

Model 35 Viscometer

Instruction Manual



Manual No. 208878, Revision P
Instrument No. 207198 (35A)
207199 (35SA)
207200 (35A/SR-12)
207201 (35SA/SR-12)

Model 35 Instruction Manual

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Houston, Texas, USA

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1 Introduction

Fann Model 35 viscometers are direct-reading instruments which are available in six- speed and twelve- speed designs for use on either 50 Hz or 60 Hz electrical power. The standard power source is 115 volts, but all models may be fitted with a transformer, making operation with 220/230 volts possible.

Fann Model 35 viscometers are used in research and production. These viscometers are recommended for evaluating the rheological properties of fluids, Newtonian and non-Newtonian. The design includes a R1 Rotor Sleeve, B1 Bob, F1 Torsion Spring, and a stainless steel sample cup for testing according to American Petroleum Institute Recommended Practice for Field Testing Water Based Drilling Fluids, API RP 13B-1/ISO 10414-1 Specification.

1.1 Background

Fann Model 35 viscometers are Couette rotational viscometers. In this viscometer, the test fluid is contained in the annular space (shear gap) between an outer cylinder and the bob (inner cylinder). Viscosity measurements are made when the outer cylinder, rotating at a known velocity, causes a viscous drag exerted by the fluid. This drag creates a torque on the bob, which is transmitted to a precision spring where its deflection is measured.







Viscosity measured by a Couette viscometer, such as the Model 35, is a measure of the shear stress caused by a given shear rate. This relationship is a linear function for Newtonian fluids (i.e., a plot of shear stress vs. shear rate is a straight line).

The instrument is designed so that the viscosity in centipoise (or millipascal second) of a Newtonian fluid is indicated on the dial with the standard rotor R1, bob B1, and torsion spring F1 operating at 300 rpm. Viscosities at other test speeds may be measured by using multipliers of the dial reading. A simple calculation that closely approximates the viscosity of a pseudo-plastic fluid, such as a drilling fluid is described in Section 7.

The shear rate may be changed by changing the rotor speed and rotor-bob combination. Various torsion springs are available and are easily interchanged in order to broaden shear stress ranges and allow viscosity measurements in a variety of fluids.

1.2 Document Conventions

The following icons are used as necessary to distinguish elements of text.

	<hr/> <p>NOTE. Notes emphasize additional information that may be useful to the reader.</p> <hr/>
	<hr/> <p>CAUTION. Describes a situation or practice that requires operator awareness or action in order to avoid undesirable consequences.</p> <hr/>
	<hr/> <p>MANDATORY ACTION. Gives directions that, if not observed, could result in loss of data or in damage to equipment.</p> <hr/>
	<hr/> <p>WARNING! Describes an unsafe condition or practice that if not corrected, could result in personal injury or threat to health.</p> <hr/>
	<hr/> <p>ELECTRICITY WARNING! Alerts the operator that there is risk of electric shock.</p> <hr/>
	<hr/> <p>HOT SURFACE! Alerts the operator that there is a hot surface and that there is risk of getting burned if the surface is touched.</p> <hr/>

2 Safety

Safe laboratory practices and procedures should be observed while operating and maintaining the Model 35 viscometer.

The safe operation of the Fann Model 35 series viscometer requires that the laboratory technician be familiar with the proper operating procedures and potential hazards associated with the instrument.

The operator should be properly trained before operating this equipment. The safe operation of this equipment may be impaired if it is used in a manner not specified by the manufacturer.



The viscometer base cover has vents to help prevent heat build-up. Do not block the vents.



During operation, the motor surface may get hot and there is risk of getting burned if the surface is touched.

2.1 Safe Electrical Operation



The power cable (P/N 203522) that comes with the viscometer is the only one that should be used with this instrument. Do not substitute with another one.

This instrument is driven by 115 volt or 230 volt electrical power. Keep hands, clothes and other objects away from the rotating parts of the machine.

The optional heated sample cups and recirculating sample cups are electrically heated. Make sure the power cord and other wiring associated with these cups and the Model 35 assembly is in good condition and properly grounded.

Make sure the viscometer's power switch is the OFF position and unplugged from the source before cleaning, repairing or performing maintenance.



Please note that when motor speed /control power switch is in the OFF position, power is only removed from the motor. However, the power switch and the capacitor will still have a charge.

Do not allow the viscometer base to get wet. If samples have been spilled or splattered, wipe clean with a damp cloth. Do not allow water to run into the base; excessive water could cause damage to the electrical components.

2.2 Standard B1 Bob



The standard B1 bob (furnished with the Model 35 series viscometers) is a hollow bob that must not be used to test samples hotter than 200°F (93°C).

Solid bobs are available for testing at higher temperatures.

2.3 Heated Sample Cup



When testing heated samples using the heated sample cups wear the proper hand protection to avoid getting burned.



When using heated sample cups, do NOT exceed 200°F (93°C).

3 Features and Specifications

The Fann direct-indicating viscometers are equipped with the standard R1 rotor sleeve, B1 bob, F1 torsion spring, and a stainless steel sample cup. Other rotor-bob combinations and/or torsion springs can be substituted to extend the torque measuring range or increase the sensitivity of the torque measurement.

Each viscometer is supplied with a 115 volt motor. For operation on 230 volts, a step-down transformer is required.

The viscometers are available in six-speed and twelve-speed models. See Table 3-1, Table 3-2, Table 3-3 and Table 3-4 for specifications. Table 3-5 lists the recommended environmental conditions for use.

The photo in Figure 3-1 shows the viscometer and the detailed drawing in Figure 3-2 identifies the individual parts.



Figure 3-1 Model 35SA Viscometer

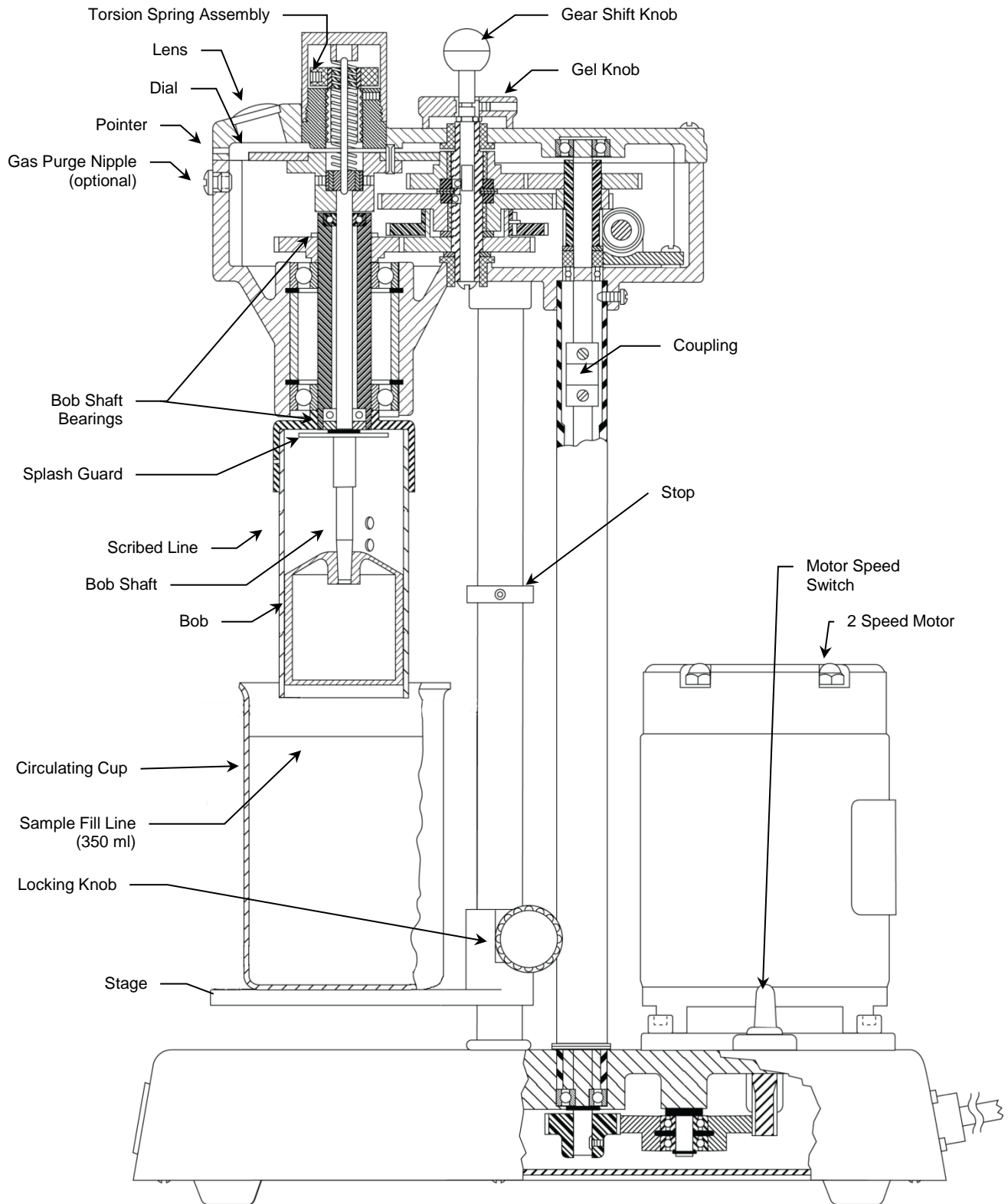


Figure 3-2 Model 35 Viscometer Schematic

Table 3-1 Model 35 Viscometer Specifications

Model No.	Part No.	Electrical	No. of Speeds	Speeds
35A	207198	115V, 60 Hz, 90W	6	600, 300, 200, 100, 6, 3
35SA	207199	115V, 50 Hz, 90W	6	600, 300, 200, 100, 6, 3
35A/SR-12	207200	115V, 60 Hz, 90W	12	600, 300, 200, 180, 100, 90, 60, 30, 6, 3, 1.8, 0.9
35SA/SR-12	207201	115V, 50 Hz, 90W	12	600, 300, 200, 180, 100, 90, 60, 30, 6, 3, 1.8, 0.9

Table 3-2 Model 35 Viscometer Sizes

Model No.	Part No.	Dimensions (LxDxH)	Weight
35A	207198	15.2 x 6 x 10.5 in. 39 x 15 x 27 cm	15 lb 6.8 kg
35SA	207199	15.2 x 6 x 10.5 in. 39 x 15 x 27 cm	15 lb 6.8 kg
35A/SR-12	207200	15.2 x 6 x 10.5 in. 39 x 15 x 27 cm	15 lb 6.8 kg
35SA/SR-12	207201	15.2 x 6 x 10.5 in. 39 x 15 x 27 cm	15 lb 6.8 kg
35A w/ case	101671768	8 x 16 x 19 in. 20.3 x 40.6 x 48.3 cm	26 lb 11.8 kg
35SA w/ case	101671770	8 x 16 x 19 in. 20.3 x 40.6 x 48.3 cm	26 lb 11.8 kg

Table 3-3 Rotor and Bob Dimensions

Unit	Radius (cm)	Length (cm)	Cylinder Area (cm ²) x Radius (cm)
B1	1.7245	3.8	71.005
B2	1.2276	3.8	35.981
B3	0.86225	3.8	17.751
B4	0.86225	1.9	8.876
R1	1.8415	n/a	n/a
R2	1.7589	n/a	n/a
R3	2.5867	n/a	n/a

Table 3-4 Rotor-Bob Specifications

ROTOR-BOB	R1 B1	R2 B1	R3 B1	R1 B2	R1 B3	R1 B4
Rotor Radius, R ₀ (cm)	1.8415	1.7588	2.5866	1.8415	1.8415	1.8415
Bob Radius, R _i (cm)	1.7245	1.7245	1.7245	1.2276	0.8622	0.8622
Bob Height, L (cm)	3.8	3.8	3.8	3.8	3.8	1.9
Shear Gap in Annulus (cm)	0.117	0.0343	0.8261	0.6139	0.9793	0.9793
Radii Ratio, R _i /R ₀	0.9365	0.9805	0.667	0.666	0.468	0.468
Maximum Use Temperature (°C)	93	93	93	93	93	93
Minimum Use Temperature (°C)	0	0	0	0	0	0

Table 3-5 Range of Environmental Conditions

Maximum Altitude	6562 ft (2000 m)
Temperature Range	41°F to 104°F (5°C to 40°C)
Maximum Relative Humidity (RH)	80% RH at 87.8°F (31°C) or less 50% RH at 104°F (40°C)

4 Installation

The Model 35 should be placed in a position where there is easy access to the power cord plug for disconnection.

Consideration should be given to the location where samples are prepared and equipment is cleaned when the test is completed. There should be sufficient storage area nearby for commonly used tools, as well as consumables.



The viscometer base cover has vents to help prevent heat build-up. Do not block the vents.

5 Operation

This section describes the operating instructions for the Model 35 series viscometers. It also includes instructions for measuring gel strength and changing rotors, bobs, and torsion springs.

To start the test, add 350 ml of pre-stirred sample to the stainless steel sample cup. The sample cup has a line that marks 350 ml as shown in Figure 3-2.

A scribed line on the rotor indicates proper immersion depth. Refer to Figure 3-2. Damage to the bob shaft bearings may occur if this immersion depth is exceeded. If other sample holders are used, the space between the bottom of the rotor and the bottom of the sample holder should be one-half inch (1.27cm) or greater.



The standard B1 Bob is hollow and should never be used to test samples hotter than 200°F (93°C).



The viscometer base cover has vents to help prevent heat build-up. Do not block the vents.



During operation, the motor surface may get hot and there is risk of getting burned if the surface is touched.

5.1 Operating the Model 35A and 35SA

The Model 35A and 35SA viscometers operate at six speeds, ranging from 3 rpm to 600 rpm. To select the desired speed, set the speed switch (located on the right side of the base) to the high or low speed position as desired. Then turn the motor on and move the gear shift knob (located on the top of the instrument) to the position that corresponds to the desired speed.

Table 5-1 lists the positions for the viscometer switch and the gear knob combinations to obtain the desired speed. The viscometer gear shift knob may be engaged while the motor is running. Read the dial for shear stress values.

Table 5-1 Six-Speed Testing Combinations for Models 35A and 35SA

Speed RPM	Viscometer Switch	Gear Shift Knob
600	High	Down
300	Low	Down
200	High	Up
100	Low	Up
6	High	Center
3	Low	Center

5.2

Operating the Model 35A/SR-12 and 35SA/SR-12

The Model 35A/SR-12 and 35SA/SR-12 have twelve speeds for testing capabilities. To achieve this broader testing range from 0.9 rpm to 600 rpm, an additional gear box shift lever is used; it is located on the right side of the gear box. See Figure 5-1. Move this lever to the left or right as determined from Table 5-2.



Never change the gear box shift lever while the motor is running. Changing it while the motor is running will result in gear damage.



Only the viscometer gear shift knob (on top of the instrument) can be changed while the motor is running.

1. Prepare the instrument for 12-speed testing by setting the gear box shift lever.
2. Select the proper speed range with the speed shift switch.
3. Turn on the motor and set the gear shift knob on the top of the instrument. Refer to Table 5-2 for the correct combination of gear box shift lever setting, speed switch selection, and viscometer gear shift knob placement. The shear stress values will appear on the dial.

Gear box shift lever

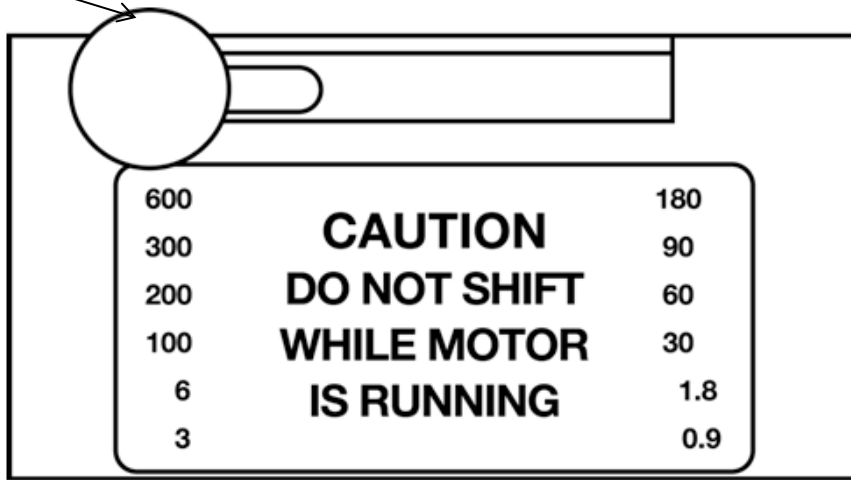


Figure 5-1 Gear Box Shift Lever

Table 5-2 Twelve-Speed Testing Combinations- Models 35A/SR-12 and 35SA/SR-12

RPM	Gear Box Shift Lever	Speed Switch	Gear Shift Knob
600	Left	High	Down
300	Left	Low	Down
200	Left	High	Up
180	Right	High	Down
100	Left	Low	Up
90	Right	Low	Down
60	Right	High	Up
30	Right	Low	Up
6	Left	High	Center
3	Left	Low	Center
1.8	Right	High	Center
0.9	Right	Low	Center

5.3 Measuring Gel Strength

The commonly used procedure for measuring gel strength is as follows:

1. Stir the sample thoroughly at 600 rpm.
2. Set the gear shift knob to the 3 rpm position, and then turn the motor to the OFF position.
3. After the desired wait time, turn the motor to the ON position at low speed.
4. Read the dial at the moment the gel breaks as noted by a peak dial reading. The gel strength units are lb/100ft².

An alternative method for measuring gel strength is as follows:

1. Stir the sample thoroughly at 600 rpm.
2. Turn the motor to the OFF position.
3. After the desired wait period, turn the gel knob (located below the gear shift knob) slowly counterclockwise.
4. Read the dial at the moment the gel breaks as noted by a peak dial reading. The gel strength units are lb/100ft².

5.4 Changing the Rotors, Bobs, and Torsion Springs

The R1-B1-F1 rotor-bob-torsion spring combination is standard for all Fann viscometers. Other rotor-bob combinations may be used, provided shear rates are calculated for the fluid being tested. Rotor-bob combinations other than R1-B1 have large gap sizes; as a result, the shear stress dial readings are not consistent with readings from a smaller gap.

The following instructions explain how to remove and replace the rotors, bobs, and torsion springs.



Calibration is required when torsion springs are changed.



Changing the rotors and bobs only reconfigures the geometry of the shear gap. These changes do not affect the torsion springs, bearings, or shaft. Therefore, calibration is not required when changing rotors or bobs.

5.4.1 Rotor Removal and Replacement

Refer to Figure 5-2.

To remove the rotor from its socket, twist the rotor clockwise and gently pull it down.

To replace the rotor, align the rotor slot and groove with the lock pin in the main shaft socket. Then push the rotor upward and turn it counterclockwise, locking it into position.

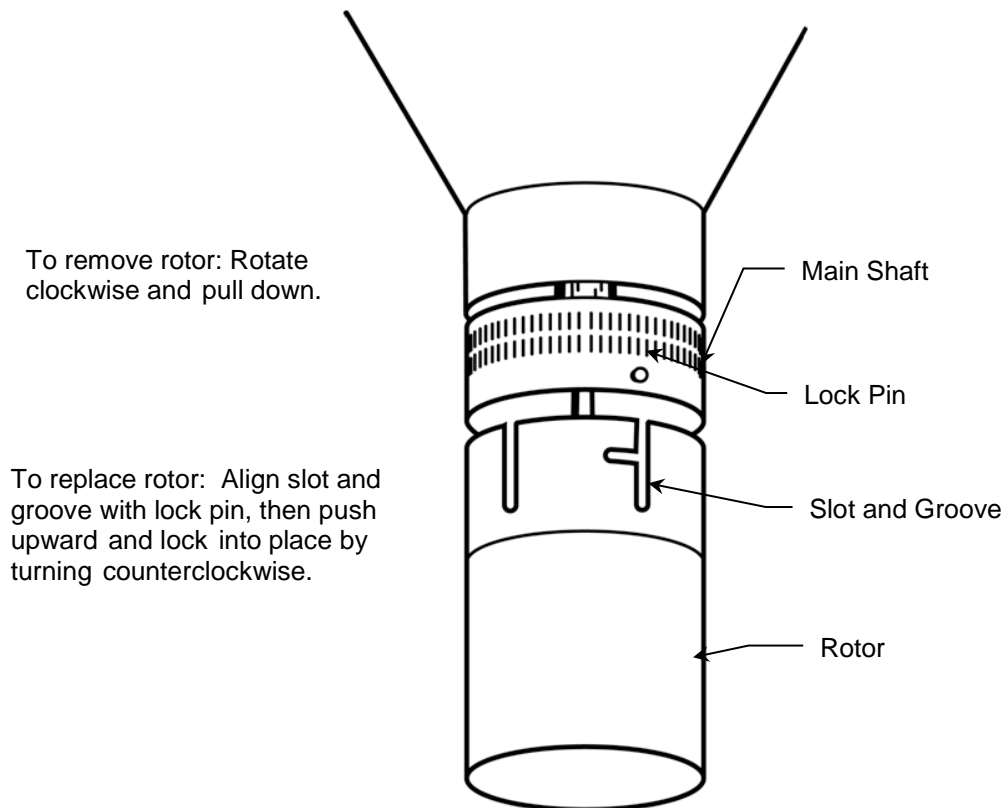


Figure 5-2 Rotor Removal and Installation

5.4.2 Bob Removal and Replacement

The bob shaft end is tapered and fits into a matching tapered hole in the bob. Refer to Figure 5-3.

1. Rotate the rotor clockwise and gently pull it down to remove it.
2. To remove the bob, twist it clockwise while pulling down.
3. To install the bob, twist it clockwise while pushing upward.

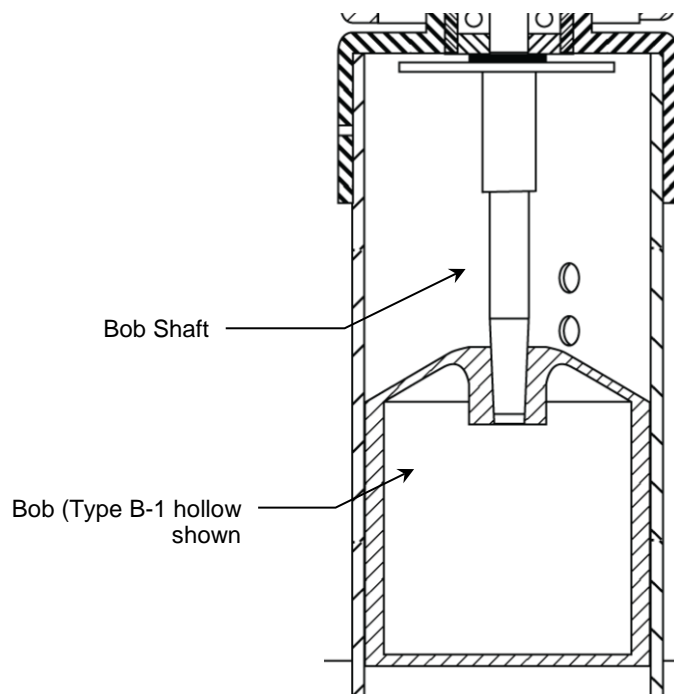


Figure 5-3 Bob and Bob Shaft

5.4.3 Torsion Spring Removal and Replacement

Refer to Figure 5-4.

1. Remove the dust cap [A] and plug screw [B].
2. Loosen set screws [C] and [D] about one-half turn. The spring can now be lifted out. Be careful not to stretch the spring.
3. Insert the new spring, making sure the bottom mandrel is properly oriented and seated. Set screw [D] should line up with the point at which the spring leaves the bottom mandrel. A notch cut into the upper end of the bottom mandrel will help locate this point. Tighten set screw [D], so that it presses against the split ring to hold the bottom mandrel of the spring.



Before tightening the set screw [C], make sure that the top of the adjustable mandrel is flush with the top of the clamp [E]. Slightly compressing or stretching the spring may be necessary to accomplish this.

4. Tighten the set screw [C]. The slot in the top of the adjustable mandrel should line up with the clamping set screw [C].
5. Loosen the set screw [F] to zero dial under index, and then rotate the knob [G] as required for alignment. Adjust the knob [G] vertically to allow the spring to be clamped in a free position, neither stretched nor compressed.
6. Tighten the set screw [F] and replace the dust cap [A].

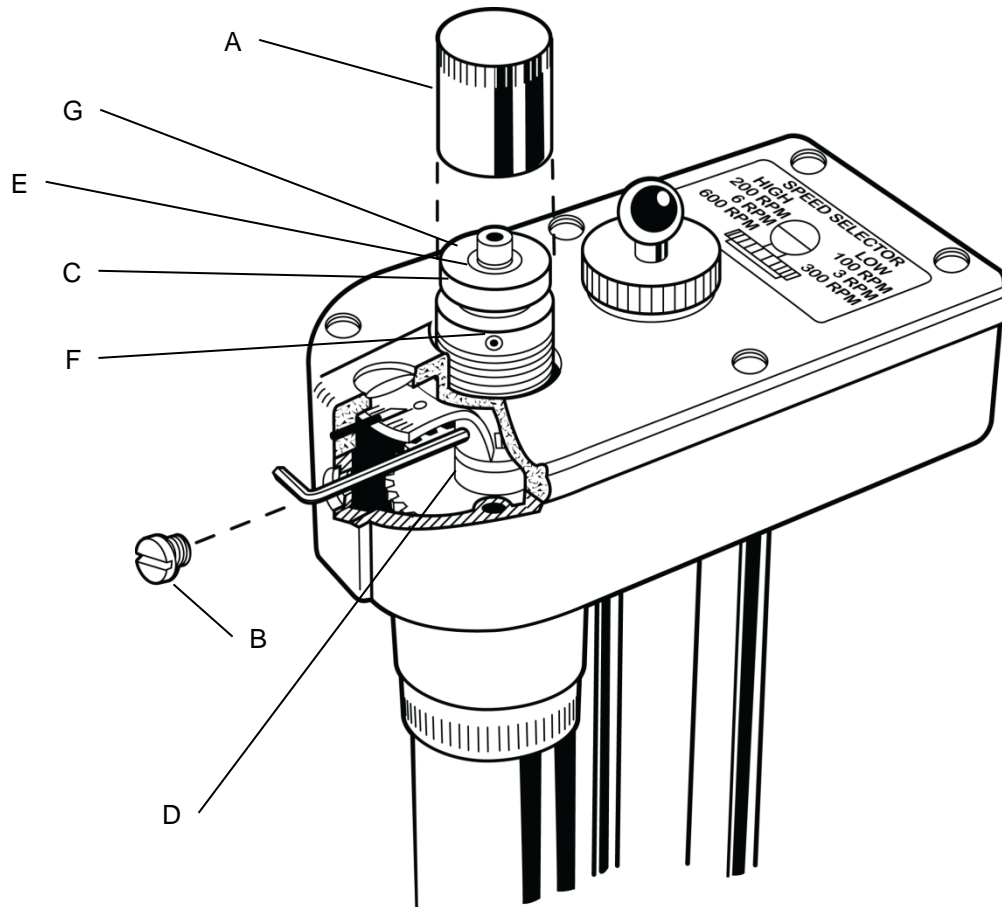


Figure 5-4 Torsion Spring Removal and Replacement

6 Instrument Calibration Check



A calibration check only verifies the instrument's correct mechanical operation — its torsion springs, bearings, and shaft.



Changing the rotors and bobs only reconfigures the geometry of the shear gap. These changes do not affect the torsion springs, bearings, or shaft. Therefore, calibration is not required when changing rotors or bobs.

Periodically, the Model 35 viscometer should be checked for proper calibration. If the measurements do not meet the specified accuracy, then the viscometer should be calibrated or repaired. For continuous accurate measurements, the instrument must be properly calibrated.



In accordance with API 13B-1 and 13B-2, Fann recommends calibrating the Model 35 before it is placed in service and at least monthly while it is in service. However, calibration frequency depends on your usage and laboratory quality assurance program.

The calibration is checked by applying known torques to the bob shaft. For any applied torque, within the torque range of the spring, there should be a specific dial reading (plus or minus a small tolerance). There are two methods of calibration check — 1) dead weight calibration check, and 2) standard fluid calibration check.

If the spring requires adjustment, the proper setting can be easily verified.

The standard fluid calibration check verifies that the complete instrument is operating properly. This calibration method will identify a bent bob shaft, rotor eccentricity, and/or runout of the rotor or bob more effectively than the dead weight method.

6.1 Dead Weight Calibration

This procedure uses the Model DW3 Calibration Kit (P/N 207853). Refer to Figure 6-1.

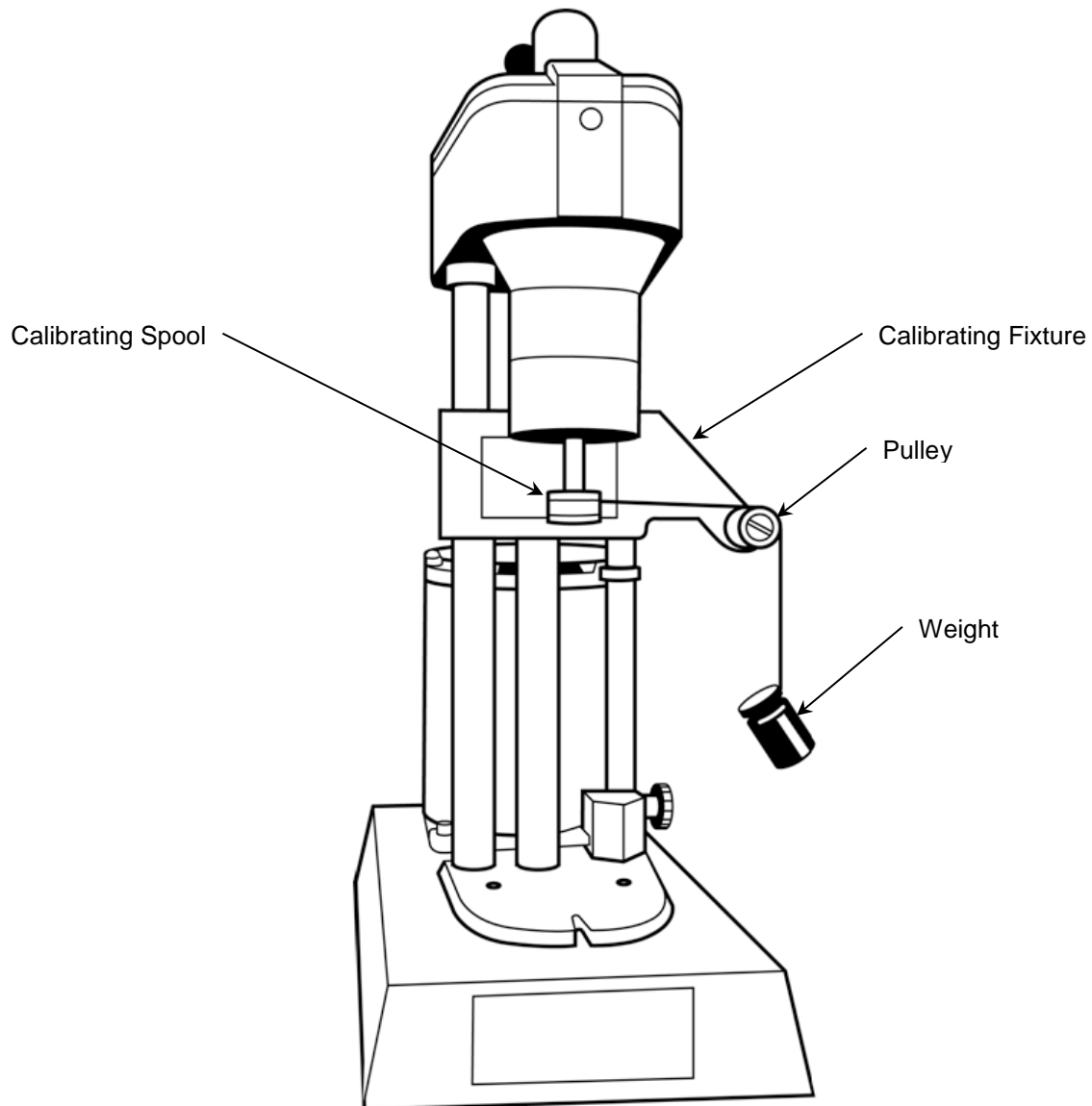


Figure 6-1 DW3 Calibration Fixture

1. Remove rotor and bob. Refer to Section 6. Be sure that the tapered end of the bob shaft is clean, and then install the calibrating spool.
2. Install the DW3 calibrating fixture by clamping it onto the upper portion of the viscometer support legs.
3. Select a weight according to Table 6-1. Insert the bead at the end of the thread into the recess in the top of the calibrating spool. Wrap the thread a little more than once around the spool and then drape the thread over the pulley.
4. Hang the selected weight on the thread, and then adjust the calibrating fixture up or down until the thread from the spool to the pulley is horizontal. Compare the dial reading with the reading on Table 6-1.
5. If necessary, adjust the torsion spring as specified in Section 6.3.

From Table 6-1, the factory tolerances for F1 spring only are $127 \pm 1/2^\circ$ for 50 grams and $254 \pm 1/2^\circ$ for 100 grams. A movement of $\pm 1/2^\circ$ is permissible when the main shaft is turning. This movement will generally be dampened out when a fluid is being tested.

Check the linearity of the dial reading with at least three weights. If the spring appears to be non-linear, then bob shaft is probably bent. An instrument with these characteristics needs additional service and/or repair.

Table 6-1 Dial Deflection for Calibration Weights and Torsion Spring Assemblies

Torsion Spring Assembly (with R1-B1 combination)	Torsion Spring Constant, k_1 Dynes/cm/degree deflection	Weight in Grams				
		10	20	50	100	200
		Dial Reading				
F-0.2	77.2	127.0	254.0	-	-	-
F-0.5	193.0	50.8	101.6	254.0	-	-
F-1	386.0	25.4	50.8	127.0	254.0	-
F-2	772.0	-	25.4	63.5	127.0	254.0
F-3	1158.0	-	-	43.0	84.7	169.4
F-4	1544.0	-	-	-	63.5	127.0
F-5	1930.0	-	-	-	50.8	101.6
F-10	3860.0	-	-	-	-	50.8

6.2 Fluid Calibration Check

This procedure describes the calibration check using only certified Newtonian calibration fluids. Fann calibration fluids are available for separate purchase (Table 9-1). All calibration standards are certified by methods traceable to the United States National Institute of Standards and Technology (NIST).

1. Make sure that the instrument is clean before immersing the rotor and bob into the calibration fluid. If necessary, remove the rotor and thoroughly clean the bob, bob shaft, and rotor. Make sure the bob shaft and rotor are straight and have not been damaged.



The batch number on the label of the calibration fluid must match the number on the viscosity/temperature chart.

2. Fill the sample cup to the scribed line with calibration fluid and place it on the instrument stage. Elevate the stage so that the rotor is immersed to the proper immersion depth. Refer to Figure 3-2.
3. Place a thermometer into the sample cup until it touches the bottom, and then secure it to the side of the viscometer to prevent breakage.
4. Operate the instrument at 100 rpm for approximately three minutes. This will equalize the temperature of the bob, rotor, and the fluid.
5. Read the dial at 300 rpm and 600 rpm. Record these numbers and the temperature from the thermometer to the nearest 0.1° C (0.15° F).

The viscosity at the 300 rpm reading should be within ± 1.5 cP of the viscosity from the temperature chart at the recorded temperature.

Divide the 600 rpm reading by 1.98; compare this value to the value on the chart.

The viscosity at the 600 rpm reading should be within ± 1.5 cP of this viscosity value.

Plot the 300 rpm reading and the 600 rpm reading then draw a straight line from zero through these two points. If the 300 and 600 points do not fall in a straight line, it is possible that the either rotor, bob, or bob shaft is bent or that other eccentricity exists.

Points at 100 rpm and 200 rpm can be plotted if verification is needed.

Readings outside the specified limits are indications that the instrument should be either calibrated or repaired. (See Section 6.3 for the procedure to calibrate the spring.)

After completion of the calibration check, carefully wipe clean the rotor surfaces (inner and outer), bob, thermometer, sample cup, and work area.

6.3 Torsion Spring Calibration

Refer to Figure 5-4 for identification of parts.



Make sure that the bob shaft is not bent before adjusting the torsion spring.

1. Remove dust cap [A], and then loosen set screw [C] about one-half turn.
2. Insert the calibration tool into the spring and rotate the adjustable mandrel (inside the spring) slightly. Turn the mandrel counterclockwise if the dial reading is too low, or turn the mandrel clockwise if the dial reading is too high.



Before tightening set screw [C], check the top of the center mandrel and be sure that it is flush with the top of the clamp [E]. To accomplish this, it may be necessary to adjust the spring by slightly compressing or stretching the spring.

3. Tighten the set screw [C]. The slot in the top of the adjustable mandrel should line up with clamping set screw [C].
4. Loosen the set screw [F] to zero dial under index, then rotate knob [G] as required for alignment, then adjust knob [G] vertically to allow the spring to be clamped in a "free" position, neither stretched nor compressed.
5. Tighten the set screw [F] and replace the dust cap [A].

7 Test Analysis

This section explains how to obtain the test results, which includes reading values from the viscometer and performing calculations.

The reference for measuring viscosity and performing calculations is API Recommended Practice for Field Testing Water Based Drilling Fluids, API RP 13B-1/ISO 10414-1.

7.1 Newtonian Viscosity Calculation

The Newtonian viscosity in centipoise (cP) may be read directly from the dial when the viscometer speed is 300 rpm and the rotor-bob-torsion spring combination is R1-B1-F1. Other springs may be used provided that the dial reading is multiplied by the "f" factor (spring constant) to calculate the viscosity.

To calculate Newtonian viscosities in centipoise with the Fann viscometer, use the following equation:

$$\eta_N = S \times \theta \times f \times C \quad \text{Equation 7-1}$$

where,

S is the speed factor (Refer to Table 7-2)

θ is the dial reading

f is the spring factor (Refer to Table 7-3)

C is the rotor-bob factor (Refer to Table 7-1)

η_N is the Newtonian viscosity (cP)

Example: Using an R2-B1 combination at a speed of 600 rpm with an F5.0 spring, and a dial deflects to 189, the viscosity is

$$\eta_N = 0.5 \times 189 \times 5 \times 0.315 = 149 \text{ cP}$$



Rotor-bob-torsion spring combinations with the larger gaps are likely to give results that differ from these figures. For best accuracy, calibrate with a standard fluid having a viscosity near the range of interest and using the R-B-F combination to be used in the test.

Table 7-1 Rotor-Bob Factor (C)

Rotor-Bob Combination	R-B Factor (C)
R1-B1	1.000
R1-B2	8.915
R1-B3	25.392
R1-B4	50.787
R2-B1	0.315
R2-B2	8.229
R2-B3	24.707
R2-B4	49.412
R3-B1	4.517
R3-B2	12.431
R3-B3	28.909
R3-B4	57.815

Table 7-2 Speed Factor (S)

Rotor (rpm)	Speed Factor (S)
0.9	333.3
1.8	166.6
3	100
6	50
30	10
60	5
90	3.33
100	3
180	1.667
200	1.5
300	1.0
600	0.5

7.2 Plastic Viscosity and Yield Point Calculation

Using R1-B1-F1 combination, test a sample at 600 rpm and record the dial reading. Change the speed to 300 rpm and record the dial reading.

Determine the plastic viscosity (PV) and yield point (YP) using the following equations. PV represents the slope of a straight line between the two dial readings. YP represents the theoretical point at which the straight line, when projected, will intercept the vertical axis.

$$PV \text{ (cP)} = \theta_{600} - \theta_{300} \qquad \text{Equation 7-2}$$

$$YP \text{ (lb/100 ft}^2\text{)} = \theta_{300} - PV \qquad \text{Equation 7-3}$$

where θ is the dial reading



A spring other than F1 may be used if the dial readings are multiplied by the proper “f” factor, but the other rotor-bob combinations cannot be used for this two-point method.

7.3 Spring Constant Calculation

This calculation applies to the dead weight calibration method.

$$K_s = \frac{G \times r \times g}{\theta} \qquad \text{Equation 7-4}$$

where

K_s is the spring constant in dyne-cm/degree deflection

G is the load in grams

g is the gravitational constant at 981cm/sec²

r is the radius arm at 1cm

θ is the dial reading in degrees

Example: The required setting for the F1 spring is 386 dynes/cm/degree deflection with the R1-B1 combination. Using the 50 gram weight supplied with the calibration kit, the spring constant is

$$K_s = \frac{50 \times 1 \times 981}{386} = 127^\circ$$

Table 7-3 Torsion Spring Specifications

Torsion Spring Assembly	Torsion Spring Constant* k_1 (dyne/cm/degree deflection)	Torsion Spring Factor f	Maximum Shear Stress with B1 Bob (dyne/cm ²)	Color Code
F0.2	77.2	0.2	307	Green
F0.5	193	0.5	766	Yellow
F1	386	1	1,533	Blue
F2	772	2	3,066	Red
F3	1,158	3	4,600	Purple
F4	1,544	4	6,132	White
F5	1,930	5	7,665	Black
F10	3,860	10	15,330	Orange

*With R1-B1 Combination

7.4 Additional Viscosity Calculations

The viscosity can also be computed using the following equations. Conversion factors are listed in Table 7-5.

$$\eta = Kf \frac{\theta}{N} \quad \text{Equation 7-5}$$

where

K is the overall instrument constant in (dyne-sec/cm²) (rpm/degree deflection)

f is the torsion spring factor

θ is the Fann viscometer reading

N is the rate of revolution of the outer cylinder

η is the viscosity in cP



For Equation 7-5, choose the correct K value (overall instrument constant) that matches the rotor-bob combination in Table 7-4. Choose the f constant that matches the torsion spring assembly in Table 7-3.

$$\eta = \frac{k_1 k_2}{k_3} (100) \frac{\theta}{N} \quad \text{Equation 7-6}$$

where

k_1 is the torsion constant, dyne-cm/degree deflection

k_2 is the shear stress constant for the effective bob surface, cm³

k_3 is the shear rate constant, sec⁻¹ per rpm

100 is the conversion factor, 1 poise = 100 cP

θ is the Fann viscometer reading

N is the rate of revolution of the outer cylinder

η is the viscosity, cP

$$\eta = \frac{\tau}{\gamma}$$

Equation 7-7

where

τ is the shear stress, dynes/cm²

τ is also calculated as $k_1 k_2 \theta$

γ is the shear rate, sec⁻¹

γ is also calculated as $k_3 N$

η is the viscosity, Poise

Table 7-4 Constants for Viscosity Calculations

Constant	Rotor-Bob Combinations					
	R1 B1	R2 B1	R3 B1	R1 B2	R1 B3	R1 B4
Overall Instrument Constant, K Standard F1 Torsion Spring $\eta = Kf\theta/N$	300	94.18	1355	2672	7620	15,200
Shear Rate Constant k_3 , (sec ⁻¹ per rpm)	1.7023	5.4225	0.377	0.377	0.268	0.268
Shear Stress Constant for Effective Bob Surface k_2 , (cm ⁻³)	0.01323	0.01323	0.01323	0.0261	0.0529	0.106

Table 7-5 Conversion Factors

	Symbol	Unit	Conversion Factor
SI Units			
Shear Stress	τ	Pa (Newton/m ²)	1 Pa = 10 dynes/cm ²
Shear Rate	γ	s ⁻¹	1 s ⁻¹ (no change)
Viscosity	η	Pa · s mPa · s	1 Pa · s = 10 poise 1 mPa · s = 1 cP
Oilfield Units (R1-B1-F1)			
Shear Stress	τ	dynes/cm ²	1*Fann = 5.11 dynes/cm ²
Shear Stress	τ	lb/100 ft ²	1*Fann = 1.065 lb/100 ft ²
Shear Stress (approx.)	τ	lb/100 ft ²	1*Fann = 1 lb/100 ft ²
Shear Rate	γ	1/sec	1/sec = 1.7023 N
Viscosity	μ	cP	$\mu = (5.11\theta / 1.70N) \times 100 = 300 \times (\theta / N)$
Effective Viscosity	μ_e	cP	$\mu_e = 300 \times (\theta / N)$

7.5 Measuring Ranges

The measuring ranges for shear stress, shear rate, and viscosity are listed in Table 7-6, Table 7-7 and Table 7-8, respectively.

Table 7-6 Shear Stress Measuring Range for Fann Direct Indicating Viscometer

Torsion Spring/ Viscometer Reading		Shear Stress Range (dynes/cm ²), $\tau = (k_1 k_2 \theta)$					
		Rotor-Bob Combinations					
		R1 B1	R2 B1	R3 B1	R1 B2	R1 B3	R1 B4
F 0.2	$\theta = 1^\circ$	1.02	1.02	1.02	2.01	4.1	8.2
	$\theta = 300^\circ$	307	307	307	605	1225	2450
F 0.5	$\theta = 1^\circ$	2.56	2.56	2.56	5.04	10.2	20.4
	$\theta = 300^\circ$	766	766	766	1510	3060	6140
F1	$\theta = 1^\circ$	5.11	5.11	5.11	10.1	20.4	40.9
	$\theta = 300^\circ$	1533	1533	1533	3022	6125	12,300
F2	$\theta = 1^\circ$	10.22	10.22	10.22	20.1	40.8	81.8
	$\theta = 300^\circ$	3066	3066	3066	6044	12,250	24,500
F3	$\theta = 1^\circ$	15.3	15.3	15.3	30.2	61.3	123
	$\theta = 300^\circ$	4600	4600	4600	9067	18,400	36,800
F4	$\theta = 1^\circ$	20.4	20.4	20.4	40.3	81.7	164
	$\theta = 300^\circ$	6132	6132	6132	12,090	24,500	49,100
F5	$\theta = 1^\circ$	25.6	25.6	25.6	50.4	102	205
	$\theta = 300^\circ$	7665	7665	7665	15,100	30,600	61,400
F10	$\theta = 1^\circ$	51.1	51.1	51.1	100.7	204	409
	$\theta = 300^\circ$	15,330	15,330	15,330	30,200	61,200	123,000

Table 7-7 Shear Rate Measuring Range for Fann Direct Indicating Viscometers

Rate of Revolution of Outer Cylinder, N (rpm)	Shear Rate Range (sec ⁻¹), $\gamma = k_3N$					
	Rotor-Bob Combinations					
	R1 B1	R2 B1	R3 B1	R1 B2	R1 B3	R1 B4
0.9	1.5	4.9	0.4	0.4	0.24	0.24
1.8	3.1	9.8	0.7	0.7	0.48	0.48
3	5.1	16.3	1.1	1.1	0.8	0.8
6	10.2	32.5	2.3	2.3	1.61	1.61
30	51.1	163	11.3	11.3	8	8
60	102	325	22.6	22.6	16.1	16.1
90	153	488	33.9	33.9	24.1	24.1
100	170	542	37.7	37.7	26.8	26.8
180	306	976	67.9	67.9	48.2	48.2
200	340	1084	75.4	75.4	53.6	53.6
300	511	1627	113	113	80.4	80.4
600	1021	3254	226	226	161	161

Table 7-8 Viscosity Range in Centipoise for Fann Direct Indicating Viscometers

Fann Model	Viscosity (cP) ⁽¹⁾					
	Rotor-Bob Combinations					
	R1 B1	R2 B1	R3 B1	R1 B2	R1 B3	R1 B4
All Models, 600 rpm max Minimum Viscosity ⁽²⁾	0.5 ⁽³⁾	0.5 ⁽³⁾	2.3	4.5	12.7	25
Model 35A & 35SA 3 rpm min Maximum Viscosity ⁽⁴⁾	30,000	9,400	135,000	270,000	762,000	1,500,000
Model 35A/SR 12 & 35SA/SR 12 0.9 rpm min Maximum Viscosity ⁽⁴⁾	100,000	31,400	400,000	890,000	2,550,000	5,000,000

Notes:

- (1) Computed for standard Torsion Spring (F1). For other torsion springs multiply viscosity range by f factor.
- (2) Minimum viscosity is computed for minimum shear stress and maximum shear rate.
- (3) For practical purposes the minimum viscosity is limited to 0.5 cP because of Taylor Vortices.
- (4) Maximum viscosity is computed for maximum shear stress and minimum shear rate.

8 Troubleshooting and Maintenance

Troubleshooting and regular maintenance procedures are described in this section. If more extensive maintenance or service of the instrument is required, please contact your Fann representative.

8.1 Troubleshooting

Table 8-1 Troubleshooting Guide

Problem or Symptom	Possible Cause	Corrective Action
Erratic dial motion	Contaminated bob shaft bearings.	Replace the bob shaft bearings (P/N 207450).
	Bent bob shaft.	Bend shaft slightly to straighten it. Contact Fann for repair or replacement.
	Rotor out of alignment.	Replace the rotor if it is damaged. See list of rotors in Table 9-1.
Out of calibration	Contaminated bob shaft bearings.	Replace the bob shaft bearings (P/N 207450).
	Bent bob shaft.	Bend shaft slightly to straighten it. Contact Fann for repair or replacement.
	Bent rotor.	Replace the rotor. See Table 9-1.
	Damaged or incorrectly installed torsion spring.	See Section 5.4 to replace the torsion spring.
	Incorrect motor speed.	Replace the motor (P/N 207446 or 207447).
Excessive noise	Lubrication failure or contamination in gears.	Contact Fann for repair.
	Worn center thrust washer.	Contact Fann for repair.
	Top cover not set properly.	Adjust the top cover.
Excessive run-out of rotor	Damaged rotor.	Replace the rotor. See Table 9-1.
	Contamination in main shaft recess.	Contact Fann for repair.

8.2 Maintenance

The instrument should be serviced by qualified personnel only. If factory service is required, contact Fann for return authorization.

These tips are recommended for properly caring for the viscometer.

- Clean the bob and rotor after each test.
- Periodically examine the bob and rotor for dents, abrasion, or other damage.
- Always remove the bob from the bob shaft when transporting instrument to avoid bending bob shaft.
- Oiling or greasing of the viscometer is not required in normal service.

9 Accessories

Table 9-1 Accessories

Torsion Springs				
Part No.	F	Constant	Max Shear Stress	Color Code
207656	F0.2	77.2	307	Green
207657	F0.5	193	766	Yellow
207465	F1	386	1,533	Blue
207658	F2	772	3,066	Red
207659	F3	1,158	4,600	Purple
207660	F4	1,544	6,132	White
207661	F5	1,930	7,665	Black
207662	F10	3,860	15,330	Orange
Rotors				
207523	R1, 303 Stainless Steel			
207942	R2, 303 Stainless Steel			
207943	R3, 303 Stainless Steel			
208983	R1, Closed-end, Stainless Steel			
208985	R2, Closed-end, Stainless Steel			
Bobs				
207521	B1, 303 Stainless Steel, Hollow			
207520	B2, 303 Stainless Steel, Solid			
207519	B3, 303 Stainless Steel, Solid			
207518	B4, 303 Stainless Steel, Solid			
Sample Cups				
101558383	Thermocup, 115 Volts, 50/60 Hz, 2 amps, 200°F			
101558384	Thermocup, 230 Volts, 50/60 Hz, 1 amp, 200°F			
207958	Double-Wall Circulating Cup			
207560	Stainless Steel Sample Cup			
Circulators				
208754	Heat-only Circulator, 90°F to 212°F, 4 liters, 115 Volts, 60 Hz, 1,000 Watt			
208755	Cooling /Heating Circulator, -20°C to 150°C, 6 liters, 115 Volts, 60 Hz, Heater Capacity 1,100 Watt			
Calibration				
207853	DW3 Dead Weight Calibration Kit			
207124	Calibration Fluid, 10 cP, 16 oz			
207119	Calibration Fluid, 20 cP, 16 oz			
207120	Calibration Fluid, 50 cP, 16 oz			
207121	Calibration Fluid, 100 cP, 16 oz			
207122	Calibration Fluid, 200 cP, 16 oz			
207123	Calibration Fluid, 500 cP, 16 oz			
207125	Calibration Fluid, 30,000 cP, 16 oz			
207126	Calibration Fluid, 100,000 cP, 16 oz			

10 Parts List

The Model 35 series of viscometers are listed in Table 10-1. The parts list for the Fann Model 35 viscometers are combined in Table 10-2.

Table 10-1 Model 35 Viscometers List

Model No.	Part No.	Electrical
35A	207198	115V, 60 Hz, 90W
35SA	207199	115V, 50 Hz, 90W
35A/SR-12	207200	115V, 60 Hz, 90W
35SA/SR-12	207201	115V, 50 Hz, 90W

Table 10-2 Model 35 Series Viscometer (35A, 35SA) Parts List

Item No.	Part No	Description
1	207484 / R	HOUSING GEAR MODEL 35 VISCOMETER
2	207867 / A	RING RETAINING INTERNAL 1.526 DIA 50 & 35/SA
3	207452 / A	BUSHING f/MODEL 35 VISCOMETER
4	207603 / A	SCREW PLUG VISCOMETER
5	207437 / A	BEARING MODEL 35 VISCOMETER (4 REQ)
6	207143 / A	RING RETAINING INTERNAL 0.694 OD CARBON SPRING STEEL
7	207585 / E	CAP DUST MODEL 35 VISCOMETER
8	207617 / A	6-32 X 3/4 THMS STAINLESS
9	101436120 / A	BASE ASSY MODEL 35A
10	207814 / A	RETAINER EXTERNAL VISCOMETER 12BL FILTER PRESS
11	207459 / D	COVER PLATE 35/SA VISCOMETER
12	120126200 / D	SHEET, INSULATING, POLYIMIDE, FIBERGLASS INNER LAYER, 0.01 THICK
13	205779 / A	FEET RUBBER 3/4in.
14	207460 / A	RIVET POP AL 3/8 LG 1/4 GRIP
15	207630 / A	6-18 X 3/8 PHIL PAN SELF TAP C
16	207448 / J	STAGE MODEL 35 VISCOMETER
17	207588 / A	KNOB
18	207597 / B	NUT CLAMP MODEL 35 VISCOMETER
19	207598 / C	SPACER CLAMP MODEL 35 VISCOMETER
20	207599 / D	ROD SUPPORT MODEL 35 VISCOMETER
21	207628 / A	10-32 X 1-1/4 SHCS BOPL
22	207620 / A	10-32 X 1/2 SHCS BOPL
23	207593 / C	COLLAR STOP MODEL 35 VISCOMETER
24	207622 / A	6-32 X 1/8 HSSS BOPL
25	205654 / A	ORING 9/16 X 3/32 NITRILE B-46 11
26	207153 / G	TUBE DRIVE f/MODEL 35 VISCOMETER, SHAFT
27	207559 / B	GEAR ASSEMBLY CLUSTER MODEL 35 VISCOMETR
28	207428 / C	SPACER 35A & 35SA VISCOMETER
29	101436119 / C	CENTER GEAR ASSY MODEL 35
30	207817 / A	WASHER FLAT .624 X .315 X .058
31	207596 / A	SPRING DETENT VISCOMETER
32	207592 / C	KNOB GEL VISCOMETER
33	207511 / A	SHIFT-ROD ASSEMBLY VISCOMETER
34	207487 / A	6-32 X 1/4 BHMS STAINLESS
35	207965 / G	SHAFT MAIN 34 and 35 VISCOMETER STAINLESS STEEL
36	207553 / A	GEAR MAIN SHAFT MODEL 35 VISCOMETER
37	207506 / A	KEY MAIN SHAFT GEAR VISCOMETER
38	207144 / A	RETAINER EXTERNAL VISCOMETER
39	207449 / A	BEARING MAIN SHAFT MODEL 35 VISCOMETER
40	207440 / C	JACK-SHAFT ASSEMBLY MODEL 35 VISCOMETER
41	207488 / A	6-32 X 3/8 BHMS STAINLESS
42	208003 / B	GEAR ASSEMBLY IDLER 35 VISCOMETER

Item No.	Part No	Description
43	207485 / A	WASHER FLAT STEEL 1/4X1/2X1/16
44	207564 / A	GEAR DRIVE SHAFT 35 VISCOMETER
45	207558 / C	SHAFT LOWER DRIVE MODEL 35 VISCO
46	207152 / C	COUPLING FLEX f/MODEL 35 VISCOMETER SHEAR TYPE, 1/4 x 1/4 BORE, 0.8 IN-LB
47	207545 / C	SHAFT UPPER DRIVE MODEL 35 VISCOMETER
48	207446 / D	MOTOR MODEL 35A VISCOMETER 115V/60Hz
49	207616 / A	1/4-28 X 5/8 SHCS STAINLESS
50	207445 / C	BOB-SHAFT ASSEMBLY 34/35 VISCO
51	207595 / C	UPPER SLEEVE CLAMP, CELL ASSEMBLY, M70, 75 & 77 VISCOMETER
52	101414748 / A	COVER SUBASSY, MODEL 35 VISCOMETER
53	207450 / A	BEARING BOB-SHAFT 35 VISCOMETER 0.5000 OD X 0.1875 ID X 0.1562 W, ABEC-7
54	207546 / E	SHIELD BEARING VISCOMETER
55	205697 / A	RETAINER RING 3/16 EXTERNAL
56	207539 / E	SPLASH-GUARD VISCOMETER
57	207523 / N	ROTOR R1 MODEL 35 303 STAINLESS STEEL
58	207521 / D	BOB MODEL 35 VISCOMETER B1
59	207465 / D	TORSION SPRING MODEL 34/35 F1.0
60	203512 / A	CABLE POWER 115V 18 AWG MALE PLUG
61	204371 / A	STRAIN RELIEF .30-.325 DIA-.1
62	204287 / A	TERMINAL RING 6 18-14 AWG BLU
63	208451 / A	WIRE JOINT SIZE 18-16 AWG (2) 18 AWG OR (2) 16 AWG WIRES
64	102425060 / A	SWITCH TOGGLE, DPDT ON/OFF MODEL 35
65	207784 / A	BOOT SWITCH MODEL 35 VISCOMETER
66	207560 / A	CUP SAMPLE f/MODEL 35 VISCOMETER 350ml
67	208878 / N	INSTRUCTION MANUAL FOR MODEL 35 VISCOMETER
68	204218 / A	WARRANTY CARD
69	205289 / A	BAG PLASTIC NON-LOCK 12in. X 6in.
70	205314 / B	LUBRICANT EXTREME PRESSURE 4oz
71	102471225 / A	16AWG Green with yellow stripe wire, 105C 600V rated, .030 inch PVC insulation, UL Type MTW, AWM STYLE 1015/1230, CSA and UL Type
72	100113195 / NW	SCREW, BIND HEAD, PHILLIPS, #4-40 X 3/8, STAINLESS STEEL
73	207998 / A	SHIM 13/16 X 5/8 X.005 VISCOMETER SPRING STEEL SHIM PHOENIX NLB812L
74	102462814 / A	FAN, 60MM X 60MM X 25MM, 115VAC SUNON P/N:MA1062-HVL Do not substitute without contacting Engineering
75	102425059 / A	TAG GROUND 35A & 35SA
76	102425061 / A	CIRCUIT BREAKER HYDRAULIC/MAGNETIC, 1 POLE, PUSH TO RESET, 1 AMPS, WHITE FOR M35
77	102425062 / A	TAG HOT SURFACE 35A & 35SA

Item No.	Part No	Description
78	203400 / A	6-32 X 1-1/4 RHMS STAINLESS
79	207632 / A	NUT 6-32 HEX REGULAR STAINLESS
80	207819 / A	WASHER SPLIT 6 STAINLESS STEEL
81	208438 / B	PLUG INTL ELECT CODE TYPE
82	208452 / B	CABLE POWER 115V 18 AWG M&F PLUG
83	208877 / C	CERTIFICATE OF CALIBRATION VISCOMETER

Parts contained in Table 10-3 are supplied in addition to those in Table 10-2 when ordering viscometers Model 35A/SR-12 or Model 35SA/SR-12.

Table 10-3 Model 35 Series Viscometer (35A/SR-12, 35SA/SR-12) Parts Additions

Item No.	Part No	Description
1	207202	GEAR BOX MODEL 35A/SR-12 60Hz
2	207205	GEAR BOX MODEL 35SA/SR-12 50Hz

11 Declaration of Conformity



Declaration of Conformity

Viscometer, Model 35 and 35SA

Fann Instrument Company
14851 Milner Road
Houston, Texas 77032

Declares that the following product:

Description:	Couette Rotational Viscometer
Model/Type reference:	Models 35A and 35SA
Ratings:	Model 35A: 115VAC, 60Hz, 90W Model 35SA: 115VAC, 50Hz, 90W Model 35A/SR12: 115VAC, 60Hz, 90W Model 35SA/SR12: 115VAC, 50Hz, 90W

Has been evaluated for compliance in accordance with the following standards and the applicable national deviations:

EN 61010-1:2010
UL 61010-1:2012
CSA C22.2 No. 61010-1-12

The requirements enumerated in the summary of testing for this product have been met.

This product fulfils the requirements of EN 61010-1:2010, CAN/CSA C22.2 No. 61010-1-2012 and UL61010-2-030:2012.

This declaration is intended to address the requirements of the European Union Low Voltage Directive (2006/95/EC).



Engineering Manager

HOUSTON, TX, USA
Place of Issue



Quality Control Manager

24th SEPTEMBER 2015
Date of Issue

Declaration of Conformity Model 35 All.docx

12 Warranty and Returns

12.1 Warranty

Fann Instrument Company warrants only title to the equipment, products and materials supplied and that the same are free from defects in workmanship and materials for one year from date of delivery. **THERE ARE NO WARRANTIES, EXPRESS OR IMPLIED OF MERCHANTABILITY, FITNESS OR OTHERWISE BEYOND THOSE STATED IN THE IMMEDIATELY PRECEDING SENTENCE.** Fann's sole liability and Customer's exclusive remedy in any cause of action (whether in contract, tort, breach of warranty or otherwise) arising out of the sale, lease or use of any equipment, products or materials is expressly limited to the replacement of such on their return to Fann or, at Fann's option, to the allowance to Customer of credit for the cost of such items. In no event shall Fann be liable for special, incidental, indirect, consequential or punitive damages. Notwithstanding any specification or description in its catalogs, literature or brochures of materials used in the manufacture of its products, Fann reserves the right to substitute other materials without notice. Fann does not warrant in any way equipment, products, and material not manufactured by Fann, and such will be sold only with the warranties, if any, that are given by the manufacturer thereof. Fann will only pass through to Customer the warranty granted to it by the manufacturer of such items.

12.2 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.

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