

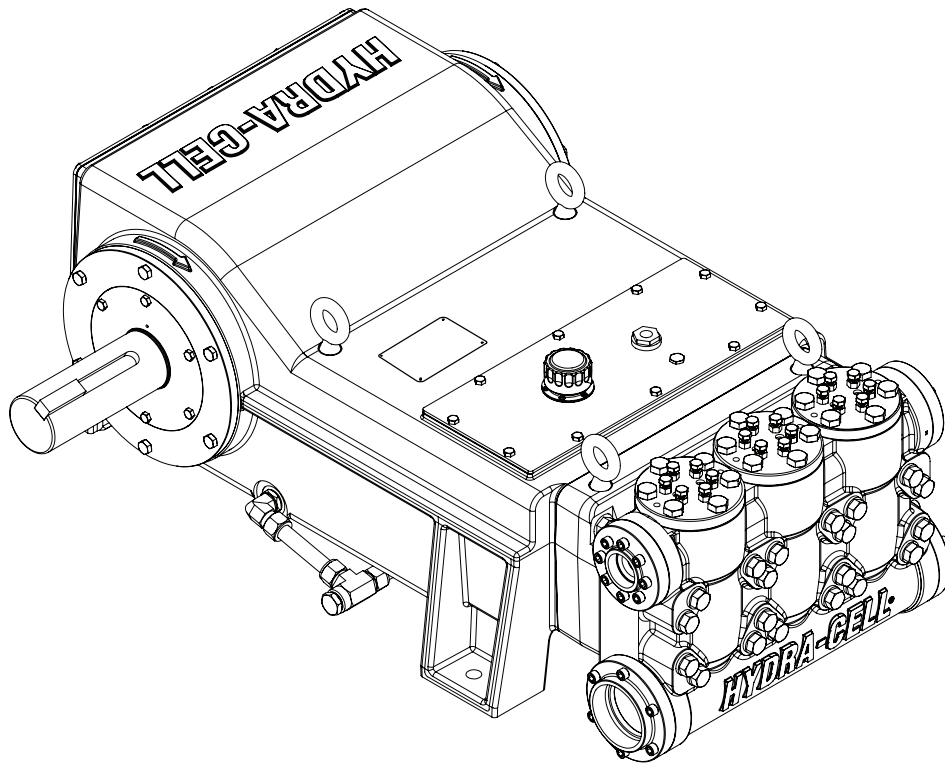
Installation, Operation & Maintenance
211-998 Rev A

Hydra-Cell[®]

Seal-less Pumps

T200 Series High Pressure

Models: T200P and T200Q



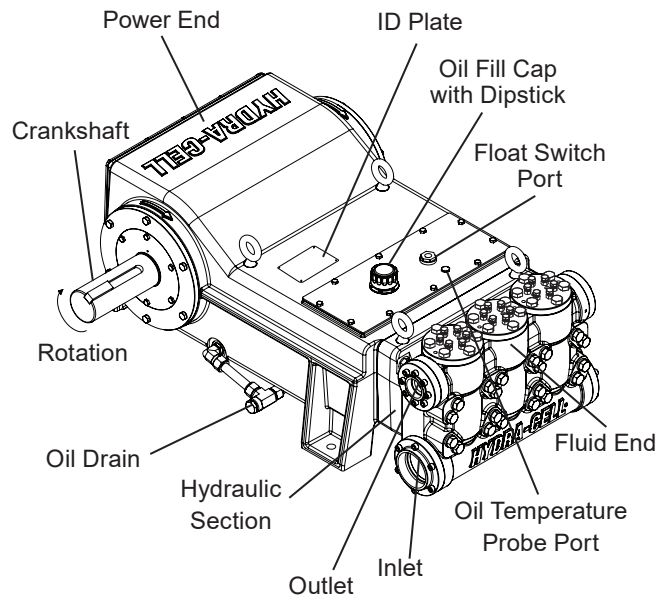
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T200 Series High Pressure - Contents

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Component Identification



T200 Series High Pressure - Specifications

Flow Capacities

| Model | Pressure psi (bar) | rpm | gpm | l/min | BPD |
|-------|--------------------|-----|------|-------|------|
| T200P | 4000 (276) | 400 | 72.0 | 272 | 2469 |
| T200Q | 4500 (310) | 400 | 63.0 | 238 | 2160 |

Delivery

| | Pressure psi (bar) | gal/rev | liters/rev |
|-------|--------------------|---------|------------|
| T200P | 500 (34) | 0.198 | 0.749 |
| | 2000 (138) | 0.193 | 0.731 |
| | 4000 (276) | 0.180 | 0.681 |
| T200Q | 500 (34) | 0.173 | 0.655 |
| | 2250 (155) | 0.168 | 0.636 |
| | 4500 (310) | 0.158 | 0.596 |

rpm

| | |
|------------------|-----|
| Maximum: | 400 |
| Maximum API 674: | 310 |
| Minimum: | 40 |

(Consult factory for speeds less than 40 rpm.)

Maximum Discharge Pressure

| | | |
|-----------------|-------|--------------------|
| Metallic Heads: | T200P | 4000 psi (276 bar) |
| | T200Q | 4500 psi (310 bar) |

Maximum Inlet Pressure 500 psi (34 bar)

Operating Temperature

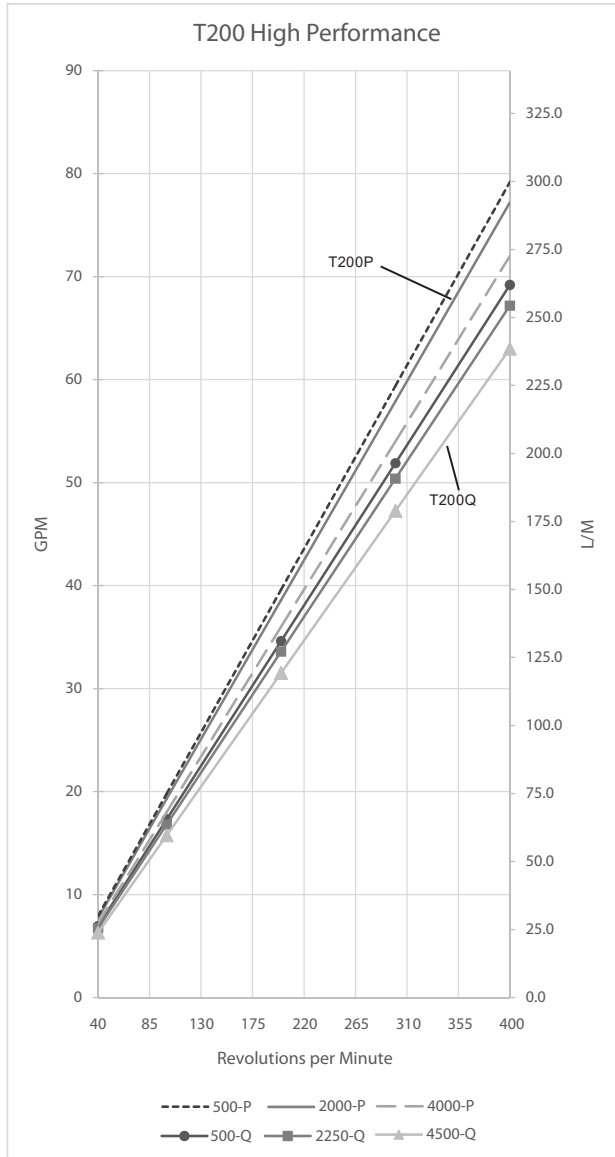
| | |
|----------|----------------|
| Maximum: | 180°F (82.2°C) |
| Minimum: | 40°F (4.4°C) |

(consult factory for temperatures outside this range)

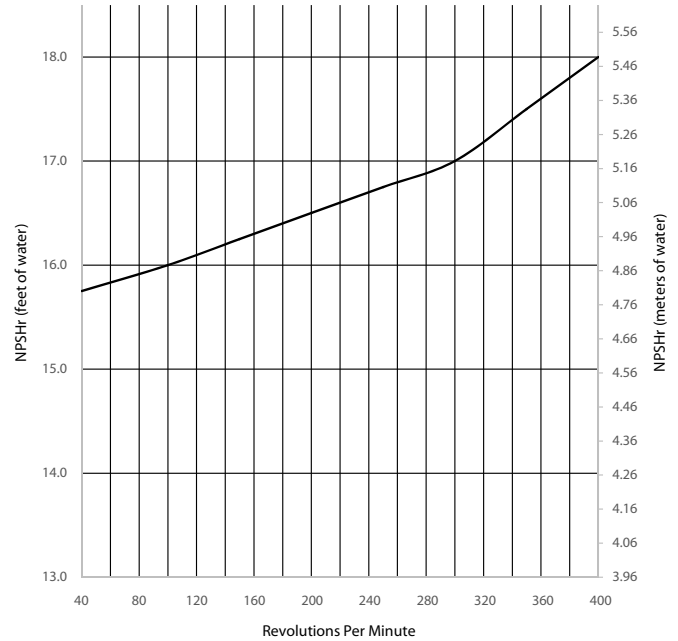
| | |
|------------------------------|--|
| Maximum Solids Size | 800 microns |
| Input Shaft | Right Side |
| Inlet Ports | Weld-On, 4 inch / SCH. 40 4 inch NPT, 4 inch Class 300 RF ANSI |
| Discharge Ports | Weld-On, 2 inch / SCH. 160 2 inch NPT, 2 inch Class 2500 RTJ ANSI |
| Plunger Stroke Length | 5 inches (127 mm) |
| Shaft Diameter | 4 inch (101.6 mm) |
| Shaft Rotation | Uni-directional (see rotation arrows) |
| Oil Capacity | 80 US quarts (75.7 liters) |
| Weight | |
| Metallic Heads: | 3000 lbs (1361 kg) |

T200 Series High - Specifications (Cont'd)

Performance



Net Positive Suction Head – NPSHr



Calculating Required Horsepower (kW)*

$$\frac{\text{gpm} \times \text{psi}}{1,460} = \text{electric motor HP}^*$$

$$\frac{\text{l/min} \times \text{bar}}{511} = \text{electric motor kW}^*$$

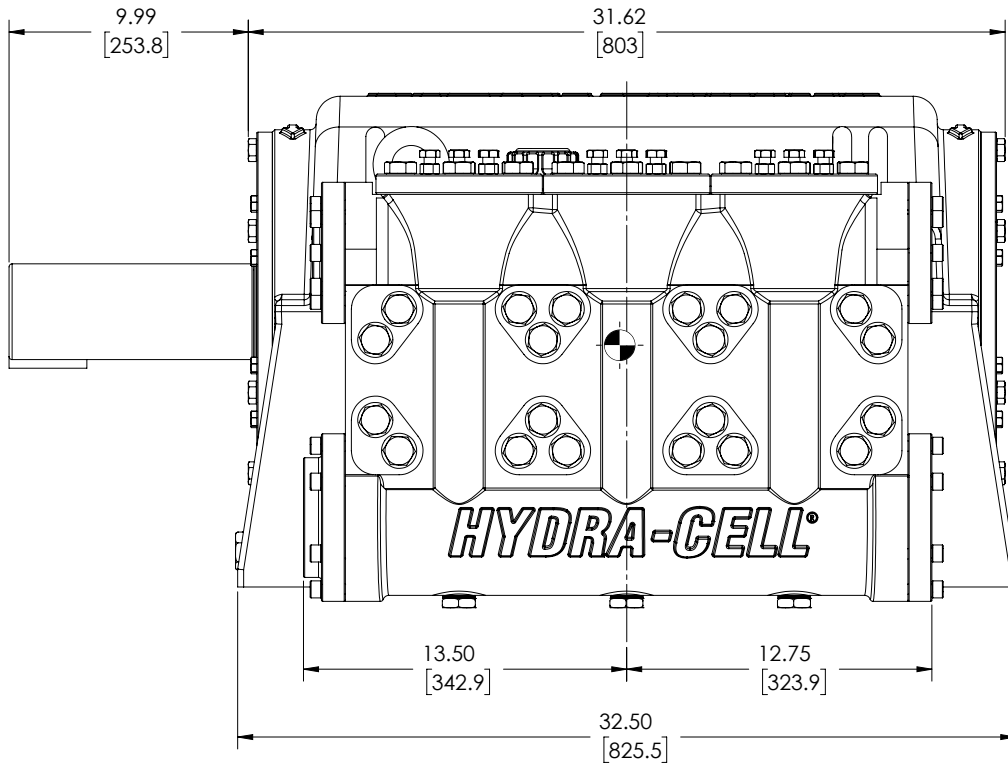
* HP/kW is required application power.

Attention!

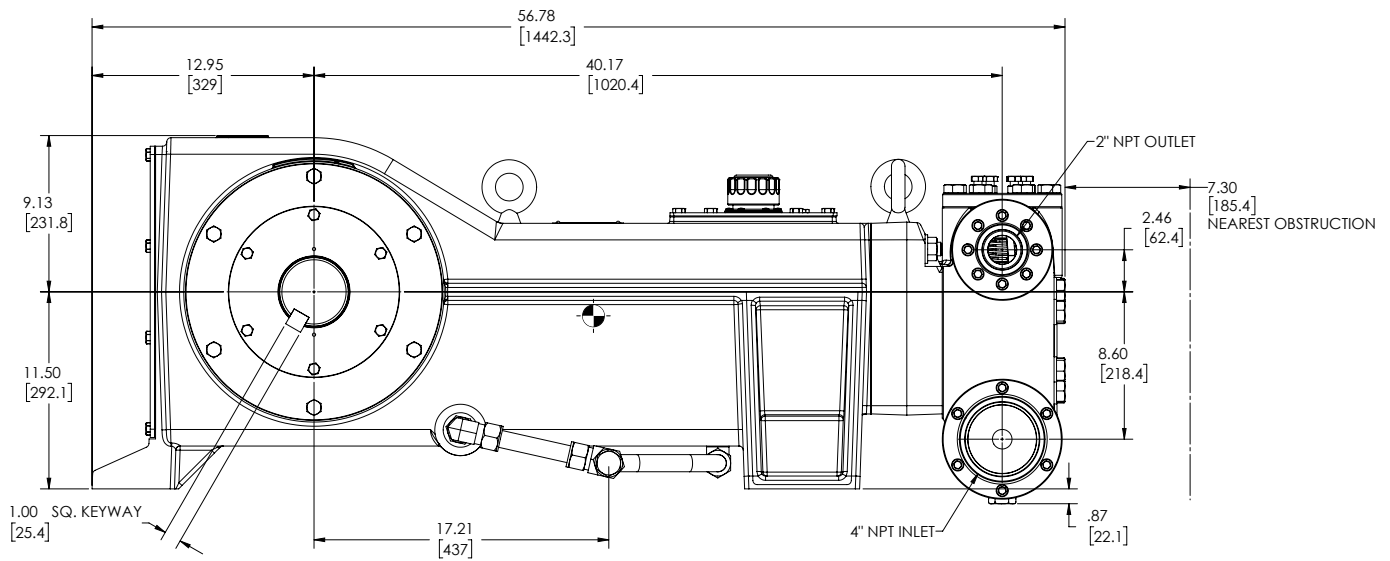
When sizing motors with variable speed drives (VFDs), it is very important to select a motor and a VFD rated for constant torque inverter duty service and that the motor is rated to meet the torque requirements of the pump throughout desired speed range.

T200 Series High Pressure - Representative Drawings

inches
(mm)

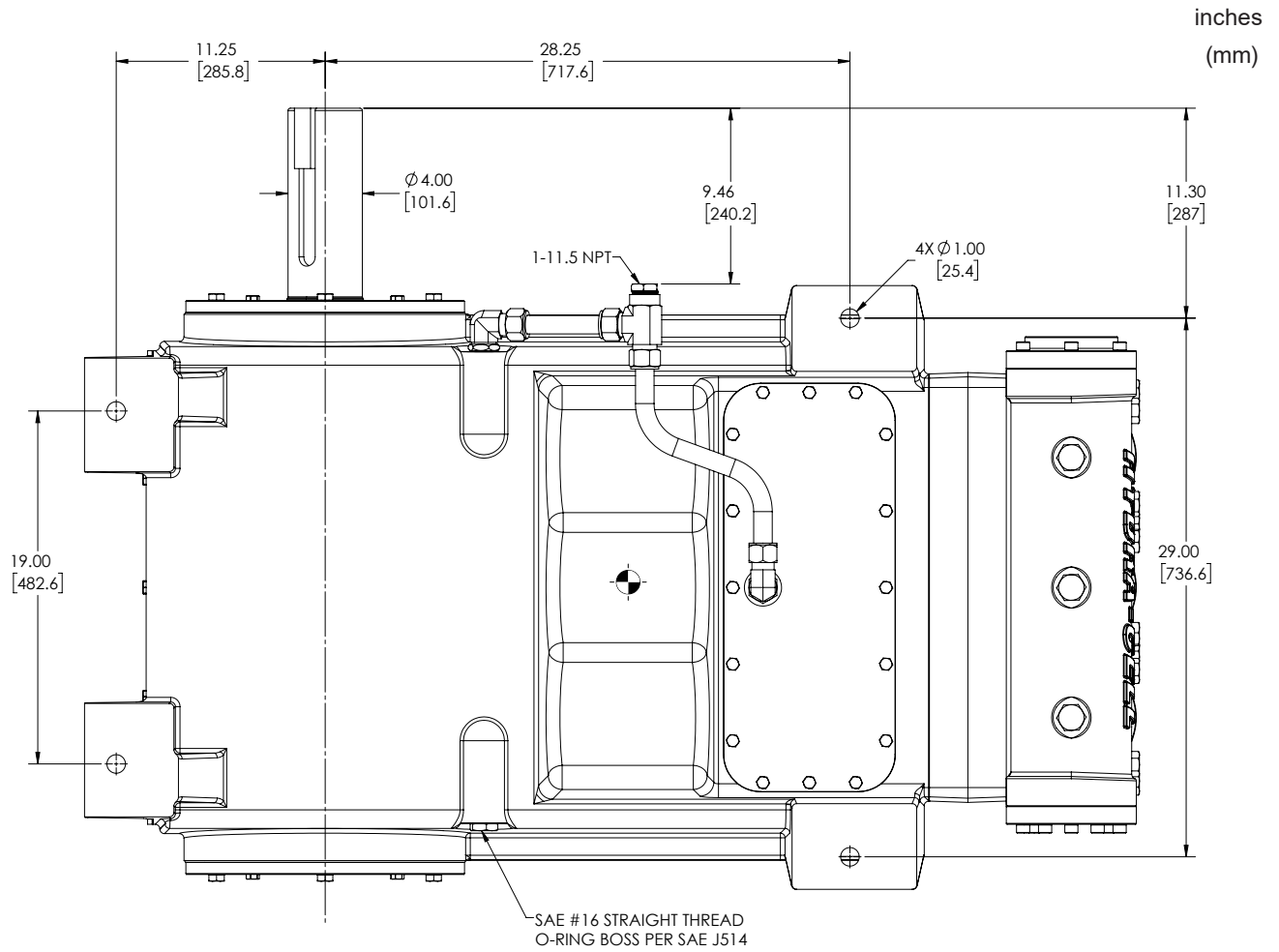


Front View



Side View

T200 Series High - Representative Drawings (Cont'd)



Bottom View

T200 Series High Pressure - Installation

Location

Locate the pump as close to the fluid supply source as possible.

Install it in a lighted clean space where it will be easy to inspect and maintain. Allow room for checking the oil level, changing the oil (drain plug on the side of pump), and removing the pump head components (inlet and discharge retainer plates, manifold, and related items). See side view representative drawing for required distance from nearest obstruction.

Rigging Information

Lift pump by attaching rigging to all four eyebolts (2). Adjust attachment lengths to keep pump level during lifting. **CAUTION: Eyebolts (2) are rated to lift the weight of the pump only. Also see center of mass references in the Representative Drawings Section.**

Mounting

CAUTION: The pump shaft rotation direction is indicated by arrows on the pump housing.

To prevent vibration, mount the pump and motor securely on a level rigid base.

On a belt-drive system, align the sheaves accurately; poor alignment wastes horsepower and shortens the belt and bearing life. Make sure the belts are properly tightened, as specified by the belt manufacturer.

On a direct-drive system, align the shafts accurately. Unless otherwise specified by the coupling manufacturer, maximum parallel misalignment should not exceed 0.015 in. (0.4 mm) and angular misalignment should be held to 1° maximum. Careful alignment extends life of the coupling, pump, shafts, and support bearings. Consult coupling manufacturer for exact alignment tolerances.

Important Precautions

Adequate Fluid Supply. To avoid cavitation and premature pump failure, be sure that the pump will have an adequate fluid supply and that the inlet line will not be obstructed. See "Inlet Piping" and consult NPSH chart.

Positive Displacement. This is a positive-displacement pump. Install a relief valve downstream from the pump. See "Discharge Piping".

Safety Guards. Install adequate safety guards over all pulleys, belts, and couplings. Follow all local codes and regulations regarding installation and operation of the pumping system.

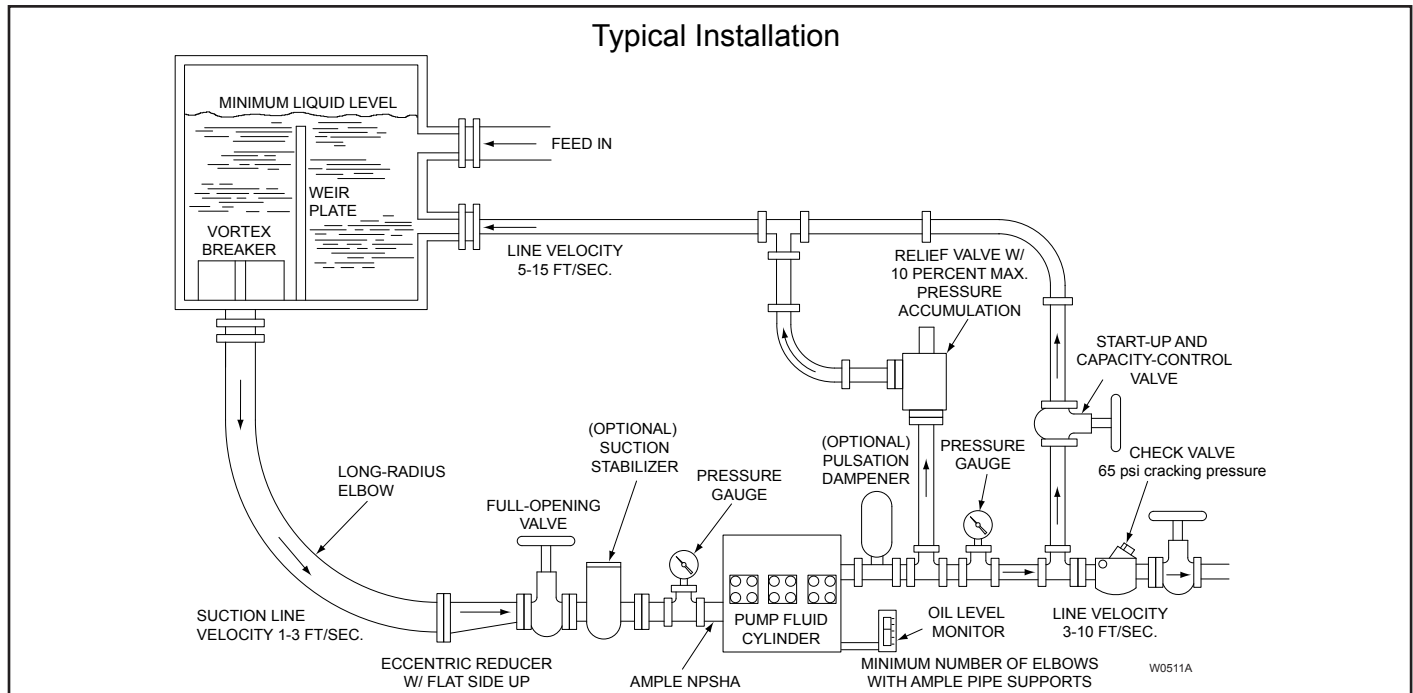
Shut-Off Valves. Never install shut-off valves between the pump and discharge pressure regulator, relief valve, or in the regulator bypass line.

Freezing Conditions. Protect the pump from freezing. See also the Maintenance Section.

Vacuum at Outlet. Do not allow a vacuum at the pump outlet during shutdown. A vacuum can damage the diaphragm at start-up. If there is a vacuum at the pump outlet, allow atmospheric pressure at the outlet for 30 minutes before starting. Wanner Engineering recommends installing an outlet check valve with a 65 psi (4.5 bar) cracking pressure to prevent a vacuum condition during shutdown.

Consult the Factory for the following situations:

- Fluid temperature applications – above 180° F (82° C) or below 40° F (4.4° C)
- Pressure feeding of pumps over 500 psig (34.5 bar)
- Viscous fluid applications above 100 Cps
- Chemical compatibility problems
- Hot ambient temperatures – above 110° F (43° C)
- Conditions where pump oil may exceed 200° F (93° C) because of a combination of hot ambient temperatures, hot fluid temperature, and full horsepower load — an oil cooler may be required
- Pump rpm less than 200



T200 Series High - Installation (Cont'd)

Accessories

Consult installation drawing on previous page for typical system components. Contact Wanner Engineering or the distributor in your area for more details.

Inlet Piping (Suction Feed)

Install drain cocks at any low points of the suction line, to permit draining in freezing conditions.

Provide for permanent or temporary installation of a vacuum gauge to monitor the inlet suction. To maintain maximum flow, NPSHA must exceed NPSHR (See chart in Specifications Section). **Do not supply more than one pump from the same inlet line if possible.**

Supply Tank

Use a supply tank that is large enough to provide time for any trapped air in the fluid to escape. The tank size should be at least five times the maximum pump flow rate (in gpm or lpm). *For example: at a maximum rate of 96 gpm, since trapped air takes five minutes to escape from water, $5 \times 96 = 480$ gallons for a recommended supply tank size.*

Isolate the pump and motor stand from the supply tank, and support them separately.

Install a separate inlet line from the supply tank to each pump.

Install the inlet and bypass lines so they empty into the supply tank below the lowest water level, on the opposite side of the baffle from the pump suction line.

If a line strainer is used in the system install it in the inlet line to the supply tank.

To reduce aeration and turbulence, install a completely submerged baffle plate to separate the incoming and outgoing liquids.

Install a vortex breaker in the supply tank, over the outlet port to the pump.

Place a cover over the supply tank, to prevent foreign objects from falling into it.

Hose and Routing

Size the suction line at least one size larger than the pump inlet, and so that the velocity will be 1-3 ft/sec (0.3 to 0.9 m/s):

For pipe in inches: Velocity (ft/sec) = $0.408 \times \text{GPM}/\text{Pipe ID}^2$

For pipe in mm: Velocity (m/sec) = $21.2 \times \text{LPM}/\text{Pipe ID}^2$

Keep the suction line as short and direct as possible.

Use flexible hose and/or expansion joints to absorb vibration, expansion, or contraction.

If possible, keep suction line level. Do not have any high points collecting vapor unless high points are vented.

To reduce turbulence and resistance, do not use 90° elbows. If turns are necessary in the suction line, use 45° elbows or arrange sweeping curves in the flexible inlet hose.

If a block valve is used, be sure it is fully opened so that the flow to the pump is not restricted. The opening should be at least the same diameter as the inlet plumbing ID.

Do not use a line strainer or filter in the suction line unless regular maintenance is assured. If used, choose a top loading basket. It should have a free-flow area of at least three times the free-flow area of the inlet.

Install piping supports where necessary to relieve strain on the inlet line and to minimize vibration.

Inlet Piping (Pressure Feed)

Provide for permanent or temporary installation of a vacuum/pressure gauge to monitor the inlet vacuum or pressure. Pressure at the pump inlet should not exceed 500 psi (34.5 bar); if it could get higher, install an inlet pressure reducing regulator. Do not supply more than one pump from the same inlet line.

Inlet Calculations

Acceleration Head

Calculating the Acceleration Head

Use the following formula to calculate acceleration head losses. Subtract this figure from the NPSHa, and compare the result to the NPSHR of the Hydra-Cell pump.

$$H_a = (L \times V \times N \times C) \div (K \times G)$$

where:

H_a = Acceleration head (ft of liquid)

L = Actual length of suction line (ft) — not equivalent length

V = Velocity of liquid in suction line (ft/sec) [$V = \text{GPM} \times (0.408 \div \text{pipe ID}^2)$]

N = rpm of crank shaft

C = Constant determined by type of pump — use 0.066 for the T100E,F,H Hydra-Cell pumps

K = Constant to compensate for compressibility of the fluid — use: 1.4 for de-aerated or hot water; 1.5 for most liquids; 2.5 for hydrocarbons with high compressibility

G = Gravitational constant (32.2 ft/sec²)

Friction Losses

Calculating Friction Losses in Suction Piping

When following the above recommendations (under "Inlet Piping") for minimum hose/pipe I. D. and maximum length, frictional losses in the suction piping are negligible (i.e., $H_f = 0$) if you are pumping a water-like fluid.

When pumping more-viscous fluids such as lubricating oils, sealants, adhesives, syrups, varnishes, etc.; frictional losses in the suction piping may become significant. As H_f increases, the available NPSH (NPSHa) will decrease, and cavitation will occur.

In general, frictional losses increase with increasing viscosity, increasing suction-line length, increasing pump flow rate, and decreasing suction-line diameter. Changes in suction-line diameter have the greatest impact on frictional losses: a 25% increase in suction-line diameter cuts losses by more than two times, and a 50% increase cuts losses by a factor of five times.

Consult the factory before pumping viscous fluids.

T200 Series High - Installation (Cont'd)

Minimizing Acceleration Head and Frictional Losses

To minimize the acceleration head and frictional losses:

- Keep inlet lines less than 6 ft (1.8 m) or as short as possible
- Use at least 4 in. (102 mm) I.D. inlet hose
- Use **suction** hose (low-pressure hose, non collapsing) for the inlet lines
- Minimize fittings (elbows, valves, tees, etc.)
- **Use a suction stabilizer on the inlet.**

Net Positive Suction Head

NPSHa must be equal to or greater than NPSHr. If not, the pressure in the pump inlet will be lower than the vapor pressure of the fluid — and cavitation will occur.

Calculating the NPSHa

Use the following formula to calculate the NPSHa:

$$NPSHa = P_t + H_z - H_f - H_a - P_{vp}$$

where:

P_t = Atmospheric pressure

H_z = Vertical distance from liquid surface to pump center line
(if liquid is below pump center line, the H_z is negative)

H_f = Friction losses in suction piping

H_a = Acceleration head at pump suction

P_{vp} = Absolute vapor pressure of liquid at pumping temperature

Notes:

- In good practice, NPSHa should be 2 ft greater than NPSHr
- All values must be expressed in feet of liquid

Atmospheric Pressure at Various Altitudes

| Altitude (ft) | Pressure (ft of H ₂ O) | Altitude (ft) | Pressure (ft of H ₂ O) |
|------------------|--------------------------------------|------------------|--------------------------------------|
| 0 | 33.9 | 1500 | 32.1 |
| 500 | 33.3 | 2000 | 31.5 |
| 1000 | 32.8 | 5000 | 28.2 |

Discharge Piping

Hose and Routing

Use the shortest, most-direct route for the discharge line.

Select pipe or hose with a **working pressure** rating of at least 1.5 times the maximum system pressure. EXAMPLE: Select a 1500 psi W.P.-rated hose for systems to be operated at 1000 psi-gauge pressure.

Use flexible hose between the pump and rigid piping to absorb vibration, expansion or contraction.

Support the pump and piping independently. Size the discharge line so that the velocity of the fluid will be 3-10 ft/sec (1-3 m/sec):

For pipe in inches: Velocity (ft/sec) = 0.408 x GPM/Pipe ID²

For pipe in mm: Velocity (m/sec) = 21.2 x LPM/Pipe ID²

Pressure Relief

Install a pressure relief valve in the discharge line. Bypass pressure must not exceed the pressure limit of the pump.

Size the relief valve so that, when fully open, it will be large enough to relieve the full capacity of the pump without overpressurizing the pump.

Locate the valve as close to the pump as possible and ahead of any other valves.

Adjust the pressure relief valve to no more than 10% over the maximum working pressure of the pump.

Route the bypass line to the supply tank, never into the suction line. See the diagram showing a typical installation at the beginning of the Installation Section.

If the pump may be run for a long time with the discharge closed and fluid bypassing, install a thermal protector in the bypass line (to prevent severe temperature buildup in the bypassed fluid).

CAUTION: Never install shutoff valves in the bypass line or between the pump and pressure relief valve.

Install a pressure gauge in the discharge line.

Vacuum at Outlet. Do not allow a vacuum at the pump outlet during shutdown. A vacuum can damage the diaphragm at start-up. If there is a vacuum at the pump outlet, allow atmospheric pressure at the outlet for 30 minutes before starting. Wanner Engineering recommends installing an outlet check valve with a 65 psi cracking pressure to prevent a vacuum condition during shutdown.

Oil Level Monitoring. Oil level is sensed by the top cover float switch (49) and can be used to control the pump system operation.

Before Initial Start-Up

Before you start the pump, be sure that:

- Pump is stored at a temperature between 40-180° F (4.4-82.2° C) for a minimum of 24 hours before start up.
- All shutoff valves are open, and the pump has an adequate supply of fluid.
- All connections are tight.
- The oil level is within the marking on the dipstick. Add oil as needed.
- Connect the float switch (if used). See Float Switch Section.
- The relief valve on the pump outlet is adjusted so the pump starts under minimum pressure.
- All shaft couplings or drive pulleys have adequate safety guards.

T200 Series High - Installation (Cont'd)

Initial Start-Up

1. Pump must be at or above 40°F (4.4°C) for 24 hours prior to starting.
2. Open the bypass line start-up and capacity-control valve so the pump may be started against negligible discharge pressure.
3. Turn on power to the pump motor.
4. Check the inlet pressure or vacuum. Inlet pressure must not exceed 500 psi (34 bar).
5. Listen for any erratic noise, and look for unsteady flow. If the pump does not clear, refer to the Troubleshooting Section.
6. If the system has an air lock and the pump fails to prime:
 - a. Turn off the power.
 - b. Open the bypass line as indicated by the installation diagram.
 - c. Jog the system on and off until the fluid coming from this port is air-free.
 - d. Turn off the power.
7. Adjust the bypass line valve to the desired operating pressure. Do not exceed the maximum pressure rating of the pump.
8. After the system pressure is adjusted, verify the safety relief valve setting by closing the bypass line valve until the relief valve opens.

Note: Fluid may come out of the safety relief valve. Provide an adequate catch basin for fluid spillage. Take all safety precautions to assure safe handling of the spillage.

9. Reset the bypass line valve to obtain the desired system pressure if needed.
10. Provide a return line from the relief valve to the supply tank, similar to the bypass line.

T200 Series High Pressure - Maintenance

Maintenance

Note: The numbers in parentheses are the Reference Numbers shown in the Parts Section of the manual.

Daily

Check the oil level and the condition of the oil with the pump turned off. The oil level should be within the marking on the dipstick. Add oil as needed or use continuous monitor.

Use the appropriate Hydra-Oil for the application (contact Wanner Engineering if in doubt).

CAUTION: If you are losing oil but don't see any external leakage, or if the oil becomes discolored and contaminated, one of the diaphragms (86) may be damaged. Refer to the Fluid-End Service Section. Do not operate the pump with a damaged diaphragm.

Do not leave contaminated oil in the pump housing or leave the housing empty. Remove contaminated oil as soon as discovered, and replace it with clean oil.

Periodically

Change the oil after the first 500 hours of operation; and then every 2000 hours or six months, whichever comes first.

Note: Minimum oil viscosity for proper hydraulic end lubrication is 4.5 cST (42.4 SSU) at 212°F (100°C).

Use of an oil cooler is recommended when process fluid and/or hydraulic end oil exceeds 180°F (82.2°C).

When changing oil, remove drain plug on the side of the pump so all oil and accumulated sediment will drain out.

Check the inlet pressure or vacuum periodically with a gauge. If vacuum at the pump inlet exceeds NPSHR, check the inlet piping system for blockages. If the pump inlet is located above the supply tank, check the fluid supply level and replenish if too low.

Inspect pump for hydraulic oil or process fluid leaks.

Shutdown Procedure During Freezing Temperatures

Take all safety precautions to assure safe handling of the fluid being pumped. Provide adequate catch basins for fluid drainage and use appropriate plumbing from drain ports, etc., when flushing the pump and system with a compatible antifreeze. Drain ports are located in the manifold.

1. Remove the inlet and outlet fluid connections.
2. Remove Manifold drain plugs (6a) 3x.
3. Use long blunt instrument to reach through the manifold drain plug ports to open the inlet valves and purge fluid from the pumping chamber.
4. Operate pump dry at full speed to purge remaining fluid.

Recommended Tools and Supplies

The following tools and supplies are recommended for servicing the T200P,Q Pump:

Ratchet and extension(s)

Bench Vise

4 mm hex bit socket

6 mm hex bit socket

10 mm hex bit socket

8 mm hex socket

17 mm hex socket

19 mm hex socket

22 mm hex socket

24 mm hex socket

30 mm hex socket

9/16 in. hex socket

13 mm open-end wrench

18 mm open-end wrench

1 3/8 in. open-end wrench

1 1/2 in. open-end wrench

Torx T30

Flathead screwdriver

No. 3 Phillips-head screwdriver

Internal retaining ring pliers

External retaining ring pliers

8 in. adjustable wrench

In-lbs Adjustable Torque wrench or torque multiplier

Ft-lbs Adjustable Torque wrench or torque multiplier

Pipe wrench

Loctite 242

Loctite 271

Loctite 567

New Hydra-Oil

Wanner T200 Medium Pressure Tool Kit (see T200 Medium Pressure Tool Kit Parts)

Wanner T200 Crankshaft Tool Kit

T200 Series High Pressure - Fluid End Service

This section explains how to disassemble and inspect all easily-serviceable parts of the pump.

Note: The numbers in parentheses are the Reference Numbers shown in the Parts Section of the manual.

Fluid End Service

Valve Stack Disassembly

- a. See *Fluid End Parts View*. Loosen and turn up hex nut (109) on bolt (110). Remove bolts (110) from valve cap (106).
- b. Remove six bolts (108) from valve cap (106).
- c. Remove valve cap/outlet valve assembly by installing two bolts (110) into threaded jack screw holes on valve cap (106).

Note: Tighten cap screws evenly.

- d. Remove inlet valve assembly (94-103) with valve extraction tools (3-5) from T200 Tool Kit.
- e. Remove inlet valve support (94-95) with check valve extractor (2) from T200 Tool Kit.

Outlet Valve Disassembly

- a. Inspect valve caps for warping or wear. Look for corrosion, scale and wear. If wear is excessive, replace valve caps. Clean valve caps of any scale and corrosion with Scotch-Brite™ pad or fine emery cloth. Wash after cleaning. To check if valve cap is warped, place a straightedge across it. A warped valve cap should be replaced.
- b. Remove valve seat (96) by turning while holding retainer in place.
- c. Inspect each of the outlet valves for damage or wear. Replace any outlet valve parts as needed.

Outlet Valve Assembly

- a. Reinstall valve cap (106) on assembled outlet valve (94-99, 102-103) with two screws (108) [Torque to 75 in-lbs (8 N-m)]. See *Fluid End Parts View*.

Inlet Valve Disassembly

- a. Inspect each of the inlet valves for damage or wear. Replace any inlet valve parts as needed.

Inlet Valve Assembly

- a. See *Fluid End Parts View*.

Valve Stack Assembly

- a. Reinstall inlet valve support (94-95).
- b. Reinstall inlet valve assembly (94-103). Make Sure an inlet valve retainer window is facing diaphragm when installing.
- c. Reinstall valve cap/outlet valve assembly. Outlet valve ports need to be inline with the outlet flange. Valve cap mounting holes will not align if outlet valve is not properly aligned.
- e. Use six bolts (102) to fasten valve cap (106). Lubricate threads and hand thread bolts, then tighten in criss-cross pattern. Torque to 350 ft-lbs (474 N-m).
- f. Fully thread hex nut (109) onto bolt (110). Hand thread bolts (110) into valve cap (106). Preload valve stack by torquing the three bolts (110) in circular pattern to 30 ft-lbs (41 N•m).

Note: Continue tightening bolts in circular pattern until bolts are properly torqued before moving to the next torque setting.

- g. Turn nut (109) down to valve cap (106) and tighten to jam nut against valve cap.

Fluid Check Valve Replacement

- a. Depressurize and empty the manifold before check valve removal. Loosen the six M20 x 2.5 bolts for each cap with an M30 socket.
- b. It is possible to remove the check valve assemblies by hand. The assemblies are installed in a stack, with the outlet check valve assembly on top of the inlet check valve assembly. If there is difficulty, two of the M20 x 2.5 cap bolts can be used as jack-bolts on either side of the cap to lift it away from the manifold.
- c. The inlet retainers have a 3/4"-10 threaded hole in the center that can be used to aid the removal process, along w/ a threaded rod and reaction bar.
- d. The retainers have a bayonet-style connection to the seats. They can be removed by twisting while holding the seat, which releases the assembly.


Drain Plug

- a. Remove and replace drain plug (6a) as needed. Apply Loctite 567 to drain plug threads. Install and tighten drain plug.

T200 Series High - Hydraulic Section Service

Note: The numbers in parentheses are the Reference Numbers shown in the Parts Section of the manual.


Hydraulic Section Disassembly

 **WARNING: Manifold (91) and assembled parts weigh over 500 pounds (227 kg). Use care in handling to prevent personal injury or damage to equipment.**

- See *Power End Parts Illustration in Parts List*. Remove drain plug (6) from side of pump and drain oil into container (capable of holding 80 qts [75.7 liters] of oil). Dispose of old oil in an approved way.
- Replace drain plug.
- See *Fluid End Parts View*. Remove four bolts (93) and washers (92), one from each corner of manifold (91). Install four extended studs (6) from T200 Tool Kit in removed bolt locations.
- Remove remaining sixteen bolts (93) and washers (92) from fluid end of pump. Carefully slide manifold (91) forward along extended studs to allow access to diaphragm plate (55).

Diaphragm Plate Disassembly

Note: Disassembly of diaphragm plate is only necessary if there is damage to the diaphragm plate itself.

 **WARNING: Manifold (91) and assembled parts weigh over 500 pounds (227 kg). Use care in handling to prevent personal injury or damage to equipment.**

- Slide manifold (91) away from diaphragm plate (55), following steps a. through d. in the Manifold Disassembly Section.

 **WARNING: Diaphragm plate (55) and assembled parts weigh over 300 pounds (136 kg). Use care in handling to prevent personal injury or damage to equipment.**

- See *Hydraulic Section Parts view*. Remove 10 cap screws (19) and remove top cover (43) on the crankcase.
- Remove two cap screws (39), upper and lower plunger clamp (37 and 38). Push plunger (36) into cylinder (57). Rotate crankshaft (30) and repeat for remaining plungers.
- Remove four cap screws (74) and four flange nuts (40) from diaphragm plate (55).
- Carefully slide diaphragm plate and assembled parts away from pump along pump studs.
- Replace diaphragm plate gasket (35) if damaged.

Check/Replace Airbleed Valve Assembly

- See *Hydraulic Section Parts view*. Unthread airbleed valve assembly (70) from diaphragm plate (55). Inspect valve and replace if needed.
- Reinstall airbleed valve. Torque to 75 ft-lbs (102 N-m).

Check/Replace Underfill Valve Assembly

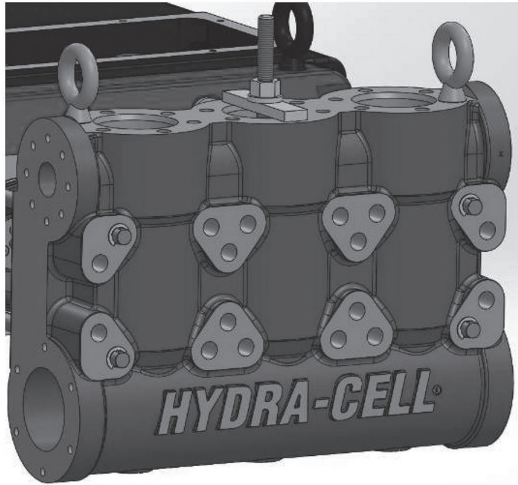
- See *Hydraulic Section Parts view*. Unthread underfill valve assembly (62) from bottom of diaphragm plate (55). Inspect valve and replace if needed.
- Reinstall underfill valve. Torque to 30 ft-lbs (41 N-m).

Check/Replace Overfill Valve Assembly

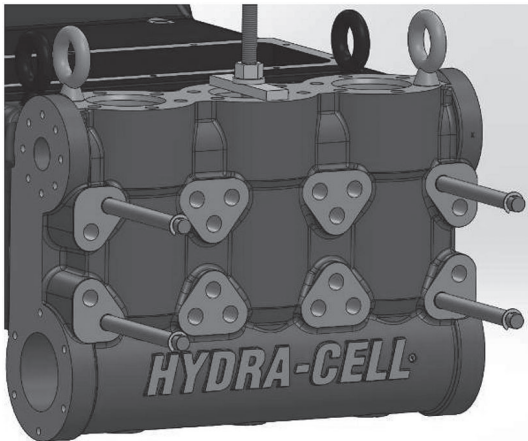
- See *Hydraulic Section Parts view*. Unthread overfill valve assembly (67) from bottom of diaphragm plate (55). Inspect overfill valve and replace if needed.
- Reinstall overfill valve. Torque to 105 in-lbs (12 N-m).

T200 High - Hydraulic Section Service (Cont'd)

Hydraulic Section Disassembly (Cont'd) Diaphragm Replacement



Extended Studs Installed, Open Assembly



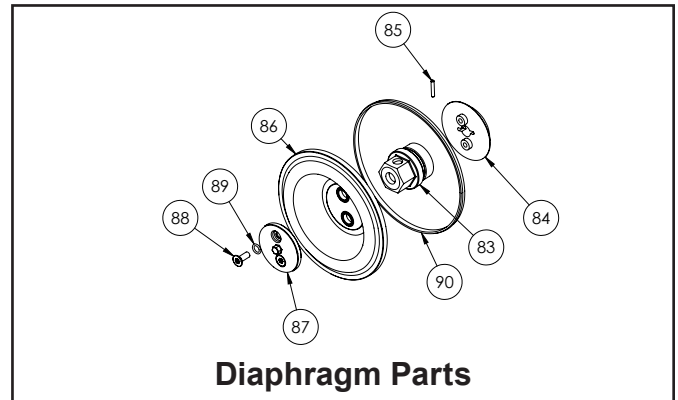
Extended Studs Installed, Closed Assembly

- Remove four manifold bolts (93) and washers and install extended studs in the locations shown above.
- Use wrench flats to turn the extended studs. When fully installed, the end of the extended stud should be no more than 8" from the flat face of the manifold. Do not overtighten the extended studs into the diaphragm plate, hand-tight is sufficient.
- After the extended studs have been fully installed, the remaining bolts and washers can be removed in any order, and the manifold can be pulled away from the diaphragm plate.
- A raised M13 hex boss is provided in the center of the followers to prevent rotation when loosening the T40 Torx screws.

- Before reinstalling the manifold onto the diaphragm plate, ensure that the diaphragm backup rings are all fully seated into the diaphragm pockets on the diaphragm plate side.
- Push the manifold against the diaphragm plate with force, listening for metal-on-metal contact. There should be a "clink" sound indicating that the backup rings were not caught between the diaphragm plate and manifold. There should be minimal gap, if any, between the diaphragm plate and manifold.
- Hold the manifold in place and re-install the manifold bolts and washers from the center of the manifold outwards, using an impact driver to fully install each one before the next.
- The extended studs can be removed once all possible bolts and washers have been fully seated. The final six bolts and washers can then replace the extended studs, and the manifold bolts can be torqued to 450 ft-lbs each, as shown in Manifold Bolt Torque Sequence.

CAUTION - Extended studs should be installed in the corner locations as shown in Manifold Eyebolt Install for maximum stability and available space between the manifold and diaphragm plate.

Diaphragm Disassembly



- See *Diaphragm Parts View*. Remove two screws (88), two O-rings (89) and follower (87).

CAUTION: If a diaphragm has ruptured and foreign material or water has entered the oil reservoir, do not operate the pump. Check all diaphragms, replace damaged diaphragms, then flush the reservoir completely and refill it with fresh oil. Never let the pump stand with foreign material or water in the reservoir, or with the reservoir empty.

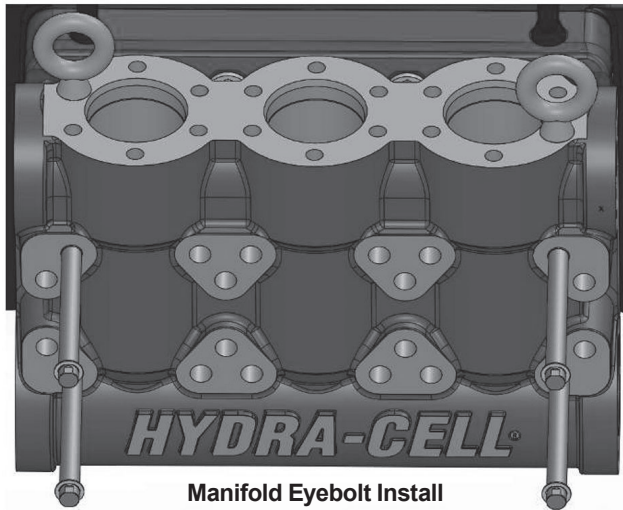
- Remove the diaphragm (86) and diaphragm back-up ring (90). Inspect diaphragm carefully for any abnormal conditions. A ruptured diaphragm generally indicates a pumping system problem, and replacing only the diaphragm will not solve the larger problem. Inspect the diaphragm for the following:
 - Small puncture.** Usually caused by a sharp foreign object in the fluid.
 - Diaphragm pulled away** from the center screw or from the cylinder sides. Usually caused by fluid being frozen in the pump, or by overpressurization of the pump.

T200 High - Hydraulic Section Service (Cont'd)

Diaphragm Disassembly (Cont'd)

- **Diaphragm becoming stiff** and losing flexibility. Usually caused by pumping a fluid that is incompatible with the diaphragm material.
 - **Slice in ridge of diaphragm.** Occurs when diaphragm is operated at cold temperatures.
 - **Diaphragm torn concentrically in the mid convolute area.** Usually an indication of an outlet vacuum condition.
- c. Replace diaphragm if needed.
d. Replace diaphragm back-up ring if needed.

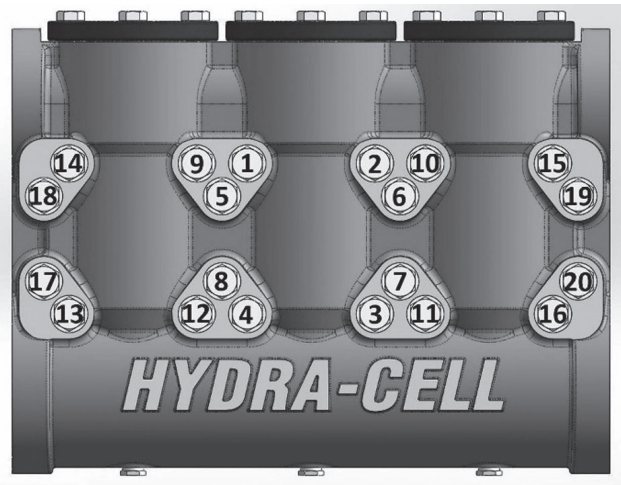
Manifold Lifting (Manifold Only)



Manifold Eyebolt Install

Eyebolts are provided for lifting the manifold by itself (not including the diaphragm plate or crankcase), when a hoist or forklift is available. The outlet check valve caps must be removed as previously described before using these eyebolts. Manifold Eyebolt Install shows where to install the eyebolts, which is in the outermost threads in line with the center of gravity.

CAUTION - Please do not lift the entire pump with the manifold/ tool kit eyebolts. Instead use the two larger eyebolts provided on top of the diaphragm plate, along with the other two located on top of the crankcase.

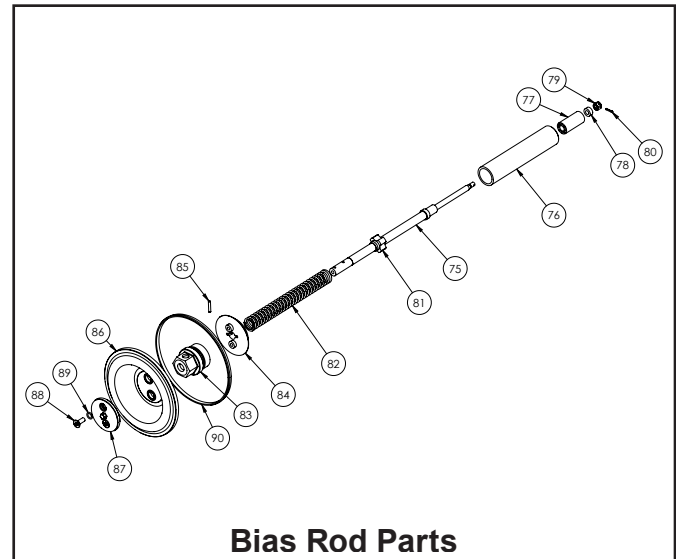


Manifold Bolt Torque Sequence

Torque Sequence:

- Snug 20 bolts (93) in order indicated, then torque to 450 ft-lbs (610 N-m) in the order indicated.

Bias Rod Disassembly



Bias Rod Parts

- See *Bias Rod Parts and Diaphragm Parts Views*. Remove diaphragm parts as in diaphragm disassembly steps a. through d.
- Remove diaphragm clamp (84).
- Remove bias spring retainer nut (83) from diaphragm plate (55).
- Remove bias rod assembly from bias tube (60).
- Check bias spring retainer nut for any rough surfaces, edges, or corrosion. Replace if necessary.
- Remove roll pin (80), slotted hex nut (79), and bias washer (78).
- Remove bias rod parts: bias rod (75), spool stop (76), valve spool (77), rod guide (81), and bias spring (82).
- Inspect rod parts. Smooth surfaces and edges as necessary with emery cloth or fine file. Replace parts as necessary.

T200 High - Hydraulic Section Service (Cont'd)

Hydraulic Section Assembly

Diaphragm Assembly

a. See *Diaphragm Parts View*.

CAUTION: It is important to observe the following steps to ensure proper assembly.

- b. Install the diaphragm (86) into diaphragm plate (55). Seat diaphragm edge with fingers. Make sure diaphragm bead is fully seated into the square groove of diaphragm plate.
- c. Install two O-rings (89) into follower (87).
- d. Attach follower to diaphragm clamp with two screws (88). Use Loctite 242 and torque to 60 in-lbs (7 N-m).
- e. Fully install back-up ring (90) between diaphragm plate and diaphragm.
- f. Repeat steps a. through e. for remaining diaphragms.

Diaphragm Plate Assembly

Note: For easier handling of diaphragm plate, use lifting device and the two eyebolts (2) installed on top of diaphragm plate.

- a. Replace diaphragm plate gasket (35) if damaged.

CAUTION: Ensure plungers (36) and cylinders (57) are lubricated with oil before assembly. Dry plungers and cylinders can bind on start-up.

- b. See *Hydraulic Section Parts Illustration*. Carefully slide diaphragm plate (55) and assembled parts along pump studs (34) flush with Power End of pump.
- c. Install four cap screws (74) into diaphragm plate. Torque to 200 ft-lbs (271 N-m).
- d. Install four flange nuts (40) onto studs. Torque to 250 ft-lbs (339 N-m).
- e. Align plunger (36) and crosshead plunger adaptor (21). Install plunger clamps (37 and 38) and two cap screws (39). Torque to 20 ft-lbs (27 N-m).

Note: Install threaded plunger clamp (38) on bottom. Position counter bored plunger clamp (39) on top. Install two cap screws (39) and tighten evenly.

- f. Hand rotate crankshaft to assure smooth operation.
- g. Install top cover gasket (42) and top cover (43) using 10 cap screws (19). Torque to 30 ft-lbs (41 N-m).

Bias Rod Assembly

CAUTION: It is important to observe the following steps to insure proper assembly.

- a. Ensure O-ring (59) is seated.
- b. See *Bias Rod Parts View*. Install Bias Tube (60) to Diaphragm Plate (55).
- c. Clean all parts before assembling.
- d. Install spool stop (76), valve spool (77), and bias washer (78) on threaded end of bias rod (75).
- e. Fully thread slotted hex nut (79) on threaded end of bias rod by hand. Turn slotted hex nut until slot aligns with hole in bias rod. Insert coil spring pin (80). Center coil spring pin with slotted hex nut.
- f. Install rod guide (81), bias spring (82), and bias spring retainer nut (83) on bias rod.
- g. Apply Loctite 242 to bias spring retainer nut threads and install into diaphragm plate. Torque to 100 ft-lbs (136 N-m).
- h. Pull bias rod out slightly through bias spring retainer nut and install diaphragm clamp (84) install dowel pin (85) into hole nearest end of bias rod (75).
- i. Let bias rod retract back into diaphragm plate.
- j. Repeat for remaining bias rod assemblies.

Manifold Assembly


- a. See *Fluid End Parts View*. Prior to manifold assembly, inspect mating surfaces of pump and manifold. Make sure they are clean and free of any foreign material. Ensure diaphragm beads are seated.
- b. Install extended studs into top corners of diaphragm plate (55).
- c. Carefully align and slide manifold (91) on extended studs.

CAUTION: The manifold should slide cleanly onto the pump and the back-up rings should be engaged into the mating grooves in the manifold prior to tightening. Failure to slide the manifold all the way on engaging the back-up rings prior to tightening can cause the back-up ring to be pinched and cause the pump to leak. If the manifold does not slide easily onto the pump, use Scotch-Brite or fine abrasive paper to clean the outer edge of the groove where the back-up ring fits.

- d. Install washers (92) and bolts (93) in manifold and hand tighten.
- e. Remove extended studs, install remaining washers (92) and bolts (93) in manifold and hand tighten.
- f. Tighten bolts (93) in torque sequence shown in illustration on page 14 to 450 ft-lbs (610 N-m).
- g. Fill pump with oil to cover marks on dipstick. Approximately 80 qts (75.7 liters).
- h. Follow instructions in Before Initial Start-Up and Initial Start-Up Section to start pump.

T200 Series High Pressure - Power End Service

Power End Disassembly

 **WARNING:** Crankcase (1) and assembled parts weigh over 2000 pounds (907 kg). Use care in handling to prevent personal injury or damage to equipment.

Float Switch Disassembly

Note: The numbers in parentheses are the Reference Numbers shown in the Parts Section of the manual.

- Disconnect float switch (48).
- Remove float switch adaptor (47) with float switch and O-ring (52) from top cover (43).
- Remove snap ring from bottom of float switch and remove baffle end cap (51).
- Remove two screws (50) and remove float switch baffle (49).
- Remove float switch (48) from float switch adaptor (47).

Crankcase Disassembly

- See *Power End Parts Illustration*. Remove oil drain plug (6), plug (46), oil fill cap assembly (44), and crankshaft key (31) and drain lubricating fluid into a suitable container, approximately 80 qts.
- Remove Fluid End and Hydraulic plate as outlined in two preceding sections.
- Remove 14 cap screws (19) and remove back cover (33).

Connecting Rod Removal

Note: Each of three Connecting rod assemblies (25*) consists of: connecting rod end, connecting rod cap, rod bushing, and two bolts.

- Remove connecting rod assembly bolts (25*) and remove connecting rod end cap (25*) with split shell bearing. Make sure numbers on connecting rod and end cap are 'top-up' in the assembly and match.

Note: Make sure to note 'top-up' orientation of numbers on connecting rod and end cap when removing. These are matched parts and must be stored together as one assembly and not mixed with any other connecting rod assemblies or parts.

- Set aside connecting rod assembly bolts, end cap, and split shell bearing (28) for use in reassembly.
- Push connecting rod assembly away from journal on the crankshaft. Move as far forward as possible.
- Repeat for remaining connecting rod assemblies.

Crankshaft Removal

Note: Reference page 29.

- Remove six cap screws (14) from shaft end of pump attaching bearing carrier assembly (assembled items 12, 13, 15, 16, 17, and 19) to the crankcase (1).
- Carefully remove crankshaft (30) and bearing carrier assembly from crankcase.
- Remove bearing carrier assembly from shaft end of crankshaft.
- Remove six screws (14) and blind end bearing carrier assembly from crankcase.
- Inspect main bearings (29) and replace if needed.

Note: Use a puller to remove main bearings from crankshaft if need to be replaced.

Bearing Carrier Disassembly

- Separate seal carrier and bearing carrier assemblies by removing six cap screws (19).
- Remove O-ring (12) from bearing carrier (13). Remove O-ring (15) from blind end seal carrier (18).
- Remove O-ring (15) from shaft end seal carrier (17). Remove two crankshaft seals (16) from shaft end seal carrier.

Connecting Rod Disassembly

Note: Make sure to note 'top-up' orientation of numbers on connecting rod and end cap when storing. These are matched parts and must not be mixed with parts from other connecting rod assemblies.


- Pull out connecting rod/crosshead assembly and remove from crankcase.
- Remove remaining one half of split shell bearing (28) from connecting rod (25*). Match with shell bearing already removed in **Connecting Rod Removal**.
- Retrieve bolts (25*), and end cap (25*) from previous step in **Connecting Rod Removal**. Be careful not to mix with parts from other connecting rod assemblies.
- Loosely assemble two bolts and connecting rod end cap with connecting rod assembly and set aside. Note proper orientation of numbers on connecting rod and end cap.
- Remove setscrews (27) by carefully applying heat to unlock wrist pin (26). Remove wrist pin, and crosshead from connecting rod end.
- Remove and disassemble remaining connecting rods.

Crosshead Disassembly

- Remove shoulder screw (23) from crosshead assembly to remove plunger adaptor (21), spherical washer pair (20), and disc springs (22).
- Disassemble remaining crosshead assemblies following step a.
- Clean crankcase for later reassembly.

T200 Series High - Power End Service (Cont'd)

Power End Assembly

 **WARNING:** Crankcase (1) and assembled parts weigh over 2000 pounds (907 kg). Use care in handling to prevent personal injury or damage to equipment.

Crosshead Assembly

Note: The numbers in parentheses are the Reference Numbers shown in the Parts Section of the manual.

- a. Start with crankcase (1) clean and ready to assemble.
- b. Assemble plunger adaptor (21), spherical washer (20), crosshead (24), and disc springs (22), with shoulder screw (23). Use Loctite 271 and torque to 100 ft-lbs (136 N-m).

Note: The concave half of spherical washer assembly (20) mates with plunger adaptor (21) and the other convex side of spherical washer assembly mates with crosshead (24).

Note: Place three disc springs on shoulder screw in an alternating order, with the first disc spring curve facing away from the head of the screw.

- c. Assemble remaining sets.

Connecting Rod Assembly

Note: Each of three Connecting rod assemblies (25*) consists of: connecting rod end, connecting rod cap, rod bushing, and two bolts.

- a. Attach assembled plunger adaptor and crosshead to connecting rod (25*) using wrist pin (26). Align marks on wrist pin with marks on crosshead (24). Lock wrist pin in place with setscrews (27). Use Loctite 271 and torque to 15 ft-lbs (20 N-m).

Note: Make sure to note 'top-up' orientation of numbers on connecting rod and end cap during assembly. These are matched parts and must not be mixed with parts from other connecting rod assemblies.

- b. Remove two bolts (25*) and connecting rod cap (25*) from connecting rod assembly. Note orientation numbers on connecting rod and end cap.
- c. Set aside bolts and end cap for later installation. Do not mix with parts from other connecting rod assemblies.
- d. Install one half of split shell bearing (28) on connecting rod. Remaining one half of split shell bearing will be installed later.
- e. Insert connecting rod/crosshead assembly into crankcase and push all the way forward. Ensure numbers are 'top-up.'
- f. Assemble and install remaining sets.

Bearing Carrier Assembly

- a. Install O-ring (12) onto bearing carrier (13).
- b. Assemble two sets.

Seal Carrier Assembly

- a. Install two shaft seals (16) into shaft end seal carrier (17). Install O-ring (15) onto shaft end seal carrier.
- b. Install O-ring (15) onto blind end seal carrier (18).

Main Bearing Installation

Note: Wear appropriate safety equipment for the following procedure.

Note: When bearings are being installed on crankshaft, verify bearing is properly seated against crankshaft shoulder.

- a. Wipe down crankshaft (30).
- b. Heat main bearing (29) to approximately 200°F (93°C). Install main bearing on blind end of crankshaft against shoulder.
- c. Heat main bearing (29) to approximately 200°F (93°C). Install main bearing on shaft end of crankshaft against shoulder.

Note: Let bearings cool to ambient air temperature before continuing with crankshaft installation.

Crankshaft Installation

Note: Reference page 29.

- a. Install one bearing carrier assembly to blind side of crankcase (1) using six cap screws (14). Torque cap screws to 75 ft-lbs (102 N-m). Crankshaft (30) will be installed on opposite side.
- b. Place remaining bearing carrier assembly on shaft end of crankshaft.

Note: No shimming of crankshaft is necessary. End play of crankshaft should be between 0.010 in. minimum to 0.200 in. maximum when installed.

- c. Install shaft end seal carrier assembly to shaft end bearing carrier using six cap screws (19). Torque cap screws to 30 ft-lbs (41 N-m).
- d. Insert crankshaft with shaft end seal and bearing carrier assembly into crankcase and insert into installed bearing carrier assembly on opposite end of crankcase. Align flange of bearing carrier assembly with flange on crankcase.
- e. Bolt flange of bearing carrier assembly to crankcase with six cap screws (14). Torque cap screws to 75 ft-lbs (102 N-m).
- f. Install blind end seal carrier assembly to blind end bearing carrier using six cap screws (19). Torque cap screws to 30 ft-lbs (41 N-m).

T200 Series High - Power End Service (Cont'd)

Connecting Rod Installation

Note: Each of three Connecting rod assemblies (25*) consists of: connecting rod end, connecting rod cap, rod bushing, and two bolts.

- a. Attach connecting rod assembly to crankshaft (30) by reaching into rear of crankcase around crankshaft and pulling connecting rod assembly until it reaches its journal on the crankshaft.

Note: Make sure to note 'top-up' orientation of numbers on connecting rod and end cap when installing. These are matched parts and must not be taken from other connecting rod assemblies.

- b. Retrieve connecting rod assembly bolts, cap, and remaining split shell bearing (28) set aside in previous steps.
- c. Reinstall connecting rod cap with remaining split shell bearing using connecting rod assembly bolts. Make sure numbers on connecting rod and cap are 'top-up' in the assembly and match. Torque two bolts to 175 ft-lbs (237 N-m).
- d. Repeat installation for remaining sets.

Crankcase Assembly

- a. Install back cover gasket (32) and back cover (33) using 14 cap screws (19). Torque to 30 ft-lbs (41 N-m).
- b. If removed, reinstall four studs (34) and torque to 75 ft-lbs (102 N-m). Reinstall two eyebolts (2) and torque to 300 ft-lbs (407 N-m).

Note: Install long threaded end of stud into crankcase (if applicable). Use Loctite 271 and torque to 75 ft-lbs (102 N-m).

- c. Install oil drain plug (6), top cover plug (46), oil fill cap assembly (44) crankshaft key (31), and add lubricating fluid.

Float Switch Assembly

- a. Assemble float switch (48) to float switch adaptor (47) finger tight plus one half turn.
- b. Remove snap ring from bottom of float switch.
- c. Install float switch baffle (49) and baffle end cap (51) on float switch.
- d. Reinstall snap ring on float switch.
- e. Position baffle end cap against snap ring.
- f. Align float switch baffle slots with holes in float switch adaptor and install screws (50). Position float switch baffle against baffle end cap and tighten screws.
- g. Install O-ring (52) on float switch adaptor. Install float switch assembly in top cover (43).
- h. Reconnect float switch.

T200 Series High Pressure - Oil Level Monitor

Oil Level Monitor Float Switch Conditions and Wiring Diagram

CAUTION: The float switch will only operate with crankshaft rotation in the direction indicated on the pump casting.

Note: The numbers in parentheses are the Reference Numbers shown in the Parts Section of the manual.

Note: The float switch (48) and adaptor (47) can be removed from the top cover without draining the pump's oil. See the Installation and Maintenance sections of the manual for float switch set-up and use.

The float switch (48) monitors the pump's oil level. The switch is used to trigger an alarm or pump shutdown when a high or low oil level is sensed in the pump's crankcase.

The T200 Medium Pressure Pump uses one of two float switch (48) configurations. The switch used can be identified by its wire lead colors and part number.

The wiring diagram below shows the operating conditions and wiring colors for each type of switch assembly.

1. Normally-Closed (NC) Switch.

The Normally-Closed Float Switch, 177-453-02 contains two normally-closed (NC) reed switches; one for high oil level, and one for low oil level. The (NC) float switch has solid Black, striped Yellow/White, and striped Red/White wire leads.

2. Normally-Open (NO) Switch.

The Normally-Open Float Switch, 177-453-03 contains two normally-open (NO) reed switches; one for high oil level, and one for low oil level. The (NO) float switch has solid Black, solid Yellow, and solid Red wire leads.

Note: The oil level should always be between the top and bottom of the sight glass. If the oil level reaches the top or bottom, the float switch will be activated.

Electrical Specifications

The following are the float switch electrical specifications:

- For P/N 177-453-02, Normally-Closed (NC) float switch: two single-pole, double-throw (SPDT) reed switches rated at 150 VDC/VAC, 1 Amp, 20 Watts (maximum).
or
For P/N 177-453-03 Normally-Open (NO) float switch: switches rated at 300 VDC/VAC, 0.5 Amp AC/0.7 Amp DC, 50 Watts (maximum).
- Resistive load only
- Magnetic float actuation
- Electrical conduit connection at top of switch adaptor: 1/2-14 NPT
- UL File No. E203716 under UL 508.
- Not rated for NEC/CEC hazardous locations. Consult factory for explosive environments.

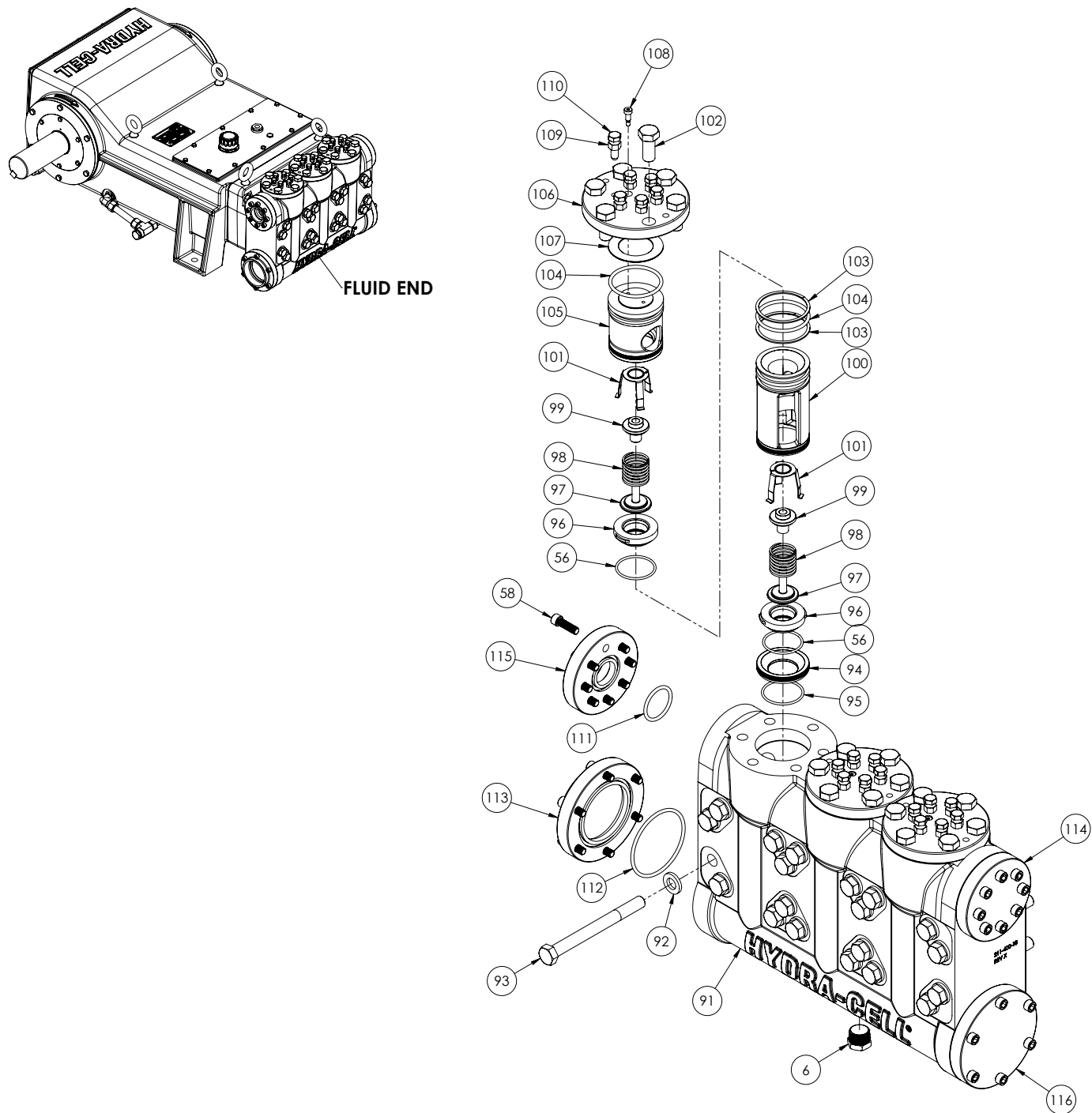
| Reed Switch Logic Table | | | | | | |
|-------------------------|------------------------------|-----------------|----------|----------------------------|-----------------|----------|
| Setpoint Contacts | 177-453-02 (Normally-Closed) | | | 177-453-03 (Normally-Open) | | |
| | Float Down | Float in Middle | Float Up | Float Down | Float in Middle | Float Up |
| High | Closed | Closed | Open | Open | Open | Closed |
| Low | Open | Closed | Closed | Closed | Open | Open |
| Float Switch Wiring | | | | | | |

Oil Level Monitor Float Switch Conditions and Wiring Diagram

T200 Series High - Torque Specifications

| T200P and Q Torque Specification Table | | | | |
|---|--------------------------------------|-------------|--------------|-------------------------------|
| Reference Number | Torque Specification ft-lbs (N-m) | Loctite No. | Part Number | Description |
| 2 | 300 (407) | - | 177-059 | Eyebolt, M20 |
| 6 | wrench-tight | 567 | 189-312 | Plug, 1 NPT SST |
| 8 | fully seated | 567 | 211-705 | Plug, Oil Drain |
| 11 | 30 (41) | - | 211-059 | Screw, HHCS, M10 |
| 14 | 75 (102) | - | 211-058 | Screw, HHCS, M14 |
| 19 | 30 (41) | - | G10-029-2010 | Screw, HHCS, M10 |
| 23 | 100 (136) | 271 | 211-023 | Screw, SHSS, M16 |
| 25 | 175 (237) | - | 211-003-02 | Bolt, Connecting Rod Assembly |
| 27 | 15 (20) | 271 | 211-014 | Screw, Set, M8 |
| 34 | 75 (102) | 271 | 211-066 | Stud, M20 |
| 39 | 20 (27) | - | 211-020 | Screw, SHCS, M8 |
| 40 | 250 (339) | - | 211-067 | Nut, Flanged, M20 |
| 45 | 15 in-lbs (1.7) | 271 | 189-565 | Screw, Pan Head |
| 46 | wrench-tight | 567 | 177-459 | Plug, 1/2-14 NPT |
| 50 | 5 in-lbs (0.6) | 271 | 211-065 | Screw, FHSS, M4 |
| 58 | 100 (136) | - | G35-081-2010 | Screw, SHCS, M12 |
| 61 | 100 (136) | - | 211-370 | Plug, Bias Tube |
| 62 | 30 (41) | - | 177-904 | Assembly, Underfill Valve |
| 67 | 105 in-lbs (12) | - | 177-905 | Assembly, Overfill Valve |
| 70 | 75 (102) | - | 177-906 | Assembly, Air Bleed Valve |
| 73 | 144 in-lbs (16.3) | - | 172-119 | Retainer, Air Bleeder |
| 74 | 200 (271) | - | 211-062 | Screw, SHCS, M16 |
| 83 | 100 (136) | 242 | 211-308 | Retainer Nut, Bias Spring |
| 88 | 60 in-lbs (7) | 242 | 177-176-XX | Screw, FHSS, M6 |
| 93 | 450 (610) | - | 211-039 | Screw, HHCS, M20 |
| 102 | 350 (475) | - | 177-044 | Screw, HHCS, M20 |
| 108 | 75 in-lbs (8) | 242 | 211-061 | Screw, SHSS, 8MM |
| 109 | finger-tight | - | 211-074 | Nut, Hex, M12, Coated |
| 110 | 30 (41) | - | 211-073 | Bolt, HHCS, M12, Coated |

T200 Series High Pressure - Fluid End Parts

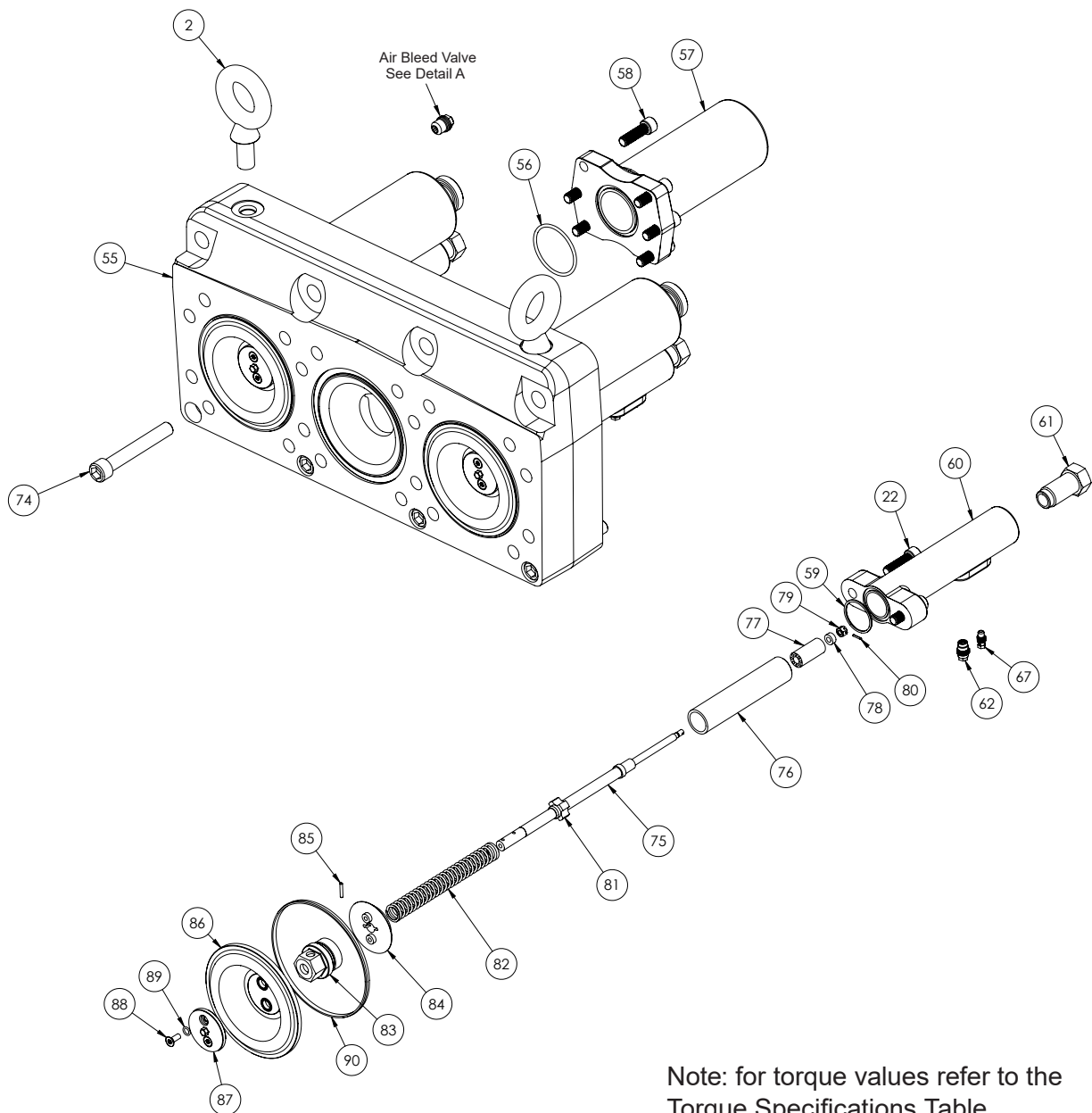
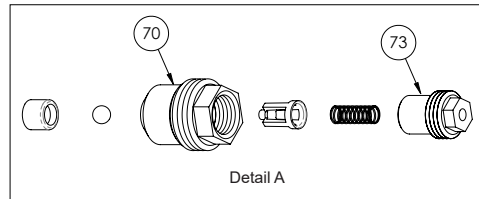
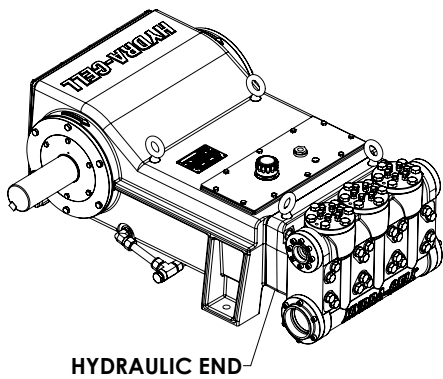


Note: for torque values refer to the Torque Specifications Table.

T200 Series High Pressure - Fluid End Parts

| Ref. No. | Part Number | Description | Quantity/ Pump |
|----------|--------------|---|-------------------|
| 6 | 189-312 | Plug, 1" NPT SST..... | 3 |
| 56 | 211-414-01 | O-ring, Buna-N..... | 6 |
| | 211-414-02 | O-ring, FKM | 6 |
| 58 | G35-081-2010 | Screw, SHCS, M12..... | 28 |
| 91 | 211-400-10 | Manifold, High Pressure..... | 1 |
| 92 | D66-048-2024 | Washer, 3/4" | 20 |
| 93 | 211-039 | Screw, HHCS, M20 | 20 |
| 94 | 211-466-01 | Inlet Valve Support, Austenitic SST | 3 |
| | 211-466-02 | Inlet Valve Support, Hastelloy C | 3 |
| | 211-466-03 | Inlet Valve Support, Duplex SST..... | 3 |
| 95 | 211-417-01 | O-ring, Buna-N..... | 3 |
| | 211-417-02 | O-ring, FKM | 3 |
| 96 | 211-464-01 | Seat, Valve, High Pressure, 17-4 SST .. | 6 |
| | 211-464-02 | Seat, Valve, High Pressure, Hastelloy C | 6 |
| | 211-464-03 | Seat, Valve, High Pressure, 316 SST | 6 |
| | 211-464-05 | Seat, Valve, High Pressure, Nitronic..... | 6 |
| 97 | 211-439-01 | Disc, Valve, Stem-guided, 17-4 SST..... | 6 |
| | 211-439-02 | Disc, Valve, Stem-guided, Hastelloy C | 6 |
| | 211-439-03 | Disc, Valve, Stem-guided, 316 SST..... | 6 |
| | 211-439-05 | Disc, Valve, Stem-guided, Nitronic | 6 |
| 98 | 211-421-01 | Spring, Valve | 6 |
| 99 | 211-438 | Bushing, Valve Stem | 6 |
| 100 | 211-469-01 | Inlet Valve Retainer, Austenitic SST | 3 |
| | 211-469-02 | Inlet Valve Retainer, Hastelloy C..... | 3 |
| | 211-469-03 | Inlet Valve Retainer, Duplex SST..... | 3 |
| 101 | 211-473-02 | Retainer, Valve Spring, 316 SST..... | 6 |
| | 211-473-03 | Retainer, Valve Spring, Hastelloy C | 6 |
| 102 | 177-044 | Screw, HHCS, M20 | 18 |
| 103 | 211-434 | Backup Ring, Scarf Cut | 6 |
| 104 | 211-415-01 | O-ring, Buna-N..... | 6 |
| | 211-415-02 | O-ring, FKM | 6 |
| 105 | 211-471-01 | Outlet Valve Retainer, Austenitic SST..... | 3 |
| | 211-471-02 | Outlet Valve Retainer, Hastelloy C..... | 3 |
| | 211-471-03 | Outlet Valve Retainer, Duplex SST | 3 |
| 106 | 211-475 | Cap, Valve Plug | 3 |
| 107 | 211-474 | Plate, Retainer, Outlet | 3 |
| 108 | 211-061 | Screw, SHSS, 8MM | 6 |
| 109 | 211-074 | Nut, Hex, M12, Coated | 18 |
| 110 | 211-073 | Bolt, HHCS, M12, Coated | 18 |
| 111 | 209-750-01 | O-ring, Buna-N..... | 2 |
| | 209-750-02 | O-ring, FKM | 2 |
| 112 | 209-751-01 | O-ring, Buna-N..... | 2 |
| | 209-751-02 | O-ring, FKM | 2 |
| 113 | 209-721-01 | Flange, 4" weld neck, 500 psi, SCH. 40, Steel | 1 |
| | 209-721-02 | Flange, 4" weld neck, 500 psi, SCH. 40, Austenitic SST | 1 |
| | 209-721-03 | Flange, 4" weld neck, 500 psi, SCH. 40, Duplex SST | 1 |
| | 209-721-04 | Flange, 4" weld neck, 500 psi, SCH. 40, Hastelloy C | 1 |
| | 209-726-01 | Flange, 4" NPT, 500 psi, Steel | 1 |
| | 209-762-01 | 4" ANSI Class 300 RF Weldment, Steel | 1 |
| | 209-762-02 | 4" ANSI Class 300 RF Weldment, Austenitic SST | 1 |
| | 209-762-03 | 4" ANSI Class 300 RF Weldment, Duplex SST | 1 |
| | 209-762-04 | 4" ANSI Class 300 RF Weldment, Hastelloy C | 1 |
| 114 | 209-722-01 | Flange, 2" blind, 4500 psi, Steel | 1 |
| | 209-722-02 | Flange, 2" blind, 4500 psi, Austenitic SST..... | 1 |
| | 209-722-03 | Flange, 2" blind, 4500 psi, Duplex SST..... | 1 |
| | 209-722-04 | Flange, 2" blind, 4500 psi, Hastelloy C | 1 |
| | 209-737-01 | Flange, 2" blind with 1" NPT, 4500 psi, Steel | 1 |
| 115 | 209-720-01 | Flange, 2" weld neck, 4500 psi, SCH. 160, Steel | 1 |
| | 209-720-02 | Flange, 2" weld neck, 4500 psi, SCH. 160, Austenitic SST..... | 1 |
| | 209-720-03 | Flange, 2" weld neck, 4500 psi, SCH. 160, Duplex SST | 1 |
| | 209-720-04 | Flange, 2" weld neck, 4500 psi, SCH. 160, Hastelloy C | 1 |
| | 209-724-01 | Flange, 2" NPT, 4500 psi, Steel..... | 1 |
| | 209-760-01 | Flange, 2500 RTJ, 2" ANSI weldment, Steel | 1 |
| | 209-760-02 | Flange, 2500 RTJ, 2" ANSI weldment, Austenitic SST | 1 |
| | 209-760-03 | Flange, 2500 RTJ, 2" ANSI weldment, Duplex SST | 1 |
| | 209-760-04 | Flange, 2500 RTJ, 2" ANSI weldment, Hastelloy C | 1 |
| 116 | 209-723-01 | Flange, 4" blind, 500 psi, Steel | 1 |
| | 209-723-02 | Flange, 4" blind, 500 psi, Austenitic SST..... | 1 |
| | 209-723-03 | Flange, 4" blind, 500 psi, Duplex SST | 1 |
| | 209-723-04 | Flange, 4" blind, 500 psi, Hastelloy C | 1 |
| | 209-735-01 | Flange, 4" blind, ported, 500 psi, Steel | 1 |

T200 Series High - Hydraulic Section Parts

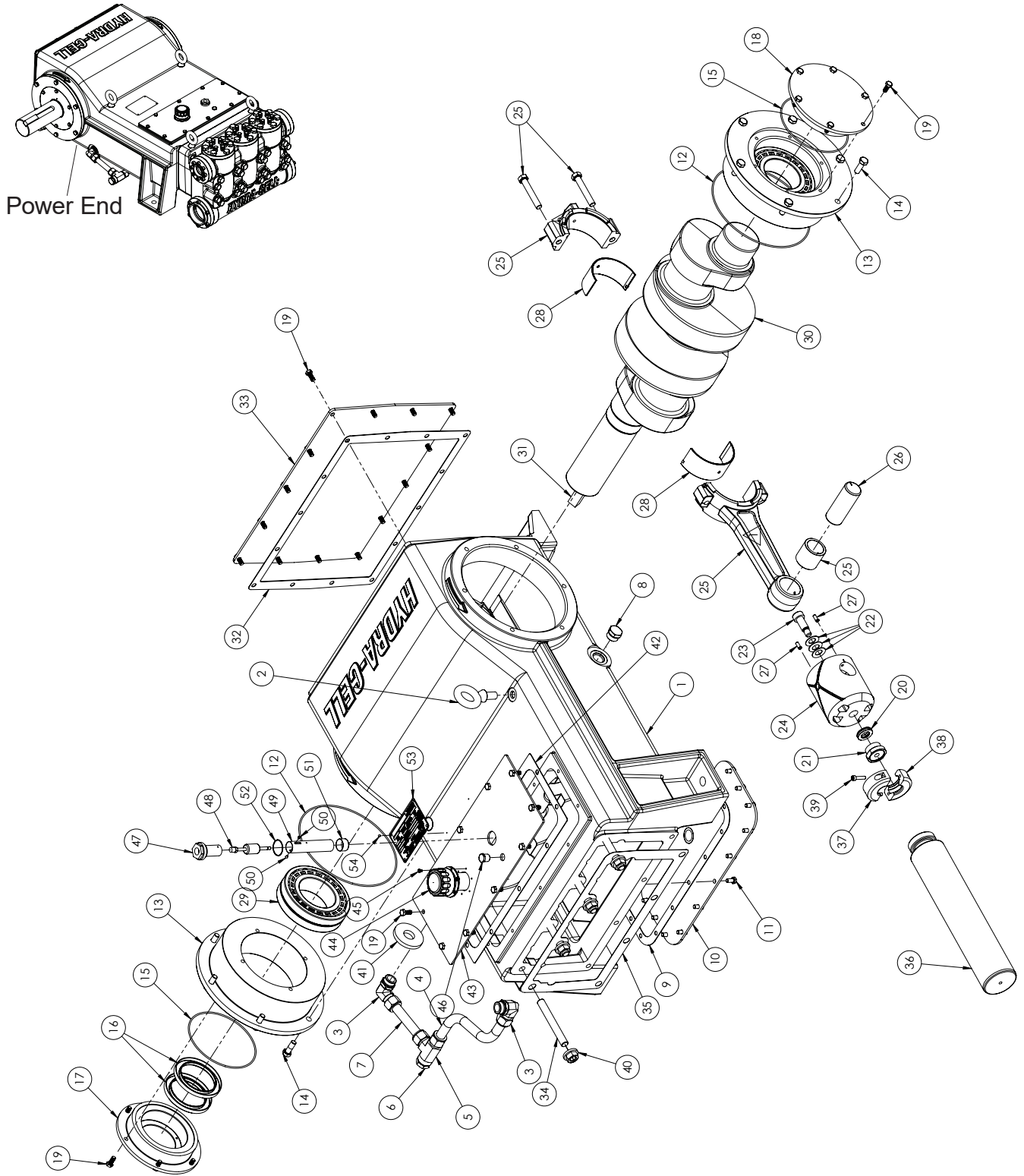


Note: for torque values refer to the Torque Specifications Table.

T200 Series High - Hydraulic Section Parts

| Ref. No. | Part Number | Description | Quantity/ Pump |
|-------------|--------------|---|-------------------|
| 2 | 177-059 | Eyebolt, M20 | 2 |
| 55 | 211-401-02 | Diaphragm Plate, High Pressure | 1 |
| 56 | 211-414-01 | O-ring, Buna-N..... | 3 |
| | 211-414-02 | O-ring, FKM | 3 |
| 57 | 211-479-01 | Cylinder P, High Pressure, 2" | 3 |
| | 211-479-02 | Cylinder Q, High Pressure, 1.875" | 3 |
| 58 | G35-081-2010 | Screw, SHCS, M12 | 24 |
| 59 | D25-034-2110 | O-ring, Buna-N..... | 3 |
| | D25-034-2111 | O-ring, FKM | 3 |
| 60 | 211-326-02 | Bias Tube, Medium..... | 3 |
| 61 | 211-370 | Plug, Bias Tube | 3 |
| 62 | 177-904 | Assembly, Underfill valve | 3 |
| 67 | 177-905 | Assembly, Overfill valve | 3 |
| 70 | 177-906 | Assembly, Air Bleed valve..... | 3 |
| 73 | 172-119 | Retainer, Air Bleeder | 3 |
| 74 | 211-062 | Screw, SHCS, M16..... | 4 |
| 75 | 211-412 | Bias Rod, High Pressure | 3 |
| 76 | 211-374 | Spool Stop..... | 3 |
| 77 | 211-313 | Valve Spool | 3 |
| 78 | 211-335 | Washer, Bias | 3 |
| 79 | 211-369 | Nut, Slotted Hex, M6 | 3 |
| 80 | 211-311 | Pin, M2 Coiled Spring | 3 |
| 81 | 211-310 | Rod Guide | 3 |
| 82 | 211-409 | Bias Spring | 3 |
| 83 | 211-308 | Retainer Nut, Bias Spring | 3 |
| 84 | 211-406 | Clamp, Diaphragm | 3 |
| 85 | 211-419 | Dowel Pin | 3 |
| 86 | 211-403-01 | Diaphragm, High Pressure, Buna-N ... | 3 |
| | 211-403-02 | Diaphragm, High Pressure, FKM | 3 |
| 87 | 211-407-01 | Follower, High Pressure, Austenitic SST..... | 3 |
| | 211-407-02 | Follower, High Pressure, Hastelloy C.. | 3 |
| | 211-407-03 | Follower, High Pressure, Duplex SST. | 3 |
| 88 | 177-176-01 | Screw, FHSS, M6, Austenitic SST | 3 |
| | 177-176-02 | Screw, FHSS, M6, Hastelloy C | 3 |
| | 177-176-03 | Screw, FHSS, M6 Duplex SST | 3 |
| 89 | 100-217-01 | O-ring, Buna-N..... | 3 |
| | 100-217-02 | O-ring, FKM | 3 |
| 90 | 211-467 | Backup Ring, Diaphragm | 3 |

T200 Series High Pressure - Power End Parts



Note: for torque values refer to the Torque Specifications Table.

T200 High Pressure - Power End Parts

| Ref. No. | Part Number | Description | Quantity/ Pump | Ref. No. | Part Number | Description | Quantity/ Pump |
|----------|--------------|-----------------------------------|-------------------|----------|--------------|--|-------------------|
| 1 | 211-001-04 | Crankcase | 1 | 29 | 211-006 | Bearing, Double Row Spherical..... | 2 |
| 2 | 177-059 | Eyebolt, M20 | 2 | 30 | 211-002-06 | Crankshaft..... | 1 |
| 3 | 211-703 | Fitting, 90 Elbow..... | 2 | 31 | 211-068 | Key, Shaft..... | 1 |
| 4 | 211-706 | Tube, Radiused | 1 | 32 | 211-052 | Gasket, Back Cover | 1 |
| 5 | 211-704 | Fitting, Run Tee | 1 | 33 | 211-007 | Cover, Back..... | 1 |
| 6 | 189-312 | Plug, 1 NPT SST | 1 | 34 | 211-066 | Stud, M20 | 4 |
| 7 | 211-707 | Tube, Straight | 1 | 35 | 211-056 | Gasket, Crankcase Front | 1 |
| 8 | 211-705 | Plug, Oil Drain | 1 | 36 | 211-404-01 | Plunger P, High Pressure, 2"..... | 3 |
| 9 | 211-054 | Gasket, Bottom Cover..... | 1 | | 211-404-02 | Plunger Q, High Pressure, 1.875"..... | 3 |
| 10 | 211-901 | Cover, Bottom, Welded Assy | 1 | 37 | 211-344 | Clamp, Plunger, CB Side | 3 |
| 11 | 211-059 | Screw, HHCS, M10 | 16 | 38 | 211-345 | Clamp, Plunger, Threaded Side..... | 3 |
| 12 | D40-037-2110 | O-ring | 2 | 39 | 211-020 | Screw, SHCS, M8 | 6 |
| 13 | 211-043 | Bearing Carrier..... | 2 | 40 | 211-067 | Nut, Flanged, M20..... | 4 |
| 14 | 211-058 | Screw, HHCS, M14 | 12 | 41 | 211-055 | Magnet, Ceramic Ring | 1 |
| 15 | 211-051 | O-ring | 2 | 42 | 211-053 | Gasket, Top Cover | 1 |
| 16 | 211-029 | Seal, Radial Shaft | 2 | 43 | 211-021 | Cover, Top | 1 |
| 17 | 211-046 | Seal Carrier, Shaft End | 1 | 44 | 211-037 | Cap, Oil Fill, Assembly | 1 |
| 18 | 211-045 | Seal Carrier, Blind End..... | 1 | 45 | 189-565 | Screw, Pan Head | 6 |
| 19 | G10-029-2010 | Screw, HHCS, M10 | 36 | 46 | 177-459 | Plug, 1/2-14 NPT | 1 |
| 20 | 211-018 | Washer, Spherical, Assembly | 3 | 47 | 211-063 | Adaptor, Float Switch | 1 |
| 21 | 211-019 | Adaptor, Plunger..... | 3 | 48 | 177-453-02 | Float Switch, Normally-Closed (NC) ... | 1 |
| 22 | 211-015 | Spring, Disc..... | 9 | | 177-453-03 | Float Switch, Normally-Open (NO) | 1 |
| 23 | 211-023 | Screw, SHSS, M16..... | 3 | 49 | 211-064 | Baffle, Float Switch..... | 1 |
| 24 | 211-005-02 | Crosshead | 3 | 50 | 211-065 | Screw, FHSS, M4..... | 2 |
| 25 | 211-003-02 | Rod, Connecting, Assembly..... | 3 | 51 | 211-071 | End Cap, Baffle | 1 |
| 26 | 211-008 | Wrist Pin | 3 | 52 | C23-010-2110 | O-ring | 1 |
| 27 | 211-014 | Screw, Set, M8 | 6 | 53 | 177-198 | Nameplate | 1 |
| 28 | 211-041 | Bearing, Split Shell (pair) | 3 | 54 | 177-196 | Scew Nail, Size 4 | 4 |

T200 Series High Pressure - Troubleshooting

Cavitation

- Inadequate fluid supply because:
 - Inlet line collapsed or clogged
 - Clogged line strainer
 - Inlet line too small or too long
 - Air leak in inlet line
 - Worn or damaged inlet hose
 - Suction line too long
 - Too many valves and elbows in inlet line
- Fluid too hot for inlet suction piping system
- Air entrained in fluid piping system
- Aeration and turbulence in supply tank
- Inlet vacuum too high (refer to “Inlet Calculations” paragraph)

Symptoms of Cavitation

- Excessive pump valve noise
- Premature failure of spring or retainer
- Volume or pressure drop
- Rough-running pump
- Premature failure

Drop in Volume or Pressure

A drop in volume or pressure can be caused by one or more of the following:

- Air leak in suction piping
- Clogged suction line or suction strainer
- Suction line inlet above fluid level in tank
- Inadequate fluid supply
- Pump not operating at proper RPM
- Relief valve bypassing fluid
- Worn pump valve parts
- Foreign material in inlet or outlet valves
- Loss of oil prime in cells because of low oil level
- Ruptured diaphragm
- Cavitation
- Warped manifold from overpressurized system
- O-rings forced out of their grooves from overpressurization
- Air leak in suction line strainer or gasket
- Cracked suction hose
- Empty supply tank
- Excessive aeration and turbulence in supply tank
- Worn and slipping drive belt(s)
- Worn spray nozzle(s)
- Cracked cylinder

Pump Runs Rough

- Worn pump valves
- Air lock in outlet system
- Oil level low
- Wrong viscosity of oil for cold operating temperatures (change to lighter weight)
- Cavitation
- Air in suction line
- Restriction in inlet/suction line
- Hydraulic cells not primed after changing diaphragm
- Foreign material in inlet or outlet valve
- Damaged diaphragm
- Fatigued or broken valve spring

Premature Failure of Diaphragm

- Frozen pump
- Puncture by a foreign object
- Elastomer incompatible with fluid being pumped
- Pump running too fast
- Excess pressure
- Cavitation
- Aeration or turbulence in supply tank

Valve Wear

- Normal wear from high-speed operation
- Cavitation
- Abrasives in the fluid
- Valve incompatible with corrosives in the fluid
- Pump running too fast

Loss of Oil

- External seepage
- Rupture of diaphragm
- Frozen pump
- Worn shaft seal
- Oil drain plug or fill cap loose
- Valve plate and manifold bolts loose

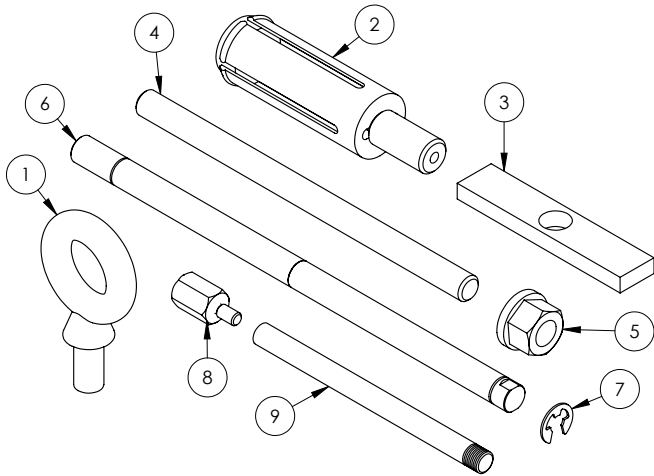
Premature Failure of Valve Spring or Retainer

- Cavitation
- Foreign object in the pump
- Pump running too fast
- Spring/retainer material incompatible with fluid being pumped
- Excessive inlet pressure

T200 Series High - Tool Kit and Pump Storage

T200 High Pressure Tool Kit

The T200 High Pressure Tool Kit (Part No. 211-800) contains the tools illustrated below. These tools are used to assist in the repair and maintenance of the T200P and Q. See the maintenance sections of this manual for specific application.



WARNING: Item 1 used to lift manifold only. Do not use to lift entire pump. Attempting to lift entire pump with Eyebolt (3) may cause personal injury or damage to equipment.

Pump Storage for T200 High Pressure

CAUTION: If the pump is to be stored more than six months take the following steps to protect against corrosion:

After Shut Down of the pump:

1. Drain all process fluid from pump. Do not drain oil from the pump.

CAUTION - Do not store the pump without oil in the reservoir.

2. Flush the fluid end of the pump with a corrosion inhibitor that is compatible with the diaphragm material and process fluid.

3. Coat camshaft or crankshaft with rust preventative; wrap with wax-impregnated cloth and then with waterproof tape.

4. Plug the suction and discharge ports of the pump to protect against dirt and moisture.

5. Store in a clean, dry place.

Prior to Start-up of the pump:

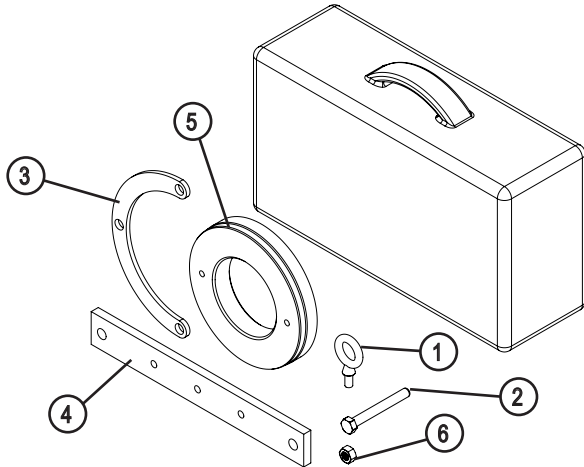
1. Drain and refill the hydraulic end of the pump with the appropriate oil.

| Ref. No. | Tool Part No. | Tool Description | Quantity/Kit |
|----------|---------------|---|--------------|
| 1 | 177-059-01 | Eyebolt, M20 | 2 |
| 2 | 177-918 | Check Valve Extractor..... | 1 |
| 3 | 211-801 | Reaction Bar..... | 1 |
| 4 | 211-802 | Threaded Rod, 3/4-10 | 1 |
| 5 | 211-803 | Flanged Nut, 3/4-10..... | 1 |
| 6 | 211-081 | Extended Stud | 4 |
| 7 | 211-082 | Clip, E-Style | 4 |
| 8 | 177-157 | Threaded Adaptor, Check Valve Extractor to Slide Hammer | 1 |
| 9 | 177-140 | Outlet Check Valve Extractor, Flanged | 1 |

T200 Series High - Crankshaft Kit and Instructions

T200 Crankshaft Tool Kit

The T200 Crankshaft Tool Kit (Part No. 211-812) contains the tools illustrated below. These tools are used to assist in installation and removal of the crankshaft.



NOTE: Thread eyebolts (1) completely into crank alignment donut (5) before use.

| Ref. No. | Tool Part No. | Tool Description | Quantity/Kit |
|----------|---------------|-------------------------------|--------------|
| 1 | 177-058 | Eyebolt, M10 | 2 |
| 2 | 211-072 | HHCS, M12 | 3 |
| 3 | 211-805 | Bar, Crankshaft Install | 1 |
| 4 | 211-806 | Bar, Crankshaft Removal | 1 |
| 5 | 211-808 | Donut, Crank Alignment..... | 1 |
| 6 | A04-045-2010 | Nut, Hex M12..... | 3 |

Crankshaft Installation

Crankshaft installation (with properly seated main roller bearing) can be aided with the use of the Crankshaft Lifter (P/N 211-708-99), plastic Crankshaft Alignment Donut (5) along with the curved Crankshaft Installation Bar (3). The crankshaft end should be fully inserted into the liner, and the eyebolt centered over the correct mark on the lifter before lifting. The donut is seated against the blind-side main bearing before installation, and helps to pilot the crankshaft into the bearing carrier. The Installation bar is attached to the interior face of the blind-side bearing carrier with three hex-head cap bolts (2) and nuts (6), and helps to push the main roller bearing into the bearing carrier. The provided bolts (with nuts already threaded on) are turned into the blind bores in the bearing carrier while the nuts bear against the curved bar. By turning each bolt in a little bit at a time in turn,

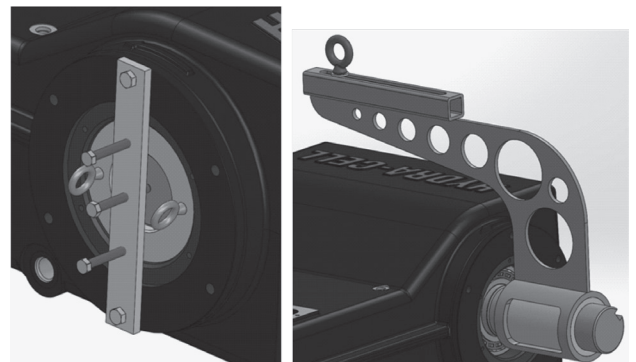
the main roller bearing axis will remain mostly concentric with the bearing carrier bore. This allows the main roller bearing to be “pushed” into the bearing carrier. Parts utilized for this operation are included in the T200 Crankshaft Kit (P/N 211-812).



Crankshaft Alignment Donut Crankshaft Installation Bar

Crankshaft Removal

Removal of the crankshaft can be aided with the use of the Crankshaft Lifter (P/N 211-708-99), plastic Crankshaft Alignment Donut (5) and the Crankshaft Removal Bar (4). With the donut seated against the blind-side main roller bearing, the bar is bolted to the crankcase with two of the bearing carrier bolts, as shown in Figure below. Three of the provided bolts (2) are then turned through the threaded holes in the bar until the outer bolts are seated against the donut, and the center bolt is seated against the end of the crankshaft. By turning each of these repeatedly in succession, the crankshaft (along with seated main roller bearing) can be pushed out of the bearing carrier and removed from the pump.



Crankshaft Removal Bar

**Crankshaft Lifter
(P/N 211-708-99)**

T200 High Pressure - Replacement Parts Kits

TO ORDER REPLACEMENT PARTS KIT: A Replacement Parts Kit contains 14 digits corresponding to customer-specified design options.

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|----|----|----|
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
|---|---|---|---|---|---|---|---|---|----|----|----|

| Digit | Order Code | Description |
|-------|------------|--|
| 1-4 | | Pump Configuration |
| | T200 | For all T200 Series Pumps |
| 5 | | Performance |
| | H | High Pressure (T200P, T200Q) |
| 6 | | Pump Head Version |
| | D | Diaphragm Kit |
| | V | Valve Kit |
| 7 | | Pump Head Material |
| | 5 | Metallic Pump Head Version |
| 8 | | Diaphragm & O-ring Material |
| | G | FKM |
| | T | Buna-N |
| 9 | | Valve Seat Material |
| | H | 17-4 PH Stainless Steel |
| | N | Nitronic 50 |
| | T | Hastelloy C |
| | X | Not included in Diaphragm Kit |
| 10 | | Valve Material |
| | F | 17-4 PH Stainless Steel |
| | N | Nitronic 50 |
| | T | Hastelloy C |
| | X | Not included in Diaphragm Kit |
| 11 | | Valve Springs |
| | E | Elgiloy |
| | T | Hastelloy C |
| | X | Not included in Diaphragm Kit |
| 12 | | Valve Spring Retainers |
| | T | Hastelloy C |
| | X | Not included in Diaphragm Kit |

*Tungsten carbide valves are not yet available for the T200.

T200 High Pressure Kit V Contents

| Part Number** | Description | Quantity |
|---------------|----------------------------|----------|
| 211-464-__ | Seat, Valve | 6 |
| 211-414-__ | O-ring | 6 |
| 211-439-__ | Disc, Valve, Stem-guided | 6 |
| 211-421-01 | Spring, | 6 |
| 211-438 | Bushing, Valve Stem, Celon | 6 |
| 211-473-__ | Retainer, Valve Spring | 6 |
| 211-434 | Ring, Backup | 6 |
| 211-415-__ | O-ring | 6 |

** Last two digits of part numbers with __ refer to specific material of construction.

T200 High Pressure Bias Rod Assembly Kit

(Part No. 211-814)

| Part Number | Description | Quantity |
|-------------|------------------|----------|
| 211-406 | Clamp, Diaphragm | 1 |
| 211-409 | Spring, Bias | 1 |
| 211-310 | Guide, Spring | 1 |
| 211-311 | Pin, Spring | 1 |
| 211-412 | Rod, Bias | 1 |
| 211-313 | Valve, Spool | 1 |
| 211-335 | Washer, Bias | 1 |
| 211-369 | Nut, Castle, M6 | 1 |
| 211-374 | Stop, Spool | 1 |
| 211-419 | Pin, Dowel | 1 |

T200 High Pressure Kit D Contents

| Part Number** | Description | Quantity |
|---------------|--------------|----------|
| 211-403-__ | Diaphragm | 3 |
| 211-467 | Ring, Backup | 3 |
| 100-217-__ | O-ring | 6 |

T200 High Pressure Hydraulic End Kit

(Part No. 211-815)

| Part Number | Description | Quantity |
|-------------|---------------------------|----------|
| 177-904 | Assembly, Underfill Valve | 3 |
| 177-905 | Assembly, Overfill Valve | 3 |
| 177-906 | Assembly, Air Bleed Valve | 3 |
| 211-056 | Gasket, Diaphragm Plate | 1 |
| 211-308 | Nut, Bias Spring Retainer | 3 |
| 211-814 | Bias Rod Assembly | 3 |

T200 - Warranty

Limited Warranty

Wanner Engineering, Inc. ("Wanner") extends to the original purchaser of equipment supplied or manufactured by Wanner and bearing its name, a limited one-year warranty from the date of purchase against defects in material or workmanship, under normal use and service, and provided the equipment is installed, operated and maintained in accordance with instructions supplied by Wanner. Wanner will repair or replace, at its option, defective parts without charge if: (a) you provide written notice of any defect within thirty (30) days from the discovery of the defect; (b) the claim is received by Wanner before the expiration of the warranty period; and (c) such parts are returned with transportation charges prepaid to Wanner Engineering, Inc., 1204 Chestnut Avenue, Minneapolis, Minnesota 55403. A return goods authorization must be received prior to the return of the defective part. No allowance will be made for repairs undertaken without Wanner written consent or approval.

Notwithstanding anything to the contrary, this warranty does not cover:

1. Electric motors (if applicable) not manufactured by Wanner. The warranties, if any, on such equipment are assigned to you by Wanner (without recourse) at the time of purchase.
2. Normal wear and/or damage caused by or related to abrasion, corrosion, abuse, negligence, accident, faulty installation or tampering which impairs normal operation.
3. Transportation costs.

This limited warranty is exclusive, and is in lieu of any other warranties (oral, express, implied or statutory) including, but not limited to, implied warranties of merchantability and fitness for a particular purpose; warranties of non-infringement; warranties arising from course of dealing or usage of trade or any other matter. Any descriptions of the equipment, drawings, specifications, and any samples, models, bulletins, or similar material used in connection with the sale of equipment are for the sole purpose of identifying the equipment and are not to be construed as an express warranty that the equipment will conform to such description. Any field advisory or installation support is advisory only. Every form of liability for direct, special, incidental or consequential damages or loss is expressly excluded and denied. All liability of Wanner shall terminate one (1) year from the date of purchase of the equipment.

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