Thermocouple Thermometers (Pyrometers)

Original Publication 1963

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FOREWORD

Standards are adopted in the public interest and are designed to eliminate misunderstandings between the manufacturer and the purchaser and to assist the purchaser in selecting and obtaining without delay the proper product for his particular need. Existence of a Standard does not in any respect preclude any member or non-member from manufacturing or selling products not conforming with the standard.

INTRODUCTORY NOTES

This Standard supersedes Thermocouple Thermometers.

The purpose of this revision is to further clarify terminology and provide thermocouple element, well and protecting tube dimensional standards.

A further purpose is to promote interchangeability between Thermocouple Thermometers and other types of temperature measuring systems using the Bushings and Wells defined in .

CONTENTS

THERMOCOUPLE THERMOMETERS (PYROMETERS)

1. Scope and Purpose

1.1 This standard applies to Thermocouple Thermometers for industrial use.

Note: It is recognized that the term "Thermocouple Pyrometer" is much more commonly used than "Thermocouple Thermometer" but there seems little justification today for continuing the use of the former. The distinction between the terms "thermometer" (heat meter) and "pyrometer" (fire meter) goes back to the time when "thermometer" meant primarily a mercurial thermometer limited to low temperatures, whereas "pyrometer" meant a device for measuring high temperatures. Today various types of thermometers and thermocouples are used interchangeably over the range from subzero temperatures to over 1000°F, so that there is no longer a valid distinction between the terms "thermometer" and "pyrometer" on the basis of temperature range. This being the case, it is felt that the more basic term "thermometer" should be used.

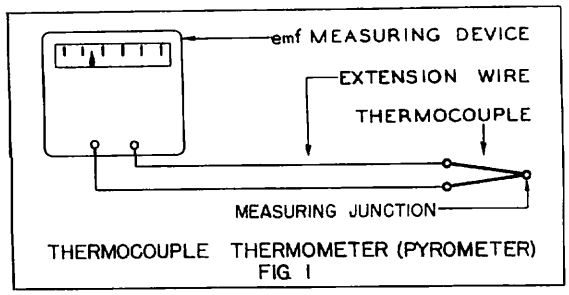
1.2 The purpose of this standard is to establish uniformity of terminology (including symbols), definitions and dimensions for Thermocouple Thermometers.

1.3 A further purpose is to promote interchangeability of Thermocouple Elements by establishing a series of preferred dimensions. These dimensions will permit interchangeability of Thermocouple Elements with Bulbs of Bimetallic Thermometers, Filled System Thermometers and Resistance Thermometers in the Wells defined in SAMA RC-17.

1.4 Listing of a size does not imply that it is suitable for all purposes. Consult manufacturers for limitations on immersion length.

2. Terminology and General Definitions

2.1 Thermocouple Thermometer (Pyrometer). A Thermocouple Thermometer (Pyrometer) is a temperature measuring system comprising an emf measuring instrument, a sensing means called a Thermocouple which produces an emf, and electrical conductors called Thermocouple Extension Wire for operatively connecting the two. (See Fig. 1)



THERMOCOUPLE THERMOMETER (PYROMETER)
FIG. 1

2.2 Thermocouple. A Thermocouple is the detecting means of a Thermocouple Thermometer comprising two conductors of dissimilar materials electrically insulated from each other except where connected together to form a Measuring Junction, the thermoelectric properties of the materials being such that, with the Reference Junction at a known temperature, the temperature of the Measuring Junction can be determined by measuring the emf developed. (See Fig. 1)

Note: A Thermocouple usually includes associated parts such as a Connection Head and Protecting Tube.

2.2.1 *Measuring Junction.* The Measuring Junction is the junction of a Thermocouple which is exposed to the temperature to be measured. This junction is sometimes called the "hot" junction. (See Fig. 1)

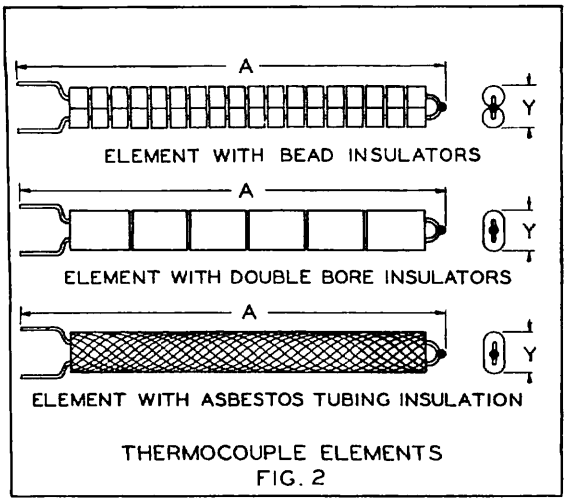
2.2.2 *Reference Junction.* The Reference Junction is the junction of a Thermocouple which is at a known or reference temperature. This junction is sometimes called the "cold" junction.

Note: In normal industry practice the Thermocouple element is terminated at the Connection Head. However, the Reference Junction is not ordinarily located in the Connection Head but is transferred to the instrument by the use of Thermocouple Extension Wire.

2.3 Thermocouple Extension Wire. Thermocouple Extension Wire is a pair of wires having such temperature-emf characteristics relative to the Thermocouple with which the wires are intended to be used that, when properly connected to the Thermocouple, the Reference

Junction is in effect transferred to the other end of the wires. (See Fig. 1)

2.4 Thermocouple Element. A Thermocouple Element is a Thermocouple designed for use as part of an assembly, such as a Thermocouple with Protecting Tube, but without associated parts such as Terminal Block, Connection Head or Protecting Tube. (See Fig. 2)

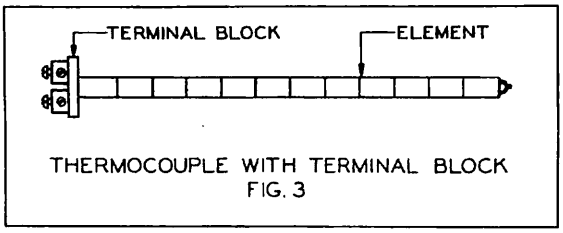


THERMOCOUPLE ELEMENTS
FIG. 2

2.4.1 *Thermocouple Element Length.* The Thermocouple Element Length (Symbol A) is the overall length of the Thermocouple Element (See Fig. 2)

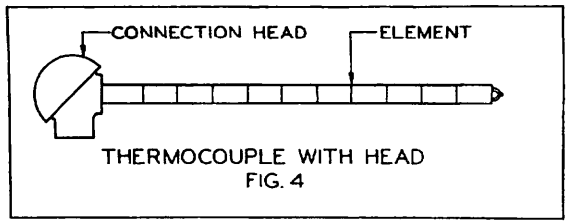
2.4.2 *Thermocouple Element Diameter.* The Thermocouple Element Diameter (Symbol Y) is the maximum transverse dimension of the insulated portion of the Thermocouple Element. (See Fig. 2)

2.5 Thermocouple with Terminal Block. A Thermocouple with Terminal Block in an assembly consisting of a Thermocouple Element to which is attached a suitable terminal block for the connection of Thermocouple Extension Wire. (See Fig. 3)



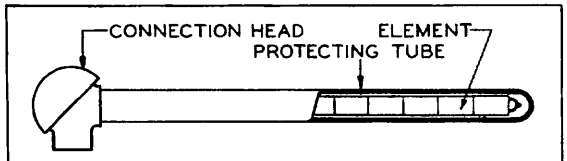
THERMOCOUPLE WITH TERMINAL BLOCK
FIG. 3

2.6 Thermocouple with Head. A Thermocouple with Head is an assembly consisting of a Thermocouple Element with a Connection Head. (See Fig. 4)



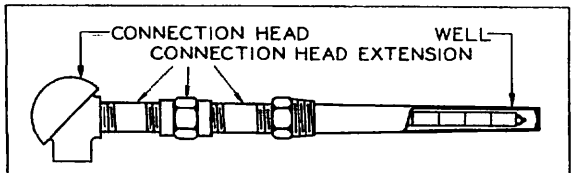
THERMOCOUPLE WITH HEAD
FIG. 4

2.7 Thermocouple with Protecting Tube. A Thermocouple with Protecting Tube is an assembly consisting of a Thermocouple Element, Protecting Tube and Connection Head. (See Fig. 5)



THERMOCOUPLE WITH PROTECTING TUBE
FIG. 5

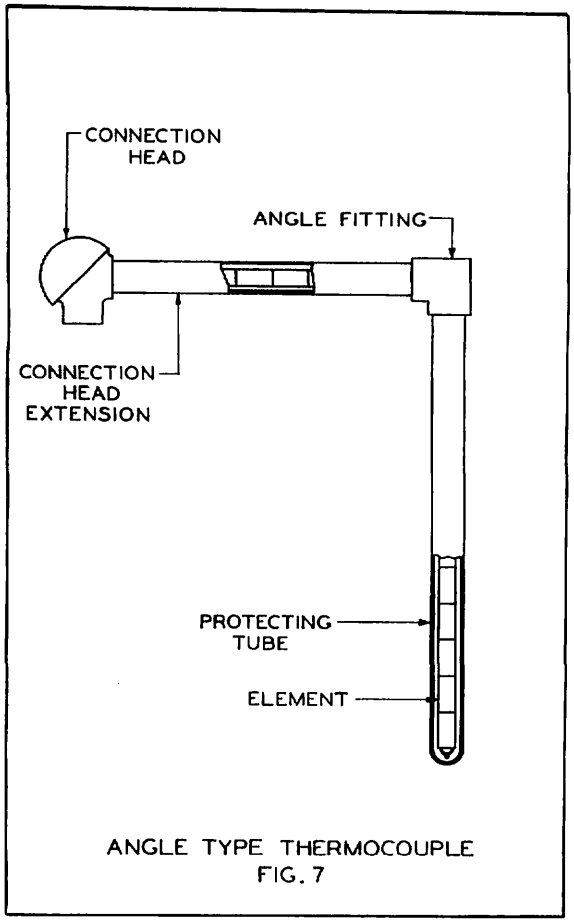
2.8 Thermocouple with Well. A Thermocouple with Well is an assembly consisting of a Thermocouple Element, Well and a Connection Head. The Connection Head is attached to the Well, usually by means of a Connection Head Extension. (See Fig. 6)



THERMOCOUPLE WITH WELL
FIG. 6

2.9 Angle Type Thermocouple. An Angle Type Thermocouple is an assembly consisting of a

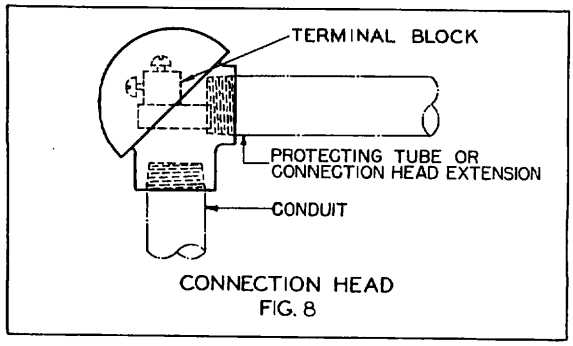
Thermocouple Element, a Protecting Tube, an angle fitting, a Connection Head Extension, and a Connection Head. (See Fig. 7)



ANGLE TYPE THERMOCOUPLE
FIG. 7

The Protecting Tube portion is sometimes called the hot leg and the Connection Head Extension portion is sometimes called the cold leg.

2.10 Connection Head. A Connection Head is a protecting housing containing a terminal block and usually provided with threaded openings for mounting on the Protecting Tube or Connection Head Extension and for attachment of a conduit. (See Fig. 8)



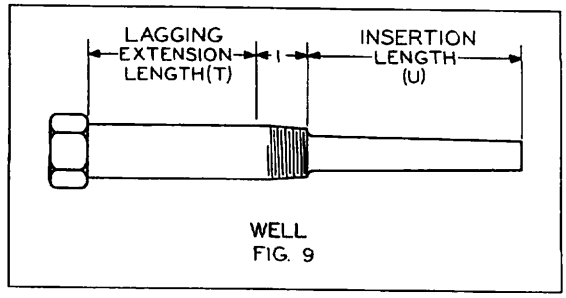
CONNECTION HEAD
FIG. 8

2.11 Connection Head Extension. A Connection Head Extension is a threaded fitting, usually a pipe nipple, or an assembly of fittings extending between the Well or angle fitting and the Connection Head. (See Figs. 6 and 7)

2.11.1 *Connection Head Extension Length.* The Connection Head Extension Length (Symbol N) is the overall length of the Connection Head Extension. (See Fig. 15)

2.12 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.

2.12.1 *Lagging Extension.* A Lagging Extension is that portion of a Well, above the external threads, intended to extend through the lagging of a vessel. (See Fig. 9)



WELL
FIG. 9

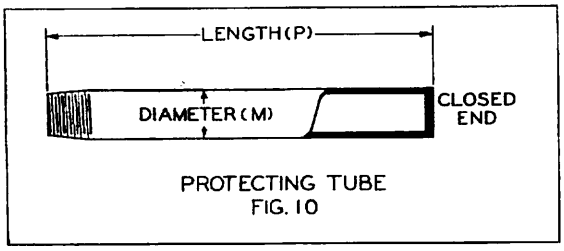
2.12.2 *Lagging Extension Length.* The Lagging Extension Length (Symbol T) is the length from the lower end of the external threads of the Well to the upper end of the portion intended to extend through the lagging of a vessel, less one inch allowance for threads. (See Fig. 9)

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

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

2.13 Protecting Tube. A Protecting Tube is a tube adapted to receive a Thermocouple Element or other temperature sensing device, designed for attachment to a Connection Head

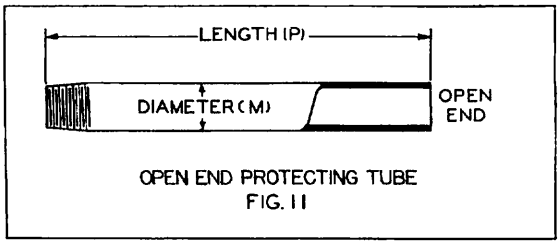
and not primarily designed for pressure-tight attachment to a vessel. (See Fig. 10)



PROTECTING TUBE
FIG. 10

Note: A Protecting Tube has one closed end unless otherwise specified.

2.13.1 *Protecting Tube Length.* The Protecting Tube Length (Symbol P) is the overall length of a Protecting Tube. (See Figs. 10 and 11)



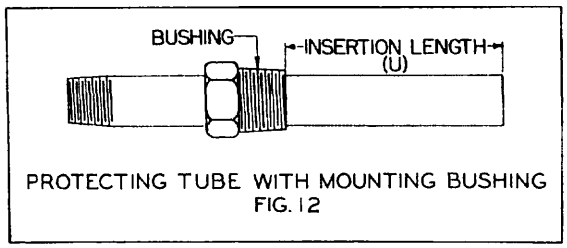
OPEN END PROTECTING TUBE
FIG. 11

Note: Nominal length is based on an end thickness of 1/4". For tubes having a heavy end wall thickness, overall length will be increased accordingly.

2.13.2 *Protecting Tube Diameter.* The Protecting Tube Diameter (Symbol M) is the outside diameter of a Protecting Tube. (See Figs. 10 and 11)

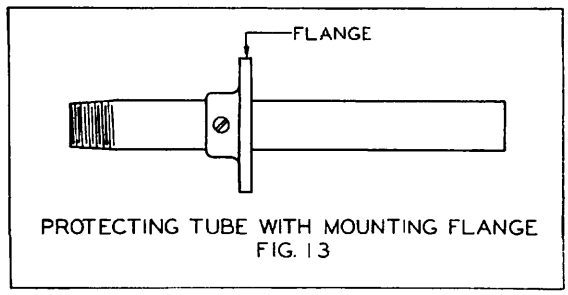
2.14 Open End Protecting Tube. An Open End Protecting Tube is a tube open at both ends adapted to receive a Thermocouple Element and designed for attachment to a Connection Head. (See Fig. 11)

2.15 Protecting Tube with Mounting Bushing. A Protecting Tube with Mounting Bushing is a Protecting Tube with a threaded bushing welded or otherwise attached to the tube and not primarily designed for pressure-tight attachment to a vessel. (See Fig. 12)



PROTECTING TUBE WITH MOUNTING BUSHING
FIG. 12

2.16 Protecting Tube with Mounting Flange. A Protecting Tube with Mounting Flange is a Protecting Tube with a mounting flange welded or otherwise attached to the tube and not primarily designed for pressure-tight attachment to a vessel. (See Fig. 13)



PROTECTING TUBE WITH MOUNTING FLANGE
FIG. 13

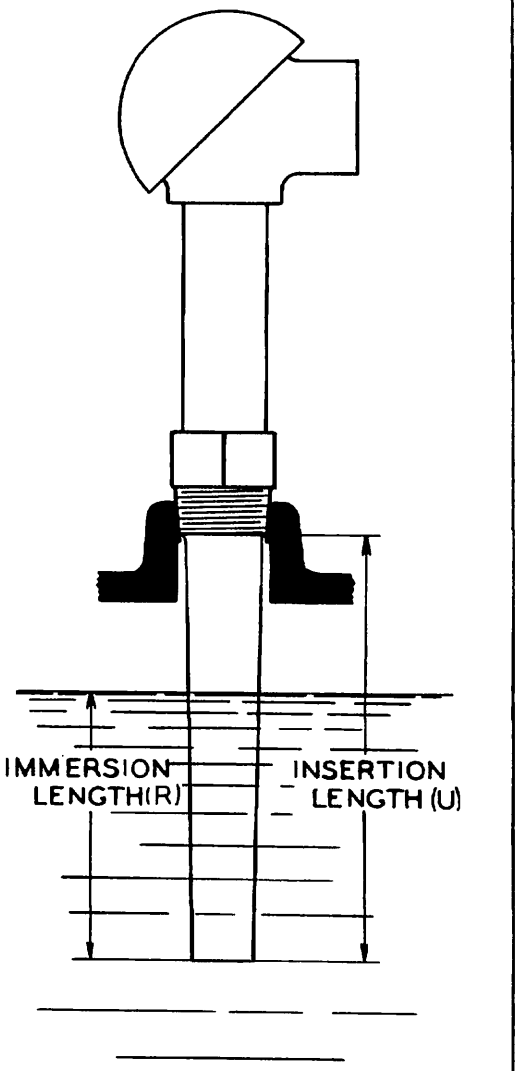
2.17 Immersion Length. The Immersion Length (Symbol R) of the Protecting Tube, Well or Thermocouple Element is the length from the free end to the point of immersion in the medium, the temperature of which is being measured. (Physically, this point may be indistinguishable but is important for proper accuracy.) (See Fig. 14)

2.18 Insertion Length. The Insertion Length (Symbol U) of the Protecting Tube, Well or Thermocouple Element is the length from the free end to, but not including, the External Threads or other means of attachment to a vessel. (See Figs. 12 and 14)

2.19 Other Forms of Thermocouples.

2.19.1 *Pipe (Pencil) Type Thermocouple.* A Pipe (Pencil) Type Thermocouple is a Thermocouple comprising a wire inside a closed end tube. The wire and the tube are joined at the closed end to form a measuring junction.

Note: A two-wire thermocouple with measuring junction welded to the closed end of the protecting tube is sometimes designated as a "Two-Wire Pencil Type Thermocouple."



IMMERSION AND INSERTION LENGTHS FOR THERMOCOUPLE WITH WELL

FIG. 14

2.19.2 *Compacted Ceramic Insulated Thermocouple.* A Compacted Ceramic Insulated Thermocouple is a thermocouple permanently installed in a metal sheath with compacted ceramic insulation.

3. Dimensions

3.1 Thermocouple With Well.

3.1.1 *Insertion Length.* The Insertion Length (Symbol U) shall be 2-1/2, 4-1/2, 7-1/2, 10-1/2, 16 or 24 inches with tolerances shown in Fig. 15.

3.1.2 *Thermocouple Element Diameter.* The Thermocouple Element Diameter (Symbol Y) shall be 1/4 maximum or 3/8 maximum inches. (See Fig. 15)

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

Note: Ordinarily, no lagging extension is used, i.e., T equals zero.

3.1.4 *Connection Head Extension Length.* The Connection Head Extension Length (Symbol N) shall be 4 or 7 inches.

Note: In cases where the Connection Head Extension Length is of the union type of construction, for an N dimension of 4 inches, the assembly may consist of two short nipples and one union. For an N dimension of 7 inches, the assembly may consist of two three-inch long nipples and a union.

3.1.5 *Thermocouple Element Length.* The Thermocouple Element Length (Symbol A) is dependent upon Dimension of U, T and N. Lengths of A corresponding to various combinations are given in Table I.

3.1.6 *Well Dimensions.* Dimensions of Wells used in 1/4 and 3/8 inch Well Type Assemblies and with other types of temperature sensing elements are given in SAMA RC 17.

3.1.7 *Thermocouple Wire Size.* The size of thermocouple wire used in Well Type Assemblies shall be No. 20 or No. 14 P&S gauge. The selection of one of these sizes shall be governed by the type of thermocouple alloy and the temperature exposure as specified in ASA Standard C96, Section 1.3.

3.1.8 *Other Dimensions.* Dimensions applying to Fig. 15 and not specified in items 3.1.1 through 3.1.7 are not essential for interchangeability and are at manufacturer's option subject to ordinary engineering considerations, such as strength and suitability for purpose.

3.2 Thermocouple with Protecting Tube.

Note: Dimensions specified in this section apply to assemblies using metal Protecting Tubes and base metal Thermocouple Elements.

3.2.1 *Protecting Tube Length.* The Protecting Tube Length (Symbol P) shall be 6, 12, 18, 24, 30 or 36 inches.

3.2.2 *Protecting Tube Diameter.* The Protecting Tube Diameter (Symbol M) shall be 9/16 inch maximum, 7/8 inch maximum or 1-5/16 inches maximum. Threads shall be 1/4 inch, 1/2 inch or 3/4 inch NPT.

Note: 3/4 inch pipe, or equivalent tubing, is commonly used for the large size. The 1-5/16" maximum dimension permits use of cast or other heavy wall tubes.

3.2.3 *Thermocouple Element Length.* The Thermocouple Element Length (Symbol A) shall be equal to the corresponding Protecting Tube Length plus 7/8 inch minimum. (See Fig. 16)

3.2.4 *Thermocouple Element Diameter.* The Thermocouple Element Diameter (Symbol Y) shall be 5/16 maximum or 17/32 maximum inches. (See Fig. 16) This diameter must be compatible with the Protecting Tube Diameter and the thermocouple wire size. (See Table II)

3.2.5 *Thermocouple Wire Size.* The size of thermocouple wire used in protecting tubes shall be No. 14 or No. 8 B&S gauge. The selection of one of these sizes shall be governed by the type of thermocouple alloys and the temperature exposure in accordance with ASA Standard C96, Section 1.3.

3.3 Angle Type Thermocouple.

3.3.1 *Protecting Tube Length.* The Protecting Tube Length (Symbol P) shall be 6, 12, 18, 24, 30, or 36 inches. (See Fig. 17)

3.3.2 *Protecting Tube Diameter.* The Protecting Tube Diameter (Symbol M) shall be 7/8 inch maximum, or 1-5/16 inches maximum. Threads shall be 1/2 inch or 3/4 inch NPT, respectively.

Note: 3/4 inch pipe, or equivalent tubing, is commonly used for the large size. The 1-5/16" maximum dimension permits use of cast or other heavy wall tubes.

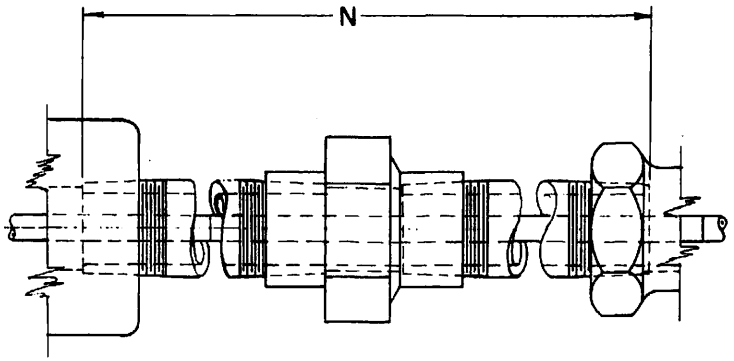
3.3.3 *Connection Head Extension.* The Connection Head Extension Length (Symbol N) shall be 12 or 18 inches. (See Fig. 17)

3.3.4 *Thermocouple Element Length.* The Thermocouple Element Length (Symbol A) is dependent upon Dimensions P and N. Lengths of A corresponding to various combinations are given in Table III. (See Fig. 17)

3.3.5 *Thermocouple Element Diameter.* The Thermocouple Element Diameter (Symbol Y) shall be 17/32 inch maximum. (See Fig. 17)

3.3.6 *Thermocouple Wire Size.* The size of thermocouple wire used in Angle Type Thermocouples shall be No. 8 B&S gauge.

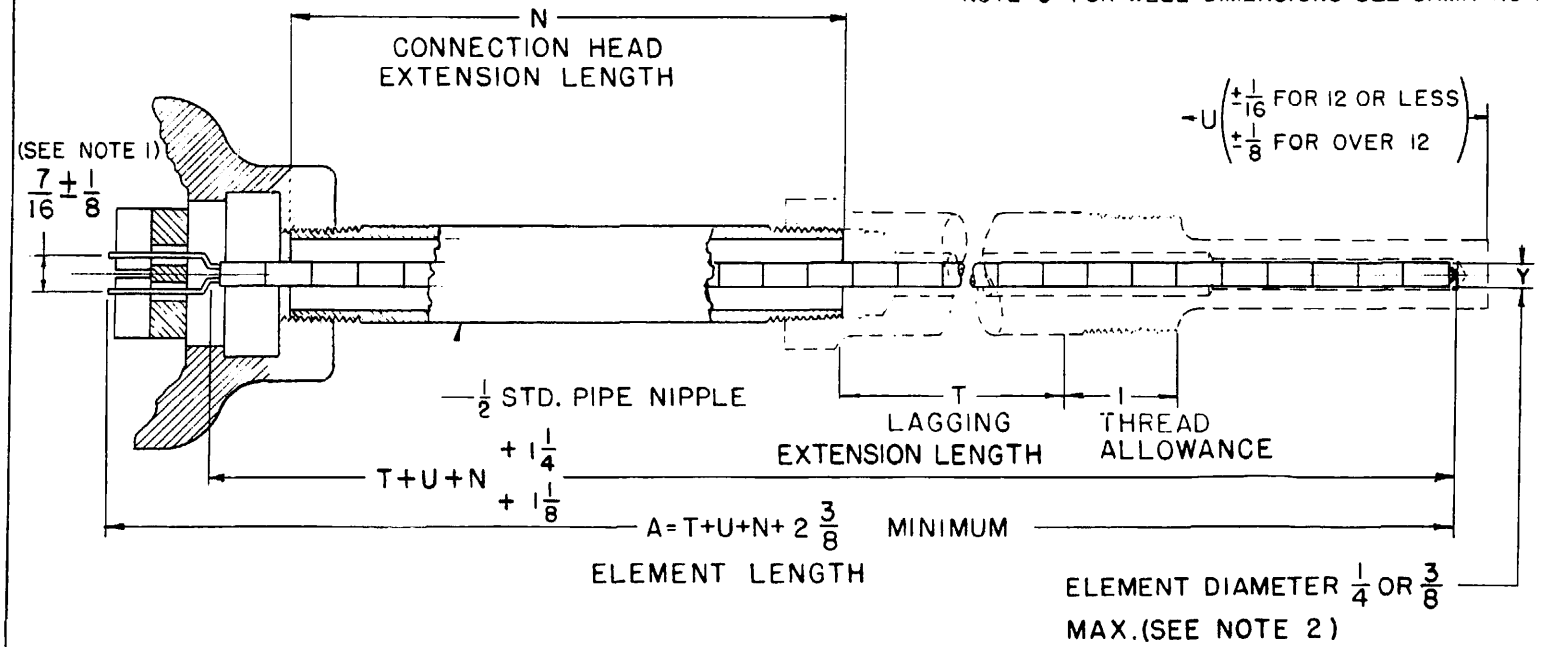
ALL DIMENSIONS IN INCHES



NOTE 1- LARGE TOLERANCE ON WIRE SPACING AT CONNECTION END PERMITS ACCEPTANCE IN VARIOUS CONNECTION HEADS. FINAL FITTING ADJUSTMENT BY ADDITIONAL BENDING, HOWEVER, MAY BE REQUIRED IN SOME CASES.

NOTE 2- THE INSULATED PORTION OF THE THERMOCOUPLE ELEMENT TO PASS THROUGH A STRAIGHT TUBULAR GAUGE .252 OR .377 I.D. OF LENGTH AT LEAST AS GREAT AS THE LONGEST INSULATOR.

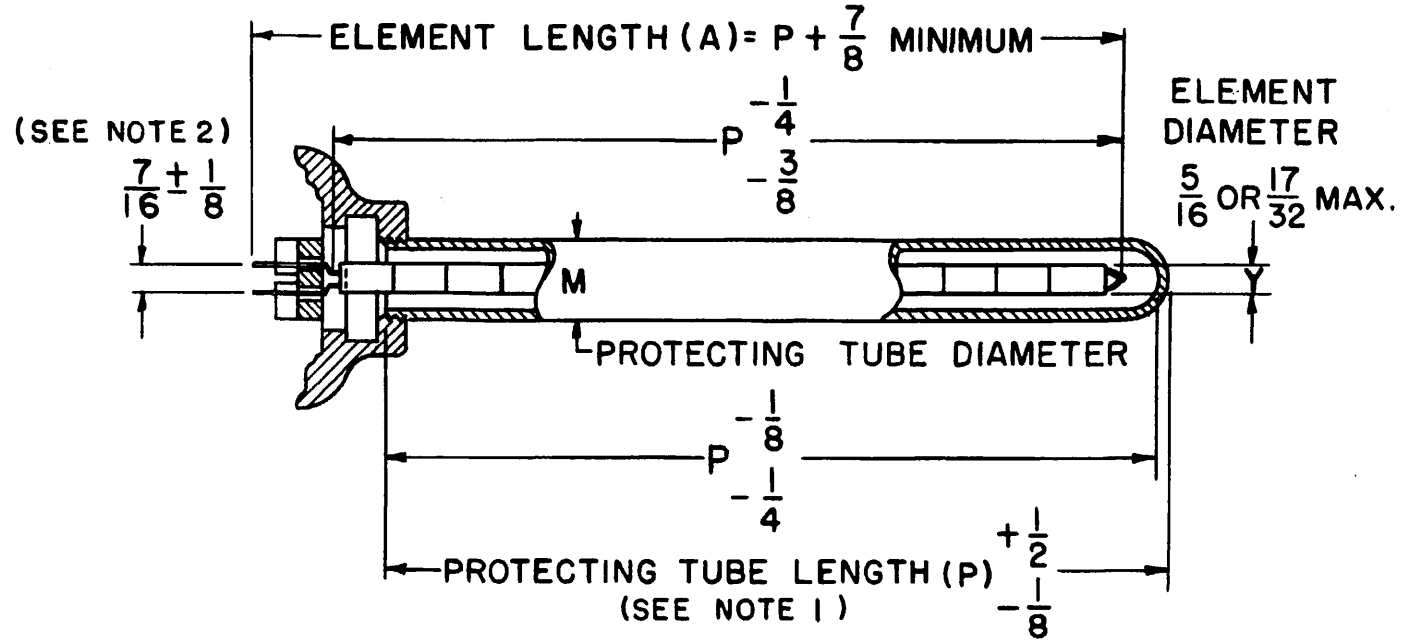
NOTE 3- FOR WELL DIMENSIONS SEE SAMA RC-17



THERMOCOUPLE WITH WELL

FIG. 15

ALL DIMENSIONS IN INCHES

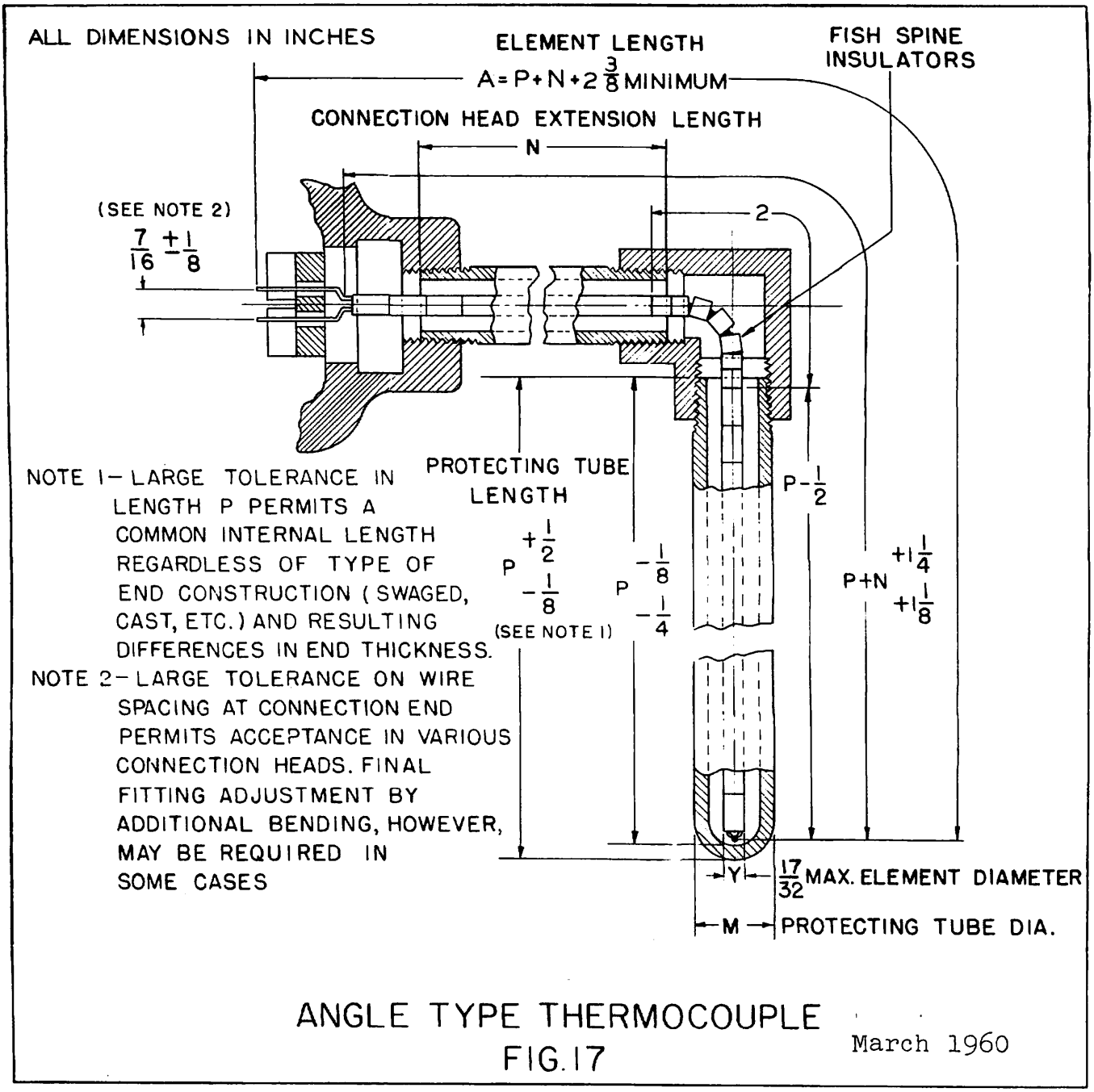


NOTE 1 - LARGE TOLERANCE IN LENGTH P PERMITS A COMMON INTERNAL LENGTH REGARDLESS OF TYPE OF END CONSTRUCTION (SWAGED, CAST ETC.) AND RESULTING DIFFERENCES IN END THICKNESS.

NOTE 2 - LARGE TOLERANCE ON WIRE SPACING AT CONNECTION END PERMITS ACCEPTANCE IN VARIOUS CONNECTION HEADS. FINAL FITTING ADJUSTMENT BY ADDITIONAL BENDING, HOWEVER, MAY BE REQUIRED IN SOME CASES.

THERMOCOUPLE WITH PROTECTING TUBE

FIG. 16



ANGLE TYPE THERMOCOUPLE
FIG. 17

March 1960

TABLE I

INSERTION AND COMPONENT LENGTHS FOR THERMOCOUPLES WITH WELLS

DIMENSIONS IN INCHES

INSERTION LENGTH	LAGGING EXTENSION LENGTH	CONNECTION HEAD EXTENSION LENGTH	THERMOCOUPLE ELEMENT LENGTH
U	T	N	A
2-1/2	0	4	8-7/8
2-1/2	0	7	11-7/8
2-1/2	2	4	10-7/8
2-1/2	2	7	13-7/8
4-1/2	0	4	10-7/8
4-1/2	0	7	13-7/8
4-1/2	3	4	13-7/8
4-1/2	3	7	16-7/8
7-1/2	0	4	13-7/8
7-1/2	0	7	16-7/8
7-1/2	3	4	16-7/8
7-1/2	3	7	19-7/8
10-1/2	0	4	16-7/8
10-1/2	0	7	19-7/8
10-1/2	3	4	19-7/8
10-1/2	3	7	22-7/8
16	0	4	22-3/8
16	0	7	25-3/8
16	3	4	25-3/8
16	3	7	28-3/8
24	0	4	30-3/8
24	0	7	33-3/8
24	3	4	33-3/8
24	3	7	36-3/8

Note: Listing of a size does not imply that it is suitable for all purposes. Consult manufacturers for limitations on immersion length.

TABLE II

THERMOCOUPLE WIRE SIZES AND COMPONENT DIAMETERS FOR THERMOCOUPLES WITH PROTECTING TUBES

THERMOCOUPLE WIRE SIZE	THERMOCOUPLE ELEMENT DIA. SYMBOL Y	PROTECTING TUBE DIMENSIONS		
		OUTSIDE DIAMETER SYMBOL M	INSIDE DIAMETER	USABLE PIPE SIZE
B&S GAUGE	INCHES - MAX.	INCHES - MAX.	INCHES - MIN.	INCHES - NOM.
14	5/16	9/16	.364	1/4 Sch. 40
8	17/32	7/8	.546	1/2 Sch. 40 or 80
8	17/32	1-5/16	.742	3/4 Sch. 40 or 80

TABLE III

PROTECTING TUBE AND COMPONENT LENGTHS FOR ANGLE TYPE THERMOCOUPLES

DIMENSIONS IN INCHES

PROTECTING TUBE LENGTH P	CONNECTION HEAD EXTENSION LENGTH N	THERMOCOUPLE ELEMENT LENGTH A
6	12	20-3/8
6	18	26-3/8
12	12	26-3/8
12	18	32-3/8
18	12	32-3/8
18	18	38-3/8
24	12	38-3/8
24	18	44-3/8
30	12	44-3/8
30	18	50-3/8
36	12	50-3/8
36	18	56-3/8