INSTRUCTION MANUAL
MODELS 3500 and 3500LS+
Viscometers

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ENGINEERING®

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General Information

Introduction

This manual contains installation, operation and maintenance instructions for the Chandler Engineering Model 3500 and 3500LS+ Viscometers.

Purpose and Use

The Chandler Engineering Model 3500 and 3500LS+ Viscometers are designed to measure the rheological properties of test fluids by measuring shear stress at specific shear rates. The Models 3500 and 3500LS+ are concentric cylinder rotational viscometers. These viscometers are the standard instruments referred to in the industry standards API Spec 10 (well cements), API RP 13B (drilling fluids) and API RP 39 (fracturing fluids).

Description

The Chandler Engineering Model 3500 and 3500LS+ Viscometers are versatile instruments that have been used in research laboratories, field and mobile labs, and onsite QC testing.

Both viscometers can be equipped with a variety of bobs, rotors, and springs. This provides the user with a wide measurement range in addition to providing different gap sizes depending upon the fluid being tested. In addition, the 3500LS+ has a low-end RPM of 0.1, enabling a measurement at $0.17 sec^{-1}$ when equipped with the R1, B1 configuration.

The measurement fluid is contained within the annular space or shear gap between the rotor and bob. The rotor is rotated at known velocities (shear rates) and the viscous drag exerted by the test fluid creates torque on the bob. This torque is transmitted to a precision torsion spring, and its deflection is measured and related to shear stress. The equations used to calculate the fluid viscosity are presented later in the manual (*Viscosity Calculations* in *Section 2 – Operating Instructions*).

Features and Benefits

- Easy to set-up, easy to operate, easy to clean and maintain.
- Broad range of sensitivity/scalability through the use of different springs and rotor/bob combinations to accommodate a wide variety of fluid types.
- Use of a DC controlled motor allows the Model 3500/3500LS+ to be used in a 50Hz or 60Hz environment while maintaining the proper RPM readings.
- Preset speed to include 1, 2, 3, 6, 10, 20, 30, 60, 100, 200, 300 and 600 RPM for the Model 3500. The Model 3500LS+ additionally has speeds of 0.1, 0.2, 0.3, and 0.6 RPM.
- Precision machining of the rotor, the bob, and support pieces allow perfect alignment each time the instrument is used.
- Stainless steel sample cup comes scribed for 350ml sample size.

Specifications

Operating Conditions: 75°F - 194°F (24°C - 90°C)
Maximum Temperature: 194°F (90°C)

Input Voltage: 110 or 220 VAC ± 15%; 50/60 Hz ± 10%
Power: 700 Watts

Dimensions: 18.2" (46cm) high x 7" (18cm) wide x 12" (31cm) deep
Shipping Dimensions: 20" (51cm) high x 13" (33cm) wide x 25" (64cm) deep

Net Weight: 47 lbs (21 kg)
Shipping Weight: 50 lbs (23 kg)

Sample Container Volume: 350mL

Shear Rate Accuracy: +/- 0.01 RPM
Torque Accuracy: +/- 0.5 dial reading from 1 to 260 degrees

Operating Speeds: Model 3500: 1, 2, 3, 6, 10, 20, 30, 60, 100, 200, 300, 600 RPM
Model 3500LS+: same as 3500 plus 0.1, 0.2, 0.3, and 0.6 RPM

Shear Rate Range: $Sec^{-1} = k_3N$ Where: N = RPM, k_3 = Shear Rate Constant
(k_3 values are listed in the Calculation Section of the manual)

Shear Rate for Specified RPM (sec^{-1})							
Rotor/Bob Configuration	**R1 B1**	**R2 B1**	**R3 B1**	**R1 B2**	**R1 B3**	**R1 B4**	**RI B5**
N = 0.1 RPM (Model LS+)	0.17	0.54	0.04	0.04	0.03	0.03	0.09
N = 0.2 RPM (Model LS+)	0.34	1.08	0.08	0.08	0.05	0.05	0.17
N = 0.3 RPM (Model LS+)	0.51	1.63	0.11	0.11	0.08	0.08	0.26
N = 0.6 RPM (Model LS+)	1.02	3.25	0.23	0.23	0.16	0.16	0.51
N = 1.0 RPM	1.70	5.42	0.38	0.38	0.27	0.27	0.85
N = 2.0 RPM	3.40	10.84	0.75	0.75	0.54	0.54	1.70
N = 3.0 RPM	5.11	16.27	1.13	1.13	0.80	0.80	2.55
N = 6.0 RPM	10.2	32.5	2.26	2.26	1.61	1.61	5.10
N = 10 RPM	17.0	54.2	3.77	3.77	2.68	2.68	8.50
N = 20 RPM	34.0	108.5	7.54	7.54	5.36	5.36	17.0
N = 30 RPM	51.1	162.7	11.3	11.3	8.04	8.04	25.5
N = 60 RPM	102	325.4	22.6	22.6	16.1	16.1	51.0
N = 100 RPM	170	542	38	38	26.8	26.8	85.0
N = 200 RPM	340	1085	75	75	53.6	53.6	170
N = 300 RPM	511	1627	113	113	80.4	80.4	255
N = 600 RPM	1021	3254	226	226	161	161	510

Shear Stress Range

Shear Stress Range, dynes/cm^2							
Rotor/Bob Configuration	**R1B1**	**R2B1**	**R3B1**	**R1B2**	**R1B3**	**R1B4**	**R1 B5**
F 0.2 θ = 1°	1.02	1.02	1.02	2.01	4.1	8.2	1.19
F 0.2 θ = 300°	307	307	307	605	1225	2450	357
F 0.5 θ = 1°	2.56	2.56	2.56	5.04	10.2	20.4	2.97
F 0.5 θ = 300°	766	766	766	1510	3060	6140	891
F1 θ = 1°	5.11	5.11	5.11	10.1	20.4	40.9	5.94
F1 θ = 300°	1533	1533	1533	3022	6125	12,300	1783
F2 θ = 1°	10.22	10.22	10.22	20.1	40.8	81.8	11.9
F2 θ = 300°	3066	3066	3066	6044	12,250	24,500	3565
F3 θ = 1°	15.3	15.3	15.3	30.2	61.3	123	17.8
F3 θ = 300°	4600	4600	4600	9067	18,400	36,800	5348
F4 θ = 1°	20.4	20.4	20.4	40.3	81.7	164	23.8
F4 θ = 300°	6132	6132	6132	12,090	24,500	49,100	7131
F5 θ = 1°	25.6	25.6	25.6	50.4	102	205	29.7
F5 θ = 300°	7665	7665	7665	15,100	30,600	61,400	8913
F10 θ = 1°	51.1	51.1	51.1	100.7	204	409	59.4
F10 θ = 300°	15330	15330	15330	30,200	61,200	123,000	17,827

Note: For the bob and rotor dimensions referenced in the above shear rate and shear stress tables, see the Dimensions and Constants Table in the Operation Section of this manual.

Accessories

35-0175 **Case, Carrying:** For safe transport of the Chandler Model 3500 Viscometer. Separate compartments for the bob and sample cup.

3500-01A (110V)
3500-01B (220V) **Thermalcup:** This unit contains a thermostat and a heater for controlling the temperature of the fluid in the stainless steel sample cup. Sample temperatures up to 200°F (93°C) can be achieved.

3500-02 **Kit, Calibration:** Used to calibrate the torque measuring system on the Chandler Model 3500 Viscometer. Kit includes a supporting bracket, 1.00 cm radius spool for bob shaft, five metric weights, and case.

Safety Requirements

READ BEFORE ATTEMPTING OPERATION OF INSTRUMENT

The Chandler Engineering Model 3500 and 3500LS+ Viscometers are designed for operator safety. Any instrument that is capable of high temperatures should always be operated with **CAUTION**!!

To ensure safety:

- Locate the instrument in a low traffic area.
- Post signs where the instrument is being operated to warn non-operating personnel.
- Read and understand instructions before attempting instrument operation.
- Observe caution notes!
- Observe and follow the warning labels on the instrument.
- Never exceed the instrument maximum temperature ratings.
- Always disconnect main power to the instrument before attempting any repair.
- Turn off the heater at completion of each test.
- Appropriately rated fire extinguishers should be located within close proximity.

Before attempting to operate the instrument, the operator should read and understand this manual.

Section 1 – Installation

Unpacking the Instrument

Remove the instrument from the packing crate carefully. The unit comes fully equipped with all the necessary components and ordered spare parts. Make sure that no parts are lost when discarding the packing materials. Place the instrument on a firm table, close to the required electrical outlets.

After the instrument is removed from the shipping crate, the equipment and spare parts should be checked against the packing list to ensure that all parts have been received and none are damaged.

Note: File an insurance claim with your freight carrier if damage has occurred during shipping. Verify all parts shown on the enclosed packing list have been received. If items are missing, please notify Chandler Engineering immediately.

Utilities Required

100-130 VAC/200-240 VAC
50/60 Hz

Tools/Equipment Required

None.

Setting Up the Instrument

1. Plug the power cord into the rear of the instrument.
2. Plug the power cord into the properly rated electrical outlet.
3. Attach bob and rotor.
4. The operating voltage of the instrument can be changed. See the Maintenance section of the manual for information on how to change the operating voltage.

Caution: Check your power supply (110 VAC or 240 VAC) against your Model 3500 power rating. Damage can occur if wrong line voltage is applied.

Note: To prevent shock hazard, connect the instrument to an electrical outlet using a three-prong socket to provide positive ground.

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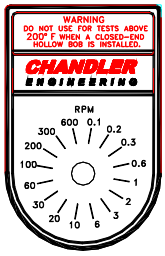
Section 2 – Operating Instructions

Performing Measurements

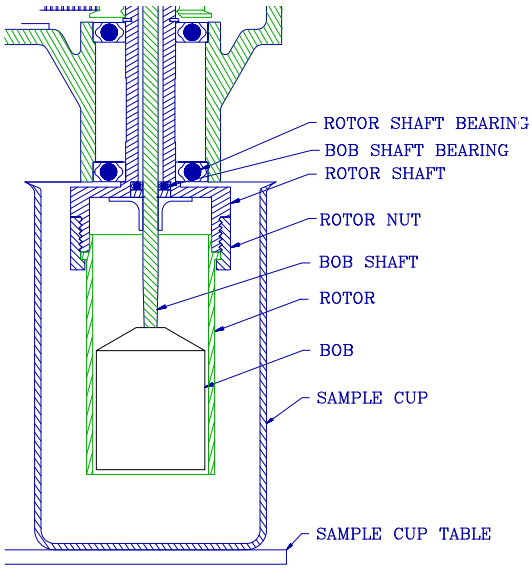
Note: Accurate measurements are dependent upon having a clean and well-maintained instrument. Always remove the rotor and bob for cleaning after each use of the instrument, and protect them from dents, scratches, abrasions, and other damage.

1. Fill the sample cup with the fluid to be tested up to the 350mL scribed line.
2. Place the sample cup on the sample cup table and rotate the cup until the three feet on the cup are engaged in the holes.
3. Raise the sample cup and cup table until the fluid level meets the scribed line on the rotor. Tighten the locking nut on the sample cup table.
4. Operate the motor at one of the preset 12 or 16 speeds. Turn the rotary dial to the desired speed. Initially, running at high speed may be beneficial to quickly fill the annular space between the rotor and bob. This is especially beneficial for high viscosity fluids.



Note: Motor speeds of 100, 200, 300 and 600 RPM have a built-in "acceleration ramp" in the electronics. It is normal for these speeds to start from zero and accelerate in a few seconds to the preset speed, while other speeds will respond almost instantly.

5. Observe the reading from the dial in the instrument by viewing through the illuminated lens. The pointer will indicate the dial reading. Allow the reading to stabilize before recording the result. Record the observation as a dial reading at the selected RPM (shear rate).
6. A schedule of increasing motor speeds (shear rates) is recommended to study "un-sheared" fluid viscosity. Alternately, a schedule of decreasing motor speeds is used to study sheared viscosity behavior. Consult the industry standard for a recommended schedule of test speeds.
7. Clean the instrument thoroughly upon completion.



Warning: ***Do not*** *submerge the rotor shaft assembly into water. Water may contaminate the bearings, causing excessive friction.*

8. Remove the rotor by holding the top portion of the rotor shaft and unscrewing the rotor nut clockwise. Avoid hitting the bob as the rotor is removed since it may damage the bob shaft. The machined surfaces of the

rotor that fit into the rotor shaft, must be kept clean and without scratches to preserve the accurate alignment of the rotor.

9. Remove the bob by turning counterclockwise until the rotation is impeded by the mechanical stop. Twist the bob while gently pulling downward. Always clean the bob and remove any debris from the tapered hole. It is very important to keep the mounting surface in the bob very clean for proper mechanical alignment of the bob.
10. To replace the bob, push gently upward and twist counterclockwise to lock the bob to the bob shaft.

Caution: Residual fluids within a hollow bob can be trapped when the bob is attached to the bob shaft. Excessive heat can vaporize this fluid and cause the bob to be under extreme pressures with possible catastrophic failure. This viscometer is designed for use with fluid temperatures up to 194°F (90°C).

Viscosity Calculations

Viscosity, by definition, is shear stress divided by shear rate. There are three different methods of calculating viscosity using the Model 3500 or Model 3500 LS+. Each method requires different constants to be used in the calculations. The constants are outlined below, followed by a detailed explanation of the three methods used for viscosity calculation. Additionally, some common oilfield viscosity computations are provided for reference.

Dimensions and Constants for Viscosity Calculations

Rotor/Bob Configuration	**R1 B1**	**R2 B1**	**R3 B1**	**R1 B2**	**R1 B3**	**R1 B4**	**R1 B5**
Rotor Radius, R_o, cm	1.8415	1.7588	2.5866	1.8415	1.8415	1.8415	1.8415
Bob Radius, R_j, cm	1.7245	1.7245	1.7245	1.2276	0.8622	0.8622	1.5987
Bob Height, L, cm	3.800	3.800	3.800	3.800	3.800	1.900	3.800
Shear Gap, in Annulus, cm	0.1170	0.0343	0.8261	0.6139	0.9793	0.9793	0.2428
Radii Ratio, R_j / R_o	0.9365	0.9805	0.667	0.666	0.468	0.468	0.8682
Overall Instrument Constant, K	300.0	94.18	1355	2672	7620	15,200	698.84
Shear Stress Constant for Effective Bob Surface k_2, cm^{-3}	0.01323	0.01323	0.01323	0.0261	0.0529	0.106	0.0154
Shear Rate Constant k_3, sec^{-1} per rpm	1.7023	5.4225	0.377	0.377	0.268	0.268	0.8503
Standard F1 Torsion Spring $\eta = Kf\theta/N$							

CHAN 35 TORSION SPRING CONSTANTS			
TORSION SPRING ASSEMBLY	**TORSION SPRING CONSTANT k_1**	**TORSION SPRING FACTOR f**	**MAXIMUM SHEAR STRESS WITH B1 BOB**
F0.2	77.2	0.2	307
F0.5	193.0	0.5	766
F1	386.0	1.0	1533
F2	772.0	2.0	3066
F3	1158.0	3.0	4600
F4	1544.0	4.0	6132
F5	1930.0	5.0	7665
F10	3860.0	10.0	15330

Method 1: Viscosity Calculation in Terms of an Overall Instrument Constant

Viscosity (cP) = K * f * (θ/N)

Where: K = overall instrument constant (units of dyne * sec * RPM per cm^2 * degree of deflection)
f = torsion spring factor (see Spring Constants Table above)
θ = Model 3500 dial reading
N = rate of revolution of the outer cylinder, RPM

Method 2: Viscosity Calculation in Terms of Three Instrument Constants

This method calculates the viscosity based on instrument constants for torsion spring, bob surface, and shear gap.

$$\text{Viscosity (cP)} = \frac{k_1 * k_2}{k_3} * 100 * \frac{\theta}{N}$$

Where: k_1 = torsion spring constant (see Spring Constants Table above), dyne-cm/degree
k_2 = shear stress constant for effective bob surface, cm^{-3}
k_3 = shear rate constant, sec^{-1}/RPM
θ = Model 3500 dial reading
N = rate of revolution of the outer cylinder, RPM

Method 3: Viscosity Calculation in Terms of Shear Stress Divided by Shear Rate

Shear stress (dynes/cm^2) = $k_1 * k_2 * \theta$

Shear rate (sec^{-1}) = $k_3 * N$

$$\text{Viscosity (cP)} = \frac{\text{Shear stress}}{\text{Shear rate}} * 100$$

Common Oilfield Computations

Note: These computations are valid only with the standard R1/B1 configuration. A spring other than F1 may be used if the dial readings are multiplied by the proper "f" factor.

Apparent Viscosity (cP)

$$AV = \theta_{600\ RPM} / 2$$

Plastic Viscosity (cP)

$$PV = \theta_{600\ RPM} - \theta_{300\ RPM}$$

Yield Point - approximate value (lb/ft^2)

$$YP = \theta_{300\ RPM} - PV$$

Yield Point – exact value (lb/ft^2)

$$YP = 1.065 * (\theta_{300\ RPM} - PV)$$

Section 3 – Maintenance

Tools Required

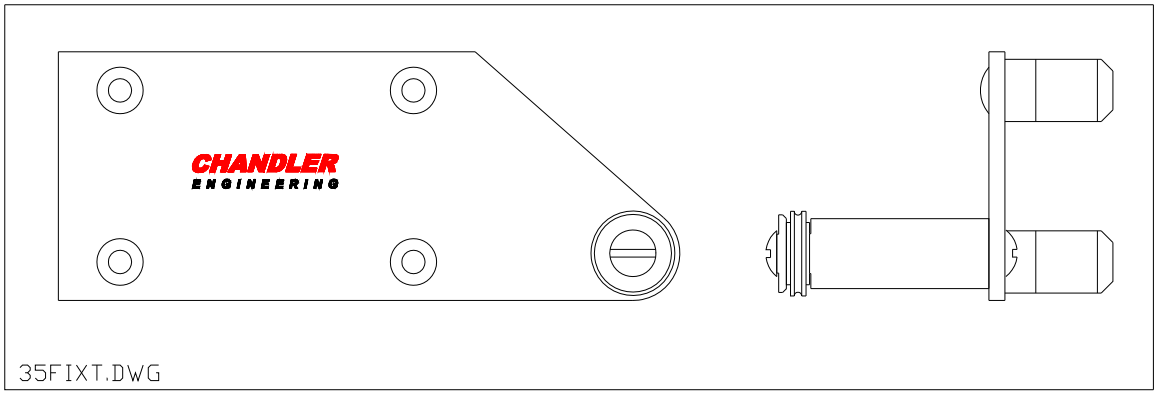
Basic Hand Tools

Cleaning and Service Tips

The rotor and bob should be thoroughly cleaned after each test. Care should be taken to insure that the bob shaft does not become bent. **Do not** submerge the rotor shaft assembly into water. Water may contaminate the bearings, causing excessive friction.

Calibration Procedure

1. The spring zero and span must be adjusted using a calibration fixture or known viscosity fluid.
2. Verify the spring calibration by attaching the pulley frame from the calibration kit to the posts on the viscometer.
3. Attach the calibration disc and thread to the tapered end of the bob shaft and hang the 10-gram weight over the pulley with the anchor on the string attached to the disc.
4. Adjust the height of the frame on the vertical support shafts until the string is horizontal between the disc and the pulley.
5. Record the dial reading.
6. Repeat the process using the 20 gram, 50 gram, 100 gram weights and with all weights removed.
7. Refer to the tables below for the dial reading limits during spring calibration.



Spring Tolerances for Calibration (Dial Reading)				
Weight (grams)	0.2 Spring	0.5 Spring	1.0 Spring	2.0 Spring
0	0	0	0	0
10	123 – 128	49 – 52	24.5 – 26	-
20	247 – 256	99 – 101	49.5 – 51.5	24.5 – 26
50	-	247 – 256	123 – 128	61 – 64
100	-	-	247 – 256	123 – 128

Calibration Adjustment

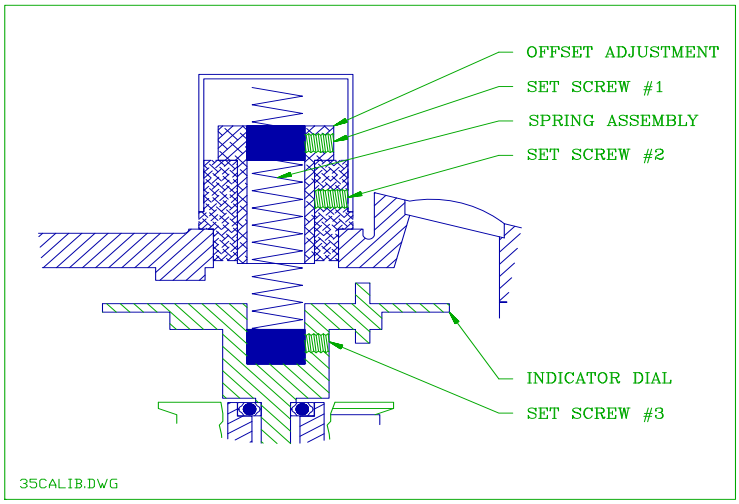
Note: if the dial readings are beyond the limits, an adjustment to the calibration must be made as follows.

1. Refer to diagram of set screws below as the adjustments are made.
2. Remove the spring cap and loosen set screw #1 using a 1/16 inch hex wrench on the zero adjust sleeve.
3. This loosens the upper spring clamp on the torsion spring assembly and allows the effective spring length to be varied by raising or lowering the mandrel inside the spring.
4. If readings are too high, move the spring mandrel down by turning it clockwise. If readings are too low, move the spring mandrel up by turning it counterclockwise.
5. Tighten set screw #1.
6. If the instrument ZERO must be adjusted, remove the spring cap and use a 1/16 inch hex wrench to loosen set screw #2.
7. Remove all weights from the calibration fixture.
8. Rotate the knurled bushing until the dial reading is 0. Tighten set screw #2.
9. Repeat the calibration procedure with the weights.
10. If the instrument will not calibrate properly, check the bob shaft bearings and refer to other potential problems listed in the Troubleshooting Guide.

Note: Calibration may require repetitive adjustments of the Span and Zero since they are interrelated. Once the dial readings fall within the acceptable limits, tighten all the set screws securely and replace the torsion spring cap.

11. Operate the instrument at 300 RPM with a 200cP fluid in the sample cup. The dial oscillations should be less than 1 dial reading. If not, clean or replace the bob shaft bearings.

Note: Dial oscillations can also be caused by a bent bob shaft or a damaged rotor assembly. Additionally, a rotor shaft belt pulley that does not slide freely vertically on the rotor shaft and key can cause bob bearing distortion.



Replacement of the Spring Assembly

1. Screw in the #4-40 x 3 inch screw shipped with the instrument.
2. Loosen set screw #3. This set screw is accessed by removing the silver plug on the front of the instrument. The dial indicator must be rotated until the set screw aligns with the hole in the casting.
3. Carefully pull the spring assembly out of the instrument.
4. Insert new spring assembly.
5. Tighten set screw #3.
6. Calibrate the instrument with the new spring following the instructions above.

Replacement of the Bob Shaft Bearings

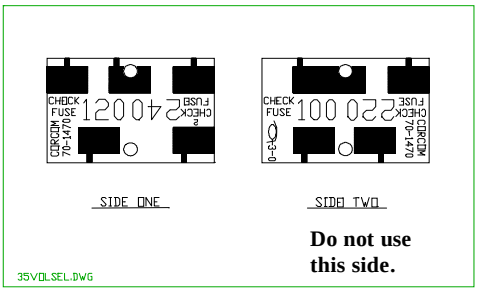
1. Remove the silver hole plug from the front of the instrument.
2. Loosen set screw #3 in the bushing.
3. Remove the torsion spring cap.
4. Loosen set screw #1 in the zero adjust sleeve.
5. Remove the 6 top cover screws.
6. Remove the spring assembly taking care not to stretch the spring.
7. Raise the gear box cover up and carefully lay it over the side of the gear box. The instrument can be laid on its side to simplify this process and to minimize the chance of damage to the attached wiring.
8. Remove the rotor.
9. Remove the bob.
10. Remove the bearing splash guard by sliding it straight down and off of the bob shaft.
11. Remove the bob shaft snap ring by laying the instrument on its side and using a pointed tool to remove the snap ring.
12. Remove the bob bearing shield.
13. Pull the dial and bob shaft assembly straight up out of the bearings. DO NOT bend the shaft.
14. Carefully remove the bob shaft bearings.
15. Replace the bearings with new (or cleaned) bearings. DO NOT use oil or grease in the bearings.

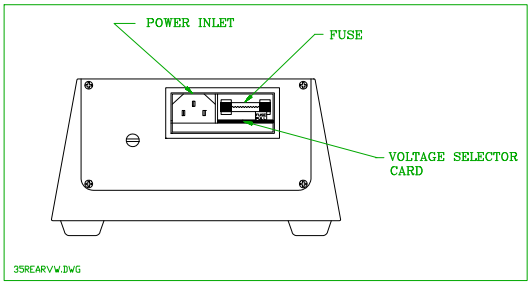
16. Reverse the procedure for re-assembly. Use great care to ensure the cleanliness of the bearings and related components to prevent dial oscillations due to bearing drag.
17. Re-calibrate the instrument.

Changing the Operating Voltage

Note: the instrument is wired to accept 100-130 or 200-240 volts at 50 or 60 Hz. The voltage selector card at the rear of the instrument is used to select the desired voltage.

1. Remove the power cord from the back connector.
2. Slide the cover to expose the fuse and voltage selector card.
3. Pull the card straight out and orient it so that the voltage on the card can be read as it is installed. (see figure below)
4. Push straight in and apply only the voltage that is indicated on the card.
5. Replace the existing fuse with the required fuse for the voltage:
   a. For 100-130 VAC operation, use a 2 Amp, 3AG, Slo-Blo fuse.
   b. For 200-240 VAC operation, use a 1 Amp, 3AG, Slo-Blo fuse.





Maintenance Schedule

MAINTENANCE SCHEDULE INSTRUMENT NAME					
COMPONENT	EACH TEST	MONTHLY	3 MONTHS	6 MONTHS	ANNUAL
Rotor	Clean				
Bob	Clean				
Instrument Calibration		Check calibration			

This maintenance schedule applies to normal usage of two tests per day. Detailed procedures for these operations are contained in your manual.
● Per API Specifications
* Where Applicable

Section 4 – Troubleshooting Guide

Problem	Solution
Unsteady Dial Reading	• The bob shaft bearings may be dirty. Replace the bearings. • The rotor and bob may not be concentric. Remove both the rotor and bob, clean all mounting surfaces, replace the rotor and bob. • The spring may be worn, replace. • The bob shaft may be bent. Replace the shaft assembly.
Belt Makes Noises	• The drive belt is too tight, adjust the belt tensioner.
Motor Operates At Wrong Speeds.	• The wiring from the RPM selector switch may be damaged. Repair the wiring.
Motor Makes Grinding Noise	• The drive transistor in the heat sink assembly may be defective. Replace the Heat Sink assembly.
Instrument Does Not Operate When Power Switch Is ON.	• Check fuses and replace if necessary. • The voltage selector card may not be properly installed. Refer to *Changing the Operating Voltage* instructions to properly install card. • The power switch may be defective, replace the switch if necessary. • The motor control board may be defective. Replace the board.

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Section 5 - Replacement Parts

Part Number	Description
09083-24	Fuse, 2A, 250V,3AG Slow Blow
35-0101	Stage
35-0102	Drive Tube
35-0111	Spacer
35-0112	Nut
35-0118	Bob (Type B1) Assembly
35-0125	Shield
35-0126	Cover, Base
35-0131	Sleeve, Zero Adjust
35-0132	Guard, Splash
35-0133	Idler Arm
35-0134	Spacer, Short Shaft
35-0135	Shaft, Short Drive
35-0136	Timing Belt Pulley Modified
3506-CUP	Sample Cup
35-0142	Switch Assembly
35-0146	Bob Shaft Assembly
35-0148	Label
35-0151	Spacer, Shaft, Long
35-0166	Torsion Spring Assembly (F1)
35-0191	Rotor
35-0193	Base
35-0198	Fan Bearing Spacer
35-0220-01	Motor Control Board Assembly (12 Speed)
35-0220-02	Motor Control Board Assembly (16 Speed)
35-0228	Shaft, Rotor
35-0290	Heat Sink Assembly
35-0295	Gear Box
35-0296	Cover, Gear Box
35-0306	Screw, Modified, Support Tube
C01184	Fuse, 1 AMP, 3AG Slow Blow
C07327	Bridge Rectifier
C07560	Standoff
C09906	Cap, Torsion Spring
P-0065	O-ring
P-0407	Switch (On-Off)
P-1233	Foot, Rubber
P-2441	Cord, Power
P-2921	Connector
P-2925	Timing Belt Pulley
P-2926	Timing Belt, Lower
P-2927	Timing Belt, Upper
P-2930	Bearing, Drive

Part Number	Description
P-2931	Bearings, Main
P-2932	Bearing, Bob Shaft
P-2933	Bearing, Idler
P-2945	Plug, Hole
P-2948	Knob, Selector
P-2950	Boot, Rubber
P-2991	Screw, Tube Support Cap
P-3000	Stepper Motor
P-3001	Power Transformer
P-3002	Knob, Locking
P-3005	Lamp
P-3006	Snap Ring
P-3073	Coupling Hub, Lower
P-3074	Coupling Hub, Upper
P-3075	Coupling Sleeve
OPTIONAL ITEMS:	
35-0246	R2 Rotor
35-0261	B2 Bob Assembly
35-0262	B3 Bob Assembly
35-0263	R3 Rotor Nut**
35-0264	R3 Rotor

** When R3 Rotor is purchased (35-264), (Type R3) Rotor Nut 35-263 must be used instead of the 35-245 R1 Rotor Nut.

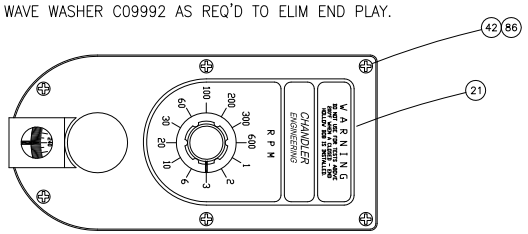
To ensure correct part replacement, always specify model and serial number of instrument when ordering or corresponding.

Section 6 - Drawings and Schematics

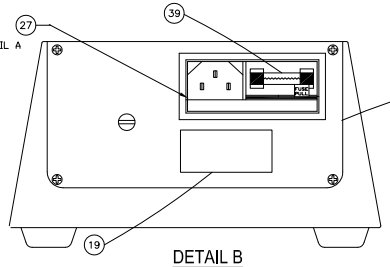
Drawing Number	Description
35-0170	Assembly, Chan 35
35-0219	Schematic, Chan 35

NOTES:

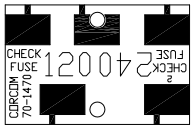
1. USE BEARING LOCKING COMPOUND TO KEEP BEARING OUTER RACE, FROM ROTATING INSIDE BORE.
   −01 100−130 VAC
   −02 200−240 VAC
2. USE WAVE WASHER C09992 AS REQ'D TO ELIM END PLAY.



DETAIL C



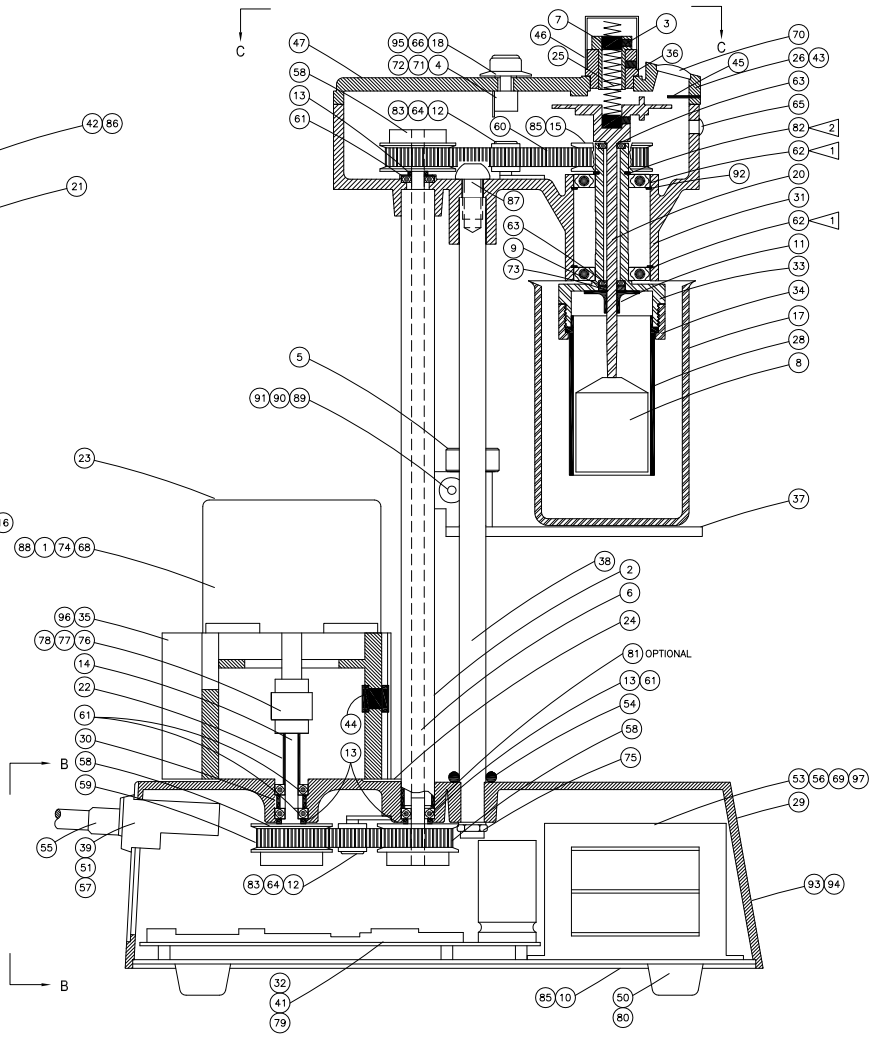
DETAIL B



VOLTAGE SELECTOR CARD USE SIDE ONE AS SHOWN

(DO NOT USE SIDE TWO)

DETAIL A



REVISIONS				
ZONE	REV	DESCRIPTION OF REVISION	DATE	APPROVALS
	M	ECN T1315, UPDATED BOM. DUPLICATE 81S	11/6/07	JB TC
D7	N	ECN T1674, REVERSED FUSE & PLUG LOCATIONS	05/22/08	AMH JS

		1	1	P−2929	LENS (REF)		70
		2	2	P−3001	XFMR,PWR,115−230/24,100VA (REF)		69
		1	1	P−3000	MOTOR,STEPPER,1.7V		68
		1	1	P−2950	BOOT,SWITCH	NOT SHOWN	67
		1	1	P−2948	KNOB SELECTOR (REF)		66
		1	1	P−2945	PLUG ,HOLE,0.25",NPSTL		65
		2	2	P−2933	BRNG,DBLROW,.6250DX.250IDX.562		64
		2	2	P−2932	BRG, BALL, SS,.1875 X .5000		63
		2	2	P−2931	BRNG,1.375ODX.625IDX.344W		62
		4	4	P−2930	BRNG,.625ODX.250IDX.281W		61
		1	1	P−2927	BELT, TIMING, UPPER		60
		1	1	P−2926	BELT,TIMING, LOWER		59
		3	3	P−2925	PULLEY,TIMING BELT,40DP,.250BO		58
		1	1	P−2921	SEL,CONN & V		57
		1	1	P−2452	VRIS ,V130LA20A,70 JOULES (REF)		56
		1	1	P−2441	CORD,APPLIANCE,9'10",17−601		55
		1	1	P−2292	ORING,BUNA,AS113−70		54
		10	10	P−1768	TERM ,FEMALE DISCONNECT,.250" (REF)		53
		1	1	P−1666	WRENCH,HEX,.0625H	NOT SHOWN	52
		1		P−1662	FUSE ,2 AMP,250V,3AG FAST BLOW		51
		4	4	P−1233	FOOT,RUBBER,0.96870D		50
		1	1	P−0407	SWTCH,TOGGLE,3A,125V,BAT HAND	NOT SHOWN	49
		1	1	P−0041	PL,SW,ON−OFF	NOT SHOWN	48
		1	1	35−0296	COVER, GEAR BOX. (REF)		47
		1	1	C09906	CAP, TORSION SPRING (REF)		46
		1	1	35−0140	POINTER (REF)		45
		1	1	C09912	GROMMET, RUBBER, 5/16		44
		1	1	35−0289	ASSY, COVER, GEAR BOX, LS		43
		6	6	C09845	WSHR,NYLON,.140x.313x.062THK		42
		6	6	C07560	STDF,M−F,6−32 X .25",1/4 HEX		41
		1	1	C06892	VARISTOR,250 VAC		40
			1	C01184	FUSE ,1 AMP,3AG SLO BLO		39
		2	2	35−0303	TUBE SUPPORT		38
		1	1	35−0101	STAGE		37
		1	1	35−0300	BUSHING (REF)		36
		1	1	35−0290	HEAT SINK ASSY		35
		1	1	35−0245	NUT,ROTOR		34
		1	1	35−0228	SHAFT,ROTOR		33
		1	1	35−0220	PCB,MOTOR CONTROL		32
		1	1	35−0295	GEAR BOX		31
		1	1	35−0198	SPACER,BEARING,FAN,SST		30
		1	1	35−0193	BASE		29
		1	1	35−0191	ROTOR,R1		28
		1	1	35−0174	LABEL		27
		1	1	35−0168	ASSY, COVER, GEAR BOX		26
		1	1	35−0166	SPRING ASSY,TORSION		25
		1	1	35−0157	BRACKET ASSY, RESISTOR		24
		1	1	35−0152	LABEL,MOTOR	NOT SHOWN	23
		1	1	35−0151	SPACER,SHAFT,Aluminum		22
		1	1	35−0148	LABEL,GEAR BOX,TOP		21
		1	1	35−0146	BOB SHAFT ASSEMBLY		20
		1	1	35−0143	LABEL,BACK COVER		19
		1	1	35−0142	SWITCH ASSY (REF)		18
		1	1	35−0139	CUP ASSEMBLY,SAMPLE		17
		1	1	35−0137	CVR,BASE,REAR		16
		1	1	35−0136	PULLEY,MOD		15
		1	1	35−0135	SHAFT,DRIVE,SHORT		14
		3	3	35−0134	SPACER,SHAFT,Aluminum		13
		2	2	35−0133	ARM,IDLER		12
		1	1	35−0132	GUARD,SPLASH		11
		1	1	35−0126	COVER,BASE		10
		1	1	35−0125	SHIELD		9
		1	1	35−0118	BOB		8
		2	2	35−0115	CLAMP SPRING (REF)		7
		1	1	35−0114	SFT,DRIVE,LONG		6
		1	1	C11015	COLLAR, SHAFT .5ID 1.250D, SS		5
		1	1	35−0153	PIPE, LIGHT (REF)		4
		1	1	35−0131	SLEEVE (REF)		3
		1	1	35−0102	TUBE,DRIVE		2
			1	35−0005−50	LABEL,"WARNING,100−130 VAC"	NOT SHOWN	1
−04	−03 −02 −01			PART NUMBER	DESCRIPTION	MATERIAL SPEC.	ITEM
QTY. REQD.				PARTS LIST			

		1	1	C10463	SRPING, WAVE, .625 OD (OPTIONAL)	.	81
		7	7	P−3181	RIVET,POP,ALUM,.187DX.250	NOT SHOWN	80
		1	1	P−3163	RECT ,BRIDGE,25A,400V,MB254 (REF)		79
		1	1	P−3075	CPLNG,SLV		78
		1	1	P−3074	CPLNG,HUB,.375 ID		77
		1	1	P−3073	CPLNG,HUB,.250D		76
		2	2	P−3014	NUT ,7/16−20,JAM		75
		4	4	P−3012	SCREW,RND HD,10−24x4"L		74
		2	2	P−3006	RING,SNAP		73
		1	1	35−0199	RTNR, PIPE LIGHT (REF)		72
		1	1	P−3005	LAMP ,TYPE 7373PS,T1−3/4 BIPIN (REF)		71
−04	−03 −02 −01			PART NUMBER	DESCRIPTION	MATERIAL SPEC.	ITEM
QTY. REQD.				PARTS LIST			

		11	11	P−3238	TERM ,DISCONNECT,RED,.187		97
		1	1	35−0223	ASSY, HEAT SINK (REF)	NOT SHOWN	96
		1	1	35−0287	SWITCH ASSY, LS (REF)		95
		1	1	35−0279	LABEL, 3500 LS	NOT SHOWN	94
		1	1	35−0149	LABEL, 3500	NOT SHOWN	93
		2	2	C10066	RING, RETAINING		92
		1	1	P−3002	KNOB, LOCKING		91
		1	1	35−0111	SPACER		90
		1	1	35−0112	NUT		89
		1		35−0005−49	LABEL, "WARNING, 200−240 VAC"	NOT SHOWN	88
		1	1	35−0306	SCREW,MODIFIED,SUPPORT TUBE		87
		6	6	C08026	SCREW, TRUSS, PPH, SS, 6−32x.75"	NOT SHOWN	86
		1	1	35−0221	BASE COVER ASSY SERIES 2		85
		2FT	2FT	R−0872	CABLE, 7 CNDCT,24 AWG,FOILSHLD		84
		2	2	187−19449	WASHER,BLK.NYLON		83
		1	1	P−3595	RING,RETAINING		82
−04	−03 −02 −01			PART NUMBER	DESCRIPTION	MATERIAL SPEC.	ITEM
QTY. REQD.				PARTS LIST			

NEXT ASSY | USED ON

APPLICATION

BREAK SHARP EDGES, DEBURR

UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES [mm]

TOLERANCES:
1 PLACE ±0.030 [.76]
2 PLACE ±0.010 [.25]
3 PLACE ±0.005 [.127]
ANGLES ±1/2°
SURF. FINISH 63

APPROVALS		DATE
DRAWN:	AH	04/17/01
CHECKED:		04/17/01
ENGR.:		04/17/01

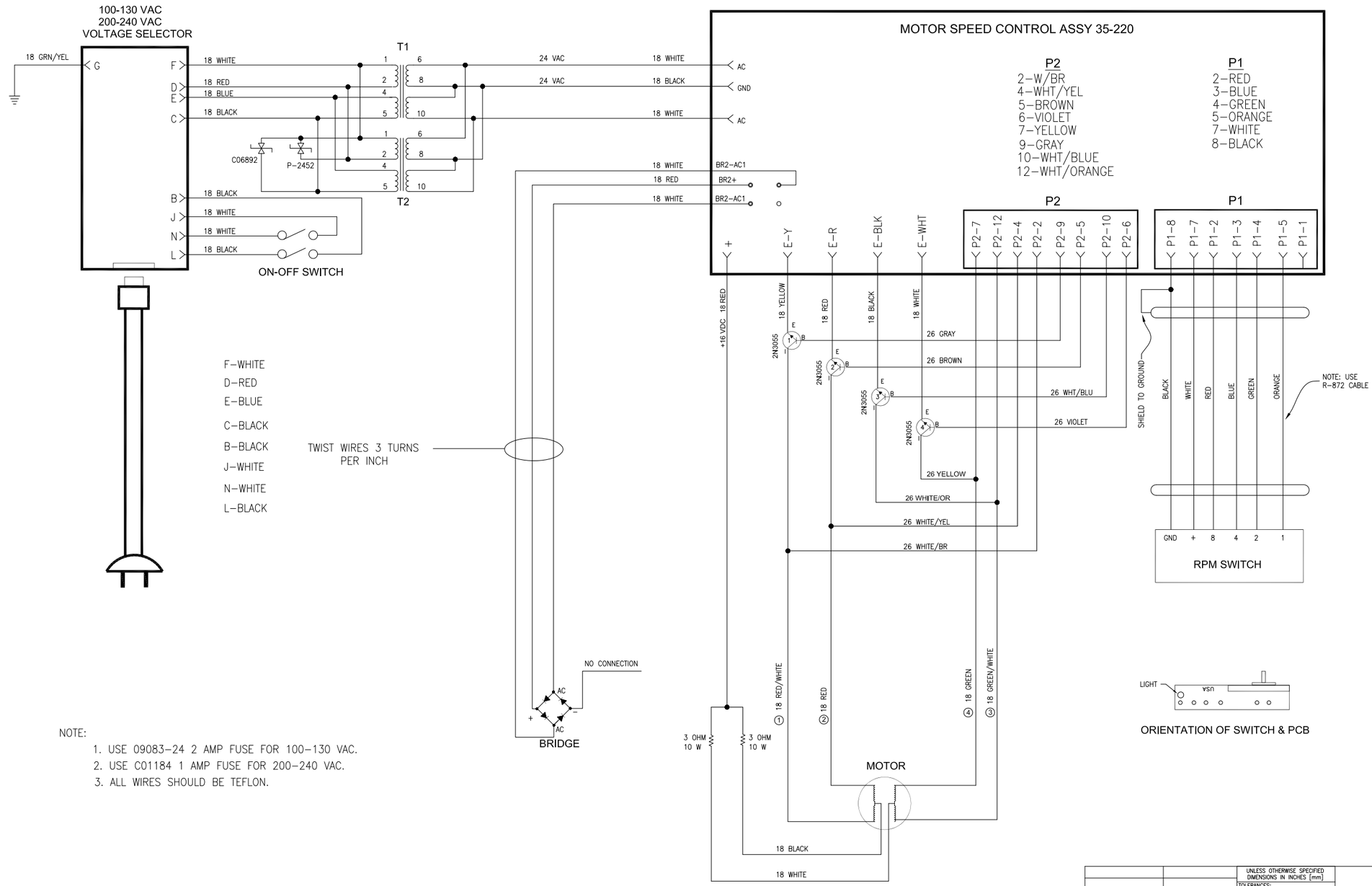
CHANDLER ENGINEERING

TITLE
ASSEMBLY
VISCOMETER FINAL,CHAN 35

SIZE	S.O. NO.	DWG NO.	REV.
A		35−0170	N

SCALE: 1 = 1 | TITLE BLOCK REV: 1.0 | SHEET: 1 of 1

REVISIONS				
ZONE	REV	DESCRIPTION	DATE	APPROVED
	K	ECN 425, 09083-24 WAS P-1662	12/13/06	JB/TC
	L	ECN T1317, ADDED NOTE 3	11/8/07	JB/TC



NOTE:

1. USE 09083-24 2 AMP FUSE FOR 100-130 VAC.
2. USE C01184 1 AMP FUSE FOR 200-240 VAC.
3. ALL WIRES SHOULD BE TEFLON.

NEXT ASSY	USED ON	UNLESS OTHERWISE SPECIFIED DIMENSIONS IN INCHES [mm]	CHANDLER ENGINEERING
APPLICATION		TOLERANCES: 1 PLACE ±0.030 [.76], 2 PLACE ±0.010 [.25], 3 PLACE ±0.005 [.127], ANGLES ±1/2°, SURF. FINISH 32	TITLE: SCHEMATIC, CHAN-35
BREAK SHARP EDGES, DEBURR		APPROVALS / DATE	
		DRAWN: JMS 3-22-93	SIZE: D; S.O. NO.; DWG NO. 35-0219; REV. L
		CHECKED: DK 3-22-93	
		ENGR.: JMM 3-22-93	SCALE: 1 = 1; TITLE BLOCK REV: 1.0; SHEET: 1 of 1