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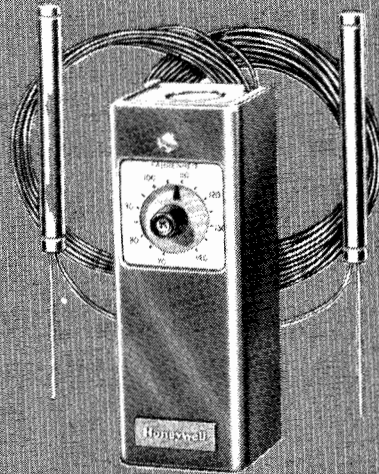
THE T991B DUAL BULB TEMPERATURE CONTROL PROVIDES PROPORTIONAL CONTROL OF SUPPLY WATER OR DUCT AIR TEMPERATURES. TWO SENSING ELEMENTS ARE USED—A SENSING BULB IS MOUNTED OUTDOORS AND A BULB OR A CAPILLARY AVERAGING ELEMENT IS MOUNTED IN THE WATER OR AIR SUPPLY BEING CONTROLLED. AS OUTDOOR TEMPERATURE CHANGES, THE T991B AUTOMATICALLY RESETS THE CONTROL POINT ACCORDING TO THE RESET RATIO SELECTED.

- Four reset ratios are available—1:1, 1:1-1/2, 1-1/2:1 and 3-1/2:1.
- Set point adjustment on front of case.
- Throttling range is adjustable from 3 F to 30 F [2 C to 17 C].
- Control may be mounted in any convenient position.
- Case and capillary tubing are ambient compensated.
- Sturdy steel case houses the diaphragm power head and lever mechanism.

M.W.  
REV. 8-81

Form No.  
60-2055-1

## PROPORTIONAL TEMPERATURE CONTROL



# T991B

**epc**

Energy Products Center

# SPECIFICATIONS

## IMPORTANT

THE SPECIFICATIONS GIVEN IN THIS PUBLICATION DO NOT INCLUDE NORMAL MANUFACTURING TOLERANCES. THEREFORE, THIS UNIT MAY NOT MATCH THE LISTED SPECIFICATIONS EXACTLY. ALSO, THIS PRODUCT IS TESTED AND CALIBRATED UNDER CLOSELY CONTROLLED CONDITIONS, AND SOME MINOR DIFFERENCES IN PERFORMANCE CAN BE EXPECTED IF THOSE CONDITIONS ARE CHANGED.

**MODELS:** T991B Dual Bulb Temperature Control—provides proportional control of supply water or duct air temperatures in heating or cooling applications. Resets the temperature control point according to changes in outdoor air temperature.

**TEMPERATURE SETTING:** 70 F to 140 F [21 C to 60 C] (when the outdoor bulb is at 70 F [21 C]).

**ELECTRICAL RATING:** 24 Vac.

**THROTTLING RANGE:** Adjustable from 3 F to 30 F [2 C to 17 C] degrees range is divided in half at the set point.

**RESET RATIOS AVAILABLE:** 1:1, 1-1/2:1, 1:1-1/2, 3-1/2:1. Refer to section on selecting the Reset Ratio.

**NOTE:** Ratio indicates change in outdoor air temperature which will cause corresponding change in heating medium control point.

**POTENTIOMETER RESISTANCE:** 135 ohms.

**MAXIMUM BULB PRESSURE:** 50 psi, with direct immersion mounting. (Refer to ratings supplied with immersion well, if used.)

### TEMPERATURE LIMITS:

RESET RATIOS	MAXIMUM OPERATING AMBIENT	MAXIMUM STORAGE TEMPERATURE	MAXIMUM BULB TEMPERATURE
1:1	125 F [52 C]	132 F [56 C]	Indoor bulb temperature plus outdoor bulb temperature must not exceed 265 F [129 C].
1:1-1/2	125 F [52 C]	125 F [52 C]	Indoor bulb temperature plus 1.5 times the outdoor bulb temperature must not exceed 312 F [156 C].
1-1/2:1	125 F [52 C]	145 F [63 C]	Indoor bulb temperature plus 2/3 times the outdoor bulb temperature must not exceed 242 F [117 C].
3-1/2:1	125 F [52 C]	145 F [63 C]	Indoor bulb temperature plus 0.29 times the outdoor bulb temperature must not exceed 206 F [97 C].

### BULB SIZES:

RESET RATIO	INDOOR BULB			OUTDOOR BULB		
	LENGTH (in.) [mm]	DIAMETER (in.) [mm]	CAPILLARY (ft) [m]	LENGTH (in.) [mm]	DIAMETER (in.) [mm]	CAPILLARY (ft) [m]
1:1	4-1/2 [114.3]	1/2 [12.7]	10 [3]	4-1/2 [114.3]	1/2 [12.7]	30 [8]
1:1 <sup>a</sup>	12 ft [3 m]	1/8 [3.2]	6 [2]	4-1/2 [114.3]	1/2 [12.7]	20 [5]
1:1-1/2	4-1/2 [114.3]	1/2 [12.7]	10 [3]	6-5/32 [156.4]	1/2 [12.7]	30 [8]
1-1/2:1	4-1/2 [114.3]	1/2 [12.7]	10 [3]	3-3/16 [81]	1/2 [12.7]	30 [8]
3-1/2:1	4-1/2 [114.3]	1/2 [12.7]	20 [5]	2-5/32 [54.7]	3/8 [9.5]	30 [8]
3-1/2:1 <sup>a</sup>	12 ft [3 m]	1/8 [3.2]	6 [2]	2-5/32 [54.7]	3/8 [9.5]	30 [8]

<sup>a</sup>Averaging element models.

(continued on page 3)

# ORDERING INFORMATION

WHEN PURCHASING REPLACEMENT AND MODERNIZATION PRODUCTS FROM YOUR TRADELINE WHOLESALE OR YOUR DISTRIBUTOR, REFER TO THE TRADELINE CATALOG OR PRICE SHEETS FOR COMPLETE ORDERING NUMBER, OR SPECIFY—

1. Order number.
2. Accessories, if desired.

IF YOU HAVE ADDITIONAL QUESTIONS, NEED FURTHER INFORMATION, OR WOULD LIKE TO COMMENT ON OUR PRODUCTS OR SERVICES, PLEASE WRITE OR PHONE:

1. YOUR LOCAL HONEYWELL RESIDENTIAL GROUP SALES OFFICE (CHECK WHITE PAGES OF PHONE DIRECTORY).
2. RESIDENTIAL GROUP CUSTOMER SERVICE  
HONEYWELL INC., 1885 DOUGLAS DRIVE NORTH  
MINNEAPOLIS, MINNESOTA 55422 (612) 542-7500

(IN CANADA—HONEYWELL CONTROLS LIMITED, 740 ELLESMERE ROAD, SCARBOROUGH, ONTARIO M1P 2V9)  
INTERNATIONAL SALES AND SERVICE OFFICES IN ALL PRINCIPAL CITIES OF THE WORLD.

DIMENSIONS: Refer to Fig. 1.

ACCESSORIES:

1. Compression fittings, immersion wells—refer to appropriate specification sheet or the TRADELINE Catalog.
2. 314439 Mounting Clips—for mounting capillary tubing (averaging element) in a duct.
3. 7640HX Averaging Element Mounting Kit—for mounting in existing installations where access to the duct is impractical.
4. Q615A Enclosure—to protect device if mounted outside; splash proof.

5. 801534 Calibration Wrench.
6. 107324A Bulb Holder—for mounting bulb in a duct.
7. 34886A Outdoor Bulb Shield—to protect outdoor bulb mounting.

OPTIONAL SPECIFICATION

T991B with 3-1/2:1 reset and 50 F to 120 F [10 C to 49 C] temperature setting scale (when the outdoor bulb is at 60 F [16 C]).

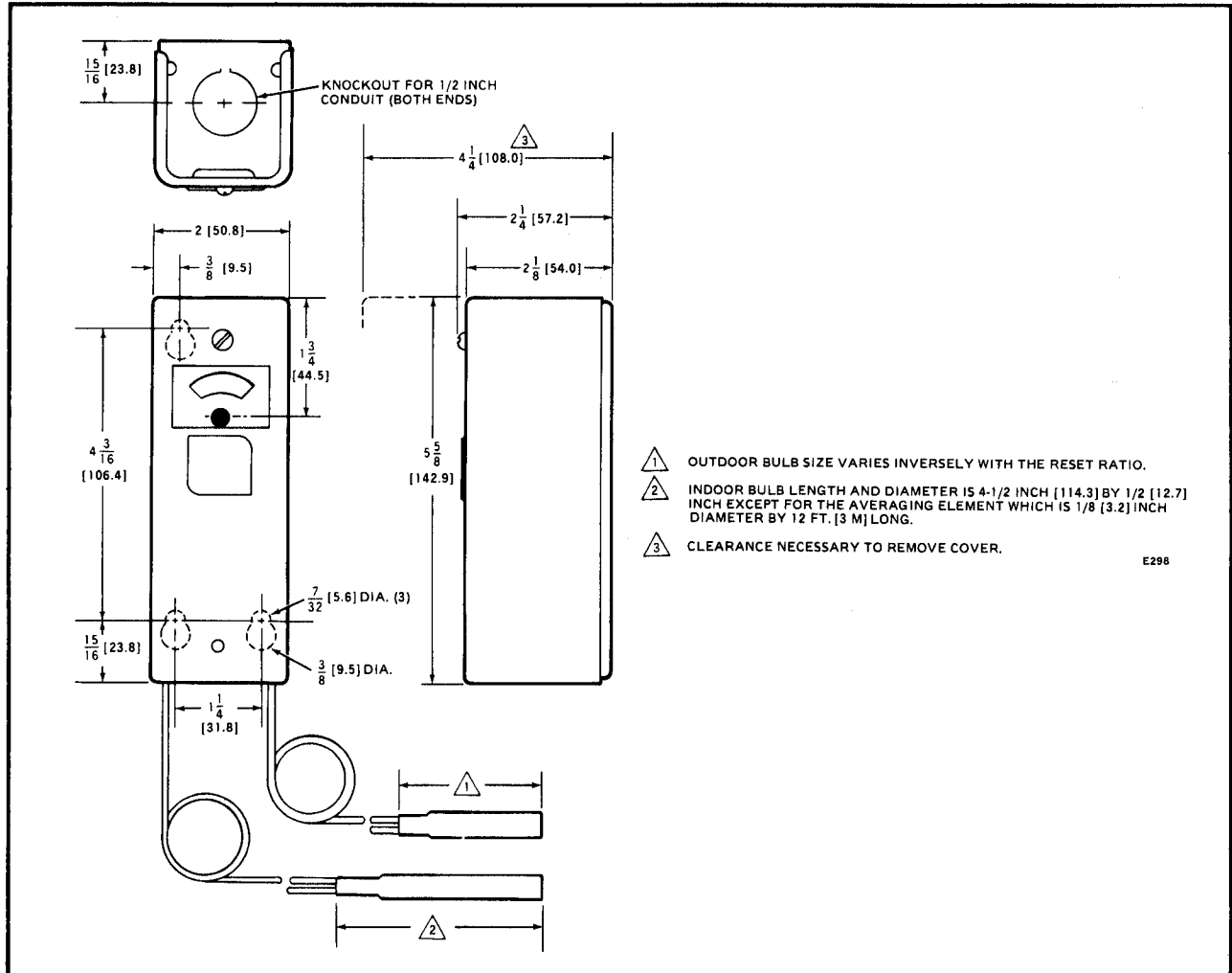


FIG. 1--APPROXIMATE INSTALLATION DIMENSIONS IN IN. [MM IN BRACKETS].

## SELECTING THE RESET RATIO

The reset ratio is not adjustable and must be specified when the control is ordered. The ratio should be selected to provide a complete range of heating medium temperatures when the outdoor temperature goes from 70 F [21 C] to the outdoor design temperature.

Sometimes experience indicates that the reset ratio that seems to be indicated will not compensate for a system variable such as heating plant recovery rate or duct sizing. In such cases, the ratio selection should be modified to meet the situation.

To select the reset ratio needed, refer to the appropriate section below. The first section, Typical Reset Ratios, shows how to quickly select the best ratio for given conditions of design temperature and heating medium temperature. The second section, Using Graphs to Determine Suitable Reset Ratios, shows how to determine if a given reset ratio is suitable for a given set of conditions.

### TYPICAL RESET RATIOS

Typical reset ratios for hydronic heating systems are given in Table I. The 3-1/2:1 ratio is most typically used in warm air or cooling applications. (Characteristics of these reset ratios are shown in Figs. 2-5.)

### USING GRAPHS TO DETERMINE SUITABLE RESET RATIOS

The graphs, Figs. 2-5, describe the response characteristics of the four reset ratios available. Use the following

method to determine which ratios are suitable for a particular installation. Unless experience dictates otherwise, start with the 1:1 ratio, Fig. 3.

1. Find the outdoor design temperature point on the scale at the bottom of the graph and draw a vertical line to the top of the graph (as line "A," Fig. 3).

2. Find the design heating medium temperature for the system and draw a horizontal line at that point (as line "B," Fig. 3). Lines "A" and "B" will cross.

3. From the point of intersection of "A" and "B," draw a line parallel to the minimum and maximum lines on the graph (as line "C"). Point "D" is the proper temperature set point. If this setting is not within the limits of the device, select the reset ratio that seems to be indicated, and repeat procedure.

TABLE I—SELECTION OF RATIO

OUTDOOR DESIGN TEMPERATURE	DESIGN HEATING MEDIUM TEMPERATURE					
	100 F [38 C]	120 F [49 C]	140 F [60 C]	160 F [71 C]	180 F [82 C]	200 F [93 C]
50 F [10 C]	1:1-1/2	—	—	—	—	—
30 F [-1 C]	1-1/2:1	1:1	1:1-1/2	—	—	—
10 F [-12 C]	—	1-1/2:1	1:1	1:1-1/2	—	—
0 F [-18 C]	—	1-1/2:1	1:1	1:1	1:1-1/2	—
-10 F [-23 C]	—	—	1-1/2:1	1:1	1:1-1/2	1:1-1/2
-20 F [-29 C]	—	—	1-1/2:1	1:1	1:1	1:1-1/2
-30 F [-34 C]	—	—	1-1/2:1	1:1	1:1	1:1

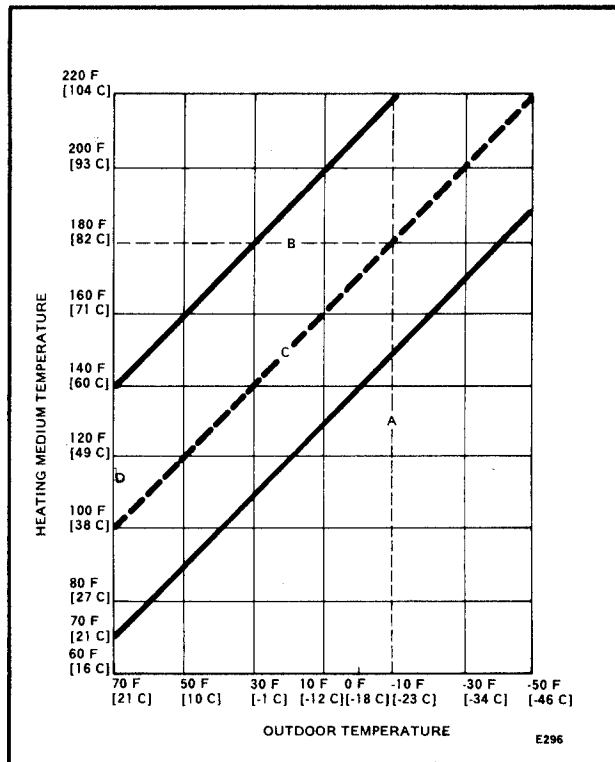
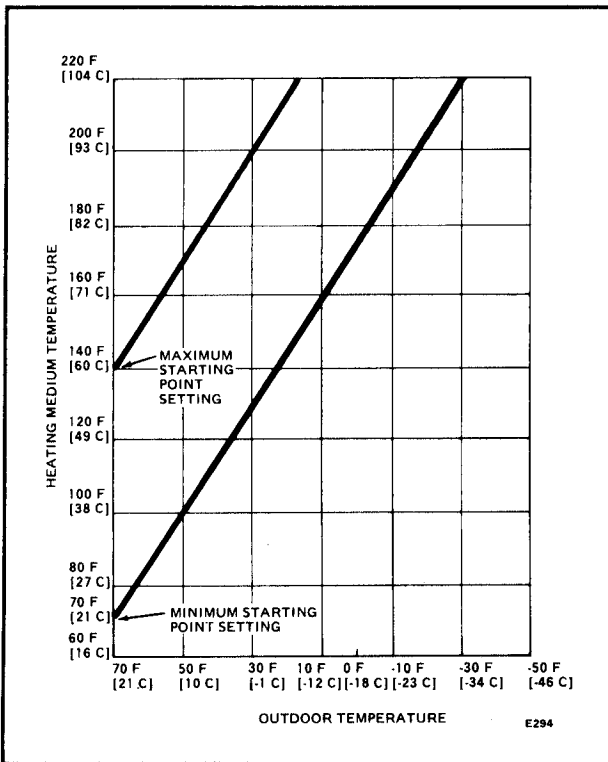


FIG. 2—GRAPH FOR 1:1-1/2 RATIO.

FIG. 3—GRAPH FOR 1:1 RATIO.

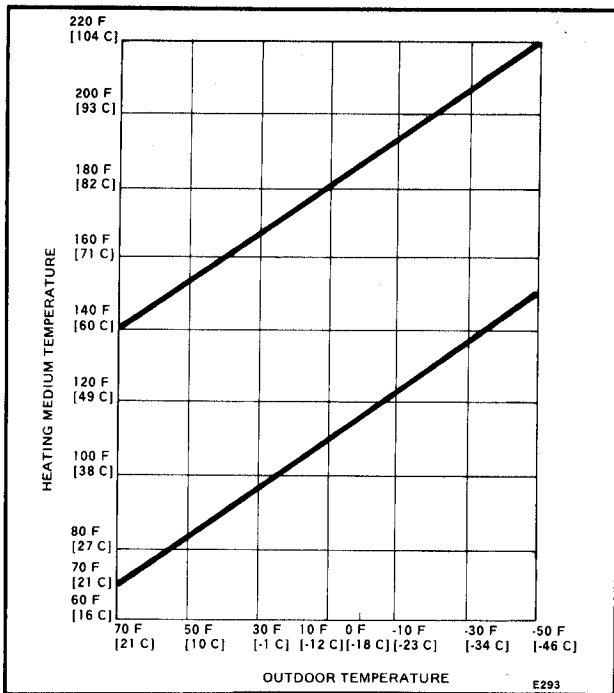


FIG. 4—GRAPH FOR 1-1/2:1 RATIO.

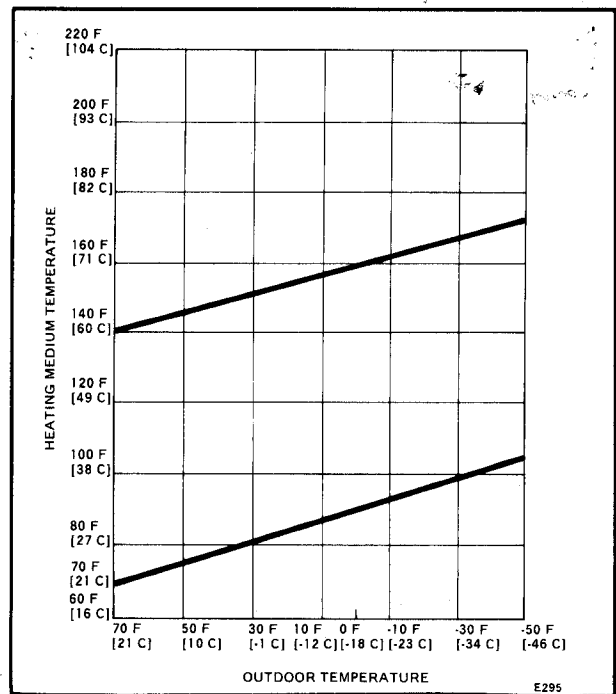


FIG. 5—GRAPH FOR 3-1/2:1 RATIO.

## INSTALLATION

### WHEN INSTALLING THIS PRODUCT . . .

1. Read these instructions carefully. Failure to follow them could damage the product or cause a hazardous condition.
2. Check the ratings given in the instructions and on the product to make sure the product is suitable for your application.
3. Installer must be a trained, experienced service technician.
4. After installation is complete, check out product operation as provided in these instructions.

### LOCATION

Mount the T991B case where temperatures will not exceed 125 F [52 C]. Follow instructions or recommendations supplied by the equipment manufacturer, if available.

The length of tubing on either bulb may limit the choice of locations. Sharp bends or kinks in the capillary tubing will affect the efficiency of the controller and must be avoided. Excess tubing should be carefully coiled and left beside the T991B.

### MOUNTING THE CONTROLLER

Refer to Fig. 1 for location of mounting holes. Remove the cover from the controller and fasten the case securely to a flat surface. The controller may be mounted in any position.

### MOUNTING THE INDOOR SENSING ELEMENT

#### WARM AIR APPLICATION

**BULB MODELS**—The plenum bulb should be mounted

inside the plenum chamber of the furnace where the hot air has free circulation around it, but far enough from the combustion chamber to prevent it from being affected by direct radiation. To prevent excessive air leakage and capillary tube damage, use the bulb holder accessory as shown in Figs. 6-8.

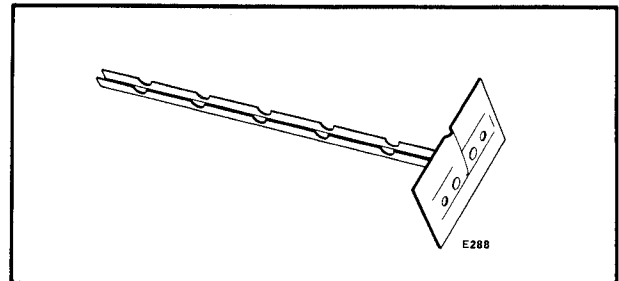


FIG. 6—PLENUM BULB HOLDER ACCESSORY.

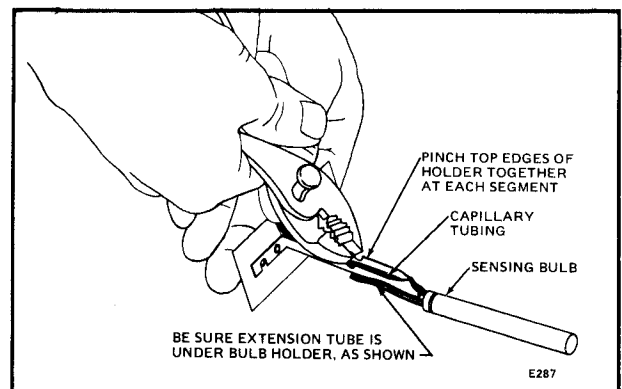


FIG. 7—INSTALLATION OF BULB IN PLENUM BULB HOLDER.

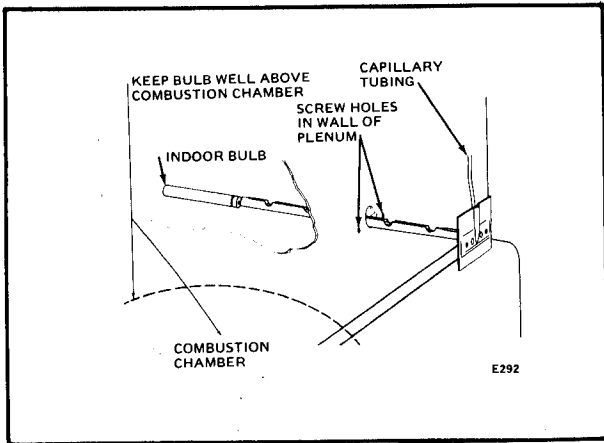


FIG. 8—MOUNTING THE BULB HOLDER IN FURNACE PLENUM.

**AVERAGING ELEMENT MODELS**—The averaging element should be mounted so that it is distributed evenly across the entire height and width of the duct. Fasten the element with perforated strap iron as shown in Fig. 9, or with capillary clips as shown in Fig. 10.

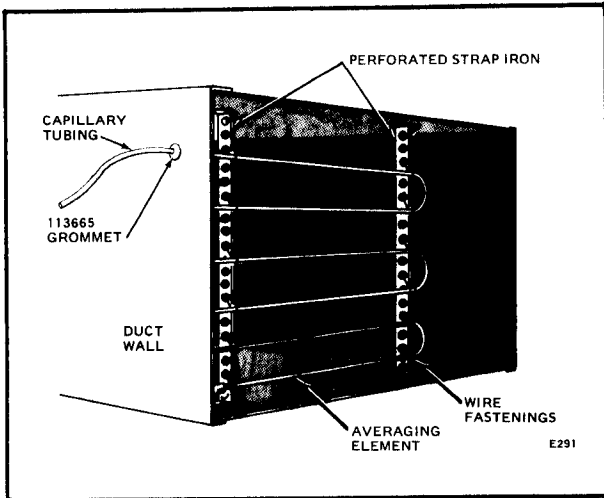


FIG. 9—AVERAGING ELEMENT MOUNTED WITH PERFORATED STRAP IRON.

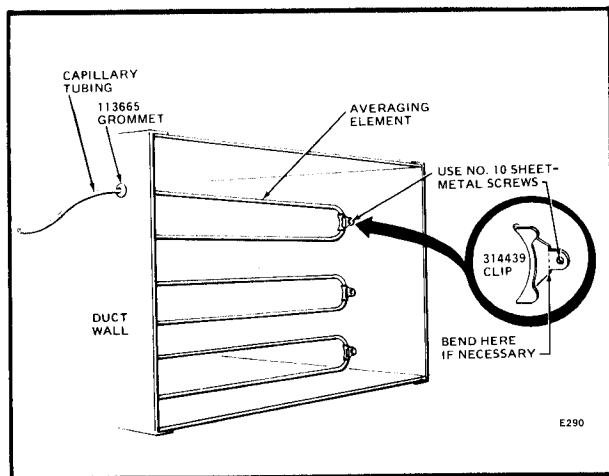


FIG. 10—ELEMENT MOUNTED WITH CAPILLARY CLIPS.

## HOT WATER BOILER INSTALLATIONS

The indoor bulb must be immersed in the boiler of hydronic heating systems. To mount the bulb, use an immersion well accessory (Fig. 11) or a compression fitting accessory (Fig. 12), or other mounting means recommended by boiler manufacturer. An immersion well should be used if high water turbulence or vibration is encountered at the bulb location.

These mounting accessories must be ordered separately. Refer to the SPECIFICATION section.

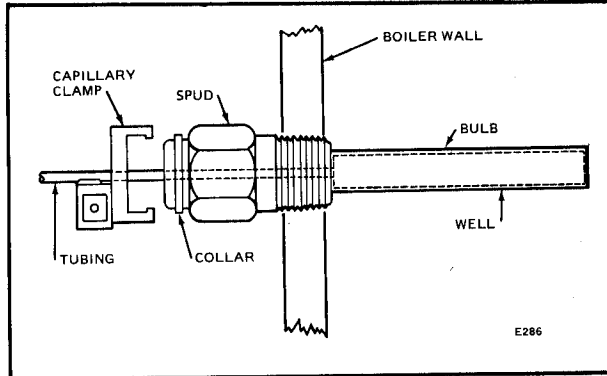


FIG. 11—IMMERSION WELL ACCESSORY.

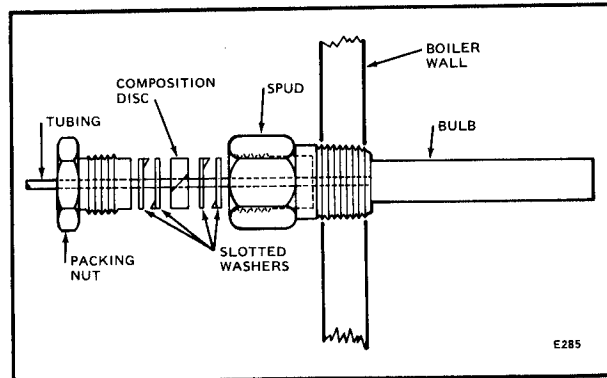


FIG. 12—COMPRESSION FITTING ACCESSORY.

## STRAP-ON MOUNTING

This section describes a strap-on mounting procedure for installing T991B Outdoor Reset Temperature Controller in hot water systems. In this type of installation, the indoor temperature controller bulb is mounted externally on the boiler discharge pipe rather than in an immersion well with a compression fitting. All other installation information in the literature accompanying this unit is applicable.

In retrofit applications, the strap-on mounting eliminates the costs and time consumed in draining the boiler and the system, installing the immersion well and bleeding the air from the system after refilling.

## LOCATION

The indoor bulb portion of the controller should be located at a point on the boiler discharge pipe that is approximately 3 ft [0.9 m] from the boiler. The controller and outdoor bulb should be mounted as indicated in the applicable installation sheet.

## OPERATION

External mounting of the sensor produces a slight offset in the temperature control point. Typically, the control temperature is increased up to 5 F [2.8 C] with a bare sensor strapped to the discharge pipe. Applying insulation around the sensor and pipe results in a decreased offset.

## MOUNTING

Mount the indoor bulb on the discharge boiler pipe as follows.

1. Secure controller bulb to pipe with duct hanger wire or metal hose clamps (Fig. 13, top).

### CAUTION

Do not overtighten clamps to point of distorting sensor bulb. Overtightening clamps will cause a significant shift in calibration.

(Steps 2 and 3 are optional and are to be used if large fluctuations in the ambient temperature occur near the pipe.)

2. Cover bulb and pipe with foam rubber insulation extending at least 6 in. [152 mm] beyond both ends of bulb (Fig. 13, bottom).

3. Secure foam rubber with duct tape. **DO NOT ALLOW DUCT TAPE TO CONTACT PIPE.**

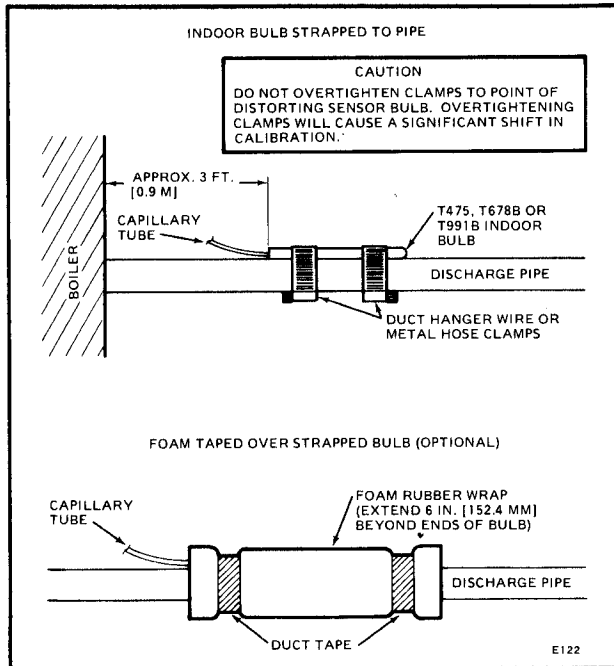


FIG. 13—STRAP-ON MOUNTING OF T991B INDOOR BULB ON A BOILER DISCHARGE PIPE.

## MOUNTING THE OUTDOOR BULB

The outdoor bulb should be installed in a shield and mounted with the shield in a horizontal position as shown in Figs. 14 and 15. Locate bulb where it will sense average weather conditions. However, structures with large glass areas absorb more radiant heat from the sun, and it may be preferable to mount the outdoor bulb where it will pick up the same sun effect. Mount bulb

high enough to prevent tampering or covering with snow, ice, or debris. Avoid vents from the house.

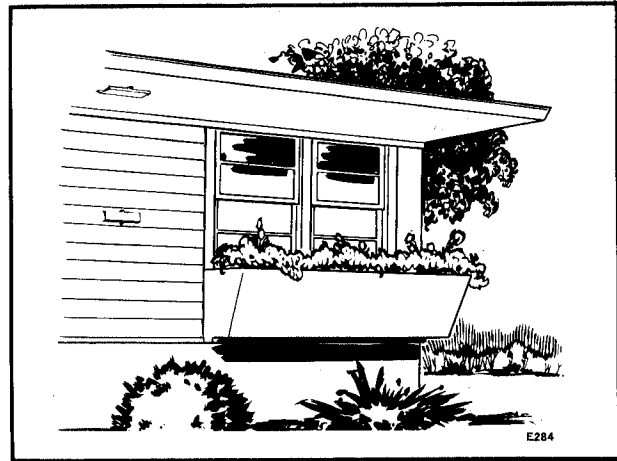


FIG. 14—TYPICAL LOCATIONS OF OUTDOOR BULB GUARD.

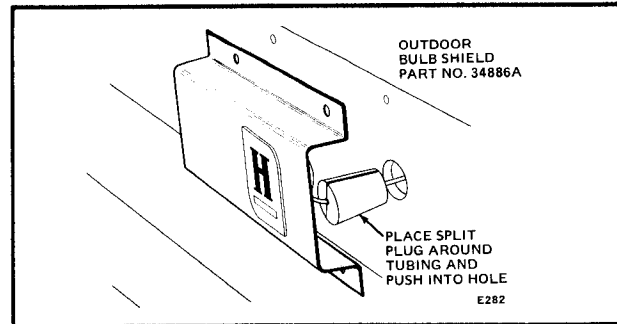


FIG. 15—MOUNTING THE OUTDOOR BULB GUARD TO WALL.

## WIRING

### CAUTION

Disconnect power supply before making wiring connections to prevent electrical shock and equipment damage.

All wiring must comply with applicable local codes and ordinances. Refer to information furnished by the system equipment manufacturer and to Fig. 16, which shows a typical application.

The T991B is rated for 24 Vac. Control case has knockouts for 1/2 in. conduit.

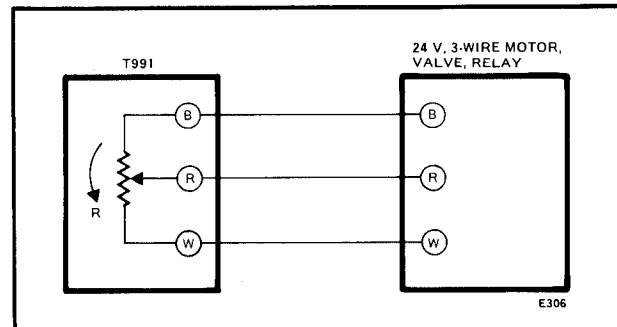


FIG. 16—TYPICAL HOOKUP.

# SETTINGS AND ADJUSTMENTS

## TEMPERATURE SET POINT

The set point of the controller is adjustable from 70 F to 140 F [21 C to 60 C]. The T991B resets this temperature set point as the outdoor temperature changes from 70 F [21 C], according to the reset ratio of the control. When outdoor bulb is at 70 F [21 C], the control point equals the set point. Adjust the initial set point by turning dial with a screwdriver.

## SETTING HINT

If in doubt as to the correct initial temperature set point, it's better to start on the low side of the range and work upward—a requirement for additional heat is easily detected. This way you will get the maximum economy from the system. Too high an initial temperature setting is difficult to detect, reduces economy, and results in poorer control.

## RESET RATIO

The reset ratio expresses the amount of change in the heating medium control point caused by a change in outdoor temperature. It is the ratio of outdoor temperature change to heating medium control point change. Notice that this is an inverse ratio; when the outdoor temperature goes down, the control point goes up.

The table below shows the change in theoretical control point that would result from a 20 F [11 C] degree change in outdoor air temperature.

RESET RATIO	SHIFT IN CONTROL POINT
1 to 1	20.0 F [11 C]
1-1/2 to 1	13.3 F [ 7 C]
1 to 1-1/2	30.0 F [17 C]
3-1/2 to 1	5.7 F [ 3 C]

When the sensed outdoor temperature is below 70 F [21 C], each degree of fall causes a related increase in control point above the dial-indicated set point temperature. Thus, on a controller with a reset ratio of 1 to 1, an outdoor temperature of 60 F [16 C] will cause a reset of 10 F [5.6 C] degrees (70 F minus 60 F = 10 F [21.1 C minus 15.5 C = 5.6 C]). The control point, then, will be 10 F [5.6 C] degrees higher than the set point temperature indicated on the scale.

## THROTTLING RANGE

Throttling range is a measurement of the change in heating medium temperature required to drive the controlled Modutrol motor or valve through its entire stroke. The throttling range is set at 10 F [-12 C] when shipped. It is adjustable from 3 to 30 F [2 C to 17 C]. Refer to Figs. 17 and 18.

To maintain accurate control of the heating medium, the throttling range should be kept as low as possible while still maintaining stable operation. An initial setting of 10 F [-12 C] degrees is recommended. If this produces hunting, it should be increased in small increments until the system stabilizes.

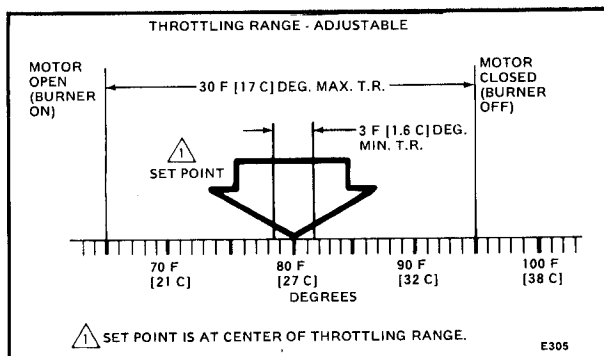


FIG. 17—RELATIONSHIP BETWEEN SET POINT AND THROTTLING RANGE.

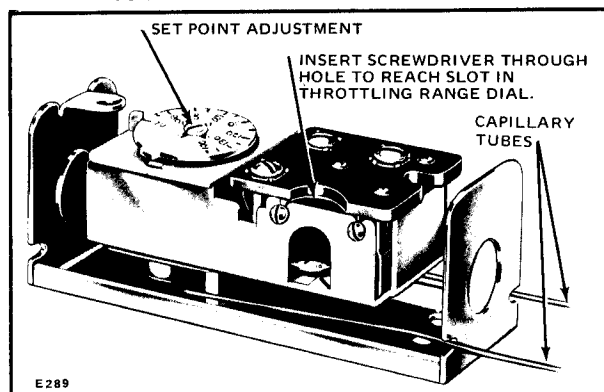


FIG. 18—INTERNAL VIEW OF T991B, SHOWING THROTTLING RANGE ADJUSTMENT DIAL.

# CALIBRATION

The T991B is carefully calibrated at the time of manufacture and will maintain adjustment for years of normal service. Poor control can be the result of many factors, and field recalibration is not recommended. If reason exists for verifying calibration, this can be performed with reasonable accuracy with a good thermometer and an ohmmeter.

## TO CHECK CALIBRATION

1. Determine the outdoor air temperature as accurately as possible at the location of the outdoor bulb. Subtract this temperature from 70 F [21 C] (the calibration reference point of the T991B) to find the DIFFERENCE TEMPERATURE.

(continued on next page)



2. Multiply the DIFFERENCE TEMPERATURE by the RESET FACTOR (see table below) to find the amount of shift, or "reset," in the control point.

RESET RATIO	RESET FACTOR
1 to 1	1.0
1 to 1-1/2	1.5
1-1/2 to 1	0.667
3-1/2 to 1	0.29

3. Determine the temperature of the heating medium at the indoor bulb and subtract the amount of the control point reset (step 2) to find the THEORETICAL SET POINT.

4. Adjust the actual set point (on the scale of the T991B) to the THEORETICAL SET POINT.

NOTE: Check the outdoor air and heating medium temperatures to make certain that they have not changed from the readings used to make the above computations. (Calibration check must be carried out with reasonable speed.)

5. With the device adjusted to the THEORETICAL SET POINT (step 3) and with the temperature conditions at the bulbs the same as those used to make previous computations, determine the resistance in each leg of the potentiometer. To do this, measure the

resistance across terminals R and W and across terminals R and B.

If the ohmmeter is accurate, and all temperature measurements and settings were precise, the two readings should be equal when the device is in calibration. However, within the accuracy of a field check, a difference in readings of 10 ohms may be considered reasonable. The resistance indicated should be approximately 70 ohms.

6. If the resistance difference found in step 5 exceeds 10 ohms, use the calibration wrench. (See ACCESSORIES under SPECIFICATIONS) to make the calibration adjustment (Fig. 18).

Find the difference between the THEORETICAL SET POINT and the actual operating point—note this reading by observing the dial markings and the indicator. For example, the THEORETICAL SET POINT is 70 F [21 C], but the actual operating point is 50 F [10 C] as indicated by the dial. This means that the control is off calibration by 20 F [11.1 C] degrees (too low). Insert the calibration wrench into the slots of the dial (see Fig. 18). Rotate the dial and the wrench until the tabs of the wrench line up with the slots in the brass calibration nut under the dial. Note this reading and turn both the calibration nut and the dial up (counterclockwise) 20 F [11.1 C]. Recheck the operating point to determine if calibration is correct. If not, repeat the preceding procedure.

## OPERATION AND CHECKOUT

The T991B senses outdoor conditions that result in a need for more or less heat indoors. The furnace or boiler is controlled to compensate for the sensed outdoor temperature changes. The result is a more consistent comfort level in the living space.

The T991B has two sensing elements—one senses the outdoor temperature; the other senses the temperature of the furnace or boiler. When outdoor temperature falls, the outdoor reset control provides increased burner operation. Consequently, more heat is available to the living space when needed.

With each change in outdoor temperature below 70 F [21 C], the T991B causes a related change in the heating medium temperature through increased or decreased burner operation.

Outdoor temperature rises—heating medium temperature decreases.

Outdoor temperature falls—heating medium temperature increases.

To produce this action, the outdoor reset control shifts its control point in the direction opposite the outdoor temperature change. This shift in control point is known as reset. Reset does not cause a change in the temperature dial setting; it shifts the point at which the switch breaks the circuit.

The amount of reset that occurs in any case depends upon the difference between the actual outdoor temperature and 70 F [21 C], and the reset ratio of the T991B.

### CHECKOUT

Operate the control to make sure that it operates properly; refer to operation and setting and adjustment information. Check the wiring connections carefully. Check controlled motor or valve operation according to installation information furnished with the device.

Dear Customer,

We welcome your comments and suggestions for improving this publication. Your assistance is greatly appreciated and will enable us to provide better technical information for you.

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