6.8 MEASURING AND TEST EQUIPMENT CONTROL

The manufacturer shall have at his disposal gages and other measuring and testing equipment necessary to assure that materials and supplies conform to the technical requirements specified. A system of comprehensive written calibration procedures shall be maintained. In order to assure continuous accuracy, the procedures shall include a schedule for equipment calibration against certified measurement standards which have known valid relationships to National Reference Standards. Defective equipment must be repaired, replaced, or re-calibrated as appropriate to the technical requirements specified. This requirement also applies to all subcontractors or vendors.

6.9 MATERIAL NON-CONFORMANCE CONTROL

The manufacturer shall establish and maintain an effective and positive system for promptly detecting and correcting materials or conditions adverse to quality, including comprehensive written procedures for their identification, segregation, and disposition. All non-conforming materials shall be positively identified and segregated in a unique holding location to prevent unauthorized use, shipment, or the intermingling with acceptable conforming materials. Repair or rework of non-conforming materials shall be in compliance with comprehensive written procedures.

6.10 CORRECTIVE ACTION (SUPPLIES AND SERVICES)

Design, purchasing, manufacturing, inspection, testing or other operations which could result in, or have resulted in non-conforming supplies, services, facilities, technical data, standards or other elements of contract performance must be identified and changed as a result of the quality control program. Corrective action shall extend to the performance of all suppliers and vendors. Corrective action shall include as a minimum:

a.) analysis of data and examination of product scrapped or reworked to determine extent or causes.

b.) analysis of trends in processes or performance of work to prevent recurrence of non-conformances.

c.) introduction of required improvements and corrections, initial review of the adequacy of such measures and the continued monitoring of the corrective action effectiveness.

6.11 WELDING

Unless otherwise specified by contractual agreement, the welding personnel and procedures shall be qualified in accordance with the applicable sections of Section IX of the ASME Boiler & Pressure Vessel Code or equivalent for all pressure containing welds.

6.12 HEAT TREATMENT

Unless otherwise specified by contractual agreement, heat treatment, when required, shall be performed in accordance with the ASME Boiler & Pressure Vessel Code requirements or equivalent or the recommendations of the material manufacturers.

6.13 PACKAGING, PRESERVATION, SHIPPING AND STORAGE

The manufacturer shall utilize standard commercial practices in packaging, preservation, shipping and storage to assure protection of the product during shipment, unless superseded by contractual agreement. These commercial practices shall be adequate to protect the quality of the products fabricated from deterioration to the point of final destination.

6.14 CUSTOMER QUALITY ASSURANCE AUDITS

Documents, procedures, and processes shall be comprehensively written and available for review by the customer specifying their implementation, or a third party inspection agency authorized to act in the customer's behalf.

6.15 RECORDS RETENTION

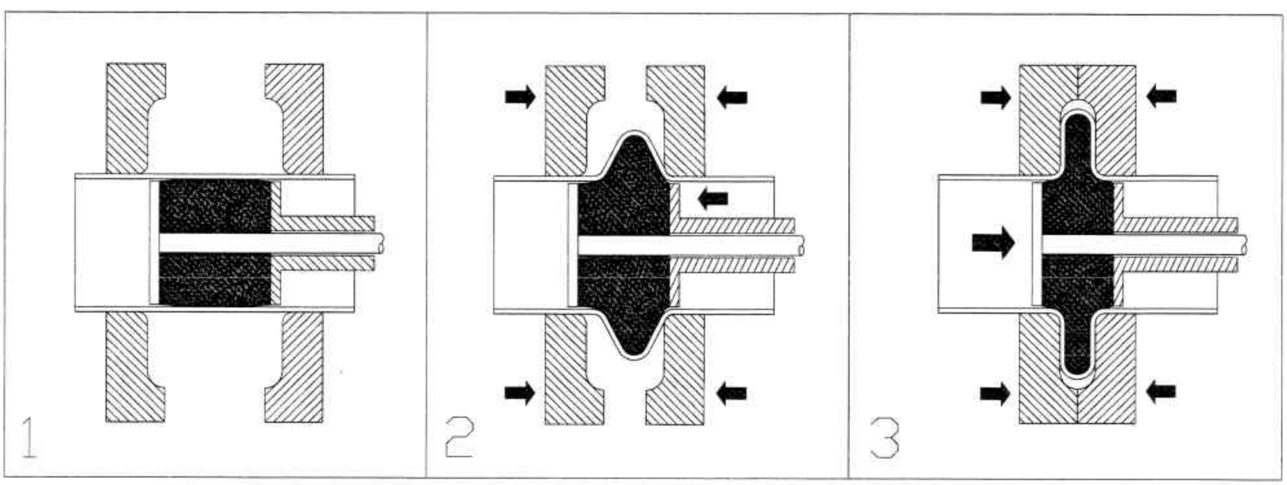
The manufacturer shall use and maintain all adequate records or data essential to the economical and effective operation of this quality control program. The records shall, as a minimum, indicate the nature and number of observations made, the number and type of deficiencies found, the quantities approved and rejected and the nature of the corrective actions taken. The quality control program shall assure the records are complete and reliable. Also, the records for monitoring work performance and for inspection and testing shall indicate the acceptability of work or products and the corrective action taken in connection with deficiencies. The quality control program shall provide for the analysis and use of these records as a basis for management review.

6.16 METHODS OF FORMING METAL BELLOWS

The following are examples of commonly used bellows forming methods. Only seamless tubes or longitudinally welded metal tubes are allowed for use with forming methods 6.16.1 thru 6.16.6.

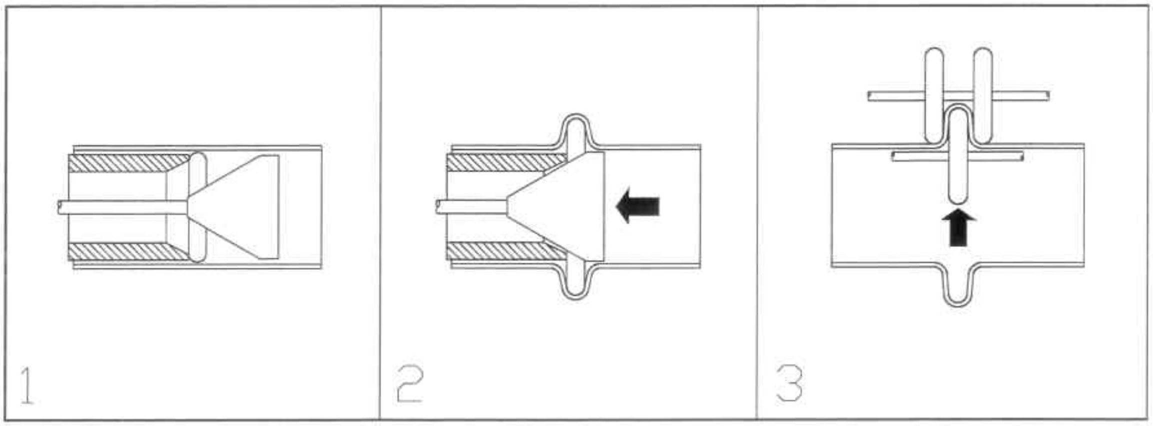
6.16.1 ELASTOMERIC FORMING

A tube is inserted over a mandrel containing a rubber torus. Axial force on the mandrel expands the torus, forming a bulge in the tube. The torus is then relaxed and the bulge is axially compressed into a convolution by external dies. Convolutions are formed one at a time. The tube is free to shorten as the convolution is formed.



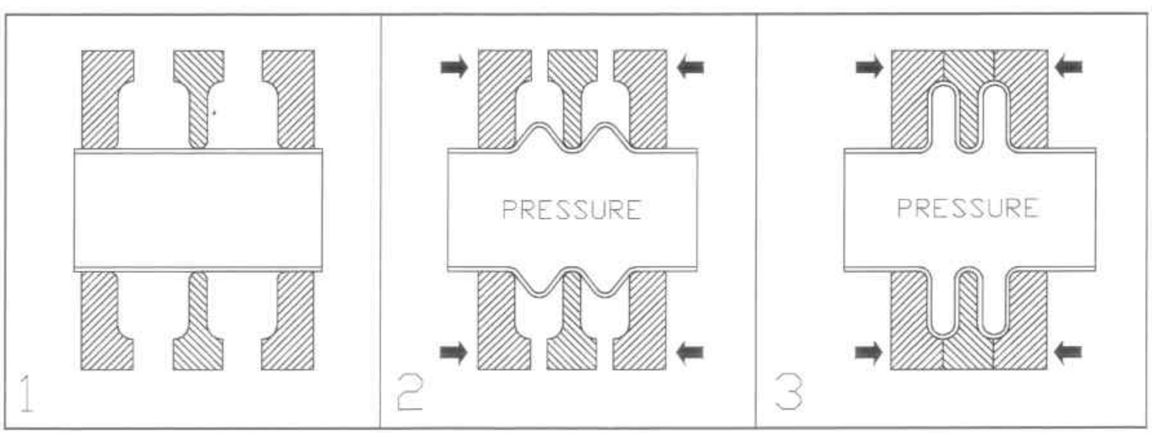
6.16.2 EXPANSION (EXPANDING MANDREL) FORMING

Individual convolutions are formed in a tube by an expanding internal mandrel. Flat spots are minimized by expanding the mandrel partially, and rotating the tube slightly. This process is repeated until an intermediate convolution height is achieved. Each convolution is subsequently sized by means of specially contoured inner and outer rollers.



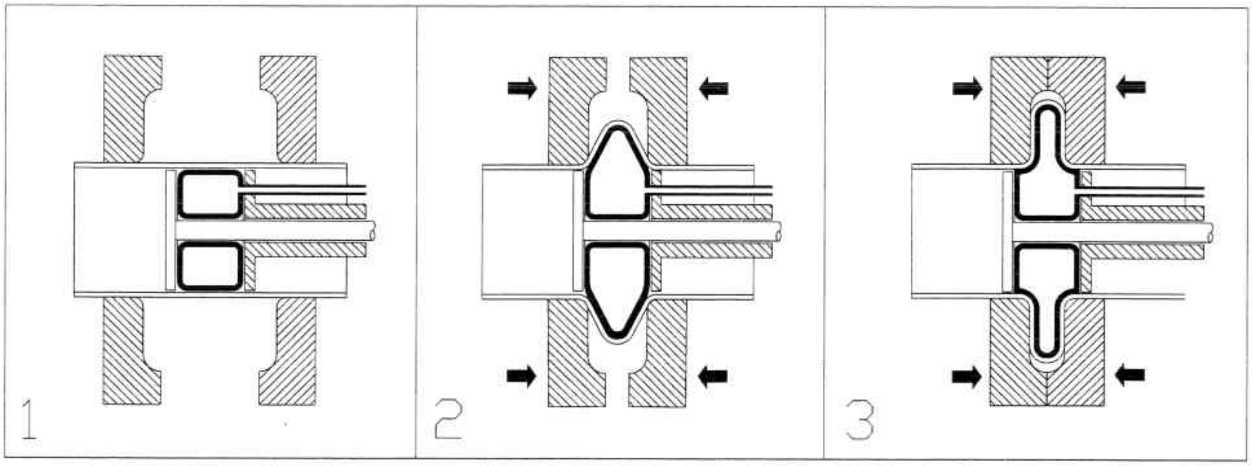
6.16.3 HYDRAULIC FORMING

A tube is placed in a hydraulic press or bellows forming machine. Circular external die rings of suitable contour are placed outside the tube at longitudinal intervals approximately equal to the developed length of the completed convolutions. The tube is filled with a medium such as water and pressurized until circumferential yielding occurs. This forming operation continues with a simultaneous circumferential yielding and controlled longitudinal shortening of the tube until the proper configuration is obtained. Individual or multiple convolutions may be formed by this method. Depending on the bellows configuration, several partial-forming steps with intermediate heat treatment may be required. Reinforced bellows may be formed by utilizing external reinforcing rings that act as part of the forming dies. After completion, when the dies are removed, the rings remain as an integral part of the bellows.



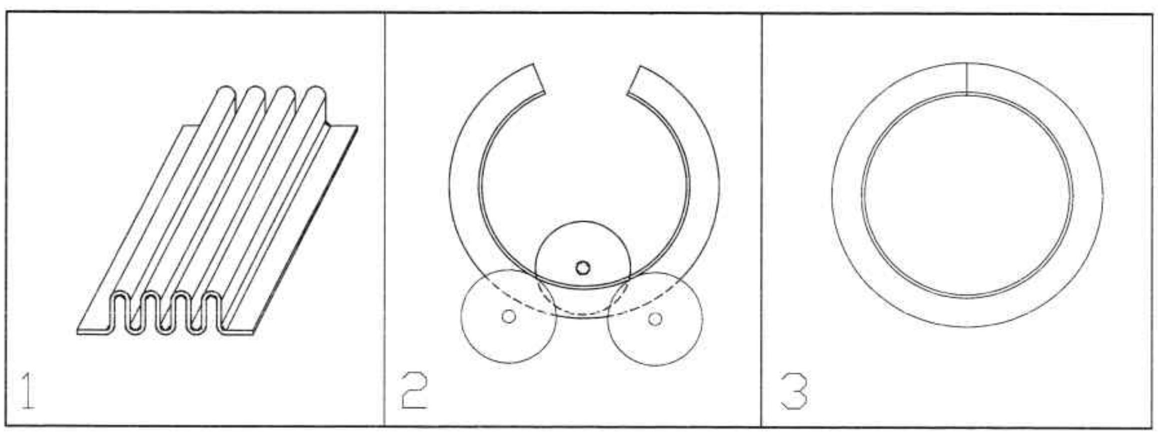
6.16.4 PNEUMATIC TUBE FORMING

This method is identical to "Elastomeric Forming" except that the initial bulge is formed by pressurizing a rubber "inner tube".



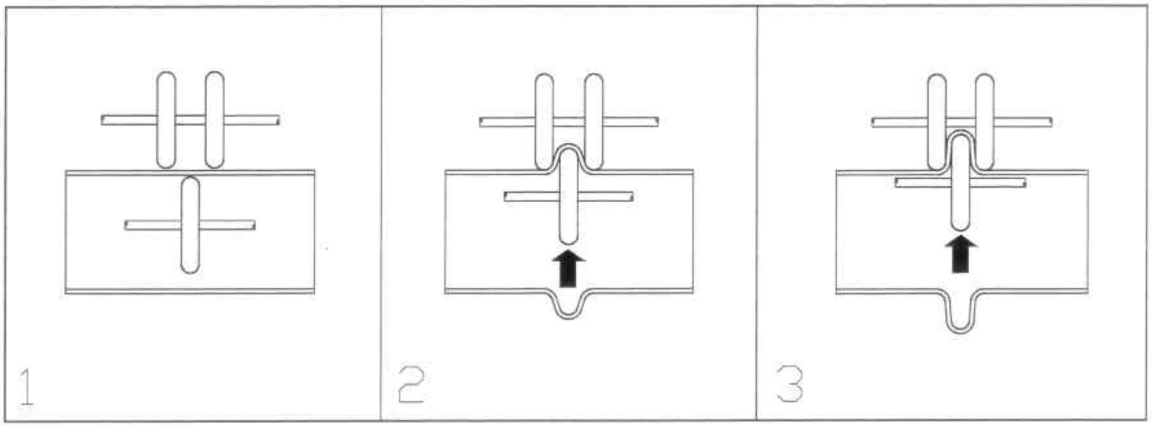
6.16.5 ROLLED CONVOLUTED SHEET

A flat sheet is mechanically convoluted by either the press-brake method or the roll forming method modified to produce straight sections. This pre-formed rail is then rolled into a tube. The bellows is completed by longitudinally welding the convoluted ends of the rail together.



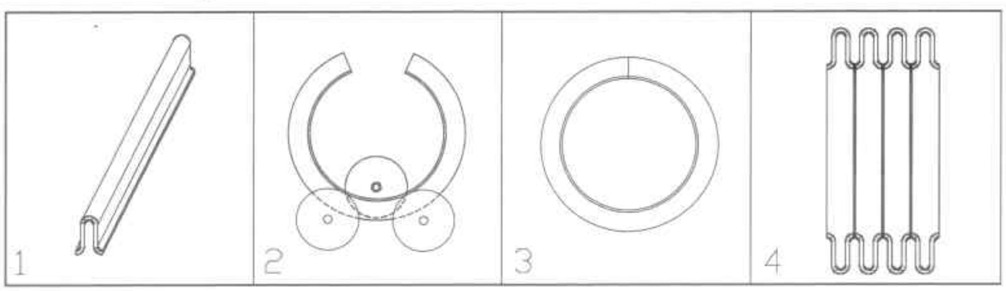
6.16.6 ROLL FORMING

A tube is placed in a forming machine and individual or multiple convolutions are formed by means of pressure exerted by forming wheels. Generally, the wheels are on both the inside and outside of the tube. Controlled longitudinal shortening of the bellows tube occurs during the forming operation. The tube may rotate about fixed-shaft forming wheels, or the tube may be fixed and the wheels rotated about the tube's circumference. The example below shows the fixed-shaft method.



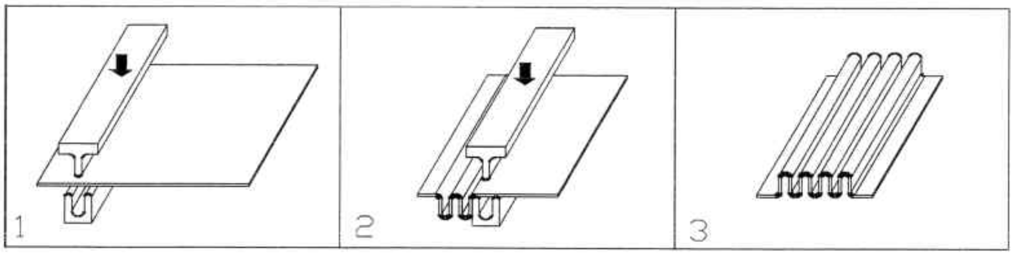
6.16.7 ROLLED RING

A flat sheet is formed into a single convolution and then rolled into a ring. The ring is completed by a longitudinal weld across the convolution. If more than one convolution is desired, the bellows is built up by a series of circumferential welds joining the convolutions together.



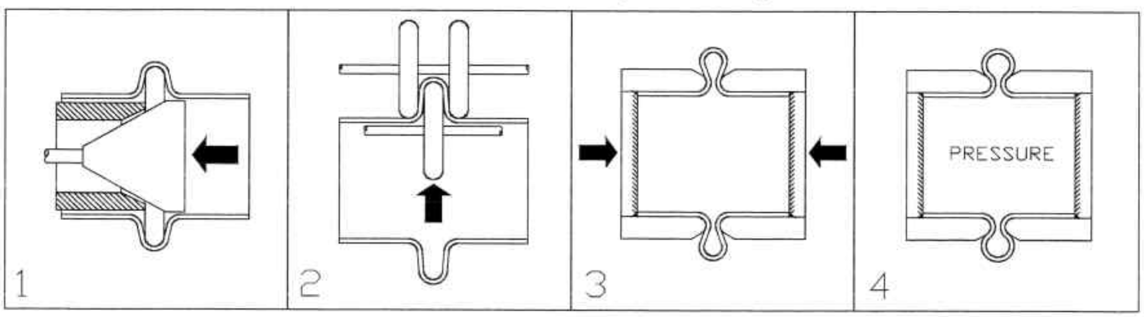
6.16.8 PRESS-BRAKE FORMING

A flat sheet is convoluted using a press-brake die to form the individual convolutions. This method is used primarily in the manufacture of bellows for rectangular Expansion Joints described in Section 5. Many convolution profiles can be achieved using this method. The most common styles are the "U" profile and "V" profiles shown in Figure 5.9. Material availability and press-break tooling limit the length of the rail. Longer lengths can be manufactured by splicing the rails together with longitudinal welds.



6.16.9 COMBINED FORMING

Some of the methods described in previous sections can be combined. One procedure for forming a toroidal bellows (Figure 4.15) combines two methods. A convolution is expansion formed with a convolution height greater than the final desired torus height. The convolution is located between forming rings similar to hydraulic forming. The rings are then pushed together and the toroid is hydraulically formed.



6.17 FABRICATION TOLERANCES

This Section covers standard manufacturing tolerances for fabricated assemblies containing Expansion Joints. If required, closer tolerances than those indicated may be obtained but must be subject to agreement between the purchaser and the manufacturer of the Expansion Joint.

Flanges for Round Expansion Joints
(Up to 96 in. Nominal Diameter)

Standard Flanges: Flanges to standards such as ANSI B16.47, B16.5, MSS SP44, AWWA C207	Dimensions and tolerances conform to the standard.
Non-Standard Machined Flanges: Including plate flanges with standard drilling	Flanges to be faced and drilled. Drilling tolerance for bolt, circle and hole location same as standard. Minimum thickness to be specified
Non-Standard Unmachined Flanges: Rolled angle, rolled bar, flame cut plate flanges, etc.	All dimensions are nominal.

LENGTH TOLERANCE (Measured between working points):

± 1/8 in. up through 3 ft.
± 1/4 in. above 3 ft. through 12 ft.
± 3/8 in. over 12 ft.

THIS SYMBOL DESIGNATES WORKING POINT:

Flanges must be installed so that bolt holes straddle a common centerline within 1/16 in..

NOTE: Good practice suggests that one mating flange in the piping system remain unwelded until the Expansion Joint has been located in position.

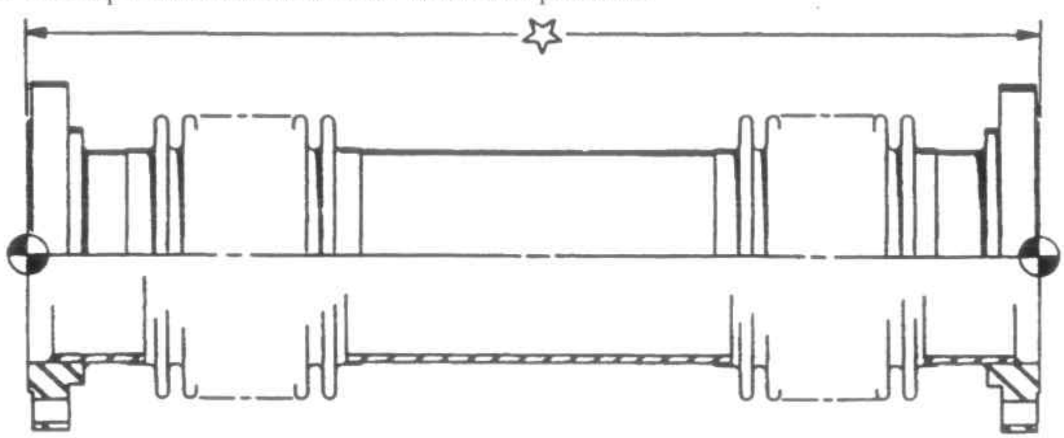
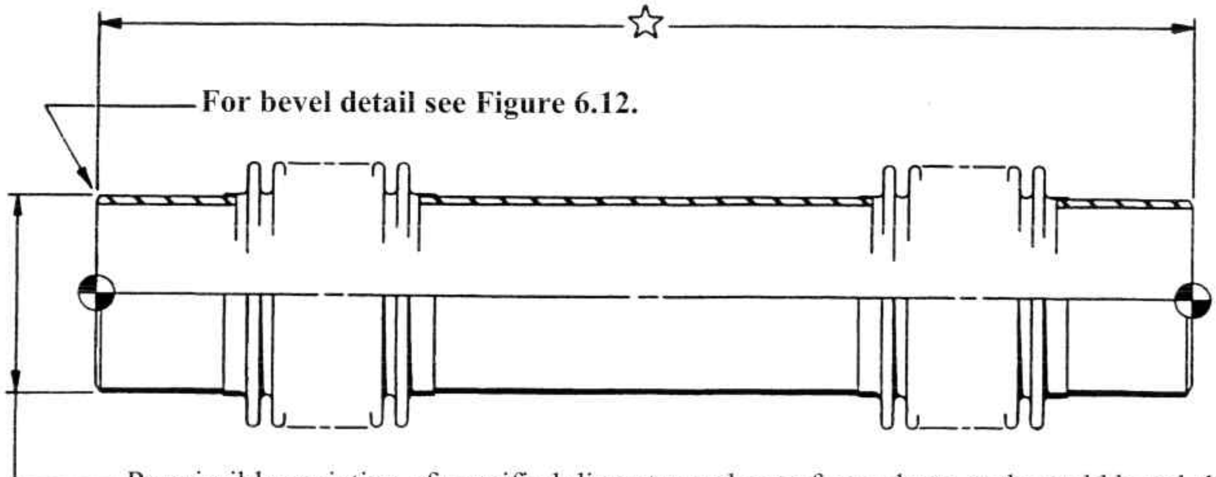
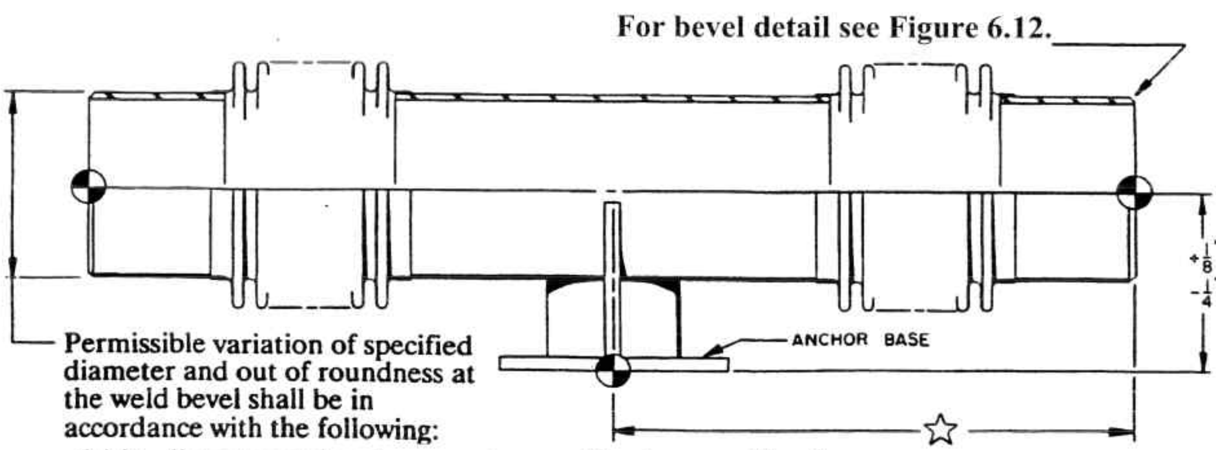


FIGURE 6.1



Permissible variation of specified diameter and out of roundness at the weld bevel shall be in accordance with the following:
24 in. diameter or less in accordance with pipe specification.
Over 24 in. diameter: Outside diameter 0.5% of the specified outside diameter based on circumferential measurement.
Out-of-roundness: Difference between major and minor diameters not to exceed 1% of nominal diameter.

FIGURE 6.2



24 in. diameter or less in accordance with pipe specification.
Over 24 in. diameter: Outside diameter 0.5% of the specified outside diameter based on circumferential measurement.
Out-of-roundness: Difference between major and minor diameters not to exceed 1% of nominal diameter.

FIGURE 6.3

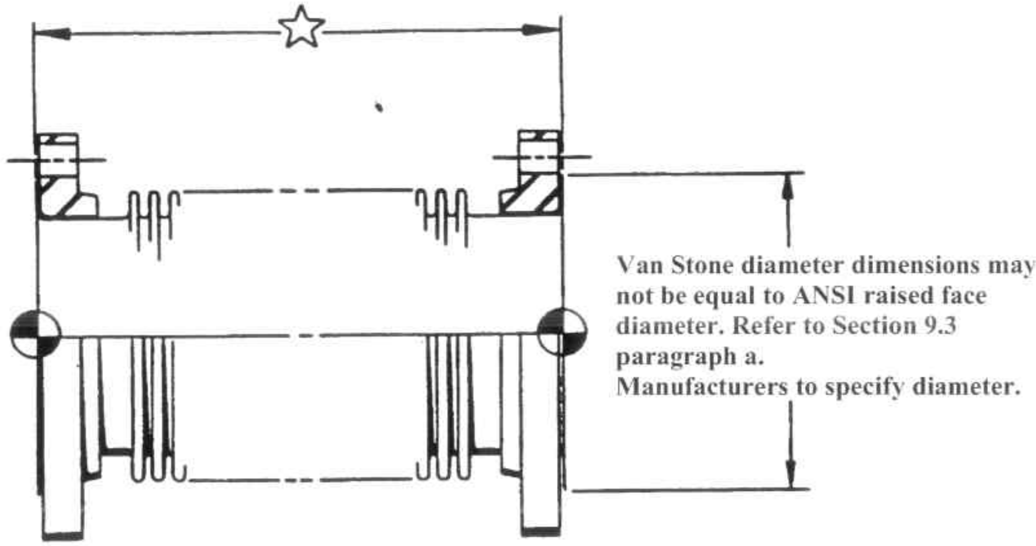


FIGURE 6.4

Flanges must be installed so that bolt holes straddle a common centerline within 1/16 in..

NOTE: Good practice suggests that one mating flange in the piping system remain unwelded until the Expansion Joint has been located in position.

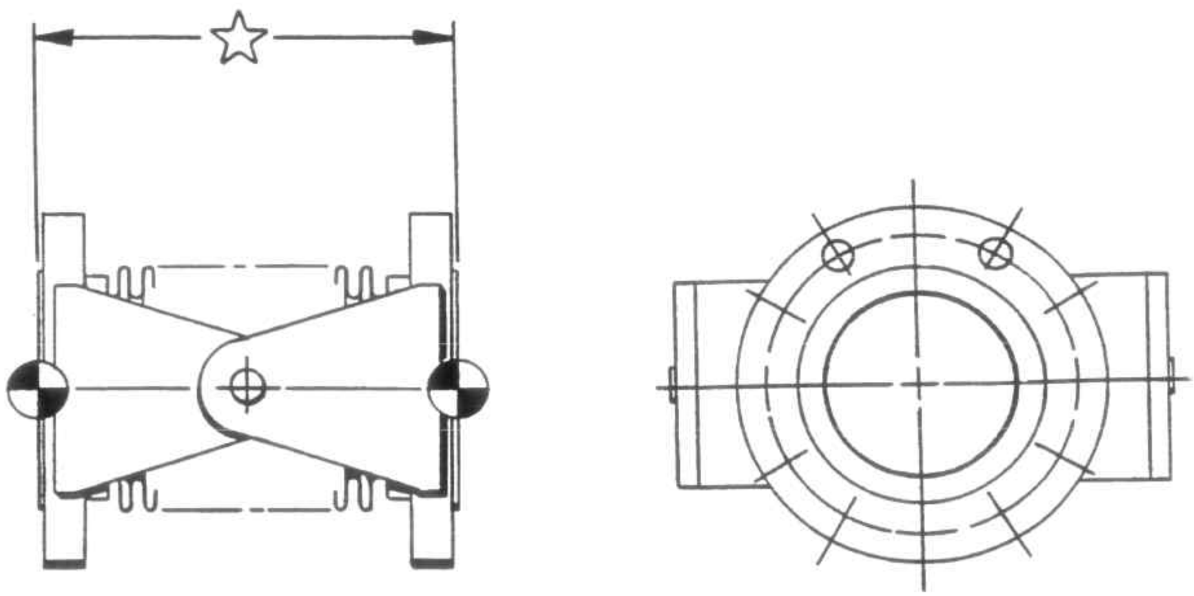
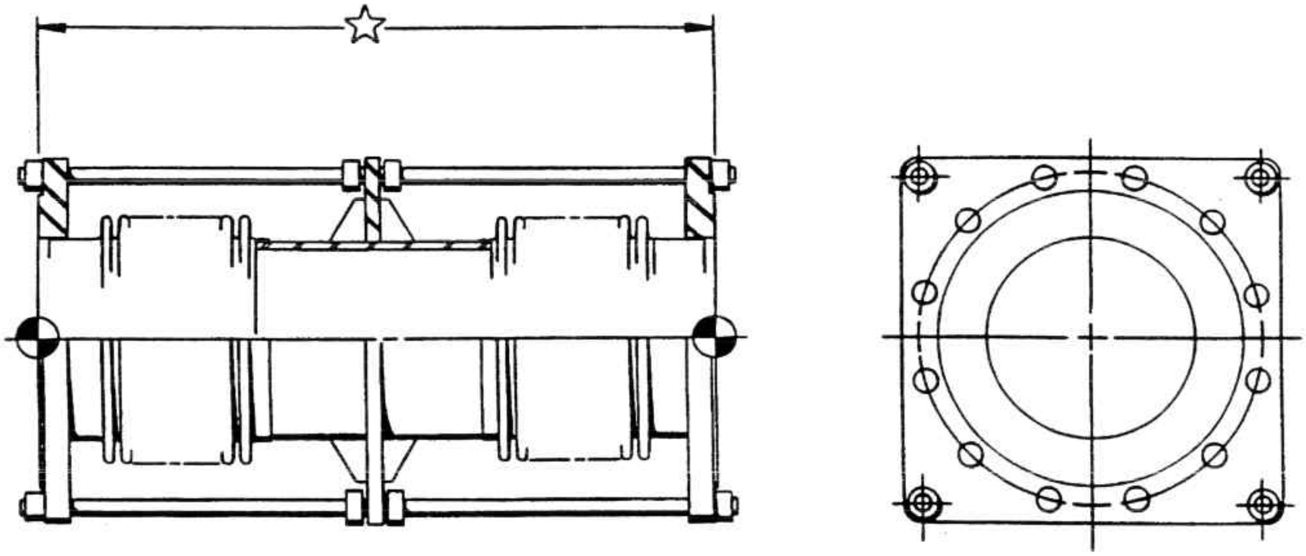


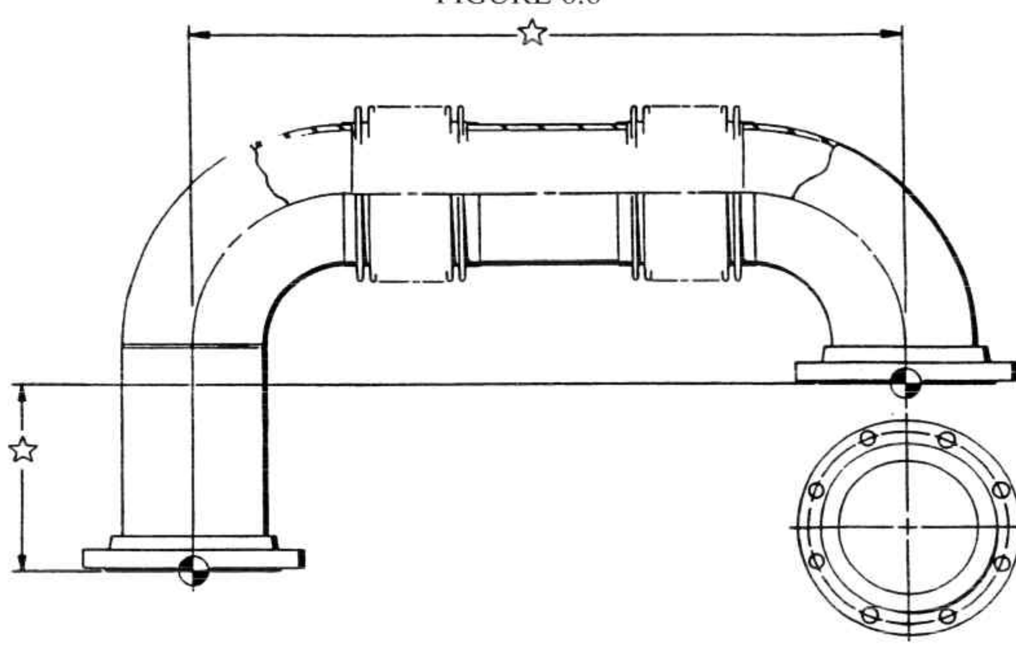
FIGURE 6.5



Flanges must be installed so that bolt holes straddle a common centerline within 1/16 in..

NOTE: Good practice suggests that one mating flange in the piping system remain unwelded until the Expansion Joint has been located in position.

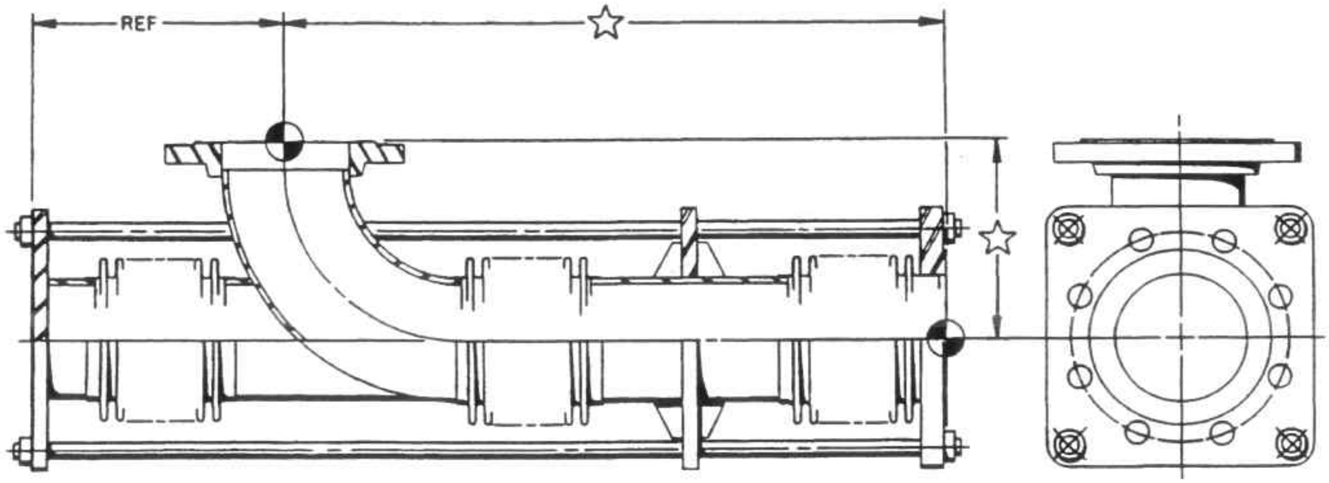
FIGURE 6.6



Flanges must be installed so that bolt holes straddle a common centerline within 1/16 in..

NOTE: Good practice suggests that one mating flange in the piping system remain unwelded until the Expansion Joint has been located in position.

FIGURE 6.7



Flanges must be installed so that bolt holes straddle a common centerline within 1/16 in..

NOTE: Good practice suggests that one mating flange in the piping system remain unwelded until the Expansion Joint has been located in position.

FIGURE 6.8