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MILITARY SPECIFICATION

FITTINGS AND FLANGES, CAST BRONZE, SILVER-BRAZING

SUITABLE FOR ULTRASONIC INSPECTION

1. SCOPE

1.1 Scope. - This specification covers tube fittings and flanges of cast bronze with ends for silver-brazing into a piping system, suitable for ultrasonic inspection. Fittings shall be interior streamlined from socket-to-socket for use with inserted ring of silver-brazing alloy. Flanges shall be suitable for use with inserted ring of silver-brazing alloy.

1.2 Classification. - Fittings and flanges shall be of the following kinds, as specified (see 6.2):

FITTINGS	Figure	Table
Caps:	17	XX
Reducer (reducing one size)	7	X
Reducer (reducing two sizes)	8	X
Straight coupling	6	X
Crosses:		
Straight	4	IX
Elbows:		
90° straight	2	IX
45° straight	5	IX
Plugs-square heads:		
Cored	15	XIX
Solid	16	XIX
Tees:		
Reducing	9	XI
Straight	3	IX
Unions:		
Nut	13	XVIII
Tailpiece	14	XVIII
Threadpiece	12	XVIII
FLANGES		
150 pound series	10	XII, XV, XVI
250 pound series	10	XIII, XV, XVI
400 pound series	10	XIV, XV, XVI
SOCKET DETAILS (fittings and unions)	1	VIII
SILVER BRAZING RING	11	XVII

2. APPLICABLE DOCUMENTS

2.1 The following documents of the issue in effect on date of invitation for bids or request for proposal, form a part of the specification to the extent specified herein.

FSC 4730

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SPECIFICATIONS

MILITARY

MIL-B-11553 - Bronze Castings, Continuous Cast.
MIL-B-15395 - Brazing Alloys, Silver.
MIL-B-16541 - Bronze, Valve: Castings.

STANDARDS

MILITARY

MIL-STD-8 - Dimensioning and Tolerancing.
MIL-STD-10 - Surface Roughness, Waviness and Lay.
MIL-STD-105 - Sampling Procedures and Tables for Inspection by Attributes.
MIL-STD-798 - Nondestructive Testing, Welding, Quality Control, Material Control and Identification and HI Shock Test Requirements for Piping System Components for Naval Shipboard Use.

(Copies of specifications, standards, drawings, and publications required by suppliers in connection with specific procurement functions should be obtained from the procuring activity or as directed by the contracting officer.)

2.2 Other publications. - The following documents form a part of this specification to the extent specified herein. Unless otherwise indicated, the issue in effect on date of invitation for bids or request for proposal shall apply.

AMERICAN SOCIETY FOR TESTING AND MATERIALS (ASTM)
B61 - Stem or Valve Bronze Castings

(Application for copies should be addressed to the American Society for Testing and Materials, 1916 Race Street, Philadelphia, Pa. 19103.)

OFFICIAL CLASSIFICATION COMMITTEE
Uniform Freight Classification Ratings, Rules and Regulations

(Application for copies should be addressed to the Official Classification Committee, 1 Park Avenue at 33rd Street, New York, N.Y. 10016.)

3. REQUIREMENTS

3.1 Materials. - Unless otherwise specified in the contract or order, fittings and flanges shall be made of material conforming to ASTM B61 or MIL-B-16541. Fittings, 2 inches or smaller, may be made of material conforming to composition 5 of MIL-B-11553.

3.1.1 Continuous melt. - Castings produced by continuous melt process may be accepted provided the controls are approved by the procuring activity and cognizant inspector. The types of sampling and metallurgical controls described in ASTM B61 used for continuous process controls are acceptable provided the following conditions of review and approval are met and maintained:

(a) The supplier shall have a quality assurance system in accordance with section 8 of MIL-STD-798.
(b) Material control shall be in accordance with section 9 of MIL-STD-798.

3.2 Working pressure and temperature. - Maximum allowable working pressures and temperatures shall be as specified in tables I and II.

Table I - Maximum working pressure and temperature for fittings

	Steam service		Water, oil or gas service	
	Maximum working pressure p.s.i.	Maximum temperature °F.	Maximum working pressure p.s.i.	Maximum temperature °F.
All fittings above 6 inch size	150	425	250	150
Unions and all fittings up to and including 6 inch size	200	425	400	150

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Table II - Maximum working pressure and temperature for flanges

Series	Sizes ips	Ratings
		Water, oil, gas or steam
Pounds	Inches	
150	1/2 to 12, inclusive	150 psi at 150°F 100 psi at 425°F
250	1/2 to 12, inclusive	250 psi at 150°F 150 psi at 425°F
400	1/2 to 10, inclusive	400 psi at 150°F 200 psi at 425°F

3.3 Design (fittings and flanges). -

3.3.1 Unless otherwise indicated, all machined surfaces marked with "√" shall be 125 RHR or smoother in accordance with MIL-STD-10.

3.3.2 Dimensioning, tolerancing and control symbols shall be in accordance with MIL-STD-8.

3.3.3 After machining, all fittings and flanges shall be cleaned to remove all foreign particles.

3.3.4 Unless otherwise noted, external surfaces may be supplied as cast provided they are cast true and smooth. Fins that are not well rounded and all burrs shall be blended.

3.3.5 Lugs, ribs, or flats may be cast on fittings for holding during machining provided placement does not interfere with ultrasonic inspection.

3.3.6 All sharp edges, except for edges at face of socket, shall be removed.

3.3.7 Within any one fitting the axis of each silver-braze socket shall not deviate from true position with the axis of any other silver-braze socket by more than 1/16 inch per foot.

3.3.8 Preinserted rings shall conform to the requirements for grade III of MIL-B-15395. Dimensions shall be as specified in 3.3.10.2.

3.3.9 Fittings and flanges shall be supplied without preinserted silver-brazing rings inserted.

3.3.10 Dimensions. -

3.3.10.1 Dimensions for fittings and flanges. - Fitting and flange dimensions shall be in accordance with figures 1 through 17 and tables III through XX, as applicable.

3.3.10.2 Dimensions for preinserted rings. - Dimensions for preinserted rings shall be as shown in figure 11.

3.3.11 Tolerances. -

3.3.11.1 Tolerances for fittings. - The tolerances specified in table III will be permitted in center-to-end dimensions for all fittings.

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Table III - Tolerances for fittings

Size	Tolerance ±	Size	Tolerance ±
Inches	Inch	Inches	Inch
1/2	0.06	3	0.10
3/4	.06	3-1/2	.10
1	.07	4	.12
1-1/4	.07	5	.12
1-1/2	.08	6	.12
2	.08	8	.15
2-1/2	.10	10	.20
		12	.20

3.3.11.2 Tolerances for flanges. - Tolerances for the flanges shall be as shown in table IV.

Table IV - Tolerances for flanges

Iron pipe size	W	T	S	O
Inches	Inch	Inch	Inch	Inch
1-1/4 and under	± 1/16	± 0.010	+ 0.003 - 0.000	+ 0.000 - 0.031
1-1/2 to 2	± 1/16	± 0.010	+ 0.005 - 0.000	+ 0.000 - 0.031
2-1/2 to 12	± 1/16	± 0.010	+ 0.007 - 0.000	+ 0.000 - 0.047

3.3.11.3 Tolerances for general dimensions. - Unless otherwise specified in the contract or order, tolerances shall be as specified in table V.

Table V - Tolerances for general dimensions
(All dimensions are in inches)

Dimensional tolerances							Casting tolerances	
Machined				Geometric (where indicated)				
Dimensions	Decimal		Fraction	Sym	Geometry	Tolerances	Dimensions	Tolerances
	2PL	3PL						
				⌒	Flat and straight	0.0005 "/in	Under 2	+1/16-1/16
Under 6	±0.010	±0.005	±1/64	⊥	Perpendicularity	0.001 "/in	2 to 5	+3/32-1/16
6 to 24	±0.020	±0.010	±1/32	∥	Parallelism	0.001 "/in	5 to 8	+1/8-3/32
24 and over	±0.030	±0.015	±1/16	⊙	Concentricity	As noted	8 to 12	+3/16-1/8
Fillets and radii. - 1/8 inch				- -			12 to 15	+1/4-3/16
Tolerances on angles to be ± 0° - 30 inches				Control symbol - MIL-STD-8			15 and over	+1/4-1/4

3.3.12 Wall thickness of reducing fittings shall be that required for the sizes specified (see table VIII).

3.3.13 The surface finish of the union seat shall be 63 RHR or smoother.

3.3.14 Except in the crotch area of elbows, tees and crosses, the 45° angle on the fitting socket O.D. may be removed by continuing dimension "S" off the back of the socket hub (see figure 1).

3.3.15 All fittings shall have sockets in accordance with table VIII.

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3.3.16 Thread pieces for unions shall have octagonal sections or round sections knurled or with ribs for use of wrenches (see figure 12).

3.3.17 The thinnest flange socket wall caused by machining the preinserted ring groove shall be not less than one-fourth the difference between dimensions "E" and "S" as shown on figure 10.

3.3.18 Flange finish. - The flange faces shall have a finish with a circular lay (concentric or phonographic) of 125 to 1000 RHR produced by machining cuts of 30 to 80 cuts of uniform depth, per inch of face width. The bore of the hub (diameter "S" of figure 10) shall have an RHR of 125 or better. Unless otherwise specified herein, the flanges shall have a waterway (diameter "T" of figure 10) machined with an RHR finish of 125 to the bore specified (see 6.2). Flanges shall not be finished on the rim provided that they are cast smooth and true. The remaining external surfaces shall not be finished except for ultrasonic inspection area and spot faces.

3.3.19 Flange drilling. - Unless otherwise specified (see 6.2) flanges shall be undrilled. Flanges shall be spot-faced on the back parallel to the face of the flange for the bolt-heads and nuts. The spot face shall cut not more than 1/32 inch below the minimum flange thickness. The number and size of holes shall conform to the dimensions specified in table VI according to the type of flange furnished.

Table VI - Spot-face dimensions

Bolt hole diameter	Spot face diameter
Inches	Inches
9/16	1-1/16
11/16	1-1/4
13/16	1-7/16
1-5/16	1-13/16
1-1/16	2-1/16

3.4 Identification. -

3.4.1 Each fitting and flange shall be identified by casting, electro-chemical etch, vibro tool etch or stamping with the following:

(a) Manufacturers name or trademark
(b) Iron pipe size
(c) Rating:
  (1) Fittings:
    1/2 inch through 6 inches - 400 WOG 200S.
    6 through 12 inches - 250 WOG 150S.
  (2) Flanges:
    (1) 150, 250 or 400 WOG, as applicable
(d) BRZ for bronze.
(e) Heat number or code (see 3.1.1).

3.4.2 All stamping shall be done with round bottom stamps.

3.4.3 Markings on the fittings and flanges shall be applied so as not to reduce the wall thickness below the minimum, and so as not to effect the strength of the fitting. Placement shall not interfere with ultrasonic inspection.

3.4.4 Flange identification markings shall be provided on the rim of all flanges. Cast identification marking is allowable on the flange back, provided placement does not subject marking to removal during machining.

3.5 Workmanship. - All fittings and flanges shall be sound, smoothly cored, true to form, uniform in texture, and free from cold shuts, porosity or any other defects which may affect their serviceability. They shall be thoroughly cleaned, both inside and outside.

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4. QUALITY ASSURANCE PROVISIONS

4.1 Responsibility for inspection. - Unless otherwise specified in the contract or purchase order, the supplier is responsible for the performance of all inspection requirements as specified herein. Except as otherwise specified, the supplier may utilize his own facilities or any commercial laboratory acceptable to the Government. The Government reserves the right to perform any of the inspections set forth in the specification where such inspections are deemed necessary to assure supplies and services conform to prescribed requirements.

4.1.1 Inspection records of the examination and tests shall be kept complete and available to the Government as specified in the contract or order.

4.2 Sampling for quality conformance inspection. -

4.2.1 Lot. - All fittings or flanges of the same size offered for delivery at one time shall be considered a lot for purposes of quality conformance inspection.

4.2.2 Sampling for examination and tests. - A random sampling of fittings or flanges shall be selected from each lot for the examination specified in 4.3 and the test specified in 4.4.2 in accordance with MIL-STD-105 at inspection level II. The acceptable quality level is 1.0 percent defective.

4.3 Examination. - Each of the samples selected in accordance with 4.2.2 shall be examined to verify compliance with all the requirements of this specification not involving tests. Examination shall be conducted as specified in table VII. Any fitting or flange in the sample containing one or more defects shall be rejected, and if the number of defective fittings or flanges in any sample exceed the acceptance number for that sample, the lot represented by that sample shall be rejected.

Table VII - Classification of defects

Categories	Defects
Critical	None defined
Major:	
101	Ultrasonic inspection bands damaged or not as specified.
102	Type, kind, and size not as specified.
103	Material not as specified.
104	Fitting or flange not sound, smoothly cored, true to form, uniform in texture, not free from cold shuts and porosity.
105	Fitting or flange surface (internal and external) not thoroughly cleaned, fins and burrs not rounded or blended.
106	Unauthorized repairs, plugs, welds or impregnation.
107	Thread missing, torn, stripped, broken or not complete.
108	Thread size not as specified.
109	Socket not smooth.
110	Socket dimensions not as specified.
111	Bottom of socket not streamlined.
112	Bottom of socket not square with axis of fitting.
113	Dimensions not within the tolerances specified.
114	Threaded pieces of unions not octagonal, knurled, or ribbed.
115	Reducing fitting wall thickness not as specified.
Minor:	
201	Marking, manufacturer's name or trademark missing, not cast, incorrect or illegible.

4.4 Tests. -

4.4.1 Air pressure leakage test. - Each fitting shall be tested underwater or with soapsuds at 100 psi air for 10 seconds. No leakage is allowed.

4.4.2 Hydrostatic pressure leakage test. - Each sample fitting or flange selected in accordance with 4.2.2 shall be subjected to a hydrostatic pressure 1-1/2 times the working pressure for one minute. Under hydrostatic pressure the fitting or flange shall not leak water, or sweat at any part of the surface.

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4.5 Inspection of preparation for delivery. - Packaging, packing and marking of packages shall be inspected to determine conformance to the requirements of section 5 herein.

5. PREPARATION FOR DELIVERY

5.1 Domestic shipment and early equipment installation. -

5.1.1 Preservation and packaging. - Preservation and packaging shall be sufficient to afford adequate protection against corrosion, deterioration and physical damage during shipment from the supply source to the using activity and until early installation. All silver-brazing and ultrasonic inspection surfaces shall be protected from damage during shipment.

5.1.1.1 Packing. - Packing shall be accomplished in a manner which will insure acceptance by common carrier and will afford protection against physical or mechanical damage during direct shipment from the supply source to the using activity for early installation. The shipping containers or method of packing shall conform to the Uniform Freight Classification Ratings, Rules and Regulations or other carrier regulations as applicable to the mode of transportation.

5.1.1.2 Marking. - Shipment marking information shall be provided on interior packages and exterior shipping containers in accordance with the contractor's commercial practice. The information shall include nomenclature, Federal stock number or manufacturer's part number, contract or order number, contractor's name and destination.

5.2 Domestic shipment and storage or overseas shipment. - The requirements and levels of preservation, packaging, packing and marking for shipment shall be specified by the procuring activity (see 6.2).

(5.2.1 The following provides various levels of protection during domestic shipment and storage or overseas shipment, which may be required when procurement is made.

5.2.1.1 Preservation and packaging. - Fittings and flanges shall be preserved and packaged by level A or C in accordance with MIL-V-3.

5.2.1.2 Packing. - Fittings and flanges shall be packed by level A, B or C in accordance with MIL-V-3.

5.2.1.3 Marking. - In addition to any special marking required, interior packages and exterior shipping containers shall be marked in accordance with MIL-STD-129).

6. NOTES

6.1 Intended use. - The installation of fittings and flanges is intended to be accomplished by brazing without exceeding a temperature of 1400°F. The fittings and flanges are intended for use with the following:

Material	Specification
Copper tube	MIL-T-24107
Copper-nickel tube	MIL-T-16420
Brass tube	MIL-T-20168

6.2 Ordering data. - Procurement documents should specify the following:

(a) Title, number and date of this specification.
(b) Kind and size of fitting required and series and size of flange required (see 1.2).
(c) Flange finish (see 3.3.18).
(d) When flanges are to be drilled (see 3.3.19).
(e) Preservation, packaging, packing and marking required, if other than specified in 5.1 (see 5.2).
(f) When ordering reducing fittings, the run should be given first and then the outlet.
(g) Quantity of fittings or flanges required.

Preparing activity:
Navy - SH
(Project 4730-N095Sh)

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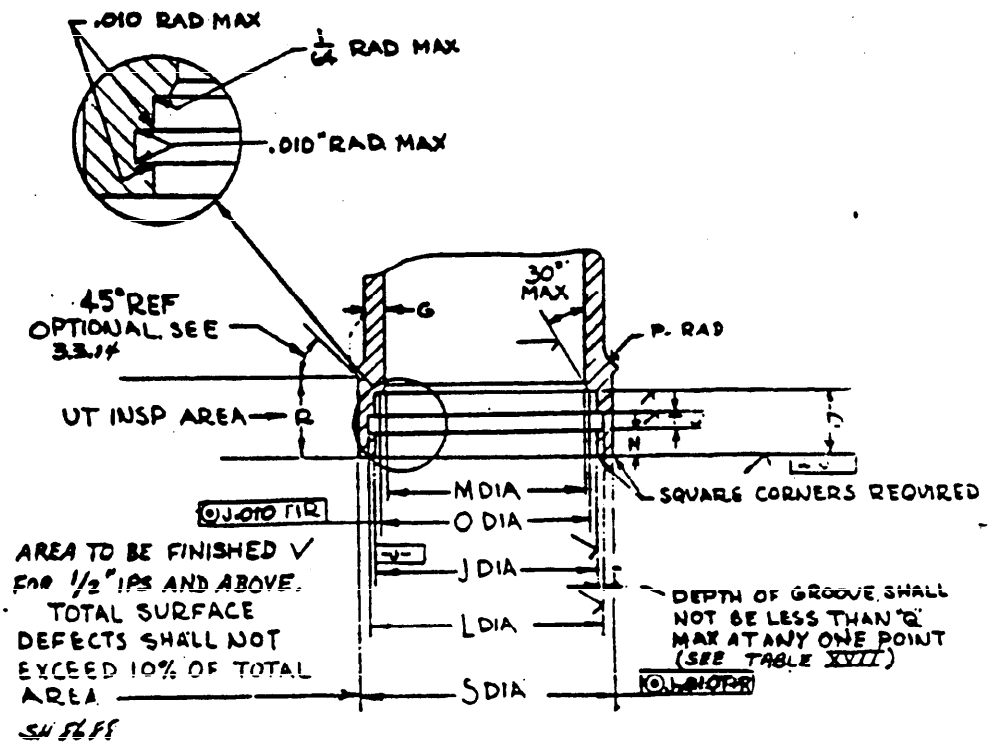

Figure 1 - Socket detail (see table VIII)

Table VIII - Detail dimensions of socket (see figure 1)

Iron pipe size	Outside diameter of tube	D	R	M		G	P	S	J		L	T	N	O
		Depth of socket +1/64 -0	Width of UT band +1/16 -0	Inside diameter of fittings		Metal thickness	Radius	Band diameter +1/8 -0	Diameter of socket		Diameter of groove	Width of groove	Fitting face of ring groove	Chamfered bore
	Maximum	---	---	---	±	Minimum	Minimum	Minimum	Minimum	Maximum	+0.020 -.000	+0.010 -.000	---	±0.010
Inches	Inches	Inches	Inches	Inches	Inch	Inch	Inch	Inches	Inches	Inches	Inches	Inch	Inch	Inches
1/4	0.504	17/64	---	0.398	0.015	0.070	5/64	0.700	0.540	0.543	0.619	0.068	9/64	---
3/8	.675	5/16	---	.532	.015	.080	3/32	.855	.675	.678	.744	.063	9/64	---
1/2	.840	3/8	33/64	.607	.020	.080	3/32	1.020	.840	.843	.929	.063	9/64	0.707
3/4	1.050	13/32	35/64	.907	.025	.090	7/64	1.250	1.050	1.053	1.159	.099	5/32	.962
1	1.315	7/16	19/32	1.171	.025	.100	7/64	1.535	1.315	1.318	1.434	.130	5/32	1.166
1-1/4	1.660	1/2	41/64	1.502	.030	.110	1/8	1.900	1.660	1.663	1.769	.130	3/16	1.522
1-1/2	1.900	5/8	49/64	1.742	.030	.120	1/8	2.160	1.900	1.905	2.011	.192	7/32	1.762
2	2.375	21/32	61/64	2.186	.030	.140	5/32	2.675	2.375	2.380	2.486	.192	15/64	2.206
2-1/2	2.875	25/32	69/64	2.686	.030	.150	5/32	3.215	2.875	2.882	2.988	.192	19/64	2.706
3	3.500	53/64	31/32	3.206	.035	.170	3/16	3.880	3.500	3.507	3.613	.255	19/64	3.311
3-1/2	4.000	7/8	1-1/64	3.766	.035	.190	3/16	4.400	4.000	4.007	4.113	.255	5/16	3.811
4	4.500	29/32	1-1/16	4.252	.040	.200	7/32	4.940	4.500	4.507	4.613	.255	21/64	4.282
5	5.563	1	1-9/64	5.278	.040	.280	5/16	6.163	5.563	5.570	5.736	.255	3/8	5.308
6	6.625	1-7/64	1-1/4	6.321	.040	.320	11/32	7.306	6.625	6.632	6.798	.255	27/64	6.351
8	8.625	1-5/16	1-29/64	8.286	.040	.380	13/32	9.425	8.625	8.632	8.798	.398	29/64	8.316
10	10.750	1-1/2	1-41/64	10.325	.040	.445	1/2	11.700	10.750	10.757	10.923	.398	35/64	10.355
12	12.750	1-5/8	1-49/64	12.322	.040	.540	9/16	13.840	12.750	12.757	12.963	.398	39/64	12.352

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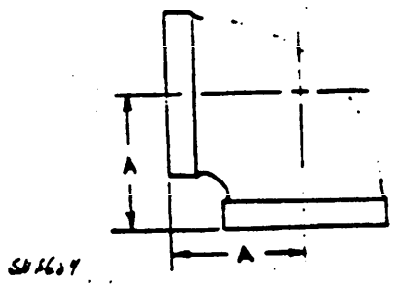

Figure 2 - Elbow straight, 90°
(See table IX)

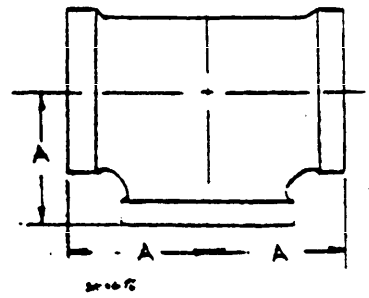

Figure 3 - Tee, straight
(See table IX)

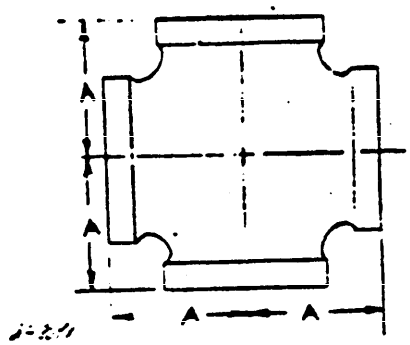

Figure 4 - Cross, straight
(See table IX)

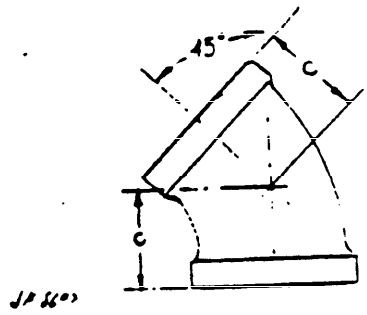

Figure 5 - Elbow straight, 45°
(See table IX)

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Table IX - Center-to-end dimensions of elbows straight 90°, tees straight, crosses straight, elbows 45° (See table VIII for detail dimensions)

Iron pipe size	A	C
	Center-to-end 90° elbows, tees and crosses	Center-to-end 45° elbows
Inches	Inches	Inches
1/2	1.244	1.014
3/4	1.414	1.124
1	1.649	1.279
1-1/4	1.909	1.439
1-1/2	2.153	1.519
2	2.526	1.668
2-1/2	2.919	2.169
3	3.299	2.389
3-1/2	3.639	2.609
4	4.010	2.830
5	4.719	3.269
6	5.442	3.678
8	6.763	4.483
10	8.268	5.348
12	9.687	6.157

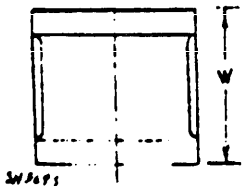

Figure 6 - Straight coupling (See table X).

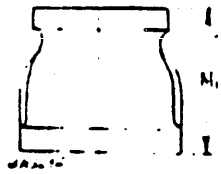

Figure 7 - Reducer (reducing one size) (See table X)

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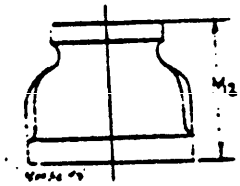

Figure 8 - Reducer
(reducing two sizes)
(See table X)

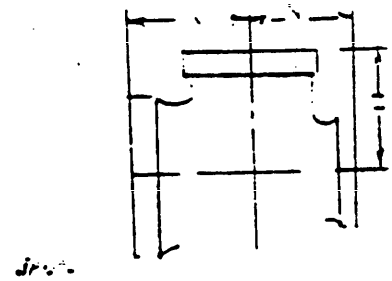

Figure 9 - Tee, reducing
(See table XI)

Table X - End-to-end dimensions of cast couplings and reducers
(See table VIII for detail dimensions)

Iron pipe size	W End-to-end (straight)	M_1 End-to-end (reducing one size)	M_2 End-to-end (reducing two sizes)	Size of reduced ends
Inches	Inches	Inches	Inches	Inches
1/4	1.252	--	--	--
3/8	1.330	1.134	--	1/4
1/2	1.570	1.450	1.254	1/4, 3/8
3/4	1.710	1.640	1.520	3/8, 1/2
1	1.930	1.825	1.755	1/2, 3/4
1-1/4	2.110	2.013	1.915	3/4, 1
1-1/2	2.170	2.140	2.050	1, 1-1/4
2	2.448	2.309	2.279	1-1/4, 1-1/2
2-1/2	3.130	3.499	3.550	1-1/2, 2
3	3.430	3.940	3.940	2, 2-1/2
3-1/2	3.680	4.250	4.250	2-1/2, 3
4	3.942	4.631	4.631	3, 3-1/2
5	4.470	5.231	5.243	3-1/2, 4
6	4.998	---	---	---
8	5.968	---	---	---
10	6.688	---	---	---
12	7.196	---	---	---

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Table XI - Center-to-end dimensions of reducing tees
(See table VIII for detail dimensions)
(For tolerances, See table III)

Iron pipe size	Center-to-end		
	X	Y	Z
Inches	Inches	Inches	Inches
1/2 by 1/2 by 1/4	1.053	1.053	1.134
1/2 by 1/4 by 1/2	1.244	1.134	1.244
3/4 by 3/4 by 1/2	1.307	1.307	1.359
3/4 by 3/4 by 3/8	1.194	1.194	1.296
3/4 by 3/4 by 1/4	1.116	1.116	1.249
3/4 by 1/2 by 3/4	1.422	1.359	1.422
3/4 by 1/2 by 1/2	1.307	1.244	1.359
3/4 by 3/8 by 3/4	1.422	1.296	1.422
3/4 by 3/8 by 3/8	1.194	1.068	1.296
3/8 by 3/8 by 1/2	1.181	1.181	1.131
1/2 by 3/8 by 3/8	1.131	1.068	1.181
1/2 by 1/2 by 3/8	1.131	1.131	1.181
1/2 by 1/2 by 3/4	1.359	1.359	1.307
3/4 by 3/8 by 1/2	1.307	1.181	1.359
3/4 by 3/4 by 1	1.565	1.565	1.500
1 by 3/8 by 1	1.643	1.439	1.643
1 by 1/2 by 3/4	1.500	1.359	1.565
1 by 3/4 by 3/8	1.272	1.194	1.439
1 by 1 by 3/8	1.272	1.272	1.439
1 by 1 by 3/4	1.500	1.500	1.565
1 by 1 by 1/2	1.385	1.385	1.502
1 by 1 by 1/4	1.194	1.194	1.392
1 by 1 by 1-1/4	1.625	1.625	1.721
1 by 3/4 by 1	1.643	1.565	1.643
1 by 3/4 by 3/4	1.500	1.422	1.565
1 by 3/4 by 1/2	1.385	1.307	1.502
1 by 1/2 by 1	1.643	1.502	1.643
1 by 1/2 by 1/2	1.385	1.244	1.502
1-1/4 by 1/2 by 1	1.721	1.534	1.825
1-1/4 by 1-1/4 by 3/8	1.350	1.350	1.621
1-1/4 by 1-1/4 by 1	1.721	1.721	1.825
1-1/4 by 1-1/4 by 3/4	1.578	1.578	1.747
1-1/4 by 1-1/4 by 1/2	1.463	1.463	1.716
1-1/4 by 1 by 1-1/4	1.903	1.825	1.903
1-1/4 by 1 by 1	1.721	1.643	1.825
1-1/4 by 1 by 3/4	1.578	1.500	1.747
1-1/4 by 3/4 by 1-1/4	1.903	1.747	1.903
1-1/4 by 3/4 by 1	1.721	1.565	1.825
1-1/4 by 3/4 by 3/4	1.578	1.422	1.747
1-1/2 by 3/4 by 3/4	1.703	1.422	1.877
1-1/2 by 1 by 1	1.846	1.643	1.955
1-1/2 by 1 by 1-1/4	2.028	1.825	2.033
1-1/2 by 1-1/4 by 1/2	1.588	1.463	1.846
1-1/2 by 1-1/2 by 1-1/4	2.028	2.028	2.033
1-1/2 by 1-1/2 by 1	1.846	1.846	1.955
1-1/2 by 1-1/2 by 3/4	1.703	1.703	1.877
1-1/2 by 1-1/2 by 1/2	1.588	1.588	1.846
1-1/2 by 1-1/2 by 3/8	1.475	1.475	1.751
1-1/2 by 1-1/4 by 1-1/2	2.158	2.033	2.158
1-1/2 by 1-1/4 by 1-1/4	2.028	1.903	2.033

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Table XI - Center-to-end dimensions of reducing tees
(See table VIII for detail dimensions)
(For tolerances, See table III), cont'd

Iron pipe size	Center-to-end		
	X	Y	Z
Inches	Inches	Inches	Inches
1-1/2 by 1-1/4 by 1	1.846	1.721	1.955
1-1/2 by 1 by 1-1/2	2.158	1.955	2.158
1-1/2 by 3/4 by 1-1/2	2.158	1.908	2.158
1-1/2 by 3/4 by 1-1/4	2.028	1.747	2.033
1-1/2 by 3/4 by 1	1.846	1.565	1.955
1-1/2 by 1-1/2 by 1-1/2	2.158	1.846	2.158
2 by 3/4 by 2	2.510	2.166	2.510
2 by 1-1/2 by 1-1/4	2.122	2.028	2.291
2 by 2 by 1-1/2	2.252	2.252	2.416
2 by 2 by 1-1/4	2.122	2.122	2.291
2 by 2 by 1	1.940	1.940	2.244
2 by 1-1/2 by 1-1/2	2.252	2.158	2.416
2 by 1-1/2 by 1	1.940	1.846	2.244
2 by 1-1/2 by 2	2.510	2.416	2.510
2 by 1-1/4 by 2	2.510	2.291	2.510
2 by 1-1/4 by 1-1/2	2.252	2.033	2.416
2 by 1-1/4 by 1-1/4	2.122	1.903	2.291
2 by 1 by 2	2.510	2.213	2.510
2 by 1/2 by 2	2.510	2.135	2.510
2-1/2 by 2-1/2 by 2	2.635	2.635	2.780
2-1/2 by 2-1/2 by 1	2.065	2.065	2.483
2-1/2 by 2-1/2 by 3/4	1.922	1.922	2.436
2-1/2 by 2 by 1-1/2	2.377	2.252	2.686
2-1/2 by 1-1/2 by 2	2.635	2.416	2.780
2-1/2 by 1-1/2 by 1-1/2	2.377	2.158	2.686
2-1/2 by 1/2 by 2-1/2	2.905	2.405	2.906
2-1/2 by 2 by 2	2.635	2.510	2.780
2-1/2 by 2-1/2 by 1-1/2	2.377	2.377	2.686
3 by 3 by 2-1/2	2.952	2.952	3.237
3 by 3 by 2	2.682	2.682	3.112
3 by 3 by 1-1/2	2.424	2.424	3.018
3 by 2-1/2 by 2-1/2	2.952	2.905	3.237
3 by 2-1/2 by 2	2.682	2.635	3.112
3 by 2 by 3	3.284	3.112	3.284
3 by 2 by 2	2.684	2.510	3.112
3-1/2 by 3-1/2 by 3	3.362	3.362	3.544
3-1/2 by 3-1/2 by 2-1/2	3.030	3.030	3.497
3-1/2 by 3 by 2-1/2	3.030	2.952	3.497
3-1/2 by 2-1/2 by 2-1/2	3.030	2.905	3.497
4 by 4 by 3-1/2	3.731	3.731	3.892
4 by 4 by 3	3.471	3.471	3.814
4 by 3 by 3	3.471	3.284	3.814
5 by 5 by 4	4.111	4.111	4.613
5 by 3 by 4	4.111	3.814	4.613
6 by 6 by 5	4.863	4.863	5.294
6 by 6 by 4	4.251	4.251	5.184
8 by 8 by 6	5.699	5.699	6.494
10 by 10 by 8	7.135	7.135	7.896
12 by 12 by 8	7.479	7.479	8.966

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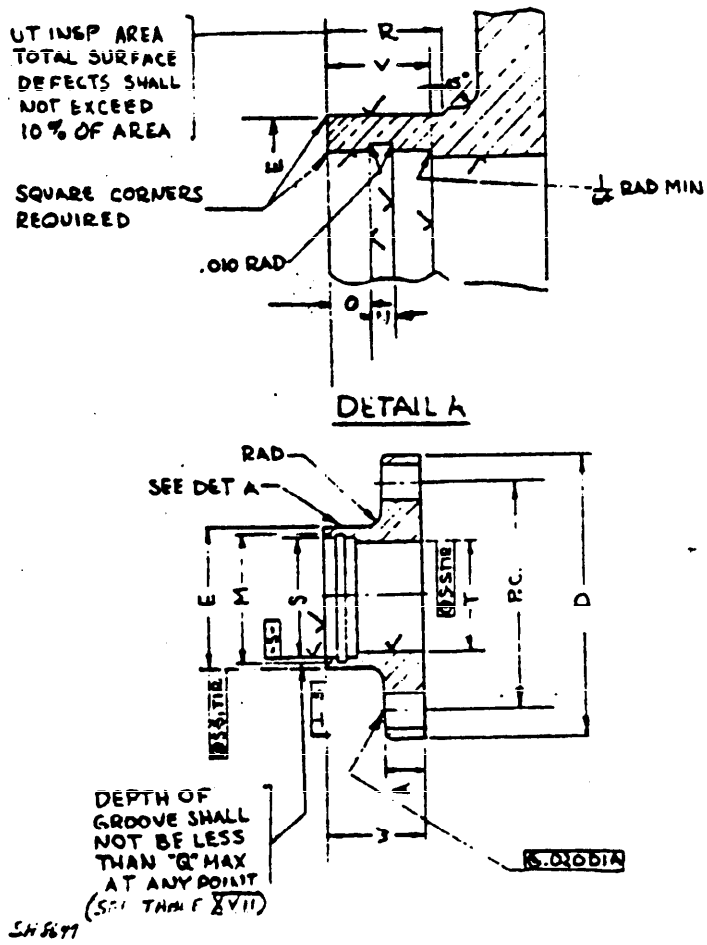

Figure 10 - Detail dimensions of flanges
(see tables XII, XIII, XIV, XV and XVI)

Table XII - Dimensions of 150 pound flanges (see figure 10)

Iron pipe size	Tubing O. D.	A +1/8 -1/64	R +1/16 -0	D	E		S	T	V +1/64 -0	W	RAD	S_1
					Inches							
Inches	Inches	Inches	Inches	Inches	Diameter	Tab,	Inches	Inches	Inch	Inches	Inch	Inch
1/2	0.840	3/8	0.500	3-9/16	1-5/32	+1/8 -0	0.840	0.71	3/8	1.219	1/4	0.008
3/4	1.050	7/16	.531	3-13/16	1-11/32	+1/8 -0	1.050	.92	13/32	1.313	1/4	.008
1	1.315	7/16	.563	4-1/4	1-5/8	+1/8 -0	1.315	1.18	7/16	1.345	1/4	.016
1-1/4	1.660	7/16	.625	4-1/2	2	+1/8 -0	1.660	1.53	1/2	1.469	5/16	.016
1-1/2	1.900	7/16	.750	5-1/16	2-1/4	+1/8 -1	1.900	1.77	5/8	1.594	5/16	.016
2	2.375	7/16	.781	5-9/16	2-3/4	+4/8 -0	2.375	2.24	21/32	1.625	5/16	.016
2-1/2	2.875	1/2	.750	6-1/8	3-1/4	+1/8 -0	2.875	2.71	5/8	1.656	5/16	.031
3	3.500	1/2	.750	6-5/8	3-7/8	+1/8 -0	3.500	3.31	5/8	1.656	5/16	.031
3-1/2	4.000	1/2	.813	7-3/16	4-3/8	+3/16 -0	4.000	3.81	11/16	1.782	3/8	.031
4	4.500	1/2	.813	7-11/16	4-15/16	+3/16 -0	4.500	4.28	11/16	1.782	3/8	.031
5	5.563	9/16	.813	9-1/16	6	+3/16 -0	5.563	5.32	11/16	1.844	3/8	.047
6	6.625	9/16	.875	10-1/8	7-1/16	+3/16 -0	6.625	6.36	3/4	1.969	7/16	.047
8	8.625	5/8	1.063	12-3/8	9-1/8	+3/16 -0	8.625	8.33	15/16	2.220	7/16	.063
10	10.750	11/16	1.187	15	11-5/16	+3/16 -0	10.750	10.38	1-1/16	2.419	1/2	.063
12	12.750	3/4	1.375	17-5/8	13-7/16	+3/16 -0	12.750	12.25	1-1/4	2.719	1/2	.063

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Table XIII - Dimenions of 250 pound flanges (see figure 10)

Iron pipe size	Tubing O. D.	A +1/8 -1/64	R +1/16 -0	D	E		S	T	V* +1/64 -0	W	RAD	S_1
Inches	Inches	Inches	Inches	Inches	Inches Diameter	Tol.	Inches	Inches	Inch	Inches	Inch	Inch
1/2	0.840	11/16	0.500	3-9/16	1-5/32	+1/8 -0	0.840	0.697	3/8	1.532	1/4	0.008
3/4	1.050	11/16	.531	3-9/16	1-11/32	+1/8 -0	1.050	.907	13/32	1.563	1/4	.008
1	1.315	3/4	.563	4-1/4	1-5/8	+1/8 -0	1.315	1.171	7/16	1.657	1/4	.016
1-1/4	1.660	13/16	.625	4-1/2	2	+1/8 -0	1.660	1.502	1/2	1.843	5/16	.016
1-1/2	1.900	13/16	.750	5-1/16	2-1/4	+1/8 -0	1.900	1.742	5/8	1.968	5/16	.016
2	2.375	13/16	.781	5-9/16	2-3/4	+1/8 -0	2.375	2.186	21/32	1.999	5/16	.016
2-1/2	2.875	15/16	.750	6-1/8	3-1/4	+1/8 -0	2.875	2.686	5/8	2.094	5/16	.031
3	3.500	15/16	.750	6-5/8	3-7/8	+1/8 -0	3.500	3.286	5/8	2.094	5/16	.031
3-1/2	4.000	1	.813	7-3/16	4-3/8	+3/16 -0	4.000	3.786	11/16	2.282	3/8	.031
4	4.500	1	.813	7-11/16	4-15/16	+3/16 -0	4.500	4.252	11/16	2.282	3/8	.031
5	5.563	1-1/16	.813	9-1/16	6	+3/16 -0	5.563	5.278	11/16	2.344	3/8	.047
6	6.625	1-3/16	.875	10-1/8	7-1/16	+3/16 -0	6.625	6.321	3/4	2.595	7/16	.047
8	8.625	1-5/16	1.063	12-3/8	9-1/8	+3/16 -0	8.625	8.286	15/16	2.907	7/16	.063
10	10.750	1-7/16	1.187	15	11-5/16	+3/16 -0	10.750	10.325	1-1/16	3.219	1/2	.063
12	12.750	1-1/2	1.375	17-5/8	13-7/16	+3/16 -0	12.750	12.322	1-1/4	3.469	1/2	.063

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Table XIV - Dimensions of 400 pound flanges (see figure 10)

Iron pipe size	Tubing O. D.	A +1/8 -1/64	R +1/16 -0	D	E		S	T	V +1/64 -0	W	RAD	S_1
					Inches							
Inches	Inches	Inches	Inches	Inches	Diameter	Tol.	Inches	Inches	Inches	Inches	Inch	Inch
1/2	0.840	11/16	0.500	4	1-1/4	+1/8 -0	0.840	0.71	3/8	1.532	1/4	0.008
3/4	1.050	11/16	.531	4-5/16	1-7/16	+1/8 -0	1.050	.92	13/32	1.563	1/4	.008
1	1.315	3/4	.563	5-1/16	1-3/4	+1/8 -0	1.315	1.18	7/16	1.657	1/4	.016
1-1/4	1.660	13/16	.625	5-3/8	2-1/8	+1/8 -0	1.660	1.53	1/2	1.843	5/16	.016
1-1/2	1.900	13/16	.750	5-15/16	2-3/8	+1/8 -0	1.900	1.77	5/8	1.968	5/16	.016
2	2.375	13/16	.781	6-1/2	2-7/8	+1/8 -0	2.375	2.24	21/32	1.999	5/16	.016
2-1/2	2.875	15/16	1.125	7-9/16	3-3/8	+1/8 -0	2.875	1/ 1	1	2.657	1/2	.031
3	3.500	15/16	1.125	8-1/8	4	+3/16 -0	3.500	1	1	2.657	1/2	.031
3-1/2	4.000	1	1.125	8-11/16	4-1/2	+3/16 -0	4.000	1	1	2.719	1/2	.031
4	4.500	1	1.250	9-1/4	5	+3/16 -0	4.500	1	1-1/8	2.906	9/16	.031
5	5.563	1-1/16	1.375	10-3/8	6-3/16	+3/16 -0	5.563	1	1-1/4	3.093	9/16	.047
6	6.625	1-3/16	1.500	11-15/16	7-5/16	+3/16 -0	6.625	1	1-3/8	3.407	5/8	.047
8	8.625	1-5/16	1.625	14-3/4	9-3/8	+3/16 -0	8.625	1	1-1/2	3.703	11/16	.063
10	10.750	1-7/16	1.875	17	11-5/8	+3/16 -0	10.75	1	1-3/4	4.157	3/4	.063

1/ Bore to suit inside diameter of tube.

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Table XV - Machining details for flange ring groove
(see figure 10)

Iron pipe size	Tubing O.D.	O		N	M
		150 and 250 pounds	400 pounds	+0.010 - .000	+0.020 - .000
Inches	Inches	Inch	Inch	Inch	Inches
1/2	0.840	0.149	0.149	0.083	0.929
3/4	1.050	.154	.154	.099	1.159
1	1.315	.154	.154	.130	1.424
1-1/4	1.660	.185	.185	.130	1.769
1-1/2	1.900	.217	.217	.192	2.011
2	2.375	.232	.232	.192	2.486
2-1/2	2.875	.217	.404	.192	2.988
3	3.500	.185	.373	.255	3.613
3-1/2	4.000	.217	.373	.255	4.113
4	4.500	.217	.435	.255	4.673
5	5.563	.217	.498	.255	5.736
6	6.625	.248	.560	.255	6.798
8	8.625	.270	.551	.398	8.798
10	10.750	.333	.676	.398	10.923
12	12.750	.426	---	.398	12.963

Table XVI - Flange drilling dimensions (see figure 10)

Iron pipe size	Tubing O.D.	Number of holes		150 pound flanges			250 pound flanges		400 pound flanges		
				Diameter of holes	Pitch circle P.C.	Pitch cord	Diameter of holes	Pitch circle P.C.	Diameter of holes	Pitch circle P.C.	Pitch cord
Inches	Inches	150 and 250 pounds	400 pounds	Inch	Inches	Inches	Inch	Inches	Inch	Inches	Inches
1/2	0.840	3	4	9/16	2-7/16	2.11	9/16	2-7/16	9/16	2-7/8	2.03
3/4	1.050	4	4	9/16	2-11/16	1.90	9/16	2-11/16	9/16	3-3/16	2.25
1	1.315	4	5	9/16	3-1/8	2.21	9/16	3-1/8	11/16	3-3/4	2.20
1-1/4	1.660	4	5	9/16	3-3/8	2.39	9/16	3-3/8	11/16	4-1/16	2.39
1-1/2	1.900	6	6	9/16	3-15/16	1.97	9/16	3-15/16	11/16	4-5/8	2.31
2	2.375	6	7	9/16	4-7/16	2.22	11/16	4-7/16	11/16	5-3/16	2.25
2-1/2	2.875	6	8	9/16	5	2.50	11/16	5	13/16	6	2.30
3	3.500	8	8	9/16	5-1/2	2.10	11/16	5-1/2	13/16	6-9/16	2.51
3-1/2	4.000	8	9	9/16	6-1/16	2.32	11/16	6-1/16	13/16	7-1/8	2.44
4	4.500	8	9	9/16	6-9/16	2.51	11/16	6-9/16	13/16	7-11/16	2.63
5	5.563	10	11	11/16	7-13/16	2.41	11/16	7-13/16	13/16	8-13/16	2.48
6	6.625	12	12	11/16	8-7/8	2.30	11/16	8-7/8	15/16	10-3/16	2.64
8	8.625	14	13	11/16	11-1/16	2.46	11/16	11-1/16	1-1/16	12-3/4	3.05
10	10.750	15	15	13/16	13-7/16	2.79	13/16	13-7/16	1-1/16	15	3.12
12	12.750	18	--	13/16	16-1/16	2.79	13/16	16-1/16	---	---	--

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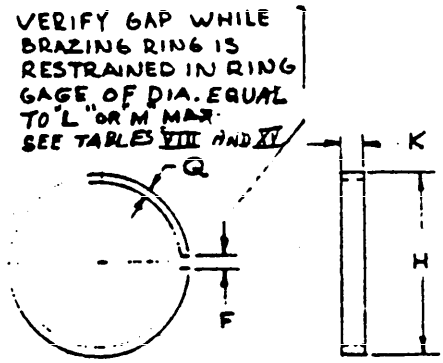

Figure 11 - Silver-brazing ring

Table XVII - Dimensions of silver-brazing ring

Iron pipe size	Q ±0.003	K ±0.003	H	F	
				Minimum	Maximum
Inches	Inch	Inch	Inches	Inch	Inch
1/2	0.040	0.078	0.949	0.073	0.130
3/4	0.050	.094	1.179	.073	.130
1	0.050	.125	1.444	.073	.135
1-1/4	0.050	.125	1.799	.073	.135
1-1/2	0.050	.188	2.031	.073	.135
2	0.050	.188	2.506	.073	.135
2-1/2	0.050	.188	3.000	.073	.135
3	0.050	.250	3.633	.073	.167
3-1/2	0.050	.250	4.133	.073	.167
4	0.080	.250	4.693	.073	.229
5	0.080	.250	5.756	.073	.229
6	0.080	.250	6.818	.073	.261
8	0.080	.391	8.818	.073	.261
10	0.080	.391	10.943	.073	.261
12	0.100	.391	12.983	.073	.261

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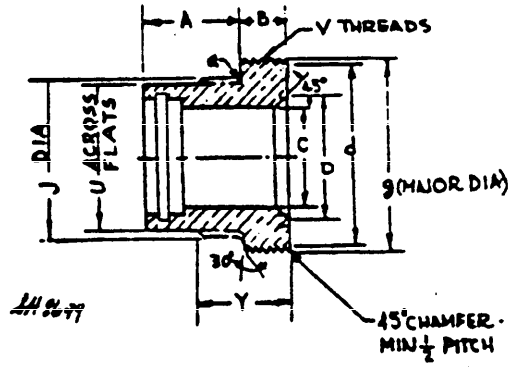

Figure 12 - Thread piece (see table XVIII)

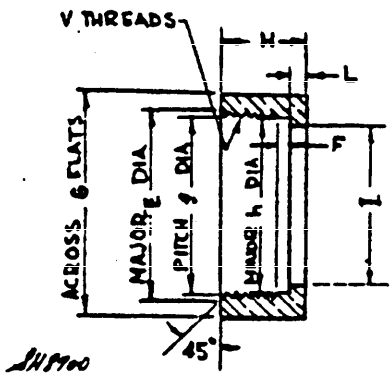

Figure 13 - Union nut
(see table XVIII)

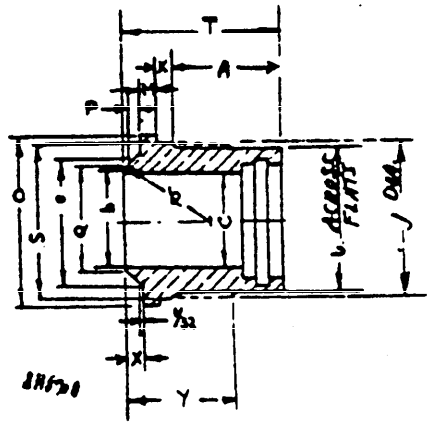

Figure 14 - Tailpiece
(see table XVIII)

Table XVIII - Detail dimensions of unions (see figures 12, 13 and 14)

Iron pipe size	A	B	C		D	E	F	G	H Minimum	I	J	K	L Minimum	M	O	P	Q	R
Inches	Inches	Inch	Inches	Inch±	Inches	Inches	Inch	Inches	Inches	Inches	Inches	Inch	Inch	Inch	Inches	Inch	Inches	Inches
1/2	1.006	25/64	0.697	0.020	0.960	1.491	0.135	1-25/32	47/64	1.220	1.168	0.145	0.145	0.145	1.345	0.113	0.835	0.591
3/4	1.085	1/2	.907	.025	1.140	1.835	.150	2-3/16	7/8	1.510	1.444	.160	.160	.160	1.650	.115	1.030	.728
1	1.197	1/2	1.171	.025	1.445	2.165	.170	2-35/64	59/64	1.820	1.724	.175	.175	.180	1.975	.135	1.315	.930
1-1/4	1.379	35/64	1.502	.030	1.770	2.601	.200	3-3/64	1-1/32	2.220	2.109	.205	.205	.210	2.395	.130	1.650	1.167
1-1/2	1.594	35/64	1.742	.030	2.060	2.921	.220	3-35/64	1-1/16	2.520	2.395	.220	.220	.230	2.710	.143	1.915	1.355
2	1.775	35/64	2.186	.030	2.545	3.521	.250	4-3/64	1-5/32	3.090	2.925	.250	.250	.260	3.310	.165	2.395	1.694

Iron pipe size	S	T	U	V	X	Y	a radius	b	c	d Pitch diameter		f Pitch diameter		g Major diameter		h Minor diameter	
										Maximum	Minimum	Maximum	Minimum	Maximum	Minimum	Minimum	Maximum
Inches	Inches	Inches	Inches	Thread	Inch	Inch	Inch	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches	Inches
1/2	1.19	1.455	1.09	14-NS2	0.159	0.156	0.094	0.741	0.972	1.4403	1.4348	1.4420	1.4492	1.4867	1.4764	1.4111	1.4100
3/4	1.47	1.559	1.35	11-NS2	.154	.188	.125	.951	1.174	1.7702	1.7640	1.7720	1.7801	1.8193	1.8172	1.7326	1.7424
1	1.78	1.736	1.63	11-NS2	.184	.188	.125	1.216	1.494	2.1001	2.0938	2.1020	2.1102	2.1592	2.1471	2.0626	2.0724
1-1/4	2.18	1.968	2.00	10-NS2	.174	.188	.125	1.561	1.828	2.5300	2.5233	2.5320	2.5407	2.5950	2.5821	2.4887	2.4992
1-1/2	2.47	2.245	2.27	10-NS2	.199	.188	.125	1.801	2.116	2.8500	2.8432	2.8520	2.8609	2.9150	2.9021	2.8087	2.8192
2	3.04	2.509	2.80	10-NS2	.224	.188	.125	2.276	2.638	3.4499	3.4430	3.4520	3.4610	3.5149	3.5020	3.4087	3.4192

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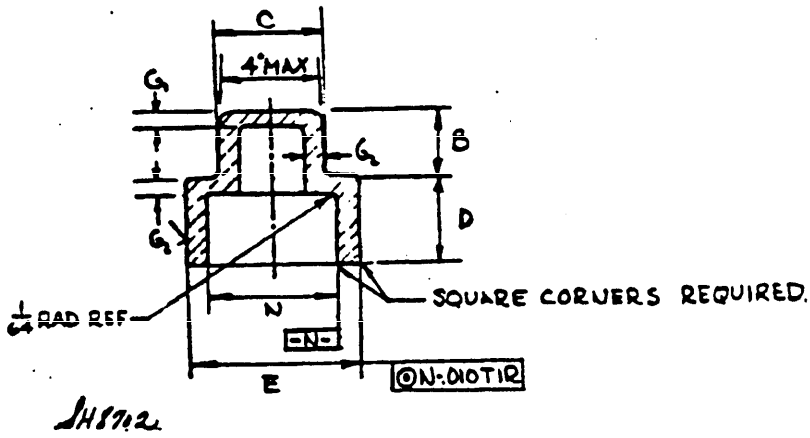

Figure 15 - Plug-cored pattern
(see table XIX)

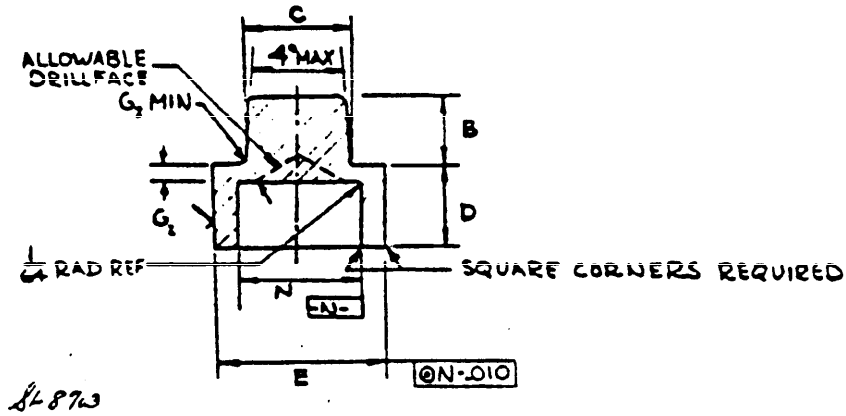

Figure 16 - Plug-solid pattern
(see table XIX)

Table XIX - Detail dimensions of plugs (see figures 15 and 16)[1/]

Iron pipe size	B	C		D		G_1	G_2	N	E	
	Height square minimum	Across flats		Plug length		Metal thickness		Inside diameter maximum	Outside diameter	
		Nominal	Maximum	Minimum	Maximum	Top Minimum	Side of face Maximum		Minimum	Maximum
Inches	Inches	Inches	Inches	Inches	Inches	Inch	Inch	Inches	Inches	Inches
1/2	0.38	9/16	0.563	0.511	0.613	0.09	0.12	0.53	0.837	0.840
3/4	.44	5/8	.625	.552	.662	.10	.13	.72	1.047	1.050
1	.50	13/16	.813	.594	.713	.11	.14	.93	1.312	1.315
1-1/4	.56	15/16	.938	.666	.799	.12	.15	1.25	1.657	1.660
1-1/2	.62	1-1/8	1.125	.801	.961	.13	.16	1.47	1.897	1.900
2	.68	1-5/16	1.313	.842	1.010	.15	.17	1.91	2.372	2.375
2-1/2	.74	1-1/2	1.500	.977	1.172	.17	.18	2.32	2.872	2.875
3	.80	1-11/16	1.688	1.034	1.240	.19	.19	2.90	3.497	3.500
3-1/2	.86	1-7/8	1.875	1.091	1.309	.20	.20	3.36	3.997	4.000
4	.92	2-1/4	2.250	1.142	1.370	.22	.22	3.83	4.497	4.500
5	.98	2-3/4	2.750	1.256	1.506	.24	.24	4.30	5.560	5.563
6	1.05	3-1/2	3.500	1.425	1.710	.30	.30	5.38	6.621	6.625

1/ Both solid and cored plug designs are acceptable.

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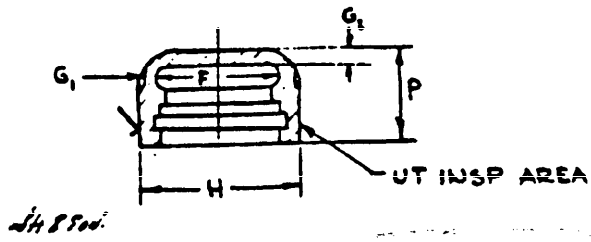

Figure 17 - Cap

Table XX - Detail dimensions of cap

Iron pipe size	F		G_1	G_2	P	H_1
	Inside diameter of fittings		Metal thickness of sides	Metal thickness of top	Height	Band diameter
	Minimum	Maximum	Minimum	Maximum		Minimum
Inches	Inches	Inches	Inch	Inch	Inches	Inches
1/2	0.840	0.900	0.090	0.120	0.931	1.17
3/4	1.050	1.110	.100	.130	1.011	1.42
1	1.320	1.390	.110	.150	1.146	1.72
1-1/4	1.660	1.730	.120	.170	1.256	2.10
1-1/2	1.900	1.970	.130	.190	1.306	2.28
2	2.380	2.450	.150	.220	1.475	2.92
2-1/2	2.880	2.980	.170	.250	1.793	3.49
3	3.500	3.600	.190	.290	1.956	4.20
3-1/2	4.000	4.100	.200	.320	2.056	4.75
4	4.500	4.600	.220	.360	2.237	5.31
5	5.560	5.660	.300	.450	2.476	6.29
6	6.670	6.720	.340	.550	2.655	7.42
8	8.625	8.725	.400	.600	3.140	9.43
10	10.750	10.850	.480	.700	3.625	11.70
12	12.750	12.850	.575	.800	4.124	13.84

Note: Socket detail dimensions shall be in accordance with figure 1 and table VIII.

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