CANNON INSTRUMENT COMPANY

CT-500/600 Series

Constant Temperature Bath

Operation Manual

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Introduction/Installation

This manual is intended to provide information on the installation, characteristics and operation of the CANNON CT-500/600 series II Constant Temperature Baths. CT-500 references in the manual will apply to all models unless otherwise indicated.

The CANNON CT-500 series II Constant Temperature Baths are designed to be used for precise viscosity measurements. Because of its temperature stability and ease of use, the baths are also suitable for many other applications where temperatures must be maintained within ± 0.01 °C

Figure 1: CANNON CT-500

Effective Temperature Range

The CANNON CT-500 will maintain temperatures of 20 °C to 100 °C ± 0.01 °C. The CT-500 includes a built-in cooling coil which, when connected to tap water or a cooling system, permits operation below or slightly above ambient temperature. The cooling coil should be used when controlling temperature within 10 °C of ambient.

The precision of kinematic viscosity measurements possible with the CT- 500 system meets the sensitivity requirements of ASTM D445.

Temperature Selection

Ten of the most commonly-used temperatures for kinematic viscosity measurement can be set using the left-hand dial on the bath front panel. The bath will equilibrate within a fraction of one degree of the desired temperature. A fine-tuning control permits further temperature adjustments.

By switching to the variable setting on the front panel, the operator can set any temperature within the operating range of the instrument.

Bath Description

The bath chamber is a cylindrical clear Pyrex® vessel 300 mm (12 inches) in diameter and 300 mm (12 inches) high. A stainless steel baffle coated with white PTFE is located in the center of the bath and provides a convenient backdrop for viewing viscometers placed in the bath. The top cover contains seven round holes 51 mm (two inches) in diameter for insertion of viscometer holders. An additional 10 mm (3/8 inch) hole is provided for a thermometer.

A solid-state control circuit provides proportional control of the temperature. The sensing element for the control circuit is a stainless steel- encased thermistor. The entire electrical control system is located in a drawer beneath the bath.

Notes/Cautions/Warnings

Please keep this manual near your system to easily access necessary information while operating or preparing for operation

Notes, caution, and warnings are used in the manual to call an operator's attention to important details prior to performing a procedure or step. Read and follow these important instructions. Failure to observe these instructions may void warranties, compromise operator safety, and/or result in damage to the instrument.

Notes *provide more information about the content that follows.*

Cautions *alert the operator to conditions that may damage equipment.*

Warnings *alert the operator to conditions that may cause injury.*

If you should find any part in this manual not clear to understand or missing article, contact your local dealer or sales representative.

Manufacturer is not liable for any loss or damage directly or indirectly caused by use of the instrument or its consequences.

This manual pertains directly to the CT-500 series II Constant Temperature Bath. For details relating to other accessories or equipment please refer to the appropriate manufacturers supplied documentation.

Safety Precautions

Always observe these signs and instructions. You must observe cautionary messages and warnings in order to protect yourself as well as prevent others from physical injury or property damages. The CT-500 comes equipped with a number of safety features as listed below.

Temperature Fault Sensor

A second thermistor in the temperature bath senses any over-temperature fault condition. If such a condition occurs, all power is removed from the bath until an operator corrects the problem and resets the over-temperature limit circuit

Thermistor Detection/Cutoff

If the control thermistor is disconnected, all power to the bath heaters is cut off.

Bath Fluid Level Cutoff

The CT-500 will not operate if the liquid level in the bath is too low. If such a condition occurs, all power is removed from the bath until the liquid level in the bath is restored to the minimum safe level.

Caution: *Safety devices may be impaired if equipment is not operated per manual instructions.*

- Only qualified personnel should operate the CT-1000.
- Read and understand all operating instructions and safety precautions listed in this manual before installing or operating the instrument. Any questions regarding instrument operation or documentation should be referred to Cannon Instrument Company.
- Do not deviate from the installation, operation, or maintenance procedures described in this manual. Improper use of the CT-500 may result in a hazardous situation and may void the manufacturer's warranty.
- Handle and transport the unit with care. Sudden jolts or impacts may cause damage to components.
- Never operate the instrument without proper levels of approved bath fluid in bath.
- Observe all warning labels. Never remove warning labels.
- Never operate damaged or leaking equipment.
- Unless procedures specify otherwise, always turn off the unit and disconnect the MAINS cable from the power source before performing service or maintenance procedures, or before moving the unit.
- Only add bath fluid to the bath when the bath temperature is within 10 °C of ambient.
- Avoid splashing liquids on the external surfaces of the CT-500, including the Pyrex® bath jar.
- Do not obstruct the cooling vent on the top of the CT-500.
- Always empty the bath before moving the unit.
- Refer all service and repairs to qualified personnel.

Warning: *Hot surfaces cautions (diagram left) are attached on or near hot surfaces of the CT-500. Avoid touching these surfaces when running the bath at temperatures above 50 °C.*

Caution: *Do not attempt to service the CT-500 system by removing panels and trying to effect repairs. Contact CANNON regarding service and repair needs.*

~MAINS	*The* **~MAINS** *symbol indicates the connections for the AC power supply. The AC*

	power input must match the electrical specifications of the instrument. *Never operate the equipment with a damaged MAINS AC power cable.* *Use only the manufacturer-supplied MAINS AC power cable. This cable must be inserted into a receptacle with a protective earth ground.*
(O)	*The* **(O)** *symbol indicates the OFF position for the electrical switches for your unit.*

Operator Safety

All technicians who use the CT-500 should follow these basic safety procedures:

- The CT-500 power cord should only be connected to a suitable AC MAINS power source (with protective earth ground) matching the specifications of the S/N label on the CT-500 rear panel.
- Place the CT-500 on a stable laboratory table or bench. If any liquids are spilled in or around any electronic components of the CT-500, remove power and contact Cannon Instrument Company before introducing power to the system again.
- Position power cords so that they are not likely to be walked on or pinched by items placed on or against them. Keep all connections as neat as possible.
- Disconnect the power cord by pulling it out by the plug. Never pull the cord itself.
- Monitor bath fluid level carefully and use caution when operating at temperature set points above ambient temperature. Liquid may expand and overflow the jar.
- Observe appropriate safety precautions when handling bath fluid (refer to the Safety Data Sheet for your bath fluid for more details.)

Warning: *Never use flammable bath liquids in any CT-500 bath.*

Specifications

The CT-500 Constant Temperature Bath consists of the bath unit and viscometer port covers. Viscometer tubes, holders, bath oil and thermometer are sold separately.

Table 1: Specifications

Specifications	Details
Model	CT-500 Constant Temperature Bath
Methodology	ASTM D445, ASTM D446, ISO 3104/3105
Applications	Formulated oil analysis, hydraulic oil analysis, additive analysis, marine fuel testing, base stock analysis, light and heavy fuel testing, waxes/paraffin, crude oil testing, glycols
Dimensions (W × D × H)	40.7 cm × 36.2 cm × 61.0 cm (16 in × 14.25 in × 22 in)
Weight	22 kg (48 lb)
Sample Capacity	7
Temperature Range & Accuracy	20 °C to 100 °C ± 0.01 °C* **Test temperatures <40 °C and high ambient temperature test environments require and optional bath cooler*
Bath Height	12 inches
Bath Volume	17 L (4.5 gal)
Operating Conditions	15 °C to 30 °C, 10% to 75% relative humidity (non-condensing), Installation Category II, Pollution Degree 2
Electrical Specifications	120 VAC, 50/60 Hz; 240 VAC, 50/60 Hz 1400 watt power consumption
Compliance	CE Mark: EMC Directive (2004/108/EC); Low Voltage Directive (2006/95/EC); HI-POT (1900 VDC, 60 sec.); ROHS

Unpack & Assemble

This section of the manual provides assistance in unpacking and assembling the CT-500 Constant Temperature Bath. Refer to Table 2 and Table 3for contents.

Caution: Some CT-500 components are heavy, including the glass jar and primary instrument housing. CANNON recommends that two people carry the shipping cartons and the heavier unpacked components.
When lifting the CT-500 bath, do not grasp the handles of the electrical drawer. Drawer handles are not designed to bear the weight of the instrument.

1. Remove all components from the shipping container(s).
2. Remove any and all packing materials (Styrofoam, etc.) from the components.
3. Verify reception of shipped materials by comparing equipment items with packing/parts list(s). Report missing items to Cannon Instrument Company immediately.
4. Inspect each component for signs of damage. Report damages to the shipper and Cannon Instrument Company immediately.

Table 2: Contents

Part number	Description
25.1005	Housing with Locked Drawer
25.2405 (115V) 25.3007 (230 V)	Rear Bath Cover with Cables
27.2300 (115V) 23.2302.011 (230 V)	Main Power Cord
25.4005 (115V) 25.5006 (230V)	Motor Stirrer
20.16	Felt Pad
25.1020	Insulation Support
25.4902	Accessories Kit
20.1	12 x 12 Pyrex Jar

Table 3: Accessories Kit (p/n 25.4902)

Part number	Description
22.39	Hole Cover and Therm Holder Set
25.3111	Front Bath Cover
01.1210 (2)	Philips Screws
27.3700	Trimpot Adjustment crewdriver
25.9991	CT-500 Series Operation Manual

Damaged Items

Retain all packing materials until the instrument is connected and functioning properly. If any component(s) must be returned to Cannon Instrument Company, the damaged item(s) should be packaged in the original shipping container. Refer to the final chapter of this manual for instructions on returning defective equipment. Customers outside the United States should contact the local CANNON agent for procedures on returning products to CANNON.

Figure 2: CT-500 Primary Components

Assembly

Assembly is performed in the place the instrument will ultimately operate, not assembled and then moved. The CT-500 series II bath requires 25 cm (10 inches) of clearance to the rear and sides of instrument for proper operation.

1. Place the bath control housing on the surface where you plan to operate the instrument. This should be a sturdy, level tabletop or bench with a non-flammable surface.

Caution: *Use caution when lifting the bath control housing as it is quite heavy.*

2. Place the felt pad(s) on top of the insulating disk. The CT-600 requires two felt pads, the CT-500 requires one felt pad.
3. Place the glass jar on top of the felt pad(s).

Caution: *Use caution when lifting the bath jar as it is quite heavy.*

4. Position the rear cover containing the motor housing, heaters, cooling coil, and baffle on top of the jar, feeding all connecting cables from the heaters, float switch and control/overtemp probes

through the vertical wiring channel in the rear of the housing. The back of the motor housing should fit over the vertical channel, and the groove on the underside of the half-round cover should fit over the edge of the jar. Refer to Figure 3.

Figure 3: Position the Rear Cover

5. Place the front bath cover (with holes for the viscometers) on top of the front half of the jar. Refer to Figure 4.

Figure 4: CT-500 Top Cover with Viscometer Holes

CT-500 Motor Stirrer Installation

Follow the procedure in this section to install the CT-500 Motor Stirrer. If you have the CT-600 Series instrument, skip to the CT-600 Series installation section and complete the installation directions in that section manual.

1. Remove the screws that fasten the top cover to the motor housing and remove the top cover.
2. Remove the motor-stirrer from its box.

Caution: *Use care when handling the motor stirrer and impeller to prevent damaging sensitive components. Do not hold the motor assembly by the shaft as this could bend the rotor shaft out of alignment.*

Note: *Two standoffs, one on each side of the opening for the motor-stirrer, serve as locating pins for the motor support pad. The holes in the pad fit loosely over these standoffs to prevent the motor from vibrating out of position.*

3. Carefully slide the motor-stirrer into place on the motor support pad, impeller shaft down, and align the motor line cord so it points toward the rear of the bath. The motor-stirrer should now lie flat on the top of the bath.
4. Lower the motor-stirrer power cord down through the vertical channel in the rear of the unit.
5. Attach the top cover, making sure all cords pass through the rear opening and down the vertical shaft. Secure the front cover first. Use the two longer screws with toothed washers from the Accessories Kit to secure the housing to the sides of the vertical shaft.

CT-600 TE Cooler and Motor-Stirrer Installation

This section of the installation procedure is for the CT-600 bath only.

The CT-600 is shipped with the top housing sections installed, but with the motor-stirrer and TE cooling unit packaged separately. To complete CT- 600 installation, remove the housing sections, install the motor-stirrer and TE cooling unit, and reassemble the housing. Follow the procedure below to install these components.

1. Remove the two screws securing the rear housing to the bath chassis as shown in Figure 5. Set the screws aside.

Figure 5: Remove Top Rear Housing

2. Loosen but DO NOT REMOVE the two top screws securing the front housing as shown in Figure 6. This will provide play for removal of the rear housing.

Figure 6: Remove Top Rear Housing

3. Remove the rear housing by sliding it backward away from the bath.
4. Remove the screws securing the front housing to the bath chassis.
5. Remove the front housing.
6. Uncoil the cables from the heaters, float switch and control/overtemp probes, and then lower the ends of the cables through the vertical channel at the rear of the bath.
7. Install the thermoelectric cooler by sliding it through the circular 2" aperture that will be enclosed by the housing. Refer to Figure 7.

Figure 7: Install TE Cooler

8. Tighten the two tab screws (one on each side of the finned tube). During tightening, the tabs will orient and seat against the bottom of the bath cover to secure the thermoelectric cooler to the bath cover. Refer to Figure 8.

Figure 8: Tighten the Two Tabs

Caution: *Make certain that, during installation, the tabs are oriented so they clear the edges of the aperture.*

9. Attach the two matching white power supply connectors together. Refer to Figure 9.

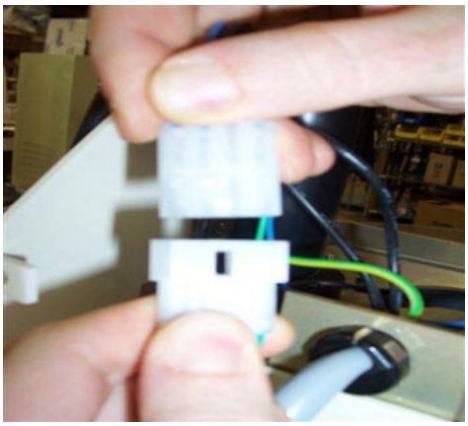

Figure 9: Secure White Power Supply Connectors

10. Attach the two matching black power supply connectors together. Refer to Figure 10.

Figure 10: Connect Black Power Supply

11. Carefully slide the motor-stirrer into place on the motor support pad, impeller shaft down with "cut out" portion corresponding to the location of the TE cooler as shown in Figure 11.

Figure 11: Lower Motor-Stirrer

12. Align the motor line cord so it points toward the rear of the bath. The motor-stirrer should now lie flat on the top of the bath.
13. Lower the motor-stirrer power cord down through the vertical channel in the rear of the unit.
14. Loosely install the front housing using the screws previously removed, but do not yet tighten the screws.
15. Install the rear housing by sliding the front flanges forward under the front housing until the two pieces mate. If there is insufficient play, loosen the front housing screws until the flanges can slide into place.
16. Secure the rear housing using the two screws previously removed as shown in Figure 12.

Figure 12: Install Rear Housing

17. Obtain two additional screws and toothed washers from the Accessories Kit. Install the screws to the tabs at the rear of the front housing to secure the housing to the vertical channel.
18. Tighten all housing screws to complete the housing installation.

Final Assembly

Connect all remaining plugs and probes to the correspondingly labeled and/or color-coded sockets at the rear of the CT-500 bath unit. Refer to Figure 13 and Figure 14.

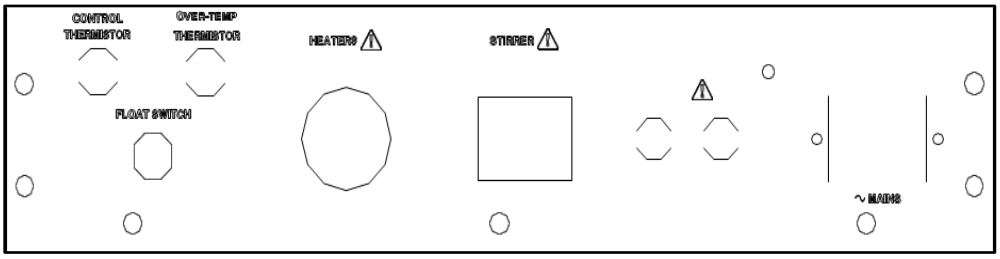

Figure 13: CT-500 Rear Panel Connections

Rear Panel Connections

- **Control Thermistor** — Connects main temperature control thermistor to the Control Unit
- **Float Switch** — Connects the fluid-level sensor to the Control Unit
- **Over-temp. Thermistor** — Connects over-temperature thermistor to the Control Unit
- **Heaters** — Supplies AC Mains power to the bath heaters
- **Stirrer** — Supplies AC Mains power to the motor-stirrer
- **Fuses** — Protects against damage or hazard in the event of an internal fault
- **MAINS** — Provides AC MAIN power entry connection

Caution: *The CT-500 power cord must be connected to an AC MAINS source matching the specifications o the S/N label on the instrument rear panel*.

Figure 14: CT-500 Rear Connections

Inserting Viscometer Tubes/Thermometers

The top cover of the CT-500 contains seven apertures, 51 mm (2") in diameter, for the insertion of viscometer tube holders. Two additional holes are provided for insertion of thermometers. Refer to Figure 15.

Figure 15: CT-500 Top Cover

Inserting Viscometer Tubes

If necessary, remove the viscometer tube hole cover(s) from the top of the bath and carefully place the viscometer tube(s), with the proper holder attached, into the bath through the aperture(s) in the top cover.

Note: *After filling the bath with fluid, adjust the height of the viscometer tube(s) to ensure that the liquid under test and/or any timing marks on the tube are a minimum of 6 mm (1/4") below the top level of the liquid.*

Thermometer Immersion

Proper thermometer immersion is critical for viscosity measurements. Even a calibrated thermometer will read incorrectly if it is not properly immersed in the bath. "Total immersion" kinematic viscosity thermometers should be used with the bulb and only the mercury column (if applicable) beneath the surface of the liquid, but with the emergent stem above the surface at ambient temperatures.

Note: *Different thermometers have different immersion requirements. Refer to the information included with your thermometer for specific instructions*.

Filling the Bath

Make sure that the bath is placed in its intended final position before adding bath fluid. The CT-500 should not be moved with bath fluid in the bath jar.

Warning: *Never use flammable bath liquids.*

1. Make sure that the instrument power is OFF and select a bath liquid appropriate to your operating temperature range (see *Appendix II – Choosing a Temperature Bath Fluid*).
2. Fill the jar with bath liquid at ambient temperature to a level sufficient to engage the float switch. This float permits bath operation when the minimum amount of fluid has been added to the bath jar.
3. Continue to add fluid until the bath liquid level has risen to approximately 40 mm (1.5") of the top of the jar.
4. Turn the instrument power ON and incrementally heat the bath to desired control temperature while monitoring the bath liquid level carefully. The bath level must be 15 mm - 20 mm (approximately ½" to ¾") from the top of the jar at the control temperature. If it becomes apparent that this liquid level will not be achieved, return the bath to within 10 °C of ambient, turn the instrument power OFF and add or remove liquid as necessary.
5. Repeat step four until you have attained the proper bath liquid level at the desired control temperature.

Caution: *Different bath liquids expand at different rates. Do not overfill the bath.*

Warning: *Monitor the level of bath liquid closely when operating the CT-500 at higher temperatures (80 °C to 100 °C). The bath liquid expands as the temperature increases. The CT-500 bath jar is not designed to contain liquid under pressure. If the bath is overfilled it may overflow.*

Draining the Bath

If it becomes necessary to drain the liquid from the bath, acquire a suitable container to hold all of the liquid drained from the bath (approximately 22 liters/4.5 - 5 gallons for the CT-500; approximately 30 liters/7 gallons for the CT-518, approximately 38 liters/9 gallons for the CT-524).

Make sure that the bath liquid is within 10 °C of ambient temperature. Then insert a tube into the bath chamber from the top opening and siphon the liquid from the bath into a container positioned lower than the bath.

Caution: *Always use a rubber bulb or similar device to apply suction to a tube containing bath fluids.*

CT-500 Operation

Front Panel

The controls for the CT-500 are divided into 5 different “control areas” on the front panel. Each corresponds with a major function of the bath as shown in Figure 16.

Power	Temperature	Temperature Adjust	Preheat	Limit Control
Provides power to the bath	Permits quick setting of standard preset bath temperatures	Permits the user to toggle between fixed and variable temperature control functions	Activates an additional heater	Adjusts the temperature parameters for safe bath operation

Figure 16: CT-500 Front Panel

In this manual, the control areas will be abbreviated as follows:

- Power = **P**
- Temperature = **T**
- Temperature Adjust = **TA**
- Preheat = **PH**
- Limit Control = **LC**

The commands in those areas will be printed in bold uppercase type, with the abbreviation preceding. For example, **TA - FIXED** refers to the left-hand dial (marked **FIXED**) in the **TEMPERATURE ADJUST** (**TA**) section of the control panel.

Turning on the CT-500

Temperature Adjust (TA) dials on the CT-500 are equipped with locks to prevent accidental changing of dial settings. Push the lock up to release the dial. When the dial has been set to the proper position, push the lock down to re-lock the dial.

1. Verify that the CT-500 has been assembled and installed correctly per instructions in previous sections.
2. Turn the bath Power switch ON. Remember that the bath heaters will not be activated if there is insufficient liquid in the bath.

Initially the Limit Control (**LC - TEMPERATURE ADJUST**) dial must be turned completely clockwise to enable the bath to heat properly. After the bath reaches operating temperature, this dial should be reset to prevent the bath from overheating.

3. Move the **TA - SELECT** switch to the left (fixed) position.
4. Release the dial lock on the **TA - FIXED** dial and reset it to **5**.
5. Re-lock the dial.

Setting the Temperature

There are two ways to set the CT-500 bath temperature. The procedure depends upon whether or not the desired temperature is on the **T - SELECT** dial.

Warning: *Do not touch hot surfaces on the CT-500 bath when operating the equipment as injuries and burns may result.*

Pre-Set Temperature Selection

1. Turn the **T - SELECT** dial to the appropriate temperature. If the temperature is above the current bath temperature, the CT-500 will begin heating and the **HEAT** LED (Light-Emitting Diode) will light.
2. Make sure the **TA - SELECT** switch is set to the left (**FIXED**) position.

To heat the bath more rapidly, turn on the **PREHEAT** (**PH**) switch. If the target temperature is below 80 °C, turn the **PH** switch off when the desired temperature is reached. For temperatures above 80 °C, keep the **PH** switch ON to maintain temperature control. When the **PH** switch has been turned on, the **PH - HEAT** LED will light.

3. As the bath temperature approaches the selected **T - SELECT** setting, the LED above the **TA** controls will start to blink as the heater duty cycle is automatically adjusted to stabilize temperature.

If the auxiliary heater was engaged, the **PREHEAT** light will also blink. Make sure to turn off the **PREHEAT** switch if operating at temperatures below 80 °C.

4. Insert the appropriate thermometer for the test temperature (see *Appendix IV - Thermometry for the CT-500* for thermometry information).

5. To adjust the bath temperature to the exact temperature desired, first unlock the **TA - FIXED** dial.
6. Read the thermometer to determine the actual temperature of the bath. Make sure that both the bath temperature and thermometer have stabilized before taking a reading.
7. Turn the **TA - FIXED** dial to adjust the temperature. After each adjustment, allow several minutes for the bath temperature to stabilize.
8. Turn the dial clockwise to increase the bath temperature or turn the dial counter-clockwise to decrease the bath temperature.
9. When the desired temperature has been reached, re-lock the **TA - FIXED** dial.
10. After the bath has reached the desired temperature, set the **HIGH TEMPERATURE LIMIT CONTROL (LC)**. This will preventthe bath from overheating if a malfunction occurs.

Adjusting the High Temperature Limit Control

During this procedure, the temperature of the bath may change slightly, but will quickly recover.

1. Using a screwdriver, slowly turn the **LC - TEMPERATURE ADJUST** control counterclockwise until the OVER TEMP message lights up on the **LC - PUSH TO RESET** button.
2. Turn the control clockwise approximately ¼ to ½ turn.
3. Push the **LC - PUSH TO RESET** button. If the bath doesn't recover, repeat step 2 and try again.

Custom Temperature Selection

Use this procedure to set the CT-500 to a temperature not already indicated on the pre-set dial.

1. Turn the **T - SELECT** dial to the temperature closest to your desired temperature. If the temperature is above the current bath temperature, the CT-500 will begin heating and the **HEAT** LED will light.
2. Move the **TA - SELECT** switch to the right (the **VARIABLE** position).

To heat the bath more rapidly, turn on the **PREHEAT** (**PH**) switch. If the target temperature is below 80 °C, turn the **PH** switch off when the desired temperature is reached. For temperatures above 80 °C, keep the **PH** switch ON to maintain temperature control. When the **PH** switch has been turned on, the **PH** - **HEAT** LED will light.

When the bath temperature is approximately at the temperature selected with the **T - SELECT** switch, the LED above the **TA** controls will start to blink as the heater duty cycle is automatically adjusted to stabilize temperature.

1. Release the lock on the **TA - VARIABLE** dial.
2. Read the thermometer in the CT-500 bath to determine the actual temperature of the bath. Make sure that both the thermometer and the bath temperature have stabilized before taking a reading.
3. Turn the **TA - VARIABLE** dial to adjust the temperature. Turn the dial clockwise to increase the bath temperature. Turn the dial counter-clockwise to decrease the bath temperature. After each adjustment, allow several minutes for the bath temperature to stabilize.

4. When the desired temperature has been reached, re-lock the **TA - VARIABLE** dial.

After the bath has reached the desired temperature, set the **HIGH TEMPERATURE LIMIT CONTROL** (**LC**). This will prevent the bath from overheating if a malfunction occurs.

Adjusting the High Temperature Limit Control

During this procedure, the temperature of the bath may change slightly, but will quickly recover

1. Using a screwdriver, slowly turn the **LC - TEMPERATURE ADJUST** control counterclockwise until the OVER TEMP message lights up on the **LC - PUSH TO RESET** button.
2. Turn the control clockwise approximately ¼ to ½ turn.
3. Push the **LC - PUSH TO RESET** button. If the bath doesn't recover, repeat step 2 and try again.

If the desired temperature is within 2 °C or 3 °C of a temperature listed on the **T - SELECT** dial, it may be possible to attain the temperature using the **TA - FIXED** dial. Because this dial has a finer adjustment than the **TA -VARIABLE** dial, the final temperature can be more easily obtained. To try this alternative method, follow the previous instructions, using the **TA - FIXED** dial instead of the **TA - VARIABLE** dial.

Verifying Limit Control Operation

The Limit Control should be checked periodically to ensure its functionality. To check the Limit Control, follow the procedure below in this section.

1. Power on the CT-500 and set the instrument to a desired bath temperature. Wait for the bath to stabilize at the desired temperature.
2. Using a screwdriver, slowly turn the Limit Control counter-clockwise until the Limit Control OVER TEMP warning lights up.

Caution: *If the Limit Control fails to light up and the Limit Control has been adjusted counter-clockwise to its furthest setting, the unit may need repairs. Contact CANNON for assistance.*

3. When the Limit Control OVER TEMP warning lights up, turn the Limit Control clockwise for ¼ turn and press the OVER TEMP button to reset the Limit Control for normal operation.

Cleaning

Periodically clean the outside of the unit with a damp cloth moistened with water and/or a mild detergent solution.

Caution: *Before cleaning the CT-500, turn off the instrument and unplug the power cord. Do not clean the instrument unless bath temperature is within 10 °C of ambient.*

Using the Thermo-Electric Cooling System (CT-600 Only)

The CT-600 thermoelectric cooling system is activated via the front panel On/Off switch. Thermoelectric cooling is generally recommended when maintaining a bath temperature within 20 °C of ambient.

The thermoelectric system should be turned off whenever the bath temperature exceeds 50 °C.

Troubleshooting

Refer to Table 4 to address issues with your CT-500 constant temperature bath.

Table 4: Troubleshooting Common Issues

Problem	Probable Cause
Bath does not appear to have power	Power cable is not connected to outlet or rear electrical drawer.
	Over-temperature control is set too low.
	Electric power is out.
	Fuse needs replaced.
Bath Liquid not agitated	Check connection of stirring motor on rear panel.
	Check impellor attachment to motor.
Bath has power but does not heat	Check connections for sensors on rear panel.
	Check temperature setting – it must be above existing bath temperature for heat to be applied.
	Bath fluid level is too low.
	Limit Control Temperature Adjust dial may be set too low. Turn completely clockwise, then press **PUSH TO RESET** button.
Bath control outside of specific limits	Bath fluid viscosity may be too high. if the fluid is too viscous at the desired temperature the stirring will be inadequate, resulting in poor control.
	Check stirring motor and motor impeller for normal function.
	Possible thermistor problem. Remove thermistor probe plug and check resistance with an ohmmeter (call CANNON for information on correct values for resistance at bath temperature).
Air bubbles in bath fluid	Fluid level may be too low.
	Stirring impeller is on shaft with the wrong orientation.
	Bath fluid is too viscous for operation at this temperature.

Spare Parts List

Presented in Table 5 is a list of parts for the CT-500 series which may be re-ordered from Cannon Instrument Company.

Table 5: CT-500 Series Spare Parts List

Instrument	Part Number	Description
All	20.22	Thermometer Holder
All	20.40	Impellor Stirrer Holder
All	22.39	Hole Covers & Thermometer Holder Set
All	25.2455	Fuse 12A 250V (2)
All	25.3111	Front bath cover
All	25.3180	Probe assembly control
All	25.3190	Probe assembly over-temp
All	27.2230	Lamp reset switch 12V
All	27.3700	Screwdriver trimpot (over-temp adjust)
All	27.6121	Support pad sponge
All	50.82	10-turn dial
CT-500	20.1	12 x 12 Pyrex Jar
CT-500	25.4005	Motor Stirrer Assembly 115V
CT-500	25.4006	Motor Stirrer Assembly 230V
CT-500	27.5250	Baffle, white
CT-518	20.1A	12 x 18 Pyrex Jar (CT-518)
CT-518	25.6010	Impellor Stirrer Upper
CT-518	25.6027	Motor Stirrer Assembly
CT-518	25.6028	Motor Stirrer Assembly
CT-518	25.6006	Baffle, white
CT-600	30.1048	Motor Stirrer Assembly 115V
CT-600	30.1051	Motor Stirrer Assembly 230V

Warranty

Products Limited Warranty

In addition to other manufacturers' warranties, CANNON Instrument Company ("the Company") warrants all products (other than reagents and chemicals) delivered to and retained by their original purchasers to be free from defect in material and workmanship for one year from the date of the Company's invoice to the purchaser. For a period of one year from the date of such invoice, the Company will correct, either by repair or replacement at the Company's sole discretion, any defect in material or workmanship (not including defects due to misuse, abuse, abnormal conditions or operation, accident or acts of God, or to service or modification of the product without prior authorization of the Company) without charge for parts and labor. The determination of whether any product has been subject to misuse or abuse will be made solely by the Company.

The Company shall not be liable for any special, incidental, or consequential damages, or any damage to plant, personnel, equipment or products, directly or indirectly resulting from the use or misuse of any product. Representations and warranties made by any person, including dealers and representatives of the Company, which are inconsistent, in conflict with, or in excess of the terms of this warranty shall not be binding upon the Company unless placed in writing and approved by an officer of the Company.

Reagent and Chemical Warranty

Cannon Instrument Company ("the Company") warrants all reagents and chemicals sold by the Company and delivered to and retained by their original purchasers to conform to the weight, specifications and standards stated on the package. The Company will, at its sole discretion, either replace or refund the price (net of freight, handling charges and taxes), of any reagent or chemical sold by the Company which does not conform to such weight, specifications and standards upon the prompt return of the unused portion. Except for replacement or refund of the net price, the Company shall not be liable for any damages occurring as a consequence of the failure of any reagent or chemical sold by the Company to conform to the weight, specifications and standards stated on the package.

Returning a Product to CANNON

Before returning a CANNON product for repair or service, make every attempt to identify the problem. If, after careful checking, the problem remains unidentified or unsolved, telephone Cannon Instrument Company (or the local service agent) to consult with a product specialist. If the specialist cannot recommend a simple solution or repair, CANNON will authorize the return of the product through the issuance of a Return Authorization number (RA).

CANNON Telephone Number 814-353-8000

CANNON Fax Number 814-353-8007

Products returned to CANNON must be carefully packed. Ship prepaid to the following address:

Cannon Instrument Company

ATTN: Return Authorization # _____

2139 High Tech Road

State College, PA 16803 USA

Please include the following:

Required Information

- The Return Authorization number (RA).
- The name and telephone number of the person at your company to contact regarding the product.
- Shipping and billing instructions for the return of the product to your location.
- A detailed explanation of the reason for the return. If the product is not covered by warranty, the customer will be provided with an estimate of the repair costs and asked for approval before any repairs are made. The customer will be required to issue a purchase order for the cost of the repairs.

Hazardous Materials

Please contact CANNON before returning a product that could possibly contain hazardous material.

Shipping Notification

Products returned without CANNON's prior authorization will not be accepted. The customer may be billed a testing fee if a product is returned to CANNON and found to be working properly.

Appendix I – Motor-Stirrer Problem Analysis

Motor-stirrer units supplied by Cannon Instrument Company are checked after assembly to ensure minimum run-out (deviation from concentric rotation) at the impeller end of the shaft. The following instructions are intended to assist those who may be experiencing excessive vibration in the motor-stirrer because of shaft run-out or misalignment of the impeller blades. The motor stirrer is picture outside of the instrument in Figure 17.

Figure 17: Motor Stirrer

Set Screw Alignment

The motor shaft contains a flat area. The coupling should be oriented so that the set screw is aligned with the flat. The stirrer shaft and motor shaft should be inserted in approximately the same length in the coupling.

Users can test for shaft run-out and impeller blade alignment by placing the motor on a soft surface with impeller facing up. Connect the motor to the appropriate AC power source and observe the impeller and shaft. If run-out is severe, the motor vibrates and the shaft flutters noticeably. The impeller will appear blurred if the impeller blades are not in the same plane.

If necessary, adjust the impeller blades by bending the large horizontal sections of each of the four segments so that they lie in the same plane. Since these segments are easily bent, check alignment whenever the impeller is bumped or if there is any suspicion that the blade segments may have become misaligned.

Shaft Run-Out Correction

The following procedure is suggested to correct shaft run-out. CANNON advises the impeller is removed while carrying out this procedure.

1. Grasp the motor firmly with the left hand and touch the tip of a soft crayon (a glass marking pencil, for example) momentarily to the side of the shaft near the impeller end while the motor is running. The mark produced by the crayon will be evident as a line part way around the shaft.
2. Disconnect the motor, hold the motor tightly against the body, and grasp the shaft in the right hand. Bend the shaft away from the line segment on the shaft.
3. Repeat the test procedure, marking the shaft at a location slightly removed from the first crayon mark.
4. If the mark appears at the same side of a shaft as the first mark and is about the same length, the bending was not great enough to alter the condition and should be repeated with more force applied. Likewise if the mark has shifted to the opposite side the force was too great, and the shaft must be bent back with less force to correct the alignment.

This is a trial-and-error process which usually must be repeated several times. When the crayon makes a line at least two-thirds of the way around the shaft, the run-out has diminished to an acceptable level. A uniform line completely around the shaft would indicate no run-out detectable by this procedure.

Appendix II – Choosing a Temperature Bath Fluid

The ideal bath liquid possesses low viscosity, high heat capacity, and low vapor pressure over a wide range of temperatures. In addition, the liquid should have a very high flash point and be relatively low in cost. If the fluid is to be used in a kinematic viscosity bath where it is necessary to view the instruments through the bath liquid, then it is important for the liquid to be clear and without color. Unfortunately, no single fluid meets all these requirements.

Because no single fluid can be used at all possible bath temperatures, the choice of a suitable fluid must begin by establishing the temperature range over which the bath will be operated. Refer to Table 3 for a list of operating temperature ranges and some liquids suitable for use in these ranges.

Table 6: Bath Fluid Options

Temperature Range (°C)	Suitable Bath Liquids
-100 °C to 10 °C	Methyl Alcohol
-10 °C to 20 °C	Isopropyl Alcohol, Low-Viscosity Silicones
-5 °C to 60 °C	Water, Low Viscosity Oils, Silicones (Dow 200 fluid, 1 cSt)
60 °C to 100 °C	White Oils with Oxidation Inhibitor, Silicones (Dow 200 fluid, 10 cSt)
100 °C to 200 °C	Silicones (Dow 200 fluid, 20 cSt)
135 °C to 200 °C	Silicones (Dow 200 fluid, 50 cSt)

Methyl Alcohol

Methyl alcohol is relatively volatile, has a low flash point, and has a degree of toxicity. The only reason for using it is that there seems to be no reasonable substitute. There are some very expensive halogen-based fluids which might be considered, but these also have a high volatility and may be somewhat toxic.

Isopropyl Alcohol

Isopropyl alcohol is less toxic than methyl alcohol and somewhat less volatile. However, it becomes very viscous at low temperatures and is therefore unsuitable for use at very low temperatures.

Silicone Fluids

Silicone fluids are available in a wide range of viscosities and can be used over a wide range of temperatures if the proper selection of viscosity is made for the temperature range of interest. Silicones are also relatively expensive liquids. However, a bath containing silicones requires extra care when used

for capillary viscometry. If silicones are introduced into a viscometer capillary, its calibration factor will be altered by a significant amount.

Water

Water is the ideal fluid in the temperature range in which it can be used. Because in some cases there is a tendency for algae formation, a degree of water treatment may be necessary. Water can be used at temperatures close to the boiling point, but water replenishment to offset evaporation becomes a nuisance and the hot vapor can make working above the bath uncomfortable. Also, it may be difficult to establish optimum control at elevated temperatures because of the rapid cooling resulting from surface evaporation.

Refined White Oils

Refined white oils (paraffin oils) of relatively low viscosity can be used at temperatures above the level at which water becomes unsatisfactory. Because these oils turn faintly yellow and continue to darken with prolonged exposure to heat, CANNON recommends adding an oxidation inhibitor to retard discoloration. The addition of an inhibitor prolongs the useful life of the oil, but it eventually becomes as dark as untreated oil.

The search for more suitable bath oils is unending. Hydrogenated vegetable oils, coconut oil, synthetic oils, and certain chemical compounds have been used with some success at various temperatures.

Appendix III – Adjusting Trimpots (Potentiometers)

The ten trimpots located immediately behind the front control panel can be accessed by pulling the drawer forward a few inches. An opening in the drawer cover allows direct access without the necessity of removing the cover. The trimpots are adjusted with a small screwdriver as shown in Figure 18.

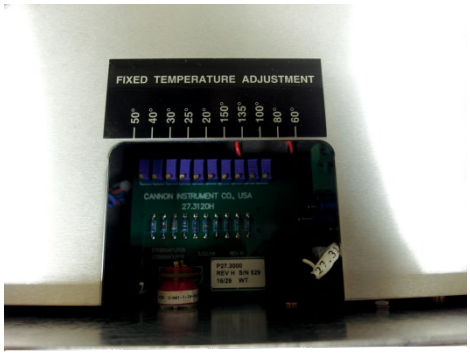

Figure 18: Adjusting Potentiometers

There is one trimpot corresponding to each of the set temperatures on the dial. These are normally set so that the **Temperature Adjust FIXED** dial is at the midpoint (500 on the ten-turn dial) of range when at the control temperature. Setting the **Temperature Adjust FIXED** dial at the midpoint ensures maximum adjustment in either direction to establish the desired temperature if additional adjustment is necessary.

If a temperature other than one that is available on the **Temperature SELECT** switch is to be accessed frequently, it is possible to obtain this temperature by adjusting the trimpot that coincides with the **Temperature SELECT** temperature that is close to the desired temperature.

For example, if 100 °F is an often needed temperature, and 40 °C is not used, set the **Temperature SELECT** switch to 40 °C and adjust the trimpot until the kinematic viscosity thermometer indicates the bath is controlling at 100 °F. Note for future reference that the 40 °C position on the select dial is now 100 °F. In some cases it is also necessary to set the **Temperature Adjust FIXED** dial to a position other than the midpoint in order to obtain the desired temperature.

While the method described above permits altering the **Temperature SELECT** setting, it may not be possible to obtain settings for temperatures that are widely different from those on the **Temperature SELECT** dial. In this case, use the **Temperature Adjust VARIABLE** dial to obtain the desired temperature.

Appendix IV - Thermometry for the CT-500

Kinematic Viscosity and Temperature

Kinematic viscosity is an extremely temperature-sensitive measurement - a change of 1 °C can sometimes lead to a viscosity change of 10 percent or more. Therefore, it is not surprising that temperature measurement and control are the most common problems encountered by laboratories performing accurate kinematic viscosity measurements.

Although capillary viscometers typically measure kinematic viscosity with a precision of several tenths of one percent, measurements accurate to within one tenth of one percent (0.1%) are possible. To achieve this, temperatures must be measured with an accuracy of 0.01 °C, and be maintained within a range of ± 0.01°C.

Thermometers

All measurements should be made with the viscometer properly immersed in a liquid constant temperature bath. Ideally, a high-quality standard platinum resistance thermometer with a precision bridge should be used to determine the temperature of the bath. Because many laboratories cannot justify the cost of such a thermometer, Cannon Instrument Company recommends the use of a calibrated ASTM kinematic viscosity thermometer and can provide one if requested.

ASTM Thermometers

Each ASTM kinematic viscosity thermometer measures only 3 degrees on a scale subdivided into 0.05 °C units (equivalent thermometers are available with Fahrenheit scales). These thermometers contain an ice-point scale which allows recalibration by determining the ice-point temperature.

Thermometer Calibration

Calibration of the thermometer is very important. Often the true temperature of a liquid differs markedly from that shown on the thermometer scale. It is not uncommon for kinematic viscosity thermometers to give readings varying as much as 0.1 °C from the actual temperature. The true liquid temperature is obtained by applying the proper correction (as noted on the original calibration certificate) to the reading showing on the thermometer scale and including any difference obtained in a recent ice-point measurement of your thermometer.

Thermometer Immersion

Proper thermometer immersion is crucial for viscosity measurements. Even a calibrated thermometer will read incorrectly if it is improperly immersed in the bath. “Total immersion” kinematic viscosity thermometers should be used with the bulb and entire mercury column (if applicable) beneath the surface of the liquid, but with the emergent stem above the surface at ambient temperatures.

Viscosity Standards

Cannon Instrument Company recommends that laboratories check their kinematic viscosity measurements with viscosity standards. If the laboratory is using CANNON calibrated viscometers and has developed a good measuring technique, kinematic viscosity determination using a standard will often point to temperature errors.

Viscosity standards should not be used to establish the correct temperature of the bath, however. Bath temperature should be checked and corrected by applying the reliable thermometric techniques outlined above.

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