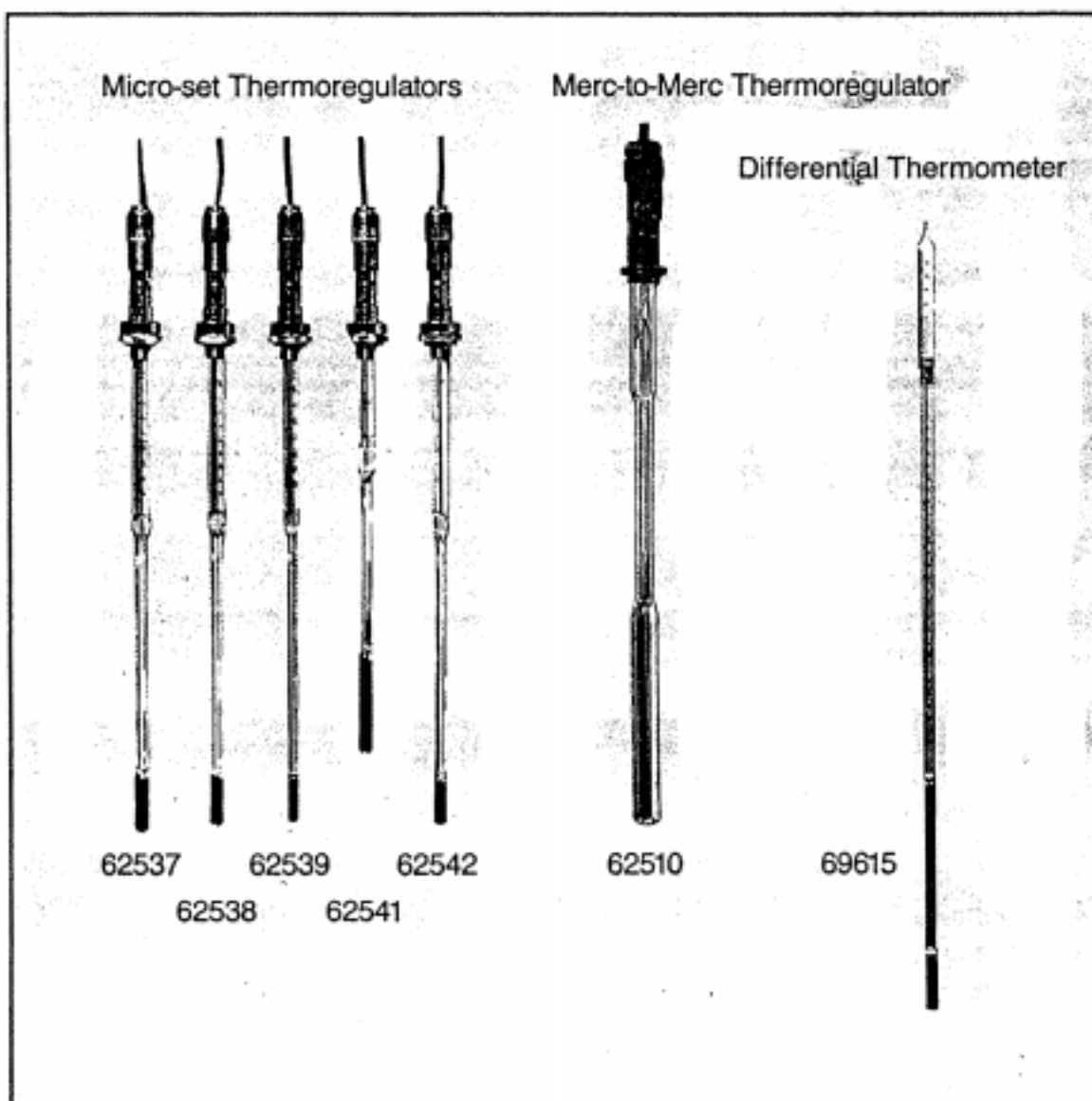


# Precision<sup>®</sup>

## Instruction Manual TS-62510 AU-1



Precision Scientific

## Differential Thermometer and Thermoregulators

### Introduction

Your satisfaction and safety are important to PRECISION SCIENTIFIC, and a complete understanding of this unit is necessary to attain these objectives.

As the ultimate user of this apparatus, it is your responsibility to understand its proper function and operational characteristics. This instruction manual should be thoroughly read and all operators given adequate training before attempting to place this unit in service. Awareness of the stated cautions and warnings, and compliance with recommended operating parameters--together with maintenance requirements--are important for safe and satisfactory operation. The unit should be used for its intended application; alterations or modifications will void the Warranty.

**WARNING:** Always wear safety glasses when working with this product, as a routine laboratory precaution.

This product is not intended, nor can it be used, as a patient connected device. In addition, this apparatus is not designed for use in Class I, II, or III locations as defined by the National Electrical Code.

**General Information:** These instructions encompass the Micro-set Thermoregulators, Merc-to-Merc Thermoregulator, and Differential Thermometer.

**WARNING:** Exercise care when handling these thermoregulators or thermometers as they are fragile and contain mercury, which is toxic. Also, safety glasses should be worn.

**MICRO-SET THERMOREGULATORS**  
 CATALOG NOS. 62537, 62538, 62539,  
 62541, AND 62542

The Micro-set Thermoregulators are manufactured with a sealed-in hydrogen atmosphere to reduce the possibility of oxidation or contamination to the mercury. This is an extremely sensitive device, with contacts that close when temperature rises and must be used with a normally closed relay control box with a current draw of less than 100 microamps. Precision Scientific Catalog #62690, Relay Control Box, is recommended. In this way, maximum sensitivity and long life are assured.

**WARNING:** Current draw across the thermoregulator contact points in excess of 100 microamps, could cause the thermoregulator to explode.

#### TECHNICAL DATA FOR MICRO-SET THERMOREGULATORS

Cat. No.	62537	62538	62539	62541	62542
Range	50 to 220F	10 to 104C	60 to 460F	-35 to +500F	-35 to +135F
Sensitivity	+0.02F	+0.011C	+0.05F	+0.005F	+0.02F

MICRO-SET THERMOREGULATORS (Contd.)

The thermoregulator consists of a sealed glass unit with a regulating mechanism at the top, a calibrated section (in degrees) containing a spindle screw, a pointer mounted on a rider, and a glass stem which contains twin capillary bores which connect to a sensitive mercury filled bulb.

The Differential Micro-set, Catalog No. 62541, differs from all of the other Micro-set Thermoregulators, inasmuch as it does not contain a calibrated section in degrees, but a 20°F adjustment section. A reservoir for storage of surplus mercury is also provided by extending a glass partition up about one-half inch into the adjustment section.

The adjustable collar of the cap is a magnet. Turning this magnet causes a second magnet, mounted on the threaded shaft inside the sealed glass chamber, to turn. As the shaft turns, a rider moves slowly up or down. Attached to the rider is a contact wire that extends into the capillary bore. The position of this contact wire in the capillary determines the temperature setting. The thermoregulator contact is open until the mercury rises to meet this contact wire.

There is a reference scale calibrated in degrees behind the rider on all thermoregulators except Catalog #62541. This reference scale permits approximate settings. Final temperature settings can be made only after the heated medium has come to equilibrium. A thermometer must be used to determine temperature--the thermoregulator is not suitable for temperature measurement.

MERC-TO-MERC THERMOREGULATORS

(CATALOG NO. 62510)

The Merc-to-Merc Thermoregulator is sealed with a hydrogen atmosphere to reduce the possibility of oxidation or

contamination to the mercury. A built-in reservoir is provided, and a fresh contact surface of mercury is present for the completion of every cycle.

This thermoregulator is designed for operation with the GCA/Precision Scientific Relay Control Box, Catalog #62690. If other types of relay devices are used, they must have a current draw of less than 100 microamps. The Merc-to-Merc Thermoregulator is adjustable over its entire temperature range of -35° to +700°F, has a control sensitivity of  $\pm 0.1^\circ\text{F}$ , but it does not have a regulating mechanism.

**WARNING:** Current draw across the thermoregulator contact points in excess of 100 microamps, could cause the thermoregulator to explode.

DIFFERENTIAL THERMOMETER

(CATALOG NO. 69615)

The Differential Thermometer is an indicating instrument which can be used to measure a temperature over a 5° span in the region of any operating point from -35° to 300°C. Direct readings can be taken to .01°C, and estimates to .001°C can be made with the aid of a magnifying glass or thermometer reading glass.

The thermometer can be quickly and accurately set to any desired working temperature by means of a calibrated setting scale. Applications include reading viscosity temperature, conducting calorimetric tests, and determining freezing or boiling points. The 5°C reading scale is 9" long, which presents a direct advantage in the fact that the region of the anticipated temperature is greatly elongated over conventional type instruments. The mercury reservoir is sealed to prevent erratic "jumping" in a mercury column quite prevalent in vacuum type differential thermometers.

## Unpacking and damage

General Information: If the instrument is received damaged, save all packing material. This merchandise was carefully packed and thoroughly inspected before leaving our factory, and responsibility for its safe delivery was assumed by the carrier upon acceptance of the shipment. Claims for loss or damage sustained in transit must, therefore, be made by the recipient upon the carrier as follows:

Concealed Loss or Damage: Concealed loss or damage means loss or damage which does not become apparent until the merchandise has been unpacked and inspected. Should either occur, make a written request for inspection by the carrier's agent within 15 days of the delivery date; then file a claim with the carrier since the damage is the carrier's responsibility.

By your following these instructions carefully, we will guarantee our full support of your claim to be compensated for loss from concealed damage.

NOTE: It is not unusual for a separation to occur in the movable mercury capillary during shipment. This should not be considered as damage since the mercury can be reunited readily.

Visible Loss or Damage: Note any external evidence of loss or damage on the freight bill, or express receipt, and have it signed by the carrier's agent. Failure to adequately describe such external evidence of loss or damage may result in the carrier's refusing to honor your damage claim. The form required to file such a claim will be supplied by the carrier.

DO NOT -- FOR ANY REASON -- RETURN THE INSTRUMENT WITHOUT FIRST OBTAINING AUTHORIZATION.

CAUTION: Exercise care when packing the thermoregulator or thermometer for return shipment to our plant. These instruments are extremely fragile. Units arriving at the factory in a broken condition will be classified as beyond repair. Be sure shipment is insured.

DO NOT return broken thermoregulators or thermometers (broken glassware and loose mercury) as it is not economically feasible to repair them in this condition, plus it is dangerous to ship unsealed mercury.

NOTE: The Dept. of Transportation (DOT) regulations limit and set standards for the shipment of mercury.

In any correspondence to GCA/PRECISION SCIENTIFIC, please include the catalog number of the thermometer or thermoregulator.

### UNITING A SEPARATED MERCURY COLUMN - THERMOREGULATORS AND DIFFERENTIAL THERMOMETERS

WARNING: Safety glasses should be worn when handling and/or heating mercury glass bulbs.

Although the best packing materials and methods are employed, rough handling during shipment may cause the mercury column(s) to separate into two or more parts in either a thermoregulator or differential thermometer. In extreme cases, where there has been an extraordinary shock, the mercury column(s) may be separated into a large number of small increments. A divided column does not in any way reflect upon the quality of the mercury or the instrument. A separated column may be united by any of three methods, employed singly or in combination.

UNITING A SEPARATED MERCURY COLUMN (Contd.)

1. Gradual cooling may be used to bring all the mercury into the bulb, where it will unite to form a single mass. Mixtures of ice and water, ice and salt, or dry ice and acetone may be used as required by the range of the differential thermometer or individual thermoregulator. The mixtures named above are in order of decreasing temperature. Avoid thermal shock.

**CAUTION:** The dry ice-acetone mixture is sufficiently cold enough to cause mercury to solidify (freezing point,  $-39^{\circ}\text{C}$ ). If this takes place, the top of the bulb should be warmed first so that the mercury will liquify at the top first, thus avoiding undue pressure within the bulb and possible breakage.

**WARNING:** Acetone is flammable. Use manufacturer's/supplier's recommended procedures when employing acetone.

2. There is an enlargement or expansion chamber at the top of the capillary. The bulb of the thermoregulator or thermometer may be heated to cause all columns of mercury to rise into the expansion chamber. Here they will either unite spontaneously, or, upon gentle tapping, with the unit in a vertical position. The bulb should then be allowed to cool slowly; whereupon all the mercury will leave the expansion chamber as a united mass.

**CAUTION:** If too much mercury is driven into the excess mercury reservoir, the top of the instrument will be broken.

There are five ways that the thermoregulator bulb should be heated; namely, in a water bath; an oil bath, rotating high over an electric heating element, rotating high above a low flame, or rotating over a heat gun.

To avoid spot heating, which will crack the glass, do not direct the heat source to a single bulb location when using a heating element, flame, or heat gun. The differential expansion of the glass and mercury will cause a glass fracture when heated too rapidly. This can be dangerous as well as destructive to the unit. Extreme caution must be exercised. Do not touch the heated portion of the bulb when handling the thermoregulator.

**WARNING:** If the thermoregulator or thermometer is broken in a bath, disconnect from electrical source, drain, and remove the mercury as soon as possible. (Note: Mercury will attack solder seams in a sheet metal bath and result in fluid leaks from the bath.)

When disposing of mercury, use proper methods according to safe, recommended procedures. Do not discard mercury in sinks or drains.

3. Gentle vertical tapping on the palm of the hand will occasionally eliminate small breaks in the column. Considerable restraint is called for in applying this method, since there is a tendency to progressively increase the force of the tapping. Exercise patience, with gentle tapping, to avoid breaking the instrument.

### MOUNTING MICRO-SET AND MERC-TO-MERC THERMOREGULATORS

**WARNING:** Safety glasses should be worn when mounting and/or handling thermoregulators.

**CAUTION:** These units are delicate and must be handled with care. They should not be exposed to thermal shocks as a result of rapid "spot" heating, and should be handled carefully to avoid breakage. Do not forcefully install in any fashion such that it would subject the assembly to mechanical stress.

Before attempting to set the thermoregulator, inspect it to observe whether there are any gas bubbles in the capillary columns. If bubbles are present, or if the mercury in the movable capillary column is separated, which may have been caused by being jarred in shipment, heat the bulb gently until the bubbles are driven up into the expansion chamber.

If there is a "separation" (bubble) in the fixed capillary (MICRO-SET THERMOREGULATOR ONLY), contact the factory for return authorization. There is a small constructional restriction, or "separation," in the capillary near the top. Continuity is provided by a wire joining the two portions of the fixed capillary. This is a normal construction characteristic. (SEE THE MICRO-SET THERMOREGULATOR DRAWING--ENLARGED VIEW.)

### MOUNTING DIFFERENTIAL THERMOMETER

**WARNING:** Safety glasses should be worn when mounting and/or handling Differential Thermometers.

**CAUTION:** The thermometer is delicate and must be handled with care. It should not be exposed to thermal shocks as a result of rapid "spot" heating, and should be handled carefully to avoid breakage. Do not forcefully install in any fashion such that it would subject the unit to mechanical stress.

An expanded hump on the thermometer, 6 1/2" from the bottom, determines the immersion depth. For maximum accuracy, the thermometer should be immersed as close as possible to the expanded hump.

### SETTING TEMPERATURE ON MICRO-SET THERMOREGULATORS

**CAUTION:** Exercise care when rotating the adjusting collar, as it is possible to jam the pointer at the top or bottom of the spindle. This could result in costly factory repair.

### CATALOG NOS. 62537, 62538, 62539, 62542

1. Energize the heat source of the apparatus with the bulb immersed so that the unit will gradually come up to temperature and not be exposed to thermal shock.
2. Turn the adjusting magnetic collar counterclockwise to lower temperature and clockwise to raise temperature. The thermoregulator is graduated with a reference scale in degrees, indicated by the pointer, which is raised or lowered by turning the adjusting magnet. This scale is not intended for absolute direct reading.
3. Allow the apparatus to stabilize and reach temperature equilibrium.

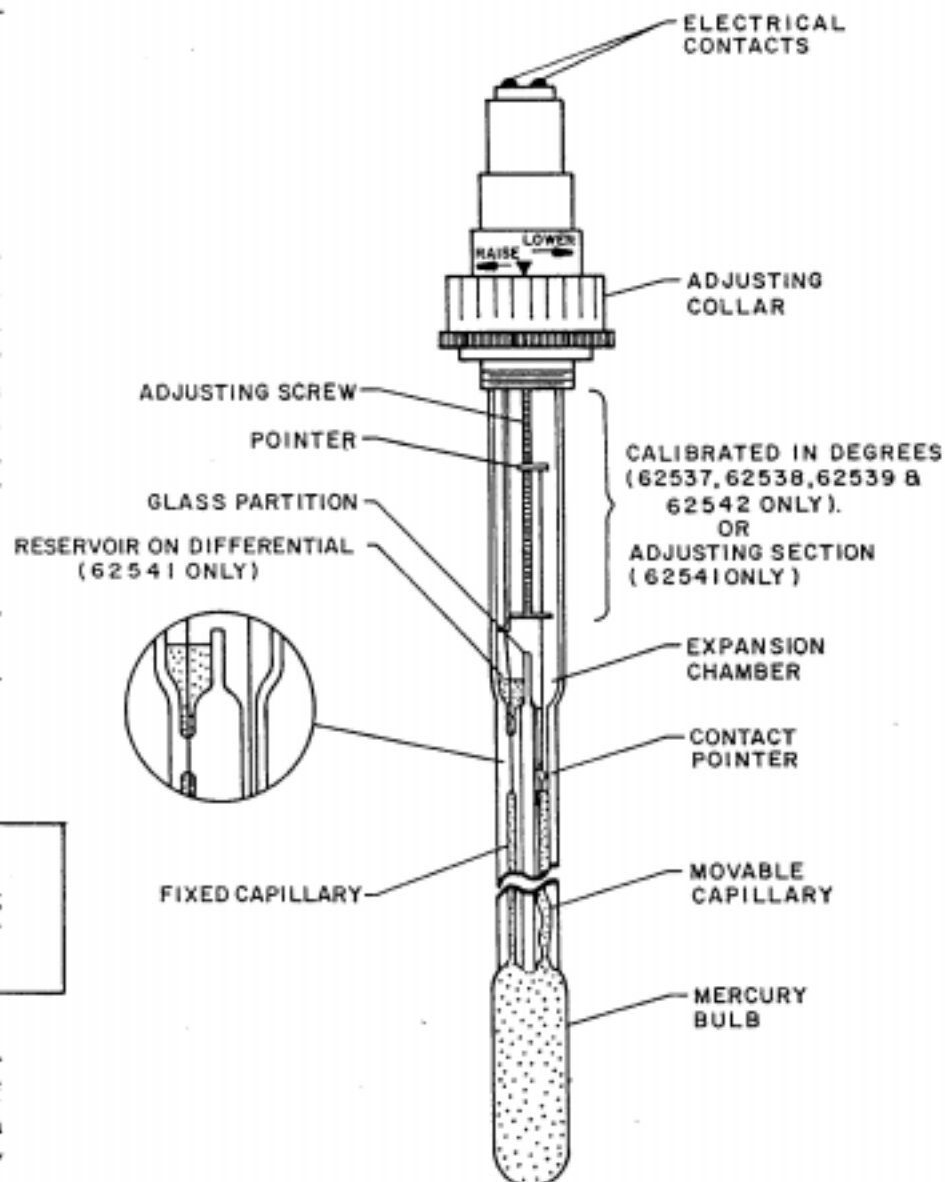
SETTING TEMPERATURE ON MICRO-SET  
THERMOREGULATORS (Contd.)

4. Insert a sensitive thermometer into the apparatus as close as possible to the bulb of the thermoregulator. Check controlling temperatures against the temperature reading of thermometer, and make final temperature adjustments by turning the adjusting collar. Adequate circulation of the bath medium is essential for maximum performance.
5. Once the temperature is set, always keep the thermoregulator in a vertical position. This will eliminate separations in the mercury column.

CATALOG NO. 62541 - ONLY

**WARNING:** Safety glasses should be worn when heating mercury in glass bulb and/or handling thermoregulators.

The Differential Micro-set, Catalog #62541, differs from all of the other micro-sets, inasmuch as the temperature setting by the above procedure covers only a 20° span. The range (-35°F to +500°F) is set by heating the mercury bulb to the desired temperature setting and displacing excess mercury from the movable right-hand column. In the vertical position, gently tap the top to displace any mercury that may have settled in the top mechanism during shipment. Invert the bulb slightly above horizontal and rotate it so that the excess mercury settles in the reservoir above the left-hand column.



MICRO-SET THERMOREGULATOR

**CAUTION:** There are five ways that the thermoregulator bulb should be heated; namely, in a water bath, an oil bath, rotating high above an electric heating element, rotating high above a low flame, or rotating above a heat gun.

SETTING TEMPERATURE ON MICRO-SET  
THERMOREGULATORS (Contd.)

To avoid spot heating, which will crack the glass, do not direct the heat source to a single bulb location when using a heating element, flame, or heat gun. The differential expansion of the glass and mercury will cause a glass fracture when heated too rapidly. This can be dangerous as well as destructive to the unit. Extreme caution must be exercised.

Do not touch the heated portion of the bulb when handling the thermoregulator.

**WARNING:** If the unit is broken in a bath, disconnect from the electrical source, drain, and remove the mercury as soon as possible. (Note: Mercury will attack solder seams in a sheet metal bath and result in fluid leaks from the bath).

When disposing of mercury, use proper methods according to safe, recommended procedures. Do not discard mercury in sinks or drains.

1. Rotate the adjusting magnetic collar until the pointer is approximately in the mid position of the 20°F span. Rotating the adjusting collar counterclockwise lowers the temperature; rotating the collar clockwise raises the temperature. Directional arrows are located on the upper barrel.

**CAUTION:** Allow the thermoregulator to cool before immersing the bulb into apparatus. Avoid thermal shock.

2. Immerse the bulb in the apparatus at the desired temperature of operation, and allow the unit to stabilize and reach temperature equilibrium.
3. Quickly remove the thermoregulator, invert it, and shake it gently in a downward direction. The mercury column will separate at the contact point of the wire.
4. By tipping the thermoregulator on one side, the excess mercury will be stored in the reservoir. Be sure no excess mercury becomes trapped in the top mechanism.

**CAUTION:** Exercise care when tipping, shaking, or handling the thermoregulator as it is very fragile.

Place the thermoregulator back into the apparatus.

5. Insert a certified thermometer into the apparatus as close as possible to the bulb of the thermoregulator.

**NOTE:** Adequate circulation or stirring must be provided in the apparatus.

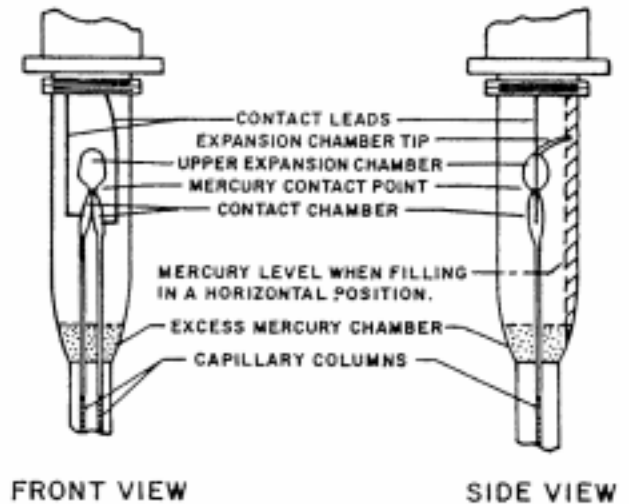
Check controlling temperature against the temperature reading of thermometer, and make close temperature adjustment by turning the adjusting collar as described previously.

6. If it is found that it is impossible to adjust within the 20° range, it will be necessary to displace additional mercury. Repeat the steps above until the thermoregulator is calibrated within the proper adjusting section.



SETTING TEMPERATURE ON MICRO-SET  
THERMOREGULATORS (Contd.)

7. Once the temperature is set, always keep the thermoregulator in a vertical position to eliminate separations in the mercury column.
8. To add mercury to the movable column, heat until the mercury is at the top of the column; then pour some of the mercury from the reservoir to the top of the movable mercury column in the right-hand capillary. Allow the mercury to cool. It must enter the capillary in a continuous column. Do not allow air pockets to form in this column; inconsistent control will result. If "bubbles" are evident, the operation must be repeated.



MERC-TO-MERC THERMOREGULATOR

SETTING TEMPERATURE ON MERC-TO-MERC  
THERMOREGULATOR

CATALOG NO. 62510

**WARNING:** Safety glasses should be worn when handling and/or heating the mercury-in-glass bulb.

1. Immerse the thermoregulator in the bath so that the bulb is completely submerged. Bring the temperature of the liquid bath as close as possible to the desired operating temperature for which the thermoregulator is to be set.
2. The two columns of mercury will rise until they touch at the contact point. (Refer to sketch, Merc-to-Merc Thermoregulators.)

3. If the mercury columns do not rise to the contact point at the bottom of the expansion chamber, remove the thermoregulator from the bath. Gently heat the bulb until the expansion chamber is filled.

**NOTE:** Be sure that one column does not exceed the other. This may be avoided by turning the thermoregulator while heating. This will heat the bulb evenly. Now, tip the thermoregulator to a horizontal position so that the tip of the expansion chamber is immersed in the surplus mercury. Allow the bulb to cool slowly in this position for 5 minutes. The mercury will then draw back into the columns. Do not chill or attempt to rush the cooling process.

SETTING TEMPERATURE ON MERC-TO-MERC  
THERMOREGULATOR (Contd.)

**CAUTION:** There are five ways that the thermoregulator bulb should be heated; namely, in a water bath, an oil bath, rotating above an electric heating element, rotating high above a low flame, or rotating above a heat gun.

To avoid spot heating, which will crack the glass, do not direct the heat source to a single bulb location when using a heating element, flame, or heat gun. The differential expansion of the glass and mercury will cause a glass fracture when heated too rapidly. This can be dangerous as well as destructive to the unit. Extreme caution must be exercised. Do not touch the heated portion of the bulb when handling the thermoregulator.

**WARNING:** If the thermoregulator is broken in a bath, disconnect from the electrical source, drain, and remove the mercury as soon as possible. (Note: Mercury will attack solder seams in a sheet metal bath and result in fluid leaks from the bath.)

When disposing of mercury, use proper methods according to safe, recommended procedures. Do not discard mercury in sinks or drains.

4. When the mercury bulb has cooled, slowly place the thermoregulator in the bath. Allow it to remain there for a few minutes to displace the excess mercury out the top of the expansion chamber.

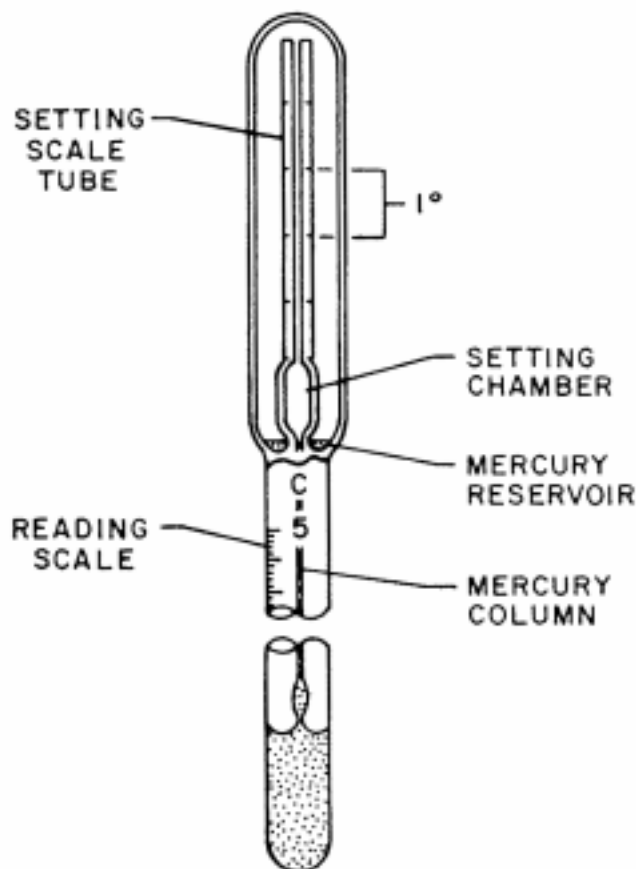
5. Allow the mercury columns to reach the contact point. Check bath temperature with a standard thermometer. Be sure there is adequate circulation of the bath media and that it is at the temperature desired for the thermoregulator setting. Allow the thermoregulator to stabilize for 2 or 3 minutes.
6. Remove the thermoregulator; quickly tip it so that the expansion chamber is below a horizontal position. Gently tap the thermoregulator head against the palm of the hand to displace the mercury into the expansion chamber and away from the contact point. This allows the columns to recede without drawing additional mercury from the expansion chamber.
7. Gently heat the bulb in the horizontal position, insuring that the expansion chamber tip is pointed downward, but not in contact with surplus mercury. After all of the surplus mercury is displaced from the expansion chamber, the thermoregulator is set.

CHECKING THE SETTING

Immerse the thermoregulator in a bath at a lower temperature (approximately 10°F lower) than which the thermoregulator has been set. Place a standard thermometer close to the mercury bulb and slowly bring the bath to temperature. When the reading on the thermometer reaches the temperature for which the thermoregulator has been set, the mercury columns should join. If they do not join at this temperature, or have joined before this temperature, the thermoregulator must be reset. If the columns have joined before the temperature on the thermometer has been reached, the thermoregulator is set at a lower temperature than is desired. If the columns join after the temperature is reached, the thermoregulator is set at a higher temperature than is desired.

SETTING THE DIFFERENTIAL THERMOMETER

**WARNING:** Safety glasses should be worn when handling and/or heating the mercury in the thermometer bulb.

DIFFERENTIAL THERMOMETER

1. Immerse the thermometer in the apparatus in which the temperature differential is to be read.

**CAUTION:** The difference between the thermometer temperature and apparatus media should not exceed 25°C. Carefully heat thermometer bulb if necessary. (See heating Procedure A or B which follows.)

2. Allow mercury to stabilize at point on reading scale.
3. If mercury does not reach approximately the 2-1/2° mark on the reading scale, follow instructions as described in Procedure A below. If the mercury extends above the 2-1/2° mark on the scale, follow Procedure B.

Procedure A: To Add Mercury to the Reading Scale

1. Heat the thermometer bulb.

**CAUTION:** There are five ways that the thermometer bulb should be heated; namely, in a water bath, an oil bath, rotating high above an electric heating element, rotating high above a low flame, or rotating above a heat gun.

To avoid spot heating, which will crack the glass, do not direct the heat source to a single bulb location when using a heating element, flame, or heat gun. The differential expansion of the glass and mercury will cause a glass fracture when heated too rapidly. This can be dangerous as well as destructive to the unit. Extreme caution must be exercised. Do not touch the heated portion of the bulb when handling the thermometer.

SETTING THE DIFFERENTIAL THERMOMETER

(Contd.)

**WARNING:** If the thermometer is broken in a bath, disconnect from the electrical source, drain, and remove the mercury as soon as possible. (Note: Mercury will attack solder seams in a sheet metal bath and result in fluid leaks from the bath.)

When disposing of mercury, use proper methods according to safe, recommended procedures. Do not discard mercury in sinks or drains.

2. Remove thermometer from heat and quickly invert it so that the top of the Setting Scale Tube is immersed in the mercury. (Refer to "Final Setting".)
3. With the thermometer remaining in the inverted position, cool the bulb. This will draw the mercury through the Setting Scale Tube into the heating chamber. The mercury must join the mercury in the Reading Scale. Avoid thermal shock when cooling.
4. Immerse the thermometer in the apparatus in which the temperature differential is to be read. When equilibrium has been established, the Setting Chamber should contain a small amount of mercury not exceeding 1/4 the volume of the Setting Chamber.
5. To remove the small amount of mercury, invert the thermometer and vigorously move it downward with a quick motion so that the excess mercury in the Setting Chamber will separate from the mercury column and settle in the entrance to the Setting Scale Tube.

6. Heat the bulb gently so that the expansion of the gas will force the excess mercury through the Setting Scale Tube. The thermometer, when placed in the apparatus being tested, should now read slightly above the 5° mark.

Procedure B: To Remove Mercury from the Setting Scale

1. Invert the thermometer and thrust downward with a quick, vigorous motion so that the excess mercury in the Setting Chamber will separate from the mercury column and settle in the entrance to the Setting Scale Tube.
2. Gently heat the bulb so that the expansion of the gas below the mercury will force the excess mercury through the Setting Scale Tube. The thermometer, when placed in the apparatus being tested, should now read slightly above the 5° mark.

Final Setting: As mentioned previously, the Differential Thermometer is equipped with a calibrated setting scale in one degree divisions to facilitate the setting of the mercury column to the immediate region of any desired operating point. After the mercury has been placed at the proper level in the Reading Scale (refer to Procedure A or B), the thermometer should be set to read at the middle point of the Reading Scale, or approximately at the 2-1/2° mark.

1. Gently heat the bulb. Be sure to revolve the thermometer to avoid spot overheating until the Setting Chamber is approximately 1/4 filled with mercury.
2. Stop heat, and do not chill.
3. Invert the thermometer and vigorously thrust it downward so that the excess mercury in the heating

SETTING THE DIFFERENTIAL THERMOMETER

(Contd.)

chamber will separate from the mercury column and settle at the entrance to the Setting Scale Tube.

NOTE: Since the previous reading was at approximately the 5°C mark (refer to Procedure A or B) and the reading desired is 2-1/2°C, an amount of mercury equivalent to 2-1/2°C should be removed from the reading scale.

4. Gently heat the bulb in an inverted position, observing the movement of the mercury into the Setting Scale Tube.
5. When the 2-1/2°C mark is reached on the Setting Scale, quickly return the thermometer to an upright position, and vigorously thrust the thermometer downward so that the excess mercury in the entrance to the Setting Scale Tube will separate and fall to the bottom of the Setting Chamber. The mercury in the Setting Chamber must unite with the mercury in the reading scale.
6. Gently heat the bulb in order to eject the remaining mercury from the Setting Scale Tube. Place this thermometer in the apparatus in which the temperature differential is to be read.

If the foregoing instructions have been carefully followed, the mercury meniscus should be approximately at the 2-1/2° point on the reading scale. If not, repeat the "Final Setting" procedure.

TROUBLESHOOTING MICRO-SET AND MERC-TO-MERC THERMOREGULATORS

1. No Heat or Erratic Temperature Control. Determine if fault is an electric component or thermoregulator by shorting the contacts in the cap attached to the leads from the control box to the thermoregulator with an insulated wire. If the control box does not cycle, repair as indicated in the control box instructions. If the malfunction is in the thermoregulator, see below. Also, be sure there is good contact between the prongs in the cap and the solder contacts on top of the thermoregulator. These contacts may wear down and cause less than adequate contact.
2. No Heat. Control box may be in a normally open operating mode, or heaters may be defective. Check continuity across heater.
3. Poor Temperature Control or Excessive Heat. Heater wattage too great or mercury bulb not close enough to heater, or there is poor circulation. Separation in movable mercury column, or gas bubbles in bulb, may also be the cause. (See paragraph, "Uniting a Separated Mercury Column".)

The mercury contained in the regulator may be oxidized, caused by a high current draw (more than 100 microamps).