British Standard

BRITISH STANDARD

BS 1724:1990

Specification for

Bronze welding by gas

UDC 621.791.3:662.766.72:546.11:547.213:006.3/.8

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by the Welding Standards Policy Committee (WEE/-) to Technical Committee WEE/19, upon which the following bodies were represented:

BNF Metals Technology Centre

British Association for Brazing and Soldering

British Non-ferrous Metals Federation

Electrical, Electronic, Telecommunications and Plumbing Union

Electricity Supply Industry in England and Wales

Heating and Ventilating Contractors' Association

Institute of Refrigeration

Joint Industry Board for Plumbing Mechanical Engineering Services in England and Wales

Society of British Aerospace Companies Limited

Welding Institute

Coopted member

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Amendments issued since publication

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Contents

Foreword

This British Standard has been prepared under the direction of the Welding Standards Policy Committee and supersedes BS 1724:1959 which is now withdrawn.

In some applications, certain of the tests described in this standard may necessitate a routine sampling procedure; such a procedure should be agreed between purchaser and manufacturer at the time of ordering. Attention is drawn to BS 2635 which covers the drafting of specifications based on limiting the number of defectives permitted in small samples.

It has been assumed in the drafting of this British Standard that the execution of its provisions is entrusted to appropriately qualified and experienced people.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 16, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

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Section 1. General requirements

1 Scope

This British Standard specifies requirements for bronze welding by any of the following combinations of gases:

a) oxy-acetylene;

b) oxy-hydrogen;

c) oxy-propane.

The parent metals covered are:

1) copper[1)];

2) carbon steel;

3) galvanized carbon steel;

4) cast iron;

5) malleable iron;

6) combination of any two of 1) to 5).

Section 1 covers general requirements and section 2 covers specific requirements for individual applications.

NOTE The titles of publications referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the definitions given in BS 499-1 apply. For convenience the following definitions from BS 499 are given below.

2.1
braze welding

the joining of metals using a technique similar to fusion welding and a filler metal with a lower melting point than the parent metal, but neither using capillary action as in brazing nor intentionally melting the parent metal

NOTE In general the melting point of the filler metal is above 850 °C.

2.2
bronze welding

a form of braze welding in which copper-rich filler metal is used

NOTE The meaning attached to this term is quite arbitrary, since bronze is not used. Bronze welding, unlike brazing, does not depend upon capillary action. It uses a gas welding technique and the bonding of the joint results from wetting the unmelted surfaces and inter-diffusion of the filler metal and the parent metal.

2.3
parent metal

metal to be joined or surfaced by welding, braze welding or brazing

2.4
filler metal

metal added during welding, braze welding, brazing or surfacing

2.5
flux

material used during welding, brazing or braze welding to clean the surfaces of the joint chemically, to prevent atmospheric oxidation and to reduce impurities. In arc welding, many other substances, which perform special functions, are added

3 Basic requirements

3.1 Parts to be joined

The parts shall be thoroughly clean, all surface scale, dirt, grease, paint, rust or other surface contamination being carefully removed.

NOTE Appendix A gives recommendations for joint design and preparation but others may be used.

3.2 Preheating

Where preheating of the parts is required, it shall be carried out in such a way that the parent metal is not over-heated, which would cause excessive surface oxidation of the parent metal or volatilization of the constituents of the filler metal when this is applied.

3.3 Flame adjustment

The flame shall be adjusted to a slightly oxidizing condition.

NOTE This requirement is necessary to minimize volatilization of the zinc in the filler metal and to minimize porosity in the resultant joint.

3.4 Flux removal

The removal of flux residues is always desirable, especially if the type of flux used may promote subsequent corrosion, and when it is required subsequently to paint or electroplate the work the flux residues shall be completely removed.

NOTE 1 Guidance on removal of flux residues is given in Appendix B.

NOTE 2 Fluxes contain irritant or toxic chemicals and should therefore be treated with appropriate caution. Irritant fumes can also be emitted on heating; these fumes should not be inhaled.

4 Operator approval

For the purposes of this standard a bronze welder shall be considered to be approved if he has either:

a) completed tests detailed in clause **5** a), b) where relevant, c) and d); or

b) obtained approval in accordance with BS 1723-4 for an appropriate process.

[1)] The process defined in clause **2** can be applied satisfactorily to certain copper alloys but, because special considerations arise with some other types of copper alloys, the scope of this specification has been limited to the coppers specified in **7.1**.

5 Examination of bronze welded joints

The examination of bronze welded joints shall be by one or more of the following methods:

a) visual examination;

b) non-destructive physical tests on completed work;

c) macro-examination of polished sections on prepared samples;

d) destructive tests on prepared samples.

NOTE 1 The purchaser or his representative should specify which of these are to be carried out.

NOTE 2 By agreement with the contractor, joints from finished work may be subjected to c) and d).

NOTE 3 The sampling procedure and number of tests should be the subject of agreement between the purchaser, or his representative, and the contractor.

6 Test procedures

6.1 General

The methods of test shall be in accordance with BS 1723-3.

6.2 Visual examination

Visual examination shall, in all cases, be based on the completed joint, and shall include the heat affected zone. The weld shall be examined for regularity of shape and size of deposit, for cleanliness of the filler metal and for evidence of porosity. Isolated blowholes or a concentration of pinholes in the weld metal shall be regarded as grounds for rejection, but isolated pinholes shall not be so regarded.

6.3 Non-destructive physical tests on completed work

Non-destructive physical tests on completed work include hydraulic or air pressure tests on complete assemblies and shall comply with the British Standard or other specification covering the performance required of the finished article.

6.4 Macro-examination of polished sections

Test specimens for macro-examination of polished sections shall be obtained from sample welds made by operators who are being tested for their ability to satisfy the requirements of this standard.

A section or sections shall be cut through the joint and shall be suitably prepared and polished. The joint shall show satisfactory penetration, adhesion and freedom from porosity in all sections examined.

6.5 Destructive tests on sample welds

6.5.1 *General*

The weld shall comply with BS 1723-3 or with **6.5.2**, **6.5.3** or **6.5.4** as appropriate.

6.5.2 *Destructive tests for butt joint in sheet and plate*

When tested in accordance with **C.1**, failure of the test piece shall occur clear of the weld and weld junctions, or if failure occurs in the weld or weld junctions at a value not less than 90 % of the tensile strength of the annealed parent metal.

6.5.3 *Destructive tests for cruciform test specimen*

When tested in accordance with **C.2**, failure shall occur clear of the weld or weld junctions, or if it occurs in the weld or weld junctions, at a value not less than 80 % of the tensile strength of the annealed parent metal.

6.5.4 *Destructive test for flattening copper tube*

When tested in accordance with **C.3**, the flattened copper weld shall show no cracking of the weld metal or lifting from the pipe wall, evidence of slight cracking at the doubled portions of the test piece shall not be a cause of rejection.

Section 2. Specific requirements

7 Bronze welding of copper

7.1 Parent metal

The parent metal shall comply with one of the chemical compositions specified in BS 6017.

Tough pitch copper shall not be bronze welded by the oxy-hydrogen process.

7.2 Filler metal and flux

The filler metal shall be either type C2 or C4 of BS 1453 (see Appendix D).

A flux shall be used.

NOTE Unless otherwise agreed between the purchaser and the manufacturer of the filler metal, the flux should comply with the recommendations of the manufacturer of the filler metal.

7.3 Tests

The various types of joint (see Appendix A) shall be subjected to the tests given in Table 1. The test procedure and the results obtained shall comply with clause **6**.

8 Bronze welding of carbon steel

8.1 Parent metal

The parent metal shall be carbon steel containing all of the following:

a) carbon 0.30 % (*m*/*m*) max;

b) sulphur 0.060 % (*m*/*m*) max;

c) phosphorus 0.060 % (*m*/*m*) max.

NOTE 1 This clause does not specify the parent metal to be used; for this purpose, reference should be made to the appropriate British Standard or other specification for material complying with the above chemical composition.

NOTE 2 Certain alloy steels are also suitable for this process, which may be used if the purchaser approves. The test requirements are then outside the scope of this standard and should be the subject of agreement between purchaser and contractor.

8.2 Filler metal and flux

The filler metal shall be either type C2 or C5 of BS 1453 (see Appendix D).

A flux shall be used.

NOTE Unless otherwise agreed between the purchaser and the manufacturer of the filler metal, the flux should comply with the recommendations of the manufacturer of the filler metal.

8.3 Tests

The various types of joint (see Appendix A) shall be subjected to the tests given in Table 2. The testing procedure and the results obtained shall comply with clause **6**.

9 Bronze welding of galvanized carbon steel

9.1 Parent metal

The parent metal shall be hot-dipped galvanized carbon steel containing all of the following:

a) carbon 0.30 % (*m*/*m*) max;

b) sulphur 0.060 % (*m*/*m*) max;

c) phosphorus 0.060 % (*m*/*m*) max.

NOTE This clause does not specify the parent metal to be used; for this purpose, reference should be made to the appropriate British Standard or other specification for material complying with the above chemical composition.

9.2 Filler metal and flux

The filler metal shall be either type C2 or C5 of BS 1453 (see Appendix D).

A flux shall be used.

NOTE 1 Unless otherwise agreed between the purchaser and the manufacturer of the filler metal, the flux should comply with the recommendations of the manufacturer of the filler metal.

NOTE 2 A properly compounded paste flux is desirable, but if powder flux is used it is recommended that it be applied in the form of a paste, in accordance with the manufacturer's instructions, to afford maximum protection to the galvanized coating.

9.3 Tests

The various types of joint (see Appendix A) shall be subjected to the tests given in Table 3. The testing procedure and the results obtained shall comply with clause **6**.

Visual examination shall show that the deposit of filler metal is free from porosity and is merged with the coating without leaving a zone deprived of zinc.

10 Bronze welding of cast iron

10.1 Parent metal

The parent metal shall be cast iron, including spheroidal graphite cast iron.

10.2 Filler metal and flux

The filler metal shall be either type C4 or C5 of BS 1453 (see Appendix D).

A flux shall be used.

NOTE Unless otherwise agreed between the purchaser and the manufacturer of the filler metal, the flux should comply with the recommendations of the manufacturer of the filler metal.

Table 1 — Tests for bronze welds in copper

Joint number (as in Appendix A)	**Type of test applicable** (see clause **5**)				
	a. **Visual examination**	**b.** **Non-destructive physical**[a]	**c.** **Polished section**	**d.** **Tensile** (see **C.1**)	**e.** **Flattening** (see **C.3**)
1. Upset butt	×	—	—	—	—
2. Lap	×	×	×	×	—
3. Square butt	×	×	×	×	—
4. V butt	×	×	×	×	—
5. V butt	×	×	×	×	—
6. Double V butt	×	×	×	×	—
7. Bell butt	×	×	×	—	×
8. Diminishing butt	×	×	×	—	×
9. Bell T	×	×	×	—	×
10. Saddle T	×	×	×	—	×
11. Short bell branch	×	×	×	—	×
12. Short stub branch	×	×	×	—	×
13. Fabricated Y	×	×	×	—	×

NOTE 1 The symbols "×" and "—" in the table indicate that the test is required or is not applicable respectively.
NOTE 2 Test joints made with weldable fittings may be subjected to the flattening test, but fracture of the fitting below the line of weld shall not be a cause for rejection.
[a] If required by the specification for the completed article.

Table 2 — Tests for bronze welds in carbon steel

Joint number (as in Appendix A)	**Type of test applicable** (see clause **5**)				
	a. **Visual examination**	**b.** **Non-destructive physical**[a]	**c.** **Polished section**	**d.** **Tensile** (see **C.1**)	**d.** **Cruciform** see **C.2**)
14. Square butt	×	×	×	×	—
4. V butt	×	×	×	×	—
15. Straight lap	×	×	×	×	—
16. T fillet	×	×	×	—	×
17. Sleeve	×	×	×	—	—
18. Saddle	×	×	×	—	—
19. Tube-to-plate	×	×	×	—	—

NOTE The symbols "×" and "—" in the table indicate that the test is required or is not applicable respectively.
[a] If required by the specification for the completed article.

Table 3 — Tests for bronze welds in galvanized carbon steel

Joint number (as in Appendix A)	**Type of test applicable** (see clause **5**)				
	a. **Visual examination**	**b.** **Non-destructive physical**[a]	**c.** **Polished section**	**d.** **Tensile** (see **C.1**)	**d.** **Cruciform** see **C.2**)
14. Square butt	×	×	×	×	—
4. V butt	×	×	×	×	—
15. Straight lap	×	×	×	×	—
16. T fillet	×	×	×	—	×
17. Sleeve	×	×	×	—	—
20. Butt	×	×	×	×	—
18. Saddle	×	×	×	—	—
19. Tube-to-plate	×	×	×	—	—

NOTE The symbols "×" and "—" in the table indicate that the test is required or is not applicable respectively.

[a] If required by the specification for the completed article.

10.3 Preheat

The temperature of preheat shall not exceed 400 °C.

NOTE The extent of preheating will depend upon the size and complexity of the casting to be welded. Complete preheating is usually necessary for complicated castings. Local preheating should be used for simple fractures, or where total preheating is impracticable.

10.4 Tests

The joint shall be tested in accordance with **6.2**, **6.3** and **6.4**.

11 Bronze welding of malleable iron

11.1 Parent metal

The parent metal shall be white heart or black heart malleable iron.

11.2 Filler metal and flux

The filler metal shall be either type C4 or C5 of BS 1453 (see Appendix D).

A flux shall be used.

NOTE Unless otherwise agreed between the purchaser and the manufacturer of the filler metal, the flux should comply with the recommendations of the manufacturer of the filler metal.

11.3 Tests

The joints shall be tested in accordance with **6.2**, **6.3** and **6.4**.

12 Bronze welding of dissimilar metals

12.1 Parent metal

The parent metal shall be a combination of any of the parent metals specified in **7.1**, **8.1**, **9.1**, **10.1**, and **11.1**.

12.2 Filler metal and flux

The filler metal shall be either type C2, C4 or C5 of BS 1453 (see Appendix D), depending on the metals to be joined.

A flux shall be used.

NOTE Unless otherwise agreed between the purchaser and the manufacturer of the filler metal, the flux should comply with the recommendations of the manufacturer of the filler metal.

12.3 Tests

Only tests common to the clauses covering each metal to be joined shall be applicable. The testing procedure and the results obtained shall comply with clause **6**.

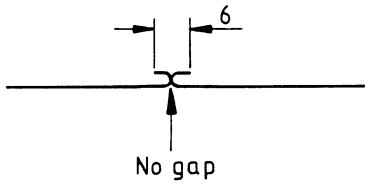
Appendix A Recommended forms of joint for use with bronze welding

NOTE The guidance on joint design given in BS 1723-2 applies in general to bronze welded joints. Guidance covering capillary penetration is not applicable.

A.1 Joints for sheets of copper

A.1.1 *Joint number 1: upset butt*

The joint is shown in Figure 1. It is suitable for sheet thicknesses from 0.5 mm up to 1 mm.

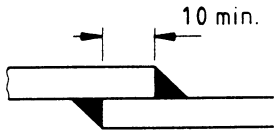


Dimension is in millimetres.

Figure 1 — (Joint number 1) Upset butt

A.1.2 *Joint number 2: lap*

The joint is shown in Figure 2. It is suitable for sheet thicknesses greater than 1 mm.

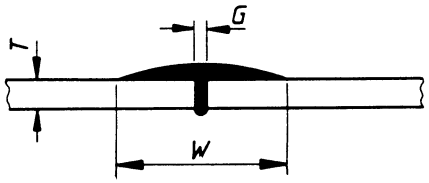


Dimensions is in millimetres.

Figure 2 — (Joint number 2) Lap

A.1.3 *Joint number 3: square butt*

The joint is shown in Figure 3. It is suitable for sheet thicknesses greater than 1 mm.

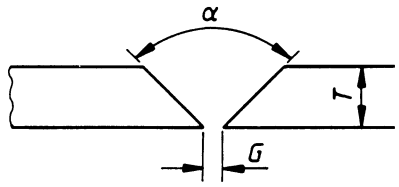


$G = \frac{T}{2}$; $W = 6\ T$

Figure 3 — (Joint number 3) Square butt

A.1.4 *Joint number 4: single V butt*

The joint is shown in Figure 4. It is suitable for sheet thicknesses greater than 3 mm up to and including 6 mm.



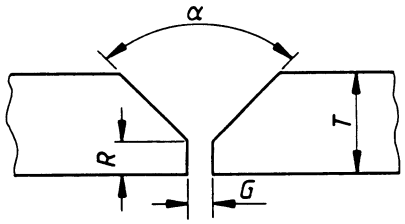
$G < \frac{T}{4}$; α = 60° to 90°

Sharp corners removed

Figure 4 — (Joint number 4) Single V butt joint

A.1.5 *Joint number 5: single V butt with root face*

The joint is shown in Figure 5. It is suitable for sheet thicknesses greater than 6 mm up to and including 12 mm.



G = 1.5 to 3.5 mm; R = 3.5 mm

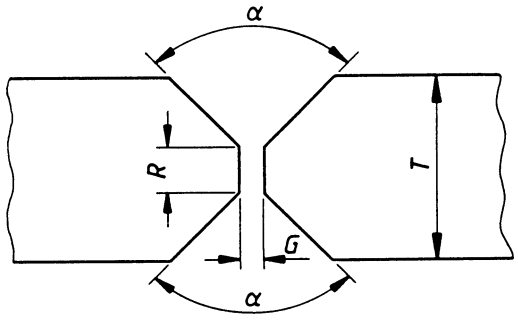
T > 60 and < 12.0

α = 60° to 90°

Figure 5 — (Joint number 5) Single V butt with root face

A.1.6 *Joint number 6: double V butt with centre root face*

The joint is shown in Figure 6. It is suitable for plate thicknesses greater than 12 mm where both sides of the joint are accessible for double-operator welding.



G = 1.5 mm; R = 3.5 mm

T > 12.0 mm; α = 60° to 90°

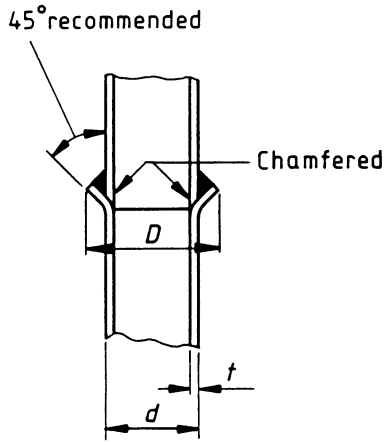
Figure 6 — (Joint number 6) Double V butt with centre root face

A.2 Joints for tubes and pipes of copper

A.2.1 *Butt joints*

A.2.1.1 *Joint number 7: bell*

The joint is shown in Figure 7. The lower pipe is swaged out to a recommended angle of 45° and the upper pipe fitted to make contact with the shoulder.

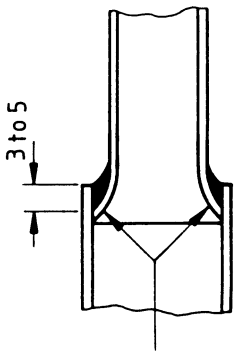


$D \geq (d + 4t)$

Figure 7 — (Joint number 7) Bell butt joint

A.2.1.2 *Joint number 8: diminishing*

The joint is shown in Figure 8. The pipe of smaller diameter is swaged out to fit the bore of the larger pipe. It is inserted to a depth of between 3 mm and 5 mm.



Pipe end swaged out to dia. of larger pipe

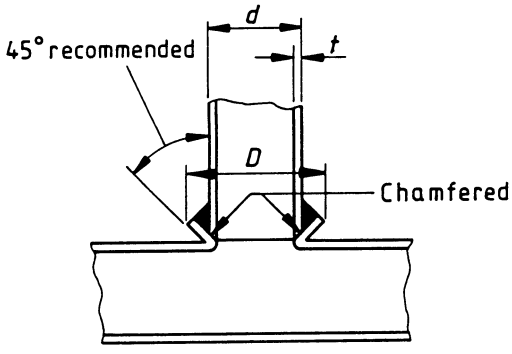
Dimension is in millimetres.

Figure 8 — (Joint number 8) Diminishing butt joint

A.2.2 *T joints*

A.2.2.1 *Joint number 9: bell*

The joint is shown in Figure 9. A small hole is first to be drilled in the main pipe and its edge swaged out to form a raised cup set at an angle of 45°. The branch is fitted on to make contact with the shoulder.



$D \geq (d + 4t)$

Figure 9 — (Joint number 9) Bell T joint

A.2.2.2 *Joint number 10: saddle type*

The joint is shown in Figure 10. A hole corresponding to the diameter of the branch pipe is shaped to make close contact and form a saddle joint.

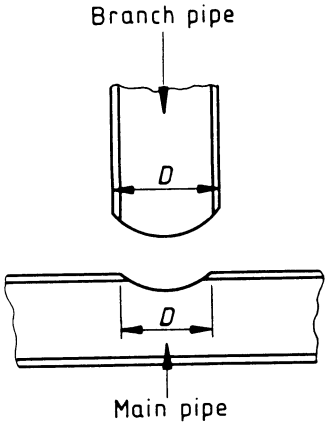


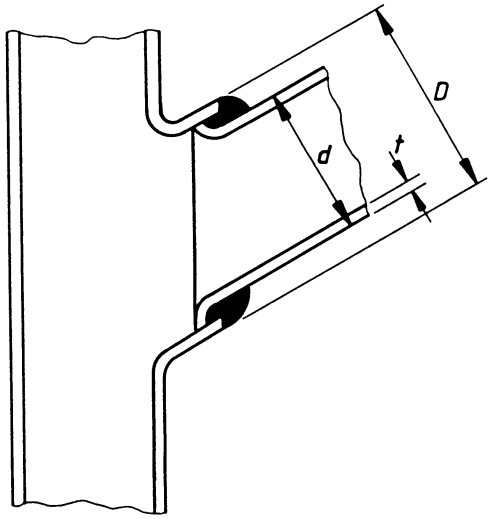
Figure 10 — (Joint number 10) Saddle T joint

A.2.3 ***Branch joints***

A.2.3.1 *Joint number 11: short bell*

The joint is shown in Figure 11. A small hole is drilled in the main pipe and its edge swaged out. The branch pipe is cut at an angle and swaged to make contact with the shoulder.

NOTE It is recommended that the angle between the branch pipe and main pipe should be not less than 30°.



$D > (d + 4t)$

Figure 11 — (Joint number 11) Short bell branch joint

A.2.3.2 *Joint number 12: short stub*

The joint is shown in Figure 12. A hole of suitable diameter is cut in the main pipe to allow the branch pipe to make contact and to form a saddle. After being tacked in position, the welding is completed in one operation.

NOTE It is recommended that the angle between branch pipe and main pipe should be not less than 30°.

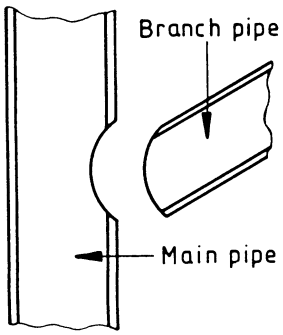


Figure 12 — (Joint number 12) Short stub branch joint

A.2.4 ***Joint number 13: fabricated Y joint***

This joint is shown in Figure 13. It is formed by cutting away two bent pipe ends to their centre lines, placing the cut edges together and joining them by welding.

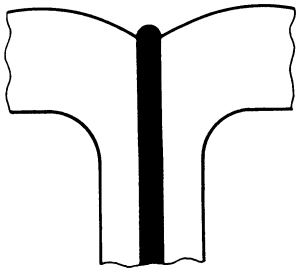


Figure 13 — (Joint number 13) Fabricated Y joint

A.2.5 ***Weldable copper fittings***

Any of the forms of joint, detailed in **A.2.1** to **A.2.4**, i.e. butt, T, saddle, branch and Y, can be produced by using weldable copper fittings. The weldable fittings are specially prepared to ensure accurate alignment and fit of main pipes or branch pipes or both and to have a suitable recess to accommodate the deposit of filler metal.

Joints numbers 7, 8, 9, 11 and 13 are suitable for all diameters and any thickness of pipe.

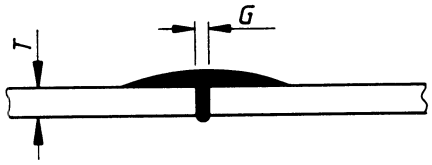
Joints numbers 9, 10, 11 and 12 are suitable for equal or unequal branches.

Joints numbers 10 and 12 are only suitable for pipes of small diameters and are not recommended for sanitary systems. The recommended types of T and branch joints for sanitary systems are joints numbers 9 and 11 and weldable fittings.

A.3 Joints for sheets of carbon steel

A.3.1 ***Joint number 14: square butt joint***

The joint is shown in Figure 14. It is suitable for sheet not more than 3 mm thick, the gap being equal to half the thickness of the sheet.



T = 3 max. $G = \frac{T}{2}$

Dimension is in millimetres.

Figure 14 — (Joint number 14) Square butt joint in carbon steel

A.3.2 ***Joint number 4: V butt joint***

The joint is shown in Figure 4. It is suitable for sheet thicker than 3 mm up to and including 6 mm. The included angle is 60° to 90° and sharp corners removed to give a gap not exceeding ¼ T.

A.3.3 ***Joint number 15: straight lap joint***

Examples of the joint are shown in Figure 15, there being one or two fillets of weld metal. This type of joint is suitable for plates of different thicknesses.

A.3.4 ***Joint number 16: T fillet joint***

Examples of the joint are shown in Figure 16. There is no thickness limit, the plate thickness may be unequal, and there may be one or two fillets.

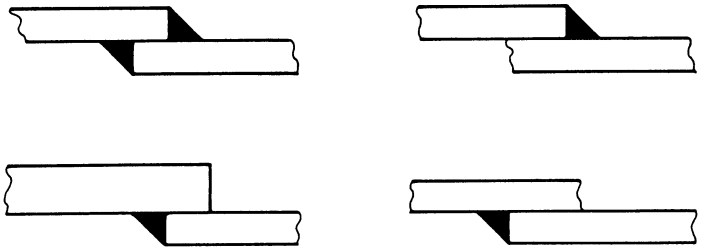


Figure 15 — (Joint number 15) Examples of straight lap joints

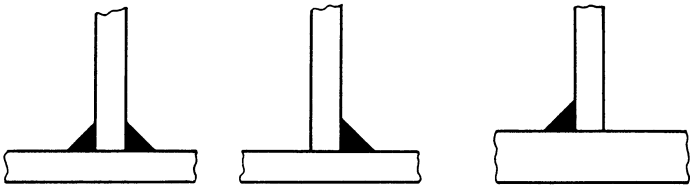


Figure 16 — (Joint number 16) Examples of T fillet joints in carbon steel

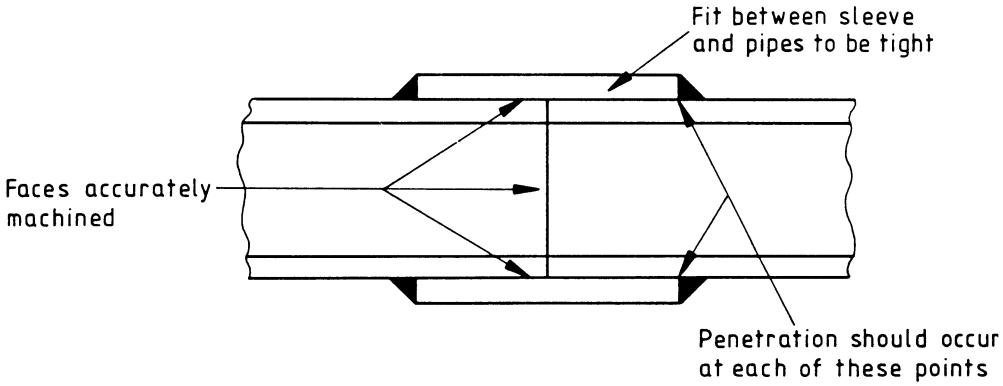


Figure 17 — (Joint number 17) Sleeve joint for carbon steel pipes (strength of the assembly should be of secondary importance)

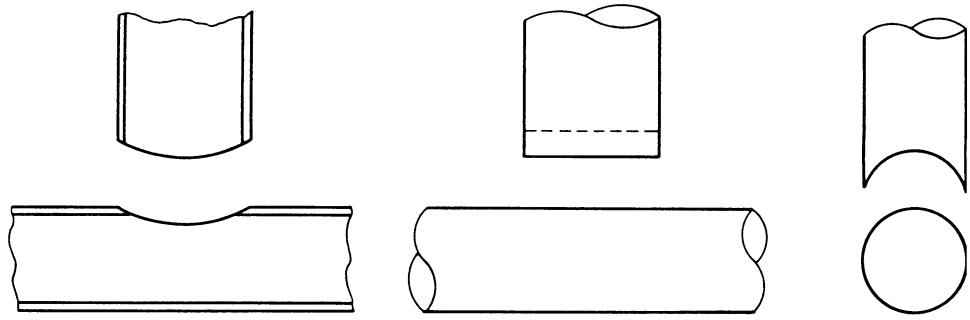


Figure 18 — (Joint number 18) Branch T saddle joints between carbon steel pipes and bars

A.4 Joints for tubes and pipes in carbon steel

A.4.1 *Joint number 17: sleeve joint*

The joint is shown in Figure 17. The strength of these joints is assumed to be of secondary importance, and subject to this consideration no dimensional limits are specified.

A.4.2 *Joint number 18: saddle joint*

The joint is shown in Figure 18. These joints may be made either without or with a hole in the main pipe, depending on whether the pipes are used for structural purposes or for conveying liquids or gases. The use of a hole in the main pipe is recommended even for structural work.

A.4.3 *Joint number 19: tube-to-plate joint*

The joint is shown in Figure 19.

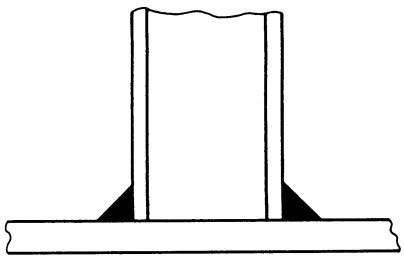


Figure 19 — (Joint number 19) Tube-to-plate joint for carbon steel assemblies

A.5 Joints for sheets of galvanized carbon steel

A.5.1 *Joint number 14: square butt joint*

The joint is shown in Figure 14. It is suitable for sheet thicknesses less than 3 mm, the gap *G* being equal to half the thickness of the sheet.

A.5.2 *Joint number 4: V butt joint*

The joint is shown in Figure 4. It is suitable for sheet thicknesses greater than 3 mm up to and including 6 mm. The included angle is 60° to 90° and sharp corners are, removed to give a gap not exceeding ¼ T.

A.5.3 *Joint number 15: straight lap joint*

Examples of the joint are shown in Figure 15, there being one or two fillets of weld metal. This type of joint is suitable for plates of different thicknesses.

A.5.4 *Joint number 16: T fillet joint*

Examples of the joint are shown in Figure 16. There is no thickness limit; the plate thickness may be unequal, and there may be one or two fillets.

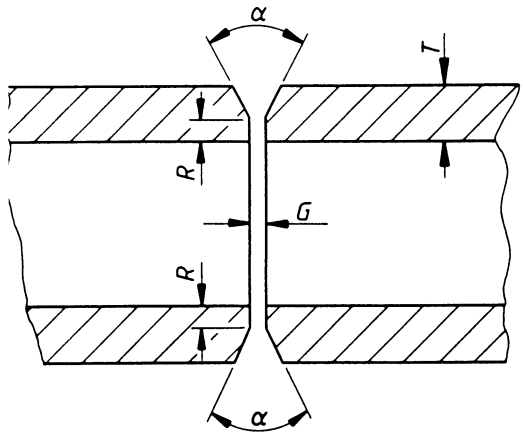
A.6 Joints for tubes and pipes of galvanized carbon steel

A.6.1 *Joint number 17: sleeve joint*

This joint is shown in Figure 17. The strength of these joints is assumed to be of secondary importance, and consequently no dimensional limits are specified.

A.6.2 *Joint number 20: butt joint*

The joint is shown in Figure 20. It is suitable for pipes with a wall thickness exceeding 3 mm. The width of the weld reinforcement is to be not less than 2 T.



$T \geq 3$ mm; $R = 1.5$ mm; α = about 60°; $G = \frac{T}{4}$ with a maximum of 1.5 mm.

Figure 20 — (Joint number 20) Butt joint for galvanized carbon steel pipes

A.6.3 *Joint number 18: saddle joint*

The joint is shown in Figure 18. These joints may be made either with or without a hole in the main pipe, depending on whether the pipes are used for structural purposes or for conveying liquids or gases.

A.6.4 *Joint number 19: tube-to-plate joint*

The joint is shown in Figure 19. Great care has to be taken to avoid damage to the galvanized coating.

NOTE In view of the possibility of destruction of the galvanized coating by flame-cutting, preparation of joints for the bronze welding of galvanized carbon steel should be by mechanical methods.

A.7 Joints for bronze welding of cast iron

It is not possible to detail forms of joint for the bronze welding of cast iron, owing to the variety of applications which occur in practice. The method of joint preparation employed should, therefore, be agreed by the designer and the contractor. In preparing the joint attention should be given to the following recommendations.

a) Cleanliness should extend to the full depth of the crack or fracture, and to a distance of not less than 12 mm on both sides of the V.

b) The final treatment of the joint should be carried out by machining, chiselling, filing or shot blasting. A ground finish is not recommended.

c) Sharp corners should be removed where there is any danger of local over-heating.

d) The minimum angle of the V should be 60°.

e) The surface to which the filler metal is applied should be as large as possible. For example, the shear V form (see Figure 21) should be used where possible.

A.8 Joints for bronze welding of malleable iron

It is impracticable to detail the form of joint for the bronze welding of malleable iron but the recommendations of **A.7** should be followed.

A.9 Joints for bronze welding of dissimilar metals

It is not possible to detail the form of joint but it should generally follow the requirements for the parent metals involved.

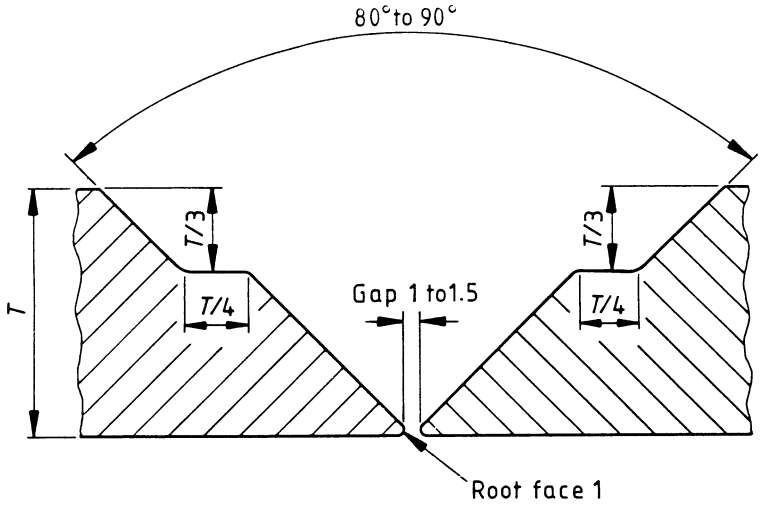
Appendix B Removal of flux residues

The removal of flux residues may be carried out by any of the following methods:

a) grit blasting (not suitable for galvanized pipe);

b) shot blasting (not suitable for galvanized pipe);

c) soaking for 5 min in a 5 % (*v*/*v*) phosphoric acid solution raised to boiling point, and subsequently rinsing in fresh cold water;



All linear dimensions are in millimetres.

NOTE All edges radiused.

Figure 21 — Shear V preparation for bronze welding

d) where no harmful results can occur, flux removal is assisted by quenching the work in water as soon as the filler metal has solidified.

Where a borax-type flux has been used and it is not possible to loosen the residue by quenching in water immediately after bronze welding, prolonged boiling in water, or a short period of pickling in cold 5 % (*v*/*v*) sulphuric acid will usually be necessary. It is essential that the use of acid be followed by thorough washing in hot water. If solution methods fail to remove a borax-type flux residue, mechanical means such as grit or shot blasting will be necessary.

Further advice on flux removal is given in BS 1723-2.

Appendix C Destructive tests for bronze welds

C.1 Tensile test on butt joint in sheet and plate

Prepare a test piece as shown in Figure 22 and leave it in the "as welded" condition without dressing. Load the test piece until failure of the test piece occurs.

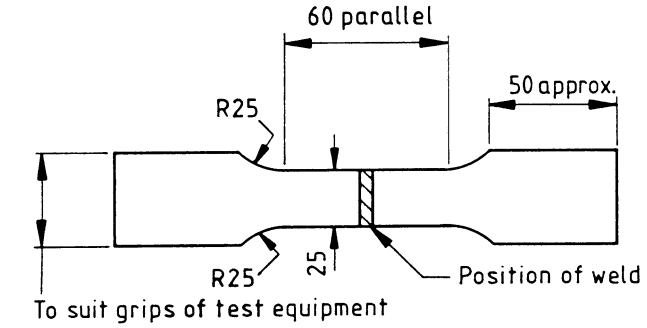
C.2 Tensile test on cruciform test speciment (sheet or plate)

Make a cruciform test piece from material equal in thickness to that to be used on a particular fabrication to the dimensions shown in Figure 23. Load the test piece until failure of the test piece occurs.

C.3 Flattening test on copper tube

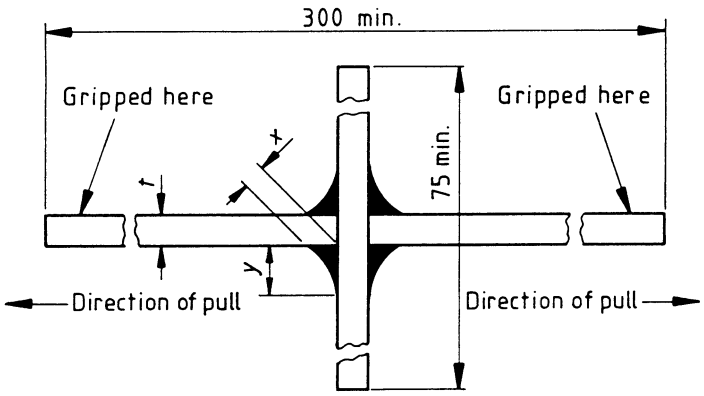
Use a test specimen representative of the work to be undertaken and which consists of two short lengths of pipe or tube welded together. The length of each pipe is twice the diameter, with a minimum length of 100 mm. Flatten the welded joint in a vice until the inner walls are substantially in contact (see Figure 24).

NOTE When pipes exceed 75 mm diameter, the test piece may be cut in half and each half flattened as shown in Figure 25.



All dimensions are in millimetres.

Figure 22 — Tensile test piece



$x \geq t$; $y \geq 1\frac{1}{2}\ t$

All dimensions are in millimetres.

Figure 23 — Cruciform test piece for the tensile testing of T fillet joints in steel

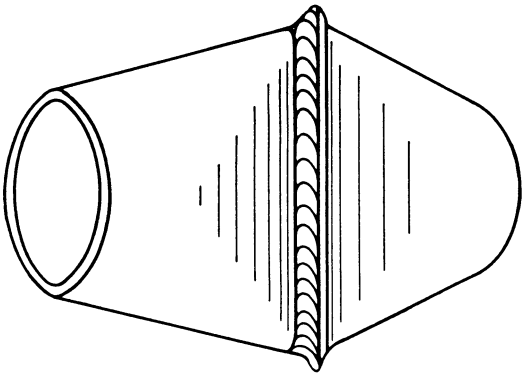


Figure 24 — Tubes generally not exceeding 75 mm diameter

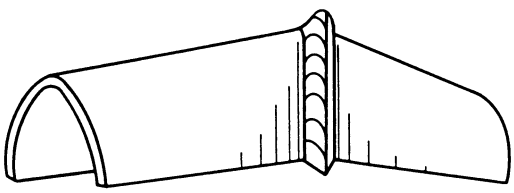


Figure 25 — Tubes exceeding 75 mm diameter

Appendix D Filler metals

While the chemical composition and other requirements for the filler metal referred to in this standard are not part of the specification, the chemical compositions given in BS 1453 are reproduced in Table 4 for information.

Table 4 — Chemical composition of copper alloy filler rods and wires (% *m*/*m*) as specified in BS 1453

Filler rod	Copper		Nickel		Silicon		Tin	Manganese		Iron		Aluminium	Lead	Zinc
	min.	max.	min.	max.	min.	max.	max.	min.	max.	min.	max.	max.	max.	
C2	58.5	61.5	—	—	0.2	0.5	0.5	—	—	—	—	0.03	0.03	the remainder
C4	58.5	61.5	—	—	0.15	0.3	0.5	0.05	0.25	—	0.5	0.03	0.03	the remainder
C5	46.0	50.0	8.0	11.0	0.15	0.5	0.5	—	0.5	—	0.5	0.03	0.03	the remainder

blank

Publications referred to

BS 499, *Welding terms and symbols.*
BS 499-1, *Glossary for welding, brazing and thermal cutting.*
BS 1453, *Specification for filler materials for gas welding.*
BS 1723, *Brazing.*
BS 1723-2, *Guide to brazing.*
BS 1723-3, *Methods for non-destructive and destructive testing.*
BS 1723-4, *Methods for specifying brazing procedure and operator approval testing.*
BS 2635, *Drafting specifications based on limiting the number of defectives permitted in small samples*[2)].
BS 6017, *Specification for copper refinery shapes.*

[2)] Referred to in the foreword only.

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