fann®

Model 50SL Rheometer
Instruction Manual

Instruction Manual 204239 Revision F

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NOTE:

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SECTION 1
INTRODUCTION

A. DESCRIPTION

The FANN Model 50SL Rheometer is a high precision, coaxial cylinder, rotational viscometer. It functions as a wide range general purpose Rheometer, and is adaptable to a wide range of viscosity testing problems and procedures. The Model 50SL Rheometer can be used to characterize shear rate dependent rheological phenomena such as Bingham plastic flow, pseudoplasticity, (which includes power law fluids) and dialatancy. Time dependent thixotropic and rheopectic flow behavior can be studied. Tests can be fconducted under conditions of accurately controlled, shear rate, temperature, and pressure.

The 50SL Rheometer can measure Shear Stress vs Shear Rate. It can be used to characterize shear rate dependent rheological phenomena. A wide viscosity measuring range is provided through the selection of available torsion springs, bobs, and sample cups.

The 50SL Rheometer must be used in conjunction with the Remote Control Option interface and a suitable Personal Computer. Operation of the 50SL Rheometer is monitored by transducer signals sensed by the 50SL Rheometer being routed through the interface to the computer. The Computer then responds through the interface with the proper operational signals to the 50SL Rheometer.

B. MEASURING PRINCIPLE

A sample of 42 ml is used with the standard R1, B1 Sample Cup and Bob. A fluid is tested in the annulus between two concentric cylinders. The outer cylinder, called the Sample Cup, is made to rotate at a prescribed angular velocity (rpm) and the viscous drag resulting from the test fluid acts on the surface of the inner cylinder, called the Bob.

The shear force at the bob surface is measured as the resulting torque by the angular displacement of a precision beryllium-copper torsion spring on the bob shaft. The torque value is converted to an electrical signal which is linear with respect to the angular deflection of the spring through an accurate, high resolution angle sensing transducer which permits Shear Stress values to be analyzed.

The angular velocity of the Sample Cup is obtained from a flywheel sensor on the drive motor.

This can be used to calculate the Shear Rate by making some assumptions about the properties of the fluid sample. It frequently is assumed that the sample fluid is Newtonian in calculating the Shear Rate.

SECTION 2
SAFETYCONSIDERATIONS

The safe operation of the FANN Model 50SL Rheometer, with the Remote Control Option and Personal Computer requires that the operator be familiar with the proper operating procedures and potential hazards associated with this equipment. Keep hands, clothes and other objects away from the moving parts of the Rheometer.

A. ELECTRICAL PRECAUTIONS

Parts of this system are operated by 115 Volt AC electrical power.

1. Make sure the main electrical source is fused and grounded.

2. Verify the power cables on the Remote Control Option, the Computer, and the plotter or printer are in good condition and have the proper ground connection.

3. Electrical problems in the wiring, motor control circuits, or heater bath of the 50SL Rheometer may not be obvious. Always disconnect the power cable to the Remote Control Option before attempting any repair.

4. Make sure the main power supply is disconnected before cleaning or moving components of the system. If sample, or oil has been spilled or splattered on the work table or elsewhere in the cabinet, wipe clean with a damp cloth. Do not use excessive water or cleaning solvent that could possibly contaminate the electrical controls or components.

B. PRESSURIZATION PRECAUTIONS

1. The Model 50SL Rheometer uses Nitrogen pressurization. Never connect the 50SL Rheometer Nitrogen Port to any other gas. Nitrogen must be supplied in approved Nitrogen gas cylinder or from a built in Nitrogen supply system. Nitrogen Cylinders must be secured to prevent the possibility of being knocked over.

2. Maintain pressure regulators on the 50SL Rheometer in good condition. Never use oil on pressure regulators. Leaking pressurization systems should be re-paired or replaced. Gauges, fittings and hoses should be kept in good condition and leaks should be corrected. Periodically test the safety relief valve to verify it will relieve if excessive pressure should occur. Pressure in excess of 1050 psi (7238 kPa) should open the relief valve and vent to atmosphere. Never plug or bypass the relief valve.

3. Do not attempt to pressurize higher than the equipment is rated. Relief valve setting must be set lower than the equipment is rated. When pressurizing always open the supply pressure first, then adjust the **PRESSURE ADJUST** regulator by turning the regulator to the right (clockwise). When de-pressurizing, shut off the supply pressure. Bleed the system of pressure by opening the **PRESSURE RELEASE** valve slowly allowing the bearing oil to drain into its reservoir, followed by the Nitrogen. Back out the regulator by turning the knob to the left (counterclockwise).

C HEATING

An over temperature alarm will sound and switch off the power to the heaters if the bath temperature exceeds about 570°F.

Tests can be conducted up to 500 ^{o}F. (260 ^{o}C). The higher the test temperature the greater the possibility of burns should hot areas be touched. Be cautious of the Heater Bath in the UP position, hot oil spilled from the heater bath, and the hot Sample Cup assembly. Be cautious not to come into contact with these areas until they have had time to cool.

The following precautions should be taken whenever the instrument is performing a test requiring the heating of the Sample:

1. Use only the recommended Heater Bath Oil. (P/N 31573).

2. Insure that the Heater Bath Oil used is free of contaminates.

3. When high temperature tests are being run make sure the area is well ventilated. DO NOT BREATH FUMES FROM THE BATH OIL.

4. In handling and heating the heater bath oil, observe the precautions listed on the label of the oil container and study and observe the precautions on the MSDS sheet for this oil.

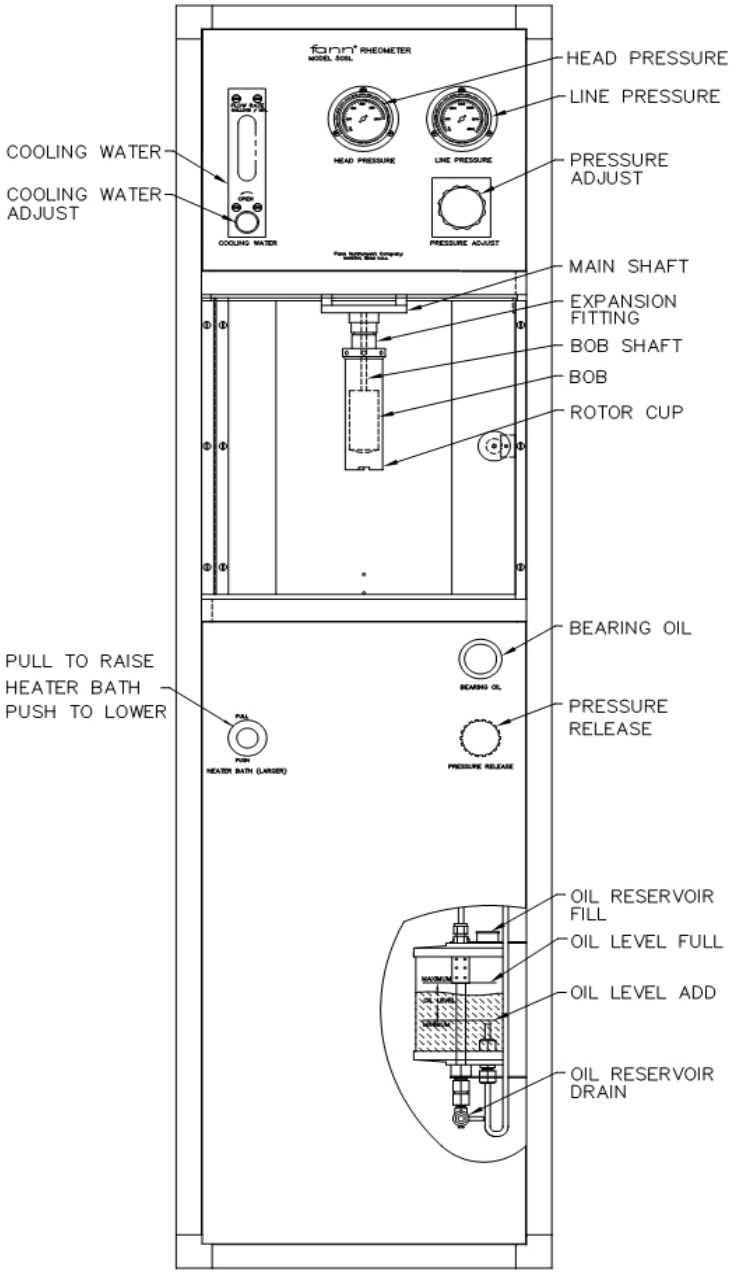

Fig. 1
Front of Model 50SL Rheometer

SECTION 3
PRESSURE AND TEMPERATURE CONTROLS

This Section describes the controls and functions for pressurization by using Nitrogen. Temperature controls are described for heating the Heater Bath and water flow controls for head cooling and heater bath cool-down. For location of these components refer to Fig. 1.

A. PRESSURIZATION SYSTEM

1. **LINE PRESSURE** Gauge - Upper Right of Front Panel

The Line Pressure gauge shows the supply pressure to the Pressure Adjust regulator. The supply pressure should always be a minimum of 100 psi (690 kPa) higher than the highest planned test pressure, and a maximum of 3000 psi. (20700 kPa).

2. **HEAD PRESSURE** Gauge - Upper Center of Front Panel

The Head Pressure gauge shows the pressure on the test sample from 0 to 1000 psi (0 to 6894 kPa). The Head Pressure gauge must always read 0 before attempting dis-assembly of the Sample Cup, Bob, and Expansion Fitting at the end of a test.

In addition to the pressure gauges, the 50SL Rheometer has a pressure transducer to electronically monitor the test pressure. This information is sent to the Personal Computer via the RCO.

3. **PRESSURE ADJUST** Regulator - Lower Right of Front Panel

The Pressure Adjust regulator is used to control the Nitrogen pressure to the Rheometer Measuring Head and test sample. The pressure applied is set by turning the adjusting knob. Turning it clockwise will increase the pressure; counterclockwise will decrease pressure.

The minimum pressure that can be obtained by turning the regulator knob counterclockwise is about 50 psi (345 kPa).

The maximum pressure available is 1000 psi (6894 kPa). The Head Pressure gauge always shows the pressure on the system.

4. **PRESSURE RELEASE VALVE** - Right Lower Front Panel

The Pressure Release needle valve drains the Head Lubricating Oil then releases whatever Nitrogen pressure is left in the system. The oil will be drained first any time pressure is released using this control. The Pressure Release valve **MUST** be used to bleed the system pressure to zero. The system pressure **MUST BE ZERO** before the Sample cup and associated parts can be accessed.

5. **BEARING OIL** pump. Right Lower Front Panel

At the end of each test the Head Oil is drained so that the proper amount of Head Oil can be injected at the start of the next test. The Bearing Oil pump is used to inject the proper charge of Head Oil into the Rheometer head bearings. The cylinder of the pump is calibrated so that one full stroke of the cylinder injects the exact amount of oil required.

CAUTION

DO NOT ATTEMPT TO INJECT OIL INTO THE RHEOMETER HEAD IF THERE IS ANY PRESSURE ON THE RHEOMETER HEAD PRESSURE GAUGE.

DO NOT INJECT MORE THAN ONE CHARGE OF OIL INTO THE RHEOMETER HEAD. THE BOB SHAFT, BOB AND TEST SAMPLE WILL BE CONTAMINATED BY THE OVERFLOWING OIL.

Pull the handle all the way **OUT** to pull the charge of oil into the pump. The knob takes considerable force to pull, and it is best to pull steadily and constantly. Once the handle is fully extended push it **IN** all the way. This will inject the oil charge into the Rheometer Head.

B. HEATING AND COOLING SYSTEMS

1. **COOLING WATER** Flow Rate Meter - Left side of Front Panel

This meter is used to measure and control the water circulating through the Rheometer head to keep it cool while the Sample Cup and Test Sample are at an elevated temperature.

The flow rate of the water is controlled by the knob on the bottom of the flow rate meter. A flow of 0.3 to 0.5 GPM. (1.2 to 2.0 liters per minute) is sufficient. This only can be adjusted during cooling when the Bath Cooling Solenoid Valve is open and allows water to flow.

2. **BATH COOLING SOLENOID VALVE** Located Internally

Normally the valve is closed. At the proper time in the RCO controlled test sequence the valve will be opened and cooling of the Heater Bath will occur automatically. No manual control is required.

CAUTION

REMOVE RUBBER PLUG FROM HOLE IN CENTER OF HEATER BATH TOP BEFORE RAISING HEATER BATH

3. **HEATER BATH** Control - Left Side of Lower Front Panel

PULL the knob to raise the Heater Bath, **PUSH** the knob to lower the Heater Bath. Releasing the knob will hold the Heater Bath in whatever position it is in when the knob was released.

SECTION 4
VISCOSITY TESTS

Viscosity tests are run by subjecting the test sample to Shear Stress at various conditions of Shear Rate, Temperature, and Pressure. The Shear stress (or viscosity) can be determined using any shear rate, fixed or variable with time and under any desired conditions of temperature, fixed or variable, and at any pressure within the limits of the instrument.

The pressure used depends on the pressure consistent with the test program being executed, however the pressure must be sufficient to prevent boiling of the sample. The required pressure must be set manually.

Shear Rate, Temperature and Time of the test program are the variables the RCO and Computer require. It is suggested this system be powered up and the temperature be allowed to stabilize during the following preparation for the test.

A. REQUIRED SAMPLE VOLUME

The amount of sample volume in the Sample Cup is critical. Too much fluid will contaminate the bearings, while too little fluid will cause insufficient coverage of the Bob, resulting in incorrect shear stress values. The normal level of sample at ambient conditions is approximately level with the bottom of the Expansion Fitting "O" Ring groove, with the Bob and Sample Cup assembled onto the Expansion Fitting. The amount of sample required to attain this level will depend on the Bob/Sample Cup combination being used.

Sample volumes for various Bob/Sample Cup combinations are shown in Table 1.

TABLE 1
TEST SAMPLE VOLUMES FOR SAMPLE CUPS (ml)

Type Bob	B1	B2	B3	B4	B5	XB1	XB2	XB5
R1 Sample Cup	42	78	96	104	52	32	73	44
R2 Sample Cup	32	68	86	94	42	22	63	34

Fill Gauges are available to load the proper volume of Sample in the Sample Cup while it is removed from the Expansion Fitting and no Bob is in it. Fill gauges are available for the following Sample Cup/ Bob combinations:

R1, B1
R2, B1
R1, B2
R1, XB5 Note: This gauge sets sample level even with top of Bob.

B. LOADING THE TEST SAMPLE

1. The Sample Cup, Bob, Expansion Fitting, and Bob Shaft should be cleaned and inspected for possible damage before each test.

2. Fill Gauge Method

   Load Sample Cup as follows:

   a. Remove the Sample Cup from the Expansion Fitting. Do not Remove the Bob.

   b. Pour test sample fluid into the Sample Cup to a depth of about 2 inches (5.08 cm).

   c. Select the Fill Gauge to match the Sample Cup/Bob combination being used.

   d. Set the bar of the Fill Gauge on top of the Sample Cup. Depress the bulb then release, to remove excess sample to the level of the bottom end of the tube.

3. Measurement Method

   Table 1 gives Sample Volume Data in (ml) for R1 and R2 Sample Cups using different Bobs.

   Measure out the volume of sample shown in Table 1, and pour it into the Sample Cup.

4. If removed, re-assemble the Bob to be used onto the Bob Shaft. If one of the Extended Bobs is to be used, refer to Section 5 for the procedure of positioning the Extended Bob on the Bob Shaft. The Standard Bob is installed by screwing it to the LEFT until snug. DO NOT OVER TIGHTEN. DO NOT APPLY ANY SIDE FORCE ON THE BOB SHAFT. The Bob Shaft can be bent easily.

5. Screw the Expansion Fitting onto the main shaft. Turn it to the RIGHT.

6. Raise the Sample Cup, with sample, slowly over the Bob being careful that none of the sample is spilled. Screw it onto the Expansion Fitting by turning it to the RIGHT. Tighten each part firmly to assure alignment, but do not over torque.

7. Remove the rubber plug in the center of the work table, then close the safety door.

C. FILL RHEOMETER HEAD WITH BEARING OIL

1. Verify the **PRESSURE RELEASE** Valve is Closed. (Refer to Fig. 1).

2. Slowly and steadily pull the **BEARING OIL** pump knob all the way **OUT** and hold until the pump is full of oil, then push the knob all the way **IN**. This will inject a proper quantity of oil into the bearings. (Refer to Fig. 1).

D. PRESSURIZATION

Pressure may be applied to the sample at this time, later, or not at all as desired by the test sequence being run.

CAUTION

DO NOT HEAT SAMPLE OVER 200 ^{O}F (93 ^{O}C)
WITHOUT PRESSURIZATION

1. Verify **PRESSURE ADJUST** Regulator is closed (Turned all the way counterclockwise). (Refer to Fig. 1).

2. When ready to apply pressure to the sample proceed as follows:

   a. Turn the **PRESSURE ADJUST** Regulator clockwise to obtain desired pressure. This pressure is read from the **HEAD PRESSURE** gauge at the center of the front panel. (Refer to Fig. 1).

   b. If heat is applied to the sample, expansion may cause an additional pressure increase. To correct for this, turn **PRESSURE ADJUST** Knob counterclockwise slightly until the **HEAD PRESSURE** Gauge shows the proper value.

E. SAMPLE HEATING

1. Positioning the Heater Bath

   Heat is applied to the sample **ONLY** when the Heater Bath is in the full UP position to submerge the Sample Cup in oil of the desired temperature. The Heater Bath may be manually raised or lowered at any time as required by the test sequence being run.

   PULL and hold the **HEATER BATH** knob until the Heater Bath is in the Full UP position and complies with test program being used. (Refer to Fig. 1).

   PUSH and hold the **HEATER BATH** knob to lower the Heater Bath as far as desired to comply with test program being used. (Refer to Fig. 1).

   Release of the **HEATER BATH** Knob stops the Heater Bath in the position it is in when the knob is released.

2. Head Cooling - Required whenever a heated test is run

   The Head Cooling Water flow rate is adjusted when a test is in process. Adjust this flow rate before the test has started. This is done be turning the **COOLING WATER** adjust valve on the bottom of the Flow meter. Adjust it in the range of 0.3 to 0.5 GPM. (1.2 to 2.0 liters per minute).

F. RUNNING A TEST - Refer to RCO Software.

1. Start the test on the controlling Personal Computer.

2. Apply pressure as described in Section 4D-2 above to comply with test program being used. Refer to Fig. 1 **HEAD PRESSURE** for pressure desired.

3. Raise and lower Heater Bath as described in Section 4E-1 above to comply with test program being used.

G. TEST TERMINATION RECOMMENDATIONS

1. Continue to allow the Rheometer to operate with the Sample Cup Assembly rotating at 100 rpm or less and the Heater Bath up while sample is cooling.

2. After sample has cooled to less than 200 ^{o}F (93 ^{o}C), lower the Heater Bath until only about 1 inch (2.54 cm) of the Sample Cup is below the work table. With the Sample Cup Assembly still rotating allow the excess bath oil to drain back into Heater Bath.

3. Lower Heater Bath fully and place the rubber plug in the hole in the top of the Heater Bath to prevent contamination of bath oil.

CAUTION

DO NOT RELEASE PRESSURE FROM SAMPLE UNTIL TEMPERATURE HAS DROPPED TO 200^{o}F (93^{o}C). OR LESS

4. Turn the **PRESSURE ADJUST** Regulator off by turning the Regulator Knob slowly all the way counterclockwise. (Refer to Fig 1). Nitrogen will be heard venting from the regulator.

5. Carefully open the **PRESSURE RELEASE** Valve. (Refer to Fig. 1). Oil, foam, and Nitrogen will be discharged into the oil reservoir. When the **HEAD PRESSURE** gauge reads zero, the venting will be complete. This allows the following steps to be performed safety.

CAUTION

THE REGULATOR WILL NOT COMPLETELY BLEED THE SYSTEM BEFORE ATTEMPTING TO REMOVE THE SAMPLE CUP
VERIFY THE SYSTEM HAS BEEN COMPLETELY VENTED
VERIFY THE HEAD PRESSURE GAUGE READS ZERO
VERIFY THE PRESSURE RELEASE VALVE IS OPEN

H. SAMPLE REMOVAL AND CLEANING

1. Remove Sample Cup

   Insert the Tommy Bar in an expansion fitting hole to prevent the Sample Cup and Expansion Fitting from turning. Unscrew Sample Cup by turning it to the Left. If it is stuck, a flat bar can be fit on the bottom for more leverage. Remove the Sample Cup carefully to prevent spillage of sample or damage to the Bob Shaft.

CAUTION

BOB SHAFT THREAD IS A LEFT HAND THREAD.
TURN BOB TO THE RIGHT TO REMOVE.

2. Remove Bob. Unscrew by turning Bob to the Right.

3. Remove Expansion Fitting

   Use Pin Spanner Wrench against holes in driven gear to hold main shaft. Insert Tommy Bar in hole in Expansion Fitting. Loosen the Expansion Fitting from Main Shaft by turning it to the Left with the Tommy Bar. Once loosened, it can be removed by hand.

4. Clean all parts with solvent to remove oil and dirt.

5. Wipe all sample and dirt from the Bob Shaft. Pay particular attention to the lower end of the Bob Shaft, threads, and thermocouple housing. These must be clean. Make sure the Bob will screw on freely with no binding of the threads.

6. Inspect the two sets of threads, Sample Cup to Expansion Fitting and Expansion Fitting to Main Shaft. All these threads must engage freely and be able to screw off and on by hand. They must not be excessively loose as this could cause mis-alignment of the parts. Damaged parts should be repaired or replaced.

CAUTION

SAMPLE CUP, EXPANSION FITTING AND MAIN SHAFT HOLD PRESSURE.
THESE PARTS CAN BE DANGEROUS IF THEIR THREADS ARE DAMAGED.

Fig. 2
Rear of Model 50SL Rheometer

SECTION 5
EXTENDED BOB

The Extended Bob may be used on the Model 50SL Rheometer when the test to be run makes it desirable to account for the Shear between the bottom of the Bob and the inside bottom of the Sample Cup. Extending the length of the Bob and tapering its bottom to make a truncated cone makes it possible to approximate the Shear obtained from a cone and plate Rheometer.

This technique requires precise setting of the Bob on the Bob Shaft so the distance between the bottom of the Sample Cup and the bottom of the Bob and will equate to a cone and plate Shear measurement.

The procedure to install an Extended Bob is described as follows:

1. Make sure the Expansion Fitting is tight on the Main Shaft. Do not install any Bob at this time. If a Bob is installed, remove it. Screw the Sample Cup onto the Expansion Fitting until it is tight against the Expansion Fitting.

2. Scribe an alignment mark across both the Expansion fitting and the Main Shaft. Scribe another alignment mark near the top of the Sample Cup and onto the expansion Fitting, then remove the Sample Cup. These alignment marks will be used in positioning the Extended Bob.

3. Remove the "O" Ring near the bottom of the Expansion Fitting that seals it to the Sample Cup.

4. Install the Extended Bob on the Bob shaft by screwing it on, (Left Hand Thread). Stop slightly before the end of the Bob Shaft becomes flush with the bottom of the Bob.

5. Tighten the set screws.

6. Verify the Model 50SL Rheometer System is operating properly by turning it on and verifying the torque reading is steady at zero.

7. Screw the Sample Cup on very carefully by hand and determine at what point the bottom of the Sample Cup contacts the bottom of the Bob. Contact will be confirmed by the instrument indicating a torque (Shear Stress) reading. Do not screw the Sample Cup on any further.
8. If contact is made in step 7, proceed to step 10.

9. If the Sample Cup should tighten against the Expansion Fitting before any contact was indicated:

    a. Remove the Sample Cup.

    b. Loosen the Bob set screws.

    c. Unscrew the Bob (turn to the right) exactly one turn. Tighten the set screws.

    d. Repeat Step 7.

e. If contact between the bottom of the Bob and the Sample Cup is still not made, repeat step 9 until it is made.

10. At the position of contact the Sample Cup will be a part of a revolution away from make up with the Expansion fitting. This distance is indicated by the relationship between the scribe mark on the Sample Cup and the scribe mark on the lower part of the Expansion chamber as marked in Step 2.

11. Determine the distance the Bob must be raised for it to touch the bottom of the Sample Cup with the Sample Cup tight to the Expansion fitting as follows:

    a. Estimate the amount of rotation (in degrees) the Sample Cup needs to be turned to make up to the Expansion Fitting as indicated by the scribe marks. Estimate to within 10 degrees.

    b. Determine the distance required for Sample Cup to align.
    1 Degree =.00014 inches
    Therefore .00014 x Estimated Degrees = vertical distance for alignment. (Distance, Alignment)

12. The clearance required between the bottom of the Bob and the bottom of the R1 Sample Cup to approximate the Shear obtained from a cone and plate Rheometer has been found to be:

    For XB1 .0125 inches (Distance, Clearance)
    For XB2 .0341 inches
    For XB5 .0270 inches

13. The distance required to raise the Bob up the Bob Shaft is the distance required for alignment of the Sample Cup plus the clearance distance for the Extended Bob being used.

14. The vertical distance the Bob moves per revolution is .0357 inches. Divide the distance required to raise the Bob (Step 13) by .0357 to obtain the number of revolutions to screw the bob.

15. Remove the Sample Cup.

16. Loosen the set screws on the Extended Bob and screw it (to the Left counterclockwise) onto the Bob Shaft the number of revolutions and part of a revolution as determined above in Step 14. Tighten the set screws.

17. Re-assemble the "O" Ring onto the Expansion Fitting.

Optional

To re-position the Extended Bob without using the above procedure, once the Extended Bob has been positioned, scribe a line to record the position. This can be done by scribing radially from the top of the Extended Bob-Bob Shaft intersection to the front top edge of the Extended Bob toward the front of the Rheometer.

Another method of recording the position of the Extended Bob to re-position it is to measure the vertical distance from the top of the Extended Bob to the lower end surface of the Expansion Fitting. Record this measurement for use when the Extended Bob is re-installed.

NOTE: The above Optional methods of re-positioning the Extended Bob are only valid after the Extended Bob has been properly positioned on a particular Rheometer and the exact location of the top of the Extended Bob is known. Maintenance performed on the Rheometer effecting the Expansion fitting, Sample Cup, or Bob Shaft will void these optional procedures.

SECTION 6
INSTALLATION

The Model 50SL Rheometer is shipped completely assembled with the exception of the Bob and the oils for bearing lubrication and the Heater Bath. These are packed separately with the accessory items.

Pick the location for the instrument using the following considerations:

* Floor space of two feet long by two feet deep (60 by 60 cm).
* Near a fresh water outlet
* Near a water drain
* Space for properly securing a Nitrogen cylinder (Not required if a Nitrogen outlet is available)
* Preferably the space should be adjacent to a wall

The Rheometer will require connections as follows:

TABLE 2.
RHEOMETER CONNECTIONS

Tap Water	1/2 or 5/8 hose adapted for 3/8 NPT	Water connection should be 25 to 75 psi. equipped with a shut off valve and a filter or strainer. Refer to Section 6B.
Water Drain	1/2 or 3/4 inch hose adapted for 3/8 NPT	Sink drain type connection located as low as possible. Refer to Section 6C.
Nitrogen	1/4 inch high pressure hose or tubing capable of 3000 psi minimum.	Hose, steel or stainless steel tubing and fittings rated at 3000 psi or above Refer to Section 6D.

CAUTION

THE RHEOMETER WEIGHS APPROXIMATELY 250 POUNDS (114 kg). USE THE PROPER TECHNIQUES WHEN LIFTING AND MOVING THE INSTRUMENT TO AVOID BACK INJURIES.

A. UNPACKING - Retrieve all accessories including Bob and oils

Unpack the instrument and roll it near the location where it is to be connected.

B. TAP WATER - 2 gal/min. (7.84 liters/minute).

Connect a tap water supply to the WATER inlet connection of the Rheometer. The connections should be made using 1/2 or 5/8 inch hose or flexible tubing. Refer to Fig. 2.

Make sure the supply outlet is equipped with a shutoff valve, and a screen or filter.

Use suitable hose or tubing adapters to connect the hose or tubing to the shutoff valve and to the Rheometer. The WATER connection is at the bottom left in the back of the Rheometer. It is a 3/8 inch female pipe thread.

C. WATER DRAIN

Connect the 3/8 inch female pipe thread DRAIN connection at the bottom left in the back of the Rheometer to a sanitary sewer drain, such as a sink drain. Use 1/2 in ID or larger hose or tubing and suitable hose or tubing adapters to make this connection. Place the other end of the hose or tubing in the drain. (Refer to Fig. 2).

D. NITROGEN CONNECTION

If Nitrogen is to be supplied from a Compressed Gas Cylinder, locate the cylinder in an out of the way location as near to the Rheometer as practical. Approved safety straps should be provided to prevent cylinder from falling over.

Should the facility be equipped with a high pressure Nitrogen outlet suitably located, connect the 50SL Rheometer to it.

CAUTION

IF THE HIGH PRESSURE GAS SUPPLY IS IN EXCESS OF 3000 psi (20700 kPa) A PRESSURE REDUCING REGULATOR MUST BE USED AT THE CYLINDER

A 6000 PSI (41400 kPa) rated regulator is available as an option for this purpose.

In making the connection, use a suitable length of 1/4 inch (6mm) inside diameter, high pressure hose, steel tubing, or stainless steel tubing. Make sure that the hose or tubing and all adapter fittings are rated for 3000 psi (20700 kPa) or higher.

1. Connect hose/tubing to the Nitrogen supply.

   a. Connection using a regulator at the Nitrogen Cylinder or a facility outlet.

      If a pressure regulator and gauge assembly is used at the cylinder, or at the laboratory outlet, it will have a suitable gland and nut and is, or can be, attached to the Nitrogen cylinder or laboratory outlet.

      Connect the hose or tubing to the outlet port of the regulator. Make sure all adapter fittings are high pressure.

   b. Connection not using a regulator at the Nitrogen Cylinder or the laboratory outlet.

Connect a Gland and Nut suitable to fit the Nitrogen cylinder to the cylinder. If a laboratory Nitrogen outlet is to be used, connect the high pressure hose or tubing to the shut off valve. Make sure all adapter fittings are high pressure.

c. Connect the hose or tubing to the laboratory Nitrogen supply.

If the Nitrogen source is a laboratory outlet (Nitrogen cylinder not used), adapt the high pressure hose/tubing to connect into the laboratory regulator or outlet. It is recommended that a shut off valve be installed at the outlet if one does not exist.

2. Connect the hose or tubing to the 50SL Rheometer.

Connect the opposite end of the hose or tubing connected to the Nitrogen source as in a,b, or c above, to the Nitrogen connection on the upper left side of the back of the Rheometer, (as viewed from the back). The Nitrogen fitting on the Rheometer is 1/4 female pipe thread. (Refer to Fig. 2).

E. POWER CONNECTIONS

All electrical power and signal inputs and outputs are supplied from the RCO located on top of the 50SL Rheometer. Connectors are located near the top of the 50SL Rheometer and make connection at the bottom of the RCO.

F. HEAD OIL

The Rheometer head oil lubricates the bearings in the Rheometer Head.

The reservoir for this oil is located inside the lower right side panel. It can be accessed by removing the lower right side panel (as viewed from the front). Turn the 6 quarter turn fasteners to release the panel. Fill the reservoir to the line on the reservoir marked **MAXIMUM** with the HEAD OIL provided, Part No 31572 (Quart). (Refer to Fig. 1).

G. HEATER BATH OIL

The Heater Bath must be in the down position to be filled with oil or have oil added. Access the heater bath by removing the plug in the top of the work table. Fill the heater bath until the oil just submerges the thermocouple tip with HEATER BATH oil, Part No. 31573 (Quart).

H. CONNECTION TO RCO

Connect the 50SL Rheometer to the Remote Control Option. Refer to the RCO Instructions for making the electrical connections between the 50SL Rheometer and the RCO on top of it.

SECTION 7
SPECIFICATIONS

The Model 50SL Rheometer has been designed to accommodate a series of interchangeable Sample Cups, Bobs, and Torsion Spring Assemblies which can be used to analyze Shear Stress ranges from 50 to 64,000 dyne/cm^2 full scale. Refer to Table 4, 5 and 6.

A. UTILITIES

The required utilities and specification limits for the 50SL Rheometer are listed in Table 3 below:

TABLE 3
RHEOMETER SPECIFICATIONS

1.	Power Requirements	115 Volt 50/60 Hz, 1000 Watts
2.	Motor Drive	Variable from 3 to 600 RPM Sample Cup Speed
3.	Sample Cup/Bob and Sample Heat	Thermo Bath, 600 Watt, Max Temp 500^{o}F (260^{o}C).
4.	Sample Cup/Bob Sample Cool	Cold Water Circulation in Thermo Bath
5.	Sample Temperature Measurement	Type "J" thermocouple in bottom of Bob shaft
6.	Nitrogen Pressurization	Nitrogen provided from external Nitrogen Source. Nitrogen pressure controlled by Nitrogen Regulator, (PRESSURE ADJUST)
7.	Bob Shaft Rotation	Controlled by Shear Stress 15 degrees maximum, Mechanical stops prevent over travel
8.	Shear Stress Transducer	Variable transformer sensing the angular position of the Bob and Bob shaft
9.	Torsion Springs (Determines Shear Stress Range)	410, 420, 440 (standard), 480 (Refer to Table 6 for details of these spring assemblies)
10.	Bob (Standard)	B1 1.7245 cm Radius x 7.62 cm long (Refer to Table 5 for alternate Bobs)
11.	Sample Cups	R1 1.8415 cm inside radius (standard) R2 1.7588 cm inside radius

B. STANDARD CONFIGURATION

The Standard configuration capabilities of the Model 50SL Rheometer are listed in Table 4 below and describe the instrument in its normal mode. Many combinations of Sample Cups, Bobs, and Springs can be installed, and any speed (Shear Rate), Temperature, and Pressure, within the specifications of the 50SL Rheometer, may be selected to be most suitable for the tests to be run. Obviously, many of the perimeters listed in the table will change as well. Table 5 shows data on the various Bobs. Table 6 shows data on the various springs.

TABLE 4
STANDARD RHEOMETER CONFIGURATION

MODEL 50SL RHEOMETER STANDARD SAMPLE CUP, BOB AND TORSION SPRING	
Nominal Sample Cup Speeds, (rpm)	2 to 600
Gear Ratio, Motor to Sample Cup	12:1
Inside Radius, R1, Sample Cup, (cm)	1.8415
Radius, B1, Bob, (cm)	1.7245
Cylinder Height of B1, Bob, (cm)	7.62
Nominal Spring constant, No.440 spring, (Newton/degree)	0.4
Bob Surface factor for the B1 Bob ($1/cm^3$), K_2	.00702
Shear Rate factor for the annulus between the R1 Sample Cup and the B1 Bob (1/s per RPM), K_3	1.7033
Nominal Bob Shaft Rotation, maximum (degrees)	15
Nominal Maximum Torque, (Newton-cm)	6.0
Shear Stress, Maximum, (Pascals)	420

C. BOB INFORMATION

Several size Bobs are in common use on the 50SL Rheometer and most are used with the R1 Sample Cup. Table 5 gives data on all commonly used Bobs when used with the R1 Sample Cup.

TABLE 5
BOB SPECIFICATIONS BASED ON R1 SAMPLE CUP

Bob	Radius cm.	Length cm.	Effective Length cm.	Shear Gap cm.	Radii Ratio	K_3 1/s/RPM
B1	1.7245	7.620	7.620	0.1170	0.9365	1.7023
B2	1.2276	7.620	7.620	0.6139	0.6666	0.3770
B3	0.8622	7.620	7.620	0.9793	0.4682	0.2682
B4	0.8622	3.810	3.810	0.9793	0.4682	0.2682
B5	1.5987	7.620	7.620	0.2428	0.8682	0.8503
XB1	1.7245	8.806	9.341	0.1170	0.9365	1.7023
XB2	1.2276	8.522	8.785	0.6139	0.6666	0.3770
XB5	1.5987	8.727	9.186	0.2428	0.8682	0.8503

D. SPRING INFORMATION

Four strength Springs are available for use with the 50SL Rheometer. Two are weaker than the standard, for use with low Shear Stresses, and one is stronger for high Shear Stress measurements. These springs are described in Table 6.

TABLE 6
AVAILABLE SPRINGS

PART NO.	SPRING NO.	COLOR CODE	K_1 Nominal Newton/degree
207789	410	GREEN	0.10
207788	420	YELLOW	0.20
207297 (Standard)	440 Standard	BLUE	0.41
204677	480	RED	0.82

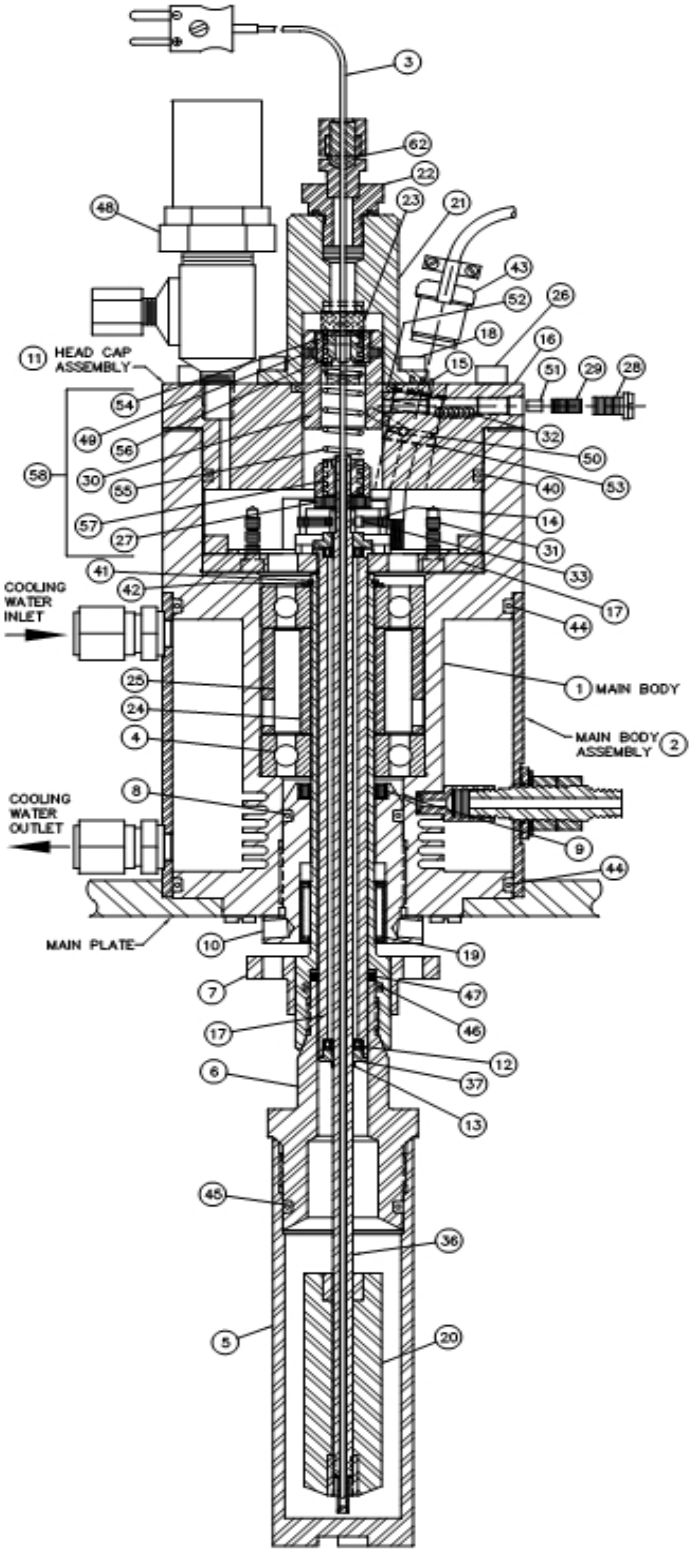

Fig. 3
Measuring Head Assembly

SECTION 8
TROUBLE SHOOTING

PROBLEM	POSSIBLE CAUSE	CORRECTION
Unable to calibrate High or Low Readings	Bent Bob Shaft	Straighten Bob Shaft Replace Bob Shaft
Oil contamination in Sample	Defective Main Shaft Seal	Tighten Seal Nut Replace Seal
Head Temperature too hot	Insufficient or no water flow Head Cooling Solenoid not opening	Adjust Flow Meter 0.5 Gal / Minute Verify power to Solenoid Debris in solenoid Clean Solenoid
Sample Temperature not reading or giving an incorrect reading.	Connector not plugged into RCO Defective Thermocouple or defective connector at RCO plug. Heater Bath temperature is incorrect	Plug in Connector Verify signal at connector. Replace Thermocouple Verify Heater Bath thermocouple operation Repair Heater Bath
Pressure setting does not hold constant. NOTE: Slight increase in pressure is normal as the sample heats.	Insufficient pressure in Nitrogen Cylinder Regulator on Cylinder set too low or is defective. (If used) Leak in Nitrogen line Leak in or around the measuring Head Leak in Quick Disconnect to Head. Pressure Release control valve not completely closed.	Replace Nitrogen Cylinder. Adjust Regulator. Repair or Replace Regulator Identify and Correct Leak. Identify and Correct Leak. Replace "O" Ring in connector. Close Valve. If defective, replace.
Motor will not run or runs erratically. Loss of mechanical	Defective Brushes Set screws loose in flexible coupling	Replace Brushes Tighten Set Screws

PROBLEM	POSSIBLE CAUSE	CORRECTION
connection between motor and tachometer-generator.	Flexible coupling failed	Replace
	Defective tachometer-generator	Replace tachometer-generator.
	No power to motor	Identify break or bad connection and repair.
	Defective Motor	Replace Motor.
Heater Bath will not move up or down.	Low Water pressure	Correct supply pressure
		Remove debris at water entrance to the 50SL.
		Correct pinched or disconnected hoses
	Obstruction in the way of the heater bath or its hydraulic cylinder	Remove obstruction
		Repair Heater Bath
	Control valve is not working properly	Push valve handle IN to raise. Pull it OUT to lower. Center position of valve prevents Heater Bath from moving. If defective repair or Replace

SECTION 9
MAINTENANCE

Section 1B explained the Principal of Operation of the Model 50SL Rheometer and mentioned the parts critical to such a measurement. The mechanical assembly that provides for these parts to operate properly is called the Measuring Head. Pressure and temperature systems, and a motor drive support the measuring head. These systems together comprise the Model 50SL Rheometer. The Model 50SL Rheometer is supported by the Remote Control Option (RCO) and a Personal Computer (PC). This assemblage comprises the operational Rheometer system.

Fig. 3 is a sectional view of the Rheometer main head assembly and the head Cap Assembly. This head assembly can be conveniently separated into the main body assembly item [2] and the head Cap assembly, item [11]. Usually the head assembly is removed. Refer to Fig. 5 for the Head Cap assembly details, and Fig. 6 for the Head Body assembly details.

The main body assembly item [2]. is usually left mounted in the 50SL cabinet. This main body has a water cavity for cooling, which is covered by an outer sleeve item [1] and is sealed by two "O" Rings item [44]. It is also equipped with porting past the water jacket for lubricating oil for the bearings. The oil is drained and replaced through this same port.

The Main Body contains the main bearings, item [4], and the bearing spacers, items [24] and [25]. The main shaft assembly is mounted through these bearings. It consists of the following items listed from bottom up on Fig. 3. Refer to Figs. 3 and 6.

* Sample Cup item [5]

* Expansion Fitting item [6] with "O" Ring item [45],

* Main Shaft with Driven Gear item [7], "O" Ring item [46] and Rulon Seal item [47].

* Seal Nut item [10], Seal item [9], and "O" Ring item [8] assembled onto it. The bottom end of the Seal Nut has needle bearing item [19] pressed into it.

* Thrust washer item [42]. (This washer is on the top of the top bearing).

* Retainer Ring item 41. (Top of the Main Shaft).

NOTE: DO NOT ASSEMBLE THE EXPANSION FITTING, SAMPLE CUP, OR BOB UNTIL THE HEAD IS COMPLETELY MOUNTED.

The Head Cap Assembly item [11] consists of the following parts and sub-assemblies mounted to the Head Cap item [16]: Refer to Figs. 3 and 5.

* Sample Thermocouple item [3]

* Terminal Cap item [21]

* Transducer Assembly, item 14

* Torsion Spring Assembly item [30]

* Quick disconnect tubing adapter fitting item 23

* Relief valve item [48]

* Transducer Mount Assembly item [17]

The Bob Shaft Housing is the stem part of the Transducer Mount Assembly and it's assembly consists of:

- Bob Shaft, item [36],
- Bob Shaft Bearings item [12],
- Shoulder Washer item [37],
- Retainer, item [13]

The disc shaped part of the Transducer Mount Assembly item [17] is used to mount it to the Head Cap item [16].

This completed assembly is then mounted on top of the main body assembly using eight 1/4 -28 socket head cap screws item [26]. After the transducer has been adjusted as outlined in Section 9C-13 then the terminal cap item [21] and sample thermocouple item [3], are mounted using six screws item [18].

After the head cap has been completely assembled, and installed in the Model 50SL cabinet, the expansion fitting item [6], can be screwed into the bottom of the main shaft item [7], then the bob item [20] can be screwed onto the bottom end of the bob shaft item [36], (left hand thread), then the sample cup, item [5] can be screwed onto the expansion fitting item [6]. The main shaft assembly is now complete.

A. OILING SYSTEM - Nitrogen Pressurization

The use of a nitrogen pressurization system requires lubrication of main bearings, therefore the seals and bearing cavity must be filled with oil (approx. 50 cm^3). Excess oil will cause the oil to run over around the bob shaft and can contaminate the sample. To avoid this condition, when nitrogen pressure is used, the 50 cm^3 of oil is drained into the oil reservoir before the system is completely de-pressurized.

Before starting the next Nitrogen pressurization test, the oil in bearing cavity is replaced using the BEARING OIL hydraulic cylinder. (Refer to Fig. 1). Refer to Section 4C for detailed operating instructions.

Changing Head Oil, (Refer to Fig. 2
Some of the oil in the reservoir is re-used each time a test is run. Depending on the type sample it is possible for some of the Sample to contaminate the oil.

1. Periodically, depending on how frequently the 50SL Rheometer is used and the type Samples, check the condition of the Head Oil in the reservoir.

2. Remove the lower right side panel (as viewed from the front). Turn the 6 fasteners 1/4 turn to release the panel.

3. Check the condition of the oil in the reservoir. The color and amount of contamination or sediment as seen through the glass reservoir will determine the need to replace the oil.

4. If the oil is to be changed, drain all the oil by opening the valve on the bottom of the reservoir. Drain the oil into a suitable container for disposal. Close the valve then re-fill the reservoir to the line on the reservoir marked MAXIMUM with the HEAD OIL provided. Replace the cabinet panel. (Refer to Fig. 1).

B. SAMPLE THERMOCOUPLE REPLACEMENT - (Refer to Fig. 3).

The sample thermocouple is of the sheath design, and is complete with a connector on one end, and a sealed mounting fitting at the proper location on the sheath.

1. Disconnect power to the Rheometer to avoid possible rotation of motor while thermocouple is being replaced.

2. Disconnect thermocouple at connector in the bottom of the RCO.

3. Unscrew thermocouple fitting item [22] from the top of Terminal Cap [21]. Pull thermocouple assembly upward and out of the top of the head. Discard the old thermocouple assembly.

4 Install the new thermocouple assembly by sliding the end of the thermocouple to the bottom of its well. Should it bind and not slide in easily, looser the terminal cap mount screws [18] to reduce the alignment problem. Once the thermocouple is at the bottom of the well, loosen the packing nut on the top of the thermocouple fitting assembly and tighten the 7/8 inch hex nut part of the thermocouple fitting into the terminal cap [21]. Raise the thermocouple up from the bottom of the well about 1/8 in. (3 mm). Tighten the packing nut.

5. Route and secure any extra thermocouple sheath to be clear of all rotating parts and electrical connections. Secure as necessary. Plug the connector into the RCO receptacle where the old thermocouple was removed. Refer to RCO connector layout on the RCO back panel. Connect power to the Rheometer.

C. BOB SHAFT BEARING REMOVAL AND REPLACEMENT - (Refer to Fig. 5)

1. Disconnect power to the Rheometer.

2. Remove Sample Cup item [5], Bob item [20], and Expansion Fitting item [6]. Refer to Section 4H-1 through 4H-3.

3. Remove Head Cap thermocouple

   a. Unplug thermocouple at its plug on the bottom of the RCO.

   b. Remove any tie-wraps from thermocouple leads.

c. Unscrew thermocouple fitting item [22] from the top of Terminal Cap item [21]. Pull thermocouple assembly upward and out of the top of the head. Be careful not to bend or kink this sheath type thermocouple.

4. Unplug transducer cable item [43] from head cap assembly.

5. Disconnect hydraulic line from top of head cap by unplugging quick-disconnect item [23].

6. Remove Head Cap

a. Remove 8 cap screws item [26] holding the head cap to main body.

b. Use two small pry bars that fit in the pry slots to raise the head cap assembly straight up far enough to unseat "O" Ring item [40].

c. Remove the head cap assembly upward until the bob shaft clears the main body. Do not bend Bob shaft.

7. Disassembly of the Head Cap Assembly

NOTE: It is suggested the head cap assembly be lightly held in a bench vise during the following dis-assembly steps.

a. Remove six terminal cap mounting screws item [18], then remove the terminal cap item [21].

b. Reach through ports in head cap and loosen (2) set screws item [27]. (Refer to Fig. 5.

c. Remove plug screw item [28] so set screw item [29] can be accessed.

d. Loosen set screw item [29].

e. Pull the zeroing sleeve [30] upward and remove zeroing sleeve and attached torsion spring assembly. DO NOT STRETCH SPRING.

8. Remove Transducer

a. Loosen set screw item [32] so that transducer electrical plug item [15] can be pushed through hole.

b. Loosen cap screw item [33] clamping arm item [35] to the bob shaft and remove (2) pan head screws item [34] (Fig. 4).

c. Lift transducer item [14] along with arm item [35] off the bob shaft gently, then push the transducer connector out of the head cap.

d. Set the transducer aside for reassembly or replacement.

9. Remove Transducer Mount

a. Remove (4) screws item [31] and gently pry stem section of the transducer mount item [17] from head cap item [16].

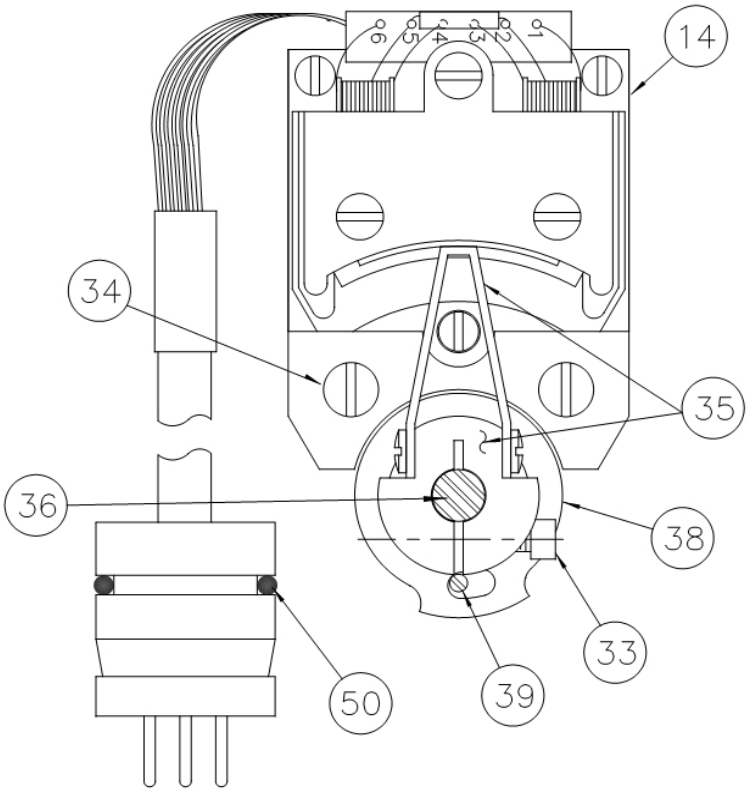

Fig. 4
Transducer Assembly

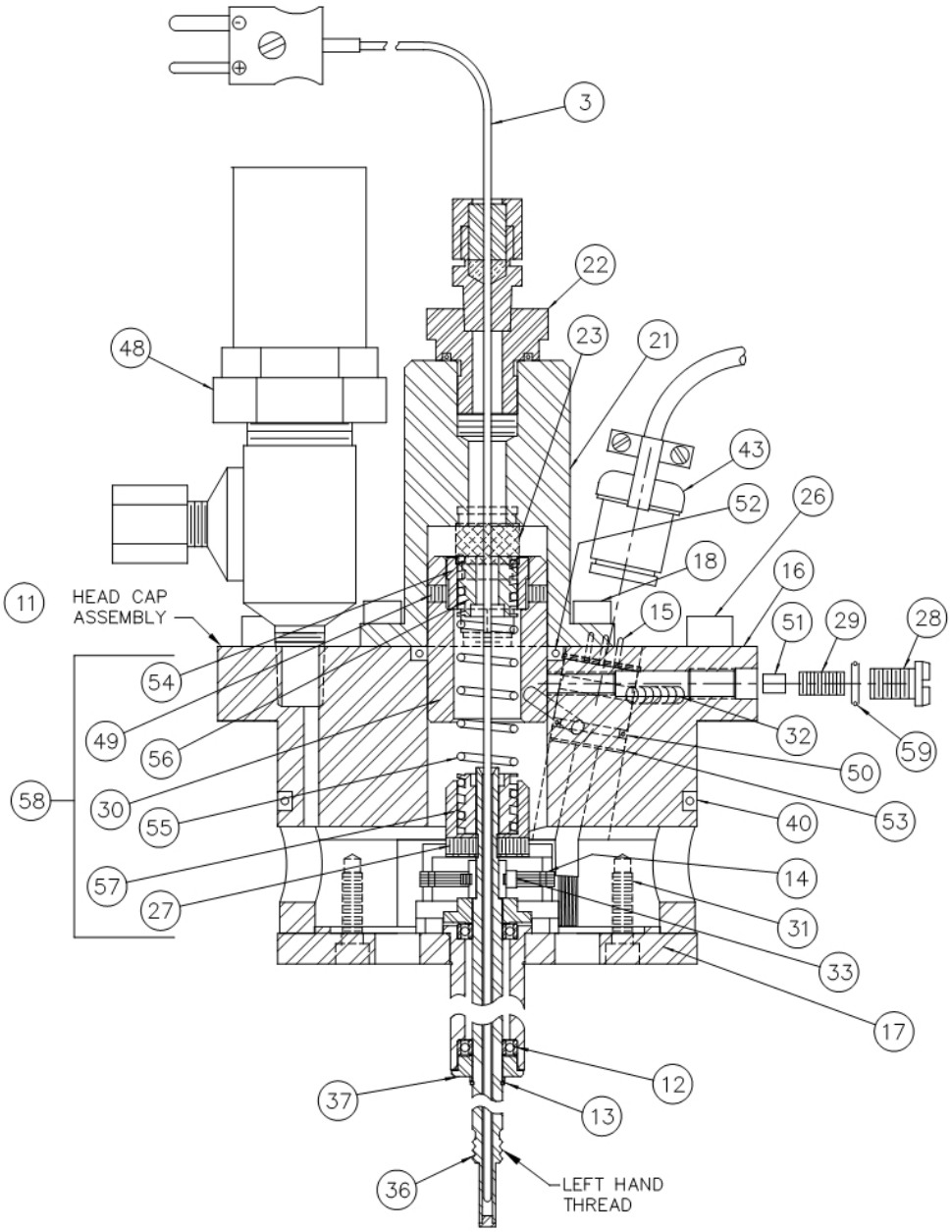

Fig. 5
Head Cap Assembly Detail

c. Pull the bob shaft out of the transducer mount from the top. If the top bearings items [12] come out with the shaft, remove it.

10. Bob Shaft Bearing Removal

a. Remove the bottom bearing item [12] from the transducer mount stem item [17], and top bearing if it did not come out with bob shaft.

b. Clean all parts

If the head cap cavity shows varnish or sedimentation from hydraulic oil, it should be washed out with Varsol or other mild solvent. Clean mating surfaces of head cap and the transducer mount.

11. Bob Shaft Bearing Replacement

a. Assemble two new bob shaft bearings item [12] into the stem of the transducer mount.

b. Assemble the bob shaft item [7] into the stem of the transducer mount item [17] from the top.

c. Install shoulder washer item [37] and retainer item [13] from bottom end of Bob Shaft against lower Bob Shaft bearing item [36] making sure the retainer is in the groove.

d. Manufacturing tolerances allow some differences in bearing end play. After assembly, check shaft for end play. This should be from .003" to .007". If end play is not correct install a thinner shoulder washer or add one or more item [59] .005 thick shim washers (Part No. 31277) if the shoulder washer is too thin.

12. Align and assemble the head cap item [16] and the transducer mount assembly item [17] using four screws item [31]. Tighten screws in a criss-cross pattern for best alignment.

13. Assemble the transducer onto the transducer mount.

a. Fit the transducer arm item [35] over the top of the bob shaft. After securing transducer assembly item [14] lightly to transducer mount with screws items [34], position arm as shown in Fig. 4.

b. Check clearance on arm item [35] when bob shaft is rotated. Be sure transducer arm does not bind at any point. Holes for screws item [34] are oversize so transducer can be shifted for alignment.

c. When alignment is correct, tighten screw item [33] and screws item [34] firmly, then recheck for free movement of arm item [35]. Limiter cam item [38] should be in the position shown in Fig. 4 with respect to stop pin item [39]. Limiter cam item [38] should not be touching stop pin item [39] but should be very close.

14. Install the transducer electrical plug in the hole in the head cap, pins toward the top. Check and if necessary replace "O" Ring item [50]. Secure by installing and tightening set screw item [32].

15. Check "O" Ring item [40] on outside of the head cap assembly for cuts, nicks, set (not round cross section) or hardness. Replace if necessary.

16. Coil excess transducer cable around cavity so it does not interfere with the transducer. Secure with screw and cable clamp.

17. Slip torsion spring assembly item [58] into place and tighten set screws item [27]. Twist Zeroing Sleeve item [30] so that limiter cam item [38] and pin item [39] are in position shown in Fig. 4. Cam should be close to but not touching pin.

18. Insert set screw cushion item [51], then tighten screw item [29]. Spring and vane should be completely free and movable for the full 15 degrees of angular deflection of the spring.

19. Replace cover screw item [28] and "O" ring item [59]. Make sure "O" ring is in good condition ar replace it.

20. Assemble terminal cap item [21] on top of head cap making sure the "O" Ring at the bottom of the cap, item [52], is in good condition. Install and alternately tighten six item 18 socket head screws.

21. Lubricate the large "O" Ring item [40]. Carefully place head cap assembly in the top of the main body assembly. A small bar or 6 inch steel rule may be temporally laid across the top of the main body to support the head cap assembly while it is being oriented. to make sure fittings and other connections will be in the proper position. Make sure the screw holes are in line with the holes in the body. When properly oriented, remove the bar and lower the head cap assembly into place.

22. Install and alternately tighten the eight 1/4-28 socket head screws item [26].

23 Install the sample thermocouple, as described in Section 9B-4 and 9B-5 above.

24. Replace RCO on top of cabinet, and plug the electrical connectors into it.

25. Plug in hydraulic quick-connect item [23].

26. Replace any cabinet panels removed. The Model 50SL Rheometer is now ready for operation.

27. Check Operation and Calibration.

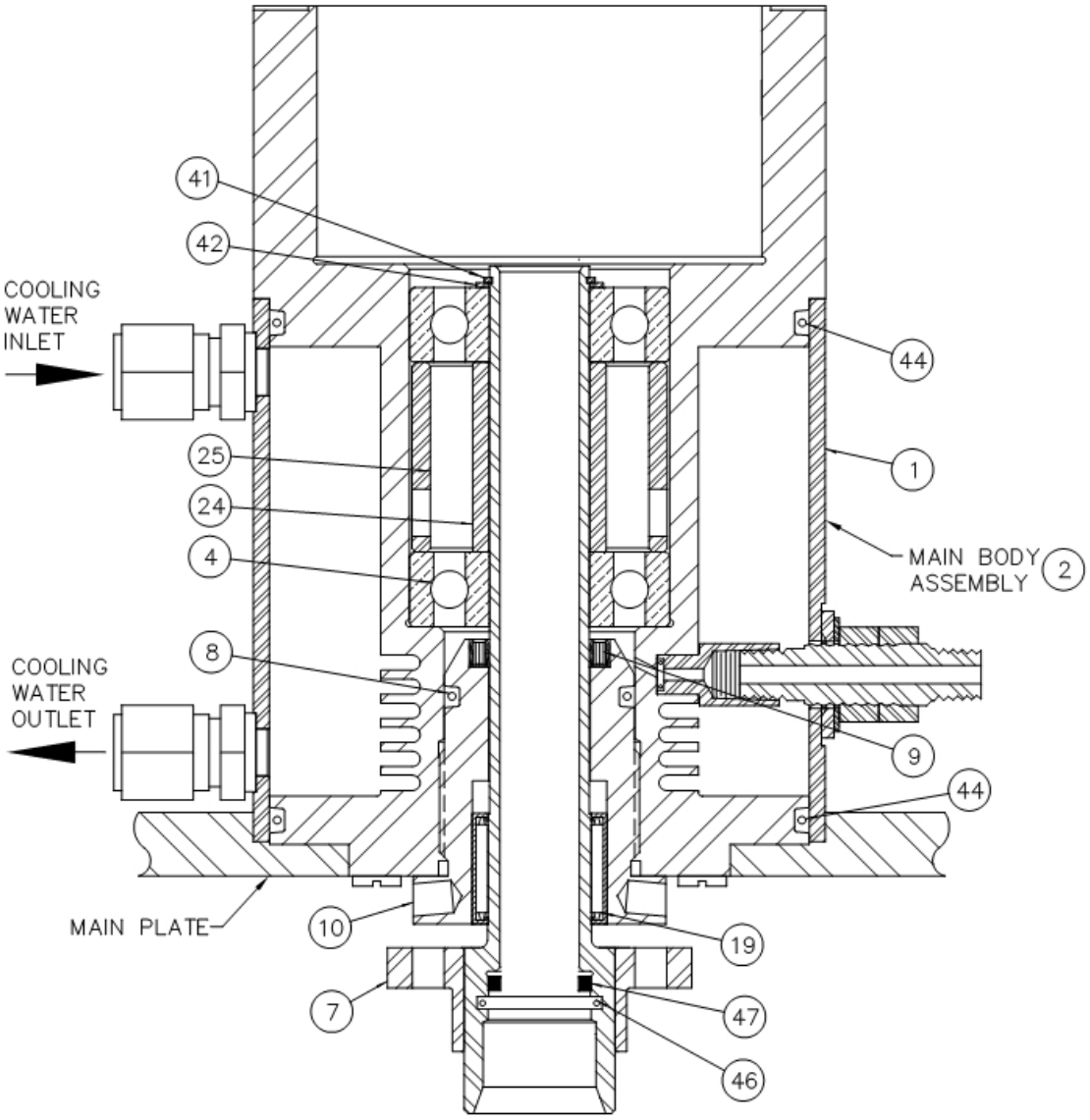

Fig. 6
Main body Assembly Detail

D. REMOVAL AND/OR REPLACEMENT - SEAL RING - MAIN BEARINGS - NEEDLE BEARING (Refer to Fig. 6)

1. Remove Head Cap Assembly as described in Section 9C-1 through 9C-6 above.

2. Use jeweler's screwdriver to remove spiral lock ring item [41] and thrust washer item [42] at top end of main shaft.

3. Use "Tommy" round bar wrench to back out seal nut item [10]. If threads are tight it may be necessary to remove gear guard assembly.

4. Slide the Main Shaft item [7] and the Seal Nut item [10] out from the bottom. Remove the Seal Nut assembly from the top end of the Main Shaft.

5. If the main bearings item [4] are to be replaced, remove them at this time, if not skip Steps 6 and 9. DO NOT REMOVE THESE BEARING UNLESS THEY ARE REPLACED.

6. If a suitable internal bearing puller with a slide hammer is available, it is the best tool to use. If not, use a wooden, plastic, aluminum or brass rod as a punch to lightly tap the top bearing upward.

   a. Tap alternately all the way around the bearing.

   b. Remove the inner spacer item [24] and outer spacer item [25] between the bearings.

   c. Repeat the pulling or tapping process for the bottom bearing.

   d. Thoroughly clean the inside of the main body.

7. Cleaning and Inspection of the Seal Nut Assembly

   a. Pry the old seal ring item [9] out of the top of the Seal Nut being careful not to scratch recess in nut.

   b. Clean the Seal Nut item [10] of any dirt or debris.

   c. Check the "O" Ring item [8] on the seal nut. Replace it if it is hard or has been nicked.

   d. Check the needle bearing item [19] in the bottom end of the Seal Nut. If the needle bearing item [19] is to be replaced, use an internal puller if available. If not us a brass or aluminum rod as a punch and drive the needle bearing out from the top of the Seal Nut. If the needle bearing is to be reused, clean it thoroughly.

8. Cleaning and Inspection of the Main Shaft.

   a. If main shaft item [7] shows abrasion in the area where seal ring rubs, it should be smoothed. Start with 600 grit emery paper, then finish with crocus cloth. A high polish surface is required for minimum wear.

   b. Inspect the Packing Washer item [47] in the bottom end of the Main Shaft. Do not remove this Rulon washer unless it is to be replaced.

      NOTE: This washer cannot be replaced without dis-assembly of the Head Assembly.

   c. Check the "O" Ring item [46] in the bottom of the Main Shaft. Replace it if it is hard or nicked.

9. Install the new bearings item [4]. (Refer to Fig. 6). Make sure the wide side of the outer race on both bearing is inserted first.

   a. Use the outer spacer item [25] or other suitable sleeve to push one bearing to the bottom of the bearing bore in the main body. Make sure that ONLY contact is made with the outer race.

   b. Install the outer and inner spacer sleeves, items [24] and [25].

   c. Install the top bearing item [4] turned the same as the bottom bearing, wide outer race first. Press or tap ONLY on the outer race. Make sure both bearings are properly seated and the spacers are in place.

10. Insert seal nut item [10] onto main shaft item [7]. Grease the new seal ring item [9] and the "O" Ring item [8] with Vaseline, then slide the seal ring item [9] over main shaft and down into seal nut seat being sure that the seal seats flush with seal nut surface. It should be a light press fit.

11. Reassemble head in reverse order starting with seal nut item [10] and main shaft item [7] as one assembly.

   a. Slide main shaft item [7] and Seal Nut Assembly, items [10, 9, and 8] through the bearings from the bottom up.

   b. Install the thrust washer item [42] below the lock ring groove. Secure by installing the spiral lock ring item [41].

12. Replace the head cap assembly into the main body assembly. Secure all screws and fittings. (Refer to Section 9C-21 through 9C-27). Calibration should not be required if measuring head was not dis-assembled.

E. TORQUE TRANSDUCER REPLACEMENT - (Refer to Figs. 4 and 5).

1. Remove Torque Transducer as described in Section 9C-1 through 9C-8 above.

2. Install new Torque Transducer as described in Section 9C-11 through 9C-16, and 9C-20 through 9C-27.

SECTION 10
PARTS LIST

A. MODEL 50SL PARTS LESS MEASURING HEAD
(Refer to Section B for Measuring Head Parts)

Part No.	Description
207152	COUPLING, SHAFT, FLEX
207304	NUT SEAL
207305	MOTOR, DRIVE
207310	BEARING, DRIVE SYSTEM IDLER GEAR
207317	DRIVE SHAFT IDLER
207329	BEARING, MOTOR DRIVE GEAR
207453	"O" RING 3-3/4 X 4 X 1/8 VIT V-14 #240-75
207454	"O" RING 7/16 X 9/16 X 1/16 VIT V-14 #013-75
207455	"O" RING 5/16 X 7/16 X 1/16 VIT V-14 #011-75
207711	CYLINDER, WATER, HEATER BATH
207713	VALVE RELIEF, 1/8 NPT X 1/4 TUBE, 800-1500 PSI
207773	VALVE, OIL DRAIN
207809	HEATER, BAND 300 WATT 115 VOLT
207866	RETAINER EXTERNAL
207867	RETAINER INTERNAL
207991	HEATER BATH
208027	STOPPER #10 RUBBER (Plug for Work Table)
208235	CAPACITOR .015 UF 600 VOLT
208317	TACHOMETER, MOTOR SPEED CONTROL
208695	CYLINDER, HEAD OIL INJECTION
208697	VALVE, CHECK 1/4 INCH TUBE BRASS 3000 PSI
208727	VALVE CHECK 1/4 NPT X 1/4 NPT, 3000 PSI
208800	THERMOCOUPLE, HEATER BATH
208982	ALARM, HEATER BATH
209094	SENSOR ASSEMBLY HALL EFFECT
209101	DOOR ASSEMBLY
209122	MAGNET, SQUARE BAR, 1/8 SQUARE X 3/4 LONG
209405	VALVE ASSEMBLY, HEATER BATH CONTROL

Part No.	Description
209406	RESERVOIR ASSEMBLY, 1 QUART GLASS
209410	HOSE 2 FEET LONG, 1/4 EASTMAN CONN. EACH END
210459	INSULATION, BULK
203961	MUFFLER, SHELL TYPE 1/4 MNPT ALUMINUM
204151	GAUGE, 3000 PSI, 2.5" DIAL, 1/4 BACK CONN.
204152	GAUGE, 1000 PSI, 2.5" DIAL, 1/4 BACK CONN.
204897	REGULATOR, 6000 PSI IN, 50-2500 PSI OUT
205217	RESERVOIR, 1 QUART 4-1/4 DIAMETER GLASS
205401	HOSE, TEFLON W/SS BRAID, 1/8 NPT X 10 INCH LONG
205647	"O" RING 1/8 X 1/4 X 1/16 Nit B-46 #006-70
205801	THERMOSTAT 50-600 ^{o}F, (10-315 ^{o}C)
206065	TRANSDUCER, PRESSURE, 0-1000 PSI
206140	VALVE, SOLENOID, TWO-WAY, N.C. 115 VOLT AC
206142	VALVE, RELIEF 25-50 PS
206152	VALVE, CHECK, 1/4 NPT, SS, 3000 PSI

B. Model 50SL Measuring Head Parts (Refer to Figs. 3,4,5,and 6 to Identify numbers on these figures)

ITEM NO.	PART NO.	DESCRIPTION
1	208709	WATER JACKET ASSEMBLY, MAIN BODY
2	208710	MAIN BODY ASSEMBLY
3	208564	THERMOCOUPLE ASSEMBLY, SAMPLE TEMPERATURE
4	207330	BEARINGS (2), MAIN BODY
5	209276 208742	SAMPLE CUP, R1, 316 STAINLESS STEEL (STD) SAMPLE CUP, R1, ALLOY C276
6	209277 208743	EXPANSION FITTING, 316 STAINLESS STEEL (STD) EXPANSION FITTING, ALLOY C276
7	207312	SHAFT ASSEMBLY, MAIN, WITH GEAR
8	207456	"O" RING, 1-1/4 ID X 1-1/2 OD X 1/8 VITON
9	207727	SEAL, OIL
10	207304	NUT, SEAL
11	209419	HEAD SUB-ASSEMBLY, 50SL

ITEM NO.	PART NO.	DESCRIPTION
12	207159	BEARING, BOB SHAFT (2)
13	207814	RETAINER
14	209050	TRANSDUCER ASSEMBLY "MARK II" COMPLETE
15	207289	MALE PLUG (PART OF ITEM 14)
16	207326	CAP, HEAD, 50C RHEOMETER
17	207325	TRANSDUCER MOUNT ASSEMBLY
18	207620	10-32 X 1/2 Socket Head Cap Screw
19	207328	BEARING, NEEDLE, 50C SEAL NUT
20	209273 208737 208732 208733	BOB, B1, 316 STAINLESS STEEL (STD) BOB, B1, ALLOY C276 BOB, EXTENDED, B1, 316 STAINLESS STEEL BOB, EXTENDED, B1, HASTELLOY
	208716 208746 207165 208738	BOB, B2, 316 STAINLESS STEEL BOB, B2, ALLOY C276 BOB, EXTENDED, B2, 316 STAINLESS STEEL BOB, EXTENDED, B2, HASTELLOY
	209173	BOB, B3, ALLOY C276
	207169	BOB, B4, ALLOY C276
	209047 208747 209140	BOB, B5, 316 STAINLESS STEEL BOB, B5, ALLOY C276 BOB, EXTENDED, B5, 316 STAINLESS STEEL
21	207299	TERMINAL CAP
22	- - -	THERMOCOUPLE FITTING (PART OF ITEM 3)
23	204041	QUICK DISCONNECT
24	207319	SPACER, INNER, BEARING
25	207320	SPACER, OUTER, BEARING
26	207868	1/4 - 28 X 1 LONG Socket Head Cap Screw
27	207622	6-32 X 1/8 LONG HEX SOCKET SET SCREW (2)
28	207321	1/4 - 28 X 1/2 LONG PHMS, MODIFIED
29	207764	10-32 X 3/8 LONG HEX SOCKET SET SCREW
30	207295	ZEROING SLEEVE
31	207611	8-32 X 1\2 LONG SOCKET HEAD CAP SCREW
32	207186	6-32 X 3/16 LONG HEX SOCKET SET SCREW
33	207869	2-56 X 3/8 LONG SOCKET HEAD CAP SCREW
34	207488	6-32 X 3/8 LONG BINDING HEAD MACHINE SCREW (2)
35	- - -	VANE, TRANSDUCER (PART OF ITEM 14)

ITEM NO.	PART NO.	DESCRIPTION
36	208741	BOB SHAFT, ALLOY C276
	209275	BOB SHAFT, 316 SS
37	207300	SHOULDER WASHER, BOB SHAFT
38	- - -	CAM, ANGLE LIMITER (PART OF ITEM 36)
39	207158	ROLL PIN 1/16 X 3/8 LONG (PART OF ITEM 17)
40	207327	"O" RING 3-1/4 ID X 3-1/2 OD 1/8
41	207812	RETAINER, (TOP OF ITEM 7)
42	207342	WASHER, THRUST (TOP OF ITEM 7)
43	208563	TRANSDUCER INTERFACE CABLE
44	205663	"O" RING 4.00 ID X 4-1/4 OD X 1/8
45	207456	"O" RING 1-1/4 ID X 1-1/2 OD X 1/8 (EXPANSION FITTING)
46	207313	"O" RING 13/16 ID X 1 OD X 3/32
47	207339	WASHER, PACKING
48	207713	RELIEF VALVE, 1100 PSI
49	207622	6-32 X 1/8 LONG HEX SOCKET SET SCREW
50	207187	"O" RING 1/2 ID X 5/8 OD X 1/16
51	207172	CUSHION, SET SCREW
52	205658	"O" RING 1 ID X 1-14 OD X 1/8
53	207870	RETAINER, INTERNAL, 5/8
54	207296	RING,CLAMPING
55	207181 207182	SPRING .064 (PART TORSION SPRING ITEM 58 STD) SPRING .046 (PART TORSION SPRING ITEM 58
56	207179 207937	MANDREL A 100K (TORSION SPRING ITEM 58 (STD) MANDREL A 25K (TORSION SPRING ITEM 58
57	207178	CUP, SPRING (PART TORSION SPRING ITEM 58)
58	207297	TORSION SPRING ASSEMBLY #440 (STD)
	207788	TORSION SPRING ASSEMBLY #420
58	207789	TORSION SPRING ASSEMBLY #410
59	204677	TORSION SPRING ASSEMBLY #480
	205650	"O" Ring 1/4 ID X 3/8 OD X 1/16 NIT
60	205653	“O” Ring 1/4 ID X 3/8 OD X 1/16 NIT
61	205647	“O” Ring 1/4 ID X 3/8 OD X 1/16 NIT

ITEM NO.	PART NO.	DESCRIPTION

C. Model 50 SL Accessories

PART NO.	DESCRIPTION
207225	WRENCH, PIN SPANNER
207338	BAR, TOMMY
207874	HEAD OIL, VISCOMETER, 1 QUART
207875	OIL, HEATER BATH, 1 QUART (2)
207884	WRENCH, HEX KEY,.050 SHORT ARM
207885	WRENCH, HEX KEY, 1/16 SHORT ARM
207886	WRENCH, HEX KEY, 5/64 SHORT ARM
207887	WRENCH, HEX KEY, 3/32 SHORT ARM
207888	WRENCH, HEX KEY, 7/64 SHORT ARM
207889	WRENCH, HEX KEY 1/8, SHORT ARM
207890	WRENCH, HEX KEY, 9/64, SHORT ARM
207891	WRENCH, HRX KEY, 5/32, LONG ARM
207892	WRENCH, HEX KEY, 3/16, LONG ARM
208015	GAUGE FILL R1/B1
208753	CALIBRATION KIT, DW-6
204239	INSTRUCTION, FANN 50SL RHEOMETER

Warranty

Fann Instrument Company warrants the product to be free from defects in material and workmanship for a period of twelve months. 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.

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.

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

Return of Items

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.

The correspondence address is:

Fann Instrument Company
P.O. Box 4350
Houston, Texas, 77210
U.S.A.
Telephone: (281)871-4482
Toll Free: (800)-347-0450
Fax: (281) 871-4358

The shipping address is:

Fann Instrument Company
14851 Milner Road, Gate 5
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U.S.A.