Stirring Fluid Loss Assembly
Instruction Manual

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Instrument No. 210194

Fann Instrument Company

Stirring Fluid Loss Assembly Instruction Manual

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1 Introduction

The Stirring Fluid Loss Assembly simulates filtration at downhole conditions in a wellbore. This test instrument determines the volume of fluid loss (filtrate) from a cement slurry, water-based mud or fracturing fluid at a set temperature and pressure. The test results are used to evaluate the fluid-loss control properties.

By controlling the fluid loss during cementing operations, the cement job will be more successful. Adding various chemicals to a cement slurry will minimize fluid loss. If fluid is lost, then cement viscosity and hydration rate will increase and circulation rate will decrease.

The advantage of this instrument is that slurry preconditioning and testing are performed in the same cell, eliminating the need to cool or transfer hot test slurry, possibly changing the properties of the test slurry.

The Stirring Fluid Loss Assembly is designed for conformance with relevant standards and practices as published by API Subcommittee 10 on Well Cements.

1.1 Document Conventions

The following icons are used in this manual as necesary.

NOTE. Notes emphasize additional information that may be useful to the reader.

CAUTION. Describes a situation or practice that requires operator awareness or action in order to avoid undesirable consequences.

MANDATORY ACTION. Gives directions that, if not observed, could result in loss of data or in damage to equipment.

WARNING! Describes an unsafe condition or practice that if not corrected, could result in personal injury or threat to health.

ELECTRICITY WARNING! Alerts the operator that there is risk of electric shock.

HOT SURFACE! Alerts the operator that there is a hot surface and that there is risk of getting burned if the surface is touched.

EXPLOSION RISK! Alerts the operator that there is risk of explosion.

2 Safety

Safe operation of the Stirring Fluid Loss Test Assembly requires the operator understand and practice the correct assembly and operation of the equipment. Improper assembly, operation, or the use of defective parts increases the likelihood of cell leakage or failure, which could result in serious injury and damage.

The slurry sample cell (reservoir) and the heating jacket are hot during operation. The operator should be aware of these hot areas and avoid contact with them. Burns can result from touching hot parts of the equipment during normal operation.

These instruments are electrically heated. As with any electric device, the wiring should be regularly checked for bad connections. These instruments should always be used on a grounded circuit.

The following sections discuss practices that should be observed to assure safe operation and maintenance of the Stirring Fluid Loss Test Assembly.

2.1 Safe Pressurization

The Stirring Fluid Loss Test Assembly uses nitrogen gas to pressurize and compressed air to cool. Nitrogen must be supplied in an approved nitrogen gas cylinder or the nitrogen supply system must be built into the laboratory. Nitrogen cylinders must be secured to meet safety standards.

Maintain pressure regulators in good condition. Never use oil on pressure regulators. Leaking pressurizing systems should be repaired or replaced. Gauges, fittings and hoses should be kept in good condition and any leaks should be promptly located and corrected.

When pressurizing the cell, always open the supply pressure first, and then adjust the regulator. Do not attempt to pressurize higher than the equipment is rated. When de-pressurizing, shut off the supply pressure, bleed the system of pressure, and then back out the regulator knob.

2.2 Safe Heating

Caution should be exercised by all personnel using the Stirring Fluid Loss Test Assembly or working nearby to avoid accidental injury caused by touching the test cell (reservoir) or heating jacket while it is hot. Safeguard the equipment after the test ends long enough for it to cool. Even after the instrument has been turned off, it can still be hot enough to cause burns.

2.3 Safe Electrical Operation

Make sure the electrical source is fused and grounded. Verify the power cord on the instrument is in good condition and that it has the proper ground connection.

Electrical problems may not be obvious by looking at the equipment. If the unit blows fuses or trips breakers, the heating time seems longer than normal or the temperature controller does not reliably maintain temperature, then electrical repair may be required. Refer to Section 7 Troubleshooting and Maintenance.

Always disconnect the power cable before attempting any repair.

2.4 Safe Test Cell Maintenance

The test cell (reservoir or sample chamber) and paddle cap constitute a pressure vessel. These safety precautions should be followed to assure safe operation:

1. The cell body and cap material should be compatible with the test sample.
2. Cell bodies with cracks, severe pitting, or damaged threads must not be used.
3. Cell caps with damaged threads, paddle shaft, or blades must not be used.

3 Features and Specifications

The Stirring Fluid Loss Test Assembly is equipped with a stirrer to simulate circulation and a heating jacket to simulate the bottomhole circulating temperature (BHCT). The pressure differential between annular and formation pressure is simulated by pressurized nitrogen. A 325 micron mesh screen (or a porous core) and a filtration chamber simulate the permeable zone. A control panel allows precise setting and controlling of the temperature and pressure.

Operators use this instrument to perform standard tests outlined in the American Petroleum Institute (API) Recommended Practice (RP) for Testing Well Cements, API RP 10B-2.

The instrument is shown in Figure 3-1 with labels identifying its components. Refer to Table 3-1 for the instrument specifications. The following sections describe its features in detail.

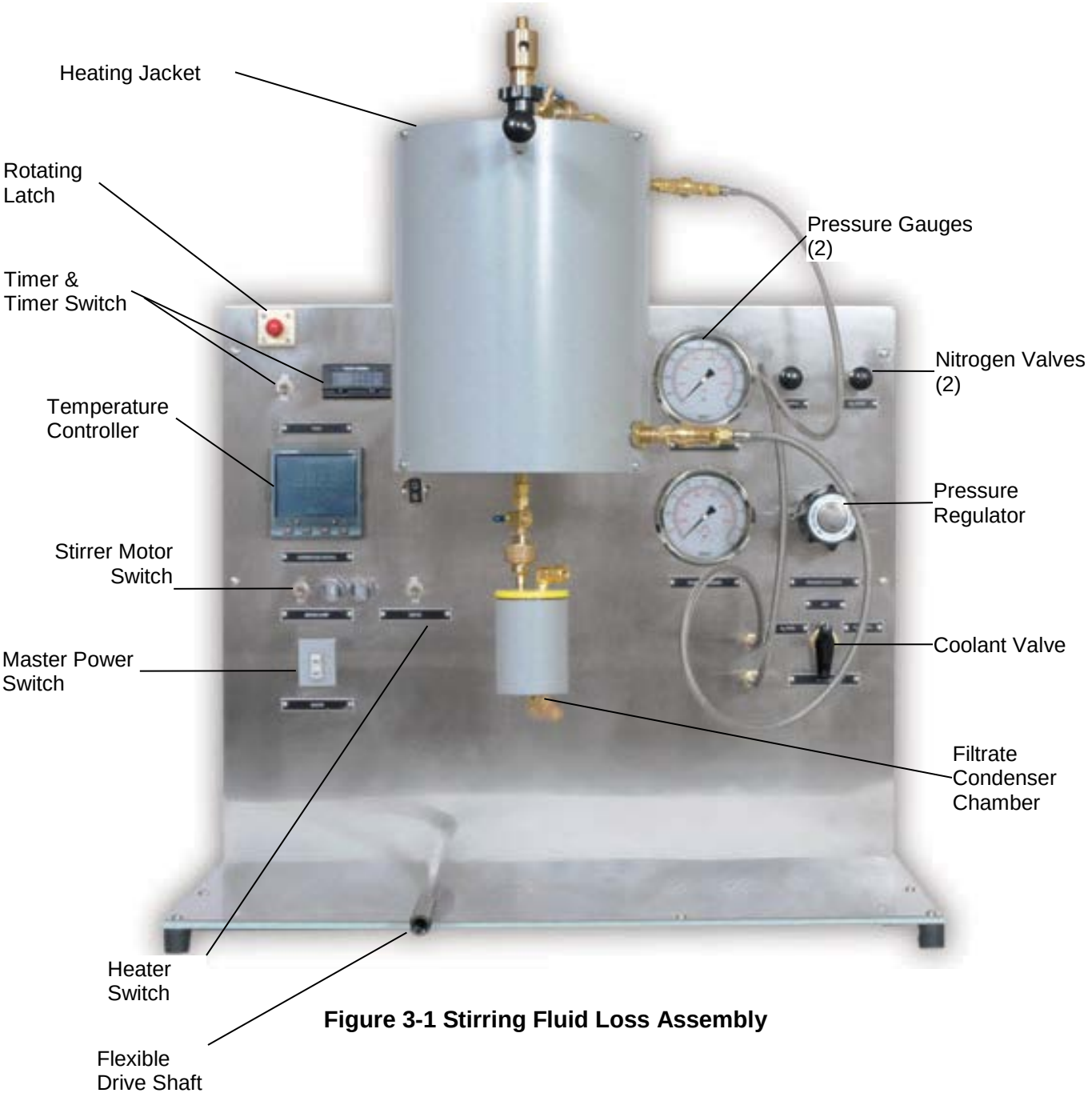


Figure 3-1 Stirring Fluid Loss Assembly

Table 3-1 Stirring Fluid Loss Test Assembly Specifications

Category	Specification
Maximum Temperature	400°F (204°C)
Maximum Pressure	2,000 psi (13.8 MPa)
Pressure Required	1,500 psi (10.3 MPa), Nitrogen gas
Filtering Area	3.5 in^2 (22.6 cm^2)
Sample Chamber (1)	
Diameter x Length (excludes valves)	3.25 x 12.0 in 8.26 x 30.5 cm
Volume (maximum fluid capacity)	701 mL
Weight (chamber and cell caps)	17.0 lb (7.71 kg)
Frame	
Depth x Width x Height	28.0 x 24.0 x 23.5 in 71.1 x 61.0 x 59.7 cm
Weight	283 lb (128 kg)
Pressure Connection	Nitrogen, 1/8 Female NPT
Air Inlet Connection	1/4 Female NPT
Water Inlet & Drain Connections	1/4 Female NPT
Voltage and Current	50–60 Hz 230 VAC, 9A

3.1 Stirring Fluid Loss Mechanical

A durable, stainless steel, base plate and frame supports the heating jacket and sample chamber and also houses built-in features - pressure and coolant controls, a temperature controller and a digital timer. Refer to Figure 3-1.

3.1.1 Paddle Cap Assembly

The paddle cap assembly, which is the stirring apparatus, consists of a paddle shaft with paddles that connect to cell cap. The cell cap has a pressure supply valve to allow pressure to flow in and out of the cell. See Figure 3-2.

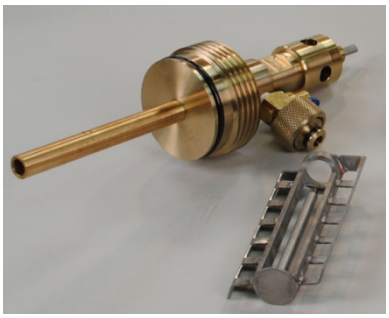


Figure 3-2 Paddle Shaft and Cell Cap

3.1.2 Sample Chamber

The sample chamber (cell or reservoir) is where the slurry sample is added and stirred at set temperature and time (conditioning). The paddle cap assembly is inserted into the sample chamber. The sample chamber is inserted into the heating jacket and held securely with a locking plate.

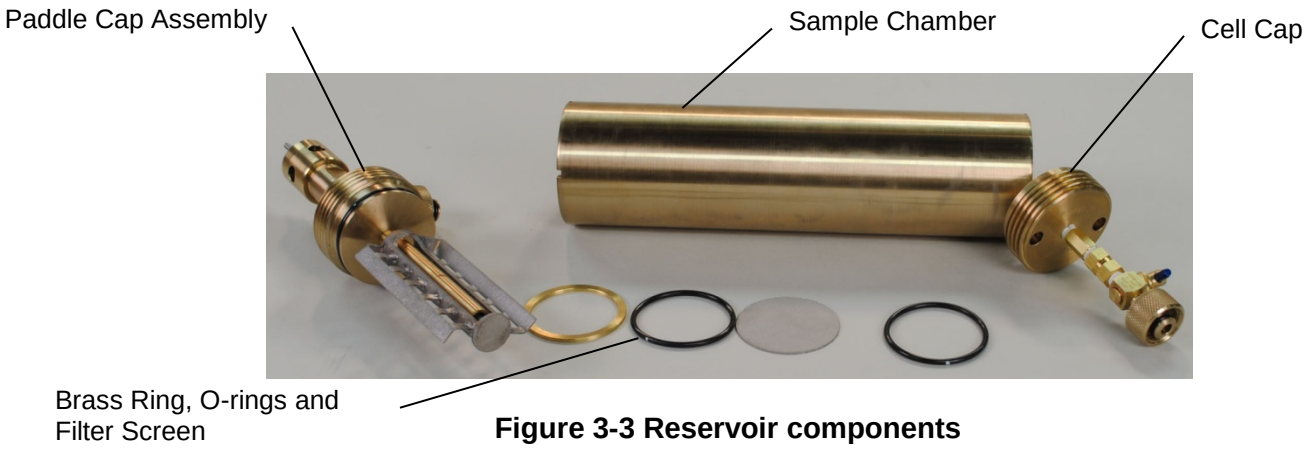


Figure 3-3 Reservoir components

3.1.3 Filtrate Condenser Chamber

The filtrate condenser chamber (filtrate unit) attaches to the cell cap. Fluid flows through a 325 mesh screen that is on the cap and through the filtrate unit, where it is cooled. The screen and filtrate chamber simulate a permeable zone. The filtrate condenser chamber and cooling system keep the filtrate from turning into steam when the test temperatures are 200°F (95°C) or greater.

The Stirring Fluid Loss Assembly comes with two filtrate condenser chambers — a standard unit and a back pressure unit with external copper tubing. See Figures 3-4 and 3-5 for the standard chamber and the back pressure chamber, respectively.

The back pressure unit is necessary when testing cement slurry containing salt at test temperatures greater than 212°F (100°C).

If back pressure is not applied, the filtrate will flash to steam when exiting the fluid loss cell and the salt will plug the small capillary tube that goes through the standard filtrate condenser. The test results will indicate that the slurry has an extremely low fluid loss when it may actually be high.

When the back pressure receiver is used, the filtrate never goes to steam. Instead pressure is maintained on the back pressure receiver to keep the filtrate as a liquid. In the back pressure receiver, the filtrate is cooled below the boiling point.

Figure 3-4 Filtrate Condenser Chamber, Standard

Figure 3-5 Filtrate Condenser Chamber, Back Pressure

3.2 Stirring Fluid Loss Controls

The control panel is divided into two sections – electrical controls on the left and pressure and coolant controls on the right.

3.2.1 Electrical Controls

The electrical controls and their functions are described below.

- **Master Power Switch** (**Master**) controls all the electrical power to the different controls.
- **Temperature Controller** (**Temperature Control**) controls the rate of the temperature rise (ramp) and the final set point temperature of the test slurry. See Section 5 for complete operating instructions. A Type J thermocouple must be used to measure the temperature.
- **Motor Switch and Fuse** (**Motor/2Amp**) supplies power to the paddle drive motor that is mounted behind the panel.
- **Timer** is an elapsed timer used to time the test duration, stirring time and fluid loss duration. A switch turns the timer on and off.
- **Heater Switch** controls power to the heater.

Figure 3-6 Electrical Controls

3.2.2 Pressure and Coolant Controls

Fluid loss tests performed with the provided reservoir should not be performed with pressures exceeding 1,500 psi (6.9 MPa).

The pressure and coolant controls and their features are described below.

Figure 3-7 Pressure and Coolant Controls

- **Supply Pressure** gauge measures the supply pressure.
- **Chamber Pressure** gauge measures the pressure in the chamber.
- **Nitrogen Supply Valve (N_2 Supply)** is the main nitrogen supply valve for the complete gas pressure system. The gauge registers incoming nitrogen pressure from the supply valve.
- **Nitrogen Vent Valve (N_2 Vent)** relieves all pressure from nitrogen manifolding and test chamber during operating procedures.
- **Pressure Regulator** regulates nitrogen pressure to the test chamber.
- **Coolant Valve** controls coolant flow to filtrate unit and heating jacket upon test completion. The three-way valve allows water or air to flow through. The valve positions are
    - **H_2O Cool** for water flow; arrow points to the right

- **Air Cool** for air flow; arrow points to the left
- **Off** to shut off; arrow points up

4 Installation

The Stirring Fluid Loss Test Assembly can generally be placed to suit the available space and the desires of the lab personnel, consistent with established work processes. Some environments encourage a right-to-left flow, while others are left-to-right.

Consideration should be given to the location of the sample preparation area and cleaning the cells following test completion.

The pressurizing system may also dictate installation-specific requirements, such as having a large compressed gas cylinder secured nearby.

There should be sufficient storage area for commonly used tools and consumable items.

Customer installed wiring, electrical connectors, and power cords are excluded from the warranty.

A Fann representative is available to install and set-up the instrument if necessary.

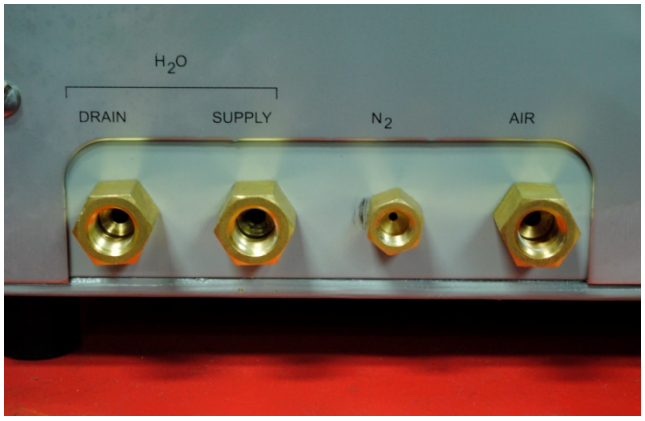


Figure 4-1 Back Panel

5 Operation

This section gives detailed instructions on operating the instrument. The following sections describe how to

- Pre-test the Instrument
- Load the Sample Chamber
- Pre-heat the Sample Chamber
- Start the Stirring Fluid Loss Test
- End the Stirring Fluid Loss Test
- Disassemble and Clean the Equipment
- Reassemble the Equipment

5.1 Pre-test the Instrument

1. Arrange sample chamber (also called reservoir, cylinder, or test cell) parts for assembly. Check all O-rings for nicks, abrasions, cement debris and brittleness. Replace damaged O-rings.
2. Lubricate threads and O-rings with heavy grease to make cleanup easier after testing is complete.
3. Check the filter screen for plugging or holes in the support plate.
4. Spin the paddle and shaft, listen for grinding sound, and feel for tightness. Refer to Section 7 Troubleshooting and Maintenance for servicing, if required.
5. Screw paddle cap assembly in one end of the sample chamber and hand-tighten. Paddle cap assembly should be as nearly flush as possible with chamber end.
6. Insert sample chamber (open end first) into the heating jacket.
7. Rotate the chamber slowly clockwise to ensure the notches engage the screws on heating jacket end.
8. Make sure the nitrogen pressure port on the sample chamber points away from you. If not, lift chamber slightly and rotate it a half turn, and recheck.
9. Swing locking plate into position to hold chamber in heating jacket. Use hand knob to tighten.
10. Attach supply pressure line that is coiled on heating jacket mount to the coupling on the side of the paddle cap assembly. Hand-tighten only.
11. To release heating jacket, pull the red knob and rotate the heating jacket 180 degrees. Pushing the knob latches the heating jacket in its new position.
12. Rotate the paddle shaft to same position as flexible drive shaft.
13. Attach flexible drive shaft into position and hand-tighten the flexible shaft collar.

Figure 5-1 Flexible Drive Shaft

14. Turn the instrument on by moving the **Master s**witch (front panel) to the **On** position.
15. Start stirring motor by moving the **Motor** switch (front panel) to the **On** position. Note that the paddle and shaft are turning properly. If necessary, review Section 7 for troubleshooting and maintenance instructions. Turn off the stirring motor. Next, proceed with pressure test.
16. Place brass spacer ring into open end of sample chamber.
17. Install O-ring on top of brass spacer ring (no grease applied). Make sure O-ring is well seated against spacer ring.
18. Insert the filter screen with fine mesh side facing down.
19. Insert a second O-ring (slightly greased) on top of the screen.
20. Screw cell cap onto the reservoir end. It should be as nearly flush as possible with reservoir end. Use special wrench to tighten the cap.
21. Close the supply pressure valve on the cap.
22. Close the nitrogen vent, **N_2 Vent**.
23. Slowly open nitrogen supply, **N_2 Supply** and listen for leaks.
24. Open supply pressure valve on the paddle cap assembly.
25. Rotate nitrogen pressure regulator to 1000 psi (7000 kPa). API RP10B-2 recommends 1000 ± 50 psi (7000 ± 300 kPa) be maintained during the test.

Do not exceed 1500 psi. Chamber pressure should allow for 100 psi differential between chamber pressure and backpressure system (not to exceed 500 psi).

26. Check for leaks. If there are no leaks, bleed off. If there are leaks, then check the valves, O-rings, packing, and make adjustments.
27. Remove the cell cap, O-rings and brass ring and proceed with adding the sample and running the test.

Reservoir cylinders and caps which show signs of cracking, severe pitting, or have damaged threads must not be used.

5.2 Load the Sample Chamber

1. Pour the slurry sample down the side of sample chamber to avoid getting slurry on top of paddle or down the paddle shaft. Fill only to top blade, not to the top of paddle. This volume is approximately 320 mL.

Do not overfill the reservoir. A potential hazard may result due to thermal expansion.

2. Place brass spacer ring into open end of sample chamber.
3. Install O-ring on top of brass spacer ring (no grease applied). Make sure O-ring is well seated against spacer ring.
4. Insert the filter screen facing the slurry sample (down).
5. Insert a second O-ring (slightly greased) on top of the screen.

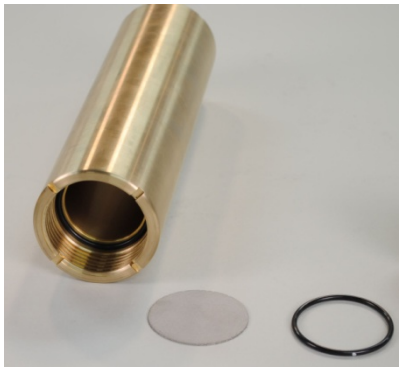


Figure 5-2 Brass Spacer and O-ring in Sample Chamber

Figure 5-3 Screen and O-ring in Sample Chamber

6. Screw cell cap onto end of reservoir. It should be as nearly flush as possible with reservoir end. Use special wrench to tighten the cap.
7. Close the supply pressure valve on the cap.
8. Start the stirring motor.

Wear thermally protective gloves when removing or inserting the heated fluid loss reservoir. The reservoir and heating jacket will be hot.

The fluid loss reservoir assembly constitutes a pressure vessel. The safety precautions listed in Section 2.1 should be followed to assure safe operation.

Do not exceed 1500 psi. Chamber pressure should allow for 100 psi differential between chamber pressure and backpressure system (not to exceed 500 psi).

5.3 Preheat the Sample Chamber

1. The sample chamber with test sample should be in the heating jacket and ready for preheating. See Section 5.2
2. Connect the Type J thermocouple to the thermocouple jack on the front of the instrument. Insert the thermocouple into the hole in the test cell.

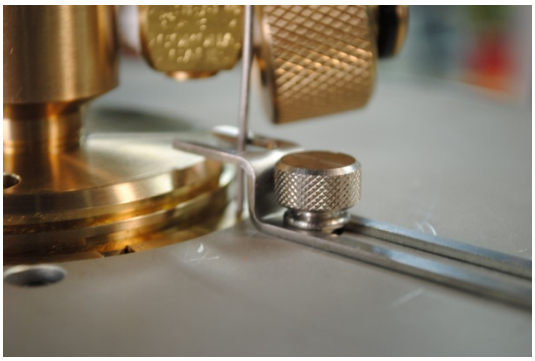


Figure 5-4 Thermocouple inserted in sample cell

To change program setting on the temperature controller, use up ▲ or down ▼ buttons to change the displayed value. After releasing the button, the display will blink to show the temperature controller has accepted the new value.

3. With **Temperature Control** set on **Manual**, press page button until screen displays **ProG LiSt**. Next choose **SEG.n**. Use up or down buttons to change value to 1.
4. Press the scroll button until the screen displays **tYPE**. Use up or down buttons to select **rmP.t**.
5. Press to **Hb.** Use up or down buttons to change to **bAnd**.
6. Press to **tGt** . Use up or down buttons to enter the BHCT. The temperature (^{o}F or ^{o}C) is set when the display blinks.
7. Press to **Dur**. Use up or down buttons to set the ramp time (minutes). Wait for the display to blink indicating that the time has been set.
8. Press to **SEG.n**. Use up or down buttons to change value to 2.
9. Press to **tYPE**. Set to **End** using up or down buttons.
10. Press to **End.t**. Set to **dwEll** using up or down buttons.
11. Change the temperature controller setting to **AUTO** and press **RUN** to proceed with programmed heating schedule.

12. Turn on the **Heater**.

13. Set **Timer (**front panel) to 0 (zero) minutes. Set a hand-held clock with an alarm to go off at to 30 minutes **plus** the heating time (minutes).

14. Occasionally, check the unit to make sure it is heating properly.

5.4 Start the Stirring Fluid Loss Test

1. Continue stirring sample until it reaches BHCT (bottomhole circulating temperature) and maintains that temperature for 30 minutes.

2. At 30 minutes after BHCT is reached, connect filtrate unit to sample chamber. Hand- tighten the filtrate unit. See Figure 5-5.

3. Turn off the stirring motor.

4. Disconnect flexible shaft (stirring cable) from paddle cap assembly.

5. Pull the red knob to unlock the heating jacket and rotate the jacket 180 degrees (upside down).

6. Push the red knob to lock jacket in new position.

7. Connect cooling hose to filtrate unit if the BHCT is ≥ 200°F (93°C). If BHCT is < 200°F (93°C), then connect the cooling hose to the heater to cool later.

8. Place a graduated cylinder or a beaker under the filtrate unit.

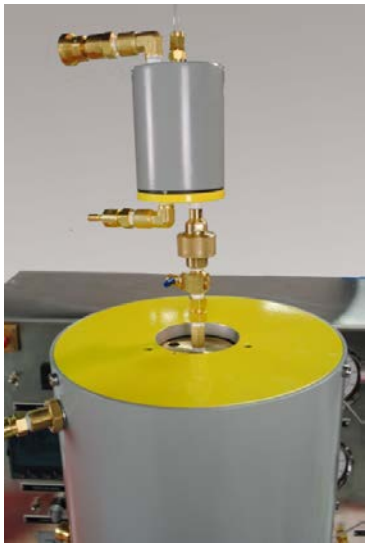


Figure 5-5 Filtrate Unit connected to the Sample Chamber

9. Open **Coolant** valve slowly for water flow, **H_2O Cool**. See Figure 5-6.

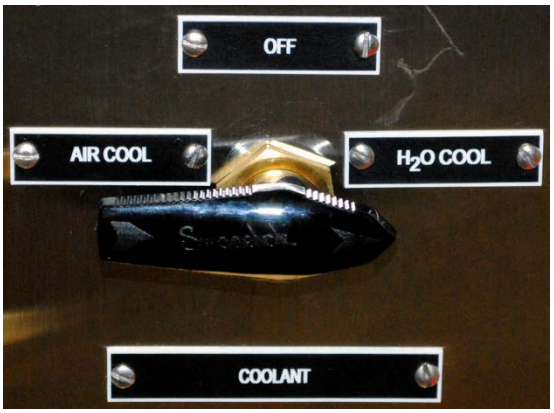


Figure 5-6 Coolant Valve open for water flow

10. After sample reaches BHCT, open valve between sample chamber and filtrate unit.

11. Start **Timer**. Begin timing fluid loss volume (mL) when valve is opened.

If slurry samples dehydrate completely (blow out) in less than 30 minutes, you will hear a hissing sound (gas released). Record the time.

12. Record the time (30 minutes maximum) and end the test.

13. If the slurry has not dehydrated after 30 minutes, stop the test.

5.5 End the Stirring Fluid Loss Test

1. Turn off the heater.

2. Close valve between sample chamber and filtrate unit.

3. Reduce nitrogen regulator pressure to approximately 200-300 psi.

4. Turn off **Coolant** valve. Valve position will be pointing up - **Off**.

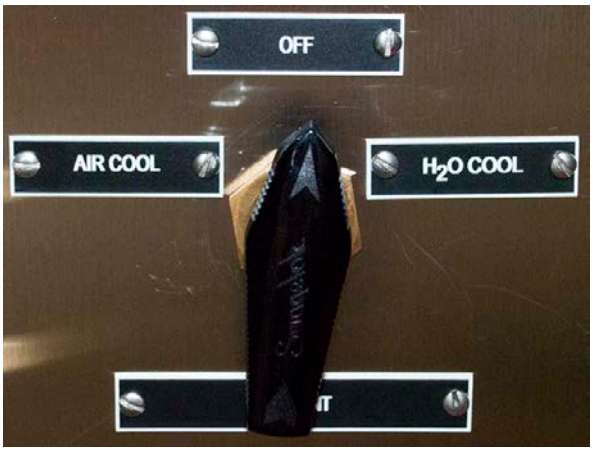


Figure 5-7 Coolant Valve in off position

5. Disconnect coolant tubes from filtrate unit and reconnect to heating jacket.

6. When temperature controller display indicates 200°F - 250°F (93°C – 121°C), rotate the **Coolant** valve slowly to flow water through the heating jacket cooling coils. This method allows faster cooling of the jacket and sample chamber.

7. When the temperature indicates approximate room temperature, rotate the **Air Cool** valve to flow air through the cooling system. This will force water out of the jacket coils. Refer to Figure 5-8.

Blow out the remanining water to prevent steam pressure from rupturing internal fittings and coils.

Figure 5-8 Coolant Valve open for air flow

8. Turn nitrogen supply and coolant valves off.
9. Release pressure setting on regulator and open nitrogen vent valve.
10. Close the sample chamber pressure supply valve.
11. Disconnect sample chamber pressure line.

Carefully remove sample chamber from heating jacket. Sample chamber may still contain pressure. If chamber is warm, place it in cool water.

Do not open valves until the chamber is completely cooled.

12. Relieve remaining chamber pressure by opening supply valve. Connection will be pointing away from you.

5.6 Disassemble and Clean Equipment

1. When pressure is completely released, back off the knob on the hold down plate and remove the cylinder from the heating unit.
2. Remove the paddle assembly, end plate, o-rings, screen and brass ring.
3. Clean these parts with water and allow it to dry before storing.
4. Attach water line to sample chamber supply fitting to flush out cement and residual slurry sample.

5.7 Reassemble Equipment

1. Insert the paddle cap assembly into the sample chamber.
2. Put sample chamber with the open end facing down into the heating jacket. Move it around until the valves and the notch on the chamber fall into place.
3. Swing locking plate into position to hold chamber in the heating jacket.
4. Secure in position by tightening hand knob.
5. Attach the nitrogen supply line. The supply valve should be open.

6. Pull the red release knob to unlock the heating jacket and rotate the heating jacket.

7. Push the red release knob to latch the chamber again.

8. Put the screen end together and test the sample chamber for leaks. Test at 1000 psi.

9. If pressure test fails, then bleed off the pressure and make adjustments where leaking occurs. Tighten the packing nut on the paddle assembly if leaking occurs there.

10. Repeat the pressure test and check for leaks.

11. If the pressure test fails again, then disassemble and replace the packing in the stirring end.

12. If the pressure test passes, then remove the screen end and attach the stirring cable to the paddle end.

13. Plug the thermocouple into the instrument and the underside of the sample chamber.

14. Place the brass ring into the open end of the sample chamber.

15. Place an O-ring on top of the brass ring.

16. Close the nitrogen vent valve and the coolant valve.

17. Reset the timer and start the next test. If no test is scheduled, then turn **Master** switch off to shut down the instrument.

6 Test Analysis

6.1 References

API Recommended Practice for Testing Well Cements, API RP 10B-2.

6.2 Results

Test results will vary.

According to API RP 10B-2, fluid loss tests that run the full 30 minutes typically show 5% variability. However, potential error increases for tests that run less than 30 minutes. For test times less than 5 minutes, the variability may be more than 30%.

A fluid loss test performed in a single laboratory on a cement slurry with a fluid-loss control additive and water, and having an average fluid-loss value of approximately 350 ml/30 min, typically has a standard deviation of approximately 84 ml/30 min and 2Vc (variability coefficient) of approximately 47%.

6.3 Variations

Variations in the procedures, the involvement of numerous people and laboratories, and the presence of multiple additives in the slurry can considerably increase test result variations. When one person performs the test on one instrument or when the fluid-loss value is low, the variation usually decreases.

To keep testing variations to a minimum, do the following:

- Keep the testing equipment in good condition, clean, and accurately calibrated.
- Perform the tests according to the prescribed procedures.
- Keep the test conditions within the acceptable limits (API or customer-specified).
- Minimize oil contamination in slurries that have been preconditioned in a high pressure-high temperature (HPHT) Consistometer.

6.4 Filtrate Volume

The volume of liquid filtrate collected is measured in milliliters (mL) to the nearest 1.0 mL. The volume is recorded at 30 seconds, and 1, 5, 10, 15, 20, and 30 minutes after the test begins.

Alternatively, the filtrate may be continuously weighed and recorded. When weighed, the filtrate specific gravity must be measured and reported at 80°F (26.7°C), and the recorded filtrate volumes corrected for specific gravity.

When a condenser is used, the filtrate volume in the condenser should be recorded.

6.5 Calculations

- For tests that run the entire 30 minutes without blowing dry, calculate API Fluid Loss as follows:

$$API\ Fluid\ Loss = 2\ Q_{30}$$

where Q_{30} is the volume of filtrate collected at 30 minutes in ml.

- If nitrogen blows through in less than 30 minutes, record the filtrate volume collected and time at which the blow-through occurs. Calculate the API Fluid Loss by the formula:

$$Calculated\ API\ \ Fluid\ Loss\ =\ 2\,Qt\ \frac{5.477}{\sqrt{t}}$$

where Qt is the volume (ml) of filtrate collected at the time t (min) of the blowout.

6.6 Reporting

When reporting the fluid loss of cement slurries, those tests where the fluid loss was measured for a full 30 minutes will be reported as “API Fluid Loss.” Those tests in which the fluid “blew out” in less than 30 minutes will be reported as “Calculated API Fluid Loss.”

7 Troubleshooting and Maintenance

Regular maintenance procedures are provided in the following sections. If your equipment needs repair or service, please contact your Fann representative.

7.1 Preventative Maintenance

Table 7-1 Preventative Maintenance Schedule

Part Name	Required Accuracy	Frequency of Calibration or Inspection
Filter Screen	n/a	Daily*
Thermometer or Thermocouple	± 2°F (±1°C)	3 months
Temperature Controller	± 2°F (±1°C)	1 month
Paddle Stirrer (speed)	140 to 180 rpm	3 months
Pressure Gauge	± 10 psi at 1000 psi	1 year

* Inspect visually before each test for plugging or tears.

7.2 Packing Replacement

1. Remove the paddle from assembly.
2. Hold drive tang and unscrew paddle, turning it counterclockwise.
3. Hold supply valve manifold and unscrew thrust bearing carrier.
4. Remove carrier.
5. Remove thrust bearing if it didn’t come off with carrier.
6. Remove packing nut from spindle housing.
7. Remove spindle.
8. Remove old packing by inserting the 0.250-inch diameter rod through standpipe and spindle housing, pushing male packing ring and packing out.
9. Clean all parts. Clean packing ring and spindle housing bore.

No cement particles should enter the packing area. Cement that is not removed will shorten the life of the new packing assembly.

10. Check parts thoroughly for wear and erosion.

11. Reassemble parts in reverse order of disassembly.

7.3 Temperature Controller and Heating Jacket

Use this procedure to test the temperature controller and heating jacket.

1. Connect a water supply of at least 40 psi to the test unit.
2. Release the heating jacket lock and rotate the sample chamber to verify the pressure lines are not binding.
3. Connect the coolant lines to the heating jacket. Rotate the coolant valve to flow water through the heating jacket. Check for leaks at all fittings. Rotate the coolant valve to **Off** position (up).
4. Set the temperature controller set point to 150°F (65.5°C). Do NOT turn on the heater switch. Feel the outside of the heating jacket for an increase in temperature. It should remain cold.
5. Turn the heater **s**witch to **On**.
6. Observe the rate of temperature increase on the controller present value (PV) display.
7. Set the temperature controller set point to 250°F (121°C).

Do NOT allow the heating jacket to rise above 200°F (93°C).

8. Observe the rate of temperature increase on the controller present value (PV) display.
9. Feel the heating jacket and note a steady temperature increase.
10. When the present value (PV) reaches 175°F (79°C), set the temperature controller to **Off**

11. Slowly rotate the coolant valve to flow water through the heating jacket until the present value (PV) is below 100°F (38°C). Then rotate the coolant valve to the closed position (up).

7.4 Pressure and Motor Check

Follow these steps to ensure proper operation:

1. Rotate the heating jacket until the handle and lock clamp are up. Verify the pressure tubing does not interfere with the rotating mechanism or heating unit.

2. Fill the sample chamber 3/8-1/2 full, approximately 400 mL with distilled water and re-assemble.

3. Install the sample chamber in the heating jacket and secure it in place with the lock plate and knob clamp. Attach the pressure line to the side pressure port on the sample chamber. Hand- tighten only. Make sure the valves on both ends of the chamber are closed, and the console nitrogen vent valve is closed. Put tygon tubing over the nitrogen vent valve outlet and the free end into a cup.

4. Connect a nitrogen source of at least 1,500 psi to the test unit. Open the supply valve on the nitrogen bottle and adjust the bottle regulator to 1,500 psi.

5. Remove the console's rear panel.

Bleed off pressure **before** tightening fittings by turning off the bottle and opening the nitrogen vent valve.

6. Slowly open the nitrogen supply valve on the front of the instrument and observe all fittings and tubing for leaks.

7. If no leaks are heard or observed on pressure gauge, slowly open the paddle cap valve. If leaks are present, the 1500 psi reading will drop. Locate the leaks.

8. Unlock and rotate the heating jacket and pressure chamber 180 degrees, then re-lock.

9. Turn rotating shaft by hand with wrench to loosen seal drag.

10. Attach the flexible rotating shaft coupling to the motor and sample chamber assembly paddle, but do not run flex shaft nut all the way up.

11. Turn the stirring motor to the on position. The shaft will rotate. Tighten the nuts and operate for 10 minutes.

12. Observe that the motor and shaft run smoothly, free of excessive noise, or change in the noise level. Check for leaks as evidenced by water on the flex shaft. Turn the stirring motor off.

13. Disconnect the drive and flip the chamber.

14. Turn off the nitrogen supply valve.

15. Slowly open the nitrogen vent valve until the gauge reads 300 psi.

16. Turn the regulator handle out until gauge needle just moves and venting is barely heard and reads 200-250 psi on the gauge.

7.5 Filtrate Condenser

1. Set the chamber pressure regulator to 200 psi.

2. Rotate the coolant valve to direct air into the heating jacket cooling lines to expel water. Close the valve when only air is heard escaping from the drain line.

3. Close the coolant valve by rotating the handle up.

4. Disconnect the cooling lines from the heating jacket.

5. Connect the filtrate unit to the sample chamber. Hand-tighten only.

6. Connect the cooling lines to the filtrate unit.

7. Slowly open the coolant valve by turning the handle to the right.

8. Check all fittings for leaks for at least 5 minutes.

9. Slowly rotate the cooling valve to the left. This directs air into the cooling lines to expel water. Close the coolant valve (handle up) when only air (nitrogen) is heard escaping from the drain.

10. Turn the nitrogen and coolant valves off. Release the pressure setting on the regulator by opening the filtrate condenser chamber with 500 mL cup under port and allow the 400-500 mL of water to expel and then open the nitrogen vent valve to bleed off nitrogen as the regulator is turned down.

Bleed off pressure **before** tightening fittings by turning off the bottle and opening the nitrogen vent valve.

7.6 Troubleshooting

Refer to Table 7-2 for assistance in troubleshooting problems with the instrument.

Table 7-2 Troubleshooting Guide

Problem or Symptom	Possible Cause	Corrective Action
The controller does not power up.	The power source is disconnected or turned off.	Check the power source.
	The main power switch has malfunctioned or failed.	Check or replace the main power switch.
	The power wiring is faulty.	Check/repair the power wiring. Refer to the wiring diagram.
The paddle does not spin.	The stirrer motor switch is turned off.	Turn the stirrer motor switch on.
	The flexible drive shaft is not connected to the paddle shaft.	Attach the flexible drive shaft to the paddle shaft. Hand-tighten the flexible shaft collar.
	The motor is bad.	Check or replace the motor.
The system does not heat up, but the heater indicator in the temperature controller is on.	The heater control switch is turned off.	Turn the heater control switch on.
	The heater fuse has blown.	Test the resistance (ohms) with an ohmmeter or multimeter. Replace the heater fuse if necessary.
The system does not heat up, and the heater indicator in the temperature controller is off.	The heater fuse has blown.	Test the resistance (ohms) with an ohmmeter or multimeter. Replace the heater fuse if necessary.
	The heater control electronics malfunctioned or failed.	Check the heater solid-state relay, and the heater circuit wiring.

Problem or Symptom	Possible Cause	Corrective Action
The temperature controller is not working.	Varies.	See the error codes that display on the screen.
The temperature reading is unreasonably high (over 500°F).	Possible open circuit in thermocouple or thermocouple cables.	Look for and repair the broken wire or loose connection at the thermocouple connector.
The temperature reading is about room temperature, and the chamber is hot.	Possible short circuit in thermocouple or thermocouple cable.	Look for and repair the short in the thermocouple connector.

8 Parts List

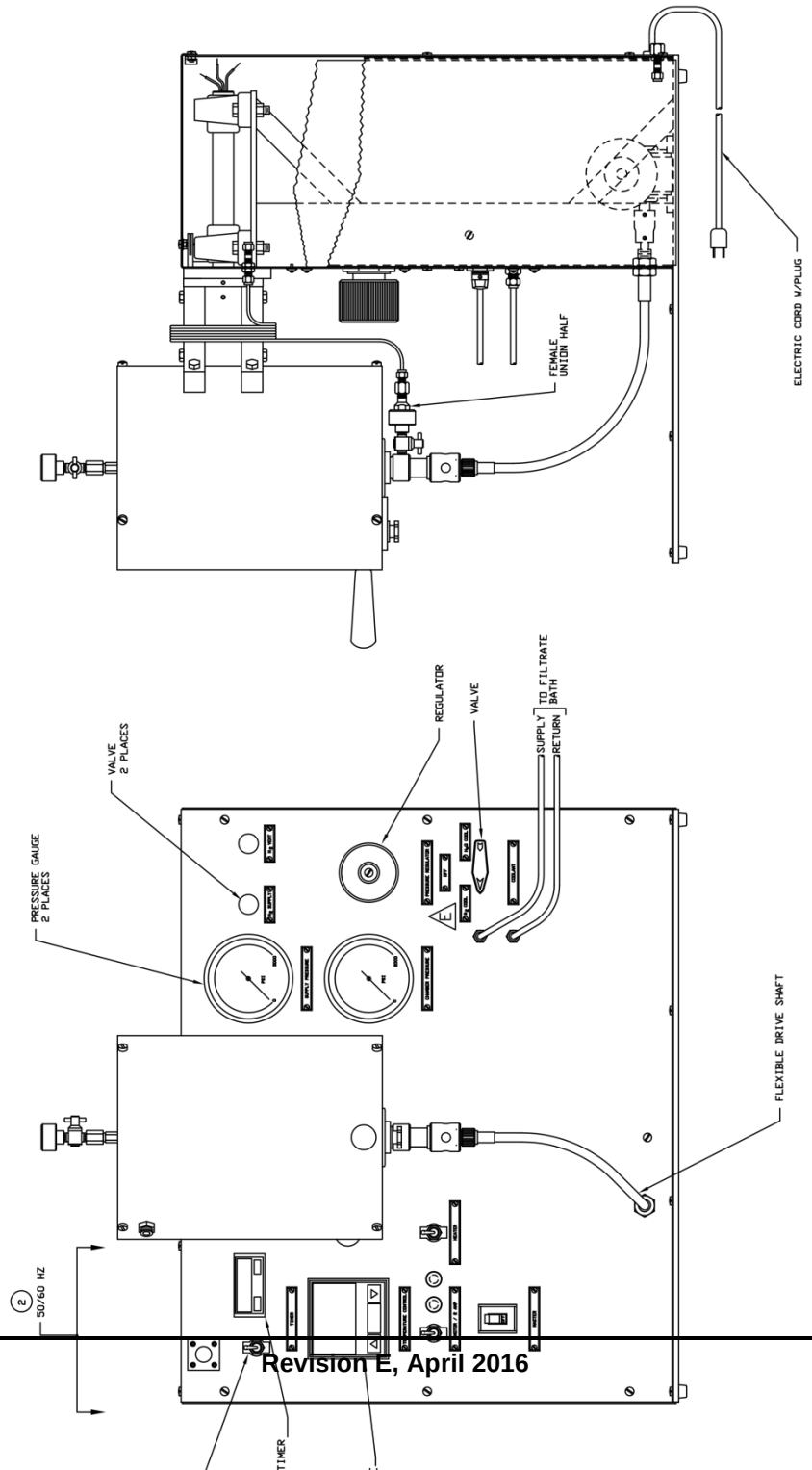
Check the following tables and assembly drawings for any replacement parts and their respective part numbers.

Table 8-1 Stirring Fluid Loss Assembly, 50/60 Hz, P/N 210194, Revision F

Item No.	Part No.	Quantity	Description
0002	100052157	1	ELECTRICAL/INSTRUMENT, 50/60Hz
0003	100052153	1	MAINFRAME ASSEMBLY
0004	100052154	1	HEATING JACKET ASSEMBLY
0005	100020388	1	CHAMBER ASSEMBLY
0006	100052155	1	MANIFOLD SYSTEM, WATER/NITROGEN
0007	100052158	1	TOOL KIT & MANUAL

Figure 8-1 Stirring Fluid Loss Assembly

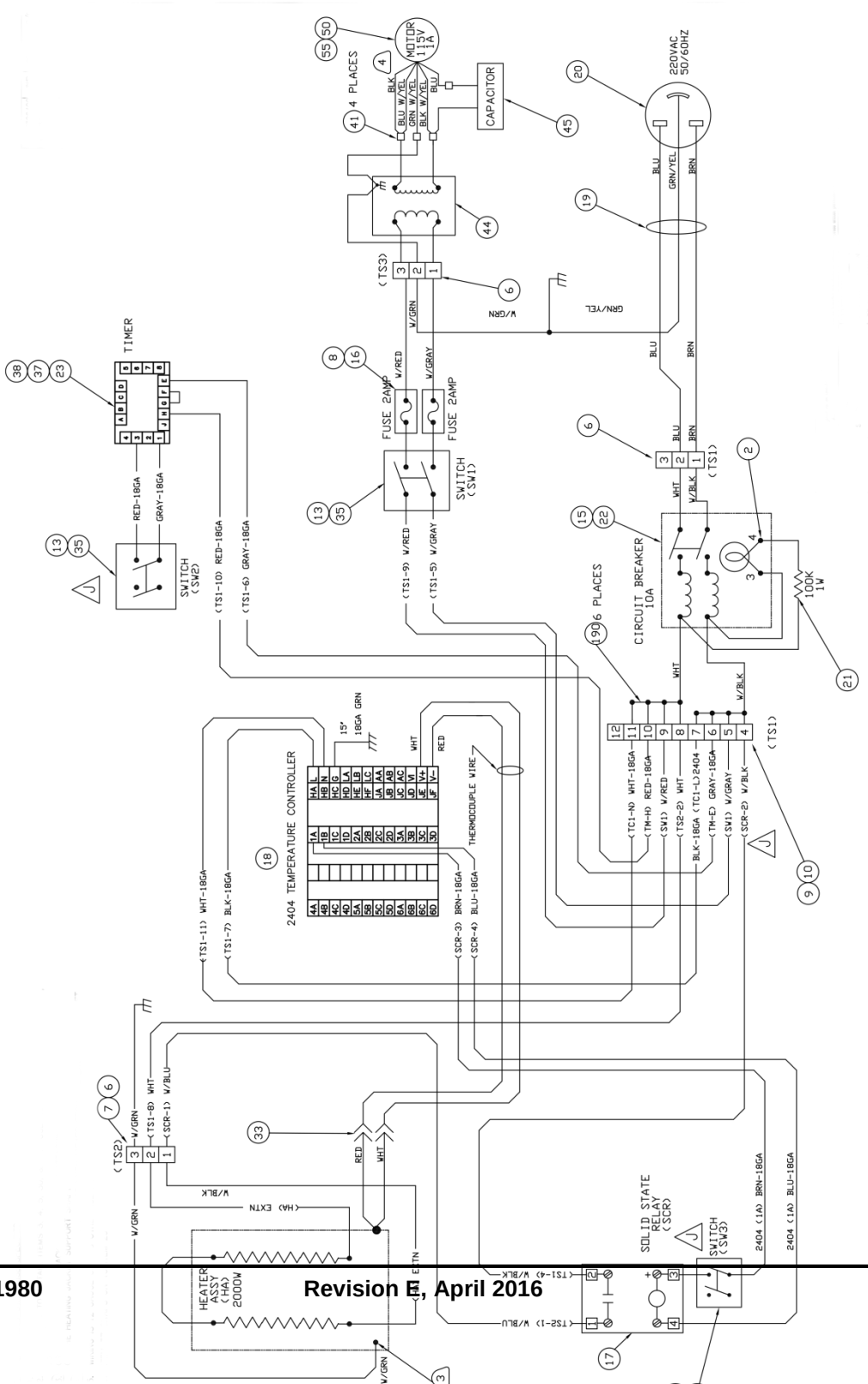
Table 8-2 Electrical Diagram, 50/60 Hz, P/N



100052157, Revision P

Item No.	Part No.	Quantity	Description
0002	100032006	2	TERMINAL, FEMALE, SLIP ON, FULLY INSULATED, FOR 18-22 GA WIRE
0003	100031553	1	WIRE, 12 GA, STRANDED, WHITE/GREEN, TEFLON®
0004	100031551	1	WIRE, 12 GA, STRANDED, WHITE/BLACK, TEFLON®
0005	100031550	1	WIRE, ELECTRICAL, 12 GA, STRANDED, WHITE, TFE TEFLON®
0006	100033585	2	STRIP, TERMINAL, 3-141
0007	100031227	2	STRIP, MARKER, MS-3-141, CINCH
0008	100033669	2	FUSE, 2 AMP, 250 V, 3AG
0009	100029406	1	STRIP, TERMINAL, 12 POSITION
0010	100029399	1	STRIP - MARKER
0011	100032234	5	TERMINAL, CRIMP, RING, 12-10 AWG, YELLOW #6
0012	100032290	11	TERMINAL, CRIMP, SNAP SPADE, 22-16 AWG, RED, #8
0013	100027339	3	NAME PLATE, ON, OFF, TOGGLE SWITCH
0015	100013123	1	SWITCH, CIRCUIT BREAKER
0016	100025526	2	HOLDER, FUSE
0017	100013136	1	RELAY, SOLID STATE, 240 VAC, 25 AMP, 3-32 VDC CONTROL
0018	101881427	1	TEMP CONTROLLER EUROTHERM
0019	205713	1	CONNECTOR ANGLE
0020	100072621	1	CORD SET ASSEMBLY, ELECTRIC, 240V, 2 CUBE AUTOCLAVE
0021	100027804	1	RESISTOR, 100000 OHM, 1 WATT
0022	349301	4	TERMINAL FEMALE
0023	101482068	1	TIMER-ELAPSED INDICATOR
0024	208547	3	WIRE 22AWG TEFLON® STRANDED BLACK
0025	208549	3	WIRE 22 AWG TEFLON® STRANDED WHITE
0026	208516	3	WIRE 22 AWG PVC STRANDED BROWN
0027	206242	3	WIRE 22 AWG TEFLON® STRANDED BLUE
0028	208517	3	WIRE 22 AWG PVC STRANDED RED
0029	206233	3	WIRE 20 AWG PVC STRANDED GRAY
0030	100031552	3	WIRE, 12 GA, STRANDED, WHITE/RED, TEFON®
0031	100032759	3	WIRE, 12 GA, STRANDED, WHITE/GRAY, TEFLON®
0032	101733741	1	THERMOCOUPLE,TYPE J
0033	100072391	1	PANEL MOUNT, SINGLE CIRCUIT, THERMOCOUPLE
0034	204293	1	TERMINAL RING NO. 6 SCREW 16-14AWG
0035	100029438	3	SWITCH, TOGGLE
0036	100013072	1.5	WIRE, THERMOCOUPLE
0037	101482069	1	TIMER OPTION MODULE
0038	101482070	1	TIMER BATTERY
0041	204331	4	BUTT SPLICE 16-14 AWG INSULATED
0042	101939760	30	TERMINAL FORK, 12-10 AWG
0043	204479	1	MOTOR 115V GEAR HD 1/15 HP 170 RPM RT ANGLE
0044	205722	1	STEP-DOWN AUTO TRANSFORMER
0045	203606	1	CAPACITOR 10 UF 250V MOTOR 20 AWG LEADS
0050	100022351	3	WIRE, ELECTRICAL, 12 GA, STRANDED, BLUE, TEFLON®
0055	101562234	1	BASE KIT MODEL 34 GEAR HD MOTOR
0060	100022353	3	WIRE, ELECTRICAL, 12 GA, STRANDED, BROWN, TEFLON®
0070	100031554	3	WIRE, 12 GA, STRANDED, WHITE/BLUE, TEFLON®
0080	206214	3	WIRE 18 AWG TEFLON® STRANDED GREEN
0100	207761	4	1/4-20 X 5/8 FHMS STAINLESS STEEL
0110	207337	4	8-32 X 5/8 FHMS STAINLESS STEEL

Item No.	Part No.	Quantity	Description
0120	207631	4	NUT 8-32 HEX REGULAR STAINLESS STEEL
0130	207639	4	WASHER EXTERNAL TOOTH 8 STAINLESS STEEL
0140	207311	1	8-32 X 3/8 THMS STAINLESS STEEL
0150	203438	4	1/4-20 X 1 HHCS STAINLESS STEEL
0160	204294	3	TIE WRAP 1/16 IN.. TO 2 IN. DIAMETER
0170	207626	4	NUT 1/4-20 HEX REGULAR STAINLESS STEEL
0180	207753	4	WASHER SPLIT 1/4 STAINLESS STEEL
0190	208487	6	TERMINAL STRIP JUMPER
0200	203373	4	1/4-20 X 5/8 HHCS STAINLESS STEEL
0210	207763	4	WASHER FLAT 1/4 STAINLESS STEEL
0220	207607	4	10-32 X 3/8 BHMS STAINLESS STEEL
0230	207871	4	WASHER, FLAT 10 STAINLESS STEEL
0240	208704	4	WASHER SPLIT 10 STAINLESS STEEL
0250	207489	8	6-32 X 1/2 BHMS STAINLESS STEEL
0260	207632	6	NUT 6-32 HEX REGULAR STAINLESS STEEL
0270	207819	6	WASHER SPLIT 6 STAINLESS STEEL
0280	208658	6	WASHER FLAT 6 STAINLESS STEEL CC-BLUE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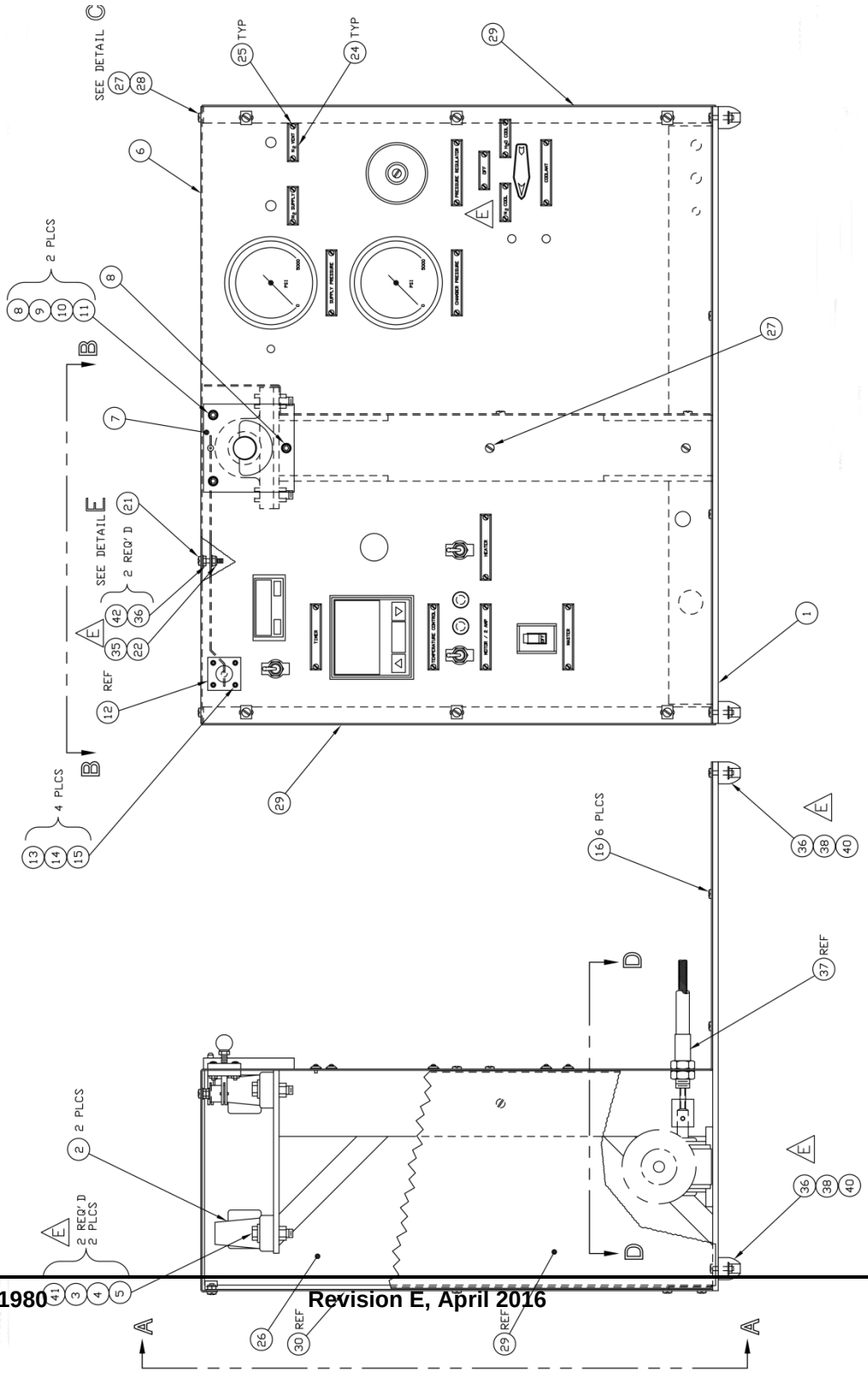
CAPACITOR
220VAC
50/60HZ
TIMER
FUSE 2AMP
SWITCH
(SW1)
SWITCH
(SW2)
6 PLACES
CIRCUIT BREAKER
10A
100K
1W
2404 TEMPERATURE CONTROLLER
THERMOCOUPLE WIRE
SOLID STATE
RELAY
(SCR)
SWITCH
(SW3)
HEATER
ASSY
(HA)
2000W
(HA) EXTN
(TS1-11) WHT-18GA
(TS1-7) BLK-18GA
(TS1-10) RED-18GA
(TS1-6) GRAY-18GA
(TS1-9) W/RED
(TS1-5) W/GRAY
(TS1-4) W/BLK
(TS2-1) W/BLU
(SCR-3) BRN-18GA
(SCR-4) BLU-18GA
(TC1-N) WHT-18GA
(TM-H) RED-18GA
(SW1) W/RED
(TS2-2) WHT
BLK-18GA (TC1-L) 2404
(TM-E) GRAY-18GA
(SW1) W/GRAY
(SCR-2) W/BLK
2404 (1A) BRN-18GA
2404 (1A) BLU-18GA

Figure 8-2 Electrical Diagram

Table 8-3 Mainframe Assembly 50/60 Hz, P/N 100052153, Revision G

Item No.	Part No.	Quantity	Description
0001	100020360	1	STAND, MOUNTING
0002	100021793	2	BEARING, - PILO BLK - BALL - 100 BORE - LOW BASE
0003	100028456	4	SCREW, HEX CAP, 3/8-16 NC X 1 1/2, PL
0004	100013059	4	WASHER, LOCK, 3/8, STEEL, PL
0005	100012921	4	NUT, HEX, 3/8-16 NC, PL
0006	100020349	1	PANEL, CONTROL
0007	100020362	1	BLOCK, ROTATION INHIBITOR
0008	100002165	3	SCREW, HEX SOCKET, 1/4-20 NC X 3/4
0009	207763	2	WASHER FLAT 1/4 STEEL
0010	207753	2	WASHER SPLIT 1/4 STAINLESS STEEL
0011	100026522	2	NUT, HEX, 1/4-20 NC, PL
0012	100020355	2	PLATE, LOCK, CHAMBER ROTATION
0013	100028274	4	SCREW, HEX SOCKET, #6-32 NC X 5/8, STAINLESS STEEL
0014	100029955	4	WASHER, LOCK, #6, STAINLESS STEEL
0015	100026587	4	NUT, HEX, 6-32 NC, STAINLESS STEEL
0016	100002182	7	SCREW, BIND HEAD, #10-32 NF X 1/4, STAINLESS STEEL
0017	100020351	1	LEVER, LOCK, CHAMBER ROTATION
0018	100020350	1	ROD, LOCK, CHAMBER ROTATION
0019	100020352	1	ROD, PUSH/PULL, LOCK, CHAMBER ROTATION
0020	100027311	2	PIN, ROLL, 59-022-094-0437, 3/32 X 7/16
0021	100029075	1	SCREW, BIND HEAD, #10-32 NF X 1, STAINLESS STEEL
0022	100026443	1	NUT, ELASTIC STOP, 10-32 NF
0023	100025893	1	KNOB, BALL, DARK RED PLASTIC, BRASS INSERT, 1/4-20 NC, 3/4 OD
0024	100020363	1	LABEL SET
0025	207664	28	4-40 X 1/4 BHMS STAINLESS STEEL
0026	100020357	1	DIVIDER, ENCLOSURE
0027	100029051	24	SCREW, BIND HEAD, #10-32 NF X 3/8, STAINLESS STEEL
0028	100032781	18	NUT, CLIP, NO.10-32, MULTIPLE THREAD, 0.375 CENTER TO EDGE MAX
0029	100020359	2	PANEL, SIDE
0030	100020358	1	ENCLOSURE, REAR
0032	100020354	1	COUPLING, MOTOR/FLEXIBLE SHAFT, PADDLE DRIVE
0033	100029923	1	WASHER, LOCK, 9/16, STEEL, PL
0034	370005	2	NUT, HEX, 9/16-18 UNF,JAM NUT, GRADE 2 ZINC PLATED
0035	100029866	1	WASHER, FLAT, #10, STAINLESS STEEL
0036	100026578	5	NUT, HEX, #10-32 UNF, STAINLESS STEEL
0037	100020697	1	FLEXIBLE DRIVE SHAFT, 18 LENGTH, 1/4 DIAMETER SHAFT
0038	100032762	4	BUMPER, RUBBER, 1 IN OD, 1 IN TALL, 5/32 IN MTG HOLE W/WASHER,70D HARDNESS, STYRENE BUTADIENE
0039	100028830	1	SCREW, SET, #10-32 NF X 1/4, CUP PORT, HEX SOCKET, PL
0040	100030888	4	SCREW, BIND HEAD, #10-32 NF X 1 1/4, STAINLESS STEEL
0041	206206	4	WASHER FLAT 3/8 STAINLESS STEEL
0042	100029957	1	WASHER, LOCK, #10, STAINLESS STEEL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25 TYP
24 TYP
29
27
28
6
2 PLCS
8
9
10
11
B
B
7
27
SEE DETAIL E
2 REQ'D
21
42
36
35
22
REF
12
1
29
4 PLCS
13
14
15
6 PLCS
16
36
38
40
37 REF
D
D
2 PLCS
2
2 REQ'D
2 PLCS
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3
4
5
36
38
40
26
REF
30
29
REF
A
A

Figure 8-3 Mainframe Assembly, Front View

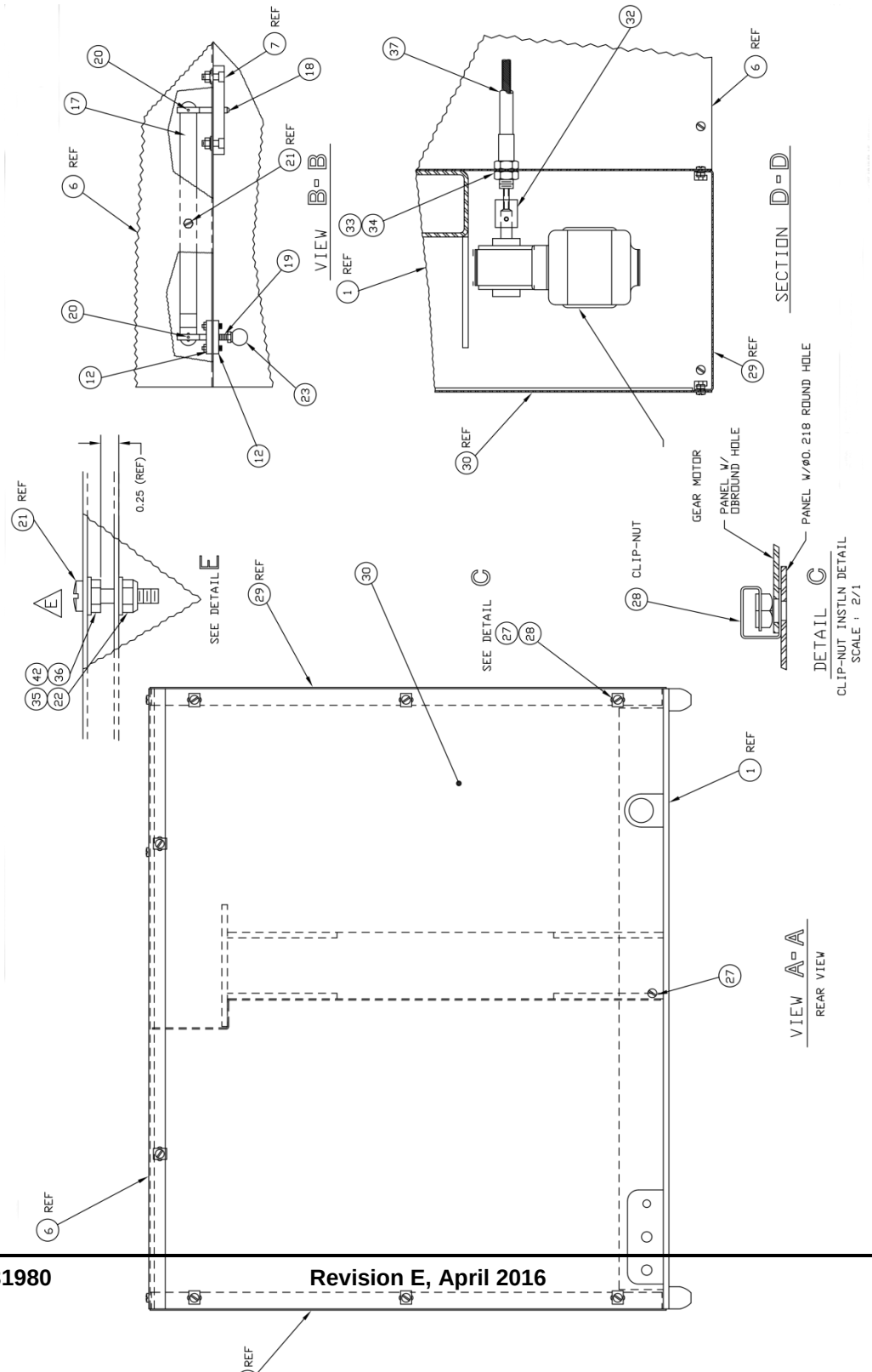
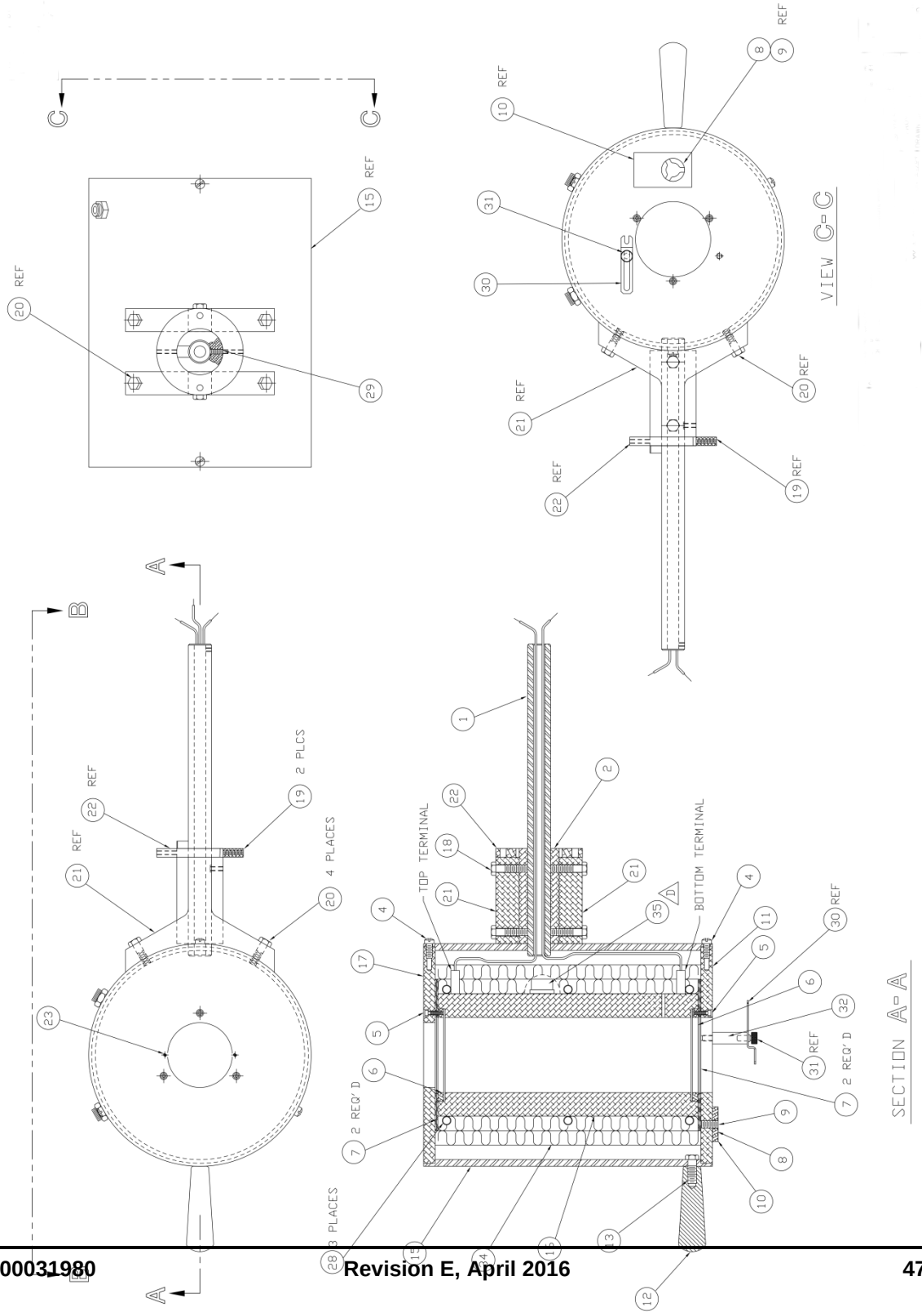

VIEW B-B
SECTION D-D
DETAIL C
CLIP-NUT INSTLN DETAIL
SCALE : 2/1
SEE DETAIL E
SEE DETAIL C
VIEW A-A
REAR VIEW
GEAR MOTOR
PANEL W/ OBROUND HOLE
PANEL W/Ø0.218 ROUND HOLE
CLIP-NUT
0.25 (REF)
REF

Figure 8-4 Mainframe Assembly, Rear View

Table 8-4 Heating Jacket Assembly, P/N 100052154, Revision G

Item No.	Part No.	Quantity	Description
0001	100020368	1	SHAFT, SUPPORT, HEATING JACKET
0002	100020369	1	COLLAR, SHAFT, SUPPORT, HEATING JACKET
0004	100028612	6	SCREW, FILLISTER HEAD MACHINE, 1/4-20 NC X 1/2
0005	100028215	6	SCREW, HEX SOCKET, #6-32 NC X 5/8
0006	100020371	2	RING, CENTERING, HEATING JACKET
0007	100020372	4	GASKET, END, HEATING JACKET
0008	100029874	1	WASHER, FLAT, 3/8 NOM, STEEL, 0.44 ID X 1 OD X 0.104 THK
0009	100032312	1	KNOB, PLASTIC, BLACK
0010	100020373	1	CLAMP, CHAMBER, HEATING JACKET
0011	100020375	1	COVER, BOTTOM, HEATING JACKET
0012	100032311	1	HANDLE, PLASTIC, TAPERED
0013	100015037	1	SCREW, HEX CAP, 3/8-16 NC X 3/4
0015	100020376	1	HOUSING, HEATING
0016	100020377	1	HEATING JACKET ASSEMBLY, CAST
0017	100020378	1	COVER, TOP, HEATING JACKET
0018	100028441	4	SCREW, HEX CAP, 5/16-18 NC X 1 1/4
0019	100028799	2	SCREW, SET, #8-32 NC X 1/2, CUP PORT, HEX SOCKET
0020	100028439	4	SCREW, HEX CAP, 5/16-18 NC X 1
0021	100020379	2	SADDLE, SUPPORT, HEATING JACKET
0022	100020353	1	COLLAR, LOCK, CHAMBER ROTATION
0023	100028274	2	SCREW, HEX SOCKET, #6-32 NC X 5/8, STAINLESS STEEL
0024	100023804	2	CONNECTOR, BULKHEAD, 1/8 FPT BOTH ENDS
0025	100024751	2	ELBOW, 1/8 MALE PIPE THREAD X 1/4 OD TUBE
0026	100049274	4	FITTING, TUBE, UNION, 1/4 IN TUBE, 90 DEG
0027	100020662	3	HOSE ASSEMBLY
0028	100029318	3	SPRING, EXTENSION, 5/16 OD X 16-3/8 LONG
0029	100028829	1	SCREW, SET, #10-32 NF X 3/8, CUP PORT, HEX SOCKET
0030	100020374	1	LATCH, SLIDE, THERMOCOUPLE
0031	100021787	1	SCREW, THUMB, 1/4-20 UNC X 1/2, KNURLED
0032	101771804	1	STANDOFF HEX MALE-FEMALE 1/4-20 X 1.5 , ZN PLATED STEEL
0033	100030821	2	SCREW, FILLISTER HEAD MACHINE, #6-32 UNC X 5/8
0034	102077139	1	FIBERGLASS INSULATION
0035	102120613	1	THERMOSTAT, SNAP DISC
0036	101889599	2	WIRE, LEAD, HIGH TEMPERATURE 842F/450C, 18 AWG,
0037	101409270	1	TERMINAL, RING, HIGH TEMP (900F,), NO. 8-10 STUD, WIRE 22-18 GA


VIEW C-C
SECTION A-A
TOP TERMINAL
BOTTOM TERMINAL
REF
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4 PLACES
2 REQ'D
3 PLACES

Figure 8-5 Heating Jacket Assembly Schematic, Part 1 of 2

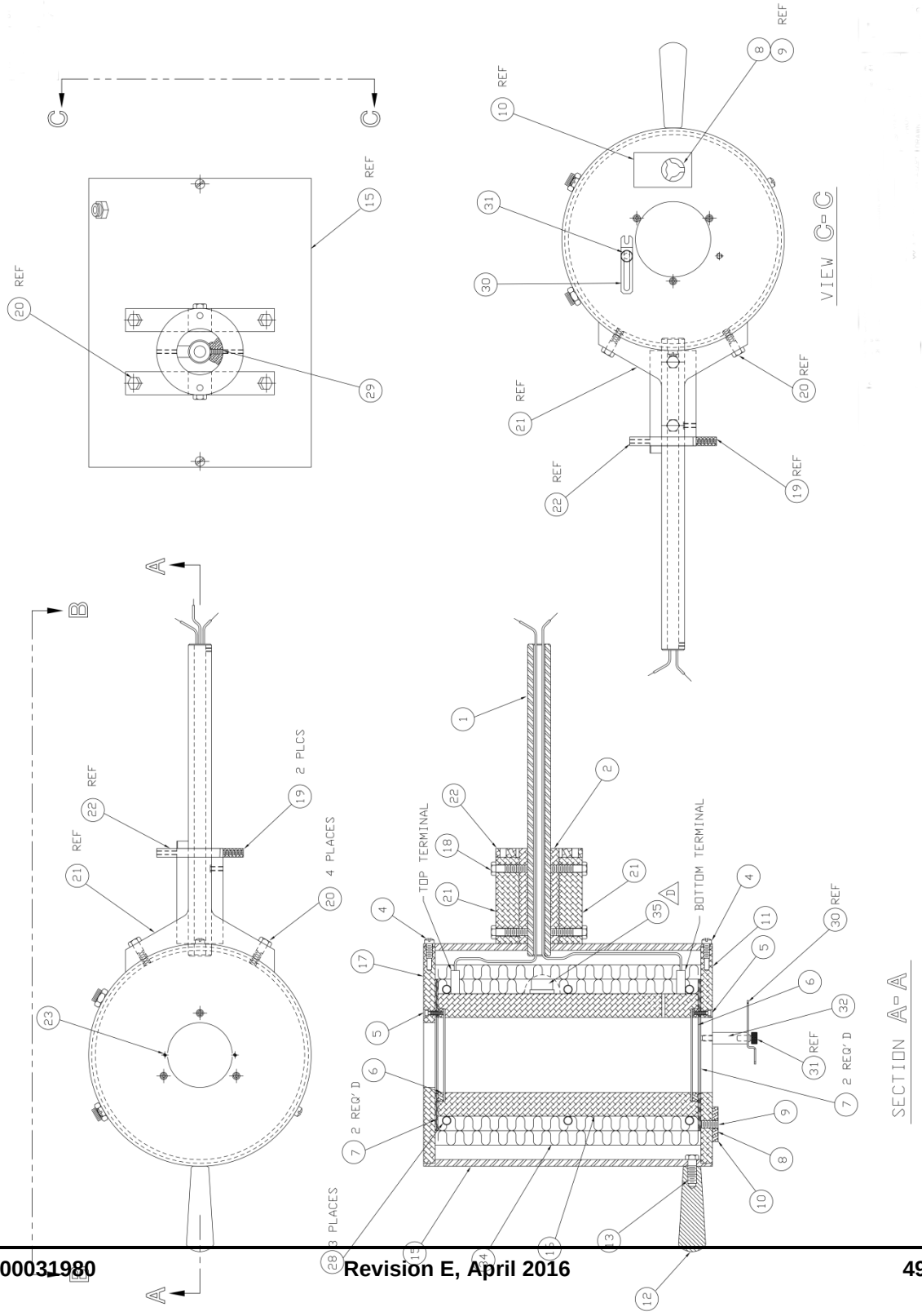
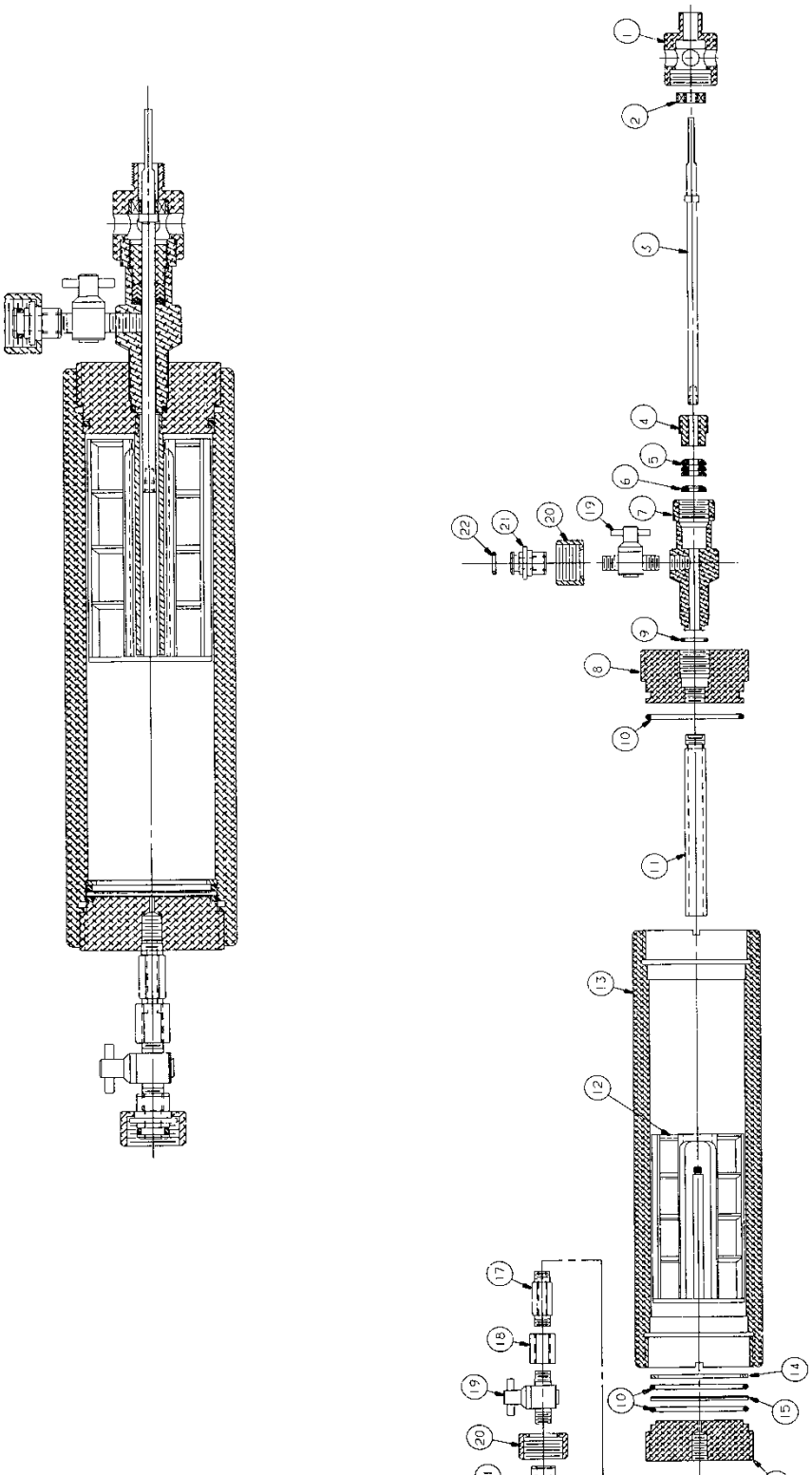

VIEW C-C
SECTION A-A
TOP TERMINAL
BOTTOM TERMINAL
2 PLCS
4 PLACES
3 PLACES
2 REQ'D
REF

Figure 8-6 Heating Jacket Assembly Schematic, Part 2 of 2

Table 8-5 Chamber Assembly, P/N 100020388, Revision C

Item No.	Part No.	Quantity	Description
0001	100001361	1	BEARING, THRUST CARRIER
0002	100007737	1	BEARING, BALL, 0.250 ID X 0.750 OD X 0.28 THICK, SEALED ON BOTH SIDES
0003	100001362	1	SPINDLE
0004	100020386	1	NUT, PACKING, CHAMBER ASSEMBLY
0005	100001896	1	PACKING, CHEVRON, 1/4 X 5/8, 3 RINGSET, NITRILE FILLED WITH SYNTHETIC GLASS & DACRON/POLYESTER, FOR HIGH TEMPERATURE
0006	100020380	1	RING, MALE, PACKING
0007	100020381	1	HOUSING, SPINDLE
0008	100020382	1	CAP, SPINDLE
0009	100001946	1	O-RING, 90 DURO, 11/16 X 1/2 X 3/32 568-112
0010	100001999	3	O-RING, 90 DURO, 2 1/2 X 2 1/4 X 1/8
0011	100020383	1	STANDPIPE
0012	100020384	1	PADDLE, SPECIAL
0013	100020385	1	CHAMBER
0014	100001364	1	RING, BACK-UP, FILTER PRESS ASSEMBLY
0015	100002402	1	SCREEN, 325 X 60 MESH, FLUID LOSS, FILTER PRESS
0016	100020387	1	HOLDER
0017	100032314	1	NIPPLE, HEX, BRASS, 1/8 NPT, 1.5 LG, B-2HLN-1.50, CAJON
0018	100016622	1	COUPLING, HEX, 1/8 NPT, FEMALE, B-2-HCG, CAJON
0019	100000593	2	VALVE, PLUG, 1/8 MNPT, BRASS, 3000 PSI, 250F, BUNA SEALS
0020	100072599	2	NUT, HAND UNION, TWO CUBE CEMENT AUTOCLAVE
0021	100072598	2	MALE HALF, HAND UNION, TWO CUBE CEMENT AUTOCLAVE
0022	100001945	2	O-RING, 90 DURO, 5/8 X 7/16 X 3/32

Figure 8-7
Chamber



Assembly

Table 8-6 Manifold System, Water/Nitrogen, P/N 100052155, Revision J

Item No.	Part No.	Quantity	Description
0001	100032368	1	CONNECTOR, BULKHEAD, FEMALE, 1/8 TB X 1/8 FPT, BRASS
0002	100032372	1	FITTING, TUBE, BULKHEAD, BRASS, 1/8 TUBE X 1/8 TUBE
0003	365101	1	TUBING COIL
0004	100033426	3	CONNECTOR BULKHEAD 1/4 TUBE X 1/4 FNPT BRASS
0005	207377	96	TUBING SOFT COPPER 1/4 X .032
0006	100031718	1	VALVE, BALL, WHITEY, B-43XS4, 1/4 SWAGELOK®, 3 WAY
0007	100021772	2	HOSE, 1/4, TEFLON® WITH STAINLESS STEEL BRAID, 1/4 TURNED AND BORED ENDS, 36 IN. LONG
0008	100032366	1	REGULATOR, PRESSURE, 0-2500 PSI OUTLET, SELF RELIEVING, STAINLESS STEEL, 1/4 NPT PORTS, PANEL MOUNTING
0009	100032365	1	GAUGE, PRESSURE, DUAL SCALE, 4 INCH, 0-2000 PSI
0010	100032364	2	VALVE, SHUT-OFF, BRASS
0011	100032362	1	GAUGE, PRESSURE, DUAL SCALE, 4 INCH, 0-5000 PSI
0012	100072597	1	FEMALE HALF, HAND UNION, TWO CUBE CEMENT
0013	100032371	1	FITTING, TUBE, CONNECTOR, BRASS, 1/8 TUBE X 1/8FPT, SWAGELOK®
0014	100032370	4	FITTING, TUBE, B-200-2-4, ELBOW, 90 DEG, BRASS, 1/8 TUBE X 1/4MALE PIPE THREAD, SWAGELOK®
0015	100032369	2	FITTING, TUBE, B-200-7-4, CONNECTOR, BRASS, 1/8 TUBE X ¼ FPT, SWAGELOK®
0016	100026081	1	TEE, UNION, 1/8 TUBING X 1/8 TUBING X 1/8 TUBING, BRASS
0019	100020578	2	UNION, BULKHEAD, 1/4 TUBE
0020	100020683	1	COUPLING, QUICK DISC, STEM, 1/4 TB, BRASS
0021	100020684	1	COUPLING, QUICK DISC, BODY, 1/4 TB, BRASS
0022	100020686	1	COUPLING, QUICK DISC, BODY, 1/8 NPT, BRASS
0023	100020685	1	COUPLING, QUICK DISC, STEM, 1/8 NPT, BRASS
0026	100033653	1	WASHER, FLAT, 3/4, STAINLESS STEEL
0027	101576155	1	BRACKET PANEL 1129, FOR TESCOM REGULATOR
0028	100029698	10 ft	TUBING, STAINLESS STEEL, 1/8 OD X 0.062 ID, 0.032 WALL THICKNESS

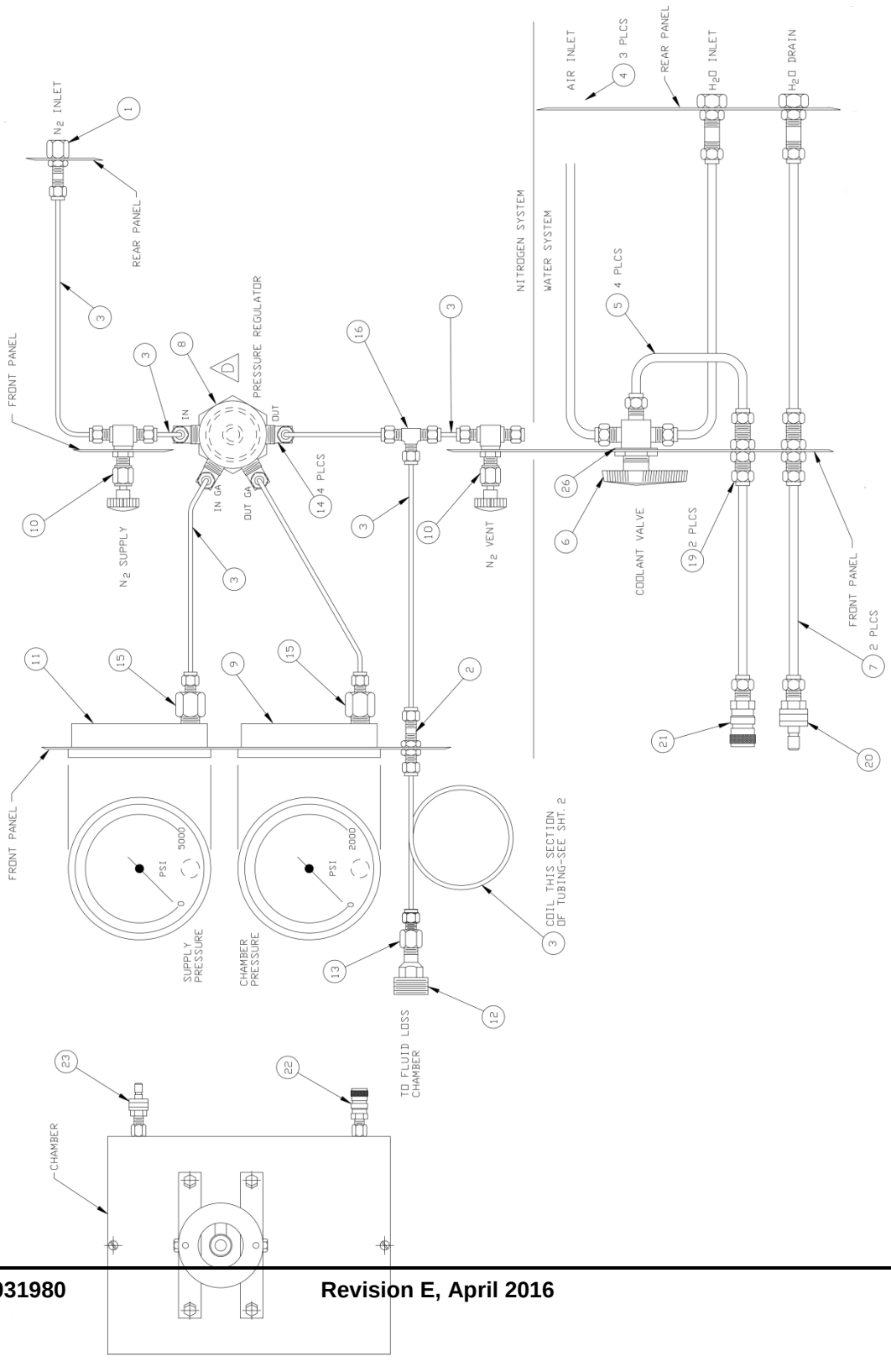

N_2 INLET
REAR PANEL
FRONT PANEL
PRESSURE REGULATOR
IN
OUT
IN GA
OUT GA
4 PLCS
N_2 SUPPLY
N_2 VENT
NITROGEN SYSTEM
WATER SYSTEM
AIR INLET
3 PLCS
REAR PANEL
H_2O INLET
H_2O DRAIN
4 PLCS
COOLANT VALVE
2 PLCS
FRONT PANEL
2 PLCS
PSI
5000
0
SUPPLY PRESSURE
PSI
2000
0
CHAMBER PRESSURE
FRONT PANEL
COIL THIS SECTION OF TUBING-SEE SHT. 2
TO FLUID LOSS CHAMBER
CHAMBER

Figure 8-8 Manifold System, Water/Nitrogen

Table 8-7 Tool Kit & Instruction Manual, P/N 100052158, Revision C

Item No.	Part No.	Quantity	Description
0001	10003198	1	INSTRUCTION MANUAL
0002	100020361	1	WRENCH ASSEMBLY
0003	100029847	1	VISE GRIP, CHAIN CLAMP
0011	100020390	1	FILTRATE CHAMBER ASSEMBLY, STANDARD

Table 8-8 Filtrate Chamber Assembly, Standard, P/N 100020390, Revision D

Item No.	Part No.	Quantity	Description
0001	100020427	1	FILTRATE CHAMBER, WATER BATH
0002	100020428	1	FILTRATE CHAMBER LID, WATER BATH
0003	100020429	1	COIL, TUBING, WATER BATH
0004	100033636	1	ELBOW, FITTING, TUBE, SWAGELOK®, 90 DEG, 1/8 TUBE X 1/8 MPT, BRASS
0005	100001930	1	O-RING, 90 DURO, 2 11/16 X 2 1/2 X 3/32 568-144
0006	100016378	2	ELBOW, 90 DEG, STREET, 1/8, B2SE
0007	100072596	1	UNION, HAND, TWO CUBE CEMENT AUTOCLAVE MANIFOLD, 5000 PSI
0008	100032367	1	CONNECTOR, MALE, 1/8 TURNED AND BORED X 1/8 MALE PIPE THREAD, BRASS
0010	100020685	1	COUPLING, QUICK DISC, STEM, 1/8 NPT, BRASS
0011	100020686	1	COUPLING, QUICK DISC, BODY, 1/8 NPT, BRASS

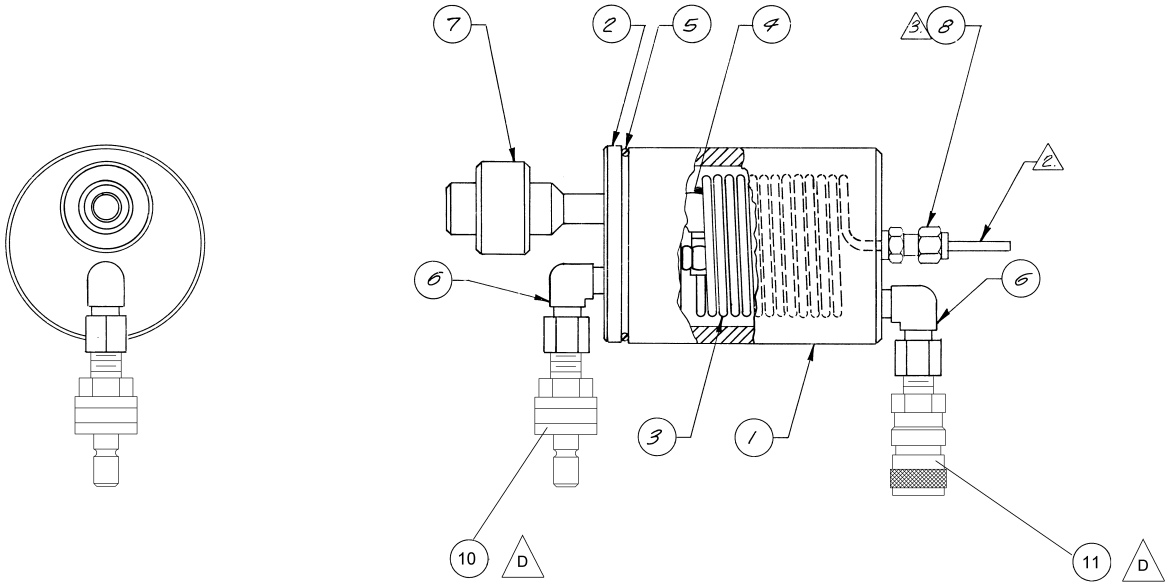


Figure 8-9 Filtrate Chamber Assembly, Standard

Table 8-9 Filtrate Chamber Assembly, Back Pressure, P/N 100020356, Revision B

Item No.	Part No.	Quantity	Description
0001	100020366	1	FILTRATE CHAMBER LID
0002	100020365	1	FILTRATE CHAMBER
0003	100020367	1	COOLING COIL
0004	100000593	1	VALVE, PLUG, 1/8 MNPT, BRASS, 3000 PSI, 250 F, BUNA N SEALS
0005	100001934	1	O-RING, 90 DURO, 1 5/8 X 1 7/16 X 3/32 568-127
0006	100072597	2	FEMALE HALF, HAND UNION, TWO CUBE CEMENT AUTOCLAVE
0007	100016378	1	ELBOW, 90 DEG, STREET, 1/8
0009	100020685	1	COUPLING, QUICK DISC, STEM, 1/8 NPT, BRASS
0010	100020686	1	COUPLING, QUICK DISC, BODY, 1/8 NPT, BRASS
0011	100024752	2	CONNECTOR, 1/8 FPT X 1/4 OD TUBE

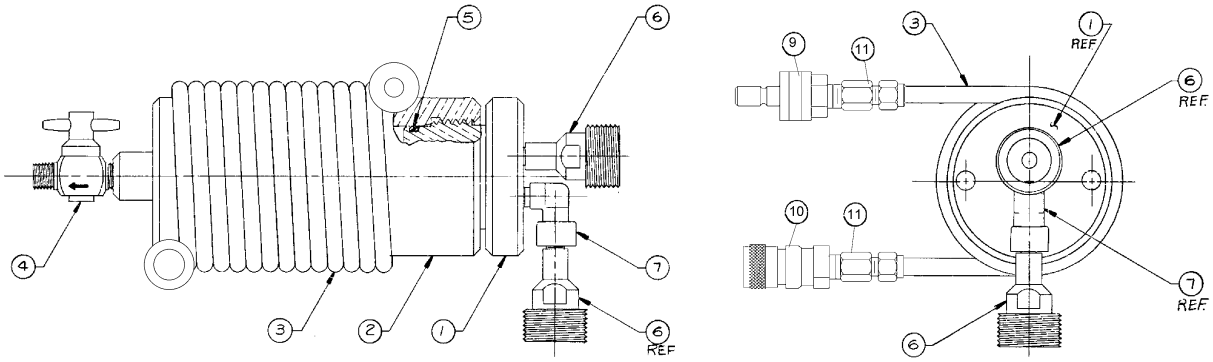


Figure 8-10 Filtrate Chamber Assembly, Back Pressure

9 Warranty and Returns

9.1 Warranty

Fann Instrument Company warrants its products to be free from defects in material and workmanship for a period of 12 months from the time of shipment. If repair or adjustment is necessary, and has not been the result of abuse or misuse within the twelve-month period, please return, freight prepaid, and correction of the defect will be made without charge.

Out of warranty products will be repaired for a nominal charge.

Please refer to the accompanying warranty statement enclosed with the product.

9.2 Returns

For your protection, items being returned must be carefully packed to prevent damage in shipment and insured against possible damage or loss. Fann will not be responsible for damage resulting from careless or insufficient packing.

Before returning items for any reason, authorization must be obtained from Fann Instrument Company. When applying for authorization, please include information regarding the reason the items are to be returned.

Our correspondence address is:

Fann Instrument Company
P.O. Box 4350
Houston, Texas USA 77210

Telephone: 281-871-4482
Toll Free: 800-347-0450
FAX: 281-871-4446
Email fannmail@fann.com

Our shipping address is:

Fann Instrument Company
14851 Milner Road, Gate 5
Houston, Texas USA 77032