BROOKFIELD DIAL READING VISCOMETER
BROOKFIELD DIGITAL VISCOMETER
MODEL DV-I

Operating Instructions

Manual No. **M/85-150-D**

The following instructions are intended for use with all standard models of Brookfield **Digital** and **Dial Reading** Viscometers. Information has been provided for the proper operation and care of your Viscometer. Additional information is available in the Brookfield booklet "More Solutions to Sticky Problems." Please contact Brookfield (or your local dealer) for any other information you desire regarding viscosity measurement and control instrumentation. Thank you for the continued use of our products.

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Principle of Operation

The Brookfield Viscometer rotates a sensing element in a fluid and measures the torque necessary to overcome the viscous resistance to the induced movement. This is accomplished by driving the immersed element, which is called a spindle, through a beryllium copper spring. The degree to which the spring is wound, indicated by the red pointer or digital display, is proportional to the viscosity of the fluid.

With **Digital** models, continuous readout of viscosity can be accomplished in three ways: by means of the integral three-digit LED display, by the 0-10 mv, or the 0-1v analog output signal which can be fed into a variety of indicating or recording devices.

The Viscometer is able to measure over a number of ranges since, for a given spring deflection, the actual viscosity is proportional to the spindle speed and is related to the spindle's size and shape. For a material of given viscosity, the resistance will be greater as the spindle size and/or rotational speed increase. The minimum viscosity range is obtained by using the largest spindle at the highest speed; the maximum range by using the smallest spindle at the slowest speed.

Measurements made using the same spindle at different speeds are used to detect and evaluate the rheological properties of the test material. Our booklet, "More Solutions to Sticky Problems," discusses the Viscometer's use in this respect.

Introduction

The Brookfield Viscometer is powered by a precision synchronous motor. Exact speeds of rotation are assured as the motor will turn erratically and spasmodically if synchronism cannot be maintained.

Speed changes are affected by a transmission having eight speeds. For **Digital** models having serial numbers above AO2400, a round speed control knob rotates both clockwise and counter-clockwise. Maximum speed (rpm) will be set at full clockwise rotation and minimum speed at full counter-clockwise rotation. The speed setting is indicated by the number on the knob located opposite the button on the Viscometer housing. Although not absolutely necessary, it is advisable to change speeds while the motor is running.

For all **Dial Reading** Viscometers and **Digital** models having serial numbers below AO2400, speed changes are affected by a gear train having either four or eight speeds. Four speed Viscometers have a square speed control knob with one number shown on each of four faces. The instrument's rotational speed is indicated by the uppermost number. Eight speed models have a square speed control knob with two numbers on each face; by moving the knob through two complete turns speeds may be changed in sequence. No trouble will be experienced in differentiating between the two speeds shown on each face since each pair is in the ratio of 20:1. To insure rotation at the indicated speed, it is important that the face of the knob upon which this speed is shown be closely parallel to the Viscometer's dial. Although not absolutely necessary, it is advisable to change speeds on any model while the motor is running.

LV Viscometers are provided with a set of four spindles and a narrow guard leg; RV Viscometers come with a set of seven spindles and a wider guard leg; HA and HB Viscometers come with a set of seven spindles and no guard leg.

The spindles are attached to the Viscometer by screwing them to the lower shaft. Note that the spindles have a **left-hand thread.** The lower shaft should be held in one hand and the spindle screwed to the left. The face of the spindle nut and the matching surface on the lower shaft should be smooth and clean to prevent eccentric rotation of the spindle.

Spindles can be identified by the number on the side of the spindle nut.

All Brookfield **Dial Reading** Viscometers are provided with a clutch lever located at the back of the instrument. Depressing the lever raises the dial against the pointer and "holds" the instrument's reading. When the clutch is released the dial will lower and the pointer will be freed.

Any of the controls on the Viscometer - the motor switch, speed change knob, and clutch - may be operated independently of the other.

Initial Setup

1. Mount the Viscometer securely on a Brookfield laboratory stand. With **Dial Reading** models, it may be necessary to unscrew the nut located at the point where the power cord enters the Viscometer. This permits the metal handle to be inserted into the laboratory stand clamp.

   NOTE: The **position** of the laboratory stand clamp assembly is **important**. Refer to Parts Identification Sheet #82-0330 for proper alignment and positioning of the clamp assembly.

   Level the Viscometer referring to the bubble level on the instrument. If the Viscometer cannot be leveled, recheck the laboratory stand assembly as shown on sheet #82-0330.

2. Verify that the Viscometer's (and recorder's, if used) power requirements match your power source before connecting it to power.

3. If using a recorder: connect the **Digital** Viscometer output cable to recorder terminals. Connect the 0-10mv red wire to the "+" terminal and the black wire to "-". Insert the plug on the other end of the cable into the Viscometer's output receptacle. Set the recorder's input selector (if so equipped) to 10 mv full scale.

   NOTE: DO NOT CONNECT DIGITAL VISCOMETER OUTPUT CABLE TO POWER!

Initialization (Digital Viscometer Only)

1. Turn power switch "on" (up), energizing Viscometer display. The power switch is on the left side of the front panel.

2. Check bubble level to be sure Viscometer is level. Turn motor switch "on" (up) and set speed selector knob to 10 or 12 rpm (depending on model). The motor switch is on the right side of the front panel.

3. Allow Viscometer to run until display reading stabilizes (or fluctuates by no more than 0.1). Turn zero adjustment knob until the display reads 00.0. This also zeros the output signal.

4. If a recorder is used, it should be zeroed after the Viscometer has been zeroed. The recorder input must be in the "run" mode. After the recorder is zeroed, switch it to the "standby" mode.

5. Turn motor switch "off", placing Viscometer in standby mode.

Operation

1. Mount guard leg on Viscometer. Attach spindle to lower shaft. Lift the shaft slightly, holding it firmly with one hand while screwing the spindle on with the other (note left-hand thread). Avoid putting side thrust on the shaft.

2. Insert and center spindle in the test material until the fluid's level is at the immersion groove in the spindle's shaft. With a disc type spindle, it is sometimes necessary to tilt the instrument slightly while immersing to avoid trapping air bubbles on its surface. (You may find it more convenient to immerse the spindle in this fashion before attaching it to the Viscometer).

3. To make a viscosity measurement, turn the motor switch "on" which energizes the Viscometer drive motor. Allow time for the indicated reading to stabilize. The time required for stabilization will depend on the speed at which the Viscometer is running and the characteristics of the sample fluid. When making a measurement at high speeds, it will be necessary to depress the clutch and turn off the motor, with the red pointer in view, on the **Dial Reading** Viscometer.

   When making a viscosity measurement, the reading should be noted and multiplied by the factor appropriate to the Viscometer model/spindle/speed combination being used. The factor is obtained from the Brookfield Factor Finder. For maximum accuracy, display readings below 10.0 should be avoided.

   When using a **Digital** Viscometer with recorder, switch recorder to "run" mode to record Viscometer reading. Note that the paper used in the strip chart recorder has a 0-100 scale. The reading on the chart is utilized in the same fashion as the Viscometer display reading.

4. Turn the Viscometer motor switch "off" when changing a spindle, changing samples, etc. Remove spindle before cleaning. It is advisable to leave the **Digital** Viscometer power switch "on" between tests to minimize drifting of the Viscometer display.

   It is recommended, when operating the **Digital** Viscometer for a lengthy period, that zero be checked occasionally. Remove spindle from the Viscometer before performing this procedure.

5. The interpretation of results and the instrument's use with non-Newtonian and thixotropic materials is discussed in the booklet, "More Solutions to Sticky Problems."

Calibration

All models of the Brookfield Viscometer are guaranteed to be accurate to within 1% of whatever full scale range is employed when used in the specified manner. Readings should be reproducible to within 0.2% of full scale subject to variations in fluid temperature, etc. Additional calibration information is available in the Brookfield booklet "More Solutions to Sticky Problems."

If it is desired to calibrate the Viscometer, Viscosity Standards are available from Brookfield Engineering Laboratories. They are available in various viscosities to suit all models of the Brookfield Viscometer. The Viscometer's calibration should only be checked under controlled conditions of temperature and in accordance with the following procedures:

LV Models (LVF, LVT, LVTD)

These instruments are calibrated to Bureau of Standards values on the basis of immersion in an infinite body with the guard leg attached. They are accurate to within 1% of full scale when the spindle is centered in any container over 2-3/4" in diameter. Using the Viscometer in

smaller containers will reduce the effective range of measurement provided by the #1 and #2 spindles. The calibration of the #3 and #4 spindles is unaffected by the size of the container used as long as the guard leg is attached.

Readings obtained in small containers and/or without the guard can be used only for comparative purposes unless correction factors are used with each spindle and with each container. Our booklet, "More Solutions to Sticky Problems," outlines the procedure to be followed in calculating these factors.

A condition of turbulent flow is created by the #1 spindle when rotating at 60 RPM in materials having viscosities less than 15 cps. If measurements are needed in this region, it is suggested that the UL Adapter accessory be used.

RV Models (RVF, RVF-100, RVT, RVTD)

These Viscometers are calibrated to Bureau of Standards values on the basis of the instrument's use, with its guard leg attached, in a 600 cc low form Griffin beaker. If the instrument is used in a larger container, the ranges over which the #1 and #2 spindles measure will be slightly increased. This effect is negligible with the other spindles (#'s 3-7) provided with the unit.

If it is desired to use the RV spindles in containers other than the one specified, it will be necessary to establish correction factors if values of absolute accuracy are required. The booklet, "More Solutions to Sticky Problems" outlines this procedure.

The #1 RV spindle should not be operated at 100 RPM because a condition of turbulent flow is produced which can cause inaccurate measurements. The lowest accurate viscosity measurable by the RV Viscometers, with standard spindles, is 100 cps.

If trouble is experienced in starting the instrument (particularly at a high speed setting), turn it "on" at a lower speed and shift to the higher speed while it is running.

H Models (HAF, HAT, HBF, HBT, HATD, HBTD)

Brookfield HA and HB Viscometers are used without guard legs. In all other respects, their calibration is based on the same operating conditions as those given previously for the RV model. It is not suggested that they be used for the measurement of viscosities below 200 cps (HA) and 800 cps (HB).

Fault Diagnosis

Problem	Cause	Action
Spindle doesn't rotate	Drive motor not energized	Turn power switch "on"
Display reads "---"	Underrange (Spindle jammed)	Consult factory
Display reads "EEE" Dial Reads 100	Overrange	Change speed and/or spindle
Recorder pen moves in wrong direction	Output polarity reversed	Exchange output leads
No recorder response	Viscometer is at zero reading	Check for output at upscale reading
	Recorder off	Check recorder power and power switch
	Output shorted	Check output connections
Display reads only "00.0" and will not respond to viscosity measurements	0-1v or 0-10mv output signal shorted	Check output connections

Specifications

Power Supply:	115V/60 Hz 230V/50 Hz or 115V/50 Hz 230V/60 Hz	
*Output Signal: **Digital**	0-10mv DC Red (+) For recording Black(-)	0-1v DC White (+) Green (-) For analog to digital interface or optional recording
Output Impedence: **Digital**	1k ohms	20k ohms

***Note:** 0-1v DC output signal supplied on **Digital** Viscometers starting with serial number **AO - - - - .**

Repairs and Service

Any Brookfield Viscometer used in the United States requiring repair or service should be returned to:

Brookfield Engineering Laboratories, Inc
240 Cushing Street
Stoughton, Massachusetts 02072

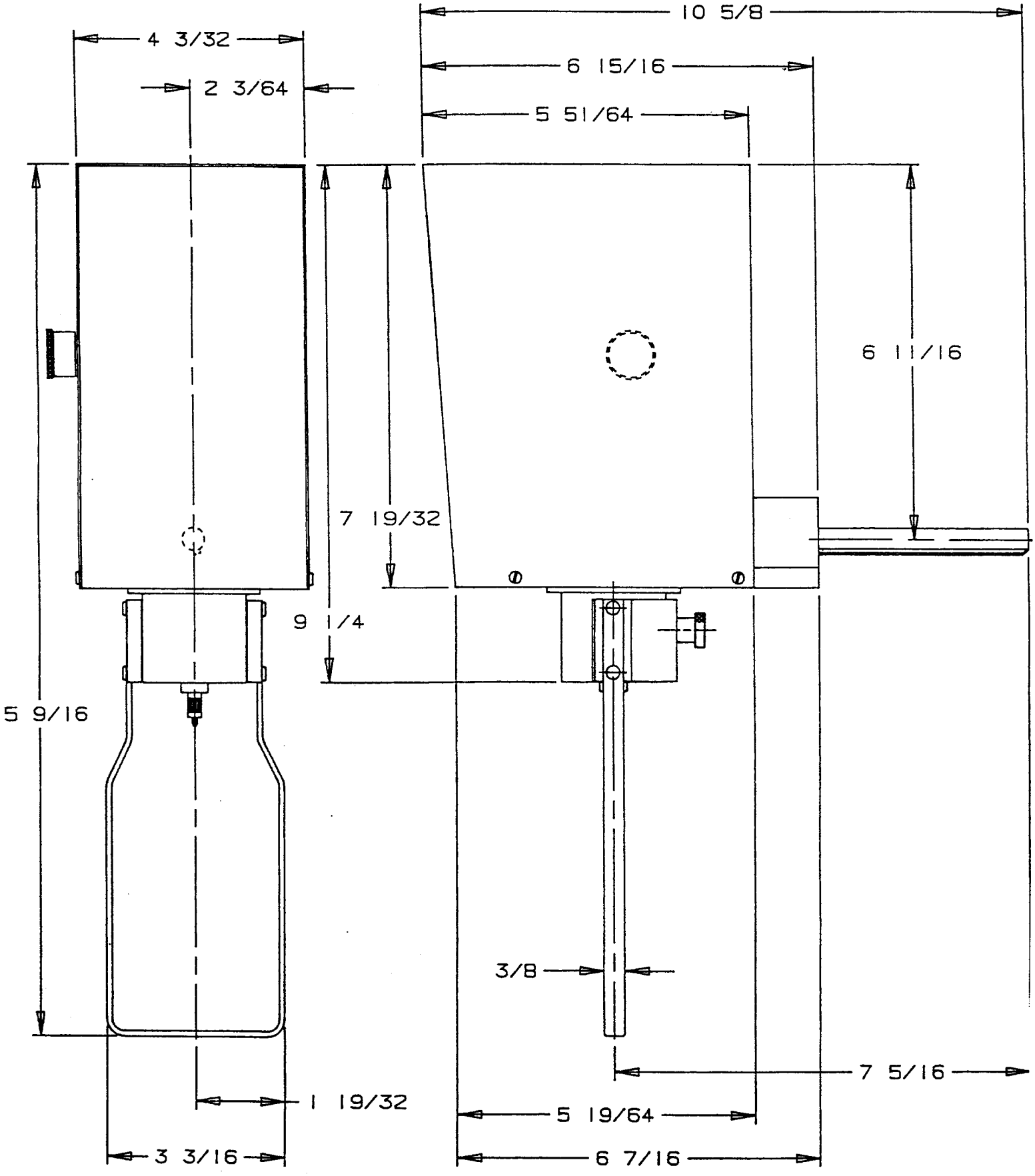
The Viscometer should be shipped in its carrying case together with all the spindles originally provided with the instrument.

For service on Viscometers located outside the United States, consult Brookfield Engineering Laboratories, Inc., or the dealer from whom you purchased the instrument.

Warranty

Brookfield Viscometers are guaranteed for one year from date of purchase against defects in materials and workmanship. The Viscometer must be returned to the manufacturer or dealer for no charge warranty service. Transportation is at purchaser's expense.

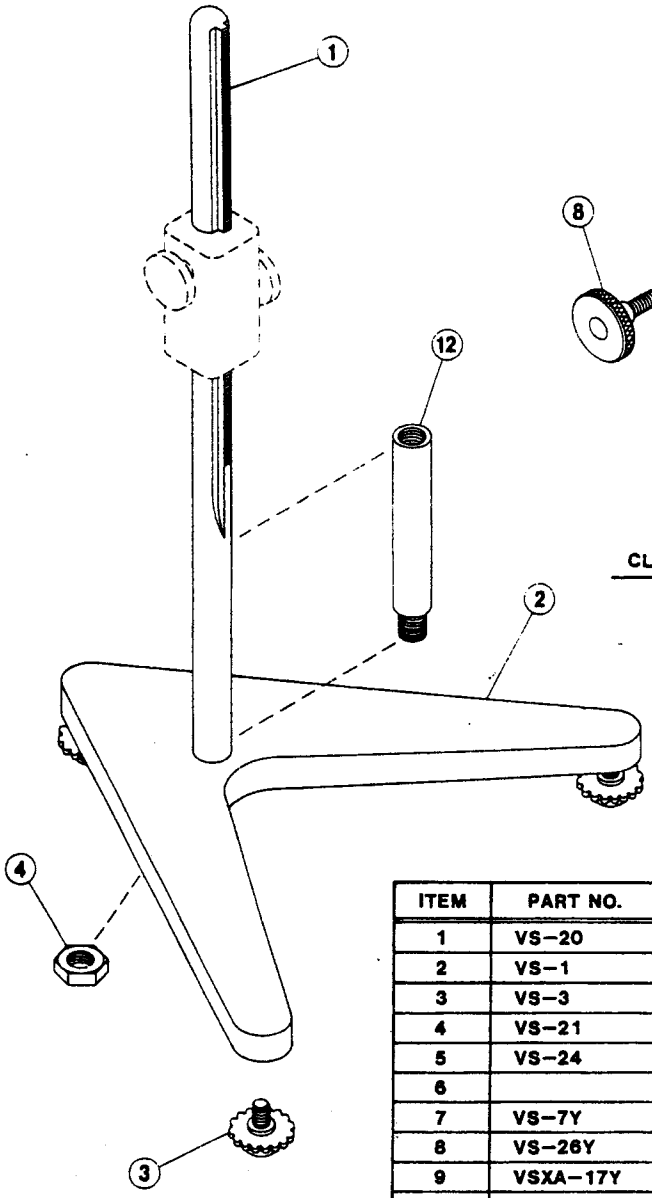
DVI & DVII HEAD DIMENSIONS
(WITH RV GUARD LEG & PIVOT CUP)

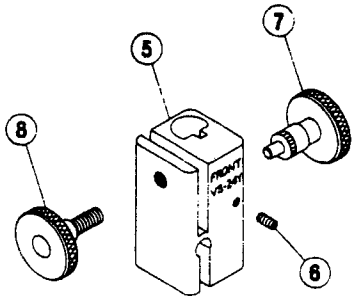


AC3-001

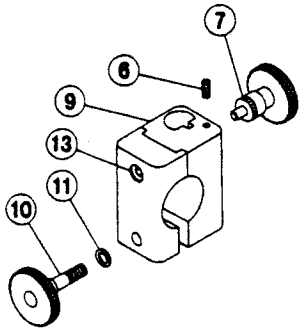
MODELS A & A-E LABORATORY STANDS

PARTS IDENTIFICATION





VS - 24Y
MODEL A
CLAMP ASSEMBLY



VS - 17AY
MODEL A-E
CLAMP ASSEMBLY

ITEM	PART NO.	DESCRIPTION	QTY.
1	VS–20	UPRIGHT ROD	1
2	VS–1	BASE	1
3	VS–3	LEVELING SCREW	3
4	VS–21	JAM NUT	1
5	VS–24	CLAMP	1
6		10–32 X 3/8 SET SCREW	1
7	VS–7Y	GEAR SCREW ASSEMBLY	1
8	VS–26Y	CLAMP SCREW ASSEMBLY	1
9	VSXA–17Y	CLAMP ASSEMBLY	1
10	VS–6AY	MODEL A-E CLAMP SCREW ASSEMBLY	1
11		1/4 I.D. X 3/8 O.D. WASHER	1
12	BLM–4E	ROD EXTENSION - 4" LONG	OPTIONAL
	BLM–4E–2	ROD EXTENSION - 8" LONG	OPTIONAL
13		1/4–20 X 3/4 HEX SOC HD SCREW	1

MODELS A & A-E LABORATORY STAND INSTRUCTIONS

Unpacking

Check carefully to see that all the components are received with no concealed damage.

1 base	1 jam nut
3 leveling screws	1 clamp assembly
1 upright rod	

Remove the three (3) leveling screws from the base and discard the packing material. Remove the jam nut from the upright rod.

Assembly

Screw the leveling screws into the base. Insert the threaded end of the upright rod into the hole in the top of the base and attach the jam nut to the rod on the underside of the base. With the rod gear rack facing forward (toward the "V" in the base), gently tighten the jam nut. When using the rod extension, screw the threaded end of the upright rod into the extension, then insert the threaded end of the rod extension into the base.

Viscometer Mounting

Dial Viscometers:

Loosen the Viscometer handle retaining nut (if supplied) and slide it down the power cord. Slide the Viscometer handle (if supplied) toward the cord and remove it from the instrument. Insert the Viscometer handle core into the hole (with the cut-away slot) in the clamp assembly. Adjust the instrument level until the bubble is centered from right to left and tighten the clamp knob (clockwise).

Digital Viscometers:

Insert the Viscometer mounting rod into the hole (with the cut-away slot) in the clamp assembly. Adjust the instrument level until the bubble is centered from right to left and tighten the clamp knob (clockwise). **Note:** If the Digital Viscometer cannot be leveled, check to insure that the rod is installed with the gear rack facing forward (toward the "V" in the base).

Explosion Proof Viscometers:

Remove the hex socket screw (item 13) from the clamp assembly and separate the clamp. Place the handle of the Viscometer against the clamp/rod assembly and reinstall the clamp and hex socket screw. Adjust the instrument level until the bubble is centered from right to left and tighten the clamp knob (clockwise).

Caution: Do not tighten the clamp knob unless the handle core is inserted in the clamp assembly.

Center the Viscometer relative to the stand base and retighten the jam nut as required. Referring to the Viscometer bubble level, adjust the leveling screws until the instrument is level.

The small screw on the clamp assembly may be loosened or tightened as necessary to provide smooth height adjustment and adequate support for the Viscometer.