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Standard Specification for Welded Partially Corrugated Stainless Tube for Potable Water and General Service¹

This standard is issued under the fixed designation A1119/A1119M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

1. Scope*

1.1 This specification describes welded austenitic, ferritic, and duplex stainless steel tube on which the external and internal surface has been modified by a cold forming process to produce an intermittent corrugation for improved formability and resistance to seismic and other environmental distortions. The tubes are used for potable water service lines and other liquid delivery systems in nominal diameters from ½ to 2 in. [13 to 50 mm].

1.2 The tube sizes and thicknesses usually furnished to this specification are 0.625 to 2.125 in. [15.88 to 48.60 mm], outside diameter and 0.028 to 0.049 in. [0.8 to 1.2 mm], inclusive, in wall thickness.

1.3 The grades of austenitic, ferritic, and duplex stainless steels included in this specification shall conform to materials listed in the governing straight tube Specifications **A268/A268M**, **A269/A269M**, or **A789/A789M**. Selection will depend upon design and service requirements.

1.4 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.5 This specification is expressed in both inch-pound and SI units. However, unless the order specifies the applicable “M” specification designation (SI units), the material shall be furnished in inch-pound units.

1.6 The following safety hazards statement pertains only to the test methods of this specification. *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

2. Referenced Documents

2.1 ASTM Standards:²

A268/A268M Specification for Seamless and Welded Ferritic and Martensitic Stainless Steel Tubing for General Service

¹ This specification is under the jurisdiction of ASTM Committee A01 on Steel, Stainless Steel and Related Alloys and is the direct responsibility of Subcommittee A01.10 on Stainless and Alloy Steel Tubular Products.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

*A Summary of Changes section appears at the end of this standard

- A269/A269M Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service
- A789/A789M Specification for Seamless and Welded Ferritic/Austenitic Stainless Steel Tubing for General Service
- A1016/A1016M Specification for General Requirements for Ferritic Alloy Steel, Austenitic Alloy Steel, and Stainless Steel Tubes
- A1047/A1047M Test Method for Pneumatic Leak Testing of Tubing
- E384 Test Method for Microindentation Hardness of Materials
- 2.2 Other Standard:
- JWWA G 119 Corrugated Stainless Steel Tubes for Water Supply

3. Terminology and Symbols

3.1 *Definitions*—For definition of general terms used in this specification, refer to Specification A1016/A1016M.

3.2 *Symbols (Corrugation Nomenclature):*

- d_1 = outside diameter of straight section
- d_2 = outside diameter of corrugated section
- L = total tube length
- l_0 = end to first corrugation
- l_1 = end to center of first corrugation
- l_2 = corrugation centerline to corrugation centerline
- l_3 = last corrugation centerline to tube end
- l_4 = length of corrugation
- t_1 = wall thickness of straight section
- N = number of corrugations in a corrugated section

4. Ordering Information

4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Such requirements may include, but are not limited to, the following:

- 4.1.1 ASTM designation and year of issue (this specification);
- 4.1.2 ASTM designation and year of issue (straight tube specification);
- 4.1.3 Alloy grade and UNS designation;
- 4.1.4 Dimensions; straight tube outside diameter, tube wall thickness (average or minimum specified) and the total tube length. Configuration of corrugated surfaces shall be according to Figs. 1 and 2, and Tables 1-3;

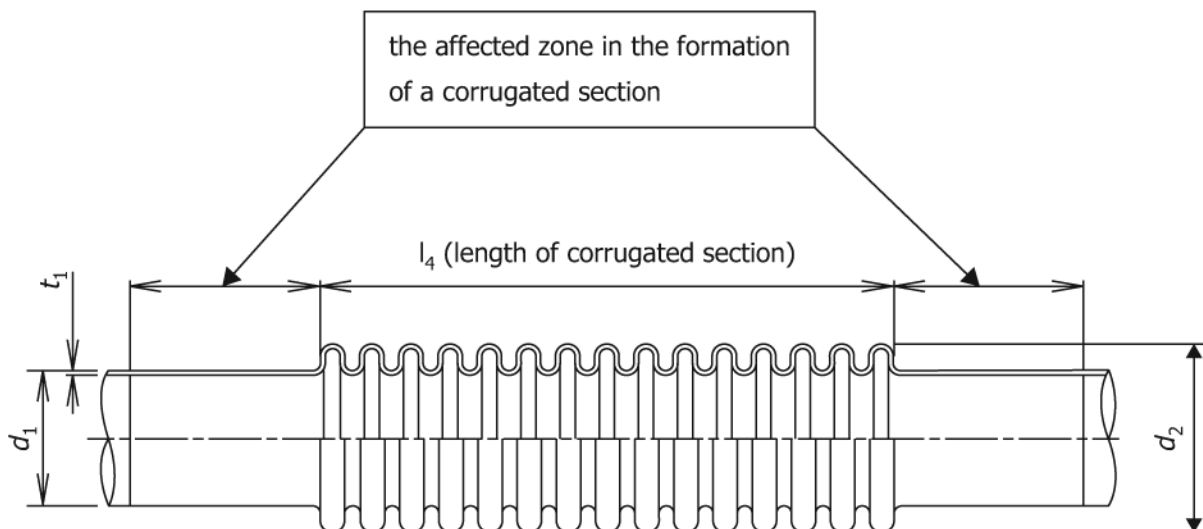


FIG. 1 Dimensions of Corrugated Segment (upper portion is a sectional view)

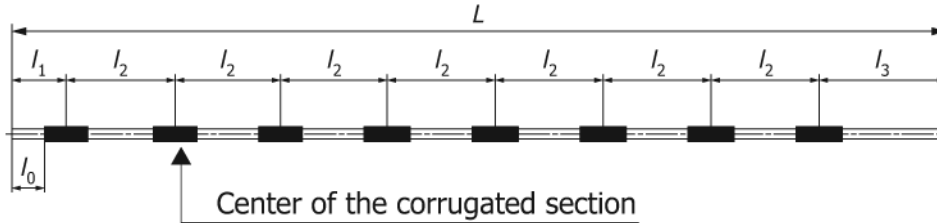


FIG. 2 Dimensions of Corrugated Tube (Schematic Expanded View) (L to be determined by ordering requirements)

TABLE 1 Component Dimensions for Corrugated Tube (see Figs. 1 and 2) (unit: inches [millimetres])

Nominal Diameter	d_1	t_1	l_0 Minimum	l_1	l_2	l_3 Minimum	l_4	N number of corrugations
½ [13]	0.625 [15.88]	0.028 [0.8]	6.0 [150]	7.575 [190]	18.7 [475]	20.0 [485]	3.150 [80]	15
¾ [20]	0.875 [22.22]	0.035 [1.0]	6.0 [150]	8.360 [210]	18.7 [475]	20.0 [465]	4.725 [120]	15
1 [25]	1.125 [28.58]	0.035 [1.0]	6.0 [150]	8.360 [210]	18.7 [475]	20.0 [465]	4.725 [120]	15
1 ¼ [30]	1.375 [34.00]	0.049 [1.2]	6.0 [153.5]	9.000 [230]	18.5 [470]	20.0 [480]	6.000 [153]	15
1 ½ [40]	1.625 [42.7]	0.049 [1.2]	6.0 [152.5]	10.425 [265]	18.1 [460]	20.0 [515]	8.850 [225]	20
2 [50]	2.125 [48.6]	0.049 [1.2]	6.0 [152.5]	10.425 [265]	18.1 [460]	20.0 [525]	8.850 [225]	20

TABLE 2 Tolerances for Diameter, Thickness and Length of Corrugated Segments (unit: inches [millimetres])

Nominal Diameter	d_1 (external diameter of straight section)		Mean Bore Allowable	t_1 (wall thickness of straight section)		l_4 (corrugated section length)	
	Standard Measurement	Permissible Difference		Standard Measurement	Permissible Difference	Standard Measurement	Permissible Difference
½ [13]	0.625 [15.88]	+0 / -0.015 [+0 / -0.37]	Not Standardized	0.028 [0.8]	±10% [±0.08]	3.150 [80]	±0.40 [±10]
¾ [20]	0.875 [22.22]	+0 / -0.015 [+0 / -0.37]		0.035 [1.0]	±10% [±0.10]	4.725 [120]	±0.40 [±10]
1 [25]	1.125 [28.58]	+0 / -0.015 [+0 / -0.37]	0.035 [1.0]	±10% [±0.10]	4.725 [120]	±0.40 [±10]	
1 ¼ [30]	1.375 [34.00]	±0.013 [±0.34]	±0.08 [±0.2]	0.049 [1.2]	±10% [±0.12]	6.000 [153]	±0.80 [±20]
1 ½ [40]	1.625 [42.70]	±0.017 [±0.43]	±0.08 [±0.2]	0.049 [1.2]	±10% [±0.12]	8.850 [225]	±0.80 [±20]
2 [50]	2.125 [48.60]	±0.019 [±0.49]	±0.10 [±0.25]	0.049 [1.2]	±10% [±0.12]	8.850 [225]	±0.80 [±20]

TABLE 3 Length Tolerances for Straight Segments (other than corrugations) (unit: inches [millimetres])

Nominal Diameter	l_1	Permissible Difference	l_2	Permissible Difference	l_3 Minimum	Permissible Difference	l_0 Minimum
½ [13]	7.575 [190]	+0.395/-0 [+10/-0]	18.7 [475]	±0.800 [±20]	20.00 [485]		6.00 [150]
¾ [20]	8.360 [210]	+0.395/-0 [+10/-0]	18.7 [475]	±0.800 [±20]	20.00 [465]		6.00 [150]
1 [25]	8.360 [210]	+0.395/-0 [+10/-0]	18.7 [475]	±0.800 [±20]	20.00 [465]	+ Not Standardized	6.00 [150]
1 ¼ [30]	9.000 [230]	+0.395/-0 [+10/-0]	18.5 [470]	±0.800 [±20]	20.00 [480]		6.00 [153.5]
1 ½ [40]	10.425 [265]	+0.395/-0 [+10/-0]	18.1 [460]	±0.800 [±20]	20.00 [515]	- 0.0	6.00 [152.5]
2 [50]	10.425 [265]	+0.395/-0 [+10/-0]	18.1 [460]	±0.800 [±20]	20.00 [515]		6.00 [152.5]

4.1.5 Quantity;

4.1.6 Packaging;

4.1.7 Nondestructive tests;

4.1.8 Corrugated tube performance tests;

4.1.9 Customer inspection;

4.1.10 Certified test reports.

5. General Requirements

5.1 Material furnished under this specification shall conform to the applicable requirements of Specification **A1016/A1016M** unless otherwise provided herein.

5.2 Corrugated sections of the tube shall be produced by cold forming (hydraulic bulge forming) the tube in such a manner that corrugations are homogeneous.

5.3 Tubes described by this specification shall be furnished with straight (plain) ends.

5.4 Lengths of the partially corrugated tube shall be supplied in the solution annealed condition in accordance with Section **7**.

6. Materials and Manufacture

6.1 The corrugated tubes shall be manufactured from welded and solution annealed straight tubes that conform to one of the following Specifications: **A268/A268M**, **A269/A269M**, or **A789/A789M**. The corrugations are formed using the hydraulic bulge forming method.

7. Heat Treatment

7.1 Heat treatment of the partially corrugated tube shall be in accordance with the governing straight tube specification.

8. Chemical Composition

8.1 The tubing specified shall conform to the chemical requirements prescribed in the governing straight tube specification.

9. Mechanical Properties

9.1 The straight tube prior to the corrugation, shall conform to the requirements for tensile properties prescribed in the governing straight tube specification.

10. Permissible Variations in Dimensions

10.1 *Diameter*—The outside diameter d_1 of the straight sections shall not exceed the diameter tolerances shown in **Table 2**. The corrugation diameter d_2 to be determined by manufacturer.

10.2 *Wall Thickness*—The wall thickness of straight and corrugated sections t_1 shall not exceed the thickness tolerances shown **Table 2**. The straight sections shall not be less than the minimum thickness specified. The corrugated sections shall not be less than the maximum 20 % reduction as measured per **13.1.7**.

10.3 *Length*—The total length L of the tubes shall be determined by purchase order requirements.

10.4 *Length of Straight Segments*—The length of the straight end l_0 and the segmented straight sections as defined by l_1 , l_2 and l_3 shall meet the tolerances shown in **Table 3**.

10.5 *Length of Corrugated Segments*—The length of the corrugated segment l_4 shall meet the tolerances shown in **Table 2**.

11. Workmanship, Finish, and Appearance

11.1 Finished tubes shall be clean and free of foreign material, shall have smooth ends free of burrs, and shall be free of injurious external and internal imperfections. Minor defects may be removed, provided the dimensional tolerances of **10.2** are not exceeded.

12. Nondestructive Tests

12.1 After corrugating operations, subject each tube to either a pneumatic or hydrostatic test as specified in the purchase order. Tubes shall be tested in the solution annealed condition.

12.1.1 *Pneumatic Test*—Each tube shall be subjected to an internal pneumatic leak test for 5 s without showing evidence of leakage. Any evidence of leakage shall be cause for rejection. The test method used shall permit easy visual detection of any leakage, such as using the air under water at a minimum of 250 psi [1.7 MPa] or the pneumatic leak method in accordance with Specifications **A1016/A1016M** and **A1047/A1047M**.

12.1.1.1 *Air Underwater Pressure Test*—Each tube shall be tested in accordance with Specification **A1016/A1016M** except using test pressure specified in 12.1.1.

12.1.1.2 *Pressure Resistance Test*—Each tube shall be tested in accordance with Specification JWWA G 119 as described in section **13.1.1**.

12.1.2 *Hydrostatic Test*—When examined with this test method, each tube shall be tested in accordance with Specification **A1016/A1016M**.

13. Corrugated Tube Performance Testing

13.1 After corrugating operations, subject each tube to the pressure resistance test and one corrugated segment per lot for the additional performance tests required (reference JWWA G 119). Tubes shall be tested in the solution annealed condition.

13.1.1 Test water pressure is set at 360 psi [2.5 MPa] with a hold time of 2 min. For tests with air pressure, the pressure is set at 85 psi [0.6 MPa] with a hold time of 5 s.

13.1.2 Pass/fail criteria is no leaks.

13.1.3 *Extension and Residual Extension Test*—The test for extension and residual extension of a corrugated tube is conducted by connecting a test supply tube as shown in Fig. 3 to a testing device as shown in Fig. 4 in the following order.

13.1.3.1 Connect one end (fixed end) of the test tube to the pressure source and seal the other end (open end). Fill the tube with water to force out any air. Support the open end so that it can extend freely in the tube axis direction.

13.1.3.2 Increase the pressure to 145 psi [1.0 MPa] within one minute. Maintain the pressure and measure the extension after one additional minute.

13.1.3.3 Decrease the pressure to below 3.6 psi [25 kPa] and measure the residual extension.

13.1.3.4 Increase the pressure to 365 psi [2.5 MPa] within 1 min. Maintain the pressure and measure the extension after one additional minute.

13.1.3.5 Pass/fail criteria is defined in **Table 4**.

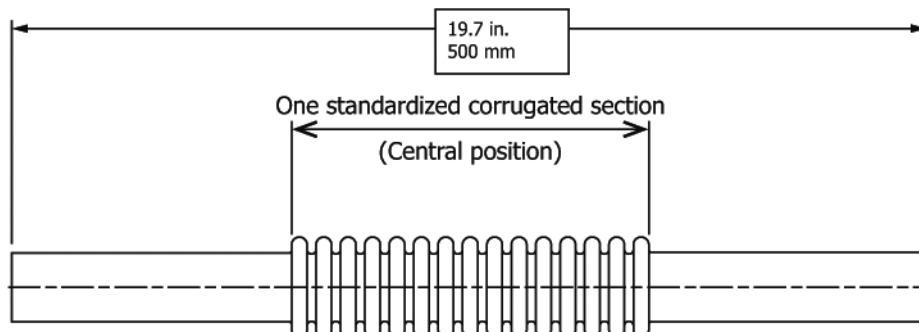


FIG. 3 Test Supply Tube (total length 19.7 in. [500 mm])

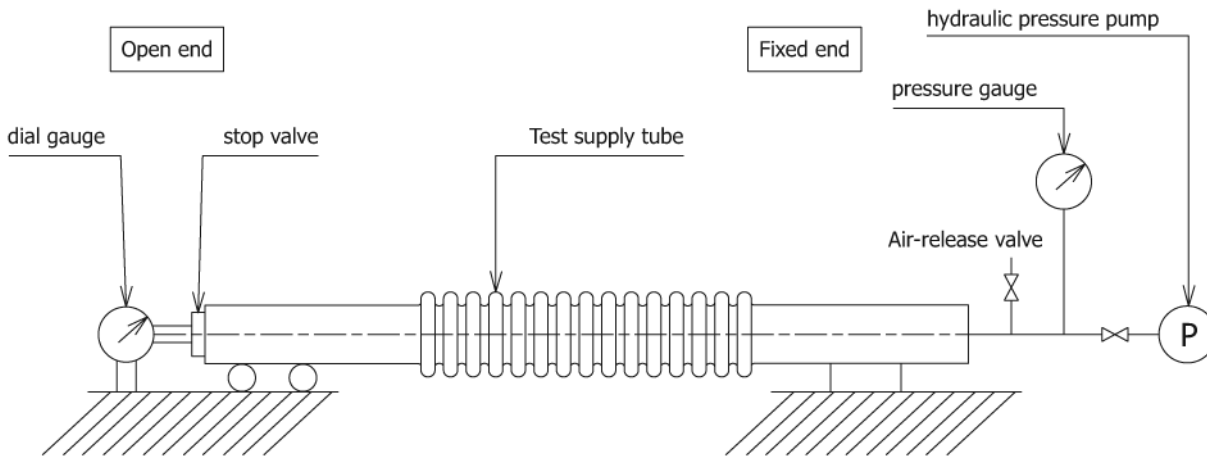


FIG. 4 Testing Configuration for Extension and Residual Extension

TABLE 4 Allowable Extension and Allowable Residual Extension (unit: inches [millimetres])

Nominal Diameter	Degree of extension at 145 psi [1.0 MPa]	Degree of residual extension after decompressing from 145 psi [1.0 MPa] to <3.6 psi [<0.025 MPa]	Degree of extension at 365 psi [2.5 MPa]
½ to 1 ¼ [13 to 30]	<0.04 [1.0]	<0.02 [0.5]	<0.20 [5.0]
1 ½ to 2 [40 to 50]	<0.08 [2.0]	<0.04 [1.0]	<0.40 [10.0]

13.1.4 *Flexibility Test*—The test for flexibility of a corrugated tube is conducted by connecting a test supply tube (Fig. 3) to a testing device as shown in Fig. 5.

13.1.4.1 Seal one end of the tube and fix the other end to the pressure source. Fill the tube with water to force out any air.

13.1.4.2 Increase the pressure to 14.5 psi [0.10 MPa]. Bend the corrugated section in small increments (0 to A for about one second) along the metal roller to the 90°. Bend it back to the original position (A to 0) using the same small increments and speed. Then bend it 90° in the opposite direction (0 to B) and back to the original position (B to 0).

13.1.4.3 Repeat the above according to the number of bends shown in Table 5.

13.1.4.4 The metal roller should have a radius less than three times the nominal diameter and the periphery should allow the corrugated section to contact the roller such that it is easy to bend the tube without any distortion to its shape.

13.1.4.5 Each bend in Fig. 5, that is, 0 to A, is considered a single bend. Therefore, 0 to A to 0 to B to 0 is four bends.

13.1.4.6 Pass/fail criteria is no leaks or visible defects.

13.1.5 *Flattening Test*—The flattening test for corrugated tube is conducted using a testing device as shown in Fig. 6.

13.1.5.1 Place one corrugated section between two flat surfaces and compress the tube until the gap between the surfaces reaches the standardized height *H*. The height *H* is calculated as ⅔ the maximum external diameter of the corrugated tube. The weld seam must be perpendicular to the compression direction.

13.1.5.2 Pass/fail criteria is no visible surface defect, for example, scratch or crack after flattening.

13.1.6 *Hardness Test*—The hardness test of a corrugated tube is conducted by measuring the axial cross section of the corrugated tube as shown in Fig. 7 using a Vickers microindentation hardness tester, see Test Method E384.

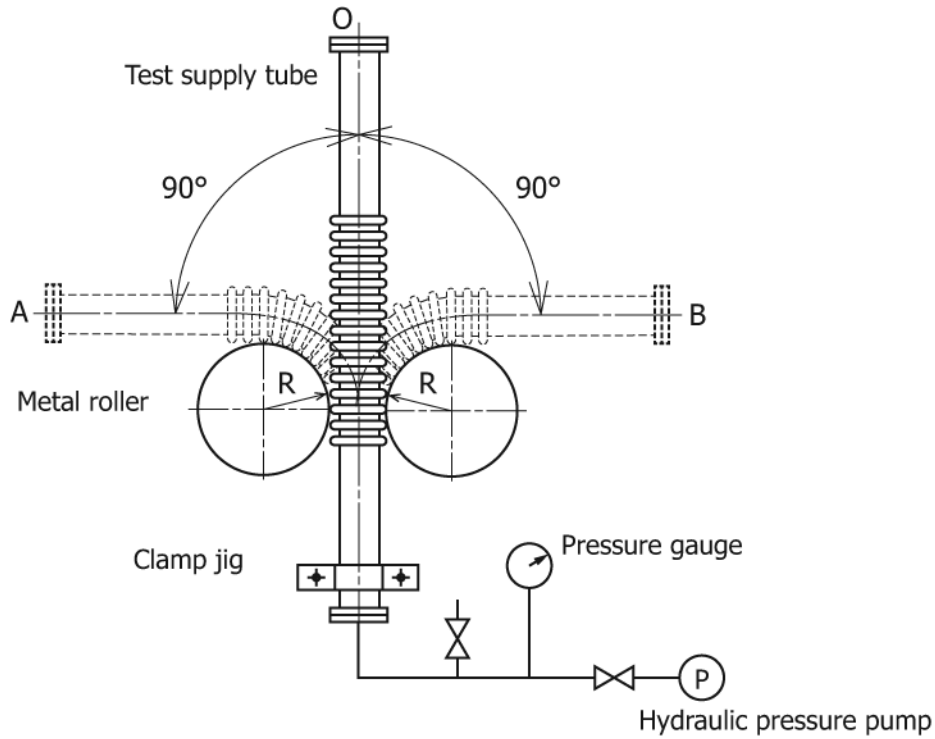


FIG. 5 Flexibility Testing Device

TABLE 5 Number of Bends

Nominal Diameter	Number of Bends
1/2 [13]	20
3/4 [20]	20
1 [25]	20
1 1/4 [30]	20
1 1/2 [40]	10
2 [50]	10

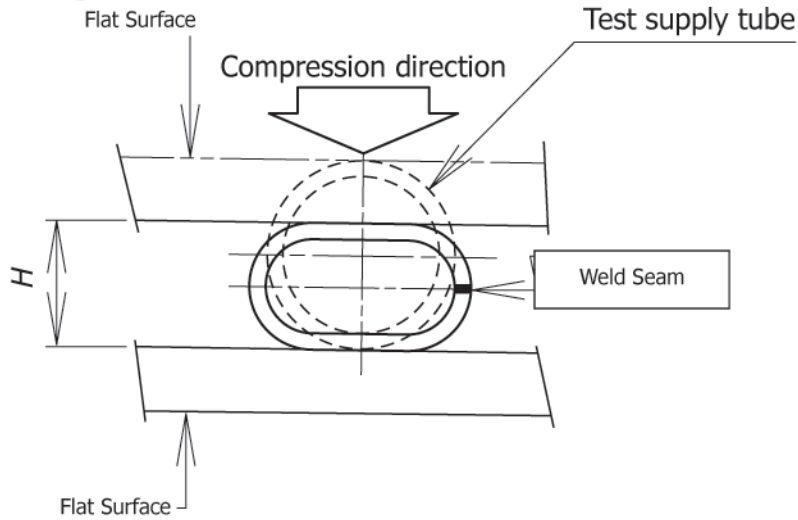


FIG. 6 Flattening Test Device

13.1.6.1 The size of a test piece, including the pitch of one corrugated section, is set at a width of 0.4 in. [10 mm]. A thermosetting resin is used to heat fix the tube so that the axial cross section is horizontal, and the measured surface is reflecting.