

# Filled System Thermometers

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The Measurement, Control & Automation Association  
P.O. Box 3698  
Williamsburg, VA 23187  
Voice and Fax: (757) 258-3100 – [mcaa@measure.org](mailto:mcaa@measure.org)  
Visit our Website at <http://www.measure.org>

## FILLED SYSTEM THERMOMETERS

### 1. Scope and Purpose

1.1 This standard applies to Filled System Thermometers for industrial use.

Note: This standard is also applicable to Filled Systems used in other devices such as transmitters or controllers.

1.2 The purpose of this standard is to establish uniformity of terminology, (including symbols) definitions and dimensions for Filled System Thermometers.

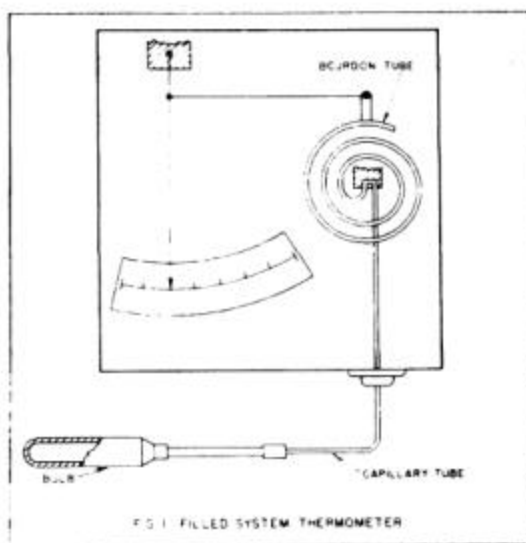
1.3 A further purpose is to promote interchangeability of Filled System Thermometers by establishing a series of preferred bulb dimensions. These dimensions will permit interchangeability of Filled System Thermometers, Bimetallic Thermometers, Resistance Thermometers and Thermocouple Thermometers in the Bushings and Wells defined in

Note: Bulbs are dimensioned only to the extent necessary for physical interchangeability in the Bushings and Wells defined in SAMA RC17.

1.4 The listing of a size does not imply that it is suitable for use with all types of actuation. Consult manufacturers for available sizes and for limitations on immersion length.

### 2. Terminology and General Definitions

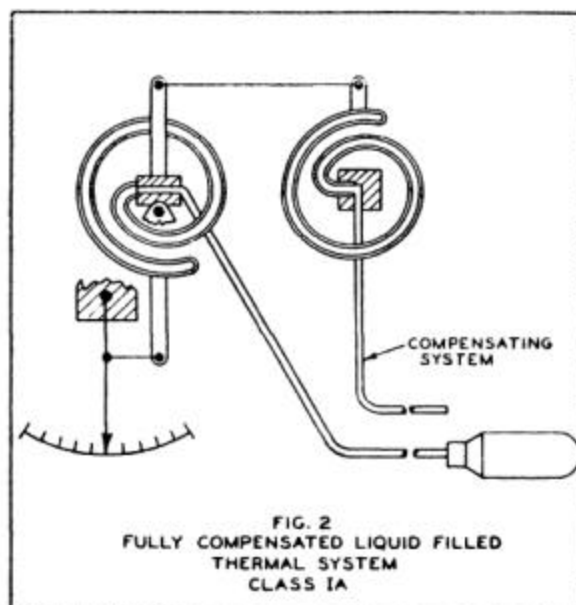
2.1 Filled System Thermometer. A Filled System Thermometer is a temperature measuring instrument comprising a Thermal System and associated means for indicating or recording. (See Fig. 1)



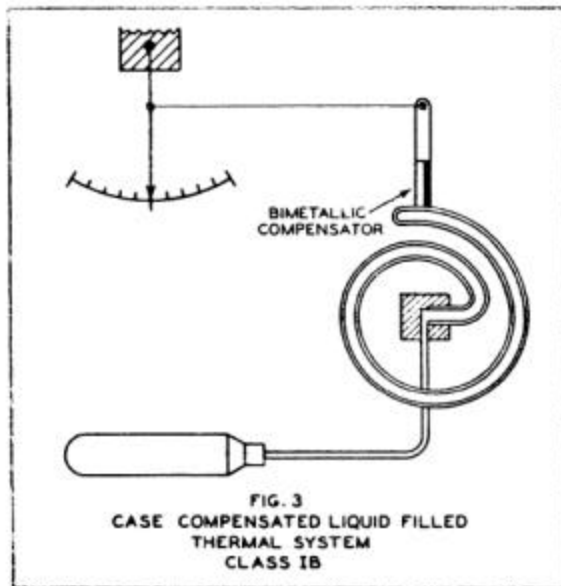
2.2 Thermal System. A Thermal System is a closed system containing a fluid fill (the temperature sensitive medium) and comprising a Bulb, an expansible device (Bourdon tube, diaphragm, capsule, bellows, etc.) and a capillary tube operatively connecting the two. The following classes of Thermal Systems are in general use. (See Fig. 1)

2.2.1 Liquid Filled Thermal System. A Liquid Filled Thermal System (Class 1) is a Thermal System completely filled with a liquid (other than a metal such as mercury) and operating on the principle of liquid expansion. The system is usually compensated for ambient temperature effects either:

- (a) With full compensation (Class 1A), the compensating means being a second Thermal System minus the bulb, or equivalent means of compensation. (See Fig. 2)

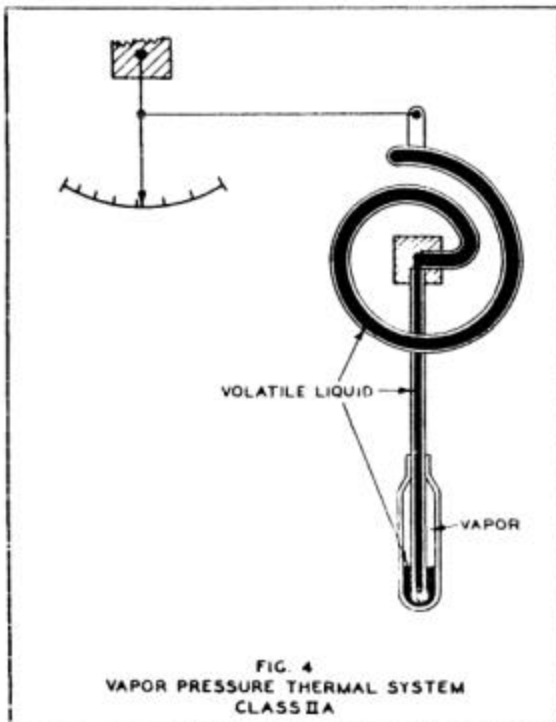


- (b) With compensating means within the case only (Class 1B). (See Fig. 3)

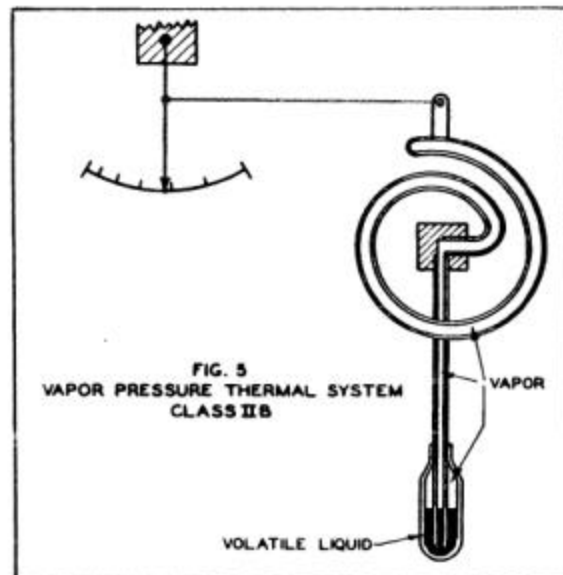


2.2.2 Vapor Pressure Thermal System. A Vapor Pressure Thermal System (Class II) is a Thermal System partially filled with a volatile liquid and operating on the principle of vapor pressure. Four types are employed:

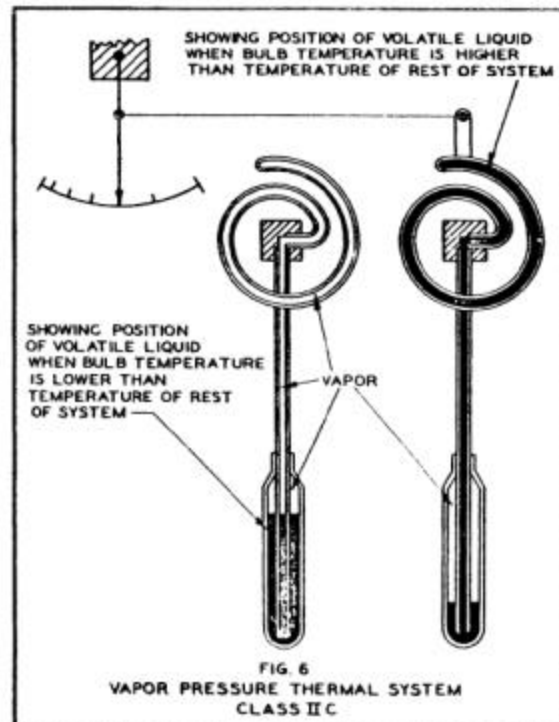
(a) Designed to operate with the measured temperature *above* the temperature of the rest of the Thermal System (Class IIA). (See Fig. 4)



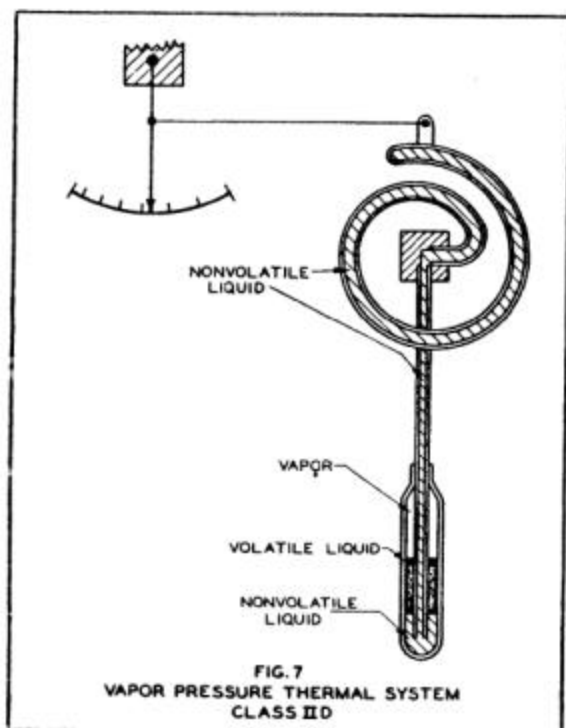
(b) Designed to operate with the measured temperature *below* the temperature of the rest of the Thermal System (Class IIB). (See Fig. 5)



(c) Designed to operate with the measured temperature *above and below* the temperature of the rest of the Thermal System (Class IIC). This type normally requires a larger Sensitive Portion than Class IIA or IIB. (See Fig. 6)

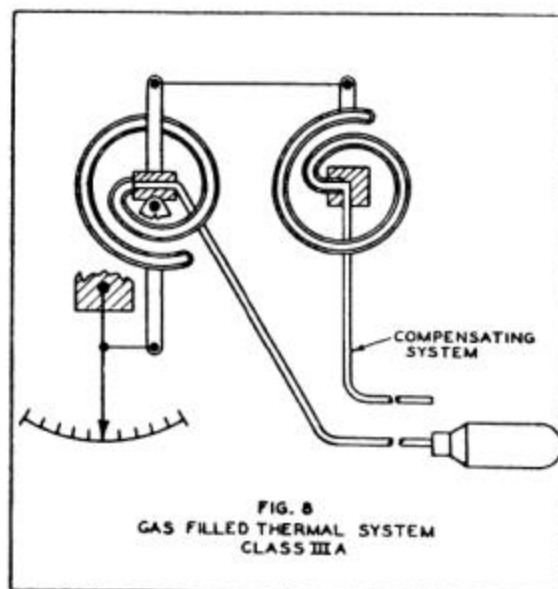


- (d) Designed to operate with the bulb temperature above, below and at the temperature of the rest of the Thermal System (Class IID). (See Fig. 7) In this type the volatile liquid is confined to the Sensitive Portion and a second relatively non-volatile liquid is used to transmit the vapor pressure to the expansible device.

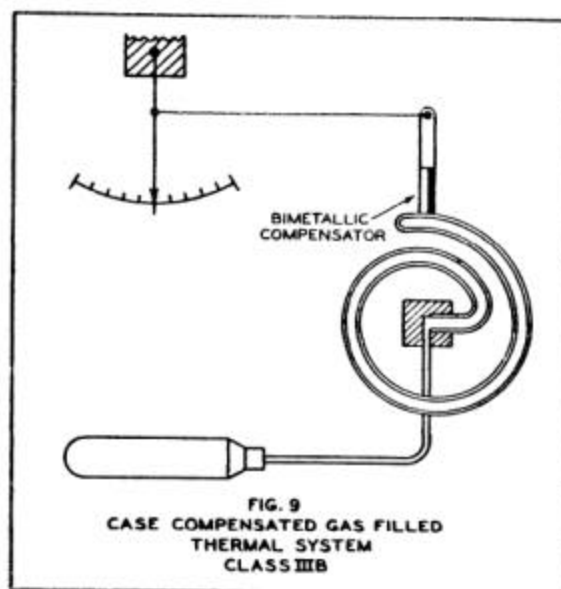


**2.2.3 Gas Filled Thermal System.** A Gas Filled Thermal System (Class III) is a Thermal System filled with a gas and operating on the principle of pressure change with temperature change. The system is usually compensated for ambient temperature effects, either:

- (a) With a second Thermal System minus the bulb, or equivalent means of compensation (Class IIIA). (See Fig. 8)

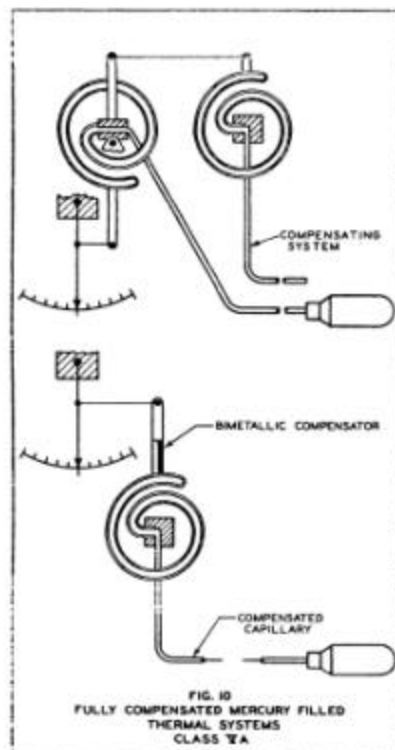


- (b) With compensating means within the case only (Class IIIB). (See Fig. 9)

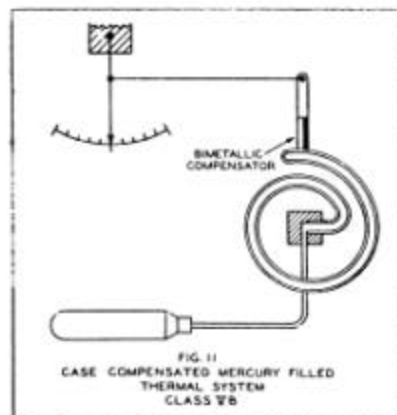


**2.2.4 Mercury Filled Thermal System.** A Mercury Filled Thermal System (Class V) is a Thermal System completely filled with mercury or mercury-thallium eutectic amalgam operating on the principle of liquid expansion. The system is usually compensated for ambient temperature effects, either

- (a) With full compensation (Class VA), the compensating means being a second Thermal System minus the bulb, or equivalent means of compensation. (See Fig. 10)



- (b) With compensating means within the case only (Class VB). (See Fig. 11)



**2.3 Bulb.** A Bulb is the sensing means of a Filled System Thermometer comprising a Sensitive Portion, its Extension and a Connector. Two commonly used types are the Plain Bulb and the Union Connected Bulb. (See Figs. 12 and 15)

**2.3.1 Sensitive Portion.** A Sensitive Portion is that portion of a Bulb enclosing the fluid fill intended to measure temperature. (See Fig. 12)

**2.3.2 Extension.** An Extension is that portion of a Bulb which extends between the Sensitive Portion and the Connector. (See Fig. 12)

**2.3.2.1 Bendable Extension.** A Bendable Extension is an Extension designed to be bent incident to installation.

**2.3.2.2 Rigid Extension.** A Rigid Extension is an Extension not designed to be bent incident to installation.

**2.3.2.3 Rigid Angle Extension.** A Rigid Angle Extension is a Rigid Extension, part of which makes an angle other than 180 degrees with the Sensitive Portion.

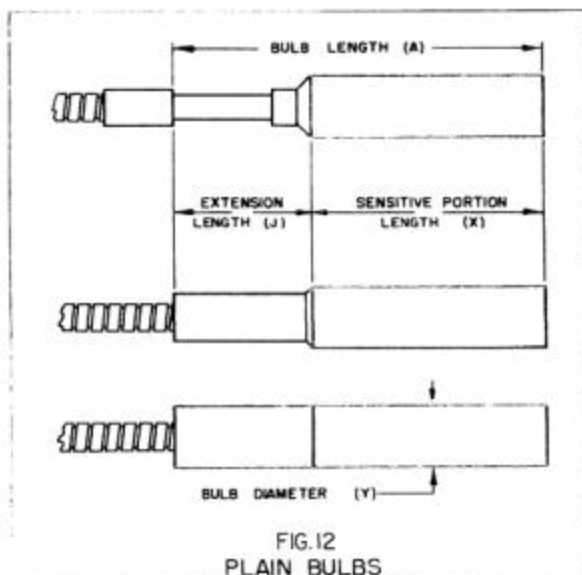
**2.3.3 Connector.** A Connector is a connecting means between the Extension and the connecting tube.

**2.3.4 Bulb Length.** The Bulb Length (Symbol A) of a Plain Bulb is the length from the free end of the Bulb to the Connector except when the Connector is of the same diameter as the Extension. In the latter case, the Bulb Length is the overall length. (See Fig. 12) The Bulb Length of a Union Connected Bulb is the length from the free end of the Bulb to the underside of the seating part. (See Fig. 15)

**2.3.5 Sensitive Portion Length.** The Sensitive Portion Length (Symbol X) is the length of the Sensitive Portion (including end wall thickness). (See Fig. 12)

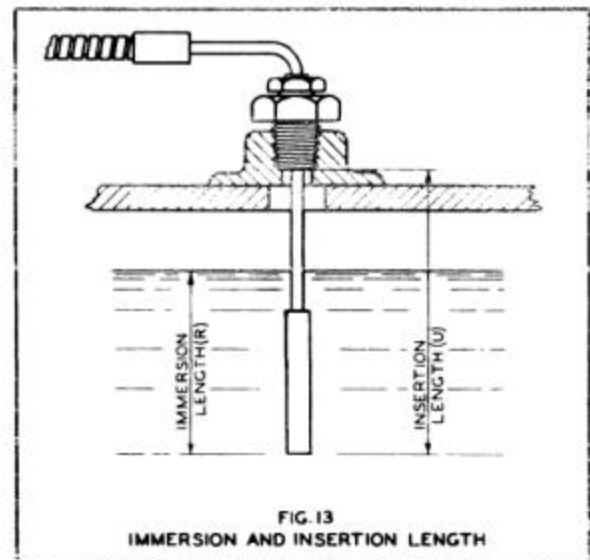
**2.3.6 Bulb Diameter.** The Bulb Diameter (Symbol Y) is the outside diameter of the Sensitive Portion. (See Fig. 12)

**2.3.7 Extension Length.** The Extension Length (Symbol J) is the length from the Sensitive Portion of the Bulb to the Connector except where the Connector is the same diameter as the Extension. In the latter case, the Extension Length is the length from the Sensitive Portion to the connecting tube. (See Fig. 12)



**2.3.8 Immersion Length.** The Immersion Length (Symbol R) is the length from the free end of the Bulb or Well to the point of immersion in the medium, the temperature of which is being measured. (Physically this point may be indistinguishable but is important for proper accuracy). (See Fig. 13)

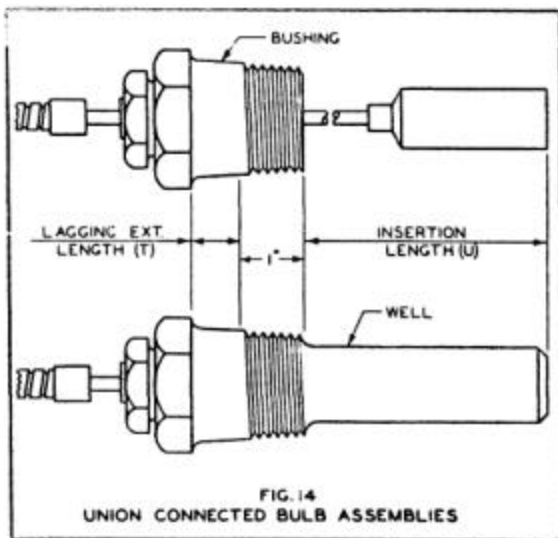
**2.3.9 Insertion Length.** The Insertion Length (Symbol U) is the length from the free end of the Bulb or Well to, but not including, the external threads or other means of attachment to a vessel. (See Fig. 13)



**2.4 Plain Bulb.** A Plain Bulb is a Bulb not provided with a Union Connection or other means for attachment to a vessel. (See Fig. 12)

**2.5 Union Connected Bulb Assembly.** A Union Connected Bulb Assembly is a Union Connected Bulb and means such as a Bushing, Flange or Well for pressure-tight attachment to a vessel. (See Fig. 14)

**2.5.1 Union Connected Bulb.** A Union Connected Bulb is a Bulb provided with a Union Connection for installation. (See Fig. 15)

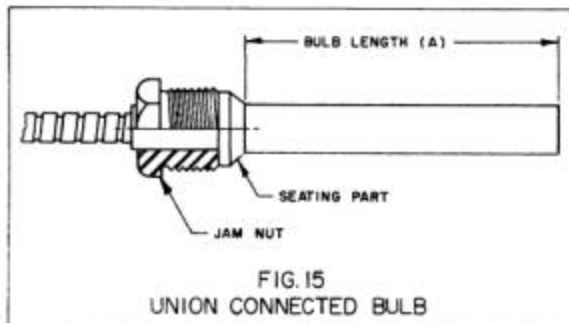


**2.7.1 Lagging Extension.** A Lagging Extension is that portion of a Bushing or Well, above the external threads, intended to extend through the lagging of a vessel. (See Fig. 14)

**2.7.2 Lagging Extension Length.** The Lagging Extension Length (Symbol T) is the length from the lower end of the external threads of a Bushing or Well to the upper end of the portion intended to extend through the lagging of a vessel, less one inch allowance for threads. (See Fig. 14)

Note: For purposes of uniform dimensioning, the allowance for thread length is one inch, regardless of pipe thread size.

**2.5.1.1 Union Connection.** A Union Connection is that portion of a Union Connected Bulb which comprises a seating part either rigidly attached to or adjustable along the Extension and a jam nut for attachment to a Bushing, Flange or Well. (See Fig. 15)



**2.7.3 External Threads for Bushings or Wells.** External threads for Bushings or Wells shall be American Standard Taper Pipe Threads (NPT) of the American Standards Association.

**2.8 Flange.** A Flange is a fitting provided with a flanged surface for attachment to a vessel and with internal threads and seating means for mounting a temperature sensing element therein. A Flange does not have a pressure-tight sheath below the flanged surface.

**2.9 Sheath.** A Sheath is a receptacle adapted to receive a temperature sensitive element but not provided with external threads or other means for pressure-tight attachment to a vessel.

**2.6 Bushing.** A Bushing is a fitting provided with external threads for attachment to a vessel and with internal threads and seating means for mounting a temperature sensing element therein. A Bushing does not have a pressure-tight sheath below the external threads. (See Fig. 14)

**2.10 Wet and Dry Bulb Assembly.** A Wet and Dry Bulb Assembly is an assembly consisting of two Bulbs, one to be identified as a Wet and one as a Dry Bulb.

**2.7 Well.** A Well is a pressure-tight receptacle adapted to receive a temperature sensing element and provided with external threads or other means for pressure-tight attachment to a vessel. (See Fig. 14)

**2.10.1 Wet Bulb.** A Wet Bulb is a Bulb, used in a humidity measuring system, having means providing for the continuous evaporation of moisture from the temperature Sensitive Portion of the Bulb.



2.10.2 *Dry Bulb.* A Dry Bulb is a Bulb used in a humidity measuring system for measuring the temperature of the surrounding air.

2.11 *Finned Bulb.* A Finned Bulb is a Bulb, a portion of which is provided with external fins.

2.12 *Capillary Bulb.* A Capillary Bulb is a Bulb, the Sensitive Portion of which is made of capillary tubing. Tubing exceeding 1/4" in diameter is not considered capillary tubing.

2.12.1 *Preformed Capillary Bulb.* A Preformed Capillary Bulb is a Capillary Bulb, the Sensitive Portion of which is coiled by the manufacturer and is not designed to be bent incident to installation.

2.12.2 *Bendable Capillary Bulb.* A Bendable Capillary Bulb is a Capillary Bulb, the Sensitive Portion of which is designed to be bent incident to installation.

2.13 *Averaging Bulb.* An Averaging Bulb is a Capillary Bulb, the Sensitive Portion of which is designed to be sensitive to the average of the temperatures along its length.

2.14 *Sanitary Bulb.* A Sanitary Bulb is a Bulb for use where sanitary requirements must be met, designed to prevent introduction or retention of foreign matter and to facilitate cleaning.

2.15 *Flush Bulb.* A Flush Bulb is a Bulb, the Sensitive Portion of which is inserted through an opening in the wall of a vessel, such as a mechanical mixer so that the Sensitive Portion forms substantially a continuation of the inner surface of the vessel.

Note: A Bulb may be a combination of two or more of the above mentioned types. Bulbs with protective coverings shall be designated with the protective covering material. For example:

1. Union Connected Fitted Dry Bulb
2. Plain Silver Plated Wet Bulb
3. Union Connected Angle Sanitary Bulb

### 3. Dimensions

3.1 *Insertion Lengths.* The Insertion Lengths (Symbol U) of Bulbs having non-adjustable seats shall be 2-1/2, 4-1/2, 7-1/2, 10-1/2, 16 and 24 inches, with tolerances as shown in Figs. 16, 17 and 18.

Note: A Bulb designed for a given Insertion Length, when used with a Bushing of a given Lagging Extension Length, will fit a Well of the same nominal diameter, the same Insertion Length and Lagging Extension Length. Also, two Bulbs designed for the same total of T and U will be physically interchangeable and usually identical, i.e., a Bulb designed for 4-1/2 inch U Length and 3 inch Lagging Length will fit a Well of 7-1/2 inch U Length and no lagging. Caution is advised in the reverse operation to be sure that immersion is adequate. (See Table I)

3.2 *Bulb Diameter.* The Bulb Diameter (Symbol Y) shall be 1/4, 3/8, 9/16, 11/16 or 7/8 inch with tolerances as shown in Figs. 16, 17 and 18.

3.3 *Lagging Extension Length.* The Lagging Extension Length, (Symbol T) if used, shall be 3 inches, except 2 inch Lagging Extension Length shall be used with 2-1/2 inch Insertion Length.

Note: Ordinarily, no Lagging Extension Length is used, i.e., T equals zero.

3.4 *Jam Nuts and Seating Parts.* Dimensions of jam nuts and seating parts shall be as shown in Figs. 16, 17 and 18. Dimensions not specified above nor shown in Figs. 16, 17 and 18 are not essential for interchangeability and are at manufacturer's option subject to ordinary engineering considerations, such as strength and suitability for purpose.

3.5 *Bushings and Wells.* Dimensions for Bushings and Wells for use with Union Connected Filled System Thermometer Bulbs and with other types of temperature sensing elements are given in SAMA RC17.



( 1 1/16 & 7/8 DIAMETER )



FILLED SYSTEM THERMOMETER BULB  
(  $\frac{9}{16}$  DIAMETER )

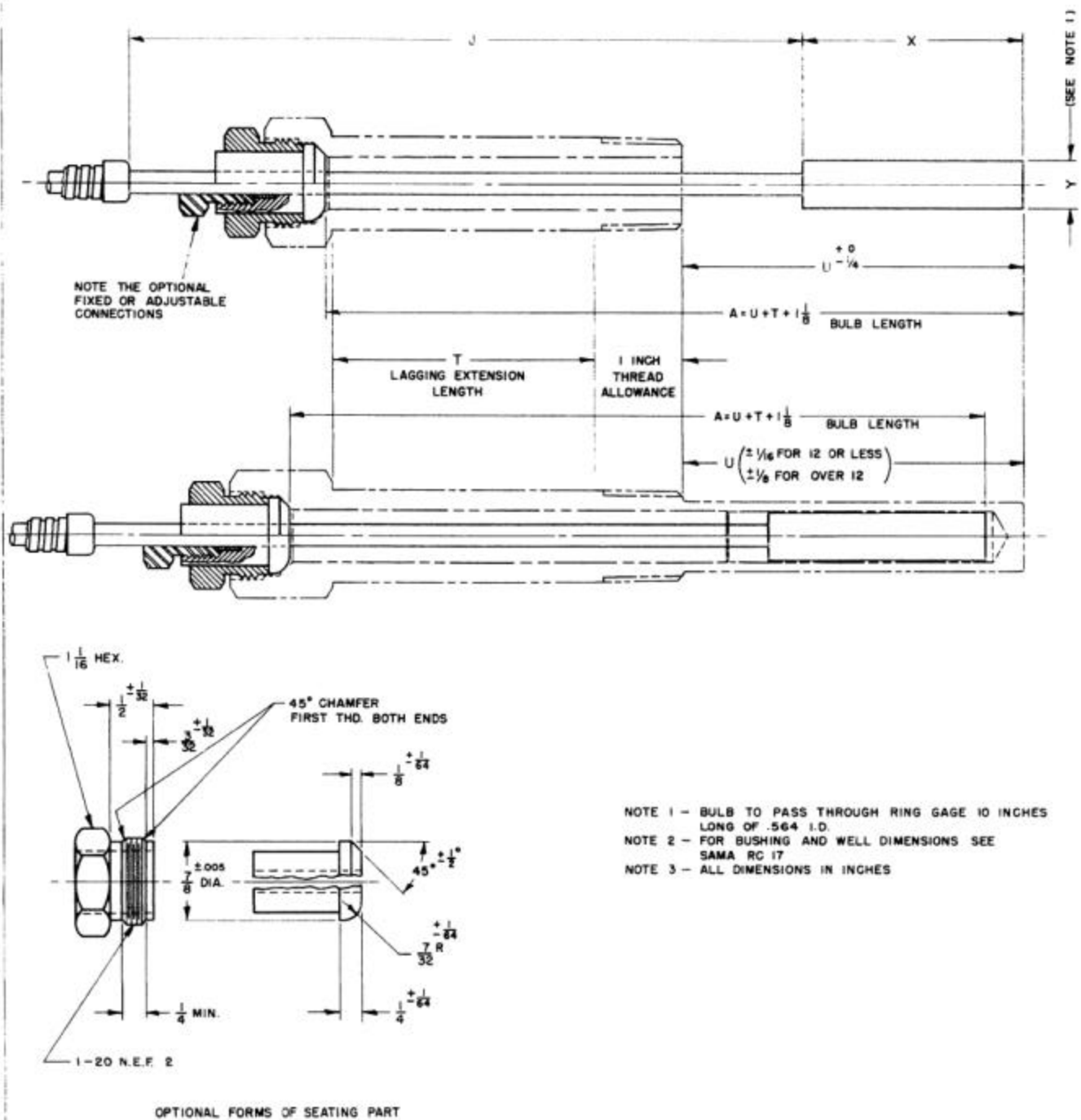


FIG. 17

FILLED SYSTEM THERMOMETER BULB  
( $\frac{1}{4}$  &  $\frac{3}{8}$  DIAMETER)

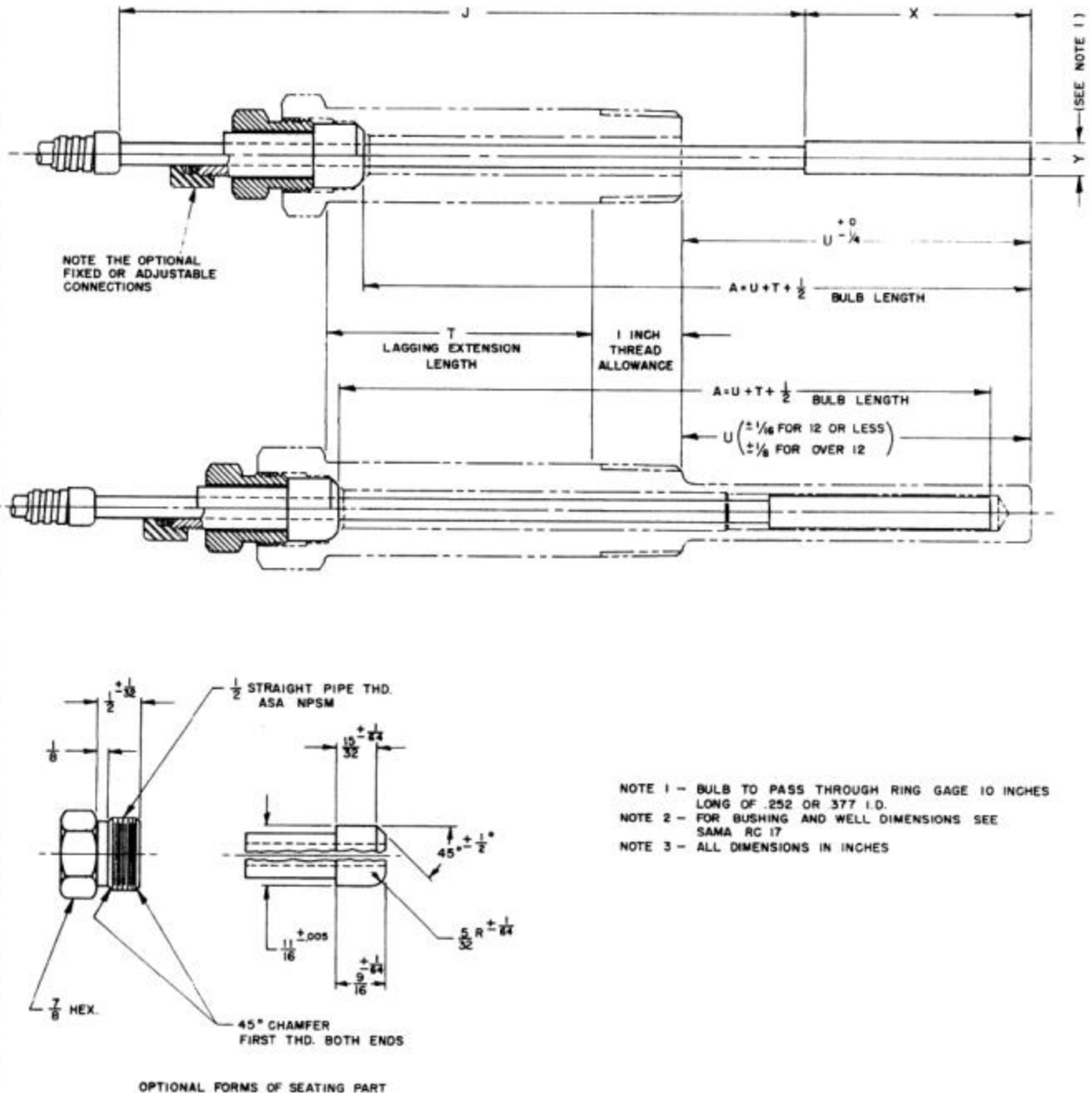


FIG. 18

TABLE I  
STANDARD INSERTION LENGTH DIMENSIONS  
FOR WELLS AND BULBS WITH BUSHINGS  
ALL DIMENSIONS IN INCHES

DIMENSIONS FOR ORDERING		DIMENSIONS FOR REFERENCE ONLY	
Insertion Length "U"	Lagging Extension Length "T"	Bulb Length "A" For 1/4 & 3/8 Bulbs	Bulb Length "A" For 9/16, 7/8 & 11/16 Bulbs
2-1/2	0	3	3-5/8
2-1/2	2	5	5-5/8
4-1/2	0	5	5-5/8
4-1/2	3	8	8-5/8
7-1/2	0	8	8-5/8
7-1/2	3	11	11-5/8
10-1/2	0	11	11-5/8
10-1/2	3	14	14-5/8
16	0	16-1/2	17-1/8
16	3	19-1/2	20-1/8
24	0	24-1/2	25-1/8
24	3	27-1/2	28-1/8

Notes:

- (1) The listing of a size does not imply that it is suitable for all types of actuation. Consult manufacturers for limitations on immersion length.
- (2) Bulb Length (Symbol A) is listed to indicate interchangeability, not as a dimension for ordering. Specify Well or Bulb with Bushing by Insertion Length (Symbol U) and Lagging Extension (Symbol T).