

MALCOM
Table-Top Digital
Viscometer
Model PC-1TL Series

INSTRUCTION MANUAL

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FORWARD

Thank you for purchasing this Malcom PC-1TL series viscometer. Like all Malcom viscometers, the PC-1TL series employs the patented spiral pump sensor for accurate and repeatable measurements. Please read this instruction manual carefully in order to take full advantage of this unit.

NOTE: Please read and understand the following conditions

1. Specifications and features are subject to change without notice.
2. Please examine the shipping box and packing material. If the packing material and shipping box are in good condition, they can be used to transport the unit. If the packing material and shipping box show deterioration or damage, do not reuse the packing material and shipping box. The control unit and sensor will need to be wrapped individually with bubble wrap, secured together, and packed carefully with packing material. Since this unit is a precision instrument, it can be damaged if it is transported in an inadequate container. In such circumstances, repairs will be charged even if the nature of the damage is covered by the warranty.
3. Never disassemble the unit. If the unit is disassembled or if it appears to have been disassembled before, you will not be entitled to warranty repairs. All such repairs will be charged for.
4. Do not attempt to lubricate the unit in any way. Only special oils can be used in the construction of the viscometer. Use of other lubricants may damage the viscometer or hinder its operation. Repairs necessary to rectify these situations are not covered by the warranty.
5. Should you find that the operation of the PC-1TL has become substandard, or that there is a problem with its use, please contact Malcom Instruments immediately. Do not attempt to repair the unit yourself, for doing so would void its warranty.

SPECIFICATIONS:

	TYPE A	TYPE B	TYPE C
Viscosity Range	10 – 1000 x 10 ³ m Pa·s	20 – 1999 x 10m Pa·s	20 – 1999 x 1 m Pa·s
RPM (N)	3 – 100 FIX 10	10 – 100 FIX 40	10 – 100
Shear Rate D	0.6 x N sec. ⁻¹	1.2 x N sec. ⁻¹	4.8 x N sec. ⁻¹
Repeat Accuracy	± 2%		
Measuring Temp	0 – 50°C Resolution 0.1		
Digital Display	Viscosity Temp, RPM		
External Output	Viscosity, Temp		
Calibration	JIS Z28809 Standard fluid, Silicon KF96		
Power	AC 115V 60Hz		
Option	Calibration Fluid:	Silicon KF96, 100 or 300CC	
	Ultrasonic Cleaner:	Model AUC-201	
	Spare Cylinder:	Outer Cylinder Part# RO-1 (Type: A, B, or C) Inner Cylinder Part# RI-1 (Type: A, B, or C)	
	The PC-1TL unit includes:	One (1) each Cylinder of either Type A, B, or C (not one of each type). Additional cylinders are available for purchase.	

NOMENCLATURE

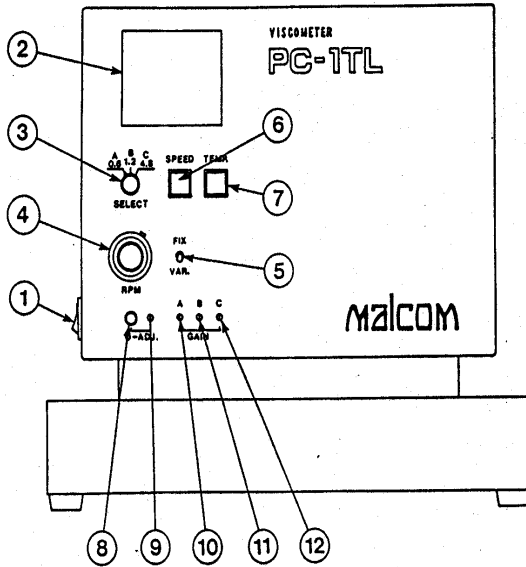


Figure 1.

1. POWER SWITCH
2. DISPLAY PANEL
3. CYLINDER TYPE SELECTOR
4. SPEED VERNIER DIAL
5. FIX-VAR SWITCH
6. SPEED BUTTON
7. TEMPERATURE BUTTON
8. 0 - ADJ BUTTON
9. 0 ADJUSTMENT
10. "A" GAIN ADJUSTMENT
11. "B" GAIN ADJUSTMENT
12. "C" GAIN ADJUSTMENT

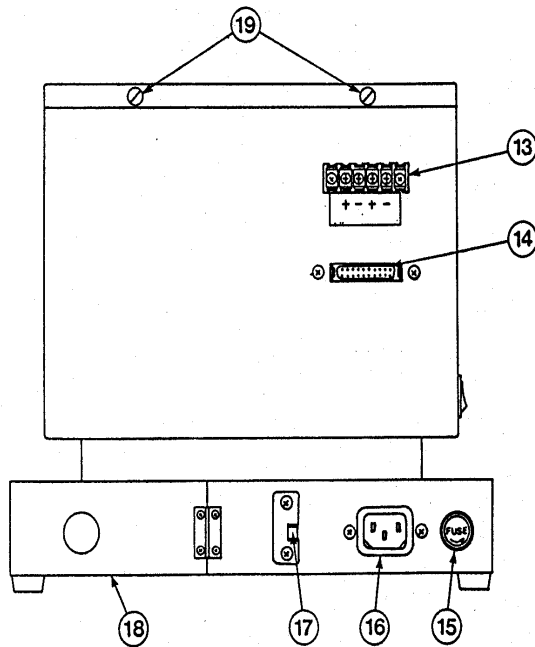


Figure 2.

13. TERMINAL BLOCK
14. VS-3 CONNECTOR
15. FUSE
16. CONNECTOR FOR POWER CORD
17. SUPPLY VOLTAGE SWITCH
18. CYLINDER STORAGE
19. COVER SCREWS

FUNCTIONS

Power Switch

Power is supplied by turning on this switch.

Display Panel

Viscosity, temperature and rotational speed appear with each unit.

Cylinder Type Selector

Depending on the cylinder which you use, turn to the correct type of measurement range of viscosity.

Ex. Cylinder Type "A", 10 – 1000 ($\times 10^3$ mPa·s)
Cylinder Type "B", 20 – 1999 ($\times 10$ mPa·s)
Cylinder Type "C", 20 – 1999 ($\times 1$ mPa·s)

Speed Vernier Dial

Turn to the required rotational speed. The range is from 3 to 100 rpm.

FIX-VAR Switch

Selects either FIXed or VARiable speed. The rpm is fixed in accordance to cylinder type when it is turned to FIX.

Ex. Type A: 10 rpm (Shear Rate = 6.0 1/S)
Type B: 40 rpm (Shear Rate = 48 1/S)
Type C: 40 rpm (Shear Rate = 192 1/S)

Speed Button

The rotational speed appears on the display panel when pushing this button. (There may be a difference between the numbers of the speed vernier dial and the display. In this situation it is recommended that the display panel value be considered the actual speed).

Temperature Button

The temperature of the liquid being measured appears on the display panel when pushing this button.

0 – ADJ Button

When calibrating the VS-3 to zero, push this button to verify on the display panel.

0 – ADJUSTMENT

This is used for 0 – ADJ calibration.

A. Gain Adjustment

This is used for calibrating the controller with Type “A” cylinders.

B. Gain Adjustment

This is used for calibrating the controller with Type “B” cylinders.

C. Gain Adjustment

This is used for calibrating the controller with Type “C” cylinders.

Terminal Block

External viscosity and temperature output.

Ex. (Viscosity)

Type A: (1mV / x10³ mPa·s)

Type B: (1mV / x 10 mPa·s)

Type C: (1mV / x 1 mPa·s)

(Temperature) (1mV / °C)

VS-3 Connector

This is to connect the cable from the VS-3 and controller.

Fuse

Use 1A type only.

Connector for power cord

Supply Voltage Switch

This is used to select the supply voltage for the controller

Supply voltage (AC V)	Range of voltage (AC V)	Fuse (A)
100	90 – 110	1
115	104 – 126	1

The switch is locked at 115 V AC at the factory.

Cylinder Storage

Cylinders can be placed in this compartment when they are not in use.

Cover Screws

The storage compartment for the VS-3 can be accessed by removing the screws.

Figure 3

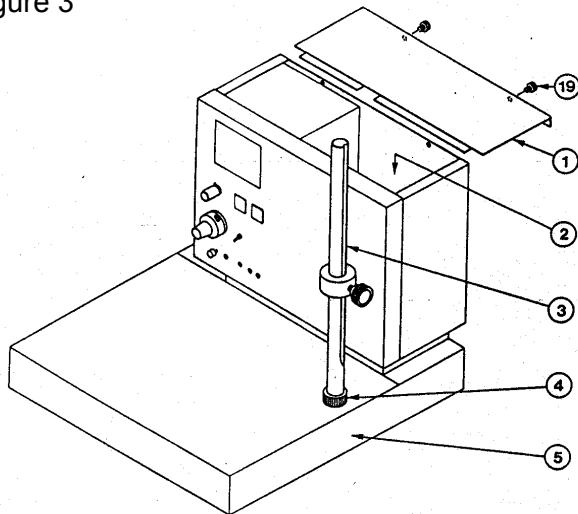


Figure 3

1. COVER
2. STORAGE FOR VS-3
3. SUPPORT SHAFT (WITH COLLAR)
4. SUPPORT SHAFT LOCK NUT
5. CONTROLLER SCREW

19. COVER SCREW

Figure 4

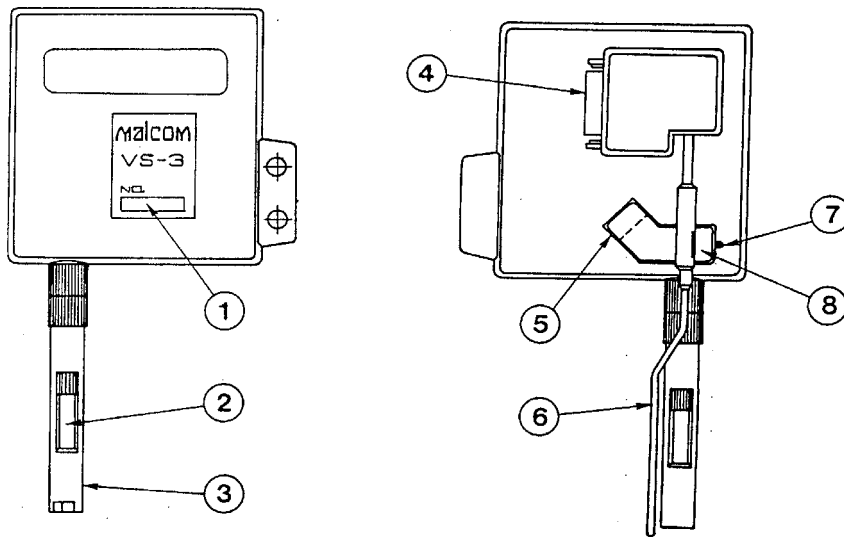


Fig 4.

1. SERIAL NUMBER
 2. INNER CYLINDER
 3. OUTER CYLINDER
 4. CONTROLLER CONNECTOR
 5. TEMPERATURE SENSOR REST
 6. TEMPERATURE SENSOR
 7. TEMPERATURE SENSOR LOCK SCREW
 8. TEMPERATURE SENSOR STOPPER
- (VS-3 MOUNT NOT SHOWN)

SETTING UP THE VS-3

Remove the cover screws and cover and take out the VS-3 from the storage compartment of the PC-1TL controller. Assemble the VS-3 and mount (see *Figure A*). Loosen the temperature sensor lock screw and position the temperature sensor into the sensor (see *Figure B*).

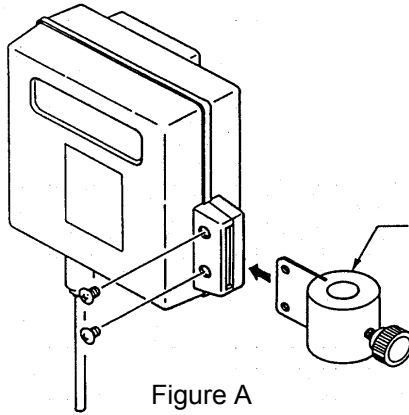


Figure A

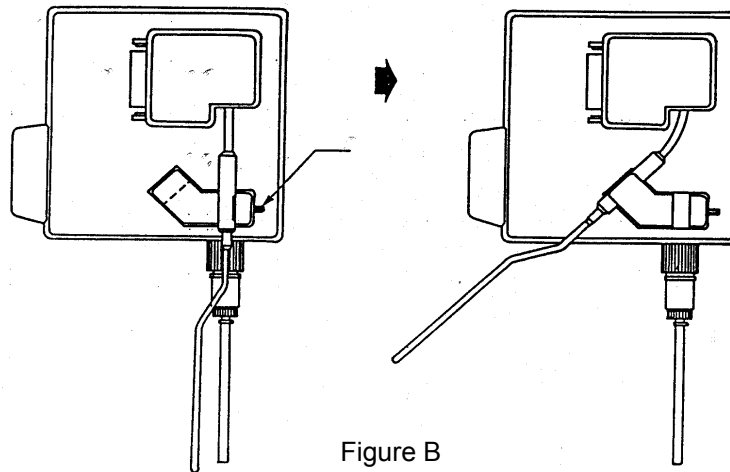


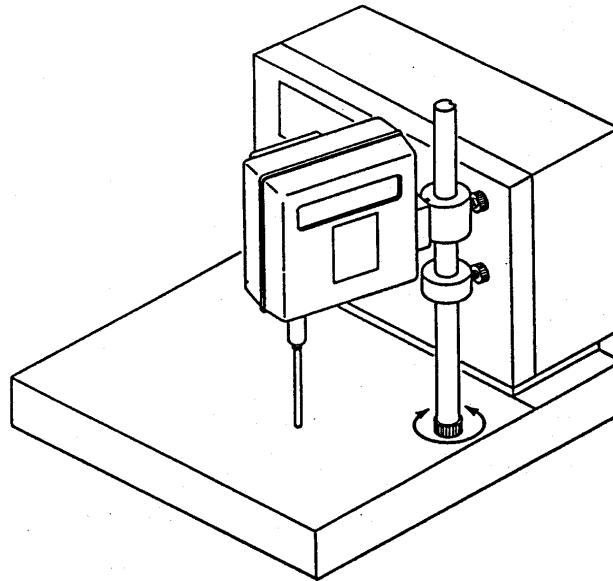
Figure B

Thread the support shaft into the controller base. Position the “V” notch of the support shaft opposite the front left corner of the controller base. Secure with the support shaft lock nut. Slide the VS-3 over the support shaft and affix its position on the collar by tightening the mount screw (*see Fig. C*).

Connect the VS-3 and controller with the connecting cable (50cm).

Should the VS-3 need to be repositioned, loosen the mount screw and support shaft lock nut and align as necessary.

Figure C.



INSTALLING THE CYLINDERS

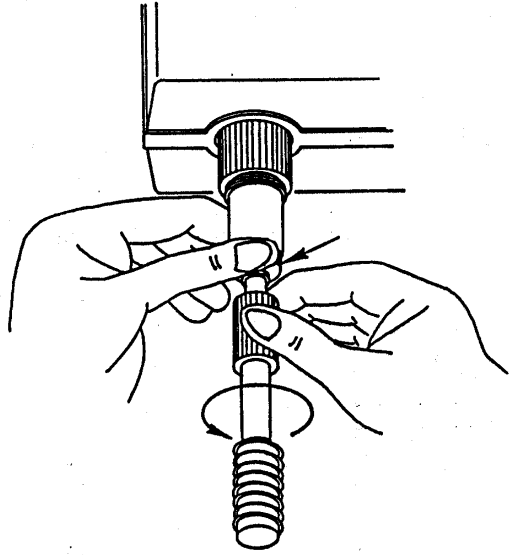
Type "A" Cylinder

Installing the inner cylinder:

Hold the cylinder but do not torque the small knurled collar on the shaft. Slide the inner cylinder up the shaft to the collar and turn counterclockwise. Do not apply any torque to do this.

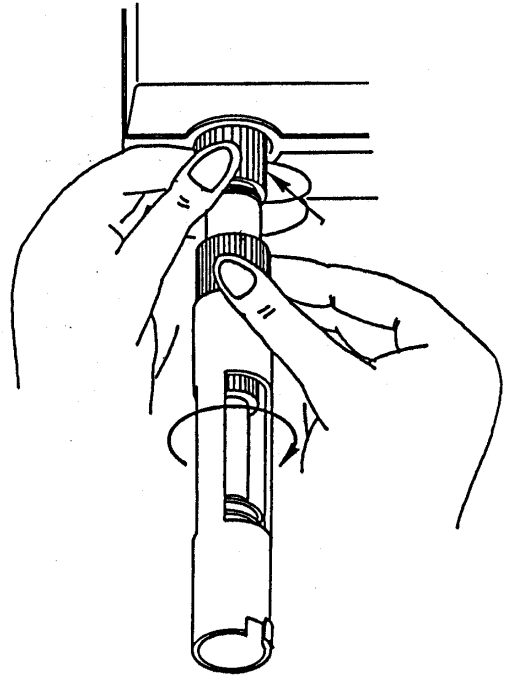
Installing the outer cylinder:

Hold the upper knurled end of the shaft. Slide the outer cylinder over the inner cylinder and turn clockwise. Make this less than finger tight.



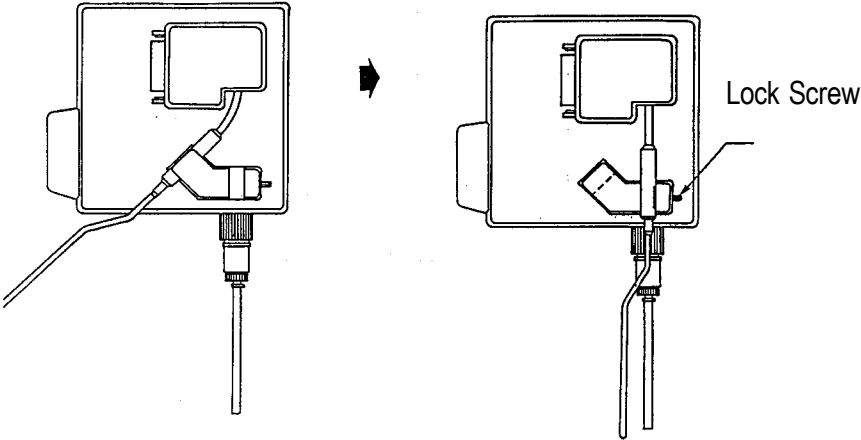
Type "B" Cylinder & Type "C" Cylinder

Installing the B and C type cylinders. Set the inner cylinder in to the cylinder first, then slide them together over the shaft. Tighten the inner and outer cylinders according to the above procedures.



POSITIONING THE TEMPERATURE SENSOR

Remove the temperature sensor from the sensor rest and set it 5mm away from and parallel to the cylinders. Tighten the temperature sensor lock screw.



CONNECTING TO THE POWER SUPPLY

Before connecting your PC-1TL to the power receptacle, check that the voltage is correct. The required voltage for your PC-1TL is shown on the label at the back of the controller base.

Connect the power cord to your PC-1TL. Plug the power cord into a properly grounded receptacle.

HOW TO USE THE PC-1TL

Switch on the power.

Turn the cylinder type selector to the type which you are going to use.

Ex. Cylinder Type "A", 10 – 1000 ($\times 10^3$ mPa·s)

Cylinder Type "B", 20 – 1999 ($\times 10$ mPa·s)

Cylinder Type "C", 20 – 1999 ($\times 1$ mPa·s)

Center a container of liquid to be measured under the VS-3.

Immerse the cylinders into the liquid as shown in "Fig. F". For the "A" Type, the cylinders should extend no further out of the liquid than the diagram indicates. The positioning of the "B" and "C" type cylinders is ideal. The lower lip of the exhaust port is at or just above the liquid surface.

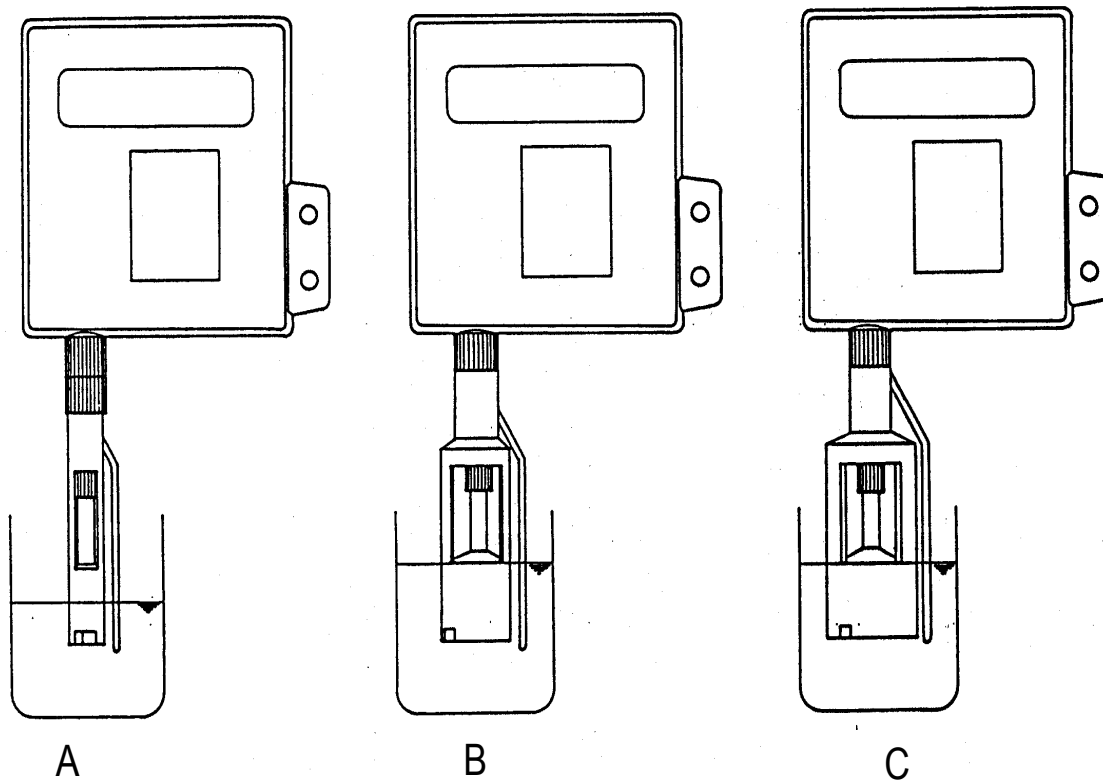


Figure F

Shear rate (D) is a function of the rotational speed. When you desire to change the shear rate, turn the FIX-VAR Switch to VAR.

Turn the Speed Vernier Dial to the required rpm.

While observing the display panel of the controller, push the Speed button and fine adjust the vernier dial to the actual rpm.

The relation between rpm and shear rate is dependent of the cylinder type.

Cylinder Type	When rpm is N	When rpm is FIX
A	$D = 0.6N$ (1/sec.)	$D = 0.6 \cdot 10 = 6$ (1/sec.)
B	$D = 1.2N$ (1/sec.)	$D = 1.2 \cdot 40 = 48$ (1/sec.)
C	$D = 4.8N$ (1/sec.)	$D = 4.8 \cdot 40 = 192$ (1/sec.)

For measuring accuracy, we recommend not to use the PC-1TL at less than 5 rpm for cylinder Type A, and less than 20 rpm for cylinder Type B or C.

This is due to the difficulty of pumping the liquid between the cylinders at low rpm.

HOW TO CLEAN CYLINDER

Clean the inner and outer cylinders immediately after every use. Failure to do so may cause the cylinders to adhere together and become inseparable.

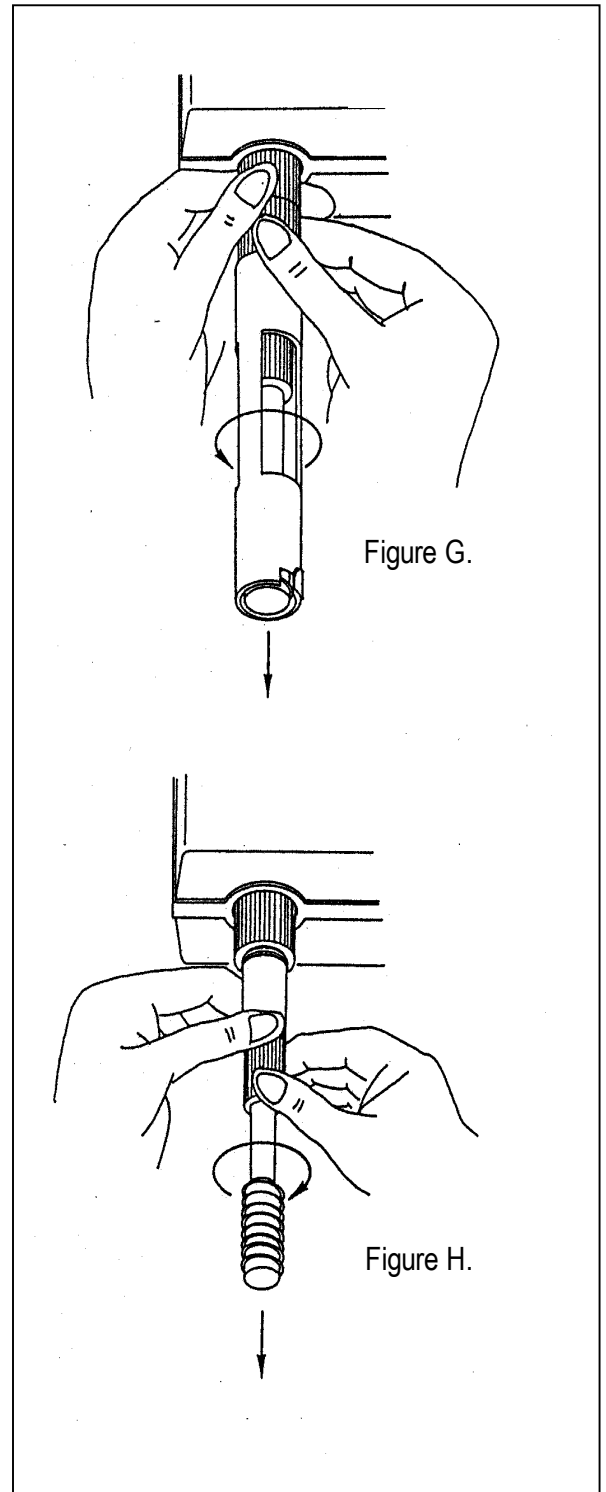
Using a small spatula helps to remove the liquid from the cylinders.

Type A Cylinder

Hold the upper knurled end of the shaft. Loosen the outer cylinder by twisting the knurled area counterclockwise (see *Figure G*). Slide the outer cylinder down off of the inner cylinder.

Hold but do not torque the small knurled collar. Grasp the knurling of the inner cylinder and rotate clockwise. Slide the inner cylinder down off the shaft. (see *Figure H*) It should require minimal or no torque at all to remove the inner cylinder.

Clean the shaft of the VS-3 with tissue or stencil wipes.



Type B Cylinder and Type C Cylinder

Hold the upper knurled end of the shaft. Loosen the outer cylinder by twisting the knurled area counter clockwise. (see Figure I) The outer cylinder can drop down and rest on the inner cylinder.

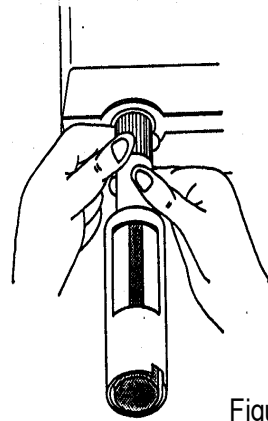


Figure I.

Hold but do not torque the small knurled collar. Grasp the knurling of the inner cylinder and rotate clockwise, slide both inner and outer cylinders down off the shaft together. (see Figure J) It should require minimal or no torque at all to remove the inner cylinder.

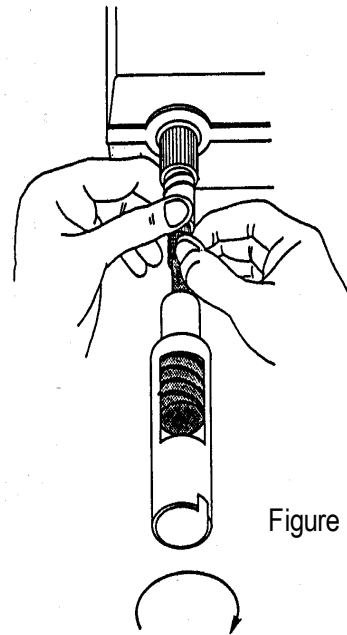


Figure J.

Clean the shaft of the VS-3 with tissue or stencil wipes.

Wash the cylinders in a solvent to completely remove the liquid residue. An ultrasonic cleaner is recommended for thorough cleaning.

TROUBLESHOOTING

Should you encounter difficulties with your PC-1TL during the course of its operation, please consult the following chart before calling your dealer for assistance.

If problems with your PC-1TL still occur even after checking the following chart, contact your Malcom dealer for service or repair.

SITUATION	CAUSE	SOLUTION
Power switch is turned on, but no display is shown.	Fuse has blown.	Replace fuse with 1A type.
VS-3 cylinder does not rotate. (Power is ON)	Fuse has blown VS-3 cable is disconnected. Cable is shorted and or open.	Replace fuse with 1A type. Make sure connection is good. Check cable pin continuity.
Unusual digital display. (Cylinder is turning): 1. "1999" Flashing. 2. Constant "0". 3. Unreasonable fluctuation. 4. Values without sample.	Cable is shorted and or open. Over torque and or over range. Viscosity too high. Contaminated bearing. Cable is shorted and or open. Viscosity is too low. Contaminated bearing. Object between inner and outer cylinder. Outer cylinder wobbling. Shaft Bent. Contaminated bearing. Loss of accuracy.	Check cable pin continuity. Out of range. Verify correct speed. Clean and lubricate. Check cable pin continuity. Change to "B" or "C" type. Clean and lubricate. Remove object. Contact MALCOM INSTRUMENTS for assistance. Contact MALCOM INSTRUMENTS for assistance. Contact MALCOM INSTRUMENTS for assistance. Recalibrate

TROUBLESHOOTING (cont.)

SITUATION	CAUSE	SOLUTION
Fluctuation in measurement: 1. Air entrapment. 2. Sample has not been expelled. 3. When changing RPM. 4. Temperature unstable.	Bubbles in paste. A cavity has formed in sample. Shear rate is transient. Sample is too small. Large difference of sample temperature and room temperature.	Remove bubbles and re-test. Oscillate sample container. Switch to fix. Provide larger sample. Minimize temperature difference.

CALIBRATION

Your PC-1TL was calibrated before it was shipped from the factory. However, when the VS-3 is replaced or when optional cylinders are to be used, the controller must be recalibrated. With gradual usage, the PC-1TL may lose accuracy, at that time recalibration is necessary.

1. 0 – ADJ (Zero Adjustment)
Switch on the power. Do not have any loading on the VS-3. (see Fig. K)
2. Turn the Cylinder Type Selector to the “A 0.6” position.
3. Flip the FIX-VAR switch to FIX.
4. Push the 0 – ADJ Button and see if the Display Panel shows “0”.
5. If it doesn't, turn the 0 – Adjustment to get “0”, while pushing the 0 – ADJ button.
6. Turn the Cylinder Type Selector to “B” and see if it shows “0” on the display panel while the 0 – ADJ button is pressed.
7. If it doesn't, turn the 0 – Adjustment to get “0” while pushing the 0 – ADJ button.
8. Repeat this procedure for C.

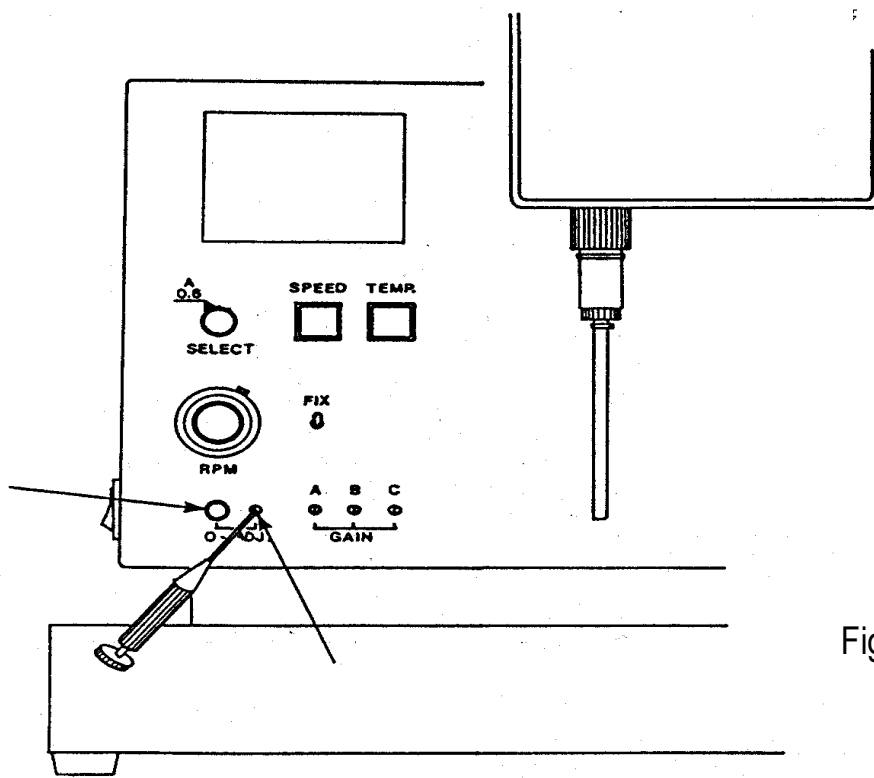


Figure K.

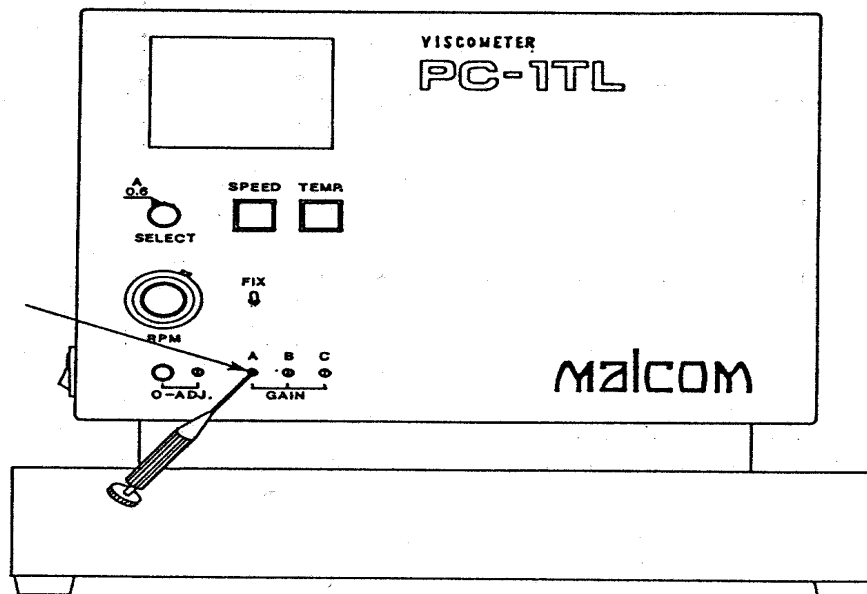
GAIN ADJUSTMENT (Type A Cylinder)

Prepare the following:

- (Part List #SS-100, specify "A" Type) Calibration liquid KF96H 100,000 (Option)
- Water bath with thermostat

1. Partially immerse the calibration liquid into the water bath set at a constant 25°C.
2. Install the A Type inner and outer cylinders to the VS-3.
3. Turn the Cylinder Type Selector to "A 0.6".
4. Flip the FIX-VAR Switch to FIX.
5. Immerse the cylinder into the calibration liquid. The lower lip of the exhaust port of the outer cylinder should be just slightly above the surface of the liquid (about 1/8").
6. Turn on the PC-1TL and let it run for five minutes. Push the temperature button to verify that the calibration fluid is at 25°C. Compare the values of viscosity on the display panel and that printed on the jar of calibration fluid. If there is a difference, turn the A Gain Adjustment so that the viscosity in the display panel is identical to that printed on the jar. (see Fig. L). Wait another five minutes and then repeat.

Figure L.



GAIN ADJ (Type B Cylinder)

Prepare the following:

- *(Part List #SS-100, specify "B" Type) Calibration liquid KF96H 10,000 (Option)*
- Water bath with thermostat

Procedure is the same as for Type A.

GAIN ADJ (Type C Cylinder)

Prepare the following:

- *(Part List #SS-100, specify "C" Type) Calibration liquid KF96H 1,000 (Option)*
- Water bath with thermostat

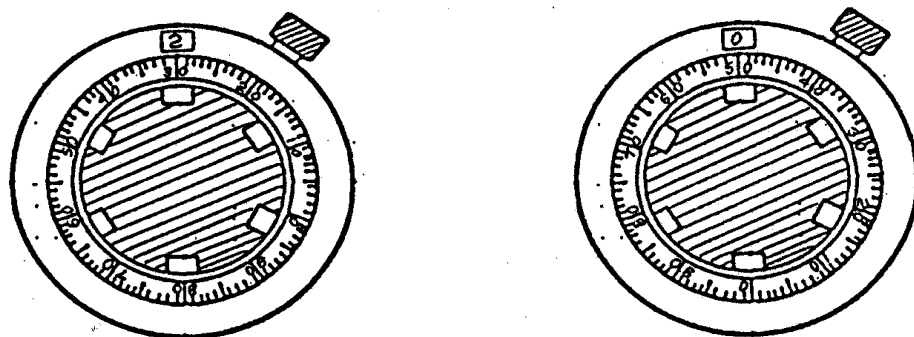
Procedure is the same as for Type A.

ADDENDUM TO MALCOM VISCOMETER INSTRUCTION MANUAL

The operation of the SPEED VERNIER DIAL and the proper choice of cleaning solvents.

The speed vernier dial enables the user to set the rotational speed of the outer cylinder. In the case of the PC-1TL models, the FIX/VAR switch must be in the VAR position.

The speed vernier dial is simple in construction; a black knob attached to a graduated dial, numbered by tens from 0 to 100 with tic marks every two units. Above the dial is a window where numbers indicate full revolutions of the knob. Now even though the dial indicates 10, 20, ... , 90, these numbers represent 1, 2, ... , 9 rpm. A value of one tenth. Inversely, the window indicates tens of RPM. So, "1" means 10 rpm



In the first example, the window shows 2 and the dial indicates 30. This should be interpreted as 20 RPM + 3 RPM = 23 RPM. The second example shows 0 in the window and 50 on the dial. This would be 0 RPM + 5 RPM = 5 RPM.

If you are already familiar with vernier dials, you have noticed that the actual RPM is one tenth of what would be read. Going back to the first example; 2 and 30 make 230, that divided by ten is 23 RPM.

The lever on the right side of the speed vernier dial is a friction lock and is not normally used. It should be kept in the up, loose position.

When cleaning the inner and outer cylinders, a solvent is recommended. However, this solvent should be mild, like isopropyl alcohol or paint thinner. Harsher solvents can dissolve epoxies used in the construction of viscometer components, rendering them inoperable. Use of these solvents, such as acetone, toluene or flux remover, will void the warranty.

APPENDIX

Calibration Fluid

Malcom Calibration Fluid is a silicone based oil which is viscosity stable, chemically inert and relatively non-toxic. The fluid has an indefinite shelf life and service life is diminished only by chemical, particulate and moisture contamination. With this in mind, the fluid should be stored in a clean, cool, dry environment, with it's lid securely tightened. Rapid cleaning of parts which have come in contact with the fluid can be done by using mineral spirits. An alternate method is repeated cleanings with isopropyl alcohol and/or detergents.

On the label of the calibration fluid are several values of importance. The viscosity is expressed in poise, (P), or Pascal seconds (Pa·s), at 25.0°C when undergoing a shear rate of “D” reciprocal seconds, (sec⁻¹). By Malcom's patented design, “D” is constant, but it is dependent upon the type of inner spiral and outer cylinder attached to the viscosity sensor and the speed which the sensor rotates.

Temperature Compensation

When calibrating your viscometer, it is recommended that the silicone oil be at a constant temperature of 25.0°C. Since the PC-1TL viscometer does not have a “thermostat”, obtaining this temperature can be difficult. For this reason, a temperature compensation table was constructed.

As an example, consider that the calibration fluid has a standard viscosity of 931 poise at 25.0°C under a shear rate of 6 reciprocal seconds. This is “A” Type. After waiting an hour for stabilization, the best temperature control you can obtain is 24.6°C, as seen on the viscometer digital display. Go to the left-most column of the table and proceed down to the 24. Now move to the right so that you are in the .6 column. You should see 1.008. This is the multiplier. At 25.0°C and standard conditions, the viscosity of the calibration fluid is 931 poise. However at 24.6°C, the viscosity is $931 \times 1.008 = 938.448$ poise. This should be rounded to the nearest poise. So, at 24.6°C, you should calibrate the viscometer to 938 poise.

°C	.0	.1	.2	.3	.4	.5	.6	.7	.8	.9
23	1.040	1.038	1.036	1.034	1.032	1.030	1.028	1.026	1.024	1.022
24	1.020	1.018	1.016	1.014	1.012	1.010	1.008	1.006	1.004	1.002
25	1.000	0.998	0.996	0.994	0.992	0.990	0.988	0.986	0.984	0.982
26	0.980	0.978	0.976	0.974	0.972	0.970	0.969	0.967	0.965	0.963
27	0.961	0.959	0.957	0.955	0.953	0.951	0.950	0.948	0.946	0.944

