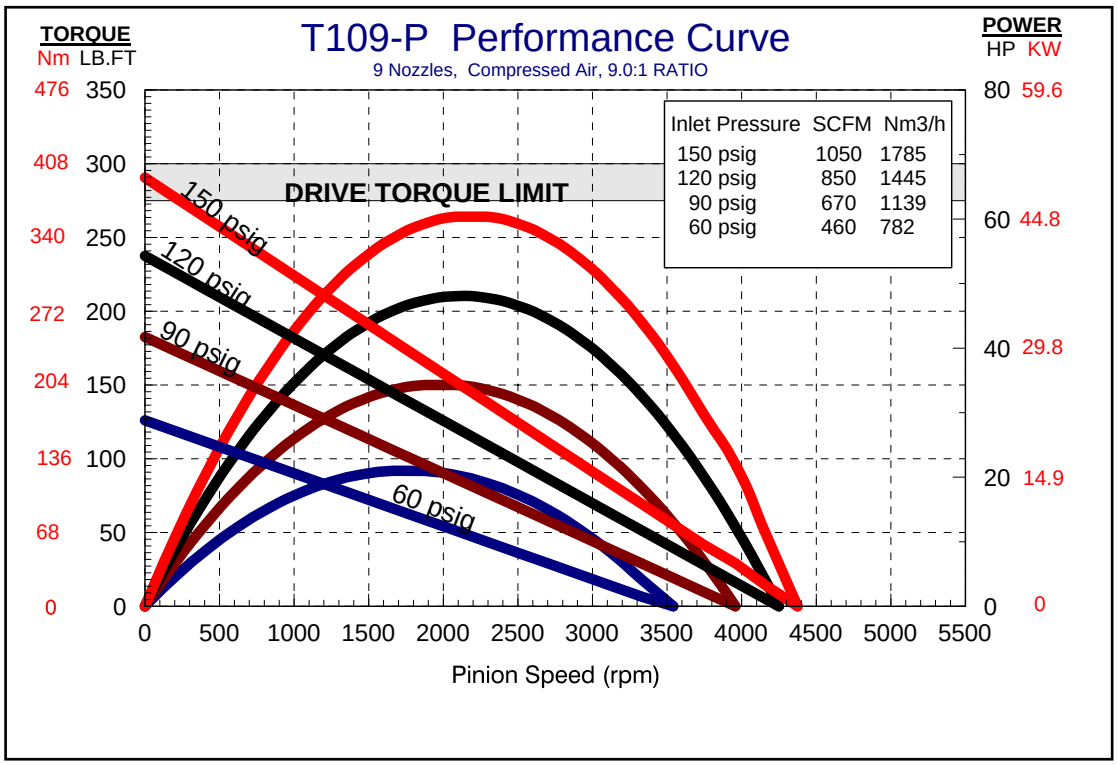
T109-P Performance Curve
9 Nozzles, Compressed Air, 9.0:1 RATIO
TORQUE
Nm LB.FT
476 350
408 300
340 250
272 200
204 150
136 100
68 50
0 0
POWER
HP KW
80 59.6
60 44.8
40 29.8
20 14.9
0 0
DRIVE TORQUE LIMIT
Inlet Pressure SCFM Nm3/h
150 psig 1050 1785
120 psig 850 1445
90 psig 670 1139
60 psig 460 782
150 psig
120 psig
90 psig
60 psig
0 500 1000 1500 2000 2500 3000 3500 4000 4500 5000 5500
Pinion Speed (rpm)

TECH DEVELOPMENT

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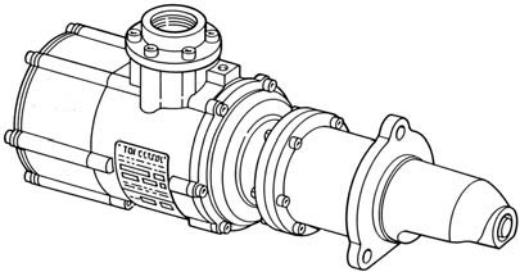
Dated: April 15, 2006

SERVICE MANUAL



T100 Series (T112B/T121B, T112D/T121D, T106F/T112F, T109P/T115P)

TURBOTWIN ENGINE AIR STARTERS

From Tech Development
6800 Poe Ave. •Dayton OH 45414
Tel: (937) 898-9600 •Fax: (937) 898-8431
Website: www.tdi-turbotwin.com

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LIST OF ILLUSTRATIONS

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SECTION 1.0 INTRODUCTION

1.1 GENERAL INFORMATION

This manual provides information for servicing, disassembly, and reassembly of the TDI Turbotwin T100 series air starters. If there are questions not answered by this manual, please contact your local TDI distributor or dealer for assistance. Illustrations and exploded views are provided to aid in disassembly and reassembly.

The TDI Turbotwin T100 series of engine starters are specially designed for starting today's automated, low-emission engines. The Turbotwin uses aerodynamic speed control, eliminating the need for a mechanical automatic trip valve (ATV) to control starter motor speed.

The Turbotwin T100 series air starters are suited to operate within a wide range of inlet pressures and ambient temperatures. These starters are designed for operation with either compressed air or natural gas.

The robust turbine motor design in the Turbotwin T100 series starters has no rubbing parts, and is therefore tolerant of hard and liquid contamination in the supply gas with almost no adverse affects. The motor is well adapted to running on "sour" natural gas.

As with all TDI air starter products, there are no rubbing parts so there is no lubrication required. This eliminates failures due to lubricator problems, the expense of installing and maintaining the system, and the messy and hazardous oil film around the starter exhaust. The starter is factory grease packed for the life of the starter so it requires no maintenance.

NOTE

Throughout this manual, the term "air" is used to donate the starter drive medium. Unless otherwise stated, "air" means compressed air or natural gas.

Please review the rest of this manual before attempting to provide service to the TDI Turbotwin T100 series starters.

1.2 WARNINGS, CAUTIONS, & NOTES

Throughout this manual, certain types of information will be highlighted for your attention:

WARNING - used where injury to personnel or damage to equipment is likely.

CAUTION - used where there is the possibility of damage to equipment.

NOTE - use to point out special interest information.

1.3 DESCRIPTION OF OPERATION

The Turbotwin T100 series starters are powered by a pair of axial flow turbines coupled to a simple planetary gear reduction set. The T100 series starters incorporate an inertia bendix drive coupled to the starter gearbox drive train to provide a means of disengaging the pinion from the engine's ring gear.

The high horsepower of the turbine air motor combined with the planetary gear speed reducer results in a very efficient and compact unit. The Turbotwin T100 series starters can be used over a wide range of drive pressures from 30 psig (2 BAR) to 150 psig (10 BAR) and are suitable for operation on either air or natural gas.

The Turbotwin T106F & T112F weighs approximately 47 pounds (21 KG) and each is capable of delivering over 44 HP (33 kW) of cranking power at their maximum pressure of either 150 psig (10 BAR) or 90 psig (6 BAR) respectively.

The Turbotwin T112B & T121B weighs approximately 55 pounds (25 KG) and each is capable of delivering over 80 HP (60 kW) of cranking power at their maximum pressure of either 150 psig (10 BAR) or 90 psig (6 BAR) respectively.

The Turbotwin T112D &T121D weighs approximately 70 pounds (32 KG) and each is capable of delivering over 80 HP (60 kW) of cranking power at their maximum pressure of either 150 psig (10 BAR) or 90 psig (6 BAR) respectively.

The Turbotwin T109P & T115P weighs approximately 59 pounds (27 KG) and is capable of delivering over 60 HP (41 kW) of cranking power at their maximum pressure of either 150 psig (10 BAR) or 90 psig (6 BAR) respectively.

1.4 INSTALLATION AND SERVICE

It is important to properly install and operate the TDI Turbotwin T100 series starters to receive the full benefits of the turbine drive advantages. It must be installed in accordance with the instructions provided by Tech Development, Inc. (TDI).

WARNING

Failure to properly install the starter or failure to operate it according to instructions provided byTDI may result in damage to the starter or engine, or cause personal injury. DO NOT OPERATE THIS STARTER UNLESS IT IS PROPERLY ATTACHED TO AN ENGINE.

NOTE

You should always have the starter's Part Number, Serial Number, Operating Pressure, and Direction of Rotation information before calling your TDI distributor or dealer.

Repair technicians or service organizations without turbine starter experience should not attempt to repair this starter until they receive factory approved training from TDI, or its representatives. Proper operation and repair of your TDI Turbotwin will assure continuous reliability and superior performance for many years.

1.5 NAMEPLATE INFORMATION

The nameplate, located on the turbine housing, provides important information regarding the construction of your T100 series starters, refer to *Figure* 1. The part number coding explanation, refer to *Figure 2*, can help you when talking to your distributor.

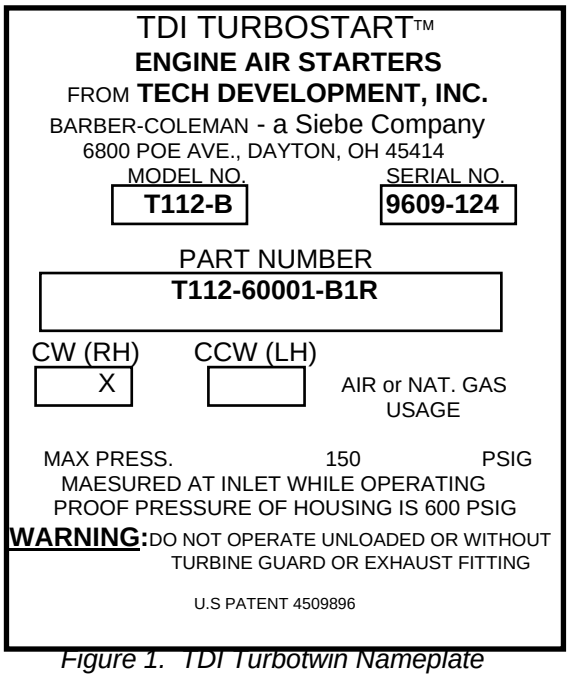

Figure 1. TDI Turbotwin Nameplate

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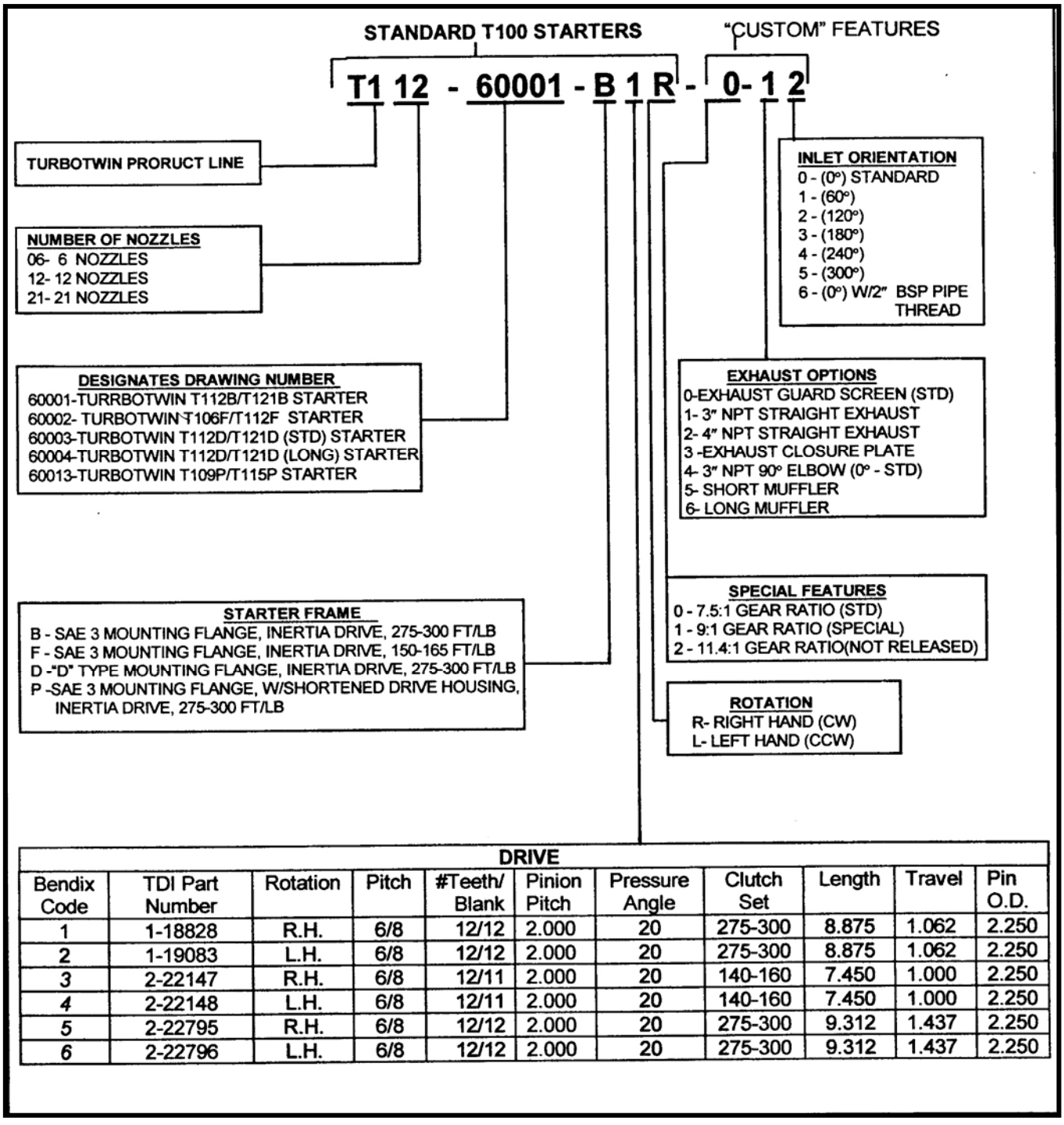


DRIVE

Bendix Code	TDI Part Number	Rotation	Pitch	#Teeth/ Blank	Pinion Pitch	Pressure Angle	Clutch Set	Length	Travel	Pin O.D.
1	1-18828	R.H.	6/8	12/12	2.000	20	275-300	8.875	1.062	2.250
2	1-19083	L.H.	6/8	12/12	2.000	20	275-300	8.875	1.062	2.250
3	2-22147	R.H.	6/8	12/11	2.000	20	140-160	7.450	1.000	2.250
4	2-22148	L.H.	6/8	12/11	2.000	20	140-160	7.450	1.000	2.250
5	2-22795	R.H.	6/8	12/12	2.000	20	275-300	9.312	1.437	2.250
6	2-22796	L.H.	6/8	12/12	2.000	20	275-300	9.312	1.437	2.250

Figure 2. Part Number Coding

SECTION 2.0 DESCRIPTION OF BASIC GROUPS

2.1 GENERAL

The TDI Turbotwin T100 Series air starters are lightweight, compact units driven by a dual stage turbine type air motor. The starter is composed of three basic assembly groups: Turbine Housing Assembly; Gearbox Housing Assembly; and Bendix Drive Assembly.

2.2 TURBINE HOUSING ASSEMBLY

The Turbine housing assembly, refer to figure 3, consists of a stage one (15) and a stage two (6) turbine wheel mounted on sungear shaft (33) . The front bearing (10) is secured by a retainer plate (32). The aft bearing is preloaded by wavy spring (12).

The ring gear (29) is heat shrunk into the front of the turbine housing (26) and secured by a setscrew (25).

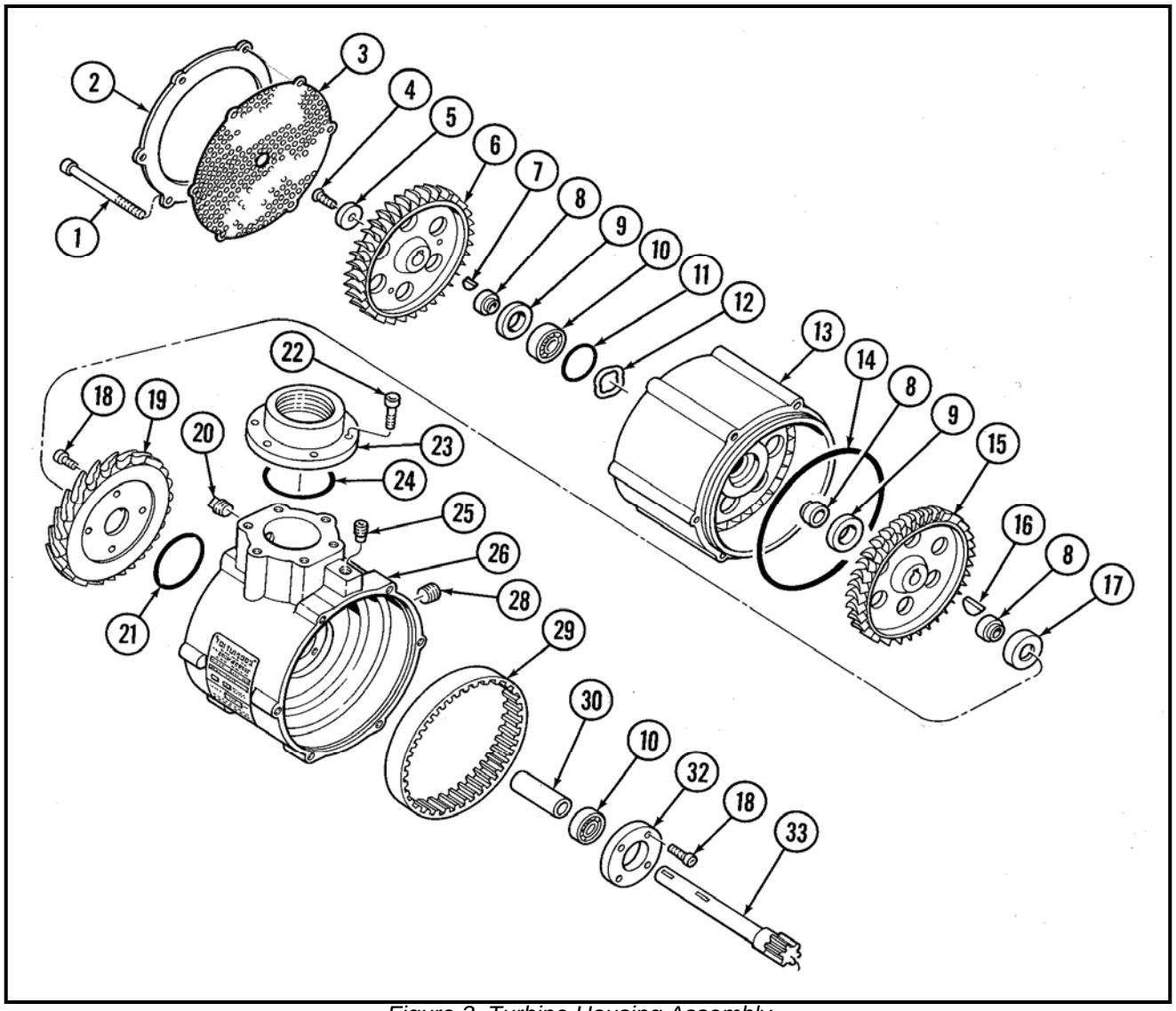


Figure 3. Turbine Housing Assembly

2.3 GEARBOX HOUSING ASSEMBLY

The gearbox housing assembly, refer to figures 4, consist of a planet gear carrier and output shaft (35), three planet gears (37), needle bearings (38), spacers (36), and bearing pins (39).

The carrier shaft is mounted on two ball bearings (41) in the gearbox housing (58). The retainer nut (48) secures the carrier shaft in the gearbox housing. The front bearing (41) is secured by a retainer plate (46). The back bearing is preloaded by use of a spring washer (42).

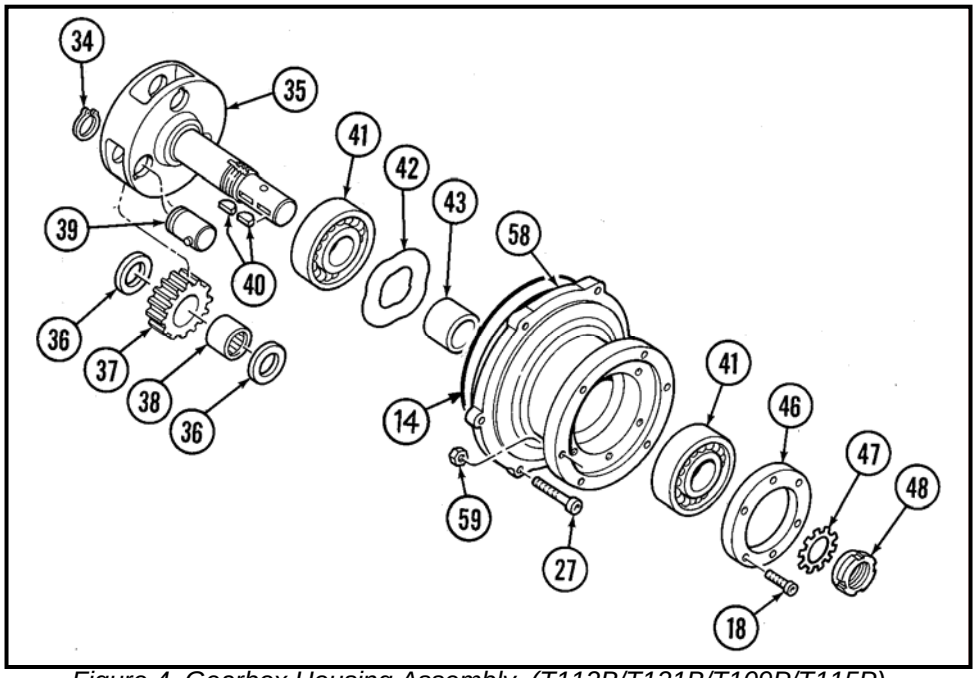


Figure 4. Gearbox Housing Assembly (T112B/T121B/T109P/T115P)

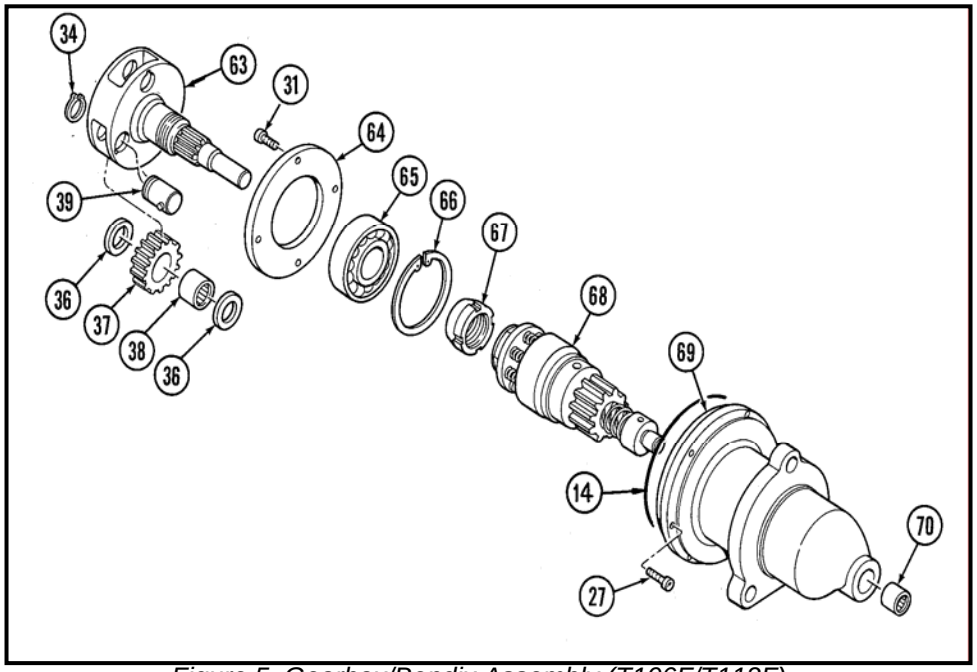


Figure 5. Gearbox/Bendix Assembly (T106F/T112F)

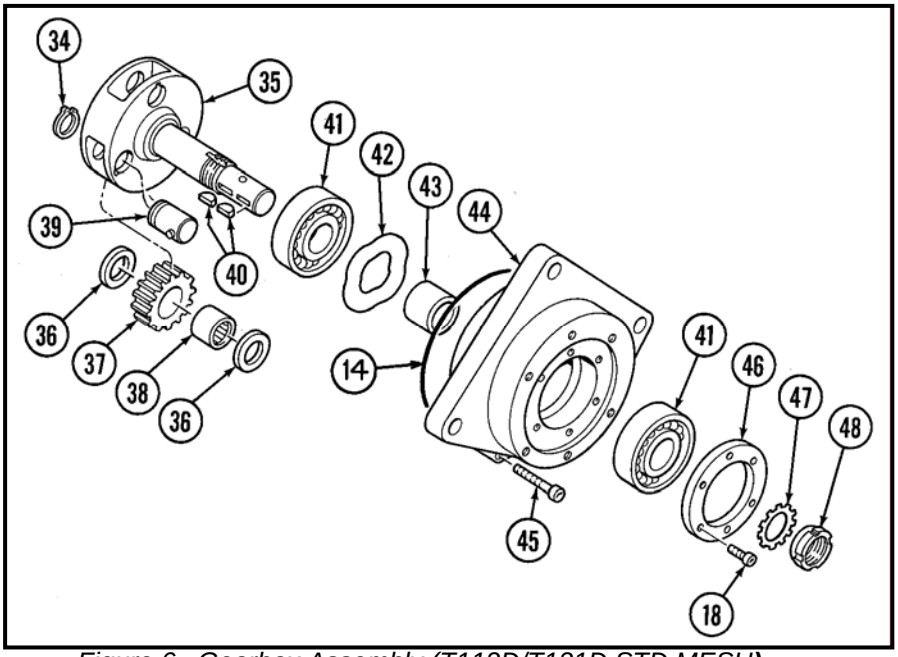


Figure 6. Gearbox Assembly (T112D/T121D STD MESH)

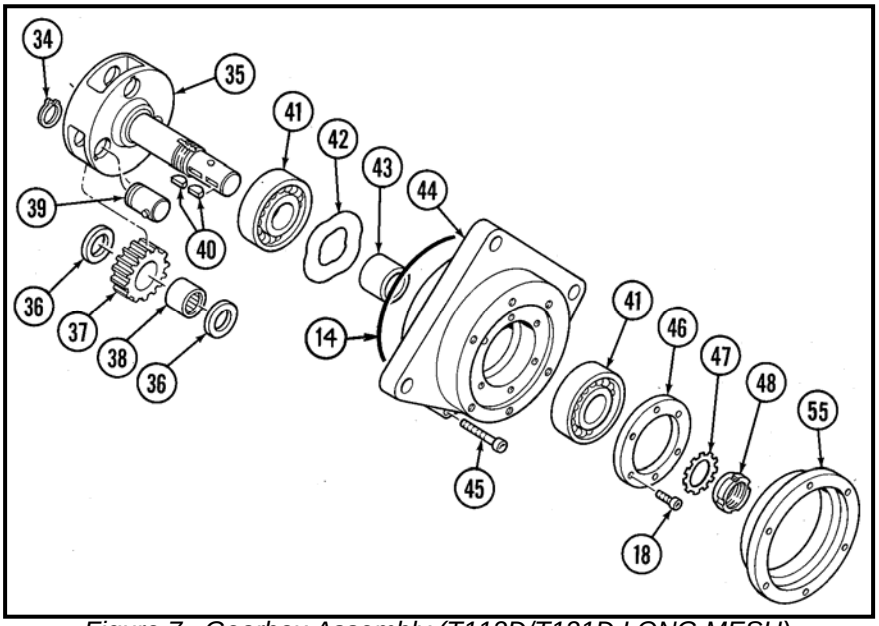


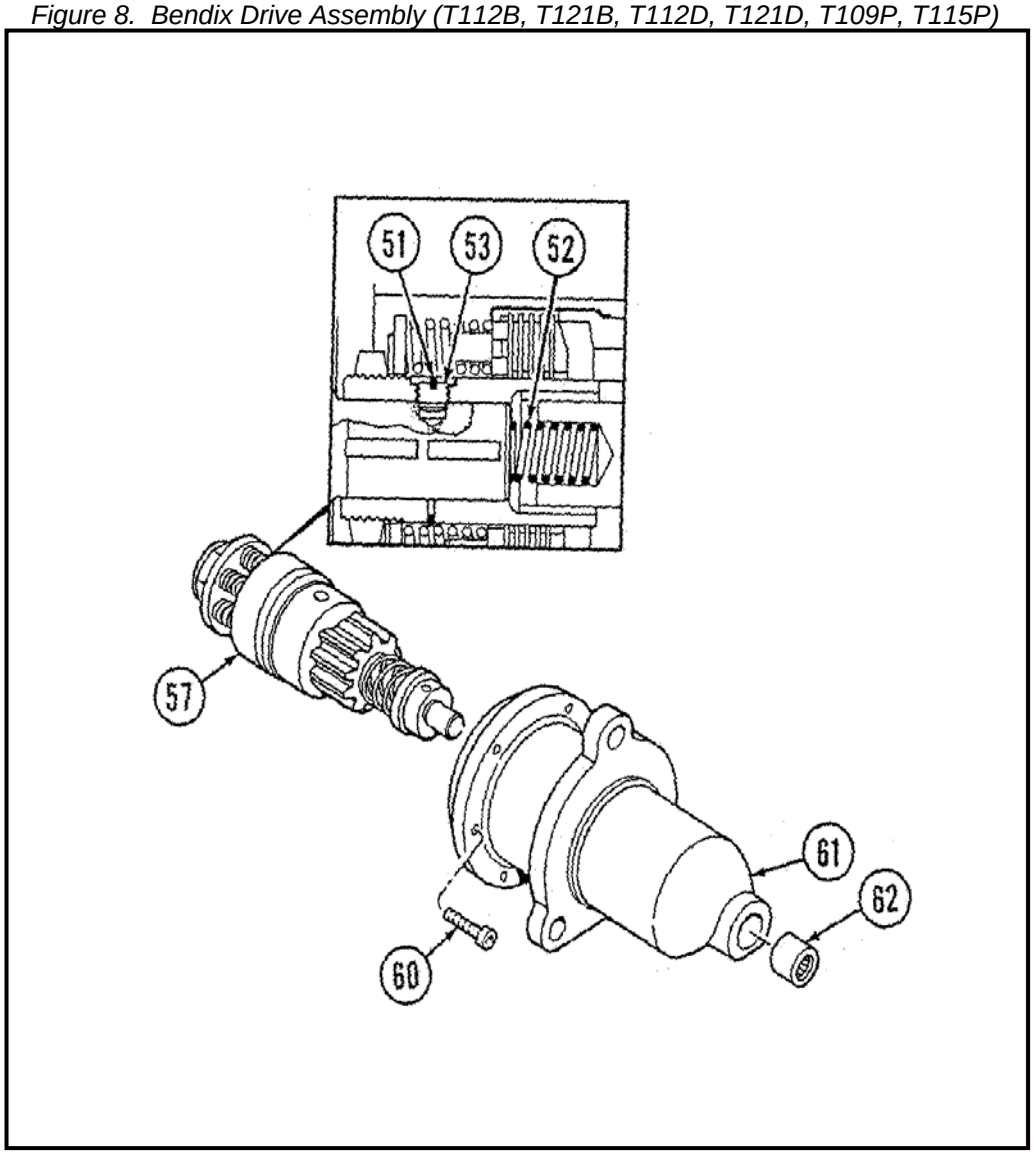
Figure 7. Gearbox Assembly (T112D/T121D LONG MESH)

2.4 BENDIX DRIVE ASSEMBLY

The Bendix drive assembly, refer to figure 8, consists of an inertial engagement drive or “bendix” (57) and drive housing (61). The bendix is mounted to the output shaft with two keys and a retaining set screw (53).

The other end of the drive unit is mounted into a needle bearing (54), which is installed in the nose of the drive housing.

Figure 8. Bendix Drive Assembly (T112B, T121B, T112D, T121D, T109P, T115P)



SECTION 3.0 DISASSEMBLY

3.1 GENERAL

Always mark adjacent parts on the starter housing; Nozzle 2/ Containment Ring (13), Turbine Housing (26), Gearbox Housing (58), and Bendix Drive Housing (61) so these parts can be located in the same relative position when the starter is reassembled.

Do not disassemble the starter any further than necessary to replace a worn or damaged part

Always have a complete set of seals and o-rings on hand before starting any overall of a Turbotwin T100 series starter. Never use old seals or o-rings.

The tools listed in *Table 1* are suggested for use by technicians servicing the Turbotwin T100 series starters. The best results can be expected when these tools are used, however the use of other tools are acceptable.

TOOL DESCRIPTION	TDI/PN
Spanner wrench	52-20134
Spanner wrench	52-21345
Shaft Removal Tool	2-26945
Stage 2 Rotor Puller Tool	52-20076
Carrier Shaft Holding Tool	52-20202
Tool, Bearing Pressing	52-20143
Tool, Bearing/Seal	2-26943

Table 1. T100 Series Service Tools

3.2 DRIVE HOUSING
(T112B,T121B,T109P,T115P)

3.2.1 Removal of Drive Housing

Mark position of bendix pinion opening relative to gearbox housing for reference during reassembly. Remove the six bolts (60) and lock nuts (59). Pull drive housing (61) from gearbox housing (58). If drive housing is too tight, tap it with a mallet to loosen.

3.2.2 Removal of Bendix Drive

In loaded spring area of drive (57) remove retaining ring (51) from set screw (53) slot.

Remove set screw using a flat head screwdriver, *Figure 9* and pull the bendix assembly from the starter carrier shaft. Remove spring (52). This spring fits loosely between the bendix assembly and carrier shaft. Remove the needle bearing (62), if necessary, by simply tapping out the “welch” plug from the front of the drive housing and press bearing out.

3.3 DRIVE HOUSING
(T112D/T121D)

3.3.1 Removal of Drive Housing

Remove the six screws (22). Mark position of bendix pinion opening relative to gearbox housing for reference during reassembly. Pull drive housing (49) from gearbox housing (44). If drive housing is too tight, tap it with a mallet to loosen.

3.3.2 Removal of Bendix Drive

In loaded spring area of drive (57) remove retaining ring (51) from set screw (53) slot.

Remove set screw using a flat head screwdriver, *Figure 9, and* pull the bendix assembly from the starter carrier shaft.

Remove spring (52). This spring fits loosely between the bendix assembly and carrier shaft. Remove the needle bearing (62), if necessary, by simply tapping out the “welch” plug from the front of the drive housing and press bearing out.

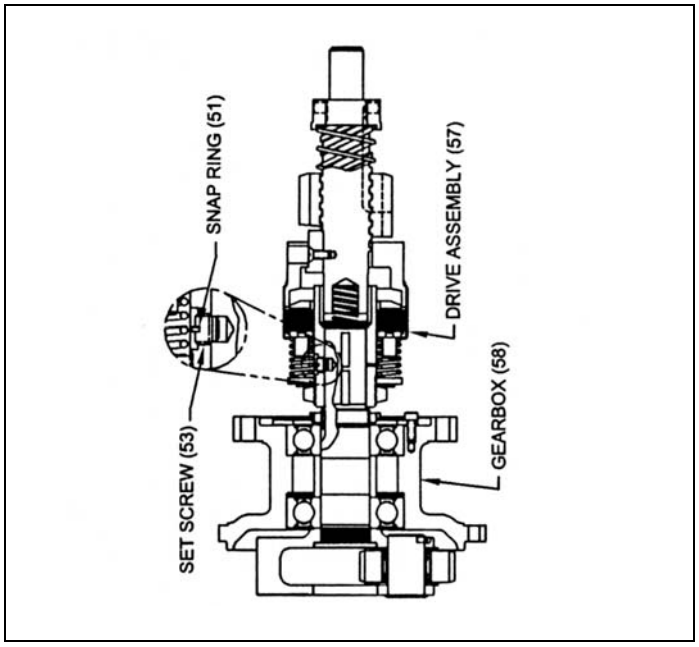


Figure 9. Bendix Drive Removal

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3.4 DRIVE/GEARBOX HOUSING
(*T106F/T112F)*

3.4.1 Removal of Drive Housing

Mark position of bendix pinion opening relative to turbine housing (26) for reference during reassembly. Per *Figure 10,* remove the six screws (27). Pull drive housing (69) from turbine housing. If drive housing is too tight, tap it with a mallet to loosen.

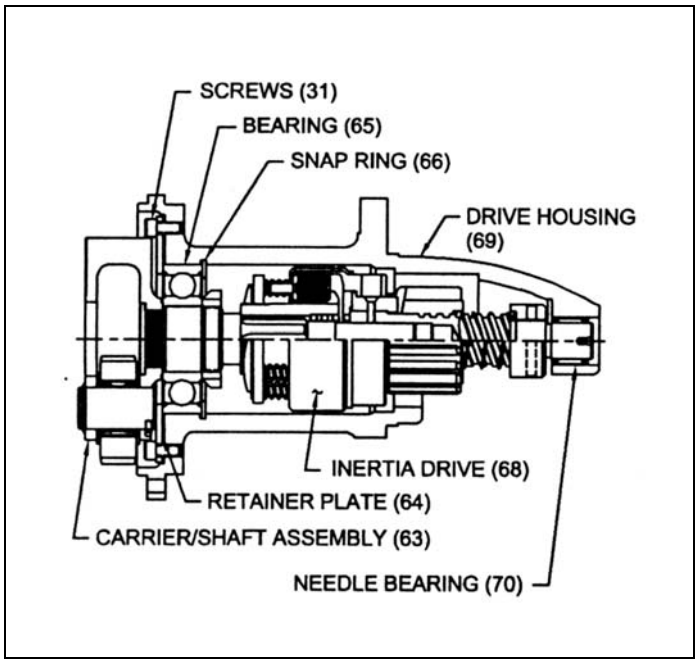


Figure 10. Bendix Drive Removal (T106F/T112F)

3.4.2 Removal of Bendix Drive

Remove four screws (31). Pull carrier shaft assembly (63) from drive housing (69). The bendix (68) will remain in the drive housing. With snap ring tool, remove snap ring (66) and bendix drive (68)from drive housing.

If it is necessary to remove needle bearing (70) from drive housing, simply press bearing out.

Mount the carrier shaft assembly on the TDI holding tool P/N 52-20202 placing the three holes on the gearbox over the dow pins. *Refer to Figure11*.

Place TDI tool P/N 52-21345 (Spanner Wrench) over shaft and into slots of retainer nut (67). Hold down carrier shaft and remove nut.

Remove bearing (65) from shaft by pressing shaft while supporting inner race of bearing. Remove bearing retainer plate (64).

3.4.3 Planet Gear Disassembly

Remove snap ring (34) from planet shaft (39) using snap ring pliers and push shaft through holes in assembly.

Slide the planet gear (37) out from the carrier shaft and remove the two nylon spacer (36). Unless the needle roller bearings 38) are damaged, do not remove. If removal is necessary, simply press bearing out.

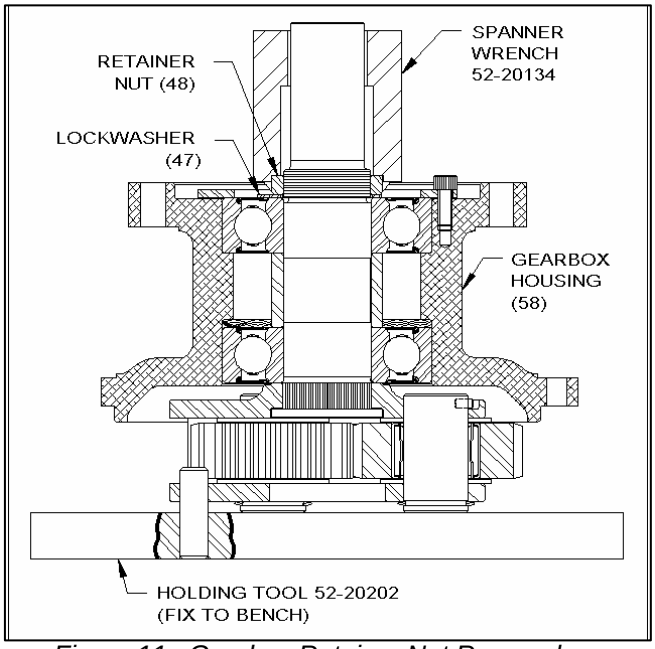


Figure 11. Gearbox Retainer Nut Removal

3.5 GEARBOX HOUSING
(*T112B/T121B,T112D/T121D,T109P/T115P)*

* The drive housing removal procedure should be performed before performing this procedure.

3.5.1 Removal of Gearbox Housing

Remove the six screws (27) and lift the gearbox assembly from the turbine assembly. If the gearbox assembly is too tight, tap it with a mallet to loosen).

3.5.2 Gearbox Disassembly

Mount the gearbox on the TDI holding tool P/N 52-20202 placing the three holes on the gearbox over the dow pins. *Refer to Figure 11*.

Remove woodruff keys (40) from shaft by tapping them with a chisel and hammer

With screwdriver remove tang of lockwasher (47) from slot of retainer nut (48).

Place TDI tool P/N 52-20134 (Spanner Wrench) over shaft and into slots of retainer nut. Hold gearbox down and remove nut.

In most cases the gearbox housing (58, D-44) can be removed from the carrier shaft (35) by holding shaft down and pulling directly up on housing. If this is not the case, press carrier shaft from housing per *Figure 12*.

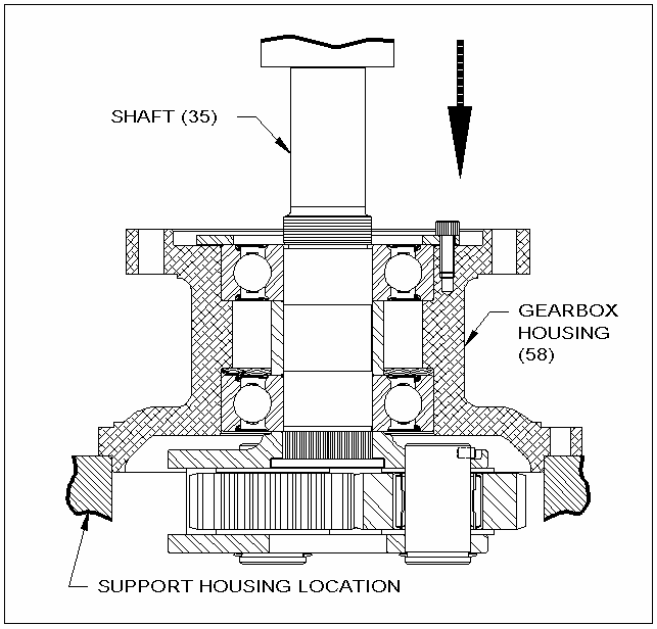


Figure 12. Pressing Out Carrier Shaft

The aft bearing (41), spring washer (42), and bearing spacer (43) will come out with the shaft. Remove aft bearing (41) from shaft by pressing shaft while supporting bearing.

If the aft bearing (41) is retained in the gearbox housing when the carrier shaft is removed, apply pressure through housing to the bearing to remove it. It will be necessary to elevate the housing with a brace to remove the bearing completely.

Remove the six screws (18) and retainer plate (46). The front bearing may then be removed by lightly tapping.

3.5.3 Planet Gear Disassembly

Remove snap ring (34) from planet shaft (39) and push shaft through holes in assembly.

Slide the planet gear (37) out from the carrier shaft and remove the two nylon spacer (36). Unless the needle roller bearings 38) are damaged, do not remove. If removal is necessary, simply press bearing out.

3.6 TURBINE HOUSING

3.6.1 Stage 2 Rotor Removal

Remove the six screws (27) that connect the gearbox assembly to the turbine housing and separate the two assemblies. Remove the four screws (18) and the clamping plate (32).

Turn the turbine to the (exhaust) end up and remove the six screws (1), screen support ring (2), and the screen (3). For the T109P, remove six screws (74) and Exhaust Cover Housing (75).

Hold the stage 2 rotor (6) and remove the turbine screw (4) and washer (5).

Install the rotor puller tool P/N 52-20076 and remove the stage 2 rotor per *Figure 13*.

Remove the woodruff key (7) using a hammer and chisel.

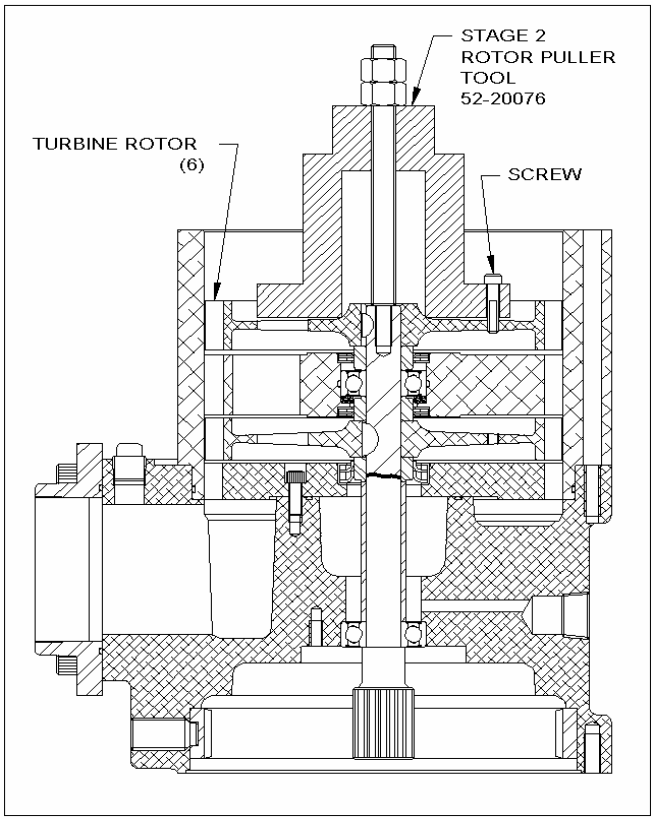


Figure 13. Turbine Rotor Removal

3.6 Turbine Shaft Removal

Using the shaft removal tool P/N 2-26945 per figure 14, press on the turbine shaft (33) while supporting the turbine housing.

Press the shaft assembly (33) through the aft bearing (10) and continue pressing until the shaft assembly is completely out of the housing (26).

Remove the woodruff key (16), seal spacer (8), bearing spacer (30), and bearing (10) from the shaft. The bearing can be removed from the shaft by pressing the shaft through the bearing. Note that if T100 is the original design *(SN: 9501-239 to9611-191),* the bearing will be pressed inside a spacer.

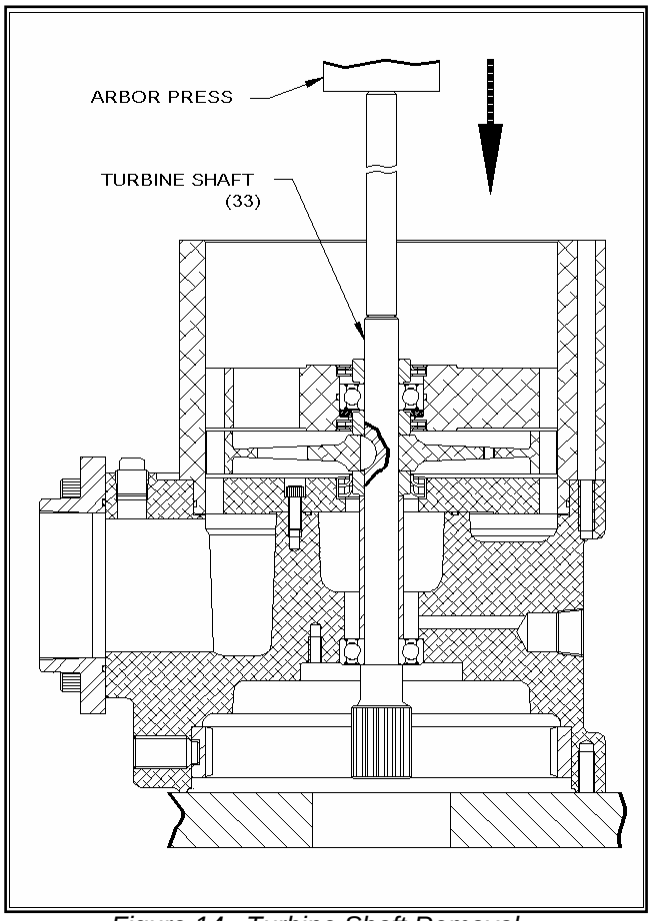


Figure 14. Turbine Shaft Removal

Separate the stage 2 nozzle assembly (13) from the turbine assembly (26) by firmly holding the turbine assembly, while tapping nozzle 2 with a mallet. If nozzle 2 is too tight, it can be removed by installing two threaded screws into nozzle 2 and using them as jacks to separate nozzle 2 from the turbine assembly. Refer to *Figure 15*.

Rotate the stage 1 rotor if necessary to allow the jacks to travel through the large holes in the rotor. The jacks will damage the stage 1 rotor if pressure is applied to them while removing nozzle 2.

The stage 1 rotor (15) may now be removed.

Remove the four screws (18) and nozzle 1 (19) from the turbine assembly. It may be necessary to tap the screws with a hammer and chisel to loosen.

On the stage 2 nozzle (13), remove the seal spacer (8) from the forward side of the nozzle. Place the stage 2 nozzle on the exhaust end. Press through the lip seal onto the bearing until it, including the 2nd lip seal and seal spacer disengages from the nozzle. Turn the nozzle over and press on the lip seal to remove.

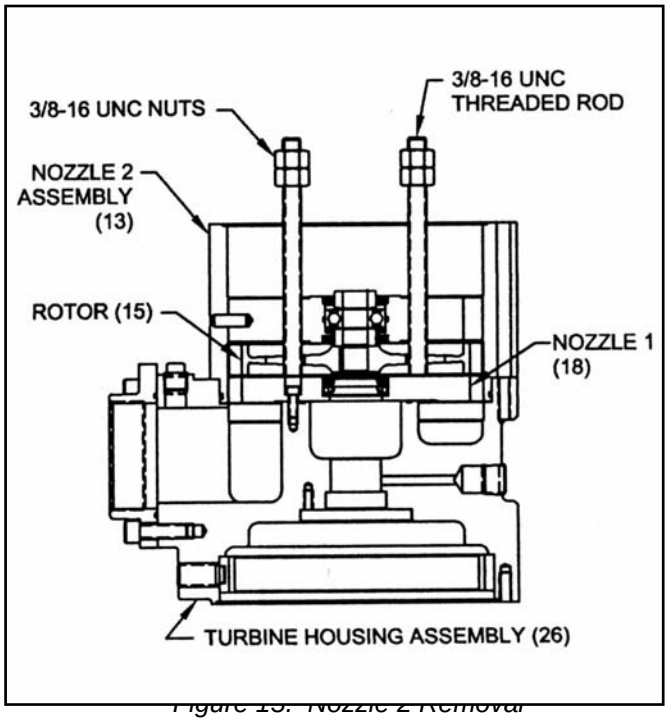


Figure 15. Nozzle 2 Removal

SECTION 4.0 CLEANING and INSPECTION

4.1 CLEANING

Degrease all metal parts, except bearings, using a commercially approved solvent. Refer to *Table 2.*

NOTE

Never wash bendix assembly or bearings in cleaning solvents. It is recommended that the bearings be replaced with new parts.

Clean aluminum parts using the solutions per *Table 2*; soak for 5 minutes. Remove parts, rinse in hot water, and dry thoroughly.

Clean corroded steel parts with a commercially approved stripper.

Clean corroded aluminum parts by cleaning as stated above and then immerse the parts in chromic-nitric-phosphoric acid pickle solution per *Table 2*. Rinse in hot water and dry thoroughly.

MATERIAL or COMPOUND	MANUFACTURER
Degreasing Solvent (Trichloroethylene) (O-T-634)	Commercially Available
Acetone	Commercially Available
Aluminum Cleaning Solution	Diversey Corp., 212 W. Monroe, Chicago, IL 60606 Dissolve 5 oz of Diversey 808 per gallon of water at 155°- 165°F.
Steel Cleaner - Rust & Corrosion	Oakite Products Corp., 50 Valley Rd., Berkeley Heights, NJ 07992 Mix 3-5 lb. of Oakite rust Stripper per gallon of water; use at 160°- 180°F.
Chromic-Nitric-Phosphoric Acid Pickle Solution	Mix 8lb. of chromic acid, 1.9 gal. of phosphoric acid, 1.5 gal. of nitric acid with enough water to make a total of 10 gal. of solution.
WARNING Follow all instructions provided with the MSDS sheets on the materials and compounds listed above.	

Table 2. Cleaning Materials and Compounds

4.2 INSPECTION

Use *Table 3* as a guide to check for acceptable condition of the parts listed.

Check all threaded parts for galled, crossed stripped, or broken threads.

Check all parts for cracks, corrosion, distortion, scoring, or general damage.

Check all bearing bores for wear and scoring. Bearing bores shall be free of scoring lines, not to exceed 0.005″ width and 0.005″ depth.

Check gear teeth and turbine housing ring gear for wear. In general, visually check for spalling, fretting, surface flaking, chipping, splitting, and corrosion. If wear is apparent, check the gear teeth dimensions in accordance with *Table 4*. Nicks and dents that cannot be felt with a .020 inch radius scribe are acceptable.

Part Description	Check For	Requirements (Defective Parts Must Be Replaced)
Bendix	Worn, loose, or missing parts	Defective unit to be replaced. Use figure 5 as a guideline for acceptable pinion wear.
Drive Housing	Cracks and breakage	Cracks are not acceptable
Planet Gear	Cracked, chipped, or galled teeth. Wear must not exceed limits per Table 4.	Wear must not exceed limits per table 4. There shall be no evidence of excessive wear.
Carrier Shaft	Cracks, scoring or raised metal in planet shaft holes and keyways. Integrity of knurl connection.	Deformation of metal smearing in planet pin holes & keyways not acceptable. Scoring on bearing diameter not to exceed .005″ depth. Wear must not exceed limits per Table 4.
Planet Pins	Wear grooves or flat spots	Wear grooves in flat spots not permitted. Wear must not exceed limits per Table 4.
Washers	Wear created grooves	Wear must not exceed limits per Table 4.
Gearbox Housing	Cracks and Breakage	Cracks and breakage not acceptable.
Sungear / Turbine Shaft	Cracks, scoring, wear created grooves, chipped or broken gear- teeth, galling or scoring on bearing surface of shaft. Raised metal on the keyway.	Wear must not exceed limits per Table 4.
Spacers	Parallelism of end surfaces	Ends must be parallel within 0.0005″.
Turbine Housing Ring Gear	Cracks and breakage Cracks, wear, chipped, or broken gear teeth.	Cracks and breakage are not acceptable. Minor surface damage is permitted if function is not impaired. Wear must not exceed limits per Table 4.
Seal Assembly	Wear grooves or scratched surfaces on carbon ring.	Wear is not permitted.
Seal Spacer	Wear Grooves	No wear permitted.
Needle Bearings	Freedom of needle rollers	Replace bearings
Ball bearings	Freedom of rotation without excessive play between races	Replace bearings
Containment Ring/ Nozzle	Corrosion, erosion, cracks and broken nozzle edges.	Cracks and breakage are not acceptable. Minor surface damage is permitted if function is not impaired.
Turbine Rotors	Corrosion, erosion, cracks and broken edges. Tip wear; bore and key way wear	Minor tip rub is permitted if function is not impaired. Wear is not permitted.

Table 3. Parts Inspection Check Requirements

PART DESCRIPTION	LIMIT, Inches
Ring gear / Turbine Housing Internal measurement between two .084″ diameter pins.	5.0890 max.
Sun Gear / Turbine Shaft Bearing diameter External measurement over two .096 diameter pins. 7.5:1 9:1 11.4:1	0.6690 min 0.952 min 0.808 min 0.670 min
Planet Gear External measurement over two .0864″ diameter pins. 7.5:1 9:1 11.4:1	 2.3067 min 2.3699 min 2.4359 min
Carrier Shaft Bearing Diameter Planet Pin Bore	 1.1800 min 0.8750 max
Planet Pins Bearing Diameter	 0.873 min
Thrust Washer Thickness	 .055 min

Table 4. Parts Wear Limits

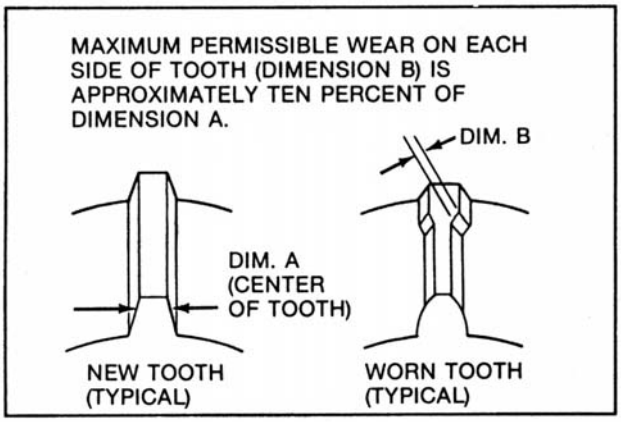


Figure 16. Gear Teeth Wear Allowances

SECTION 5.0 ASSEMBLY

5.1 GENERAL

The tools listed in *Table 1* are suggested for use by technicians servicing the T100 Series starters. The best results can be expected when the proper tools are used, however, use of other tools is acceptable.

CAUTION

Replace all screws , O-rings, lip seals, and bearings when the T100 Series starter is reassembled. These parts are included in the overhaul kits shown in Section 6.0

NOTE

Always press the inner race of a ball bearing when installing a bearing on a shaft. Always press the outer race of a ball bearing when installing into a housing.

Refer to Section 6.0, for a list of kits and components, which are available to aid in rebuilding T100 Series starters.

Lubricate all O-rings with petroleum jelly or Parker-O-Ring Lube before assembly. Refer to *Table 5* for a list of materials to be use during assembly.

MATERIALS	SOURCE
Petroleum Jelly	Commercially Available
Parker-O-Ring Lube	Commercially Available
Loctite RC290	Commercially Available
Grease, gearbox	TDI P/N 9-94121-001

Table 5. Materials for Assembly

CAUTION

The screws that secure the Containment Ring/ Stage 2 Nozzle must have a drop of Loctite RC290 applied to the threads before being used.

5.2 TURBINE HOUSING

5.2.1 Turbine Shaft Installation

Press the bearing (10) onto the shaft (33) until seated. Support the shaft and press on the inner race only with press tool P/N 2-26943 per *Figure 17.* Note that if

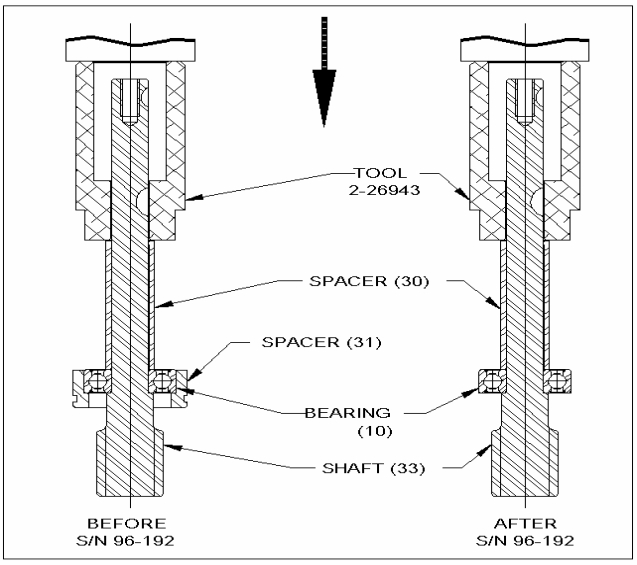


Figure 18. *Pressing Spacer onto Bearing*

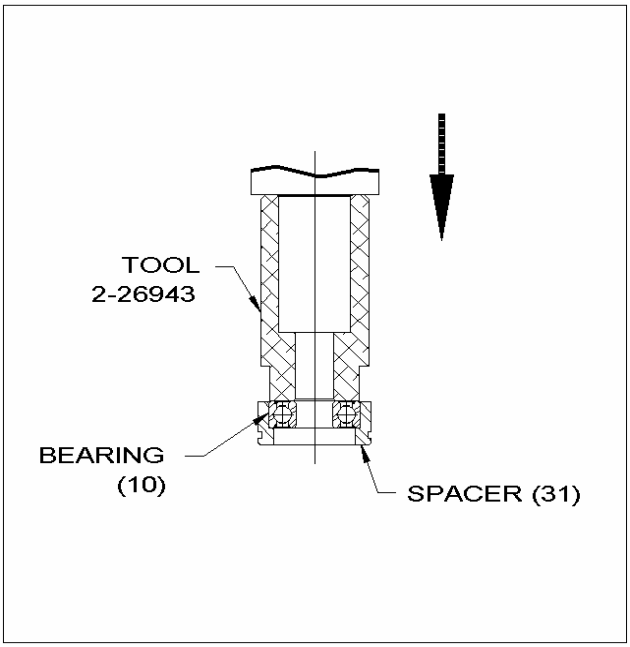


Figure 17. Pressing Front Turbine Bearing

T100 is the original design (SN: 9501-239 to 9611-191), press the spacer (31) onto the outer race of the bearing (10) per *Figure 18* by supporting the bearing outer race, and then press the bearing/spacer (10, 31) onto the shaft.

Press the bearing/shaft assembly, keyway end first, into bearing housing of the turbine housing. Use press tool P/N 2-26943 if required per *Figure 19. D*o not press on the end of the shaft because the load could damage the balls of the bearing.

Install bearing retainer plate (32) and secure with four screws (18). Torque screws to 30 in-lbs.

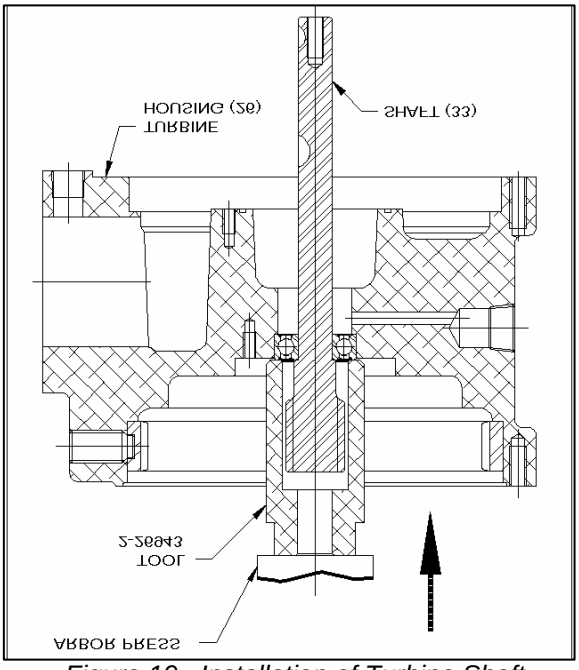


Figure 19. Installation of Turbine Shaft

Place turbine housing front surface (sungear end) on flat surface. Install long bearing space (30) over shaft.

Install the seal spacer (8) onto the shaft. Note the small end of the spacer faces the long bearing spacer.

Install the O-ring (21) into the aft face of the turbine housing (26).

5.2.2 Nozzle 1 Installation

Press the aft seal (17) into nozzle 1 (19) using press tool P/N 2-26943 per *Figure 20* with the lips facing up.

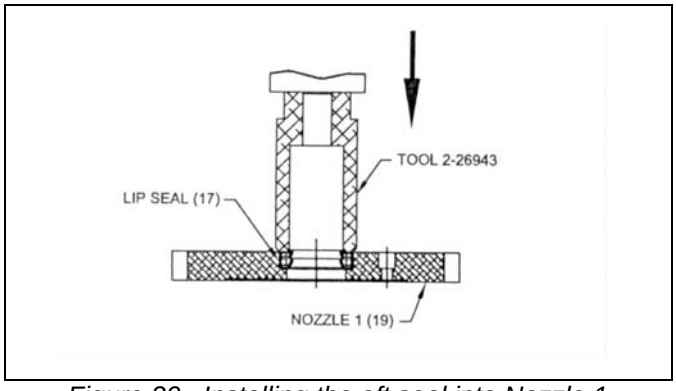


Figure 20. Installing the aft seal into Nozzle 1

Install nozzle 1 onto the turbine housing (26). Orient the nozzles facing the air inlet (23). Install four screws (18) to secure the nozzle. Do not tighten the screws at this time.

5.2.3 Rotor 1 Installation

Install the woodruff key (large key) (16) for stage 1 rotor into the shaft (33).

Install the stage 1 rotor (15), while supporting sun gear end of shaft, onto the turbine shaft by aligning the slot in the rotor with the woodruff key and hand press the rotor until firmly seated. Use press tool P/N 2-26943 if required.

Visually inspect that the key was not pushed out during assembly. Note that the direction of rotation was oriented properly. This turbine rotor can be installed backwards.

Temporarily install Nozzle 2 on the turbine housing. Tighten the four screws that secure nozzle 1 (18) to 30 in-lb. The four screws can be accessed via the holes in nozzle 2 and the first stage turbine rotor. Remove Nozzle 2 when the four screws are tight.

5.2.3 Nozzle 2 Installation

Press the lip seal (9) into the forward side of nozzle 2 with seal lip facing up. Use press tool P/N 2-26943.

Install the O-ring (11) into the bearing bore of nozzle 2 (13). DO NOT LUBRICATE THIS O-RING.

Install O-ring (14) onto the outer diameter of nozzle 2.

Install nozzle 2 (13) onto the turbine housing (26). The three flats of nozzle 2 are always oriented opposite the turbine housing air inlet (SN 9505-213 to 9611-191).

Install the seal spacer (8) onto the shaft with the small end facing the aft bearing (10).

Install the wavy spring washer (12) into the bearing bore of the stage 2 nozzle.

Support the sun gear end of the shaft. Press the aft bearing (10) onto the shaft by pressing onto the inner and outer race simultaneously. Use press tool per *Figure 21*. Press until bearing is seated.

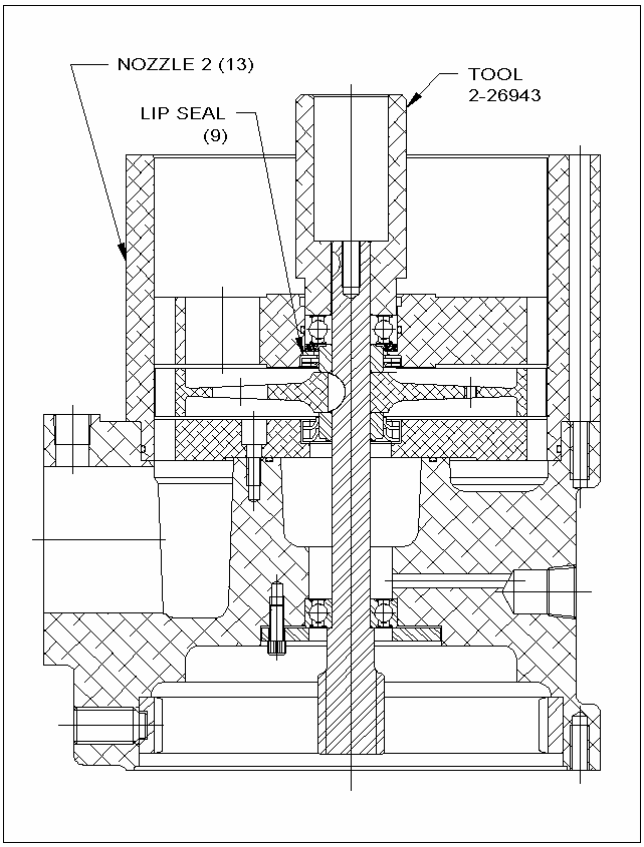


Figure 21. Pressing Aft Bearing onto Shaft

Install the seal spacer (8) with the small end facing the aft bearing (10).

Press the lip seal (9) into the stage 2 nozzle using press tool P/N 2-26943 with lip seal facing up.

Install the stage 2 woodruff key (7) into the shaft (33).

5.2.4 Stage 2 Rotor Installation

Install the stage 2 rotor (6) onto the shaft. Use press tool P/N 2-26943 if required. Visually inspect that the key was not pushed out during assembly. Note that the direction of rotation was oriented properly. This turbine can be installed backwards.

Install the rotor washer (5) and secure with screws (4). Tighten screw to 100 in-lb.

Install the exhaust screen (3) and back plate (2). Secure with six screws (1). Tighten the screws to 80 in-lb.

5.2.5 Air Inlet Installation

Place the O-ring (24) into the groove on the air inlet (23).

Install the 2″ NPT air inlet flange (23) and secure with six screws (22). Tighten the six screws to 170 in-lb.

Mark the number of stage 1 nozzles (usually 6, 12,or 21) onto the O.D. of the unit for identification of the unit prior to name plate installation.

5.3 GEARBOX HOUSING

(T112B/T121B, T112D/T121D, T109P/T115P)

5.3.1 Planetary Gear Carrier Reassembly

If disassembled, press needle bearing (38) into planet gears (37). The planet gears are not identified by part number, therefore, dimensionally check if correct gears are being used. Use table 4 for over the wire measurements.

With a thrust washer (36) on each side of gear, slide gear into carrier shaft slots (35), and align with pin holes.

Lightly slide plant shafts into aligned holes, making sure snap ring groove on end of pins goes in first per *Figure* 22.

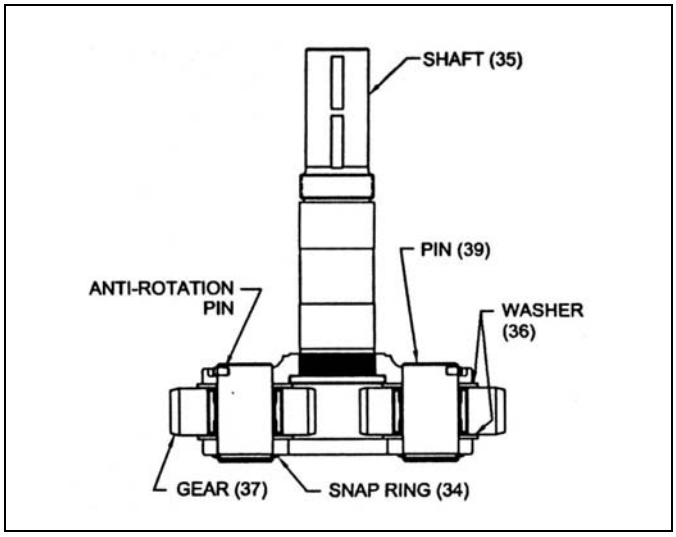


Figure 22. Planet Gear Carrier Shaft Assembly

NOTE

Make sure that anti-rotation pins on shafts are properly located in retaining slots of carrier shaft (35).

Install snap ring (34) with a snap ring tool.

5.3.2 Gearbox Reassembly

Press the bearing (41) into the forward side of the gearbox housing (58, D-44). Pressing force should be on the outer race only.

Install retainer plate (46) and secure with six screws (18).

Press rear bearing (41) onto carrier shaft (35) using TDI Tool P/N 52-20143 per *Figure 23*. Pressing force should be on the inner race of bearing.

Install spring washer (42) and bearing spacer (43) onto shaft and locate against bearing.

Position carrier shaft assembly (35,41,42,43) into bearing bore of the gearbox housing (58). Lift up on housing and slide shaft down. If shaft will not slide into bearing bore, press housing per *Figure 24* until bearing is seated (41).

Place gearbox assembly on TDI Tool P/N 2-20202 per *Figure 25*. Install lockwasher (47) and then retainer nut (48). Torque to 600-800 in-lb. Tang lockwasher into retainer nut slot.

Place O-ring (14) onto outer diameter of gearbox assembly.

Thoroughly grease planet gears, ring gear and sun gear using the grease specified in *Table 5* and pack the center of the gears with grease.

5.3.3 Gearbox to Turbine Housing Assembly

Rotate carrier shaft (35) slightly, and at the same time, align gearbox into the front of turbine housing (26).

Install six screws and torque 90-120 in-lbs.

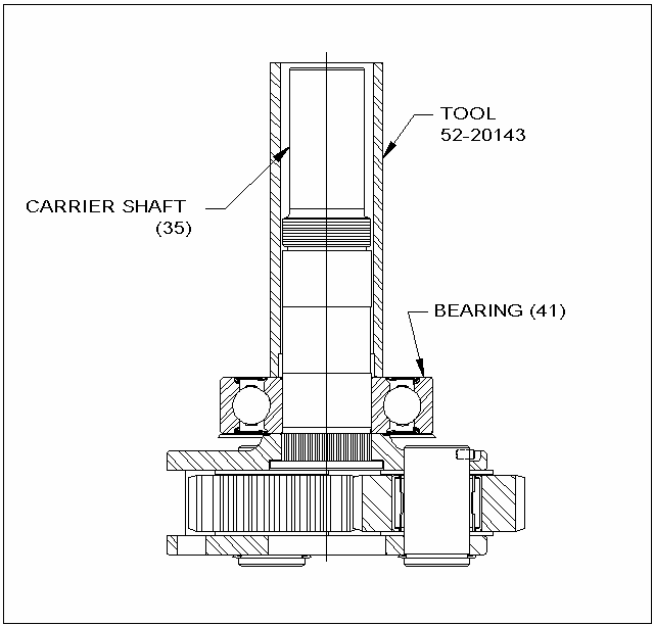


Figure 23. Pressing Rear Bearing onto Carrier Shaft

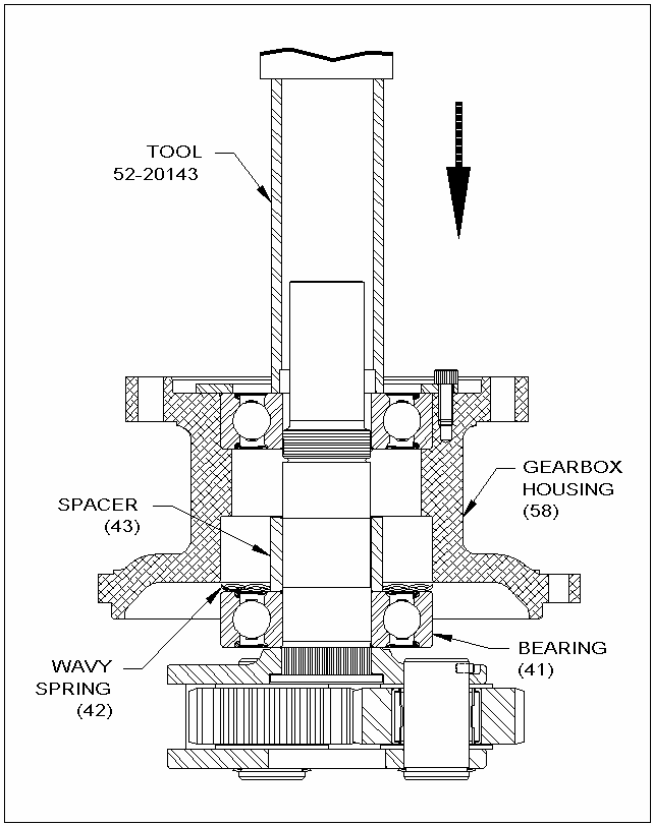


Figure 24. Installing Carrier Shaft into Gearbox Housing

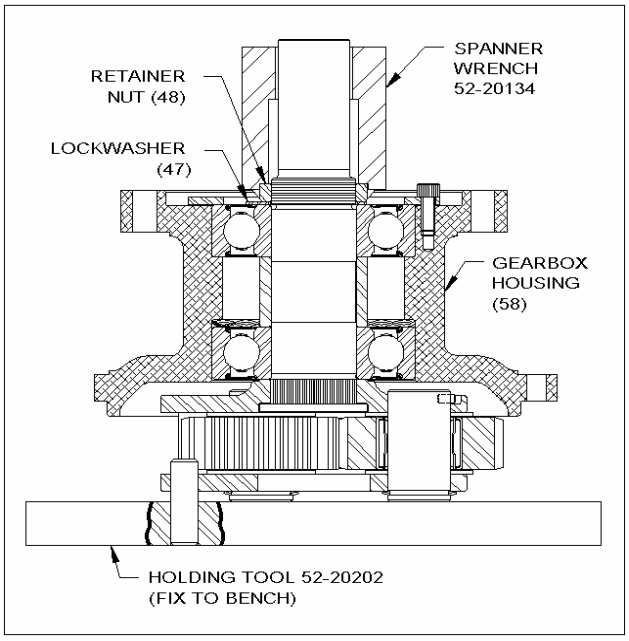


Figure 25. Tightening Retainer Nut

5.4 DRIVE HOUSING
(T112B/T121B, T112D/T121D, T109P/T115P)

5.4.1 Bendix Drive Installation

Install two woodruff keys (40). Ensure keys are properly installed per *Figure 26*.

Position bendix assembly (57) on shaft with retainer set screw (53) removed. Install spring (52) between bendix cavity and end of output shaft. Slide bendix over shaft until set screw hole aligns with set screw hole in shaft.

Install set screw and tighten firmly. Slip retainer (51) ring into set screw slot.

5.4.2 Bendix Drive Housing Installation

If disassembled, press needle bearing (62, P-80) into drive housing (61) until flush with bottom surface.

Mount drive housing over bendix drive, and align holes for desired bendix opening orientation with starter inlet connection. Torque bolts and nuts to 90-120 in-lbs.

5.5. DRIVE/GEARBOX HOUSING
(T106F/T112F)

5.5.1 Planetary Gear Carrier Reassembly

If disassembled, press needle bearing (38) into planet gears (37). The planet gears are not identified by part number, therefore, dimensionally check if correct gears are being used. Use table 4 for over the wire measurements.

With a thrust washer (36) on each side of gear, slide gear into carrier shaft slots (63), and align with pin holes.

Lightly slide plant shafts (39) into aligned holes, making sure snap ring groove on end of pins goes in first.

NOTE

Make sure anti-rotation pins on shafts are properly located in the retaining slots of the carrier shafts (63).

5.5.2 Planetary Carrier Bearing Installation

Install bearing retainer plate (64) over carrier shaft (63)

Press bearing (65) onto shaft making sure pressing force is on inner race of bearing only.

Place carrier shaft assembly onto TDI Tool P/N 52-20202, see Figure 27. Thread retainer nut (67) onto shaft (63). Hold carrier assembly down and torque nut to 600-800 lb.-in. with spanner wrench, TDI Tool P/N 52-21345.

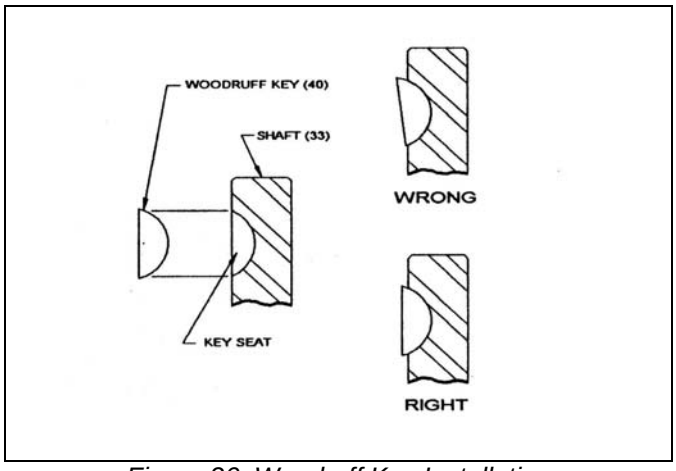


Figure 26. Woodruff Key Installation

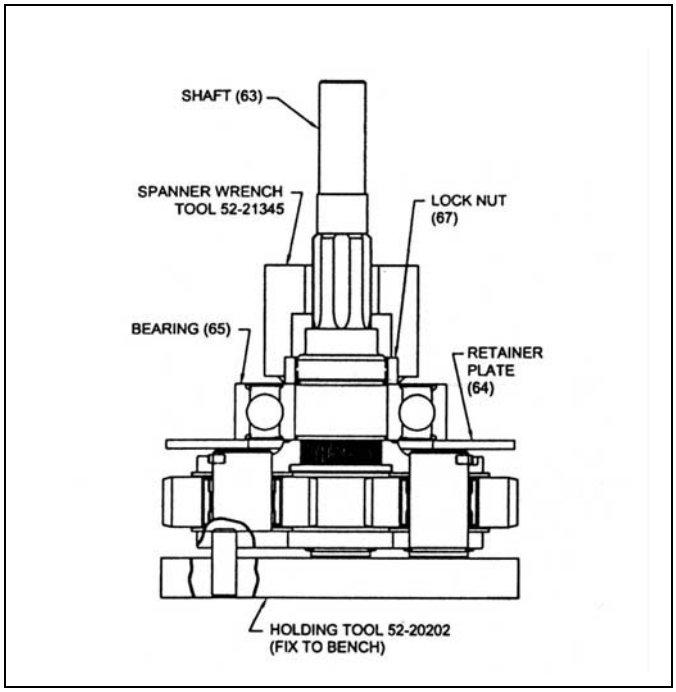


Figure 27. Tightening Retainer Nut (T106F, T112F)

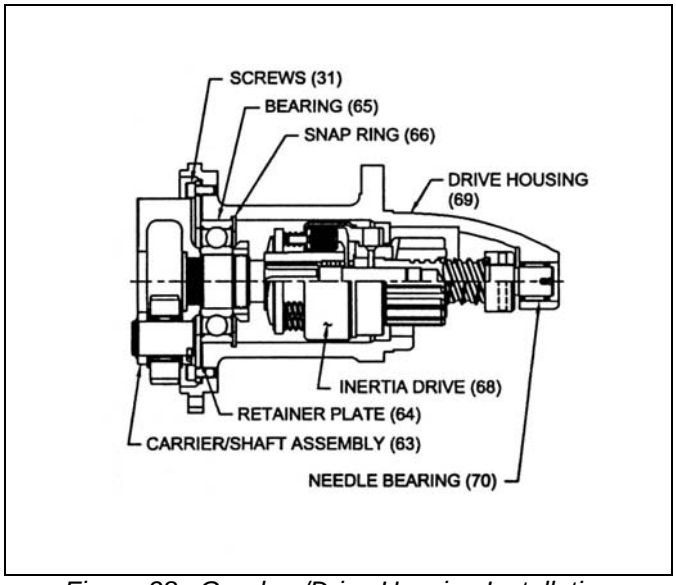


Figure 28. Gearbox/Drive Housing Installation (T106F/T112F)

5.5.3 Bendix Drive Installation

Install bendix drive (68) into drive housing (69), aligning bendix shaft into front needle bearing (70).
With snap ring tool, install snap ring (66)into drive housing (69).

Align carrier shaft assembly (63) into bendix drive and push assembly until seated against snap ring (66) per *Figure 28*.

Install six screws (27) and torque 90 to 120 lb.-in.

SECTION 6.0 PARTS LIST

The components illustrated and/or described in this section are for the Turbotwin T100 series air starters. When rebuilding a T100 series starter, it is recommended to purchase, and completely install the appropriate service kit(s).

Key No.	Description	Part Number	B	D	F	P
1	Screw (6)	11F- 25020-072	✓	✓	✓	
2	Screen Support Ring	2-20831				
3	Screen	2-26148				
4	Screw	19F- 25028-012	✓	✓	✓	✓
5	Washer	9-93047				
6	Rotor 2	2-26604				
7	Woodruff Key	9-90211-006				
8	Seal Spacer (3)	9-93083-001	✓	✓	✓	✓
9	Seal, Lip (2)	2-26719	✓	✓	✓	✓
10	Bearing (2)	9-91224	✓	✓	✓	✓
11	O-ring (2)	9-90001-027	✓	✓	✓	✓
12	Wave Spring Washer	9-90439	✓	✓	✓	✓
13i	Nozzle 2/Containment Ring R.H.	2-27333-00R				
13ii	Nozzle 2/Containment Ring L.H.	2-27333-00L				
14	O-ring	9-90001-050	✓	✓	✓	✓
15	Rotor 1	2-26603				
16	Woodruff Key	9-90211-009				
17	Lip Seal	2-22376	✓	✓	✓	✓
18	Screw (14)	14F-19024-008	✓	✓	✓	✓
19i	Nozzle 1, R.H. 21 Noz	2-26718-21R				
19ii	Nozzle 1, L.H. 21 Noz	2-26718-21L				
19iii	Nozzle 1, R.H. 12 Noz	2-26718-12R				
19iv	Nozzle 1, L.H. 12 Noz	2-26718-12L				

Key Number	Description	Part Number	B	D	F	P
19v	Nozzle 1, R.H. 6 Noz	2-26718-06R				
19vi	Nozzle 1, L.H. 6 Noz	2-26718-06L				
20	Pipe Plug	9-93556-004				
21	O-ring	9-90001-034	✓	✓	✓	✓
22	Screw (6) or (12 for T112D/T121D std)	14F-31218-016	✓	✓	✓	✓
23	Inlet Flange	1-18967				
24	O-ring	9-90001-037	✓	✓	✓	✓
25	Set Screw (See Note 1)	52F-50013-016				
26	Turbine Housing (See Note 1)	2-27045				
27	Screw (6)	14F-25020-016	✓		✓	✓
28	Pipe Plug	9-93501-004				
29	Ring Gear (See Note 1)	1-18780				
30	Bearing Spacer	9-93091-001				
31	Screw (4)	14F-25020-008			✓	
32	Clamping Plate	2-26750				
33	Turbine Shaft	2-26554				
34	Retainer Ring (3)	9-92001-001				
35	Planet Gear Carrier Shaft	2P-20156-006				
36	Washer (6)	9-93004				
37	Planet Gear (3)	1-19441				
38	Needle Roller Bearing (3)	9-91004-001	✓	✓	✓	✓
39	Planet Shaft (3)	2P-20182				
40	Woodruff Key (2)	9-90211-019				
41	Bearing (2)	9-91351	✓			

Key	Description	Part Number	B	D	F	P
42	Wave Spring Washer	9-90402-025				
43	Bearing Spacer	9-93007				
44	Gearbox Housing	2-22226				
45	Screw (6)	14F-25020-028		✓		
46	Retainer Plate	1-18817				
47	Lockwasher	9-93061-007				
48	Retainer Nut	9-92127-007				
49	Drive Housing	2-22301				
50i	Inertia Drive Assembly, R.H.	2-22795				
50ii	Inertia Drive Assembly, L.H.	2-22796				
51	Retaining Ring	Included with item 50 or 57				
52	Spring	Included with item 50 or 57				
53	Set Screw	Included with item 50 or 57				
54	Needle Bearing	9-91393				
55	Adapter Plate	2-22794				
56	Screw	14F-31218-020		✓		
57i	Inertia Drive Assembly, R.H.	1-18828				
57ii	Inertia Drive Assembly, L.H.	1-19083				
58	Gearbox Housing	1-18810				
59	Lock Nut (6)	9-92107-015	✓			✓
60	Screw (6)	11F-31218-024	✓			
61	Drive Housing	1-18822				
62	Needle Bearing	9-91005	✓	✓		
63	Carrier Shaft	3P-20858-006				
64	Retainer Plate	2-20855				
65	Bearing	9-91356			✓	

Key	Description	Part Number	B	D	F	P
66	Snap Ring	9-92001-006				
67	Lock Nut	9-92105-008				
68i	Inertia Drive Assembly, R.H.	2-22147				
68ii	Inertia Drive Assembly, L.H.	2-22148				
69	Drive Housing	2-20826				
70	Needle Bearing	9-91380			✓	
71	Washer, Flat	9-93018-011				
72	Nut, Hex	9-92108-003				
73	Cover, Plate	2-20192				
74	Screw (6)	11F-25020-072				✓
75	Housing, Exhaust Cover	2-27069				
76	Spring, Compression	9-90408-016				
77	Post	2-27223				
78	Drive Housing	2-25617				
79	Screw (12)	11F-31218-024				✓
80	Needle Bearing	9-91423				✓

Model	Overhaul Kit for S/N's before: 9611-191	Overhaul Kit for S/N's after: 9611-192
B	T10B-27618	T10B-27634
D	T10D-27619	T10D-27635
F	T10F-27617	T10F-27633
P	T10P-27620	T10P-27636

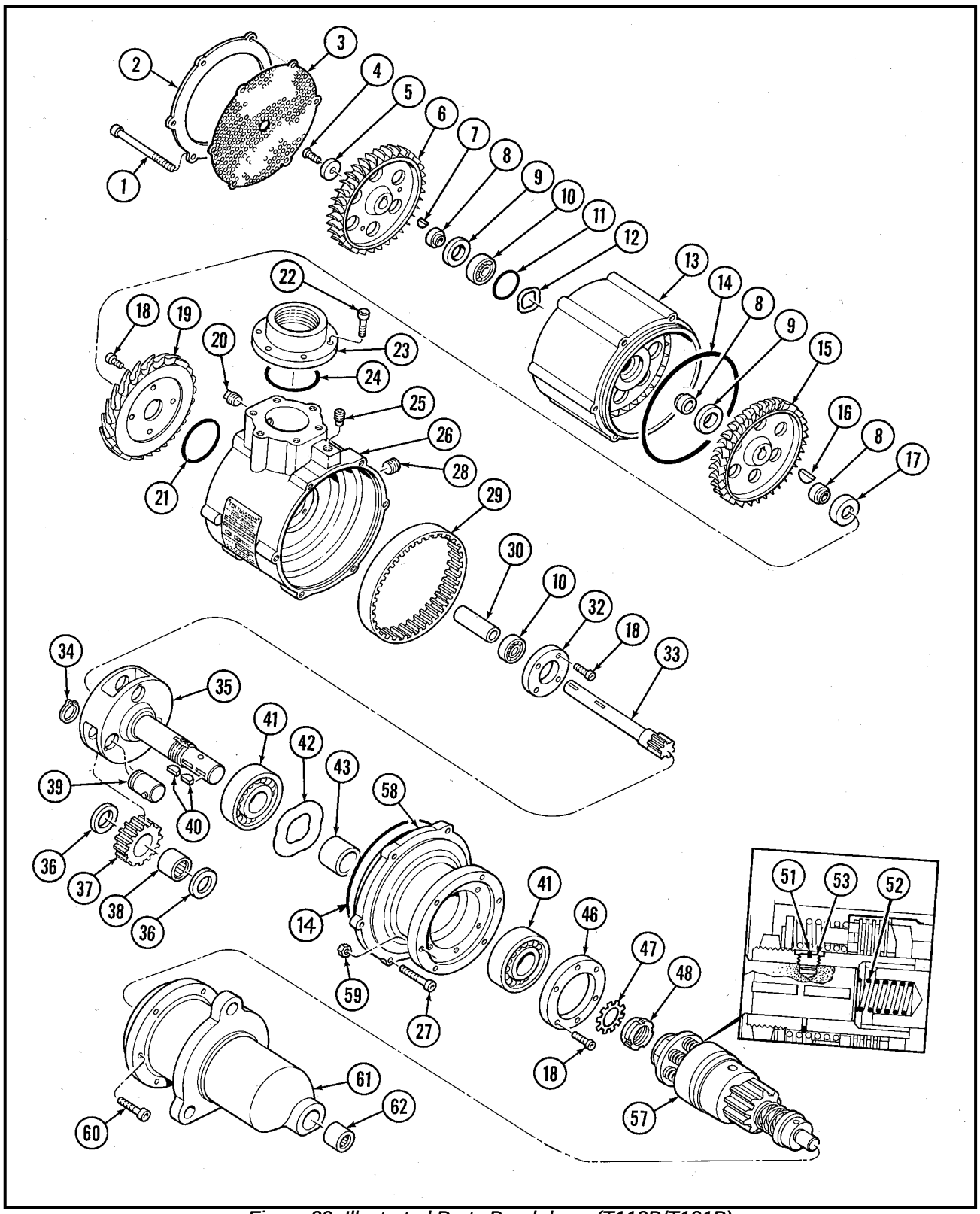


Figure 29. Illustrated Parts Breakdown (T112B/T121B)

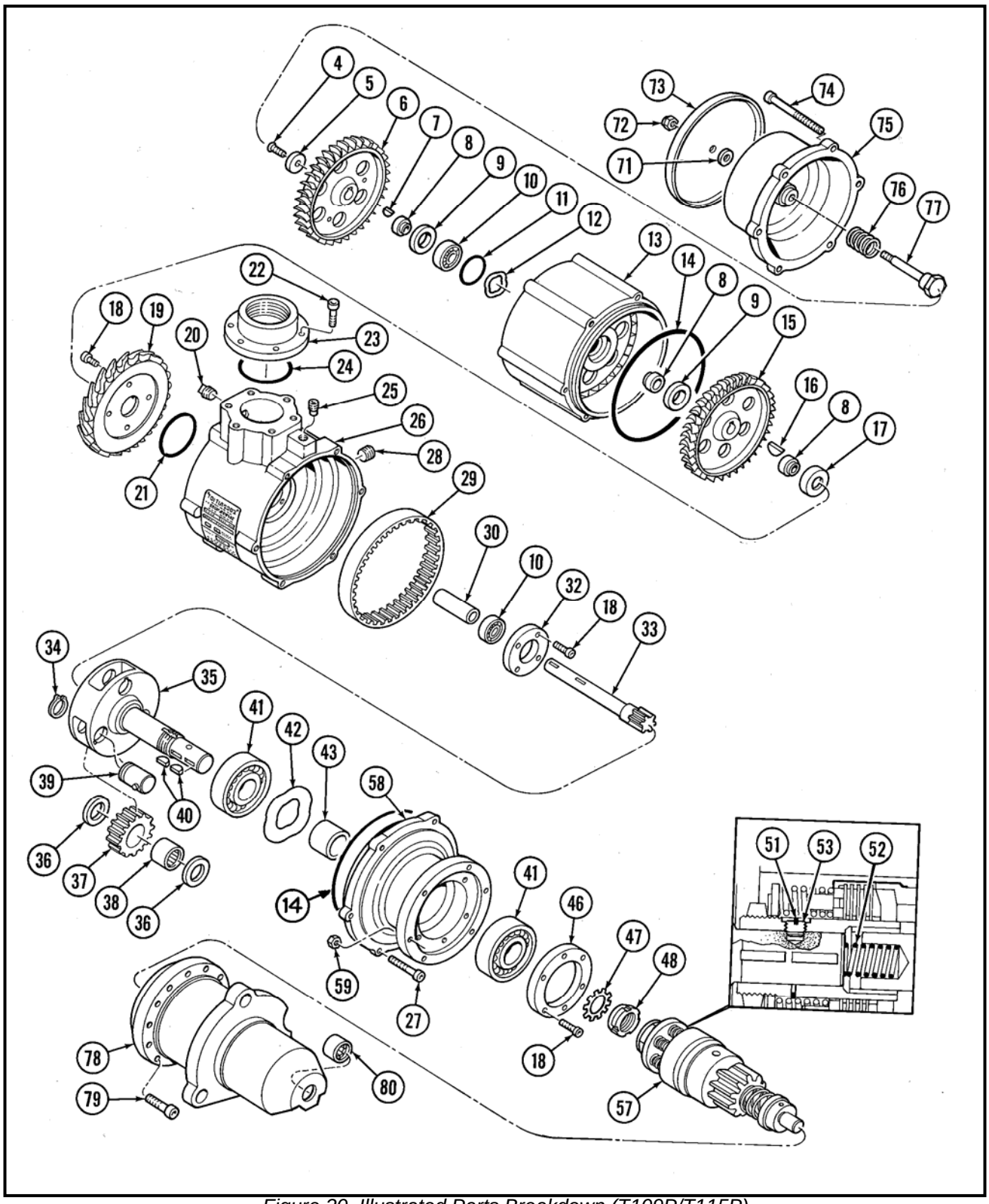


Figure 30. Illustrated Parts Breakdown (T109P/T115P)

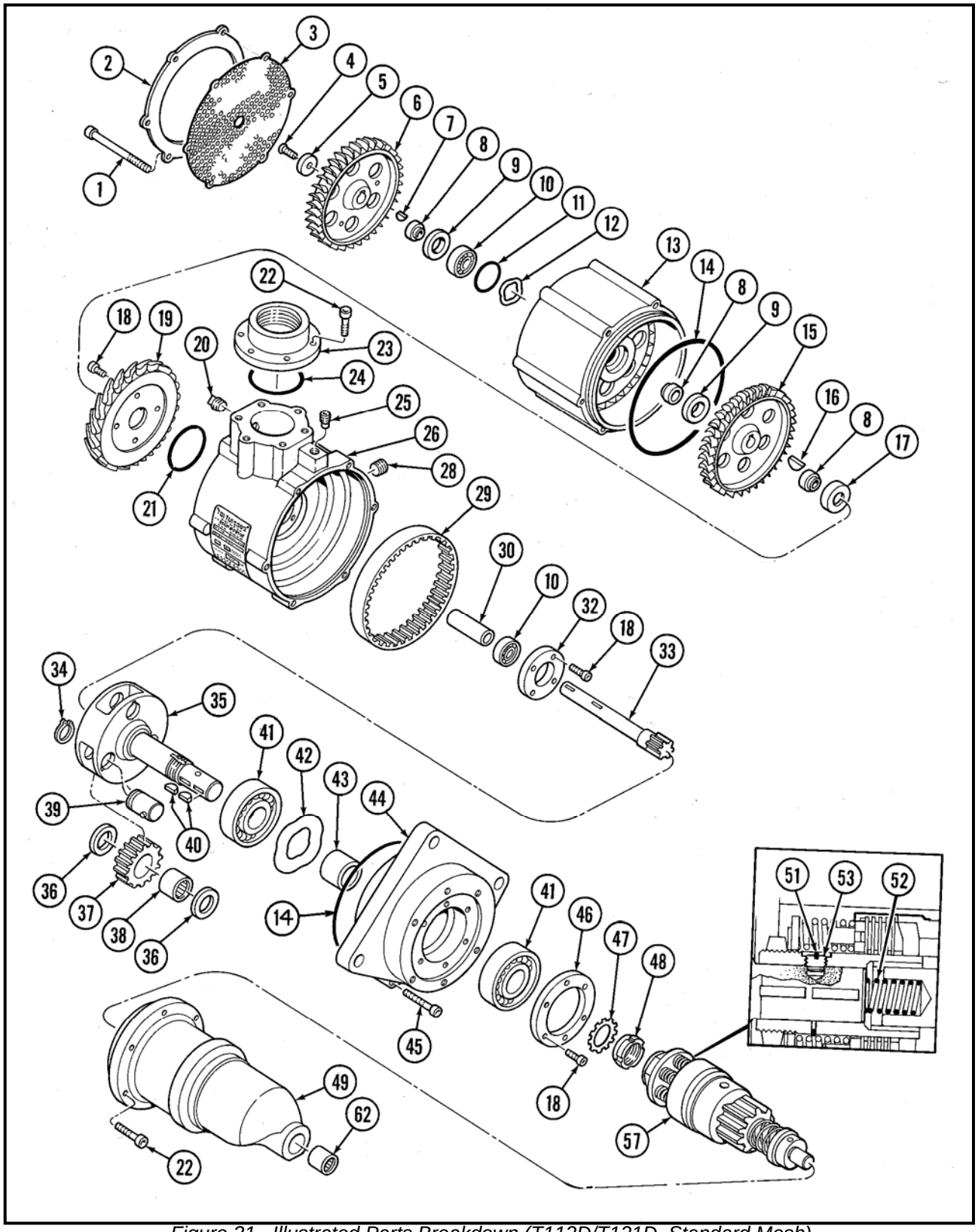


Figure 31. Illustrated Parts Breakdown (T112D/T121D, Standard Mesh)

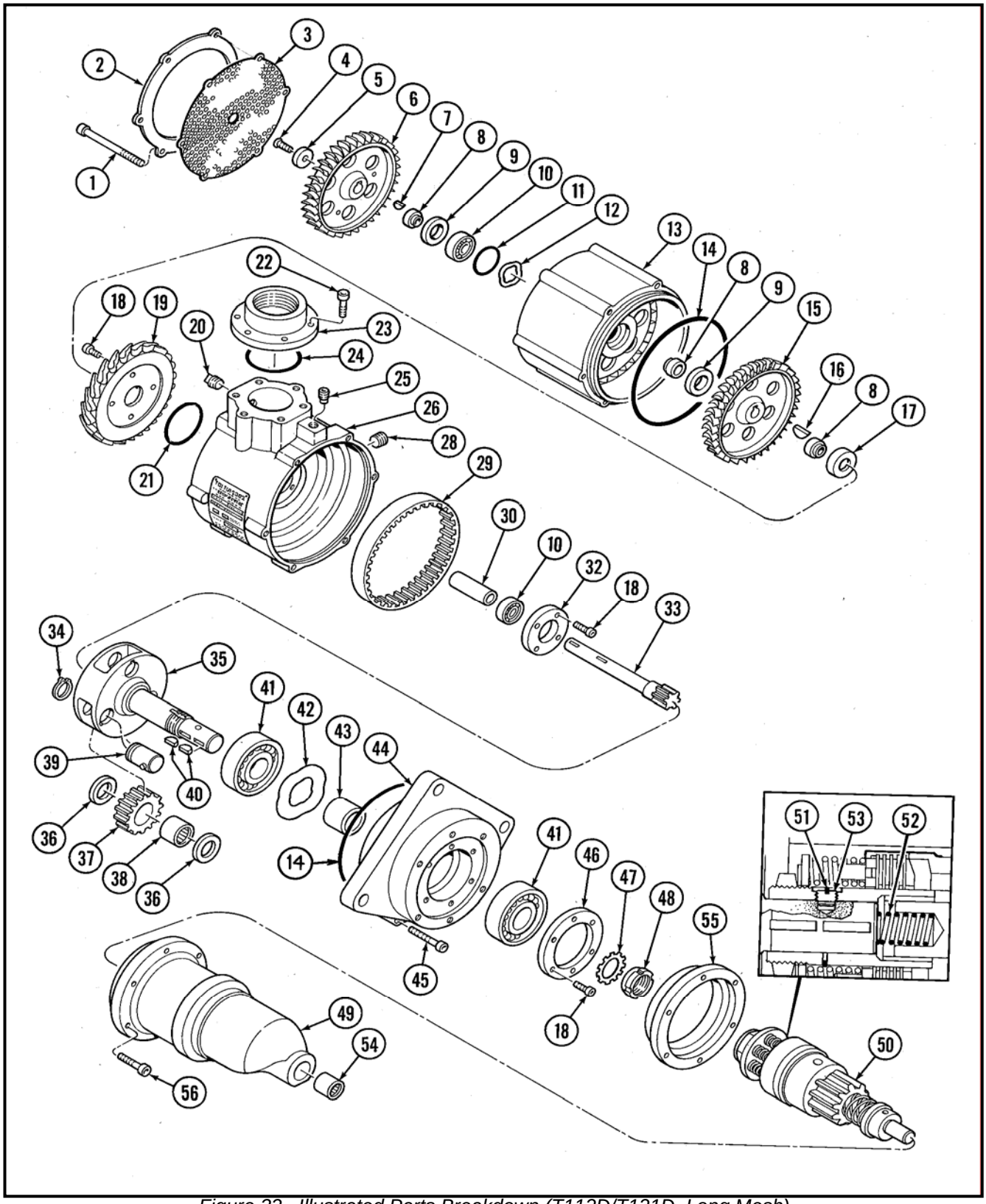


Figure 32. Illustrated Parts Breakdown (T112D/T121D, Long Mesh)

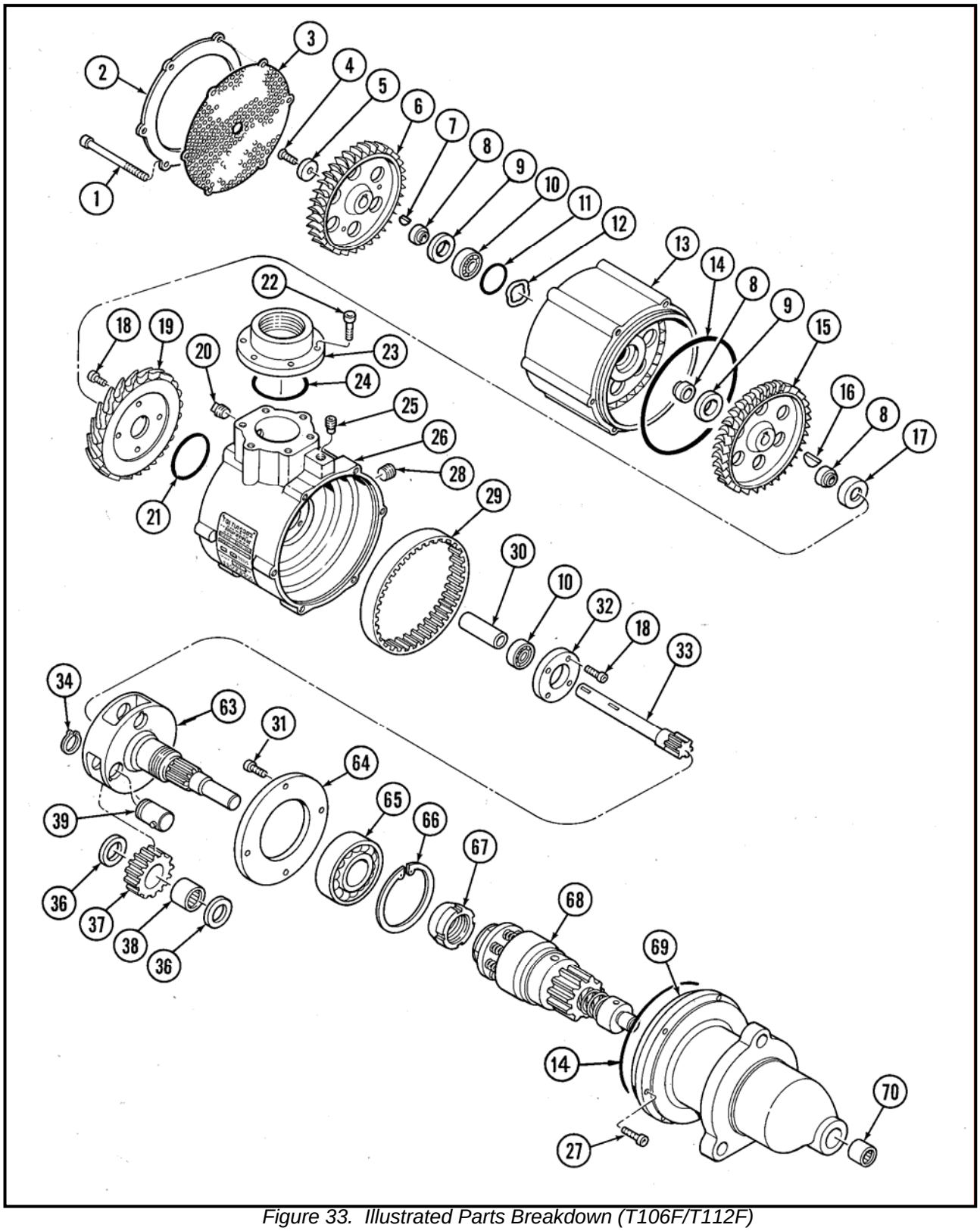


Figure 33. Illustrated Parts Breakdown (T106F/T112F)

SECTION 7.0 ACCESSORIES

SIZE	PART NUMBER
RELAY VALVES	
1½" STAINLESS STEEL (AMOT)	52-93505
2" STAINLESS STEEL (AMOT)	52-93505-100
1½" 316 SST MANUALLY OPERATED	52-93508-300
2" 316 SST MANUALLY OPERATED	52-93508-400
1¼" NPT; BUNA N	RLVA-25683-001-1
1½" NPT; BUNA N	RLVA-25683-001-1-01
1¼" NPT; VITON	RLVA-25683-001-2
1½" NPT; VITON	RLVA-25683-001-2-01
12VDC; 1¼"; BUNA N	RLVA-25683-012-1
12VDC; 1½"; BUNA N	RLVA-25683-012-1-01
12VDC; 1¼"; VITON	RLVA-25683-012-2
12VDC; 1½"; VITON	RLVA-25683-012-2-01
24VDC; 1¼"; BUNA N	RLVA-25683-024-1
24VDC; 1½"; BUNA N	RLVA-25683-024-1-01
24VDC; 1¼"; VITON	RLVA-25683-024-2
24VDC; 1½"; VITON	RLVA-25683-024-2-01
110VDC; 1½"; VITON	RLVA-25683-110-2-01
120VAC; 1½"; VITON	RLVA-25683-120-2-01

PRESSURE REGULATORS	
2" GAS 300	52-93552
2" GAS 125	52-93553
1½" AIR; MAX 1200 SCFM	52-20724-100
2" AIR; MAX 1600 SCFM	52-20724-200

Y-STRAINERS	
1½" CARBON STEEL BODY, #40 MESH, SST SCREEN	52-93549-100
2" CARBON STEEL BODY, #40 MESH, SST SCREEN	52-93549-200
1½" CAST IRON BODY, #40 MESH, SST SCREEN	52-93550-100
2" CAST IRON BODY, #40 MESH, SST SCREEN	52-93550-200

SIZE	PART NUMBER
GAUGES	
REAR CENTER MOUNT	52-21982
U-CLAMP REAR CENTER MOUNT	52-21982-100
BOTTOM MOUNT	52-21982-200

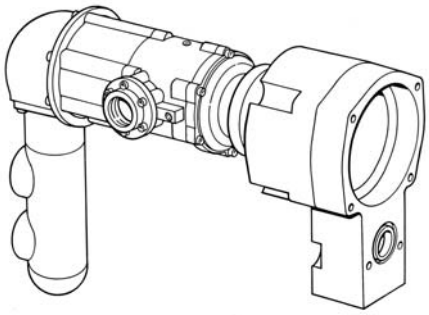
EXHAUST	
3" ELBOW KIT	T100-27015
ECP KIT	T100-27068
MUFFLER KIT (21 NOZ)	T100-27074
MUFFLER KIT (6/12 NOZ)	T100-27075
3" NPT ADAPTER KIT - FEMALE	T100-27651
4" NPT ADAPTER KIT - FEMALE	T100-27652
4" STRAIGHT PIPE KIT	T100-27791
3" ELBOW KIT	T100-27900
EXHAUST ELBOW W/ 3" PIPE WELD FLANGE	T100-28182-001
EXHAUST ELBOW W/OUT WELD FLANGE	T100-28182-002

CONTROL & SOLENOID VALVES	
1/8" NPT STR CONROL VALVE	52-93504
1/4", 24 VDC, CONDUIT	52-21981
1/4", 12 VDC, GROMMET	52-21981-002
1/4", 120 VAC, CONDUIT	52-93506-100
1/4", 120 VAC, GROMMET	52-93506-200
1/4", 24 VDC, CONDUIT	52-93506-300
1/4", 24 VDC, GROMMET	52-93506-400
1/4" 72 VDC	52-93506-500

TECH DEVELOPMENT

Publication T1-728
Dated: April 15, 2006

INSTALLATION AND OPERATING MANUAL



MODEL: T100-C (60069)
*TURBO**TWIN*** Engine Air Starter

AN 02-460

From Tech Development
6800 Poe Ave. •Dayton OH 45414
Tel: (937) 898-9600 •Fax: (937) 898-8431
www.tdi-turbotwin.com

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1.0 GENERAL INFORMATION

The following instructions detail the removal of the two existing vane type starter motors and the installation of the new TDI *TURBOTWIN* air starter. If there are questions not answered in this manual, please contact your TDI distributor or dealer for assistance.

The T100 *TURBOTWIN* starters are designed for operation with compressed air or natural gas; materials used are compatible with "sour" natural gas and marine environments. Small amounts of foreign matter or liquid in the air stream will not adversely affect *TURBOTWIN* starters. As with all other TDI starters, no lubrication is required in the air supply.

Please review the rest of this manual before installing the T100 *TURBOTWIN* series air starter.

WARNINGS, CAUTIONS AND NOTES

Certain types of information are highlighted in this manual for your attention:

WARNING - used where injury to personnel or damage to the equipment is likely.

CAUTION - used where there is the possibility of damage to the equipment.

NOTE - used to point out special interest information.

NOTE

Throughout this manual, the term "air" is used to designate the starter drive medium. Unless other wise stated, air " means either compressed air or natural gas.

1.1 PRODUCT IDENTIFICATION

The starter nameplate which is attached to the turbine housing contains the following information: model number, serial number, part number, direction of rotation and the maximum rated operating pressure.

The maximum operating pressure is measured at the check port on the starter inlet with the starter in operation.

CAUTION

Exceeding the maximum pressure shown on the nameplate may result in damage to the starter or damage to the engine.

The housing proof pressure is 600 psig and is also shown on the nameplate. This means the turbine housing will not burst when subjected to a static pressure of 600 psig.

2.0 STARTER INSTALLATION

A turbine air starter does not require lubrication in the supply air. Therefore, if a vane type starter motor is being replaced, TDI recommends that all lubrication devices and lines are removed to minimize flow restrictions.

WARNING

If a fuel (pulse) lubricator has previously been installed in the system, disconnect and plug the line to eliminate spraying diesel fuel on the engine.

WARNING

Do not operate this starter unless it is properly connected to the engine.

CAUTION

Prior to beginning the removal of the existing starter motors insure the unit is shutdown, post lube has timed off, fuel and start gas are off. Tag out and lock out in full accordance with standard OSHA / Company rules and regulations.

The starter should be installed with the inlet in a position between horizontal and straight down. Any condensation will be restricted to the air lines and not in the starter.

The components listed in the Table 1 (T100C Installation Kit) are required to complete starter installation.

QTY	PART NUMBER	DESCRIPTION
1	2-28673	Gear Adapter
1	2-28674	Tongue Driver
1	2-28676	Exhaust Adapter, Weld
1	9-90001-165	O-ring
1	9-90001-228	O-ring
1	9-90002-041	O-ring
1	9-90211-029	Woodruff Key
1	9-91502-008	Dowel Pin
1	9-92149	Bearing Retainer Nut
1	9-93142	Lock washer
6	14F-25028-012	Screw
4	14F-37516-016	Screw

Table 1. T100-C Installation Kit (P/N: T100-28675)

The tools listed in Table 2 (T100-C Tools Kit) are suggested for use when installing the T100-C air starter, and can be borrowed from TDI to perform starter installation. The

best results can be expected when these tools are used, however the use of other tools is acceptable.

TOOL DESCRIPTION	TDI/PN
¾" Square Drive Socket	2-28724
Gear Puller Pad	2-28722
Gear Puller	2-28720
Torque Wrench	2-28719
Anti-rotation Tool	2-28716
Locknut Socket	2-28718

Table 2. T100-C Tools Kit (P/N: T100-28721)

2.1 VANE STARTER REMOVAL

Remove the split flange clamps from the inlet and exhaust hoses on the starter end of the hoses. Retain the bolts and clamps to be used later. Discard the o-rings.

Remove one inlet flange fitting and both exhaust flange fittings from the vane starters. Retain these for later use.

Remove the eight mounting nuts from each vane starter motor mount flange and retain these for later reuse.

Remove and discard both the vane starter motors.

Remove the split flange clamps from the oil drain on the bottom starter adapter. Retain the bolts and clamps for later reuse.

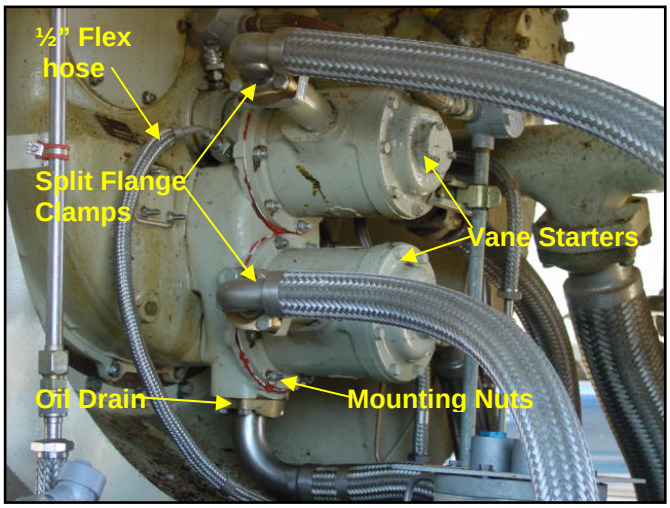


Figure 1. Vane Starter Removal

Remove the ½" metal flex hose from the starter gear lubrication jet and disconnect the hose at its origin on the main oil line. Since this hose is no longer required install a pressure cap at the main oil line fitting.

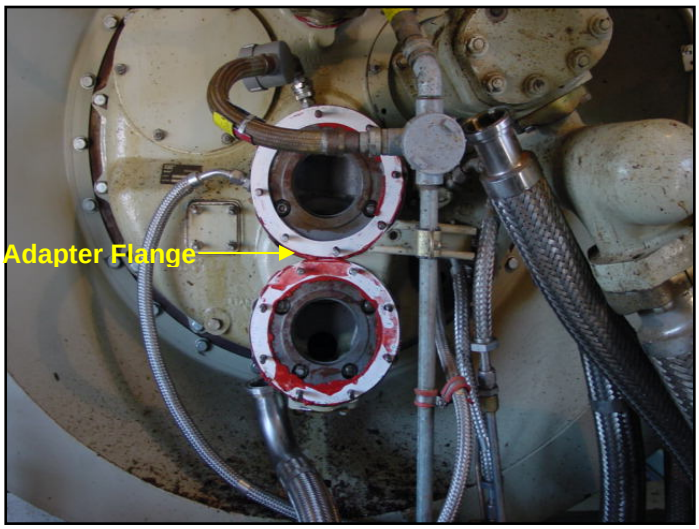


Figure 2. Starter Adapter Removal

Remove the six starter adapter retaining nuts and washers. Retain these for later reuse. Remove the starter adapter by gently prying behind the adapter. Slide the starter adapter off the studs and discard the adapter.

Remove the o-ring from the adapter mounting pilot ring.

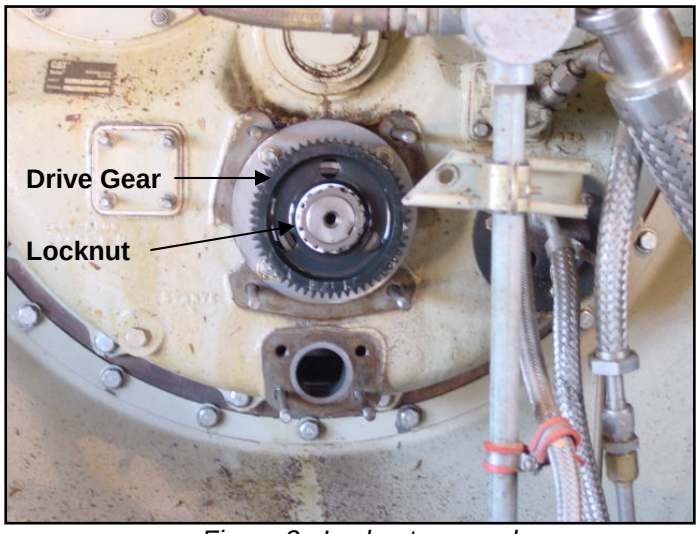


Figure 3. Locknut removal

Use a small punch or similar tool de-stake the lock washer on the starter drive gear.

Using the holding tool, special socket and ½" break over bar loosen the drive gear locknut. Remove and discard the locknut & washer.

Publication T1-728
Issued April 15, 2006

Install the puller center guide bolt in the threaded hole of the drive gear shaft. Install the puller and remove the drive gear as shown in figure 4.

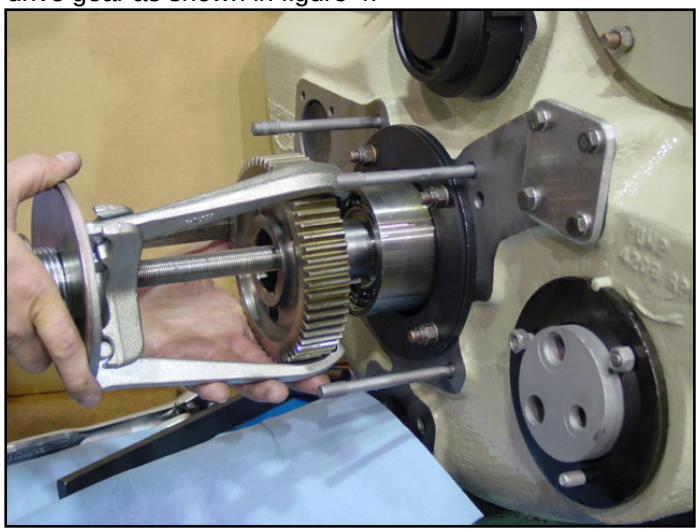


Figure 4. Drive Gear Removal

Remove the existing drive key from the gear shaft. Install the new high strength key provided with the kit.

2.2 T100-C AIR STARTER INSTALLATION

NOTE

All bolts should be lubricated with anti-seize compound prior to use. All torque specifications contained herein are for lubricated threads.

Install the new drive hub supplied with the kit until it is completely seated on the shaft shoulder. Insure the key and hub slot are aligned.

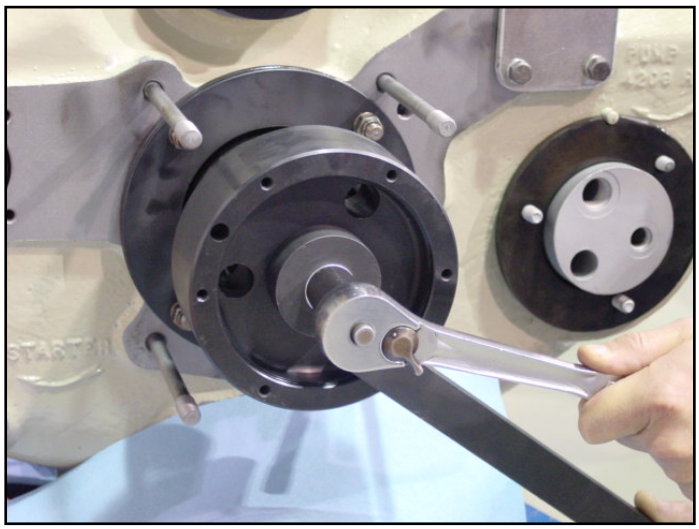


Figure 5. Drive Hub Installation

Install the new lock washer and locknut supplied with the kit. Using the holding tool, special socket and a torque wrench tighten the nut and torque to 165-175 ft. lbs. (224-237 Nm). Use caution to align one nut slot with a lock tab on the washer. Bend the lock tab over and insure it is locked in the nut.

Place the 3/8" dowel pin supplied with the kit in the hub piece. Place the hub cover in place on the hub and install six allen head screws finger tight. Use a soft hammer and tap the hub cover in place while pressing the dowel pin in the cover. Torque the allen head screws to 180 in. lbs. (20.4 Nm).

Remove the TDI starter from the adapter provided in the kit. Retain the bolts for later reuse.

Install a new o-ring on the adapter mounting pilot ring on the accessory drive. Install a new o-ring on the oil drain port of the new TDI adapter.

Slide the new TDI adapter on the mounting studs. Use caution to insure the adapter is installed flat to avoid o-ring damage. Install the washers and nuts retained at removal. Alternately tighten the nuts to guide the adapter on to the mounting pilot ring.

Torque the nuts to 125 ft. lbs. (170 Nm)

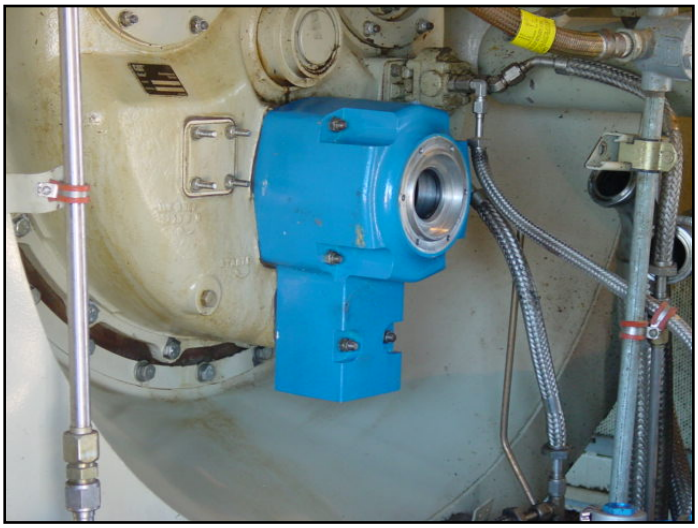


Figure 6. TDI Adapter Installation

Install the T100-C air starter. Use caution to align the “drive blade” with the slot in the drive hub cover. Insure the 2" inlet port is in the left horizontal position. Install the bolts retained at removal and tighten to 190 in. lbs. (21.5 Nm)

NOTE

Use of a pipe thread sealer or Teflon tape is recommended for the installation of all pipe thread fittings in the following steps.

Install a 1½" X 2" bushing reducer when required. Install the 1 ½" split flange inlet adapter retained from the vane motor at removal.

Place a new o-ring on the exhaust manifold flange. Install the exhaust manifold pointed down on the TDI starter with the threaded ports facing to the right. Torque the 3/8" allen screws to 170 in. lbs. (19.26 Nm).

Install the split flange exhaust adapters, retained from the vane motor at removal in the exhaust manifold of the TDI starter.

NOTE

Only one of the two 1 ½" inlet hoses will be required for the TDI starter. Select the one most suited to the fit of your new starter system at this time. Disconnect the unused hose and discard.

CAUTION

Use caution when installing metal flex hoses to avoid any unnecessary twisting or rub from adjacent hoses, brackets, or hardware.

Install the inlet hose, and a new o-ring supplied with the kit, on the starter split flange adapter using the bolts and clamps retained at removal.

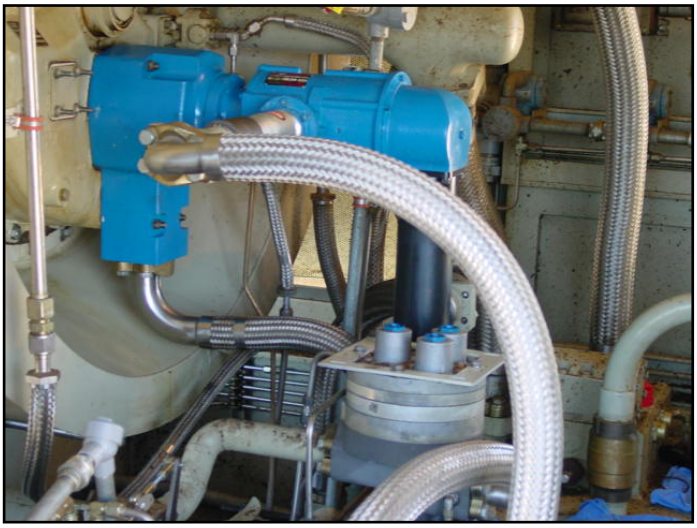


Figure 7. Air Starter Installation

Disconnect the opposite end of the inlet hose from the oil lubricator and retain the bolts and clamps for later reuse.

Remove the bolts split flange clamps retaining both lubricators and remove the lubricators.

NOTE

Oil lubricators are not required for TDI starters. However, one set of inlet and outlet fittings will be required. Remove one set of fittings and discard both lubricators.

Install one set of lubricator fittings into the 1½" pipe collar provided in the kit, and reinstall in one of the previous lubricator locations using a new o-ring. Install the split flange blank cover and new o-ring, provided in the kit, on the remaining unused lubricator location.

Reinstall the hose end removed earlier with a new o-ring provided.

Install both exhaust split flange adapters in the exhaust manifold. Install both exhaust hoses using new o-rings provided.

Figure 8. Exhaust Hose Installation

After completion of the installation remove all lock out and tag out protection in accordance with OSHA / Company rules and regulations.

During the first start cycle observe operation and soap check for leaks at all fittings and hoses that were disturbed during the installation. Repeat this step if required - no leaks permitted.

3.0 SUPPLY LINE INSTALLATION

WARNING

Be sure to either bleed the pressurized air reservoir and/or safety the system such as closing all valves prior to installing starter supply line.

Care must be taken to ensure that all inlet supply line piping is no less than 1.5" and all components used are capable of passing the required air flow.

NOTE

Valves with a Cv of 40 or higher are recommended.

If the supply line must be longer than 20 feet, the inlet supply line piping should be increased to 2" in diameter to ensure proper performance by your ***TURBOTWIN***.

Because turbine starters such as the ***T100 TURBOTWIN*** *series* are sensitive to flow restrictions, care must be taken to use uniform hose or tubing and fittings for connection of the supply line. Tees, elbows and line length must be kept to a minimum. TDI recommends that hose or flex couplings are installed to eliminate possible leakage caused by strain on the supply line.

Normally, an air strainer is not required. However, in dirty environments use of a #40 mesh Y-strainer is recommended. The ***T100 TURBOTWIN*** *series* is highly tolerant of dirt in the air line, however, starter life can be increased with the use of an air strainer.

A pressure regulator is required when the air supply pressure is great enough to exceed the starter operating pressure (at the inlet port) and/or the maximum torque.

The supply line should be dry-fitted for proper alignment /location prior to final assembly. All pipe threaded joints should be sealed with Loctite Pipe Thread Sealant (TDI P/N 9-94085) or equivalent for leak tight joints prior to final assembly. Be sure to tighten all joints to proper torque after final assembly.

CAUTION

In cold weather climates, care should be taken while designing your installation to prevent condensation from developing in the starter system. In systems with a regulator valve or relay valve, there is the possibility of freeze-ups.

A tee connection with a quick disconnect can be added to the inlet. This will allow an external air source to be used to accomplish a “blow start” if the system freezes. Once the engine has been started, the other system components may be thawed.

CAUTION

On new installations, it is strongly recommended to blow out the supply line with air to remove possible dirt and welding slag prior to final connection to the *TURBOTWIN* starter. Be sure to secure the free end of the supply line prior to blowing out the line.

4.0 INLET PRESSURE PORT

A 1/4" NPT port is located on the air inlet. This port may be used to check the supply pressure at the starter when the starter is operating. Remove the 1/4" NPT pipe plug and save for later use. Install a 1/4" minimum size tubing to the port. Route the tubing away from the starter to a safe location away from the engine. Install a pressure gauge on the tubing. This pressure monitoring line/gauge may be permanently installed. Use Loctite Pipe Thread Sealant or equivalent. Alternately, a pressure transducer may be installed at the pressure check port and electrical lines routed to a digital display at the operator's station. This pressure port is invaluable in diagnosing air starter and/or installation problems.

5.0 EXHAUST PIPING

The turbine exhaust may be plumbed away from the starter area. All starters using natural gas must be piped according to industry codes and local regulations.

The performance of a turbine starter will be decreased because of back pressure when smaller than recommended exhaust piping is installed. If back pressure hampers starter performance, compensation can be made by increasing the supply pressure. Consult your TDI distributor for advice.

Exhaust piping should be routed downward to help prevent any accumulation of condensation in the starter motor.

If the overhung section of the starter is not otherwise supported, TDI recommends supporting the exhaust piping with a suitable bracket(s).

6.0 NATURAL GAS INSTALLATION

The installation of the starter using natural gas is similar to the air installation except all fittings, piping, valves and regulators must be compatible with natural gas.

Proper control of natural gas is a major consideration when used in the starter system. All starters using natural gas must pipe the exhaust according to industry codes and local regulations.

There is a natural gas vent port in the turbine housing that is plugged for compressed air use. This vent is used to remove any natural gas that could leak past the primary turbine shaft seal. Remove this 3/8"NPT plug and install a line to carry gas away from the starter area.

WARNING

Do not connect the turbine housing vent line to the turbine exhaust line. Exhaust gas can pressurize the housing.

7.0 PIPING SYSTEM

Only type approved metallic hose assemblies are approved in permanently pressurized compressed air lines of starters. Non-metallic hose assemblies are allowed only in cases where the piping system will be emptied after the starting procedure.

Pipe unions must be type approved by GL. Downstream of the pressure regulator a pressure relief valve is to be provided.

8.0 STARTER OPERATION

Prior to operation, check that all connections are tight and free from leaks. Check the 1/4" NPT pipe plug or a pressure gauge/transducer that may be connected to the pressure port on the starter inlet.

WARNING

Do not operate the TDI *TURBOTWIN* starter with air pressure greater than the pressure rating on the nameplate. This pressure is measured at the starter inlet while the starter is running.

The maximum operating pressure limit is the inlet pressure measured at the starter's inlet pressure check port. In order to check the starter, a 1/4"NPT pipe tap connection is provided in the inlet housing to attach a pressure gauge/transducer). The maximum pressure assumes an open exhaust (standard turbine exhaust guard). The standard exhaust guard causes no back pressure.

The static non-flowing supply pressure will always be higher than the operating (dynamic) pressure. The maximum pressure limit (proof pressure) that the TDI *TURBOTWIN* starter housings may be subjected to is 600 PSIG (42 BAR). System pressure that exceeds the maximum operating limit must use a pressure reducing device to ensure that the operating pressure limit to the TDI *TURBOTWIN* starter is maintained.

System static pressure that exceeds the 600 PSIG (42 BAR) limit must, in addition to pressure reducer devices, incorporate a pressure relief valve set below 600 PSIG (42 BAR) in the supply air line.

All appropriate local pressure codes and pressure limitations on other system components must be adhered to and supersede the guidelines given in this manual.

Consult your TDI distributor if you have exhaust plumbing that creates back pressure and reduces starter performance. You may be able to increase the supply pressure to restore the lost power.

Follow the engine manufacturer's instructions for starting the engine.

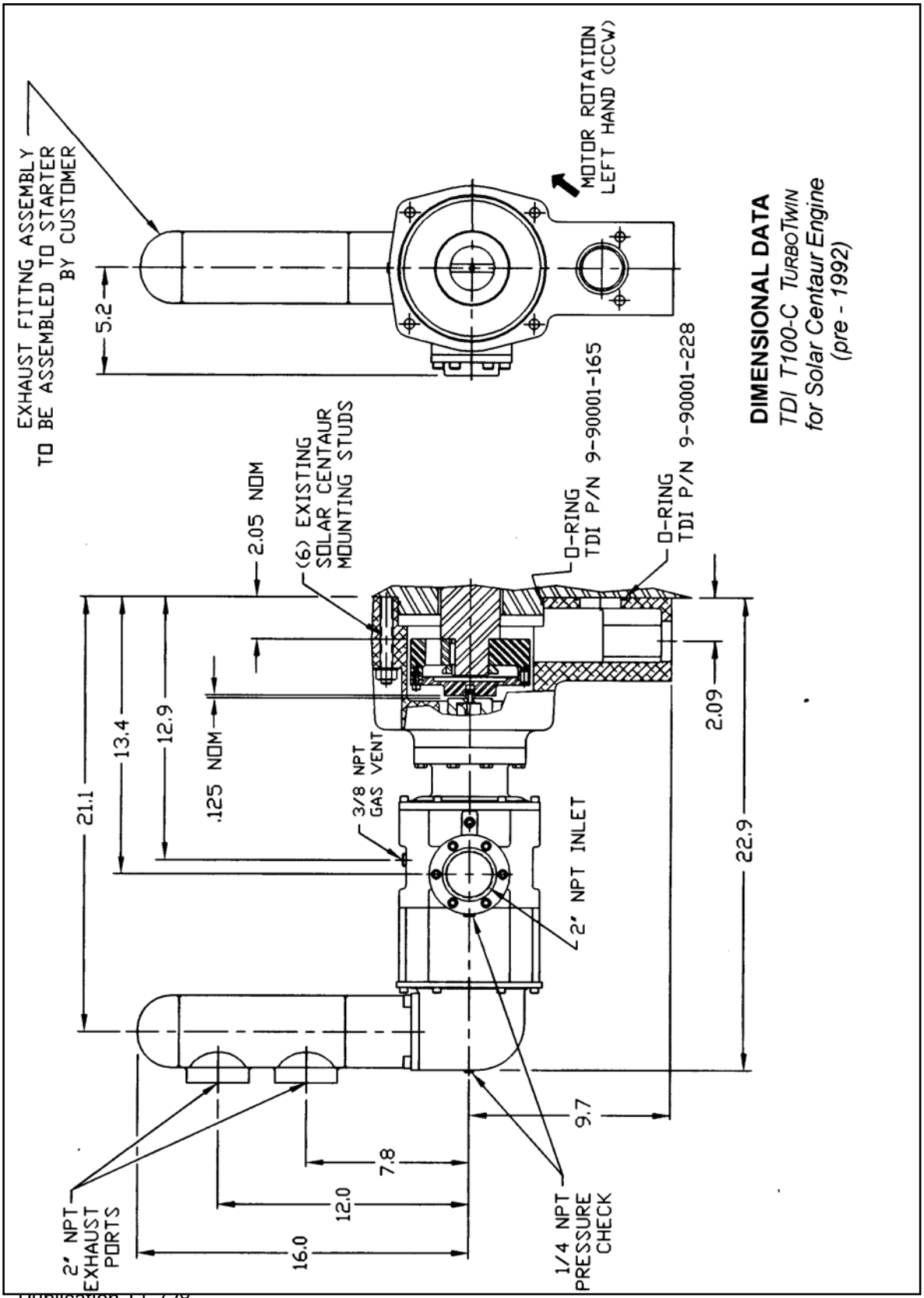


Figure 9. T100-C Envelope drawing

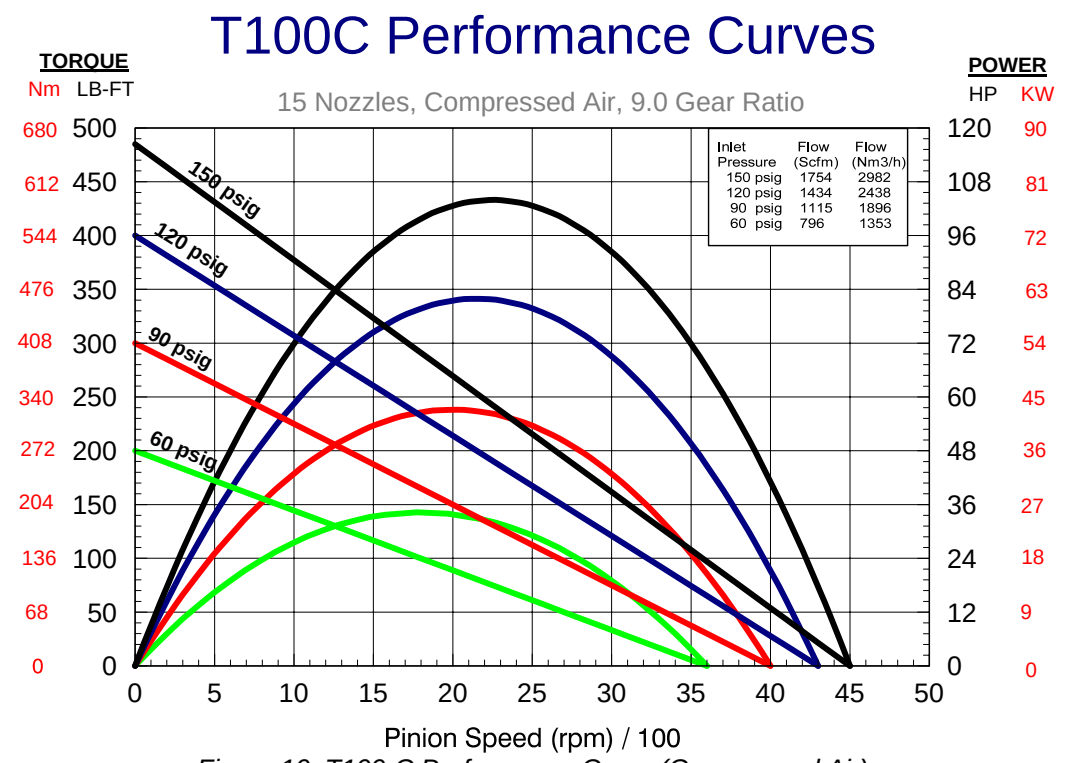


Figure 10. T100-C Performance Curve (Compressed Air)

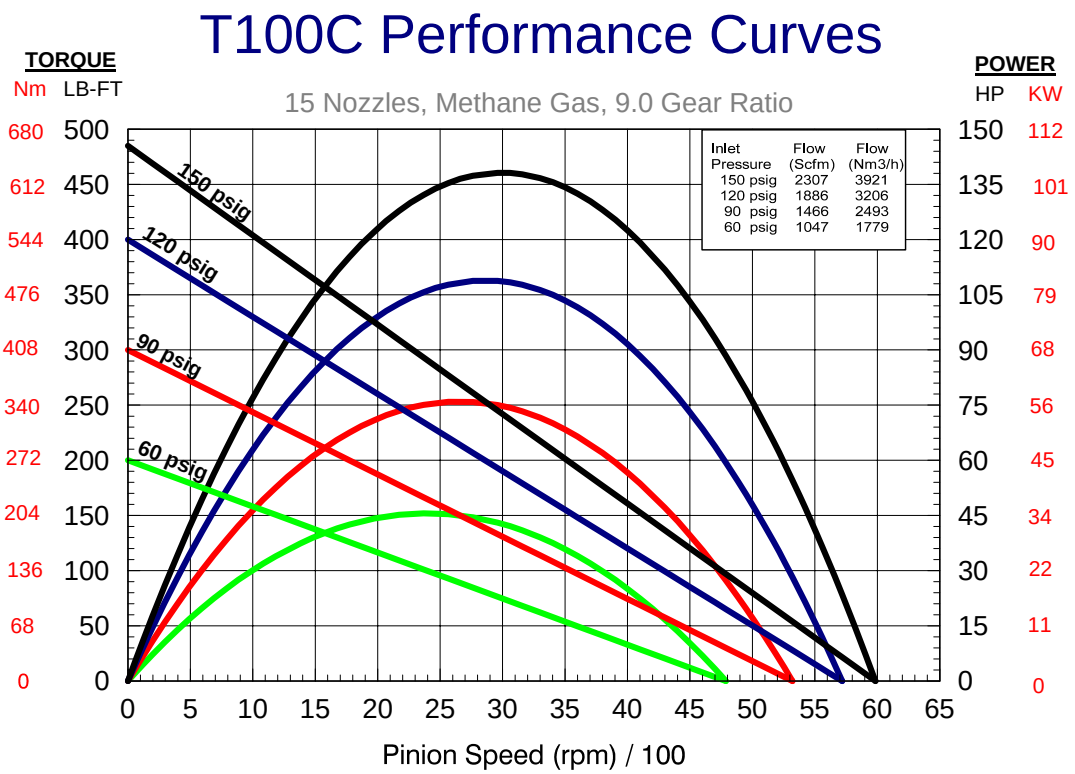
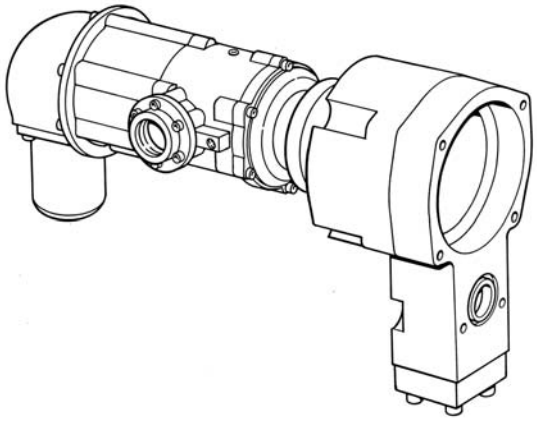


Figure 11. T100-C Performance Curve (Methane Gas)

TECH DEVELOPMENT

INSTALLATION AND OPERATING MANUAL



MODEL: T100-C (60057)
*TURBO**TWIN*** Engine Air Starter

From Tech Development
6800 Poe Ave. •Dayton OH 45414
Tel: (937) 898-9600 •Fax: (937) 898-8431
Website: www.tdi-turbotwin.com

1.0 GENERAL INFORMATION

This manual provides instructions for the installation and operation of the TDI T100-C *TURBOTWIN* Air Starter. If there are questions not answered in this manual, please contact your TDI *TURBOTWIN* distributor or dealer for assistance.

The T100 *TURBOTWIN* starters are designed for operation with compressed air or natural gas; materials used are compatible with “sour” natural gas and marine environments. Small amounts of foreign matter or liquid in the air stream will not adversely affect *TURBOTWIN* starters. As with all other TDI starters, no lubrication is required in the air supply.

Please review the rest of this manual before installing the T100 *TURBOTWIN* series air starter.

WARNINGS, CAUTIONS AND NOTES

Certain types of information are highlighted in this manual for your attention:

WARNING - used where injury to personnel or damage to the equipment is likely.

CAUTION - used where there is the possibility of damage to the equipment.

NOTE - used to point out special interest information.

NOTE

Throughout this manual, the term “air” is used to designate the starter drive medium. Unless other wise stated, air “ means either compressed air or natural gas.

1.1 PRODUCT IDENTIFICATION

The starter nameplate which is attached to the turbine housing contains the following information: model number, serial number, part number, direction of rotation and the maximum rated operating pressure.

The maximum operating pressure is also stamped on the nameplate. This pressure is measured at the check port on the starter inlet with the starter in operation.

CAUTION

Exceeding the maximum pressure shown on the nameplate may result in damage to the starter or damage to the engine.

The housing proof pressure is 600 psig and is also shown on the nameplate. This means the turbine housing will not burst when subjected to a static pressure of 600 psig.

2.0 INSTALLING THE STARTER

A turbine air starter does not require lubrication in the supply air. Therefore, if a vane type starter motor is being replaced, TDI recommends that all lubrication devices and lines removed to minimize flow restrictions.

WARNING

If a fuel (pulse) lubricator has previously been installed in the system, disconnect and plug the line to eliminate spraying diesel fuel on the engine.

The starter should be installed with the inlet in a position between horizontal and straight down. Any condensation will be restricted to the air lines and not in the starter.

WARNING

Do not operate this starter unless it is properly connected to the engine.

The following steps can be used to properly install the T100-C on the engine:

- Remove the entire starting system from the skid. This includes the motors, starter gearbox pad, lubricators and inlet manifold. There should be six studs and the female portion of the "slot" drive remaining on the accessory gear case. The two 2" exhaust hoses can remain in place. Make note of the "clocking" positions of both the inlet and exhaust ports of the existing vane motors.
- Install a new O-ring around the bearing housing on the accessory gear case.
- Install the O-ring on the overflow hole (lower small hole) on the face of the T100-C (60057) housing.
- Position the male driver end of the "slot" drive on the starter motor in the vertical position.
- Position the female portion of the "slot" drive in the vertical position to match the male end.
- Install the T100-C housing assembly over the studs being careful not to damage the O-ring.
- Reinstall the washers and nuts.
- Remove the hex head screws that secure the TDI motor assembly to the flange casting.
- Without pulling the motor backwards and disengaging the "slot" drive positions, rotate the motor until the inlet is at the 9 o'clock position or positioned in the original position. Reinstall the TDI motor screws and tighten.

- You will have either a threaded or welded manifold for the air inlet that accommodates the lubricators and the two 2" inlet hoses at the base of the skid attached to the start gas inlet piping. If this is welded together use a pipe plug to block off one of the female holes as only one inlet hose will be used.

- If threaded, disassemble and create a manifold for only one hose from the remaining pieces. Remove one of the 2" NPT-hydraulic flange adapters from the inlet ports of one of the original air motors and install into the TDI motor using thread sealer.

- Reconnect the 2" hose from the air inlet at the base of the skid into the TDI starting motor.

- Remove the socket head screws holding the exhaust back cover and remove cover.

- Install TDI PN 2-28676 exhaust manifold (not include in 60057 assy) in the 6 o'clock position.

- Reinstall hex screws with minimal thread locking compound.

- Remove the exhaust 2" NPT-hydraulic flange adapters (2) from each of the removed (IR) vane motors and install into the installed TDI exhaust manifold using light thread sealer.

- Connect the existing 2" exhaust hoses to the hydraulic portion of the adapter.

- There is an oil feed tube that lubricates the gear case on the original (IR) gear case. Follow this tube to its source and remove. Cap the hole using a pipe plug.

- There are oil supply lines feeding the lubricators for the original vane motors. This supply line typically comes from the oil reservoir. Depending upon the application there could be two of these supply lines. Follow these lines back to their source and remove them.

NOTE

If the supply lines lead to the base of the engine oil reservoir have the pipe plugs ready to install quickly as oil will rush out from the reservoir.

3.0 SUPPLY LINE INSTALLATION

WARNING

Be sure to either bleed the pressurized air reservoir and/or safety the system such as closing all valves prior to installing starter supply line.

The *T100 -C* air starters come standard with a 2" NPT female pipe thread for the inlet connection port**.** The supply line consists of the line from the air source, a pressure regulator (when necessary), a manual or relay valve, and the connection to the starter inlet. Hard piping may be used, but a section of flexible tubing should be installed at the starter to prevent leaks due to engine vibration.

Care must be taken to ensure that all inlet supply line piping is no less than 1.5" and all components used are capable of passing the required air flow.

NOTE

Valves with a Cv of 40 or higher are recommended.

If the supply line must be longer than 20 feet, the inlet supply line piping should be increased to 2" in diameter to ensure proper performance by your ***TURBOTWIN***.

Because turbine starters such as the ***T100 TURBOTWIN*** *series* are sensitive to flow restrictions, care must be taken to use uniform hose or tubing and fittings for connection of the supply line. Tees, elbows and line length must be kept to a minimum. TDI recommends that hose or flex couplings are installed to eliminate possible leakage caused by strain on the supply line.

Normally, an air strainer is not required. However, in dirty environments use of a #40 mesh Y-strainer is recommended. The ***T100 TURBOTWIN*** *series* is highly tolerant of dirt in the air line, however, starter life can be increased with the use of an air strainer.

A pressure regulator is required when the air supply pressure is great enough to exceed the starter operating pressure (at the inlet port) and/or the maximum torque.

The supply line should be dry-fitted for proper alignment /location prior to final assembly. All pipe threaded joints should be sealed with Loctite Pipe Thread Sealant (TDI P/N 9-94085) or equivalent for leak tight joints prior to final assembly. Be sure to tighten all joints to proper torque after final assembly.

CAUTION

In cold weather climates, care should be taken while designing your installation to prevent condensation from developing in the starter system. In systems with a regulator valve or relay valve, there is the possibility of freeze-ups.

A tee connection with a quick disconnect can be added to the inlet. This will allow an external air source to be used to accomplish a “blow start” if the system freezes. Once the engine has been started, the other system components may be thawed.

CAUTION

On new installations, it is strongly recommended to blow out the supply line with air to remove possible dirt and welding slag prior to final connection to the *TURBOTWIN* starter. Be sure to secure the free end of the supply line prior to blowing out the line.

4.0 INLET PRESSURE PORT

A 1/4" NPT port is located on the air inlet. This port may be used to check the supply pressure at the starter when the starter is operating. Remove the 1/4" NPT pipe plug and save for later use. Install a 1/4" minimum size tubing to the port. Route the tubing away from the starter to a safe location away from the engine. Install a pressure gauge on the tubing. This pressure monitoring line/gauge may be permanently installed. Use Loctite Pipe Thread Sealant or equivalent. Alternately, a pressure transducer may be installed at the pressure check port and electrical lines routed to a digital display at the operator's station.

This pressure port is invaluable in diagnosing air starter and/or installation problems.

5.0 EXHAUST PIPING

The turbine exhaust may be plumbed away from the starter area. All starters using natural gas must be piped according to industry codes and local regulations.

The performance of a turbine starter will be decreased because of back pressure when smaller than recommended exhaust piping is installed. If back pressure hampers starter performance, compensation can be made by increasing the supply pressure. Consult your TDI distributor for advice.

Exhaust piping should be routed downward to help prevent any accumulation of condensation in the starter motor.

If the overhung section of the starter is not otherwise supported, TDI recommends supporting the exhaust piping with a suitable bracket(s).

6.0 NATURAL GAS INSTALLATION

The installation of the starter using natural gas is similar to the air installation except all fittings, piping, valves and regulators must be compatible with natural gas.

Proper control of natural gas is a major consideration when used in the starter system. All starters using natural gas must pipe the exhaust according to industry codes and local regulations.

There is a natural gas vent port in the turbine housing that is plugged for compressed air use. This vent is used to remove any natural gas that could leak past the primary turbine shaft seal. Remove this 3/8"NPT plug and install a line to carry gas away from the starter area.

WARNING

Do not connect the turbine housing vent line to the turbine exhaust line. Exhaust gas can pressurize the housing.

7.0 PIPING SYSTEM

Only type approved metallic hose assemblies are approved in permanently pressurized compressed air lines of starters. Non-metallic hose assemblies are allowed only in case the piping system will be emptied after the starting procedure.
Pipe unions must be type approved by GL. Downstream of the pressure regulator a pressure relief valve is to be provided.

8.0 STARTER OPERATION

Prior to operation, check that all connections are tight and free from leaks. Check the 1/4" NPT pipe plug or a pressure gauge/transducer that may be connected to the pressure port on the starter inlet.

WARNING

Do not operate the TDI *TURBOTWIN* starter with air pressure greater than the pressure rating on the nameplate. This pressure is measured at the starter inlet while the starter is running.

The maximum operating pressure limit is the inlet pressure measured at the starter's inlet pressure check port. In order to check the starter, a 1/4"NPT pipe tap connection is provided in the inlet housing to attach a pressure gauge/transducer). The maximum pressure assumes an open exhaust (standard turbine exhaust guard). The standard exhaust guard causes no back pressure.

The static non-flowing supply pressure will always be higher than the operating (dynamic) pressure. The maximum pressure limit (proof pressure) that the TDI *TURBOTWIN* starter housings may be subjected to is 600 PSIG (42 BAR). System pressure that exceeds the maximum operating limit must use a pressure reducing device to ensure that the operating pressure limit to the TDI *TURBOTWIN* starter is maintained.

System static pressure that exceeds the 600 PSIG (42 BAR) limit must, in addition to pressure reducer devices incorporate a pressure relief valve set below 600 PSIG (42 BAR) in the supply air line.

All appropriate local pressure codes and pressure limitations on other system components must be adhered to and supersede the guidelines given in this manual.

Consult your TDI distributor if you have exhaust plumbing that creates back pressure and reduces starter performance. You may be able to increase the supply pressure to restore the lost power.

Follow the engine manufacturer's instructions for starting the engine.

9.0 PREVENTIVE MAINTENANCE

The TDI ***TURBOTWIN*** starters provide distinct advantages of size and efficiency as compared to electric motor, vane-type or other turbine-type starters. It is important to properly install the starter to receive full benefit of these advantages. Repair technicians or service organizations without turbine starter experience should not attempt to repair this starter until they receive factory approved training from TDI, or its representatives.

Proper operation and repair of your TDI TURBOTWIN starter will assure continued reliable and superior performance for many years.

9.1 Every Six (6) Months

Perform the following procedures at six (6) months intervals if the normal cranking cycle is 0 - 10 seconds.

9.1.1 Check the amount and condition of grease in the planetary gearbox. If gearbox requires re-greasing, only use TDI grease. Approximately one (1) pint of grease is needed to repack the gearbox.

9.1.2 Check the turbine bearing and carrier output bearings for freedom of rotation without excessive play between races. If bearings are damaged, replace them with genuine TDI parts. Refer to TDI Service Manual for part numbers.

9.2 Every Three (3) Months

Follow the six (6) month procedures if there are severe starter loading or extended duration crank cycles. Also perform these procedures every three (3) months when starter is used for motoring the engine for maintenance or valve adjustments.

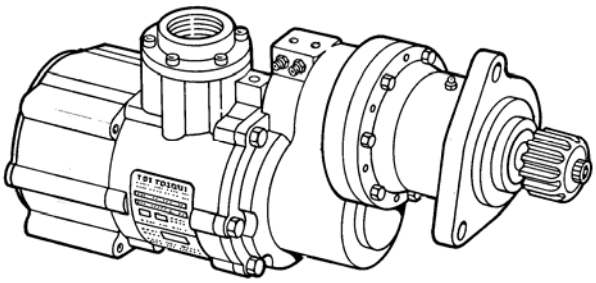
Motoring Crank Cycle: 10 -60 seconds

Extended Crank Cycle: 60 seconds or longer

TECH DEVELOPMENT

Publication T1-721, Revision 3
Dated: April 15, 2006

INSTALLATION AND OPERATING MANUAL



MODEL: T100-V

TURBOTWIN Engine Air Starters

AN 98-440

From Tech Development
6800 Poe Ave. •Dayton OH 45414
Tel: (937) 898-9600 •Fax: (937) 898-8431
Website: tdi-turbotwin.com

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LIST OF ILLUSTRATIONS

1.0 GENERAL INFORMATION

This manual provides instructions for the installation and operation of the TDI *T100-V TURBOTWIN* Air Starters. If there are questions not answered in this manual, please contact your TDI *TURBOTWIN* distributor or dealer for assistance.

The T100-V starters are turbine driven starters with a pre-engaged starter drive. The *T100-V* starters have applications ranging from 1800 CID (30 Liters) on diesel engines and up to 18000 CID (300 Liters) on gas engines. The *T100-V* models are suited to operate within a wide range of inlet pressures and ambient temperatures. The engine size and parasitic loading will determine the exact minimum pressure that will assure reliable cranking.

The *T100-V* starters are designed for operation with compressed air or natural gas; materials used are compatible with "sour" natural gas and marine environments. Small amounts of foreign matter or liquid in the air supply will not adversely affect *T100-V* starters. As with all TDI starters, no lubrication is required in the air supply.

Please review the rest of this manual before installing the *T100-V* air starter.

WARNINGS, CAUTIONS, AND NOTES

Certain types of information are highlighted in this manual for your attention:

WARNING - used where injury to personnel or damage to the equipment is possible.

CAUTION - used where there is the possibility of damage to the equipment.

NOTE - used to point out special interest information.

NOTE

Throughout this manual, the term "air" is used to designate the starter drive medium. Unless otherwise stated, "air" means either compressed air or natural gas.

1.1 DESCRIPTION

The T100-V features three basic subassemblies: a unique two stage turbine motor section, an offset/spur gear assembly and a pre-engage drive assembly.

The two stage motor section features greater stall torque than a single stage turbine plus aerodynamic speed control. This aerodynamic speed control helps protect the *T100-V* starter from damage caused by starter motor over speed. In addition, a specially designed motor housing module and low-mass rotors provide fail-safe operation.

The *T100-V* employs 9.25:1 ratio spur gearbox. This low gear ratio allows the turbine motor to spin at low speeds for long bearing life. At a typical 3000 rpm pinion speed, the turbine is rotating at a low 27750 rpm.

A reliable pre-engaged drive delivers the torque to the pinion. The pinion is translated out to engage the engine's ring gear via the starter's engagement piston.

Compressed air or natural gas is used to power the *T100-V* through the inlet port. The air or gas is expanded through the first nozzle or stators. The high velocity gas impinges on the first stage rotor to yield torque to the gearbox through momentum exchange. The gas is further directed through the second stage stators which impart additional torque to the second stage rotor.

1.2 PRODUCT IDENTIFICATION

The starter nameplate which is attached to the turbine housing contains the following information: model number, serial number, part number, direction of rotation and the maximum rated operating pressure.

The directions of rotation are either right hand or left hand rotation as shown in Figure 1. Right Hand rotation is defined as clockwise rotation as viewed from the pinion end of the starter, and Left Hand rotation is counter clockwise rotation viewed from the pinion end of the starter.

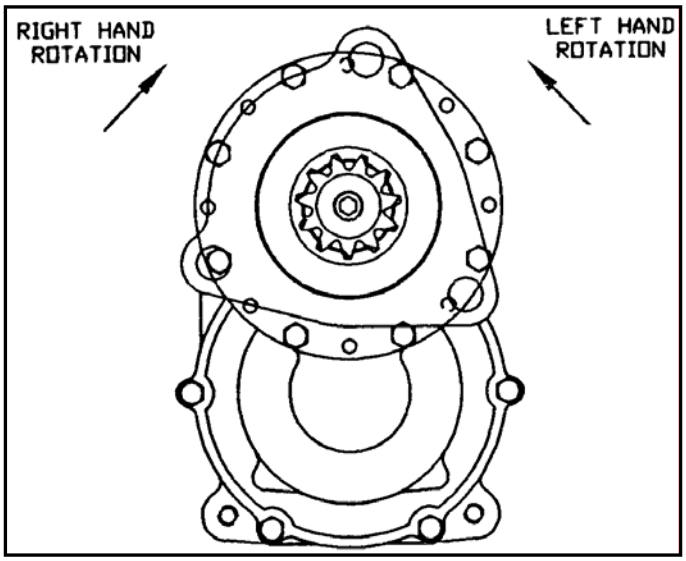


Figure 1. Direction of Rotation viewed from Pinion End.

The maximum operating pressure identified on the nameplate is measured at the check port on the starter inlet with the starter in operation.

CAUTION

Exceeding the maximum pressure shown on the nameplate may result in drive failure, damage to the starter, or damage to the engine.

The housing proof pressure is 600 psig and is also shown on the nameplate. This means that the turbine housing will not burst when subjected to a static pressure of 600 psig.

1.3 PHYSICAL CHARACTERISTICS

Figure 2 shows the standard configuration for the T100-V with exhaust screen. This model weighs approximately 54 lbs. and is 16.8 inches in length. The turbine housing diameter is 6.8 inches, which is common to all T100 *TURBOTWIN* air starters.

1.4 PERFORMANCE

The performance curve for the T100-V illustrates the pinion torque versus pinion speed (rpm) at a constant drive air pressure, and horsepower versus pinion speed at a constant drive air pressure. The pinion speed is shown on the horizontal axis while the pinion torque is shown on the left edge of the vertical axis. Air consumption rates are given for the various drive pressures. The drive gas used for the performance curve is air.

2.0 ORIENTATION OF THE STARTER

If the factory orientation of the starter turbine housing assembly does not fit your engine installation, this component can be re-oriented.

Determine the required orientation of the turbine housing assembly and gearbox housing assembly. The turbine housing assembly can be rotated to six different positions relative to the gearbox housing assembly. The drive assembly can be rotated to twenty four positions relative to the inlet port.

Orientation of the starter should be accomplished prior to installing the starter on the engine.

CAUTION

All screw threads are treated at the factory with a fastener retention compound. Every screw and tapped hole must be clean and have a drop of Loctite 242 applied to the threads before being installed.

3.0 INSTALLING THE STARTER

A turbine air starter does not require lubrication in the supply air. Therefore, if a vane type starter motor is being replaced, TDI recommends that all lubrication devices and lines be removed to minimize flow restrictions.

WARNING

If a fuel (pulse) lubricator has previously been installed in the system, disconnect and plug the line to eliminate spraying diesel fuel on the engine.

The starter should be installed with the inlet valve in a position between horizontal and straight down. Any condensation will be restricted to the air lines and not in the starter.

WARNING

Do not operate this starter unless it is properly connected to an engine.

3.1 SUPPLY LINE INSTALLATION

WARNING

Be sure to either bleed the pressurized air reservoir and/or safety the system such as closing all valves prior to installing any starter supply line.

T100-V starters come standard with a 2" NPT female pipe thread for the inlet connection port**.** The supply line consists of the line from the air source, a pressure regulator (when necessary), a manual or relay valve, and the connection to the starter inlet. Hard piping may be used, but a section of flexible tubing should be installed at the starter to prevent leaks due to engine vibration.

Care must be taken to ensure that all inlet supply line piping is no less than 1.5" and that all components used are capable of passing the required air flow.

NOTE

Valves with a Cv of 40 or higher are recommended.

If the supply line must be longer than 20 feet, the inlet supply line piping should be increased to 2" in diameter to ensure proper performance by your *TURBOTWIN*.

Because turbine starters such as the *T100-V* are sensitive to flow restrictions, care must be taken to use uniform hose or tubing and fittings for connection of the supply line. Tees, elbows and line length must be kept to a minimum. TDI recommends that hose or flex couplings be installed to eliminate possible leakage caused by strain on the supply line.

Normally, an air strainer is not required. In dirty environments, use of a #40 mesh Y-strainer is recommended. The ***T100-V*** is highly tolerant of dirt in the air line, however, starter life can be increased with the use of an air strainer.

A pressure regulator is required when the air supply pressure is great enough to exceed the starter operating pressure (at the inlet port) and/or the maximum torque.

A manual ball valve may be used to admit drive air/gas to the starter. The manual valve should be located in a safe position away from the engine.

A preferred valve is pilot-operated, which can be pneumatically or electrically actuated. The valve should be located close to or even on the starter inlet for best performance. Pneumatic or electrical control lines may be routed virtually anywhere for the customer's preferred operating station. This type of valve actuates from a fully closed to a fully open position very rapidly. TDI offers a variety of relay valves such as P/N RLVA-25683-001-2-01, which is a 1-1/2" port, pneumatically actuated valve.

The supply line should be dry-fitted for proper alignment/location prior to final assembly. All pipe-threaded joints should be sealed with Loctite Pipe Thread Sealant (TDI P/N 9-94085) or equivalent for leak tight joints prior to final assembly. Be sure to tighten all joints to proper torque after final assembly.

CAUTION

In cold weather climates, care should be taken while designing your installation to prevent condensation from developing in the starter system. In systems with a regulator valve or relay valve, there is the possibility of freeze-ups.

A tee connection with a quick disconnect can be added to the inlet. This will allow an external air source to be used to accomplish a "blow start" if the system freezes. Once the engine has been started, the other system components may be thawed.

CAUTION

On new installations, it is strongly recommended to blow out the supply line with air to remove possible dirt and welding slag prior to final connection to the *TURBOTWIN* starter. Be sure to secure the free end of the supply line prior to blowing out the line.

3.2 INLET PRESSURE PORT

A 1/4" NPT port is located on the air inlet. This port may be used to check the supply pressure at the starter when the starter is operating. Remove the 1/4" NPT pipe plug and save for later use. Install 1/4" minimum size tubing to the port. Route the tubing away from the starter to a safe location away from the engine. Install a pressure gauge on the tubing. This pressure monitoring line/gauge may be permanently installed. Use Loctite Pipe Thread Sealant or equivalent. Alternately, a pressure transducer may be installed at the pressure check port and electrical lines routed to a digital display at the operator's station.

This pressure port is invaluable in diagnosing air starter and/or installation problems.

3.3 EXHAUST PIPING

The turbine exhaust may be plumbed away from the starter area. All starters using natural gas must be piped according to industry codes and local regulations.

The performance of a turbine starter will be decreased because of back pressure when smaller than recommended exhaust piping is installed. If back pressure hampers starter performance, compensation

can be made by increasing the supply pressure. Consult your TDI distributor for advice.

Exhaust piping should be routed downward to help prevent any accumulation of condensation in the starter motor.

If the overhung section of the starter is not otherwise supported, TDI recommends that the exhaust piping be supported with a suitable bracket(s).

3.4 SOFT START VALVE & FILTER FITTING

The ***"soft start"*** **fitting (P/N: 2-28243)**, by providing a slower opening of the starter relay valve, eliminates excessive starter pinion gear loading. The soft start fitting is identified by the mark "EL-SOFT START" found on its body. This fitting **MUST** be installed at the starter relay valve as shown in figure 4. It is screwed into the applied pressure ("IN" or "APP") port on the starter relay valve. There are currently no approved substitutions for this fitting.

The **filter fitting (P/N: 2-28270)** provides contamination protection to the starter's pre-engagement mechanism and the soft start fitting installed downstream. The filter fitting is to be installed on the "IN" port of the starter as shown in figure 4. It appears similar to the soft start fitting, however, there are no identifying marks on the filter fitting.

For multiple starter applications, a soft start fitting must be installed on **EACH** relay valve and a filter fitting must be installed on **EACH** starter as shown in figure 5.

CAUTION

For maximum pinion life and full warranty coverage, the soft start valve (P/N: 2-28243) MUST be installed in the applied pressure port (APP) of the relay valve.

3.5 NATURAL GAS INSTALLATION

The installation of the starter using natural gas is similar to the air installation except all fittings, piping, valves and regulators must be compatible with natural gas.

Proper control of natural gas is a major consideration when used in the starter system. All starters using natural gas must pipe the exhaust according to industry codes and local regulations.

There is a natural gas vent port in the turbine housing that is plugged for compressed air use. This vent is used to remove any natural gas that could leak past the primary turbine shaft seal. Remove this 3/8"NPT plug and install a line to carry gas away from the starter area.

WARNING

Do not connect the turbine housing vent line to the turbine exhaust line. Exhaust gas can pressurize the turbine housing.

3.6 PIPING SYSTEM

Only type approved metallic hose assemblies are approved in permanently pressurized compressed air lines of starters. Non-metallic hose assemblies are allowed only in case the piping system will be emptied after the starting procedure.

Pipe unions must be type approved by GL. Downstream of the pressure regulator a pressure relief valve is to be provided.

4.0 STARTER OPERATION

Prior to operation, check that all connections are tight and free from leaks. Check the 1/4" NPT pipe plug or a pressure gauge/transducer that may be connected to the pressure port on the starter inlet.

WARNING

Do not operate the TDI *TURBOTWIN* starter with air pressure greater than the pressure rating on the nameplate. This pressure is measured at the starter inlet while the starter is running.

The maximum operating pressure limit is the inlet pressure measured at the starter's inlet pressure check port. In order to check the starter, a 1/4"NPT pipe tap connection is provided in the inlet housing to attach a pressure gauge/transducer). The maximum pressure assumes an open exhaust (the standard turbine exhaust guard). The standard exhaust guard causes no back pressure.

The static non-flowing supply pressure will always be higher than the operating (dynamic) pressure. The maximum pressure limit (proof pressure) that the *T100-V* starter housings may be subjected to is 600 PSIG (42 BAR). System pressure that exceeds the maximum operating limit must use a pressure reducing device to ensure that the operating pressure limit to the *T100-V* starter is maintained.

System static pressure that exceeds the 600 PSIG (42 BAR) limit must, in addition to pressure reducer devices,

incorporate a pressure relief valve set below 600 PSIG (42 BAR) in the supply air line.

NOTE

For maximum life of the starter pinion and for the protection of the engine ring gear, limit the operating pressure to that necessary to start the engine at its most difficult starting conditions.

All appropriate local pressure codes and pressure limitations on other system components must be adhered to and supersede the guidelines given in this manual.

Consult your TDI distributor if you have exhaust plumbing that creates back pressure and reduces starter performance. You may be able to increase the supply pressure to restore the lost power.

Follow the engine manufacturer's instructions for starting the engine.

CAUTION

The grease used in the planetary system has a shelf life of 2 years. Therefore, if the starter is NOT installed and operated on the engine for 2 years after the starter is manufactured, the grease should be replaced prior to starter operation. The manufactured date is reflected in the starter serial number. (Ex: 0602-0567 has a manufactured date of February 2006).

4.1 BASIC OPERATION

The basic operation of the starter follows:

Pressurized air or natural gas is admitted to the starter's engagement piston chamber via the "in" control port by opening the manual or solenoid valve. The air then translates the starter's piston forward allowing the pinion to engage the engine's ring gear.

The forward movement of the piston causes the starter's "out" control port to open. Air is then transmitted to the automatic pilot port (APP) on the relay valve causing the relay valve to open.

Pressurized air or natural gas is admitted to the starter's turbine assembly by the opening of the relay valve. The air expands through the turbine which produces shaft rotation and torque. The starter motor torque causes the engine to accelerate. The fuel and ignition systems now fire the engine. Closing the relay valve stops the starter.

The operator may decrease starter life by the continual operation of the starter after the engine has started. Upon a successful engine start, turn the air off to the starter immediately. Minimizing the time the starter is operating unloaded (i.e. the engine is running) will maximize starter life. If a start is aborted, a restart may be attempted after the engine and the starter has come to rest.

CAUTION

Do not engage the starter while the engine is running.

The drive air pressure is the primary starter control parameter**.** It is important, especially on new installations, to measure this pressure during several engine starts. The secondary parameter is the starter pinion speed. This speed is usually measured by knowledge of the engine starting speed and the starter cranking ratio. The cranking ratio is the number of ring gear teeth divided by the number of pinion teeth. The starter pinion speed is then found by multiplying the engine speed by the cranking ratio. The pinion speed is usually 2000-3500 rpm at typical engine starting speed.

4.2 AUTOMATED START PANEL

The starter drive pressure measured at the starter inlet will need to be set. As noted above, for maximum life of the starter pinion and for the protection of the engine ring gear, limit the operating pressure to that necessary to start the engine at its most difficult starting conditions.

The speed control parameter will then need to be set. Engine starting speed along with the cranking ratio number can be used to determine starter pinion speed. The pinion speed is usually 2000-3500 rpm for a typical engine starting speed. Once the start sequence has begun, the air is admitted to the starter. The starter begins to accelerate the engine. Once the firing speed of the engine is reached, the automated start panel may deliver fuel to the engine. The engine will begin to accelerate under its own power. The starter should be dropped out of the sequence at a rpm higher than the firing speed, but less than the engine idle speed.

The automated start panel should monitor engine speed to determine air on and air off. Do not simply use time as a control parameter. Avoiding excessive operation of the starter after the engine is firing will maximize the starter life.

5.0 WARRANTY

TDI *TURBOTWIN* ENGINE STARTER WARRANTY

Tech Development Inc. (TDI) warrants to the original user of the TDI *TURBOTWIN*™ Model T100-V Series air starters to be free from defects in material and workmanship for a period of one year from the date of installation. The warranty period shall not extend beyond two years from the date the unit was manufactured. (i.e.: a unit with a manufactured date of July 1999 (SN: 9907-101) will not be covered under warranty after July 2001). The conditions of this warranty are: **a)** TDI is notified within this period by return of such product to TDI or its authorized distributor/dealer, transportation prepaid by user; **b)** the starter has been installed according to TDI's specifications; **c)** the starter has not been misused, abused, or improperly maintained by user; **d)** the defect is not the result of normal wear and tear; **e)** the starter has been repaired with parts manufactured or authorized by TDI; and **f**) TDI installation and repair procedures as outlined in the appropriate manual were properly followed.

Tech Development Inc. will repair, or at its option, replace the unit during the warranty period at no charge to the customer, provided it is returned to TDI with the proper return procedure.

Tech Development Inc. makes no other warranty, and implied warranties including any warranty or merchantability or fitness for a particular purpose are hereby disclaimed.

This warranty constitutes the entire obligation of Tech Development Inc. relating to the sale and use of such product, and TDI's maximum liability is limited to the purchase price of such product at the date of purchase. In no event shall TDI be liable for incidental, indirect, consequential, or special damages of any nature arising from the sale or use of such engine starter product.

6.0 OPERATOR'S TROUBLESHOOTING GUIDE

TROUBLE	PROBABLE CAUSE	SOLUTION
1. Air always flow through exhaust	A. Relay valve improperly installed.	A. Check typical installation diagram and correct.
	B. Relay valve not sealing properly.	B. Check for damaged sealing ring, replace relay valve or damaged parts.
	C. Solenoid is not sealing, pressure remains in APP port of relay valve.	C. Check solenoid potential at the lead to ground should be 0. If not, fix ignition switch problem.
2. Starter engages but does not run,	A. Bad relay valve	A. Replace relay valve.
3. Starter does not run, small air flow from turbine exhaust or drive housing.	A. Nozzle blockage.	A. Remove blockage or obstruction from nozzles.
4. Starter does not run. Normal air flow from exhaust.	A. Excessive bends in the supply line.	A. Shorten length or straighten supply air line.
5. Pinion does not engage	A. Air pressure is too low	A. Increase air pressure to 40 - 150 psig.
	B. Control lines to starter ports reversed.	B. Check installation diagram and correct.
	C. Solenoid valve not operating or plugged.	C. Check wiring and solenoid operation. Correct wiring, remove blockage, or replace solenoid valve as needed.
	D. Damaged pinion teeth.	D. Replace pinion or starter drive as necessary.
6. Starter runs but engine cranks slowly or not at all.	A. Air pressure too low	A. Increase air pressure to 40 – 150 psig.
	B. Excessive back pressure.	B. Check Exhaust Closure Plate.
	C. Nozzle blocked or damaged.	C. Remove blockage or replace damaged parts.
7. Starter continues to operate after start button is released.	A. Solenoid valve is not sealing correctly.	A. See 1C above
	B. Relay valve is not sealing correctly.	B. See 1B above
8. Air tank pressure decays after extended shut down.	A. Air connections are not tight.	A. Tighten loose fittings. Repair or replace damaged fittings.
	B. Damaged air lines: crushed, frayed, and kinked.	B. Replace damaged lines.
	C. Relay valve is not sealing correctly.	C. See 1B above
	D. Solenoid valve is stuck open.	D. A. See 1C above

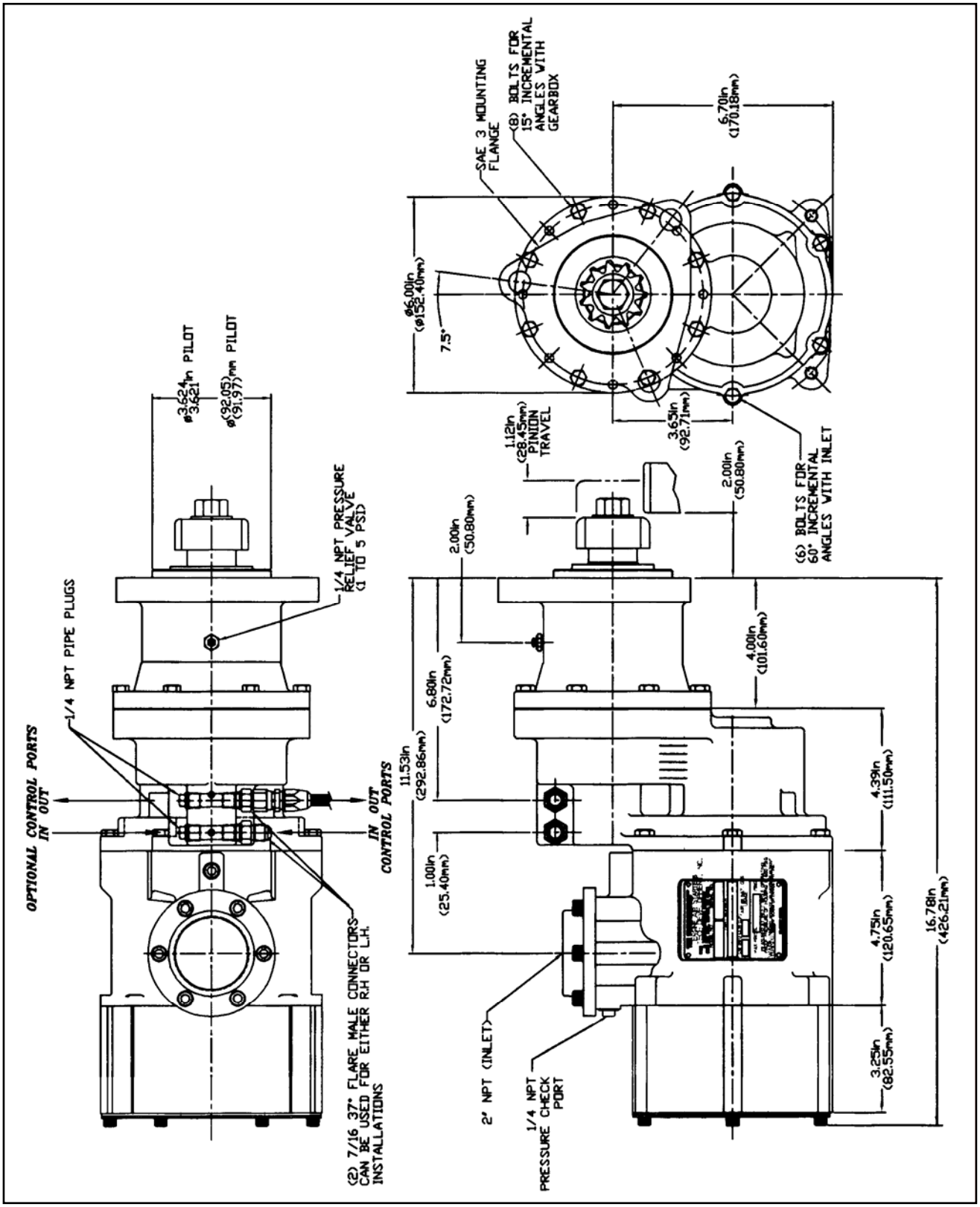
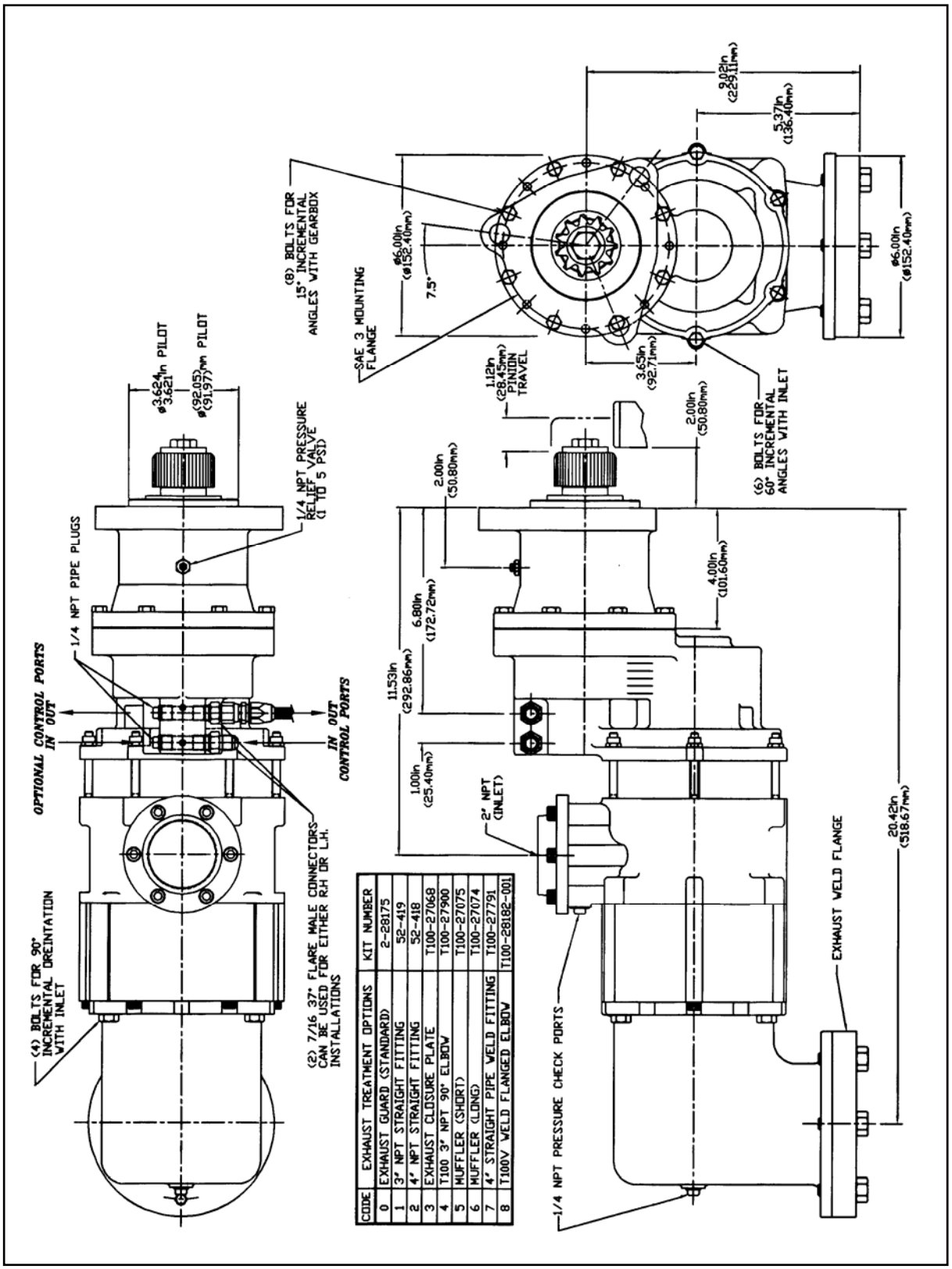


Figure 2. T100-V *TURBOTWIN* Air Starter with Exhaust Guard



CODE	EXHAUST TREATMENT OPTIONS	KIT NUMBER
0	EXHAUST GUARD (STANDARD)	2-28175
1	3" NPT STRAIGHT FITTING	52-419
2	4" NPT STRAIGHT FITTING	52-418
3	EXHAUST CLOSURE PLATE	T100-27068
4	T100 3" NPT 90° ELBOW	T100-27900
5	MUFFLER (SHORT)	T100-27075
6	MUFFLER (LONG)	T100-27074
7	4" STRAIGHT PIPE WELD FITTING	T100-27791
8	T100V WELD FLANGED ELBOW	T100-28182-001

Figure 3. T100-V *TURBOTWIN* Air Starter with Flanged Exhaust Elbow

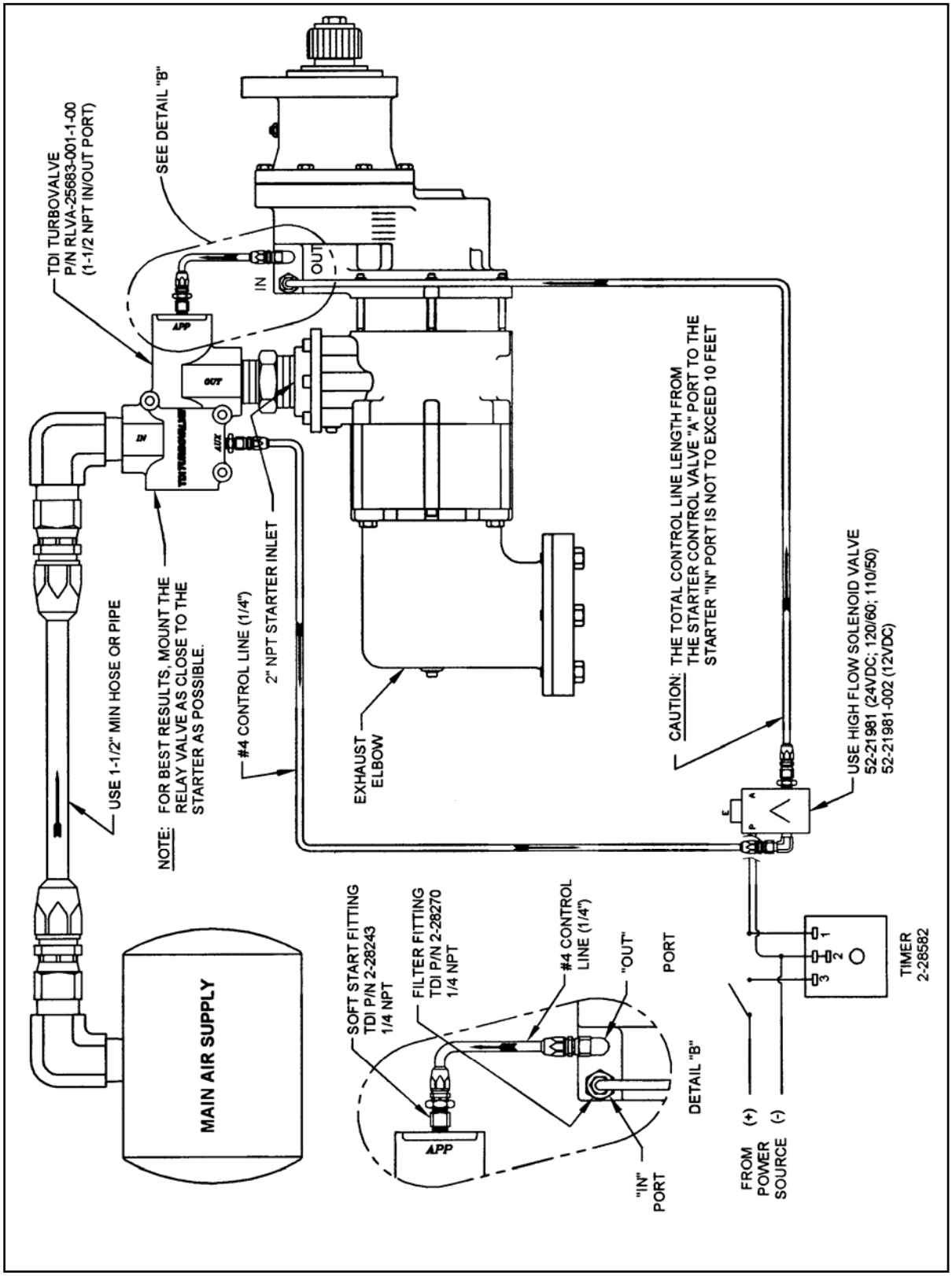
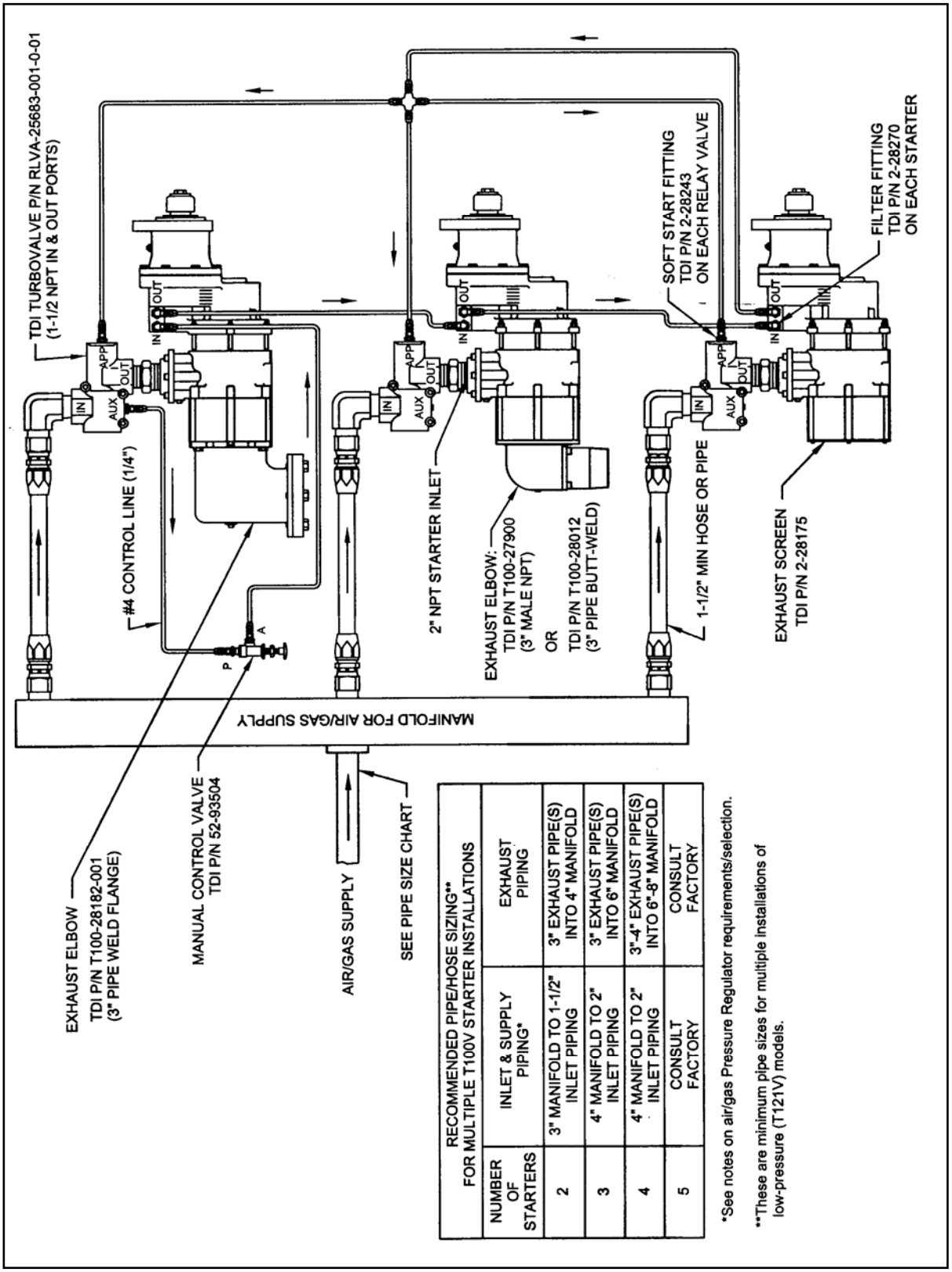


Figure 4. T100-V *TURBOTWIN* Air Starter Installation Drawing



RECOMMENDED PIPE/HOSE SIZING** FOR MULTIPLE T100V STARTER INSTALLATIONS		
NUMBER OF STARTERS	INLET & SUPPLY PIPING*	EXHAUST PIPING
2	3" MANIFOLD TO 1-1/2" INLET PIPING	3" EXHAUST PIPE(S) INTO 4" MANIFOLD
3	4" MANIFOLD TO 2" INLET PIPING	3" EXHAUST PIPE(S) INTO 6" MANIFOLD
4	4" MANIFOLD TO 2" INLET PIPING	3"-4" EXHAUST PIPE(S) INTO 6"-8" MANIFOLD
5	CONSULT FACTORY	CONSULT FACTORY

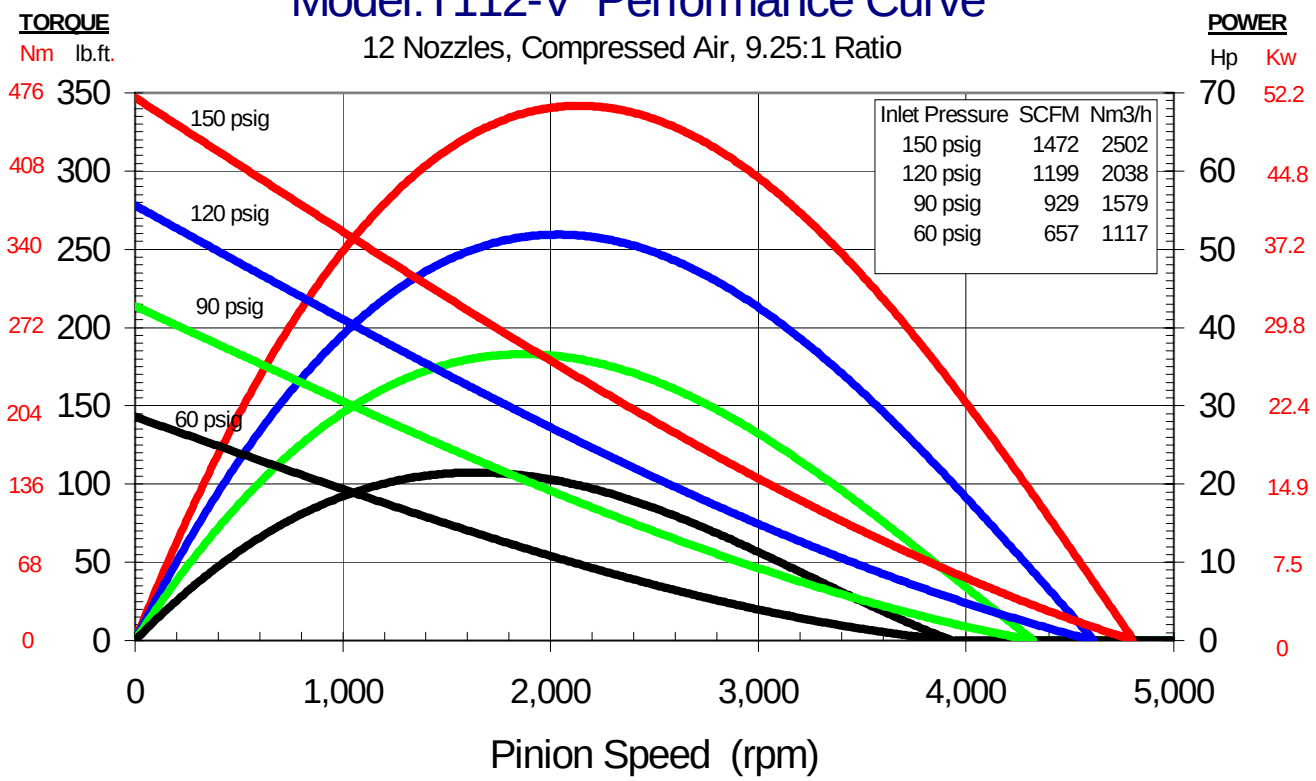
*See notes on air/gas Pressure Regulator requirements/selection.

**These are minimum pipe sizes for multiple installations of low-pressure (T121V) models.

Figure 5. T100-V *TURBOTWIN* Air Starter Installation Drawing (Multiple Starters)

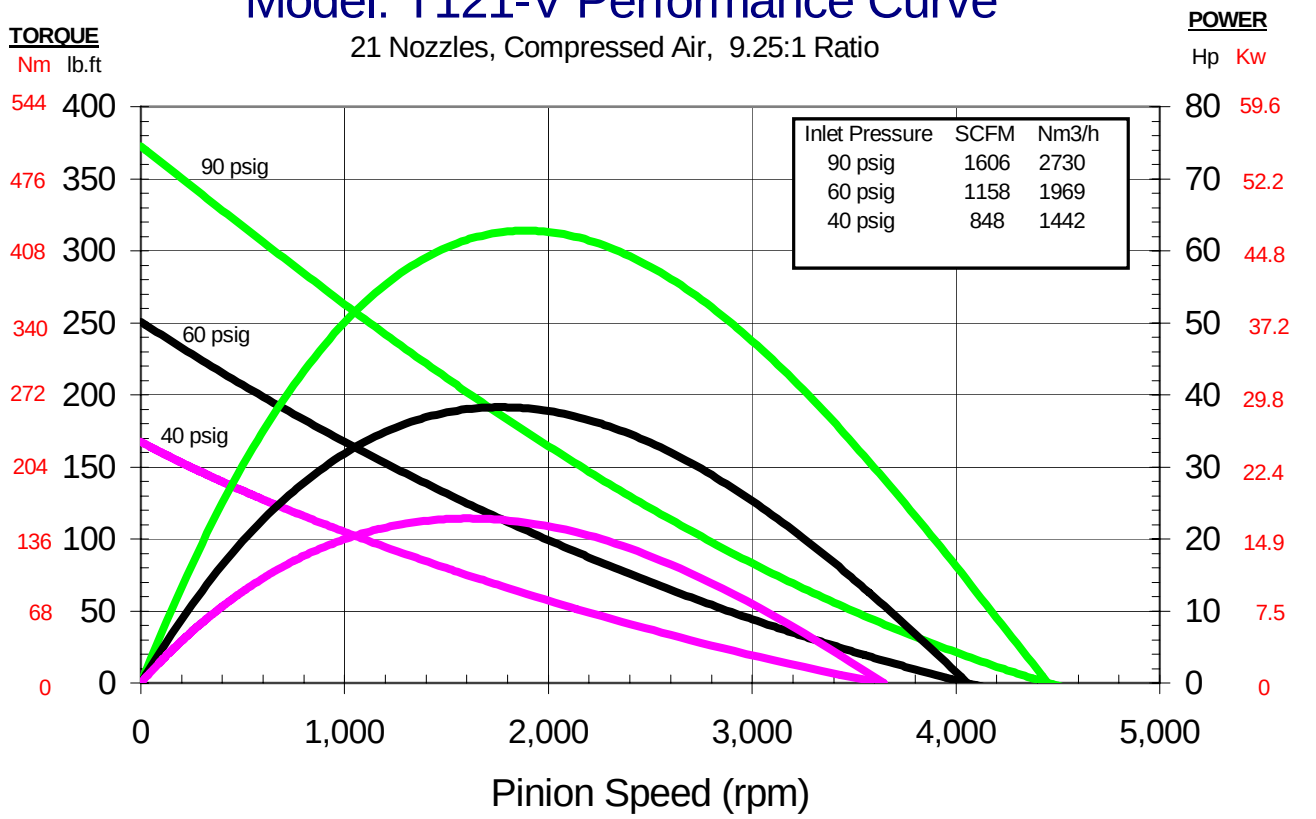
Model:T112-V Performance Curve

12 Nozzles, Compressed Air, 9.25:1 Ratio



Model: T121-V Performance Curve

21 Nozzles, Compressed Air, 9.25:1 Ratio



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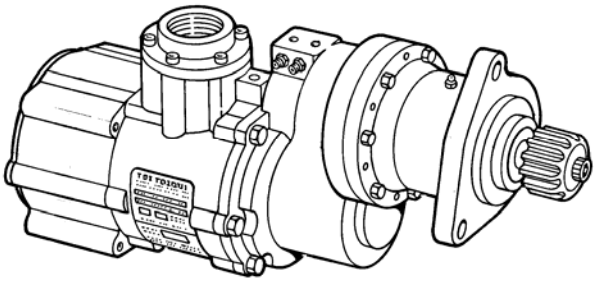
TECH DEVELOPMENT

Publication T1-723
Issued April 15, 2006

SERVICE MANUAL



T100-V

TURBOTWIN Engine Air Starters

From Tech Development
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Tel: (937) 898-9600 •Fax: (937) 898-8431
Website: www.tdi-turbotwin.com

SECTION 1.0 INTRODUCTION

1.1 GENERAL INFORMATION

This manual provides information for servicing, disassembly, and reassembly of the TDI Turbotwin T100-V air starters. If there are questions not answered by this manual, please contact your local TDI distributor or dealer for assistance. Illustrations and exploded views are provided to aid in disassembly and reassembly.

The TDI Turbotwin T100-V engine starters are specially designed for starting today's automated, low-emission engines. The Turbotwin uses aerodynamic speed control, eliminating the need for a mechanical automatic trip valve (ATV) to control starter motor speed.

The Turbotwin T100-V air starters are suited to operate within a wide range of inlet pressures and ambient temperatures. These starters are designed for operation with either compressed air or natural gas.

The robust turbine motor design in the Turbotwin T100-V starters has no rubbing parts, and is therefore tolerant of hard and liquid contamination in the supply gas with almost no adverse affects. The motor is well adapted to running on "sour" natural gas.

As with all TDI air starter products, there are no rubbing parts so there is no lubrication required. This eliminates failures due to lubricator problems, the expense of installing and maintaining the system, and the messy and hazardous oil film around the starter exhaust. The starter is factory grease packed for the life of the starter so it requires no maintenance.

NOTE

Throughout this manual, the term "air" is used to donate the starter drive medium. Unless otherwise stated, "air" means compressed air or natural gas.

Please review the rest of this manual before attempting to provide service to the TDI Turbotwin T100-V starters.

1.2 WARNINGS, CAUTIONS, & NOTES

Throughout this manual, certain types of information will be highlighted for your attention:

WARNING - used where injury to personnel or damage to equipment is possible.

CAUTION - used where there is the possibility of damage to equipment.

NOTE - use to point out special interest information.

1.3 DESCRIPTION OF OPERATION

The Turbotwin T100-V starters are powered by a pair of axial flow turbines coupled to a simple planetary gear reduction set. The T100-V starters incorporate an inertia bendix drive coupled to the starter gearbox drive train to provide a means of disengaging the pinion from the engine's ring gear.

The high horsepower of the turbine air motor combined with the spur gear speed reducer results in a very efficient and compact unit. The Turbotwin T100-V starters can be used over a wide range of drive pressures from 40 psig (2.6 BAR) to 150 psig (10 BAR) and are suitable for operation on air or natural gas.

1.4 INSTALLATION AND SERVICE

It is important to properly install and operate the TDI Turbotwin T100-V starters to receive the full benefits of the turbine drive advantages. It must be installed in accordance with the instructions provided by Tech Development, Inc. (TDI).

WARNING

Failure to properly install the starter or failure to operate it according to instructions provided byTDI may result in damage to the starter or engine, or cause personal injury. DO NOT OPERATE THIS STARTER UNLESS IT IS PROPERLY ATTACHED TO AN ENGINE.

Repair technicians or service organizations without turbine starter experience should not attempt to repair this starter until they receive factory approved training from TDI, or its representatives. Proper operation and repair of your TDI Turbotwin will assure continuous reliability and superior performance for many years.

1.5 NAMEPLATE INFORMATION

The nameplate located on the turbine housing provides important information regarding the construction of your T100-V starters. Refer to *Figure* 1.

NOTE

You should always have the starter's Part Number, Serial Number, Operating Pressure, and Direction of Rotation information before calling your TDI distributor or dealer.

TURBOTWIN™
PNUEMATIC STARTER
TECH DEVELOPMENT INC.
6800 POE AVE.,DAYTON OH

MODEL NO.	SERIAL NO.	CW (RH)	(CCW) LH)
T112V	9911-210	X	

PART NUMBER
T112-60031-01R-1-03 …
AIR OR NAT. GAS USAGE HOUSING PROOF PRESSURE IS 600 PSIG

MAX OPERATING INLET PRESS. 150 PSIG
WARNING DO NOT OPERATE UNLOADED, WITHOUT EXHAST GUARD OR WITHOUT EXHAUST FITTING

Figure 1. TDI Turbotwin Nameplate

2.0 DESCRIPTION OF BASIC GROUPS

2.1 GENERAL

The TDI Turbotwin T100-V air starters are lightweight, compact units driven by a dual stage turbine type air motor. The starter is composed of three basic assembly groups: Turbine Housing Assembly; Gearbox Housing Assembly; and Drive Assembly.

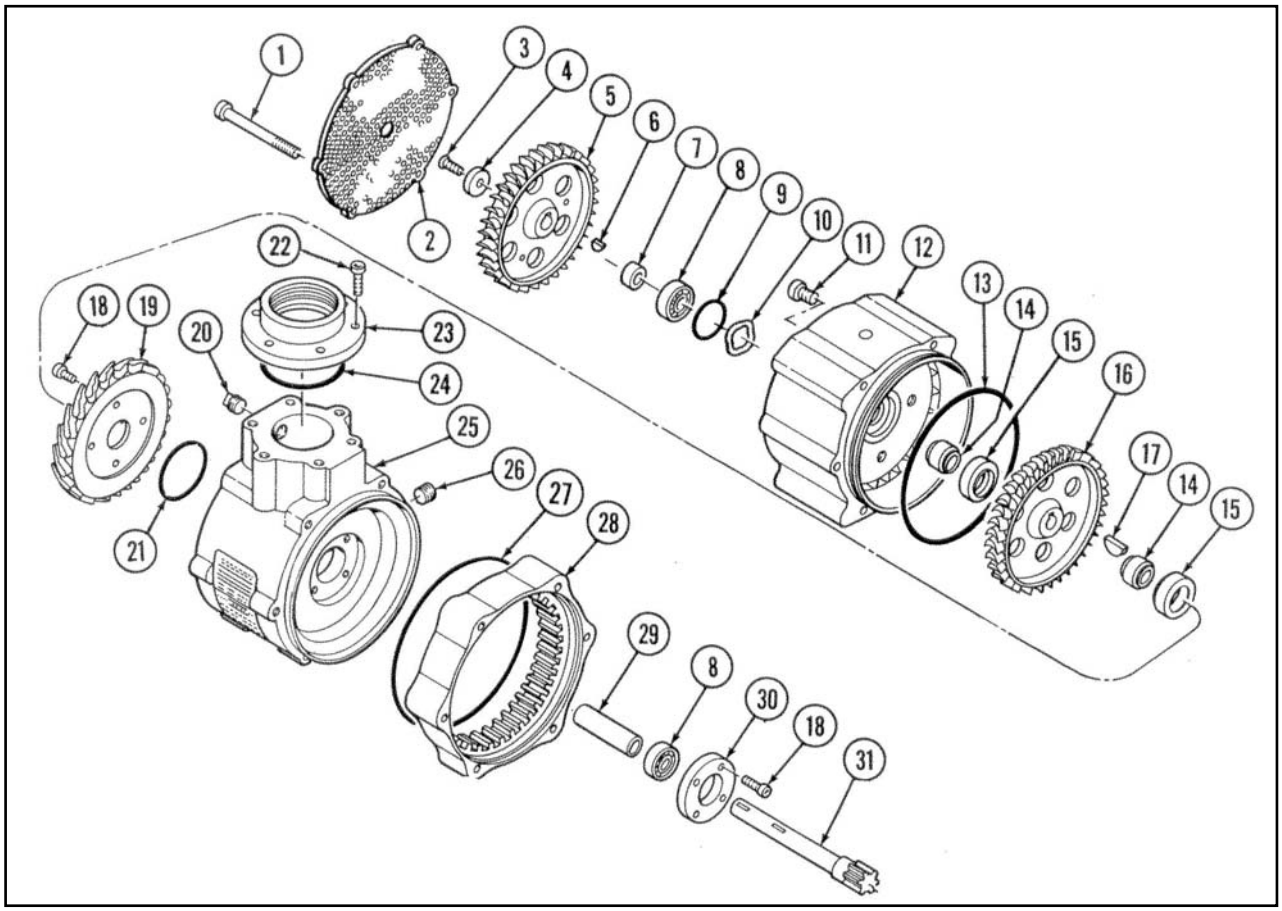
2.2 TURBINE HOUSING ASSEMBLY

The Turbine housing assembly, refer to figure 3, consists of a stage one (13) and a stage two (5) turbine wheel mounted on sungear shaft (30) . The front bearing (8) is secured by a retainer plate (29). The aft bearing (8) is preloaded by a wavy spring (10).

The ring gear (27) is installed between the turbine assembly (23) and the gearbox housing and secured by four screws (25).

Figure 3.

Turbine Housing Assembly



2.3 GEARBOX HOUSING ASSEMBLY

The gearbox housing assembly, refer to figures 4, consist of a planet gear carrier shaft (32), three planet gears (34), needle bearings (35), spacers (33), and bearing pins (36).

The carrier shaft is mounted on two ball bearings (38) in the gearbox housing (48). The aft bearing is preloaded by use of spring washers (39). The forward bearing is installed into the bearing housing (43), which is secured by four screws (44) to the gearbox housing. The spur gear (45) is installed on the carrier shaft and secured by the bearing locknut (47).

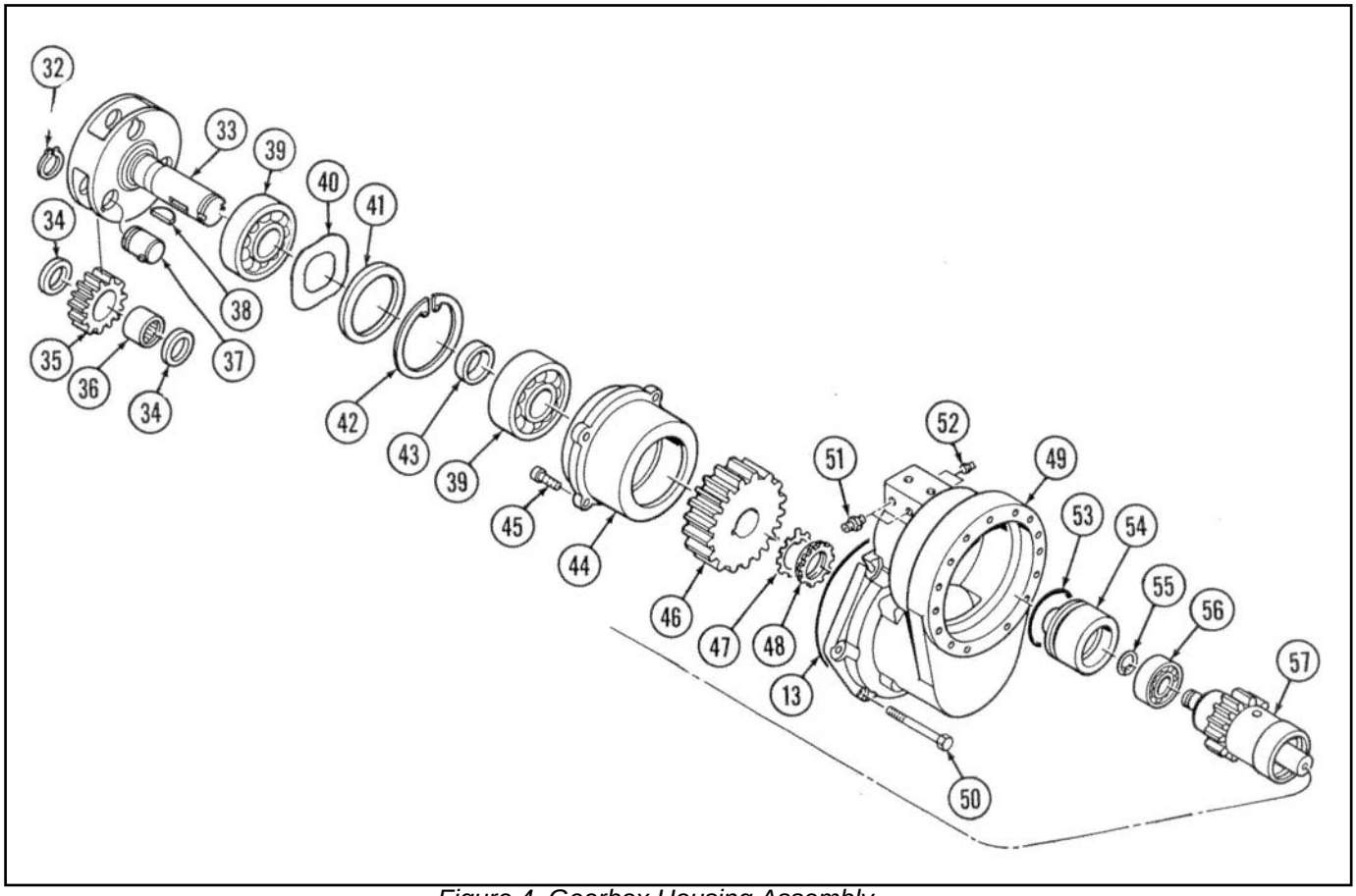


Figure 4. Gearbox Housing Assembly

2.4 DRIVE ASSEMBLY

The drive assembly, refer to figure 5, consists of a piston (53), helical shaft spline (56), dental clutch (58) and drive pinion shaft (61). The clutch assembly (56 thru 64) is installed into the spur gear (65). The spur gear (65) is supported by the aft bearing (66), which is secured by the retaining ring (67).

The roller bearing (69) is installed into spur gear (65) and secured by retaining ring (70). The forward bearing (66) is pressed into the drive housing. The lip seal (75) is pressed into the forward side of drive housing (72).

The pinion collar (76) is installed on pinion shaft (61) behind pinion (77), which is secured by washer (78) and screw (79).

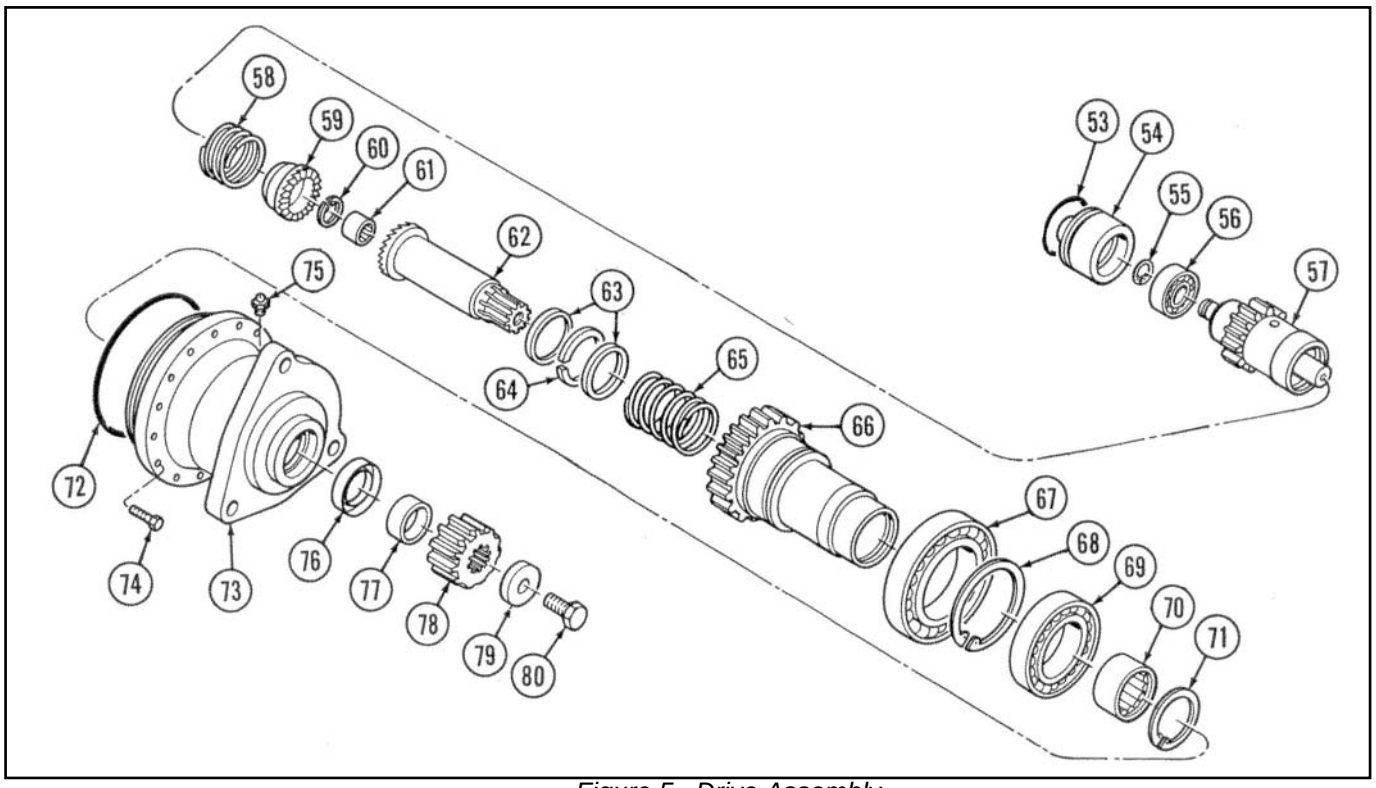


Figure 5. Drive Assembly

SECTION 3.0 DISASSEMBLY

3.1 GENERAL

Always mark adjacent parts on the starter housing; Nozzle 2/ Containment Ring (11), Turbine Housing (23), Gearbox Housing (48), and Drive Housing (72) so these parts can be located in the same relative position when the starter is reassembled.

Do not disassemble the starter any further than necessary to replace a worn or damaged part

Always have a complete set of seals and o-rings on hand before starting any overall of a Turbotwin T100-V starter. Never use old seals or o-rings.

The tools listed in *Table 1* are suggested for use by technicians servicing the T100-V Turbotwin starters. The best results can be expected when these tools are used, however the use of other tools are acceptable. Contact TDI for a list of additional tools that maybe required when overhauling T100-V air starters.

TOOL DESCRIPTION	TDI/PN
Spanner wrench	52-20134
Spanner wrench	52-21345
Shaft Removal Tool	2-26945
Stage 2 Rotor Puller Tool	52-20076
Carrier Shaft Holding Tool	52-20202
Tool, Bearing Pressing	52-20143
Tool, Bearing/Seal	2-26943

Table 1. T100-V Service Tools

3.2 DRIVE HOUSING

3.2.1 Removal of Drive Housing

Mark position of drive assembly (72) relative to gearbox housing (48) for reference during reassembly.

Remove the eight screws (73) and pull drive assembly from gearbox housing. If drive housing is too tight, tap it with a mallet to loosen.

Remove o-ring (71) from aft end of drive housing(72).

NOTE

Before removing the eight screws (73), install a spacer between pinion (77) and drive housing (72) to allow for easy installation during reassembly.

3.2.2 Pre-engaged Drive Disassembly

Secure pinion (77) in a soft tooth vise while supporting aft end of the T100-V air starter. Rotate pinion screw (79) counterclockwise to remove using a 3/4" socket and wrench.

NOTE

Use only a soft tooth vise to secure the pinion to avoid damaging pinion.

This screw is torqued to 60 lb ft during assembly therefore a large wrench may be required when removing screw.

Remove washer (78), pinion (77) and spacer (76) from pinion shaft (61). If pinion is too tight, place a screwdriver underneath pinion and lift up on pinion to remove from shaft.

Remove helical spline shaft assembly (54-64) from spur gear shaft (65). Remove spring (64) from shaft.

Use press tool and arbor press to remove spur gear shaft (65) from drive housing (72) as shown in figure ?.

Use a screwdriver to remove lip seal (75) from forward end of drive housing (72).

Remove retainer ring (70) and bearing (69) from forward end of spur gear shaft (65).

Remove retainer ring (67) and press bearing (66) from spur gear shaft (65) as shown in figure ?.

Remove retainer ring (54) and bearing (55) from helical spline shaft (56).

3.5 GEARBOX HOUSING

3.5.1 Removal of Gearbox Housing

Remove the screws (25) securing the gearbox (48) to the turbine assembly (23).

Remove ring gear (27) from turbine (23) or gearbox assembly (48). The ring gear could remain on either assembly when separation occurs.

3.5.2 Gearbox Disassembly

Place gearbox assembly (48) on flat surface with aft end facing up.

Remove four screws (44) and lift carrier shaft assembly (32) from gearbox housing.

Place carrier shaft assembly on carrier shaft holding tool (52-20202) and use a screwdriver to remove tang of lock washer (46) from slot of retainer nut (47).

Place TDI tool P/N 52-20134 (Spanner Wrench) over shaft and into slots of retainer nut (47). Hold carrier shaft assembly down and turn spanner wrench counter clockwise to remove retainer nut, lock washer (46), spur gear (45), and woodruff key (37) from carrier shaft (32) as shown in figure ?.

Use an arbor press to remove carrier shaft (32) from bearing housing (43). The bearing housing must be elevated and supported to remove carrier shaft per figure ?

NOTE

Do not support the bearing housing on the four lips as they could break while pressing on carrier shaft.

Remove spring washer (39), spring retaining plates (40), and bearing spacer (42) from carrier shaft.

Remove aft bearing (38) from shaft by pressing shaft while supporting bearing.

3.5.3 Planet Gear Disassembly

Remove retainer ring (31) from planet shaft (36) and push planet shaft through assembly.

Slide the planet gear (34) from carrier shaft and remove two spacers (33).

Use press tool to remove needle bearing (35) from planet gear (34).

3.6 TURBINE HOUSING

3.6.1 Stage 2 Rotor Removal

Place the turbine assembly (23) with ring gear (27) on a flat surface with (exhaust) end up and remove the six screws (1), and the screen (2).

Secure the stage 2 rotor (5) and remove the turbine screw (3) and washer (4).

Install the rotor puller tool P/N 52-20076 and remove the stage 2 rotor as shown if figure ?.

Remove the woodruff key (6) from the turbine shaft (30).

3.6 Turbine Shaft Removal

Place the turbine housing on a flat surface with the sun gear end facing up.

Remove four screws (16) and bearing retainer plate (29) from turbine housing.

Using the shaft removal tool P/N 2-26945, press on the aft end of the turbine shaft (30) while supporting the turbine housing (23). See figure ?.

Press the turbine shaft (30) through the aft bearing (8) until the shaft is completely out of the housing (23) as shown in figure ?.

Remove the woodruff key (14), seal spacer (7), bearing spacer (28), and bearing (8) from turbine shaft (30). The bearing can be removed from the shaft by pressing the shaft through the bearing while supporting bearing.

Separate the stage 2 nozzle assembly (11) from the turbine assembly (23) by firmly holding the turbine assembly, while tapping nozzle 2 with a mallet. If nozzle 2 is too tight, it can be removed by installing two threaded screws into nozzle 2 and using them as jacks to separate nozzle 2 from the turbine assembly.

NOTE

Rotate the stage 1 rotor if necessary to allow the jacks to travel through the large holes in the rotor. The jacks will damage the stage 1 rotor if pressure is applied to the rotor while removing nozzle 2.

Remove stage 1 rotor (13) and o-ring (12) from nozzle 2.

Remove the four screws (16) and nozzle 1 (17) from the turbine assembly. It may be necessary to tap the screws with a hammer and chisel to loosen.

Remove o-ring (19) from aft end of turbine housing.

Remove the seal spacer (15) from the forward side of nozzle 2 (11). Place the stage 2 nozzle on the exhaust end. Press through the forward lip seal onto the bearing until it, including the aft lip seal and seal spacer disengages from the nozzle. Turn the nozzle over and press on the forward lip seal to remove.

SECTION 4.0 CLEANING and INSPECTION

4.1 CLEANING

Degrease all metal parts, except bearings, using a commercially approved solvent. Refer to *Table 2.*

Clean aluminum parts using the solutions per *Table 2*; soak for 5 minutes. Remove parts, rinse in hot water, and dry thoroughly.

Clean corroded steel parts with a commercially approved stripper.

Clean corroded aluminum parts by cleaning as stated above and then immerse the parts in chromic-nitric-phosphoric acid pickle solution per *Table 2*. Rinse in hot water and dry thoroughly.

MATERIAL or COMPOUND	MANUFACTURER
Degreasing Solvent	Commercially Available
Acetone	Commercially Available
Aluminum Cleaning Solution	Diversey Corp., 212 W. Monroe, Chicago, IL 60606 Dissolve 5 oz of Diversey 808 per gallon of water at 155°- 165°F.
Steel Cleaner - Rust & Corrosion	Oakite Products Corp., 50 Valley Rd., Berkeley Heights, NJ 07992 Mix 3-5 lb. of Oakite rust Stripper per gallon of water; use at 160°- 180°F.
Chromic-Nitric-Phosphoric Acid Pickle Solution	Mix 8lb. of chromic acid, 1.9 gal. of phosphoric acid, 1.5 gal. of nitric acid with enough water to make a total of 10 gal. of solution.
WARNING Follow all instructions provided with the MSDS sheets on the materials and compounds listed above.	

Table 2. Cleaning Materials and Compounds

4.2 INSPECTION

Use *Table 3* as a guide to check for acceptable condition of the parts listed.

Check all threaded parts for galled, crossed stripped, or broken threads.

Check all parts for cracks, corrosion, distortion, scoring, or general damage.

Check all bearing bores for wear and scoring. Bearing bores shall be free of scoring lines, not to exceed 0.005″ width and 0.005″ depth.

Check gear teeth and turbine housing ring gear for wear. In general, visually check for spalling, fretting, surface flaking, chipping, splitting, and corrosion. If wear is apparent, check the gear teeth dimensions in accordance with *Table 4*. Nicks and dents that cannot be felt with a .020 inch radius scribe are acceptable.

Part Description	Check For	Requirements (Defective Parts Must Be Replaced)
Pinion	Chipped Teeth, Cracks	Defective unit to be replaced. Use figure 5 as a guideline for acceptable pinion wear.
Drive Housing	Cracks and breakage	Cracks are not acceptable
Planet Gear	Cracked, chipped, or galled teeth. Wear must not exceed limits per Table 4.	Wear must not exceed limits per table 4. There shall be no evidence of excessive wear.
Carrier Shaft	Cracks, scoring or raised metal in planet shaft holes and keyways. Integrity of knurl connection.	Deformation of metal smearing in planet pin holes & keyways not acceptable. Scoring on bearing diameter not to exceed .005″ depth. Wear must not exceed limits per Table 4.
Planet Pins	Wear grooves or flat spots	Wear grooves in flat spots not permitted. Wear must not exceed limits per Table 4.
Washers	Wear created grooves	Wear must not exceed limits per Table 4.
Gearbox Housing	Cracks and Breakage	Cracks and breakage not acceptable.
Sungear / Turbine Shaft	Cracks, scoring, wear created grooves, chipped or broken gear- teeth, galling or scoring on bearing surface of shaft. Raised metal on the keyway.	Wear must not exceed limits per Table 4.
Spacers	Parallelism of end surfaces	Ends must be parallel within 0.0005″.
Turbine Housing Ring Gear	Cracks and breakage Cracks, wear, chipped, or broken gear teeth.	Cracks and breakage are not acceptable. Minor surface damage is permitted if function is not impaired. Wear must not exceed limits per Table 4.
Seal Assembly	Wear grooves or scratched surfaces on carbon ring.	Wear is not permitted.
Seal Spacer	Wear Grooves	No wear permitted.
Needle Bearings	Freedom of needle rollers	Replace bearings
Ball bearings	Freedom of rotation without excessive play between races	Replace bearings
Containment Ring/ Nozzle	Corrosion, erosion, cracks and broken nozzle edges.	Cracks and breakage are not acceptable. Minor surface damage is permitted if function is not impaired.
Turbine Rotors	Corrosion, erosion, cracks and broken edges. Tip wear; bore and key way wear	Minor tip rub is permitted if function is not impaired. Wear is not permitted.

Table 3. Parts Inspection Check Requirements

PART DESCRIPTION	LIMIT, Inches
Ring gear / Turbine Housing Internal measurement between two .084″ diameter pins.	5.0890 max.
Sun Gear / Turbine Shaft Bearing diameter External measurement over two .096 diameter pins. 7.5:1 9:1 11.4:1	0.6690 min 0.952 min 0.808 min 0.670 min
Planet Gear External measurement over two .0864″ diameter pins. 7.5:1 9:1 11.4:1	 2.3067 min 2.3699 min 2.4359 min
Carrier Shaft Bearing Diameter Planet Pin Bore	 1.1800 min 0.8750 max
Planet Pins Bearing Diameter	 0.873 min
Thrust Washer Thickness	 .055 min

Table 4. Parts Wear Limits

SECTION 5.0 ASSEMBLY

5.1 GENERAL

The tools listed in *Table 1* are suggested for use by technicians servicing the T100-V starters. The best results can be expected when the proper tools are used, however, use of other tools is acceptable.

CAUTION

Replace all screws , O-rings, lip seals, and bearings when the T100-V starter is reassembled. These parts are included in the overhaul kit shown in Section 6.0

NOTE

Always press the inner race of a ball bearing when installing a bearing on a shaft. Always press the outer race of a ball bearing when installing into a housing.

Refer to Section 6.0, for a list of kits and components, which are available to aid in rebuilding T100-V starters.

Lubricate all O-rings with petroleum jelly or Parker-O-Ring Lube before assembly. Refer to *Table 5* for a list of materials to be use during assembly.

MATERIALS	SOURCE
Petroleum Jelly	Commercially Available
Parker-O-Ring Lube	Commercially Available
Loctite RC290	Commercially Available
Grease, gearbox	TDI P/N 9-94121-001

Table 5. Materials for Assembly

CAUTION

The screws that secure the Containment Ring/ Stage 2 Nozzle must have a drop of Loctite RC290 applied to the threads before being used.

5.2 TURBINE HOUSING

5.2.1 Turbine Shaft Installation

Press the bearing (8) onto the shaft (30) until seated. Support the shaft and press on the inner race only with press tool P/N 2-26943.

Press the bearing/shaft assembly (8, 30), keyway end first, into bearing housing of the turbine housing (23). Use press tool P/N 2-26943 if required. *D*o not press on the end of the shaft because the load could damage the balls of the bearing.

Install bearing retainer plate (29) and secure with four screws (16). Torque screws to 40 in-lbs.

Place turbine housing with sun gear end down on a flat surface, while using ring gear to support turbine housing. Install long bearing space (28) and seal spacer (7) over shaft.

Install the O-ring (19) into the aft face of the turbine housing (23).

5.2.2 Nozzle 1 Installation

Press the aft seal (15) into nozzle 1 (19) using press tool P/N 2-26943 per *Figure ?* with the lips facing up.

Install nozzle 1 onto the turbine housing (23). Orient the nozzles facing the air inlet (21) and install four screws (16) to secure the nozzle. Do not tighten the screws at this time.

NOTE

The rotation of the turbine assembly is opposite from the pinion rotation, therefore this nozzle must be configured for LH (CCW) if the pinion rotation is RH (CCW), or configured for RH (CW) if pinion rotation is LH (CCW).

5.2.3 Rotor 1 Installation

Install the large woodruff key (14) for stage 1 rotor into the turbine shaft (30).

Install the stage 1 rotor (13), while supporting sun gear end of shaft, onto the turbine shaft by aligning the slot in the rotor with the woodruff key and hand press the rotor until firmly seated. Use press tool P/N 2-26943 if required.

Visually inspect that the key was not pushed out during assembly. Note that the direction of rotation was oriented properly. This turbine rotor can be installed backwards.

Install spacer (7) onto sun gear (30).

To center nozzle 1, temporarily install Nozzle 2 (11) on the turbine housing and tighten the four screws that secure nozzle 1 (17) to 30 in-lb. The four screws can be accessed via the holes in nozzle 2 and the first stage turbine rotor. Remove Nozzle 2 when the four screws are tight.

5.2.4 Nozzle 2 Installation

Install the O-ring (9) into the bearing bore of nozzle 2 (11). DO NOT LUBRICATE THIS O-RING.

Install O-ring (12) onto the outer diameter of nozzle 2 and install nozzle 2 (11) onto the turbine housing (23).

NOTE

The rotation of the turbine assembly is opposite from the pinion rotation, therefore this nozzle must be configured for LH (CCW) rotation if the pinion rotation is RH (CW), or configured for RH (CW) if pinion rotation is LH (CCW).

Install the seal spacer (7) onto the shaft and the wavy spring washer (10) into the bearing bore of the stage 2 nozzle.

While supporting the sun gear end of the shaft, press the aft bearing (8) onto the shaft by pressing onto the inner and outer race simultaneously. Use press tool 2-26943 per *Figure ?*. Press until bearing is seated.

Install the stage 2 woodruff key (6) into the shaft (30).

5.2.4 Stage 2 Rotor Installation

Install the stage 2 rotor (5) onto the shaft. Use press tool P/N 2-26943 if required. Visually inspect that the key was not pushed out during assembly. Note that the direction of rotation was oriented properly. This turbine can be installed backwards.

Install the rotor washer (4) and secure with screws (3). Tighten screw to 100 in-lb.

Install the exhaust screen (2) and secure with six screws (1). Tighten the screws to 80 in-lb.

5.2.5 Air Inlet Installation

Place the O-ring (22) into the groove on the air inlet (21).

Install the 2″ NPT air inlet flange (21) and secure with six screws (20). Tighten the six screws to 170 in-lb.

5.3 GEARBOX HOUSING

5.3.1 Planetary Gear Carrier Reassembly

Press needle bearing (35) into planet gears (34). The planet gears are not identified by part number,

therefore, dimensionally check if correct gears are being used. Use table 4 for over the wire measurements.

With a thrust washer (33) on each side of gear, slide gear into carrier shaft slots (32), and align with pin holes.

Lightly slide plant shafts into aligned holes, making sure retainer ring groove on end of pins goes in first.

NOTE

Make sure that anti-rotation pins on shafts are properly located in retaining slots of carrier shaft (32).

Install retainer ring (31) onto planet shaft (36) using a retainer ring tool. See figure ?

5.3.2 Gearbox Reassembly

Install bearing (38) into the bearing housing (43) and secure with retaining ring (41).

Press aft bearing (38) onto carrier shaft (32) using TDI Tool P/N 52-20143 per *Figure ?* Pressing force should be on the inner race of bearing.

Install spring washer (39), spring retaining plate (40) and bearing spacer (42) onto shaft and locate against bearing.

Position bearing housing assembly (38,41,43) over carrier shaft (32) and press until firmly seated.

Install woodruff key (37) into slot on carrier shaft (32) and install spur gear (45) on carrier shaft aligning slot on gear with woodruff key.

Place bearing housing assembly on carrier shaft holding tool P/N 2-20202 per *Figure ?*. Install lockwasher (46) and retainer nut (47). Torque to 90-100 ft.lb. Tang lock washer into retainer nut slot.

Place O-ring (12) onto outer diameter of gearbox housing (48).

Install carrier shaft assembly into aft side of gearbox housing (48) and secure with four screws (44). Torque to 113 in-lbs.

5.4 DRIVE HOUSING

5.4.1 Drive Reassembly

Install bearing (69) into forward end of spur gear shaft (65) and secure with retaining ring (70).

Press bearing (66) onto spur gear shaft (65) and secure with retaining ring (67) as shown in figure ?.

Press bearing (68) into drive housing (72) until seated firmly into housing.

Press lip seal (75) into forward end of drive housing (72) and install O-ring into O-ring groove on drive housing.

Install spur gear assembly (65-67) into gearbox drive housing (72) until firmly seated.

Install bearing (55) onto aft end of drive shaft assembly (56-61) and secure with retaining ring (54). Lubricate drive shaft assembly using TDI grease P/N: 9-94121-002.

Lubricate inner diameter of spur gear assembly (65) using TDI grease P/N: 9-94121-002.

Install spacer (62), spring (64), and pinion spacer (76) onto pinion drive shaft assembly (56-61) then install into aft end of spur gear (65). The gears on helical shaft (56) must be aligned into the aft end of the spur gear shaft (65).

Press the helical shaft assembly into the spur gear shaft (65) until end of shaft protrudes from forward end of drive housing as shown in figure ?

Maintain pressing force and install pinion onto drive shaft (61). Secure with screw (79). Torque to 60 ft. lb.

Install spacer between pinion (79) and drive housing (72) before releasing pressure from helical shaft.

5.5 FINAL ASSEMBLY

Place turbine assembly (23) with aft end on a flat surface and install ring gear. Ensure notches on ring gear are aligned with screw positions on turbine housing.

Thoroughly grease planet gears (34), ring gear (27), sun gear (30), spur gears (45, 65) using TDI grease P/N: 9-94121-002.

Rotate carrier shaft (35) slightly, and at the same time, align gearbox into the front of turbine housing (26).

Install six gearbox to turbine assembly screws (25) and torque 113 in-lbs.

Install drive assembly (72) onto gearbox assembly (48) and secure with eight screws (73). Torque to 113 in. lbs.

SECTION 6.0 PARTS LIST

The components illustrated and/or described in this section are for the Turbotwin T100-V air starters. When rebuilding a T100-V starter, it is recommended to purchase, and completely install the appropriate service kit(s).

ILLUSTRATED PARTS LIST FOR MODEL T100-V SERIIES AIR STARTERS

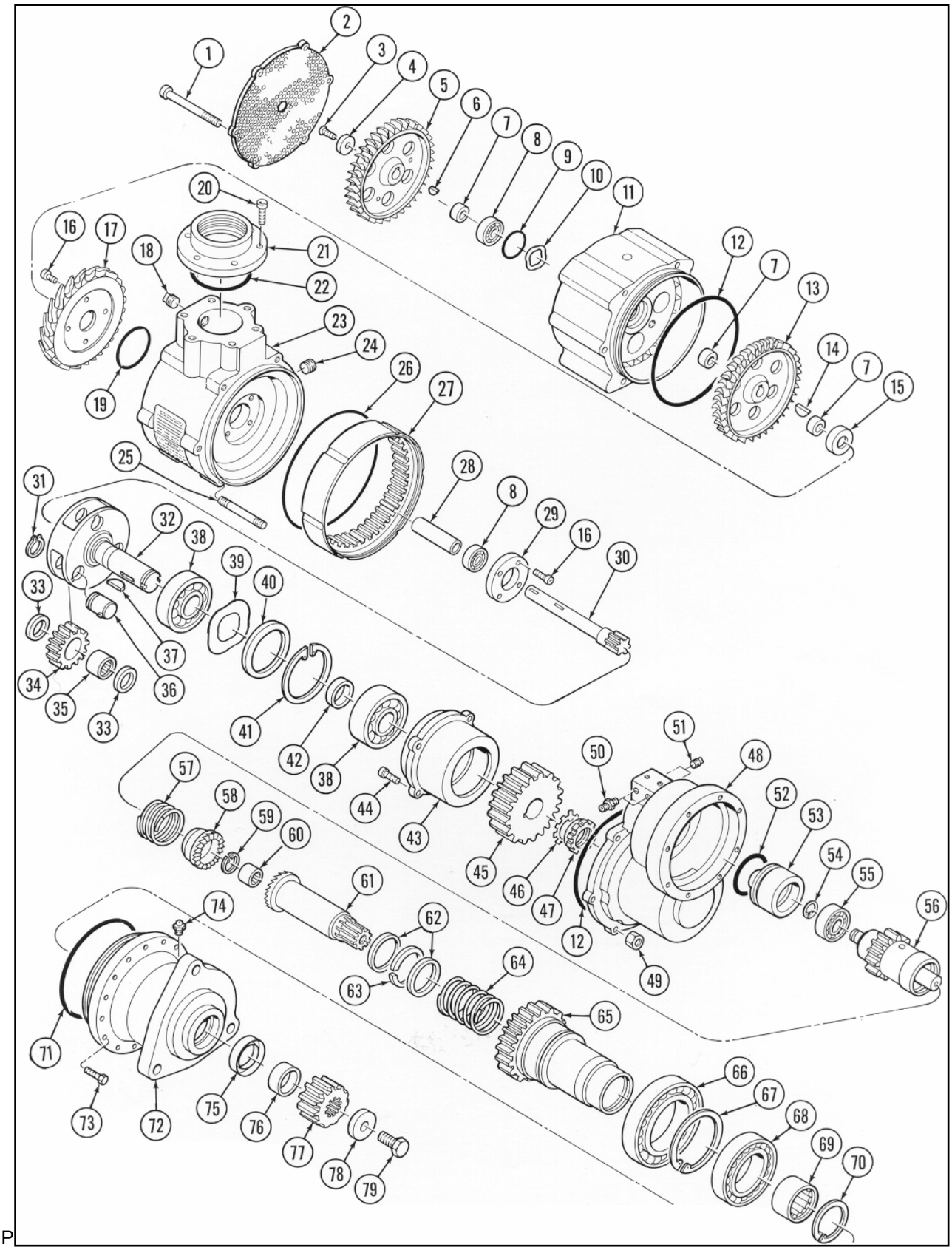
KEY NO.	DESCRIPTION	PART NUMBER	OVERHAUL KIT P/N: T10V-28574
1	Screw (6)	11F- 25020-064	x
2	Exhaust Guard	2-28175	
3	Screw	19F- 25028-012	x
4	Washer	9-93047	x
5	Rotor 2 (See Note)	2-26604	
6	Woodruff Key	9-90211-006	x
7	Bearing Spacer (3)	9-93091-005	x
8	Bearing (2)	9-91224	x
9	O-ring (1)	9-90001-027	x
10	Wave Spring Washer	9-90439	x
11i	Nozzle 2/Containment Ring R.H. (See Note)	2-27825-00R	
11ii	Nozzle 2/Containment Ring L.H. (See Note)	2-27825-00L	
12	O-ring (2)	9-90001-050	x
13	Rotor 1(See Note)	2-26603	
14	Woodruff Key	9-90211-009	
15	Lip Seal	2-22376	x
16	Screw (8)	14F-19024-008	x

KEY NO.	DESCRIPTION	PART NUMBER	OVERHAUL KIT P/N: T10V-28574
17i	Nozzle 1, R.H., 9 Nozzles (See Note)	2-26718-09R	
17ii	Nozzle 1, L.H., 9 Nozzles (See Note)	2-26718-09L	
17iii	Nozzle 1, R.H., 12 Nozzles (See Note)	2-26718-12R	
17iv	Nozzle 1, L.H., 12 Nozzles (See Note)	2-26718-12L	
17v	Nozzle 1, R.H., 15 Nozzles (See Note)	2-26718-15R	
17vi	Nozzle 1, L.H., 15 Nozzles (See Note)	2-26718-15L	
17vii	Nozzle 1, R.H., 21 Nozzles (See Note)	2-26718-21R	
17viii	Nozzle 1, L.H., 21 Nozzles (See Note)	2-26718-21L	
18	Pipe Plug	9-93556-004	
19	O-ring	9-90001-034	x
20	Screw (6)	14F-31218-016	x
21	Inlet Flange	1-18967	
22	O-ring	9-90001-037	x
23	Turbine Housing	2-27869	
24	Pipe Plug	9-93501-004	
25	Screw (6)	71F-25020-036	x
26	O-Ring	9-90001-050	x
27	Ring Gear	2-27870	
28	Bearing Spacer	9-93091-001	
29	Clamping Plate	2-26750	
30	Turbine Shaft	2-27238	
31	Retainer Ring (3)	9-92001-001	

KEY NO.	DESCRIPTION	PART NUMBER	OVERHAUL KIT P/N: T10V-28574
32	Carrier Shaft (9:1)	2-27798-001	
33	Spacer, Gear (6)	9-93004	
34	Planet Gear (3)	1-18779	
35	Needle Roller Bearing (3)	9-91004-001	x
36	Planet Shaft (3)	2P-20182	
37	Woodruff Key	9-90227-025	
38	Bearing (2)	9-91003	x
39	Wave Spring Washer	9-90402-025	
40	Spring Retaining Plate	2-27731	
41	Retaining Ring	9-92001-033	
42	Bearing Spacer	9-93007-003	
43	Housing, Bearing	2-27226	
44	Screw (4)	14F-25020-012	x
45	Gear, Spur	2-27712	
46	Lockwasher, Bearing	9-93061-007	
47	Locknut, Bearing	9-92127-007	
48	Housing, Gearbox	2-27728	
49	Locknut (6)	9-92134-001	
50	Fitting, Filter	2-28270	
51	Plug, Pipe (2)	9-93556-004	
52	O-Ring, Piston	9-90001-327	x
53	Piston	2-27921	
54	Retainer Ring	9-92001-041	
55	Bearing	9-91254	x
56i	Spline, Helical Shaft, R.H. (See Note 1)	2-27977-00R	
56ii	Spline, Helical Shaft, L.H. (See Note 1)	2-27977-00L	

KEY NO.	DESCRIPTION	PART NUMBER	OVERHAUL KIT P/N: T10V-28574
57	Spring, Compression	9-90444	
58i	Clutch, Helical, R.H.	2-27713	
58ii	Clutch, Helical, L.H.	2-27716	
59	Ring, Retainer	9-92001-037	
60	Bearing, Needle Roller	9-91409	x
61i	Shaft, Drive Pinion R.H.	2-28169-001	
61ii	Shaft, Drive Pinion L.H.	2-28169-002	
62	Washer, Thrust	9-93120	x
63	Ring, Retainer	2-28051	
64	Spring, Compression	9-90447	
65	Gearshaft, Spur	2-27711	
66	Bearing, Ball	9-91431	x
67	Ring, Retaining	9-92001-036	
68	Bearing, Ball	9-91434	x
69	Bearing, Needle Roller	9-91435	x
70	Ring, Retainer	9-92001-042	
71	O-Ring	9-90001-158	x
72	Housing, SAE	2-27729	
73	Screw	71F-25020-016	x
74	Fitting, Vent	9-93662-012	
75	Seal, Lip	2-22084	x
76	Spacer, Pinion	2-28178	
77i	Pinion, R.H. 6/8P, 12T	2-28167-001	
77ii	Pinion, L.H. 6/8P, 12T	2-28167-002	
78	Washer, Pinion	9-93124	x
79	Screw	71F-50020-016	x

Note: The rotation of the turbine assembly is opposite from the pinion rotation, therefore the rotors and nozzles must be configured for LH (CCW) rotation if the pinion rotation is RH (CW), or configured for RH (CW) if pinion rotation is LH (CCW).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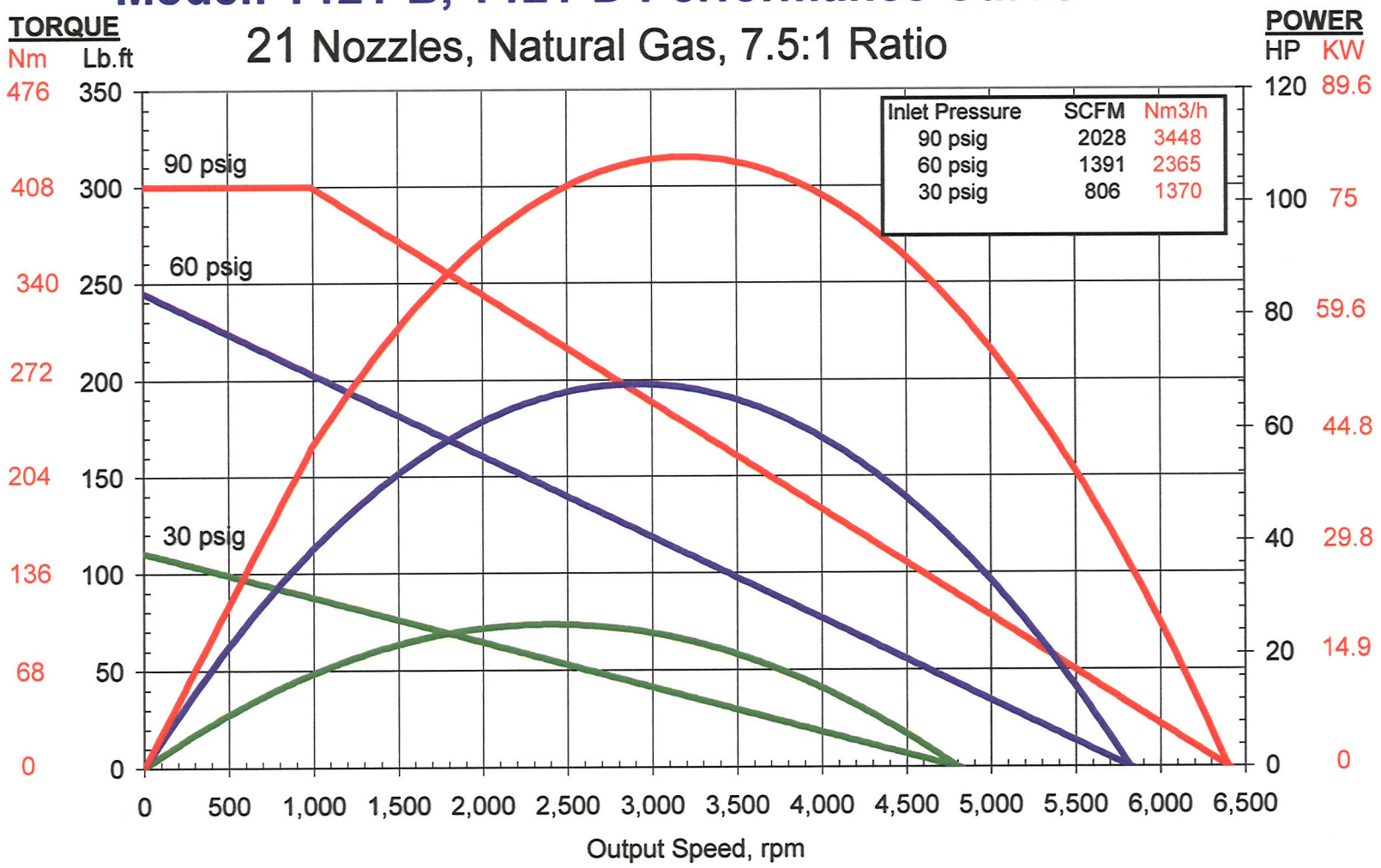
Model: T121-B, T121-D Performance Curve

21 Nozzles, Natural Gas, 7.5:1 Ratio



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MACHINE SUPPORT
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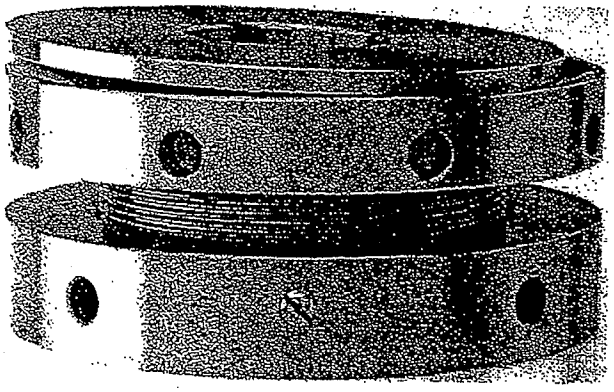
Procedure for installing Vibracon® SM elements



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4 Procedure for installing Vibracon® SM elements

Step 1 Check foundation quality

a) The bottom ring area of the Vibracon® SM element should be covered by the foundation for 100%. The spherical top part of the element must have at least 75% contact with machine foot.
b) Foundation roughness should be sandblasted quality of Sa 2.5 minimum or machined Ra 6.3
c) The contact surface between foundation and bottom ring of the Vibracon® SM element should be checked using the bottom ring of the element until a evenly distributed bearing surface of a minimum which is given by the machinery manufacturer or classification society. In all other cases we recommend a minimum bearing surface of 75 %.
d) The taper between foundation and machine feet should be less then 4°.
e) Foundation and machine foot should be clean from paint and grease.

Step 2 Check if the Vibracon® SM element thread and spherical layers are protected with Molycote® or other grease.

Step 3 Check if the Vibracon® SM element is placed concentric with the bolt-hole.

Step 4 Align the machine.

a) Keep in mind while aligning the machine to add 0,10 mm to the target alignment because of the fact that the Vibracon® SM elements will loose height at the moment the foundation bolts are secured. This will happen only the first time the element is used because of the grease inside of the thread.
b) Please remember: Vibracon® SM elements are not designed for lifting machinery!
c) Height differences after 1 cycle (pitch):

SM12	1 mm
SM16	1.5 mm
SM20 / SM42	2 mm
SM48 / SM64	3 mm

Step 5 Tighten the foundation bolts. We recommend to do this in two steps.

Step 6 During or after tightening of the foundation bolts recheck the alignment and check for "soft foot". A "soft foot" occurs if one or more of the Vibracon® SM elements are not carrying the same load as the other elements.

Step 7 After installing the machinery provide corrosion protection of the element by painting or alternative method.

Step 8 The bolt tension has to be checked after test run.

If you have any questions, please contact Machine Support.
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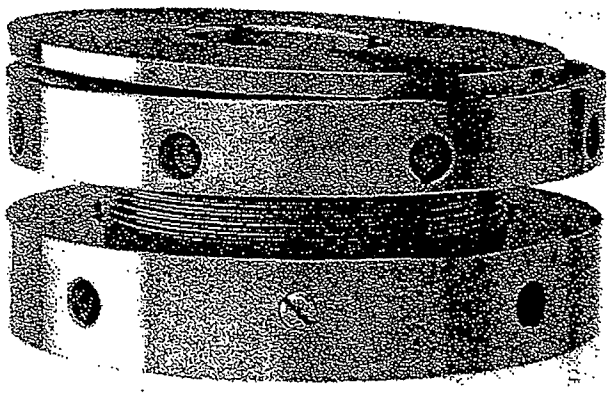
Application design instructions for Vibracon® SM elements



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Application design instructions

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3 Application design instructions

This chapter will give you a guideline to design applications with Vibracon® SM elements. The basic designs we are showing here are approved by most shipbuilding classification societies, if not we will indicate this.

Before starting to design an application with Vibracon® SM elements check with all involved parties (machine manufacturer, shipyard, owner, classification society) if they have approved on the use of the elements. Inform your local dealer or Machine Support if there are any objections against the use of the elements.

3.1 Choosing the element size

In general we advise you to follow the machine designers rules of foundation bolts. If for example an E-motor should be secured with M36 foundation bolts then just use SM36 Vibracon® SM elements. It is always possible to request a detailed calculation of the size of elements. Machine Support BV has special software for calculating the element size and bolt data.

For critical applications like propulsion units or large equipment (over 20 tons) we advise you to contact your local dealer or Machine Support for a detailed calculation and sound advise.

The method for determining the size of elements is based on the calculation of two forces:

$$F_{weight} = \frac{M \times 9.81}{n \times 1000} \qquad (1)$$

$$F_{torque} = \frac{P}{R \times W \times n} \times \frac{60000}{2 \times \pi} \qquad (2)$$

Where:
- F_{weight} = Force due to the weight of the machine (kN)
- F_{torque} = Force due to the reaction torque of the machine (kN)
- M = Mass (kg)
- n = Number of elements (use all bolt holes, unless machine manufacturer has given his approval to reduce the number of bolts).
- P = Power (kW)
- R = Revolutions (rpm)
- W = Width of foundation, measured between bolt holes (mm)

When the forces on the elements have to be calculated from a gearbox, the manufacturer of the gearbox has to submit the data of the maximum force on each element.

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If the gearbox manufacturer is not able to give these figures (mainly for small gearboxes) Machine Support can calculate these based on introducing a trust force factor.

The total machine load on the element is now:

$$F_{vibracon} = S \times (F_{weight} + F_{torque} + F_{trust}) \qquad (3)$$

Where S is a safety factor which is:

1.5 for non-reciprocating machinery like generators, E-motors and gearboxes.

2 for reciprocating machinery like diesel engines and reciprocating compressors.

After we have determined the machine load on the element it is possible to select a **minimum** size of Vibracon® SM element with the table on the Vibracon® SM general design table figure 6.2 of chapter 6.

> **Very Important:** If the size of the Vibracon® SM element is smaller than the corresponding size of the bolt which the manufacturer has determined, then please select the element that fits to this bolt size.

Be advised to check also the size of the element with the foot size and foot design of the machine.

(For a calculation example see chapter 9)

3.2 *Determining the bolt torque and length*

We advise to use 8.8 graded bolts, yield strength > 630 N/mm², in Vibracon® SM applications. The advised bolt torque can be found on with the table on the Vibracon® SM general design table figure 6.2 of chapter 6.

We advise to ensure that the foundation bolt has a minimum elongation of: **0.2 mm**

There are several alternatives to get enough elongation in the foundation bolt, the common used are mentioned below:

1. Creating enough clamping length by using an extension sleeve;
2. Reducing the shank diameter (contact your local dealer or Machine Support for a calculation of the elongation).

The clamping length is the total distance between bolt head and nut, this distance is equal to the sum of :

- Foundation thickness
- Final Vibracon® SM height
- Machine foot thickness
- Extension sleeve height

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We advise to use always at least one extension sleeve of which the final height will be determined after the alignment has been performed.

3.3 Designing a chocking arrangement

Herewith we give you some guidelines for designing a chocking arrangement with Vibracon® SM elements.

1. make sure that the bottom ring of the element is fully supported;
2. make sure that at least 75% of the top part of the element is covered by the foot of the machine;
3. use the nominal height as engineering height.

Figure 3.1 shows a typical application with a Vibracon® SM element.

3.4 Machining the foundation: Yes or No?

Before installing the elements on a foundation it should be checked for it's quality:

a) The bottom ring area of the Vibracon® SM element should be covered by the foundation for 100%. The spherical top part of the element must have at least 75% contact with machine foot.
b) Foundation roughness should be sandblasted quality of Sa 2.5 minimum or machined Ra 6.3
c) The contact surface between foundation and bottom ring of the Vibracon® SM element should be checked using the bottom ring of the element until a evenly distributed load bearing surface of a minimum which is given by the machinery manufacturer or classification society. In all other cases we recommend a minimum load bearing surface of 75%.
d) The taper between foundation and machine feet should be less then 4°.
e) Foundation and machine foot should be free from paint and grease.

3.5 Fitted bolts

The use of fitted bolts with Vibracon® SM elements can be done according to figure 3.2. It is up to the designer to decide if he wants to ream the elements also. We advise to ream the elements only in case there are thrust forces involved like in the situation of a gearbox. Machine Support can supply special elements with a smaller bolt hole diameter.

3.6 Dowel pins

Never fit a dowel pin in a Vibracon® SM element. You will not only influence it's adjustment capabilities but you can also influence it's load capacities. For examples of dowel pin installation with Vibracon® SM elements check figure 2.2.

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3.7 Reducing the height of the Vibracon® SM elements

It is possible to reduce the height of the elements but this will also reduce the adjustment capability. Don't exceed the min. reduced height as mentioned on the table on the Vibracon® SM general design table figure 6.2 of chapter 6. The centre part and bottom part of the element have to be machined, see figure 2.4.

3.8 Extending the height of the elements

It is also possible to order extended bottom parts for Vibracon® SM elements. The final height of the element should not exceed the diameter of the element, see figure 2.3.

3.9 Enlarging the bolt hole of the Vibracon® SM element

For this you always need approval from Machine Support and classification society. It is allowed to enlarge the bolt hole of the elements in accordance with the following table:

Type	Bolt	Enlarged bolt hole (mm)
SM12	M16	17
SM16	M20	21
SM20	M24	25
SM24	M30	31
SM30	M36	37
SM36	M42	43
SM42	M48	49
SM48	M56	57
SM56	M64	65
SM64	M72	73

Figure 2.5. Table for enlarged bolt holes

Please contact your local dealer or Machine Support to make a calculation of the bolt torque and the recommended clamping length.

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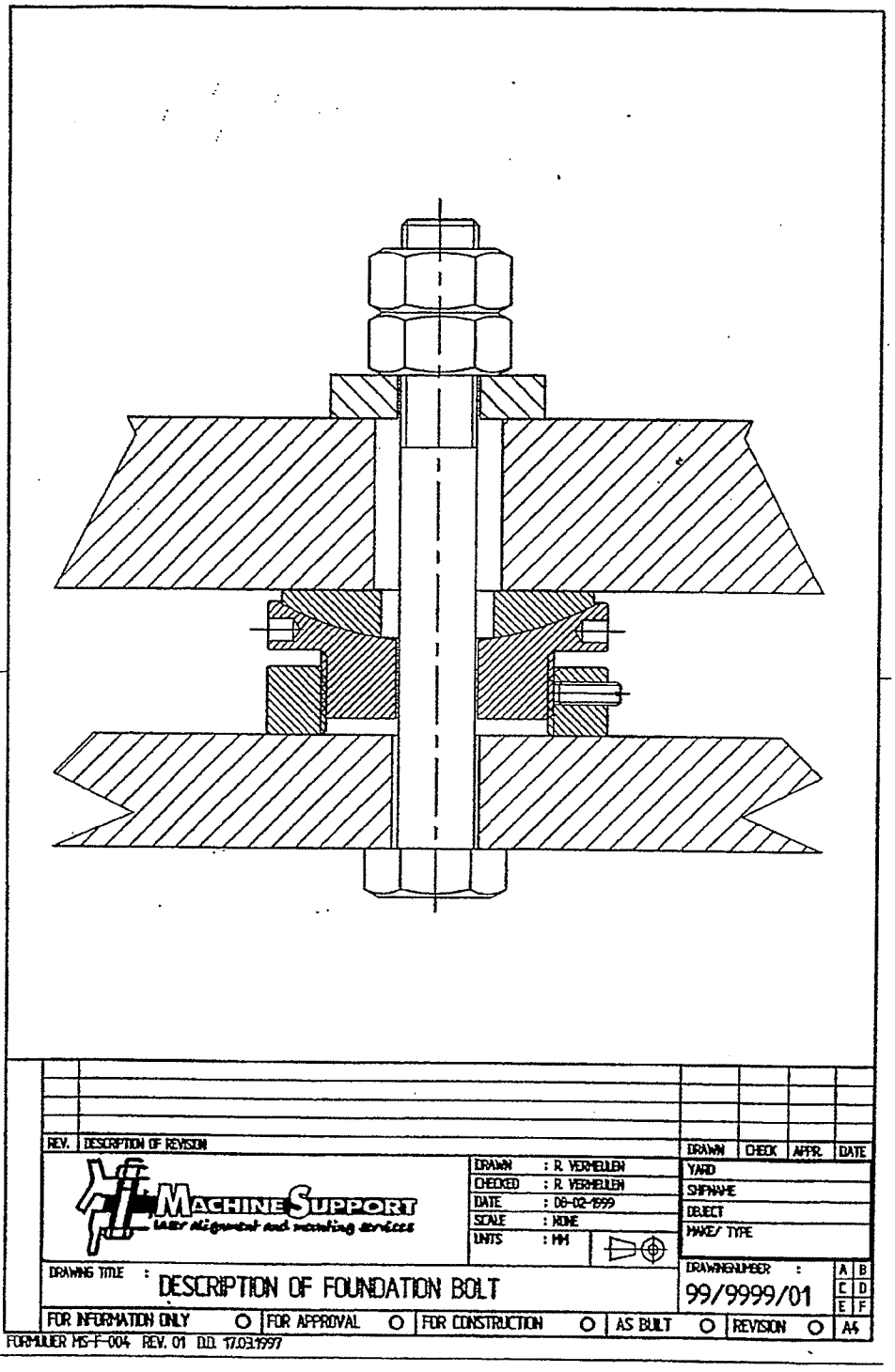

Figure 3.1 Description of foundation bolt

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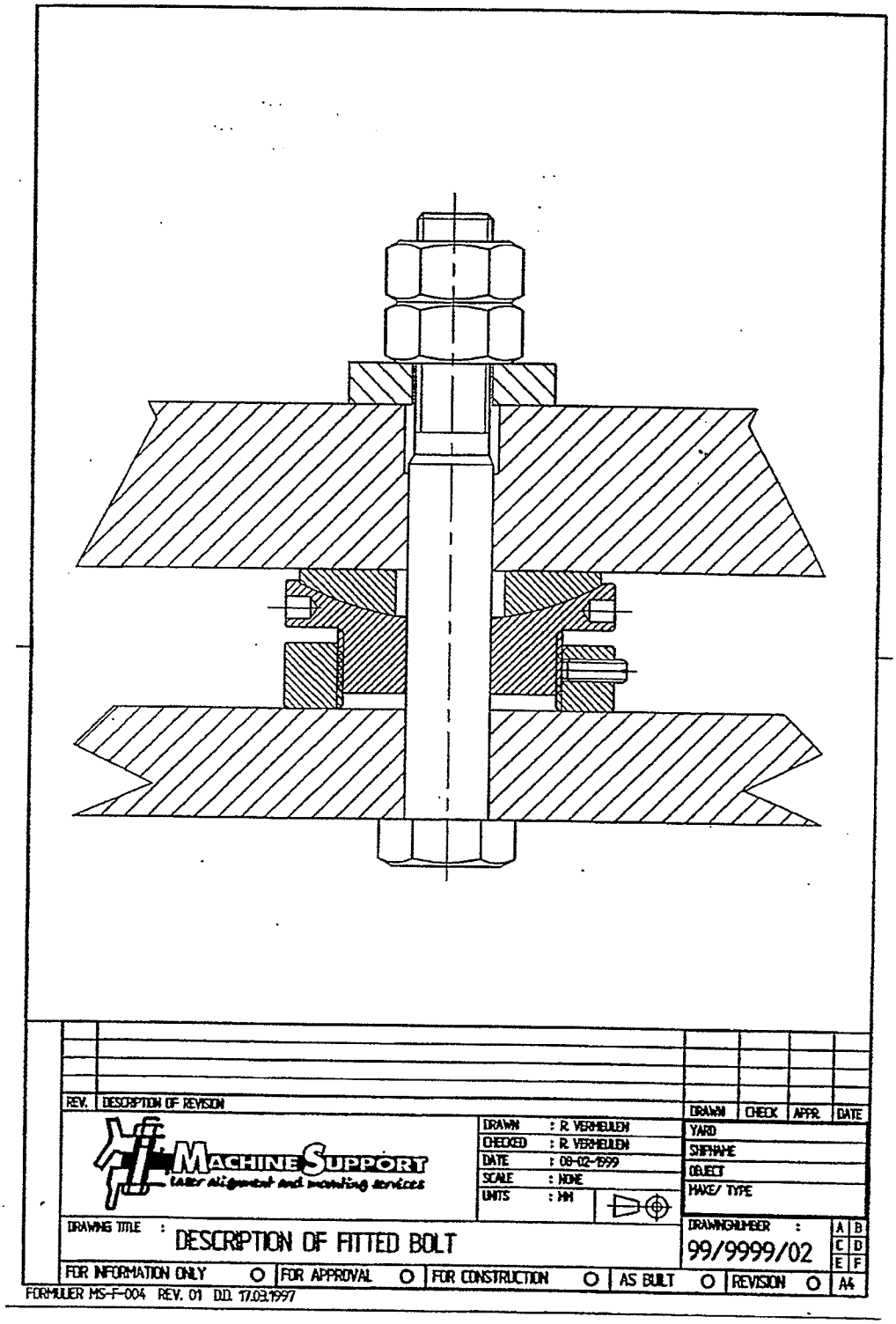
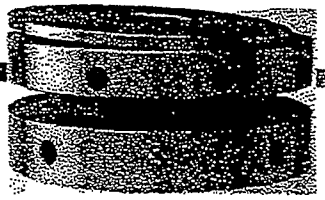


Figure 3.2 Description of fitted bolt

CANSTAR
Instruments Inc.



Hardy:
Vibration Transmitters & Monitoring

Hardy:
-Shaker Tables

BETEX®:
Induction Heaters

Laser Alignment Systems

BETEX®:
Hydraulic Bearing/Hub Pullers

Ringfeder® Couplings:
-rigid
-torsional soft
-flywheel

Ringfeder® Locking Devices:
-Internal
-Shring Discs®

Vibracon®:
-Adjustable Shims

Hardy:
Process weighing & Force Measurement

CANSTAR3000:
Condition Monitoring of rotating and reciprocating machinery:

On line data collection of overalls and spectral data

4 Procedure for installing Vibracon® SM elements

Step 1 Check foundation quality

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e) Foundation and machine foot should be clean from paint and grease.

Step 2 Check if the Vibracon® SM element thread and spherical layers are protected by Molycote® or other grease.

Step 3 Check if the Vibracon® SM element is placed concentric with the bolt-hole.

Step 4 Align the machine.

a) Keep in mind while aligning the machine to add 0,10 mm (0.004") to the target alignment because of the fact that the Vibracon® SM elements will loose height at the moment the foundation bolts are secured. This will happen only the first time the element is used because of the grease inside of the thread.
b) Please remember: Vibracon® SM elements are not designed for lifting machinery!
c) Height differences after 1 cycle (pitch):

SM12	1 mm (~0.040")
SM16	1.5 mm (~0.060")
SM20 / SM42	2 mm (~0.079")
SM48 / SM64	3 mm (~0.118")

Step 5 Tighten the foundation bolts. We recommend to do this in two steps.

Step 6 During or after tightening of the foundation bolts recheck the alignment and check for "soft foot". A "soft foot" occurs if one or more of the Vibracon® SM elements are not carrying the same load as the other elements.

Step 7 After installing the machinery provide corrosion protection of the element by painting or alternative method.

Step 8 The bolt tension has to be checked after test run.

Would you require additional information or have an questions, please call Canstar at 780-440-1362, or cell 780-910-1265

031126

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780-440-0373
nstarinstruments.com

WLD1800/1800R

Guided Float Type Liquid Drain Trap

Model	WLD1800, WLD1800R
Sizes	1/2", 3/4"
Connections	NPT
Body Material	Stainless Steel
PMO Max. Operating Pressure	400 PSIG
PMA	400 PSIG @ 500˚ F
TMA	500˚ F @ 400 PSIG

WLD1800
(Non-Repairable)

WLD1800R
(Repairable)

TYPICAL APPLICATION

The WLD1800 is used on industrial air and gas applications for drainage of liquid from systems.

HOW IT WORKS

This liquid drainer has a float-operated valve that gives the trap a modulating flow characteristic. The amount of liquid flowing into the drainer is sensed by the float which positions the main valve to discharge the liquid at the same rate as it is received.

FEATURES

- Stainless steel body
- All stainless steel internals for longer service life
- Guided float ensures proper valve seating on every cycle
- Repairable unit available (WLD1800R model)

SAMPLE SPECIFICATION

The liquid drain trap shall have a guided-float operation with a tamper proof seal welded stainless steel body and all stainless steel internals. The unit shall be available with an in-line repairable version. All units to be equipped with FNPT threaded end connections.

INSTALLATION

The installation should include isolation valves to facilitate maintenance and an in-line strainer. The trap must be level and upright for the float mechanism to operate. Trap must be sized and properly located in the system.

MAINTENANCE

Close isolation valves prior to any maintenance. The WLD1800 is a disposable unit, but with the WLD1800R all working components can be replaced. Repair kits include float, lever & seat assembly and gaskets. For full maintenance details see Installation and Maintenance Manual.

MATERIALS

Body	Stainless Steel, AISI 304
Inlet & Outlet Fittings	Stainless Steel, AISI 304
Float Assembly	Stainless Steel, AISI 304
Valve & Lever Assembly	Stainless Steel, AISI 303
Seat	Hardened Stainless Steel
*Gasket (Repairable only)	Grafoil
Washer, Seat	302 Stainless Steel
*Bolt, Hex, HD	Stainless Steel, AISI 316
*Nut, Jam	Stainless Steel, 18-8

** WLD1800R Repairable unit only*

HOW TO ORDER

Refer to the capacity chart to determine which model is required to satisfy the condensate load. Specify model, orifice and pipe size that meets the load requirement.

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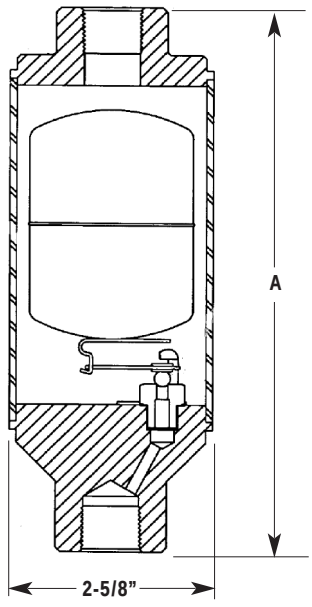
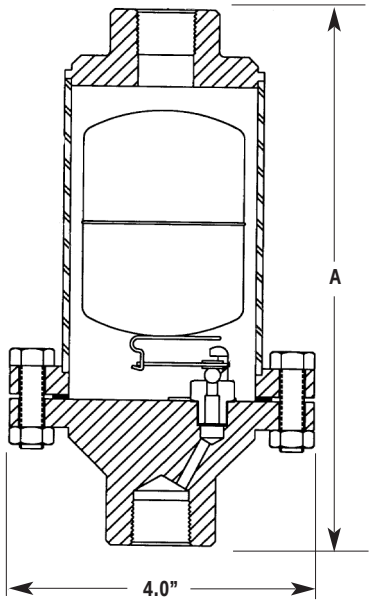
WLD1800/1800R

Guided Float Type Liquid Drain Trap



WLD1800
(Non-Repairable)



WLD1800R
(Repairable)

DIMENSIONS – *inches / pounds*

Model	Size (Inlet x Outlet)	A	Weight (lbs)
WLD1801	3/4” x 1/2”	7	4
WLD1801R	3/4” x 1/2”	7 3/8	4
WLD1802	3/4” x 3/4”	7	4
WLD1802R	3/4” x 3/4”	7 3/8	4
WLD1803	1/2” x 1/2”	7	4
WLD1803R	1/2” x 1/2”	7 3/8	4

COLD WATER CAPACITIES – *(lbs/hr)*

Model	Orifice	Differential Pressure (PSI) 1	2	5	10	15	20	30	50	100	150	175	200	250	275	300	350	400
WLD1800 SERIES	.078	60	80	120	130	180	260	315	400	570	700	750	800	900	940	1050	1050	1120
	#38	90	120	175	195	275	385	470	610	860	1050	1125	1200	1350	1425			
	.125	160	230	325	365	510	730	790	1150	1630	2000	2150						

CAPACITY CORRECTION FACTORS

Specific Gravity	1	.98	.96	.94	.92	.90	.88	.86	.84	.82	.80	.75	.70	.65	.60	.55	.50
Correction Factor	1	.99	.98	.97	.959	.949	.938	.927	.917	.906	.894	.866	.837	.806	.775	.742	.707

Note: To obtain capacity with a liquid other than water multiply water capacity by correction factor.