

Copper and copper alloys — Forgings

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British Standard

ICS 77.150.30

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National foreword

This British Standard is the English language version of EN 12420:1999. It supersedes BS 3885:1965 which is withdrawn, and together with BS EN 12165:1998, it supersedes BS 2872:1989 which is withdrawn.

The UK participation in its preparation was entrusted by Technical Committee NFE/34, Copper and copper alloys, to Subcommittee NFE/34/1, Wrought and unwrought copper and copper alloys, which has the responsibility to:

- aid enquirers to understand the text;
- present to the responsible international/European committee any enquiries on the interpretation, or proposals for change, and keep the UK interests informed;
- monitor related international and European developments and promulgate them in the UK.

A list of organizations represented on this subcommittee can be obtained on request to its secretary.

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Summary of pages

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English version

Copper and copper alloys — Forgings

Cuivre et alliages de cuivre — Pièces forgées

Kupfer und Kupferlegierungen — Schmiedestücke

This European Standard was approved by CEN on 13 December 1998.

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Ref. No. EN 12420:1999 E

Foreword

This European Standard has been prepared by Technical Committee CEN/TC 133, Copper and copper alloys, the Secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by July 1999, and conflicting national standards shall be withdrawn at the latest by July 1999.

Within its programme of work, Technical Committee CEN/TC 133 requested CEN/TC 133/WG 6, Forgings, to prepare the following standard:

EN 12420, *Copper and copper alloys — Forgings*.

This European Standard has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive(s).

For relationship with EU Directive(s), see informative annex ZA, which is an integral part of this standard.

Forging stock is specified in the following standard:

EN 12165, *Copper and copper alloys — Wrought and unwrought forging stock*.

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Luxembourg, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom.

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1 Scope

This European Standard specifies the composition, the property requirements and tolerances on dimensions and form for copper and copper alloy die and hand forgings.

The sampling procedures, the methods of test for verification of conformity to the requirements of this standard, and the delivery conditions are also specified.

2 Normative references

This European Standard incorporates, by dated or undated reference, provisions from other publications. These normative references are cited at the appropriate places in the text and the publications are listed hereafter. For dated references, subsequent amendments to or revisions of any of these publications apply to this European Standard only when incorporated in it by amendment or revision. For undated references, the latest edition of the publication referred to applies.

EN 1655, *Copper and copper alloys — Declarations of conformity*.

EN 1976, *Copper and copper alloys — Cast unwrought copper products*.

EN 10002-1, *Metallic materials — Tensile testing — Part 1: Method of test (at ambient temperature)*.

EN 10003-1, *Metallic materials — Brinell hardness test — Part 1: Test method*.

EN 10204, *Metallic products — Types of inspection documents*.

EN ISO 196, *Wrought copper and copper alloys — Detection of residual stress — Mercury(I) nitrate test*. (ISO 196:1978)

EN ISO 6509:1995, *Corrosion of metals and alloys — Determination of dezincification resistance of brass*. (ISO 6509:1981)

ISO 1101, *Technical drawings — Geometrical tolerancing — Tolerancing of form, orientation, location and run-out — Generalities, definitions, symbols, indications on drawings*.

ISO 1811-2, *Copper and copper alloys — Selection and preparation of samples for chemical analysis — Part 2: Sampling of wrought products and castings*.

ISO 6507-1, *Metallic materials — Hardness test — Vickers test — Part 1: HV 5 to HV 100*.

ISO 6957, *Copper alloys — Ammonia test for stress corrosion resistance*.

NOTE Informative references to documents used in the preparation of this standard, and cited at the appropriate places in the text, are listed in a bibliography, see annex A.

3 Definitions

For the purposes of this standard, the following definitions apply:

3.1

forgings

wrought products, hot formed by hammering or pressing

3.1.1

die forgings

forgings produced between closed dies

3.1.2

hand forgings

forgings produced between open dies

3.1.3

cored forgings

forgings produced between closed dies including cores

3.2

inspection lot

definite quantity of products of the same form, the same grade or alloy and material condition and the same thickness or cross-section, collected together for inspection (testing)

4 Designations

4.1 Material

4.1.1 General

The material is designated either by symbol or number (see Tables 1 to 8).

4.1.2 Symbol

The material symbol designation is based on the designation system given in ISO 1190-1.

NOTE Although material symbol designations used in this standard might be the same as those in other standards using the designation system given in ISO 1190-1, the detailed composition requirements are not necessarily the same.

4.1.3 Number

The material number designation is in accordance with the system given in EN 1412.

4.2 Material condition

For the purposes of this standard, the following designations, which are in accordance with the system given in EN 1173, apply for the material condition:

M Material condition for the product as manufactured without specified mechanical properties;

H Material condition designated by the minimum value of hardness requirement for the product with mandatory hardness requirements;

NOTE 1 Products in the H... condition may be specified to Vickers or Brinell hardness. The condition designation H... is the same for both hardness test methods.

S (suffix) Material condition for a product which is stress relieved.

NOTE 2 Products in the M or H... condition may be specially processed (i.e. mechanically or thermally stress relieved) in order to lower the residual stress level to improve the resistance to stress corrosion and the dimensional stability on machining (see 5 g), 5 h) and 8.4).

Except when the suffix S is used, material condition is designated by only one of the above designations.

4.3 Product

The product designation provides a standardized pattern of designation from which a rapid and unequivocal description of a product is conveyed in communication. It provides mutual comprehension at the international level with regard to products which meet the requirements of the relevant European Standard.

The product designation is no substitute for the full content of the standard.

The product designation for products to this standard shall consist of:

- denomination (Forging);
- number of this European Standard (EN 12420);
- material designation, either symbol or number (see Tables 1 to 8);
- material condition designation (see Tables 10 to 12).

The derivation of a product designation is shown in the following example.

EXAMPLE

Forging conforming to this standard, in material designated either CuZn39Pb3 or CW614N, in material condition H080, shall be designated as follows:

5 Ordering information

In order to facilitate the enquiry, order and confirmation of order procedures between the purchaser and the supplier, the purchaser shall state on his enquiry and order the following information:

- a) quantity of product required (mass or number of pieces);
- b) denomination (Forging);
- c) number of this European Standard (EN 12420);
- d) material designation (see Tables 1 to 8);
- e) material condition designation (see 4.2 and Tables 10 to 12) if it is other than M;
- f) nominal dimensions and/or toleranced drawing of the forging or finished part including the number of the drawing (see 6.6).

NOTE 1 It is recommended that the product designation, as described in 4.3, is used for items b) to e).

In addition, the purchaser shall also state on the enquiry and order any of the following, if required:

- g) whether the products are required to pass a stress corrosion resistance test. If so, which test method is to be used (see 8.6) if the choice is not to be left to the discretion of the supplier. If the purchaser chooses ISO 6957, the pH value for the test solution is to be selected;
- h) whether the products are to be supplied in a thermally stress relieved condition;
- i) for products in alloy CuZn36Pb2As (CW602N), whether the dezincification resistance acceptance criterion required is other than grade A (see 6.4);
- j) test method to be used for measurement of hardness, i.e. Brinell or Vickers (see 8.2) unless the test method is left to the discretion of the supplier;
- k) whether in special cases tensile testing is required (see 6.2.2).

NOTE 2 The property requirements and details of testing should be agreed between the purchaser and the supplier.

Forging EN 12420 – CuZn39Pb3 – H080

Forging EN 12420 – CW614N – H080

Denomination

Number of this European Standard

Material designation

Material condition designation

- l) whether a declaration of conformity is required (see 9.1);
- m) whether an inspection document is required, and if so, which type (see 9.2);
- n) whether there are any special requirements for marking, labelling or packaging (see clause 10).

EXAMPLE

Ordering details for 200 forgings conforming to EN 12420, in material designated either CuZn39Pb3 or CW614N, in material condition H080, according to drawing number XY000:

200 pieces
Forging EN 12420 — CuZn39Pb3 — H080
— drawing number XY000

or

200 pieces
Forging EN 12420 — CW614N — H080
— drawing number XY000

6 Requirements**6.1 Composition**

The composition shall conform to the requirements for the appropriate material given in Tables 1 to 8.

NOTE As the materials specified in this standard vary considerably in their resistance to shaping, forging temperature and stresses generated in the die, they have been classified into three groups of similar hot working characteristics. They have also been subdivided into two categories that reflect their availability, category A materials being more generally available than those of category B (see Table 9).

6.2 Mechanical properties**6.2.1 Hardness**

The hardness properties shall conform to the appropriate requirements given in Tables 10 to 12.

The purchaser shall indicate which test method shall be used. The test shall be carried out in accordance with the appropriate method given in 8.2.

For forgings produced from materials of category B the hardness properties shall be agreed between the purchaser and the supplier.

6.2.2 Tensile properties

This standard does not specify mandatory tensile properties. The values in brackets given in Tables 10 to 12 are for information only.

If a purchaser requires in special cases tensile property testing then the minimum values for tensile strength, 0,2 % proof strength and elongation, the location and size of test pieces and the sampling rate shall be agreed at the time of enquiry and order [see 5 k)]. In these cases the hardness values detailed in Tables 10 to 12 become non-mandatory.

6.3 Electrical properties

Forgings produced from the category A materials listed in Table 13 shall conform to the electrical properties specified in Table 13.

For forgings produced from category B materials listed in Table 9, if electrical properties are required, they shall be agreed between the purchaser and the supplier.

6.4 Resistance to dezincification

- for grade A: maximum 200 μm ;
- for grade B: mean not to exceed 200 μm and maximum 400 μm [see 5 i)].

The test shall be carried out in accordance with 8.5.

NOTE Products in this alloy may be subjected to heat treatment in the range 470 °C to 550 °C during manufacture. Should the user need to heat the material above 530 °C then advice should be sought from the supplier.

6.5 Residual stress level

Forgings ordered in the stress relieved condition (see Note 2 to 4.2) shall show no evidence of cracking when tested. The tests shall be carried out in accordance with 8.6.

6.6 Tolerances for die forgings**6.6.1 General**

The tolerances specified in 6.6.2 to 6.6.7 apply to all category A and category B materials listed in Table 9. Tolerances on dimensions and on form indicated in the drawings of a forging shall conform to the tolerances specified in this standard. If no tolerances are indicated in the drawings, the tolerances given in this standard shall apply.

NOTE 1 It is recommended that reference to this standard is made on the drawings.

Two different types of dimensions are distinguished for die forgings.

- a) dimensions within the die cavity which originate from the forging shape in one separate die part and which does not have components moving towards one another, see dimensions n in Figure 1.

NOTE 2 These die parts can consist of one single piece or of several components immovable towards one another.

- b) dimensions across the die parting line which originate from two or more die parts moving towards one another, see dimensions t in Figure 2.

NOTE 3 The die forging produced in the dies demonstrated in Figures 1 and 2 is shown in Figure 3.

Table 1 — Composition of copper

Material designation		Composition in % (m/m)							Density ²⁾ g/cm ³ approx.	
Symbol	Number	Element	Cu ¹⁾	Bi	O	P	Pb	Other elements (see note)		
								total	excluding	
Cu-ETP	CW004A	min.	99,90	—	—	—	—	—	Ag, O	8,9
		max.	—	0,000 5	0,040 ³⁾	—	0,005	0,03	—	
Cu-OF	CW008A	min.	99,95	—	—	—	—	—	Ag	8,9
		max.	—	0,000 5	— ⁴⁾	—	0,005	0,03	—	
Cu-HCP	CW021A	min.	99,95	—	—	0,002	—	—	Ag, P	8,9
		max.	—	0,000 5	—	0,007	0,005	0,03	—	
Cu-DHP	CW024A	min.	99,90	—	—	0,015	—	—	—	8,9
		max.	—	—	—	0,040	—	—	—	

¹⁾ Including silver, up to a maximum of 0,015 %.

²⁾ For information only.

³⁾ Oxygen content up to 0,060 % is permitted, subject to agreement between the purchaser and the supplier.

⁴⁾ The oxygen content shall be such that the material conforms to the hydrogen embrittlement requirements of EN 1976.

NOTE The total of other elements (than copper) is defined as the sum of Ag, As, Bi, Cd, Co, Cr, Fe, Mn, Ni, O, P, Pb, S, Sb, Se, Si, Sn, Te and Zn, subject to the exclusion of any individual elements indicated.

Table 2 — Composition of low alloyed copper alloys

Material designation			Composition in % (m/m)										Density ¹⁾ g/cm ³ approx.	
Symbol	Number	Element	Cu	Be	Co	Cr	Fe	Mn	Ni	Pb	Si	Zr	Others total	
CuBe2	CW101C	min.	Rem.	1,8	—	—	—	—	—	—	—	—	—	8,3
		max.	—	2,1	0,3	—	0,2	—	0,3	—	—	—	0,5	
CuCo1Ni1Be	CW103C	min.	Rem.	0,4	0,8	—	—	—	0,8	—	—	—	—	8,8
		max.	—	0,7	1,3	—	0,2	—	1,3	—	—	—	0,5	
CuCo2Be	CW104C	min.	Rem.	0,4	2,0	—	—	—	—	—	—	—	—	8,8
		max.	—	0,7	2,8	—	0,2	—	0,3	—	—	—	0,5	
CuCr1	CW105C	min.	Rem.	—	—	0,5	—	—	—	—	—	—	—	8,9
		max.	—	—	—	1,2	0,08	—	—	—	0,1	—	0,2	
CuCr1Zr	CW106C	min.	Rem.	—	—	0,5	—	—	—	—	—	0,03	—	8,9
		max.	—	—	—	1,2	0,08	—	—	—	0,1	0,3	0,2	
CuNi1Si	CW109C	min.	Rem.	—	—	—	—	—	1,0	—	0,4	—	—	8,8
		max.	—	—	—	—	0,2	0,1	1,6	0,02	0,7	—	0,3	
CuNi2Be	CW110C	min.	Rem.	0,2	—	—	—	—	1,4	—	—	—	—	8,8
		max.	—	0,6	0,3	—	0,2	—	2,4	—	—	—	0,5	
CuNi2Si	CW111C	min.	Rem.	—	—	—	—	—	1,6	—	0,4	—	—	8,8
		max.	—	—	—	—	0,2	0,1	2,5	0,02	0,8	—	0,3	
CuNi3Si1	CW112C	min.	Rem.	—	—	—	—	—	2,6	—	0,8	—	—	8,8
		max.	—	—	—	—	0,2	0,1	4,5	0,02	1,3	—	0,5	
CuZr	CW120C	min.	Rem.	—	—	—	—	—	—	—	—	0,1	—	8,9
		max.	—	—	—	—	—	—	—	—	—	0,2	0,1	

For information only

¹⁾ For information only.

Table 3 — Composition of copper-aluminium alloys

Material designation		Composition in % (m/m)											Density ¹⁾ g/cm ³ approx.
Symbol	Number	Element	Cu	Al	Fe	Mn	Ni	Pb	Si	Sn	Zn	Others total	
CuAl6Si2Fe	CW301G	min.	Rem.	6,0	0,5	—	—	—	2,0	—	—	—	7,7
		max.	—	6,4	0,7	0,1	0,1	0,05	2,4	0,1	0,4	0,2	
CuAl7Si2	CW302G	min.	Rem.	6,3	—	—	—	—	1,5	—	—	—	7,7
		max.	—	7,6	0,3	0,2	0,2	0,05	2,2	0,2	0,5	0,2	
CuAl8Fe3	CW303G	min.	Rem.	6,5	1,5	—	—	—	—	—	—	—	7,7
		max.	—	8,5	3,5	1,0	1,0	0,05	0,2	0,1	0,5	0,2	
CuAl9Ni3Fe2	CW304G	min.	Rem.	8,0	1,0	—	2,0	—	—	—	—	—	7,4
		max.	—	9,5	3,0	2,5	4,0	0,05	0,1	0,1	0,2	0,3	
CuAl10Fe1	CW305G	min.	Rem.	9,0	0,5	—	—	—	—	—	—	—	7,6
		max.	—	10,0	1,5	0,5	1,0	0,02	0,2	0,1	0,5	0,2	
CuAl10Fe3Mn2	CW306G	min.	Rem.	9,0	2,0	1,5	—	—	—	—	—	—	7,6
		max.	—	11,0	4,0	3,5	1,0	0,05	0,2	0,1	0,5	0,2	
CuAl10Ni5Fe4	CW307G	min.	Rem.	8,5	3,0	—	4,0	—	—	—	—	—	7,6
		max.	—	11,0	5,0	1,0	6,0	0,05	0,2	0,1	0,4	0,2	
CuAl11Fe6Ni6	CW308G	min.	Rem.	10,5	5,0	—	5,0	—	—	—	—	—	7,4
		max.	—	12,5	7,0	1,5	7,0	0,05	0,2	0,1	0,5	0,2	

¹⁾ For information only.

Table 4 — Composition of copper-nickel alloys

Material designation		Composition in % (m/m)													Density ¹⁾ g/cm ³ approx.	
		Symbol	Number	Element	Cu	C	Co	Fe	Mn	Ni	P	Pb	S	Sn		Zn
CuNi10Fe1Mn	CW352H	min.		Rem.	—	—	1,0	0,5	9,0	—	—	—	—	—	—	8,9
		max.		—	0,05	0,1 ²⁾	2,0	1,0	11,0	0,02	0,02	0,05	0,03	0,5	0,2	
CuNi30Mn1Fe	CW354H	min		Rem.	—	—	0,4	0,5	30,0	—	—	—	—	—	—	8,9
		max.		—	0,05	0,1 ²⁾	1,0	1,5	32,0	0,02	0,02	0,05	0,05	0,5	0,2	

¹⁾ For information only.
²⁾ Co max. 0,1 % is counted as Ni.

¹⁾ For information only.²⁾ Co max. 0,1 % is counted as Ni.

Table 5 — Composition of copper-nickel-zinc alloys

Material designation		Composition in % (m/m)									Density ¹⁾ g/cm ³ approx.
Symbol	Number	Element	Cu	Fe	Mn	Ni	Pb	Sn	Zn	Others total	
CuNi7Zn39Pb3Mn2	CW400J	min.	47,0	—	1,5	6,0	2,3	—	Rem.	—	8,5
		max.	50,0	0,3	3,0	8,0	3,3	0,2	—	0,2	
CuNi10Zn42Pb2	CW402J	min.	45,0	—	—	9,0	1,0	—	Rem.	—	8,4
		max.	48,0	0,3	0,5	11,0	2,5	0,2	—	0,2	

¹⁾ For information only.

¹⁾ For information only.

Table 6 — Composition of copper-zinc alloys

Material designation		Composition in % (m/m)									Density ¹⁾ g/cm ³ approx.
Symbol	Number	Element	Cu	Al	Fe	Ni	Pb	Sn	Zn	Others total	
CuZn37	CW508L	min.	62,0	—	—	—	—	—	Rem.	—	
		max.	64,0	0,05	0,1	0,3	0,1	0,1	—	0,1	
CuZn40	CW509L	min.	59,5	—	—	—	—	—	Rem.	—	
		max.	61,5	0,05	0,2	0,3	0,3	0,2	—	0,2	

¹⁾ For information only.

¹⁾ For information only.

Table 7 — Composition of copper-zinc-lead alloys

Material designation		Composition in % (m/m)										Density ¹⁾ g/cm ³ approx.	
Symbol	Number	Element	Cu	Al	As	Fe	Mn	Ni	Pb	Sn	Zn	Others total	
CuZn36Pb2As	CW602N	min.	61,0	—	0,02	—	—	—	1,7	—	Rem.	—	8,4
		max.	63,0	0,05	0,15	0,1	0,1	0,3	2,8	0,1	—	0,2	
CuZn38Pb2	CW608N	min.	60,0	—	—	—	—	—	1,6	—	Rem.	—	8,4
		max.	61,0	0,05	—	0,2	—	0,3	2,5	0,2	—	0,2	
CuZn39Pb0,5	CW610N	min.	59,0	—	—	—	—	—	0,2	—	Rem.	—	8,4
		max.	60,5	0,05	—	0,2	—	0,3	0,8	0,2	—	0,2	
CuZn39Pb1	CW611N	min.	59,0	—	—	—	—	—	0,8	—	Rem.	—	8,4
		max.	60,0	0,05	—	0,2	—	0,3	1,6	0,2	—	0,2	
CuZn39Pb2	CW612N	min.	59,0	—	—	—	—	—	1,6	—	Rem.	—	8,4
		max.	60,0	0,05	—	0,3	—	0,3	2,5	0,3	—	0,2	
CuZn39Pb2Sn	CW613N	min.	59,0	—	—	—	—	—	1,6	0,2	Rem.	—	8,4
		max.	60,0	0,1	—	0,4	—	0,3	2,5	0,5	—	0,2	
CuZn39Pb3	CW614N	min.	57,0	—	—	—	—	—	2,5	—	Rem.	—	8,4
		max.	59,0	0,05	—	0,3	—	0,3	3,5	0,3	—	0,2	
CuZn39Pb3Sn	CW615N	min.	57,0	—	—	—	—	—	2,5	0,2	Rem.	—	8,4
		max.	59,0	0,1	—	0,4	—	0,3	3,5	0,5	—	0,2	
CuZn40Pb1Al	CW616N	min.	57,0	0,05	—	—	—	—	1,0	—	Rem.	—	8,3
		max.	59,0	0,30	—	0,2	—	0,2	2,0	0,2	—	0,2	
CuZn40Pb2	CW617N	min.	57,0	—	—	—	—	—	1,6	—	Rem.	—	8,4
		max.	59,0	0,05	—	0,3	—	0,3	2,5	0,3	—	0,2	
CuZn40Pb2Sn	CW619N	min.	57,0	—	—	—	—	—	1,6	0,2	Rem.	—	8,4
		max.	59,0	0,1	—	0,4	—	0,3	2,5	0,5	—	0,2	

¹⁾ For information only.

1) For information only.

Table 8 — Composition of complex copper-zinc alloys

Material designation		Composition in % (m/m)										Density ¹⁾ g/cm ³ approx.
Symbol	Number	Cu	Al	Fe	Mn	Ni	Pb	Si	Sn	Zn	Others total	
CuZn23Al6Mn4Fe3Pb	min.	63,0	5,0	2,0	3,5	—	0,2	—	—	Rem.	—	8,2
	max.	65,0	6,0	3,5	5,0	0,5	0,8	0,2	0,2	—	0,2	
CuZn25Al5Fe2Mn2Pb	min.	65,0	4,0	0,5	0,5	—	0,2	—	—	Rem.	—	8,2
	max.	68,0	5,0	3,0	3,0	1,0	0,8	—	0,2	—	0,3	
CuZn35Ni3Mn2AlPb	min.	58,0	0,3	—	1,5	2,0	0,2	—	—	Rem.	—	8,3
	max.	60,0	1,3	0,5	2,5	3,0	0,8	0,1	0,5	—	0,3	
CuZn36Sn1Pb	min.	61,0	—	—	—	—	0,2	—	1,0	Rem.	—	8,3
	max.	63,0	—	0,1	—	0,2	0,6	—	1,5	—	0,2	
CuZn37Mn3Al2PbSi	min.	57,0	1,3	—	1,5	—	0,2	0,3	—	Rem.	—	8,1
	max.	59,0	2,3	1,0	3,0	1,0	0,8	1,3	0,4	—	0,3	
CuZn37Pb1Sn1	min.	59,0	—	—	—	—	0,4	—	0,5	Rem.	—	8,4
	max.	61,0	—	0,1	—	0,3	1,0	—	1,0	—	0,2	
CuZn39Mn1AlPbSi	min.	57,0	0,3	—	0,8	—	0,2	0,2	—	Rem.	—	8,2
	max.	59,0	1,3	0,5	1,8	0,5	0,8	0,8	0,5	—	0,3	
CuZn39Sn1	min.	59,0	—	—	—	—	—	—	0,5	Rem.	—	8,4
	max.	61,0	—	0,1	—	0,2	0,2	—	1,0	—	0,2	
CuZn40Mn1Pb1	min.	57,0	—	—	0,5	—	1,0	—	—	Rem.	—	8,3
	max.	59,0	0,2	0,3	1,5	0,6	2,0	0,1	0,3	—	0,3	
CuZn40Mn1Pb1AlFeSn	min.	57,0	0,3	0,2	0,8	—	0,8	—	0,2	Rem.	—	8,3
	max.	59,0	1,3	1,2	1,8	0,3	1,6	—	1,0	—	0,3	
CuZn40Mn1Pb1FeSn	min.	56,5	—	0,2	0,8	—	0,8	—	0,2	Rem.	—	8,3
	max.	58,5	0,1	1,2	1,8	0,3	1,6	—	1,0	—	0,3	
CuZn40Mn2Fe1	min.	56,5	—	0,5	1,0	—	—	—	—	Rem.	—	8,3
	max.	58,5	0,1	1,5	2,0	0,6	0,5	0,1	0,3	—	0,4	

1) For information only.

Table 9 — Material groups and categories

Material group	Category A material designations		Category B ¹⁾ material designations	
	Symbol	Number	Symbol	Number
I	CuZn40	CW509L	CuZn37	CW508L
	CuZn36Pb2As	CW602N	CuZn39Pb0,5	CW610N
	CuZn38Pb2	CW608N	CuZn39Pb1	CW611N
	CuZn39Pb2	CW612N	CuZn23Al6Mn4Fe3Pb	CW704R
	CuZn39Pb2Sn	CW613N	CuZn25Al5Fe2Mn2Pb	CW705R
	CuZn39Pb3	CW614N	CuZn35Ni3Mn2AlPb	CW710R
	CuZn39Pb3Sn	CW615N	CuZn36Sn1Pb	CW712R
	CuZn40Pb1Al	CW616N	CuZn37Pb1Sn1	CW714R
	CuZn40Pb2	CW617N	CuZn39Sn1	CW719R
	CuZn40Pb2Sn	CW619N	CuZn40Mn1Pb1	CW720R
	CuZn37Mn3Al2PbSi	CW713R	CuZn40Mn2Fe1	CW723R
	CuZn39Mn1AlPbSi	CW718R	—	—
	CuZn40Mn1Pb1AlFeSn	CW723R	—	—
	CuZn40Mn1Pb1FeSn	CW722R	—	—
II	Cu-ETP	CW004A	Cu-HCP	CW021A
	Cu-OF	CW008A	Cu-DHP	CW024A
	CuAl8Fe3	CW303G	CuAl6Si2Fe	CW301G
	CuAl10Fe3Mn2	CW306G	CuAl7Si2	CW302G
	CuAl10Ni5Fe4	CW307G	CuAl9Ni3Fe2	CW304G
	CuAl11Fe6Ni6	CW308G	CuAl10Fe1	CW305G
III	CuCo1Ni1Be	CW103C	CuBe2	CW101C
	CuCo2Be	CW104C	CuCr1	CW105C
	CuCr1Zr	CW106C	CuNi1Si	CW109C
	CuNi2Si	CW111C	CuNi2Be	CW110C
	CuNi10Fe1Mn	CW352H	CuNi3Si1	CW112C
	CuNi30Mn1Fe	CW354H	CuZr	CW120C
	—	—	CuNi7Zn39Pb3Mn2	CW400J
	—	—	CuNi10Zn42Pb2	CW402J

¹⁾ No mechanical properties are specified in this standard for these materials.

Table 10 — Mechanical properties for forgings of category A, material group I

Designations		Material condition		Thickness in direction of forging		Hardness		Tensile properties (for information only)		
Symbol	Number			Die- and hand-forgings up to and including 80 mm	Hand-forgings over 80 mm	HB min.	HV min.	Tensile strength R_m N/mm ² min.	0.2 % Proof strength $R_{p0.2}$ N/mm ² min.	Elongation A % min.
CuZn40	CW509L	M		X	X					
		H075		X	X	75	80	(340)	(100)	(25)
CuZn36Pb2As	CW602N	M		X	X					
		H070		X	X	70	75	(280)	(90)	(30)
CuZn38Pb2 CuZn39Pb2 CuZn39Pb2Sn CuZn39Pb3 CuZn39Pb3Sn CuZn40Pb1Al CuZn40Pb2 CuZn40Pb2Sn	CW608N	M		X	X					
	CW612N									
	CW613N									
	CW614N	H075	—	—	X	75	80	(340)	(110)	(20)
	CW615N									
	CW616N									
	CW617N	H080	—	—	—	80	85	(360)	(120)	(20)
CuZn37Mn3Al2PbSi	CW713R	M	X	X	X					
	H125		—	—	X	125	130	(470)	(180)	(16)
	H140		X	X	—	140	150	(510)	(230)	(12)
CuZn39Mn1AlPbSi	CW718R	M	X	X	X					
	H090		—	—	X	90	95	(410)	(150)	(15)
	H110		X	—	—	110	115	(440)	(180)	(15)
CuZn40Mn1Pb1AlFeSn	CW721R	M	X	X	X					
	H100		X	X	X	100	105	(440)	(180)	(16)
CuZn40Mn1Pb1FeSn	CW722R	M	X	X	X					
	H085		X	X	X	85	90	(390)	(150)	(20)

NOTE 1 N/mm² is equivalent to 1 MPa.

Table 11 — Mechanical properties for forgings of category A, material group II

Designations		Material condition		Thickness in direction of forging		Hardness		Tensile properties (for information only)		
Symbol	Number			Die- and hand-forgings up to and including 80 mm	Hand-forgings over 80 mm	HB min.	HV min.	Tensile strength R_m N/mm ² min.	0,2 % Proof strength $R_{p0.2}$ N/mm ² min.	Elongation A % min.
Cu-ETP	CW004A	M		X	X			as manufactured, without specified mechanical properties		
	CW008A	H045		X	X	45	45	(200)	(40)	(35)
CuAl8Fe3	CW303G	M		X	X			as manufactured, without specified mechanical properties		
		H110		X	X	110	115	(460)	(180)	(30)
CuAl10Fe3Mn2	CW306G	M		X	X			as manufactured, without specified mechanical properties		
		H120		—	X	120	125	(560)	(200)	(12)
		H125		X	—	125	130	(590)	(250)	(10)
CuAl10Ni5Fe4	CW307G	M		X	X			as manufactured, without specified mechanical properties		
		H170		—	X	170	185	(700)	(390)	(15)
		H175		X	—	175	190	(720)	(360)	(12)
CuAl11Fe6Ni6	CW308G	M		X	X			as manufactured, without specified mechanical properties		
		H200		X	X	200	210	(740)	(410)	(4)

NOTE 1 N/mm² is equivalent to 1 MPa.

Table 12 — Mechanical properties for forgings of category A, material group III

Designations		Thickness in direction of forging		Hardness		Tensile properties (for information only)		
Material	Material condition	Die- and hand-forgings up to and including 80 mm	Hand-forgings over 80 mm	HB min.	HV min.	Tensile strength R_m N/mm ² min.	0,2 % Proof strength $R_{p0.2}$ N/mm ² min.	Elongation A % min.
CuCo1Ni1Be CuCo2Be	CW103C	X	X	as manufactured, without specified mechanical properties				
	CW104C	X	X	210	220	(650)	(500)	(8)
CuCr1Zr	CW106C	X	X	as manufactured, without specified mechanical properties				
	H110 ¹⁾	X	X	110	115	(360)	(270)	(15)
CuNi2Si	M	X	X	as manufactured, without specified mechanical properties				
	H140 ¹⁾	—	X	140	150	(470)	(320)	(12)
	H150 ¹⁾	X	—	150	160	(490)	(340)	(12)
CuNi10Fe1Mn	CW352H	X	X	as manufactured, without specified mechanical properties				
	H070	X	X	70	75	(280)	(100)	(25)
CuNi30Mn1Fe	CW354H	X	X	as manufactured, without specified mechanical properties				
	H090	X	X	90	95	(340)	(120)	(25)

¹⁾ Solution heat treated and precipitation hardened.NOTE 1 N/mm² is equivalent to 1 MPa.

Table 13 — Electrical properties

Material designation		Electrical properties at 20 °C			
		conductivity		volume resistivity $\frac{\Omega \cdot \text{mm}^2}{\text{m}}$ max.	mass resistivity ²⁾ $\frac{\Omega \cdot \text{g}}{\text{m}^2}$ max.
		$\frac{\text{m}}{\Omega \cdot \text{mm}^2}$ min.	% IACS ¹⁾ min.		
Symbol	Number				
Cu-ETP	CW004A	58,0	100,0	(0,017 24)	(0,153 3)
Cu-OF	CW008A	58,0	100,0	(0,017 24)	(0,153 3)
CuCo1Ni1Be	CW103C	25,0 ³⁾	43,1 ³⁾	(0,040 0) ³⁾	(0,352 0) ³⁾
CuCo2Be	CW104C				
CuCr1Zr	CW106C	43,0 ⁴⁾	74,1 ⁴⁾	(0,023 26) ⁴⁾	(0,206 7) ⁴⁾
CuNi2Si	CW111C	17,0 ⁵⁾	29,3 ⁵⁾	(0,058 82) ⁵⁾	(0,517 6) ⁵⁾

1) IACS = International Annealed Copper Standard.

2) For calculation of mass resistivity of coppers and of CuCr1Zr (CW106C) the density of 8,89 g/cm³ has been used; for other copper alloys the density of 8,8 g/cm³ has been used.

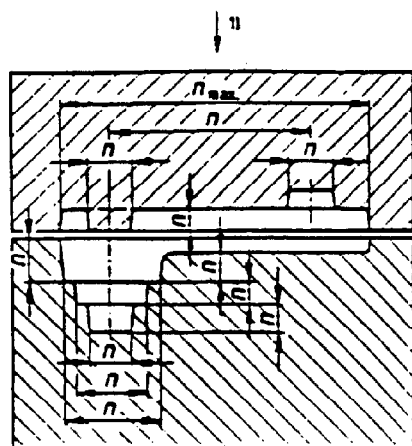
3) Only for material condition H210.

4) Only for material condition H110.

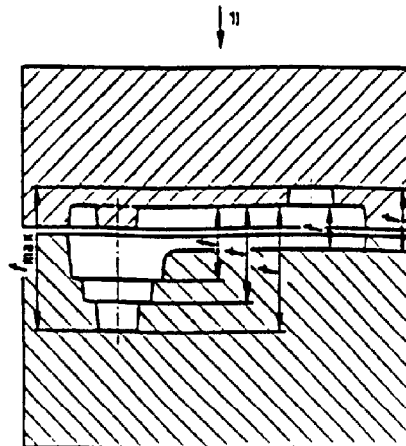
5) Only for material conditions H150 and H140.

NOTE 1 The % IACS values are calculated as percentages of the standard value for annealed high conductivity copper as laid down by the International Electrotechnical Commission. Copper having a volume resistivity of $0,017\,24 \frac{\Omega \cdot \text{mm}^2}{\text{m}}$ at 20 °C is defined as corresponding to a conductivity of 100 %.NOTE 2 1 MS/m is equivalent to $1 \frac{\text{m}}{\Omega \cdot \text{mm}^2}$.

NOTE 3 Figures in brackets are not requirements of this standard but are given for information only.



1) direction of forging

Figure 1 — Dimensions n within the die cavity

1) direction of forging

Figure 2 — Dimensions t across the die parting line

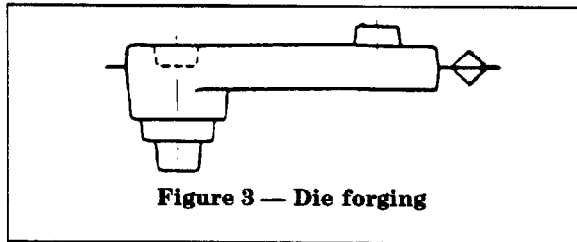


Figure 3 — Die forging

For recommended machining allowances and extra material see B.3.10 and Table B.6.

6.6.2 Tolerances for dimensions within the die cavity and for dimensions across the die parting line

The dimensions n and t shall conform to the tolerances given in Table 14 for material group I, Table 15 for material group II and Table 16 for material group III.

The largest dimension t_{max} in the direction of forging is the basic dimension for applying tolerances for dimensions t across the die parting line. The tolerance for t_{max} depends on the area A of the part viewed in the direction of blow. The area A in the case of round parts is equal to the area of the circle and in the case of irregularly shaped parts is equal to the area of the circumscribing rectangle (see Figure 4). All smaller dimensions t have the same tolerance as t_{max} .

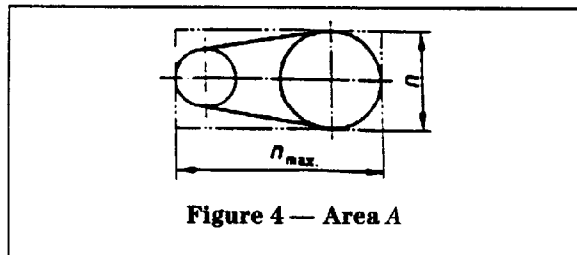


Figure 4 — Area A

The tolerances given in Tables 14 to 16 are also applicable for die forgings which are produced with a die cavity in one die half only facing a plane opposite die half.

The tolerance need not necessarily be applied symmetrically about the nominal dimension; it may be all plus or all minus.

6.6.3 Mismatch

Mismatch is not associated with a particular direction (see Figure 5).

The mismatch shall be determined by reference to the largest nominal dimension n_{max} as viewed in the direction of forging (see Figure 5).

The permissible mismatch is given in Tables 14 to 16.

The maximum permitted mismatch shall be indicated above the title block or in the title block of the drawing of the forging, e.g. mismatch max. 0,5 mm.

Mismatch is not included in the tolerances for dimensions within the die cavity: the tolerances for dimensions within the die cavity and for mismatch are in this case independently applied (see Figures 6 and 7).

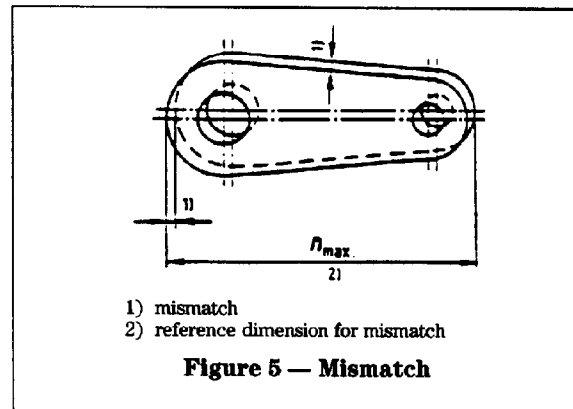


Figure 5 — Mismatch

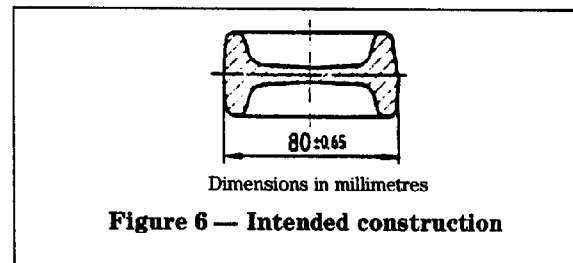


Figure 6 — Intended construction

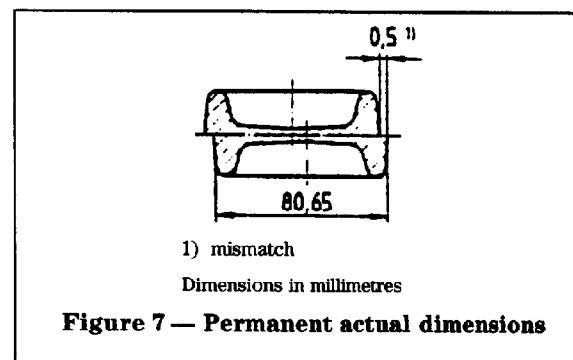


Figure 7 — Permanent actual dimensions

6.6.4 Flash projection

The flash projection shall be determined by reference to the largest nominal dimension n_{max} perpendicular to the direction of forging (see Figure 8).

The permissible flash projection is given in Tables 14 to 16.

The flash originating from the die parting line shall be trimmed by the manufacturer.

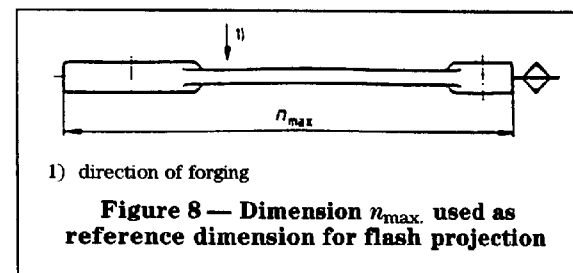
Figure 8 — Dimension n_{max} used as reference dimension for flash projection

Table 14 — Tolerances for die forgings of material group I, categories A and B

Nominal dimension		Tolerance on dimensions $t_{\max}$ (within die cavity)	Tolerance on dimensions $t_{\max}$ (across the die parting line) for area A in square millimetres						Tolerances on form		
			up to and including 2 500	over 2 500 up to and including 5 000	over 5 000 up to and including 10 000	over 10 000 up to and including 20 000	over 20 000 up to and including 40 000	over 40 000 up to and including 80 000	Mismatch (see 6.6.3) max.	Flash projection (see 6.6.4) max.	Flatness tolerance (see 6.6.6) max.
—	20	$\pm 0,2$	$\pm 0,3$	$\pm 0,3$	$\pm 0,4$	—	—	—	0,3	0,3	0,3
20	50	$\pm 0,3$	$+0,5$ $-0,3$	$+0,5$ $-0,3$	$+0,6$ $-0,4$	$+0,7$ $-0,4$	$+0,9$ $-0,5$	$+1,2$ $-0,5$	0,3	0,3	0,3
50	100	$\pm 0,4$	$+0,5$ $-0,3$	$+0,6$ $-0,3$	$+0,6$ $-0,4$	$+0,8$ $-0,5$	$+1,0$ $-0,5$	$+1,3$ $-0,6$	0,5	0,4	0,5
100	150	$\pm 0,5$	—	—	$+0,7$ $-0,4$	$+0,9$ $-0,5$	$+1,1$ $-0,5$	$+1,4$ $-0,6$	0,6	0,5	0,7
150	200	$\pm 0,6$	—	—	—	$+1,0$ $-0,5$	$+1,2$ $-0,5$	$+1,4$ $-0,7$	0,8	0,5	0,9
200	300	$\pm 0,8$	—	—	—	—	—	$+1,6$ $-0,7$	0,8	1,0	1,4
Ejector mark (see 6.6.5)		$\pm 0,3$	$\pm 0,3$	$\pm 0,3$	$\pm 0,3$	$\pm 0,5$	$\pm 0,5$	$\pm 0,8$	—	—	—

Values in millimetres

Table 15 — Tolerances for die forgings of material group II, categories A and B

Nominal dimension		Tolerance on dimensions n (within die cavity)	Tolerance on dimensions t_{max} (across the die parting line) for area A in square millimetres						Tolerances on form		
			up to and including 2 500	over 2 500 up to and including 5 000	over 5 000 up to and including 10 000	over 10 000 up to and including 20 000	over 20 000 up to and including 40 000	over 40 000 up to and including 80 000	Mismatch (see 6.6.3) max.	Flash projection (see 6.6.4) max.	Flatness tolerance (see 6.6.6) max.
—	20	$\pm 0,3$	$\pm 0,55$	$\pm 0,45$	$\pm 0,6$	—	—	—	0,3	0,4	0,45
20	50	$\pm 0,5$	$+0,75$ $-0,45$	$+0,75$ $-0,45$	$+0,9$ $-0,6$	$+1,05$ $-0,6$	$+1,35$ $-0,75$	$+1,8$ $-0,75$	0,3	0,4	0,45
50	100	$\pm 0,6$	$+0,75$ $-0,45$	$+0,75$ $-0,45$	$+0,9$ $-0,6$	$+1,2$ $-0,75$	$+1,5$ $-0,75$	$+1,95$ $-0,9$	0,5	0,6	0,75
100	150	$\pm 0,8$	—	—	$+1,05$ $-0,6$	$+1,35$ $-0,75$	$+1,65$ $-0,75$	$+2,1$ $-0,9$	0,6	0,8	1,05
150	200	$\pm 0,9$	—	—	—	$+1,5$ $-0,75$	$+1,8$ $-0,75$	$+2,1$ $-1,05$	0,8	0,8	1,35
200	300	$\pm 1,2$	—	—	—	—	—	$+2,4$ $-1,05$	0,8	1,0	2,1
Ejector mark (see 6.6.5)		$\pm 0,3$	$\pm 0,3$	$\pm 0,3$	$\pm 0,3$	$\pm 0,5$	$\pm 0,5$	$\pm 0,8$	—	—	—

Values in millimetres

Table 16 — Tolerances for die forgings of Material group III, categories A and B

Nominal dimension		Tolerance on dimensions <i>n</i> (within die cavity)	Tolerance on dimensions <i>t</i> _{max} (across the die parting line) for area A in square millimetres						Tolerances on form			
over	up to and including		up to and including 2 500	over 2 500 up to and including 5 000	over 5 000 up to and including 10 000	over 10 000 up to and including 20 000	over 20 000 up to and including 40 000	over 40 000 up to and including 80 000	Mismatch (see 6.6.3) max.	Flash projection (see 6.6.4) max.	Flatness tolerance (see 6.6.6) max.	
—	20	±0,4	±0,6	±0,6	±0,8	—	—	—	0,3	0,4	0,6	
20	50	±0,6	+1,0 -0,6	+1,0 -0,6	+1,2 -0,8	+1,4 -0,8	+1,8 -1,0	+2,4 -1,0	0,3	0,4	0,6	
50	100	±0,8	+1,0 -0,6	+1,0 -0,6	+1,2 -0,8	+1,6 -1,0	+2,0 -1,0	+2,6 -1,2	0,5	0,6	1,0	
100	150	±1,0	—	—	+1,4 -0,8	+1,8 -1,0	+2,2 -1,0	+2,8 -1,2	0,6	0,8	1,4	
150	200	±1,2	—	—	—	+2,0 -1,0	+2,4 -1,0	+2,8 -1,4	0,8	0,8	1,8	
200	300	±1,6	—	—	—	—	—	+3,2 -1,4	0,8	1,0	2,8	
Ejector mark (see 6.6.5)		±0,3	±0,3	±0,3	±0,3	±0,5	±0,5	±0,8	—	—	—	

Flash caused by deburring, punching or piercing or through-die inserts (see G1, G2, G3 and G4 in Figure 9) is permissible, provided that it is either removed during machining or is not objectionable if left on the finished part. This flash shall be indicated in the drawing and shall not exceed 1,5 mm.

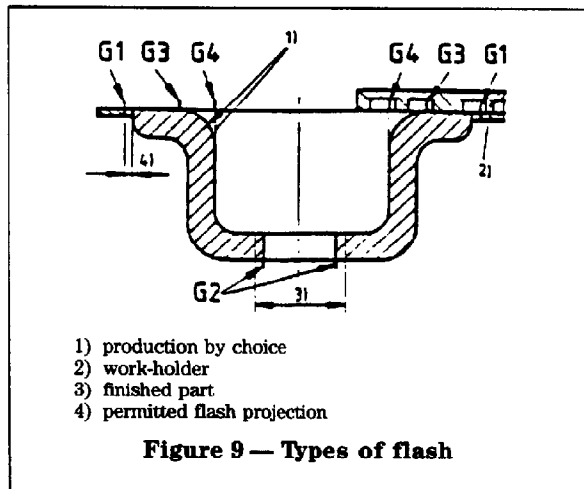


Figure 9 — Types of flash

Flash projection is applied independently of dimensional tolerances.

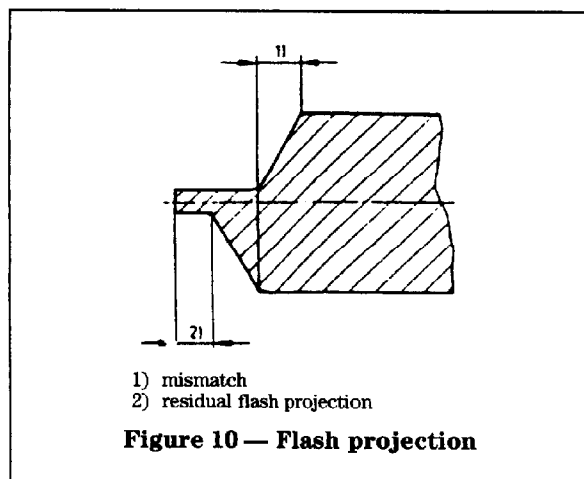


Figure 10 — Flash projection

NOTE As the flash of type samples is generally trimmed by hand they do not represent the quality of trimming during bulk production.

6.6.5 Ejector marks

If ejectors are necessary for manufacturing reasons, ejector marks can result as ridges (convex) or indentations (concave), (see Figure 11 and Tables 14 to 16). If the ejector marks may be either concave only or convex only, the total permissible variation applies.

EXAMPLE

Permissible ejector mark: $\pm 0,3$ mm

Ejector mark only raised: $^{+0,6}_0$ mm

Ejector mark only recessed: $^0_{-0,6}$ mm

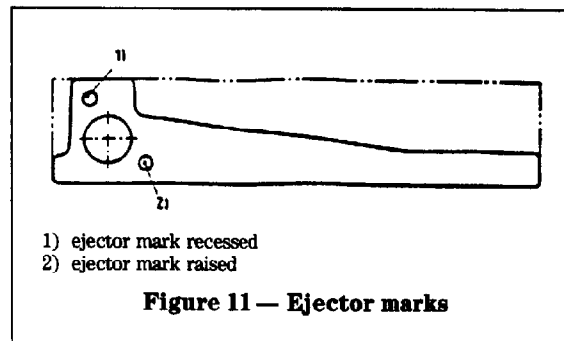


Figure 11 — Ejector marks

6.6.6 Flatness tolerances

In addition to the tolerances caused by the forging process, deviation from flatness can result from distortion, when ejecting, flash clipping, or any heat treatment.

Flatness tolerances shall be determined by reference to the largest nominal dimension n_{max} as viewed in the direction of forging, see Figure 12 and Tables 14 to 16, and they are applied independently from all tolerances of form or position.

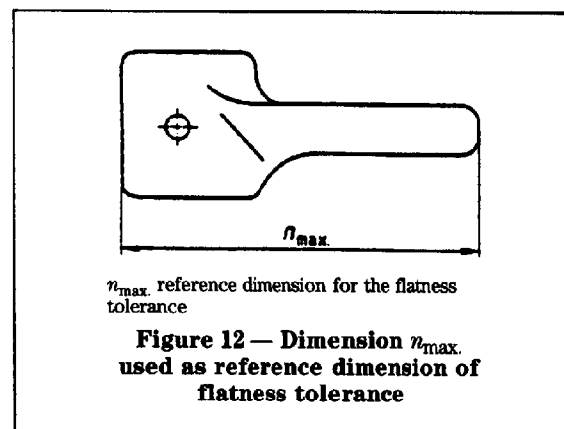


Figure 12 — Dimension n_{max} used as reference dimension of flatness tolerance

6.6.7 Angular tolerances

The tolerances in Table 17 apply to all angles except draft angles.

NOTE For draft angles see guidelines for design in annex B.

Table 17 — Angular tolerances

Nominal dimension l_1 of the shorter leg ¹⁾ of the mm		Tolerances of angle $\alpha^{1)}$
over	up to and including	
—	20	$\pm 2^\circ$
20	50	$\pm 1^\circ$
50	100	$\pm 0^\circ 30'$
100	200	$\pm 0^\circ 30'$
200	300	$\pm 0^\circ 25'$

¹⁾ See Figure 13.

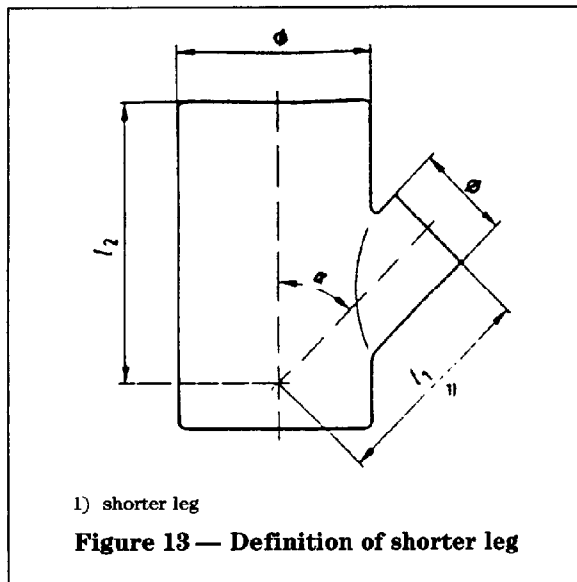


Figure 13 — Definition of shorter leg

6.7 Tolerances for cored forgings

External diameter a and internal diameter b and depth of core penetration h for cored forgings shown schematically in Figure 14 shall conform to the tolerances given in Table 18.

6.8 Tolerances for hand forgings

6.8.1 General

The tolerances given in 6.8.2 and 6.8.3 apply to all materials of categories A and B listed in Table 9.

The purchaser may supply nominal dimensions and/or a toleranced drawing of the forging or finished part but the tolerances on dimensions and on form shall conform to the requirements of 6.8.2 and 6.8.3.

NOTE 1 It is recommended that reference to this standard is made on drawings.

In order to facilitate the preparation of drawings and the manufacture of sawing templates, all sawed length and sawed width dimensions shall carry identical tolerances; the tolerance band being governed by the maximum length.

NOTE 2 For recommended machining allowances and extra mass see B.4.3, B.4.4 and Table B.7.

6.8.2 Tolerances on dimensions

Dimensions generally produced by machining n -dimensions and by forging t -dimensions shall conform to the tolerances given in Table 19 (see Figure 15).

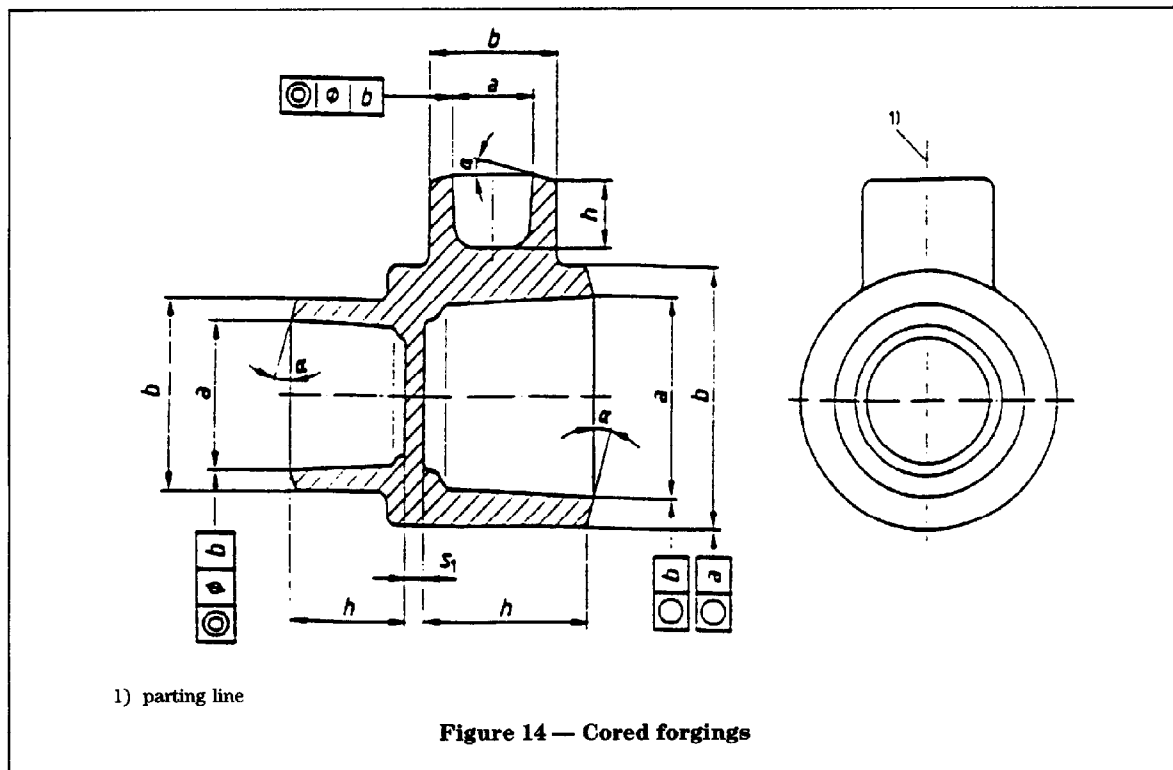


Figure 14 — Cored forgings

Table 18 — Tolerances of cored forgings

Values in millimetres

Nominal diameter a		Tolerance on nominal diameter		Circularity		Concentricity	Tolerance on depth of core penetration h		
over	up to and including	a	b	a	b		up to and including 30	over 30 up to and including 50	over 50 up to and including 80
10 ¹⁾	20	$\pm 0,2$	$\pm 0,3$	0,4	0,6	0,6	$\begin{smallmatrix} 0 \\ -0,5 \end{smallmatrix}$	—	—
20	40	$\pm 0,3$	$\pm 0,5$	0,5	0,9	0,8	$\begin{smallmatrix} 0 \\ -0,5 \end{smallmatrix}$	$\begin{smallmatrix} 0 \\ -0,7 \end{smallmatrix}$	—
40	60	$\pm 0,4$	$\pm 0,6$	0,6	1,2	1,0	$\begin{smallmatrix} 0 \\ -0,6 \end{smallmatrix}$	$\begin{smallmatrix} 0 \\ -0,8 \end{smallmatrix}$	$\begin{smallmatrix} 0 \\ -1 \end{smallmatrix}$
60	80	$\pm 0,5$	$\pm 1,0$	1,0	2,0	1,2	$\begin{smallmatrix} 0 \\ -0,7 \end{smallmatrix}$	$\begin{smallmatrix} 0 \\ -0,9 \end{smallmatrix}$	$\begin{smallmatrix} 0 \\ -1,2 \end{smallmatrix}$
80	100	$\pm 0,6$	$\pm 1,2$	1,2	2,4	1,4	$\begin{smallmatrix} 0 \\ -0,8 \end{smallmatrix}$	$\begin{smallmatrix} 0 \\ -1,0 \end{smallmatrix}$	$\begin{smallmatrix} 0 \\ -1,5 \end{smallmatrix}$
100	120	$\pm 0,7$	$\pm 1,4$	1,4	2,8	1,6	$\begin{smallmatrix} 0 \\ -1,0 \end{smallmatrix}$	$\begin{smallmatrix} 0 \\ -1,2 \end{smallmatrix}$	$\begin{smallmatrix} 0 \\ -1,8 \end{smallmatrix}$
120	—	$\pm 0,8$	$\pm 1,6$	1,6	3,2	2,0	$\begin{smallmatrix} 0 \\ -1,5 \end{smallmatrix}$	$\begin{smallmatrix} 0 \\ -1,8 \end{smallmatrix}$	$\begin{smallmatrix} 0 \\ -2,0 \end{smallmatrix}$

¹⁾ Including 10.

NOTE 1 For cored forgings it is recommended that the diameter of the core penetration should be equal to or greater than 10 mm.

NOTE 2 The ratio depth of core penetration/diameter of core penetration is generally less than 2.

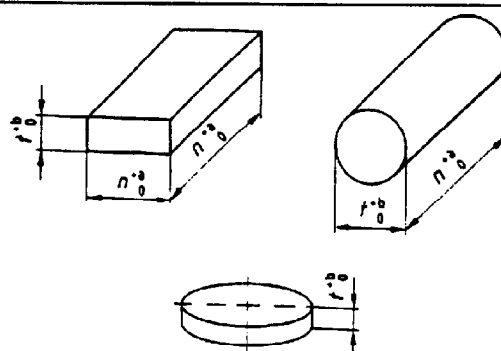
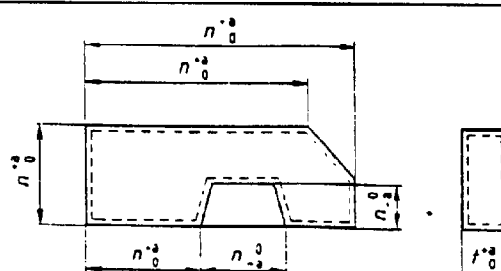
NOTE 3 The web-thickness X is generally equal to or more than the adjacent wall thickness.

NOTE 4 Symbols for form tolerances and position tolerances according to ISO 1101.

Table 19 — Tolerances a and b for dimensions n and t

Values in millimetres

Nominal dimensions		Plus tolerance b for t ¹⁾	Plus or minus tolerance a for n ²⁾
over	up to and including		
—	50	4	4
50	100	5	5
100	150	8	6
150	250	10	10
250	400	12	15
400	630	—	20
630	1 000	—	25
1 000	1 600	—	30
1 600	2 500	—	35

¹⁾ In the direction of forging.²⁾ Perpendicular to the direction of forging.NOTE External dimensions are specified as plus tolerances, see tolerance $+a$ in Figures 15 and 16, and internal dimensions are always specified as minus tolerances, see tolerance $-a$ in Figure 16.Figure 15 — Dimensions t and n Figure 16 — Dimensions $+a$ and $-a$

As variations in the finished diameter of discs and stepped hand forgings are difficult to control due to spread and edge distortion, no tolerances are specified. It is recommended either that these tolerances be agreed between purchaser and supplier or that these parts are supplied in the pre-machined condition.

6.8.3 Flatness tolerance

In addition to the tolerances caused by the forging operation, there will be deviations from flatness due to bending, twisting or the release of stresses, particularly during any subsequent heat treatment.

Forgings shall conform to the flatness tolerances given in Table 20, which are related to the length of the forging and are applied independently from dimensional tolerances.

Dependent on the forging geometry (e.g. different section thicknesses) the deviation from flatness may be checked using a straight edge or surface plate. Where this is not possible, a datum plane shall be established by positioning the forging on three datum points.

6.9 Surface conditions

Forgings as blanks have a surface corresponding to the manufacturing process.

Ridges, indentations, folds, mechanical damage on the surface of forgings, which will have no detrimental effect on the use of the forgings shall not be cause for rejection. Such surface irregularities and imperfections may be removed by suitable means provided that this does not invalidate the specified tolerances.

NOTE Hand forgings are generally completely machined.

6.10 Drawings

The purchaser shall supply a drawing of the finished part for die and cored forgings and if necessary for hand forgings. If possible, also a drawing of the forging showing the dimensions and tolerances as well as the tooling points of first-stage machining should be supplied.

Guidelines for the design of forgings are given in annex B.

The manufacturer of die forgings shall prepare a drawing of the forging, including tolerances, from the data submitted by the purchaser. This drawing shall be checked and approved by the purchaser and returned to the manufacturer before die-production is started.

Unless otherwise agreed between the manufacturer and the purchaser, the manufacturer shall produce type samples which shall be submitted to the purchaser for testing. When approved, the type sample and the drawing of the forging shall be the basis of agreement for bulk production.

7 Sampling

7.1 General

When required (e.g. if necessary in accordance with specified procedures of a supplier's quality system, or when the purchaser requests inspection documents with test results, or for use in cases of dispute), an inspection lot shall be sampled in accordance with 7.2 and 7.3.

7.2 Analysis

The sampling rate shall be in accordance with Table 21. A test sample, depending on the analytical technique to be employed, shall be prepared from each sampling unit and used for the determination of the composition.

NOTE 1 When preparing the test sample, care should be taken to avoid contaminating or overheating the test sample. Carbide tipped tools are recommended; steel tools, if used, should be made of magnetic material to assist in the subsequent removal of extraneous iron. If the test samples are in finely divided form (e.g. drillings, millings), they should be treated carefully with a strong magnet to remove any particles of iron introduced during preparation.

NOTE 2 In cases of dispute concerning the results of analysis, the full procedure given in ISO 1811-2 should be followed.

Results may be used from analyses carried out at an earlier stage of manufacturing the product, e.g. at the forging stock stage, if the material identity is maintained and if the quality system of the manufacturer is certified as conforming to EN ISO 9001 or EN ISO 9002.

7.3 Hardness, stress corrosion resistance and dezincification resistance and electrical property tests

The sampling rate shall be in accordance with Table 21. Sampling units shall be selected from the finished products. The test samples shall be cut from the sampling units. Test samples, and test pieces prepared from them, shall not be subjected to any further treatment, other than any machining operations necessary in the preparation of the test pieces.

Table 20 — Flatness tolerance

Dimensions in millimetres

Method of measurement	Flatness tolerance for nominal length						
	up to and including 100	over 100 up to and including 250	over 250 up to and including 400	over 400 up to and including 630	over 630 up to and including 1 000	over 1 000 up to and including 1 600	over 1 600 up to and including 2 500
Straight edge	1	1,5	2,5	3	4	5	6
Datum point	±1	±1,5	±2,5	±3	±4	±5	±6

Table 21 — Sampling rate

Mass of an individual forging kg		Size of inspection lot for one test sample kg
over	up to and including	up to and including
—	0,5	500
0,5	2,0	1 000
2,0	10	1 500
10	—	2 000

NOTE Larger inspection lots require sampling in proportion up to a maximum of five test samples.

8 Test methods

8.1 Analysis

Analysis shall be carried out on the test pieces, or test portions, prepared from the test samples obtained in accordance with 7.2. Except in cases of dispute, the analytical methods used shall be at the discretion of the supplier. For expression of results, the rounding rules given in 8.8 shall be used.

NOTE In cases of dispute concerning the results of analysis, the methods of analysis to be used should be agreed between the disputing parties.

8.2 Hardness test

The hardness test shall be carried out on the test pieces cut from the test samples obtained in accordance with 7.3.

For the Brinell test according to EN 10003-1 a 0,102 F/D^2 ratio of 10 shall be used.

For the Vickers test according to ISO 6507-1 a test force of 49,03 N or 294,21 N shall be used.

8.3 Tensile test

When required, the tensile properties shall be determined in accordance with EN 10002-1 on the test pieces prepared from the test samples obtained in accordance with 7.3.

8.4 Electrical conductivity test

The electrical conductivity test method used shall be at the discretion of the supplier and shall be carried out on the test pieces prepared from the test samples obtained in accordance with 7.3.

NOTE In cases of dispute the method of test should be agreed between the disputing parties.

8.5 Dezincification resistance test

The test method given in EN ISO 6509 shall be used on the samples obtained in accordance with 7.3. A test piece shall be taken from each sample, so as to expose a prepared transverse cross-section surface to the test solution.

At the completion of the test:

- for grade A, the maximum depth of dezincification in a longitudinal direction (i.e. along the forged flow) shall be measured;
- for grade B, the mean depth of dezincification (see annex C) and the maximum depth of dezincification, in a longitudinal direction, shall be measured.

8.6 Stress corrosion resistance test

The test method given in either ISO 6957 or EN ISO 196 shall be used on the test pieces prepared from the test samples obtained in accordance with 7.3. The choice of which of these tests is used shall be at the discretion of the supplier, unless a preference is expressed by the purchaser [see 5 g)].

8.7 Retests

8.7.1 Analysis, hardness, tensile, electrical conductivity and dezincification resistance tests

If there is a failure of one, or more than one, of the tests in 8.1, 8.2, 8.3, 8.4 or 8.5, two test samples from the same inspection lot shall be permitted to be selected for retesting the failed property (properties). One of these test samples shall be taken from the same sampling unit as that from which the original failed test piece was taken, unless that sampling unit is no longer available, or has been withdrawn by the supplier.

If the test pieces from both test samples pass the appropriate test(s), then the inspection lot represented shall be deemed to conform to the particular requirement(s) of this standard. If a test piece fails a test, the inspection lot represented shall be deemed not to conform to this standard.

NOTE If an inspection lot in alloy CuZn36Pb2As (CW602N) fails the dezincification resistance test when tested or retested, the supplier has the option to further heat treat the inspection lot and resubmit it for all the tests called for on the order, except for analysis.

8.7.2 Stress corrosion resistance test

If a test piece fails the test, the inspection lot represented by the failed test piece shall be permitted to be subjected to a stress relieving treatment. A further test sample shall then be selected in accordance with 7.3.

If a test piece from the further test sample passes the test, the stress relieved material shall be deemed to conform to the requirements of this standard for residual stress level and shall then be subjected to all the other tests called for on the purchase order, except for analysis. If the test piece from the further test sample fails the test, the stress relieved material shall be deemed not to conform to this standard.

8.8 Rounding of results

For the purpose of determining conformity to the limits specified in this standard, an observed or a calculated value obtained from a test shall be rounded in accordance with the following procedure, which is based upon the guidance given in annex B of ISO 31-0:1992. It shall be rounded in one step to the same number of figures used to express the specified limit in this standard.

The following rules shall be used for rounding:

- a) if the figure immediately after the last figure to be retained is less than 5, the last figure to be retained shall be kept unchanged;
- b) if the figure immediately after the last figure to be retained is equal to or greater than 5, the last figure to be retained shall be increased by one.

9 Declaration of conformity and inspection documentation

9.1 Declaration of conformity

When requested by the purchaser [see 5 l)] and agreed with the supplier, the supplier shall issue for the products the appropriate declaration of conformity in accordance with EN 1655.

9.2 Inspection documentation

When requested by the purchaser [see 5 m)] and agreed with the supplier, the supplier shall issue for the products the appropriate inspection document in accordance with EN 10204.

10 Marking, labelling, packaging

Unless otherwise specified by the purchaser and agreed by the supplier, the marking, labelling and packaging shall be left to the discretion of the supplier [see 5 n)].

Annex A (informative)

Bibliography

In the preparation of this European Standard, use was made of a number of documents for reference purposes. These informative references are cited at the appropriate places in the text and the publications are listed hereafter.

EN 1173, *Copper and copper alloys — Material condition or temper designation.*

EN 1412, *Copper and copper alloys — European numbering system.*

EN ISO 9001, *Quality systems — Model for quality assurance in design/development, production, installation and servicing.*
(ISO 9001:1994)

EN ISO 9002, *Quality systems — Model for quality assurance in production, installation and servicing.*
(ISO 9002:1994)

ISO 31-0:1992, *Quantities and units — Part 0: General principles.*

ISO 1190-1, *Copper and copper alloys — Code of designation — Part 1: Designation of materials.*

Annex B (informative)

Recommended guidelines for design

B.1 Introduction

This annex gives general guidelines which enable the purchaser to take into account manufacturing processes when designing a forged component.

It is recommended that the purchaser should contact the manufacturer for advice, especially in the case of forgings which are difficult to produce with respect to material, shape and size.

B.2 General information

As forgings are generally produced near net shape with good dimensional accuracy and surface finish, any subsequent machining is minimized. The consolidated wrought structure produced by forging allied with appropriate design, can achieve optimal grain/fibre flow which will better withstand any high operational stresses that the component may be subjected to in subsequent service (compare Figures B.1 and B.2 with Figure B.3).

During the design of forgings large cross-sectional changes, abrupt transitions, and accumulation of material should be avoided. Thin forgings of large surface areas are notably problematic due to their susceptibility to warping which usually necessitates difficult straightening operations.

As changes in the design are difficult after tool manufacture has begun, it is recommended that any possibility of alteration should be fully discussed between the purchaser and the supplier prior to die production so that if necessary or practical they can be accommodated economically. The purchaser should also be aware that the accommodation of such modifications or the requirement for smaller dimensions/tolerances than those specified or recommended in this standard will increase the cost of production as a consequence of shorter die life and increased production times.

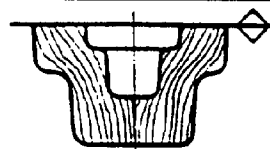


Figure B.1 — Forged in the die from a bar: Suitable fibre flow

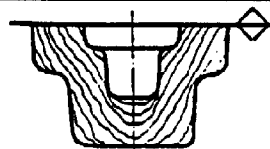


Figure B.2 — Forged in the die from a rough forging: Suitable fibre flow

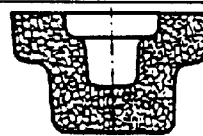


Figure B.3 — Casting: No fibre flow

B.3 Guidelines for die forgings

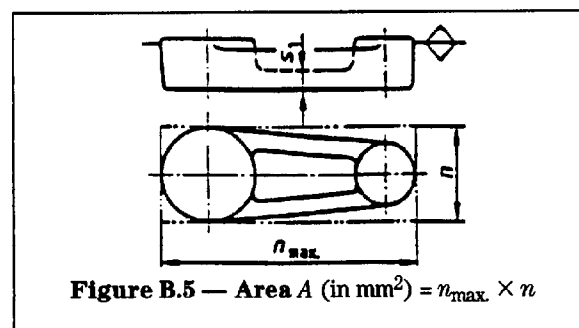
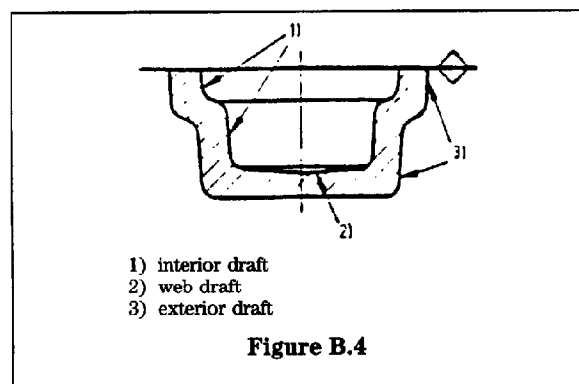
B.3.1 Drafts

Generally all areas lying in the direction of forging of the die components should have 30° external and 1° internal drafts, in order that the parts can be easily lifted out of the die. In particular cases, larger or even smaller drafts may be necessary for reasons associated with the die and/or the press.

The use of web drafts is recommended, particularly in the case of parts of large area with relatively small wall thickness, in order that material can flow easily from the centre to the sides (see Figure B.4).

B.3.2 Web thicknesses

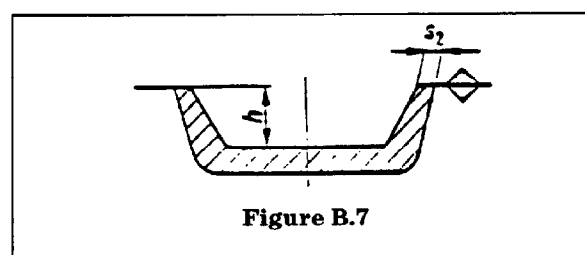
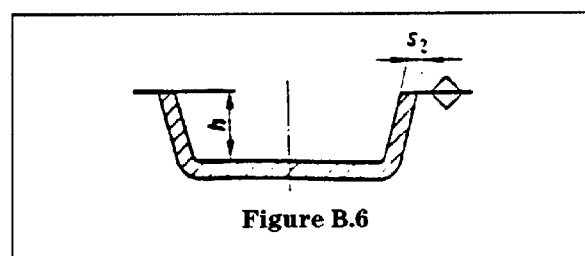
The smallest web thickness s_1 depends on the largest area A of the die forging transverse to the direction of forging, which, in the case of round parts, is equal to the area of the circle and in the case of irregularly shaped parts is equal to the area of the circumscribing rectangle (see Figure B.5 and Table B.1).



B.3.3 Side wall thicknesses

Side wall thicknesses s_2 apply to uniform and symmetrical cross-sections (see Figure B.6 and Table B.2).

If tapering of cross-sections is unavoidable for constructional reasons, gradual tapering of the wall thickness from the web to the level of the flash is advisable. For this purpose the smallest wall thickness should be that for the side wall thickness s_2 (see Figure B.7 and Table B.2).



Differences and abrupt changes in wall thicknesses in the direction of the flash should be avoided. However if such changes are unavoidable, they should be kept to a minimum and should incorporate gradual transitions (see Figures B.8 and B.9).

Table B.1 — Web thicknesses

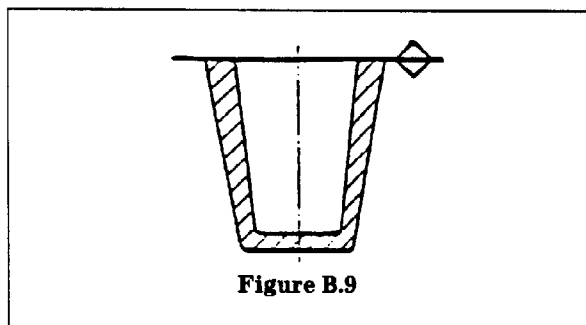
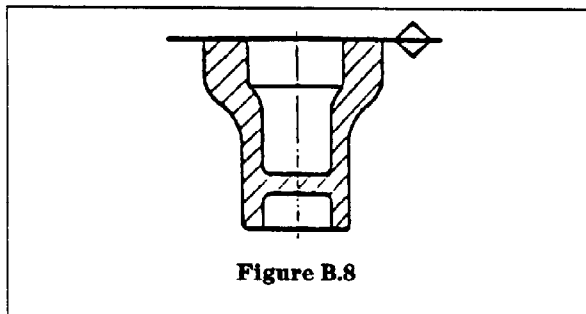
Dimensions in millimetres

Material group	Minimum web thickness s_1 for area A in square millimetres					
	up to and including 2 500	over 2 500 up to and including 5 000	over 5 000 up to and including 10 000	over 10 000 up to and including 20 000	over 20 000 up to and including 40 000	over 40 000 up to and including 80 000
I	2	3	4	5,5	7	10
II	3	4,5	6	8,25	10,5	15
III	4	6	8	11	14	20

Table B.2 — Side wall thicknesses

Dimensions in millimetres

Material group	Minimum side wall thicknesses s_2 for nominal dimension h						
	up to and including 10	over 10 up to and including 14	over 14 up to and including 20	over 20 up to and including 32	over 32 up to and including 50	over 50 up to and including 80	over 80
I	2	2,5	3	3,5	4	5	6
II	3	3,75	4,5	5,25	6	7,5	9
III	4	5	6	7	8	10	12



B.3.4 Rib design

The drafting angles of ribs should follow the general guidelines of B.3.1 and have the recommended dimensions given in Table B.3. The end faces of ribs are normally rounded, r_1 generally being equal to half the rib thickness s_3 (see Figure B.12).

If ribs are provided for reasons of improving strength, they are generally not more than half the height of the outer ribs, and should preferably incorporate gradual transitions (see Figures B.10 and B.11).

Where possible, ribs should have the same thickness s_3 overall on the end face as this facilitates die manufacture (see Figure B.13).

In order to obtain well formed ribs, the ratio height: thickness of the rib should be as small as possible.

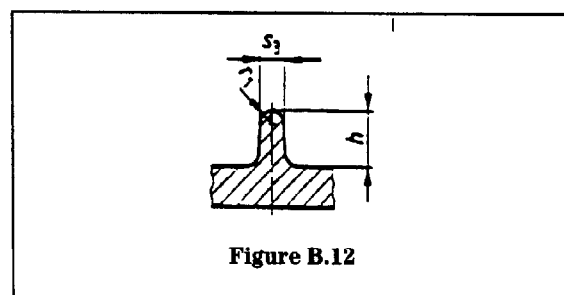
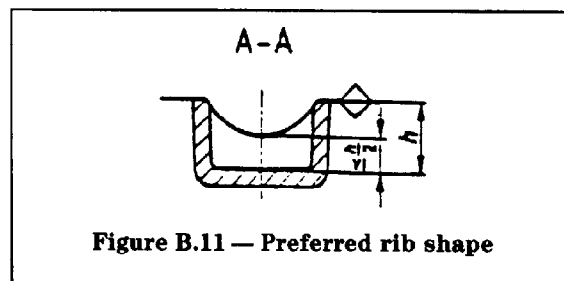
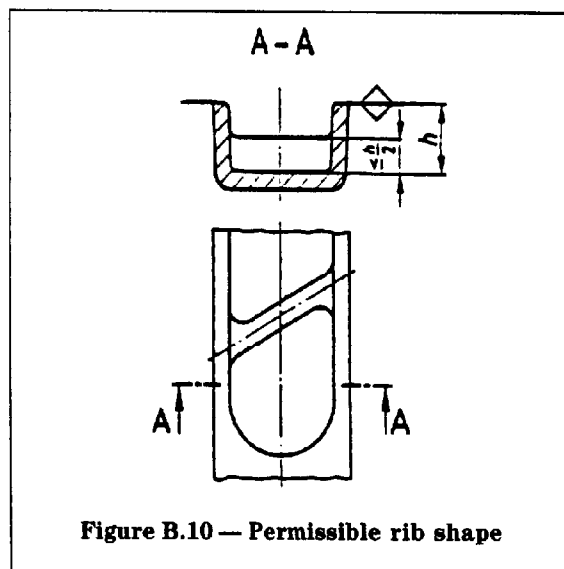


Table B.3 — Ribs

Dimensions in millimetres

Material group	Minimum rib radius r_1 and minimum rib thickness s_3 for nominal dimension h						
	up to and including 4	over 4 up to and including 6	over 6 up to and including 10	over 10 up to and including 16	over 16 up to and including 25	over 25 up to and including 40	over 40
I	0,5	0,5	0,5	1	1	1,5	2
II	0,75	0,75	0,75	1,5	1,5	2,25	3
III	1	1	1	2	2	3	4
I	2	2,5	3	4	5,5	7	> 10
II	3	3,75	4,5	6	8,25	10,5	> 15
III	4	5	6	8	11	14	> 20

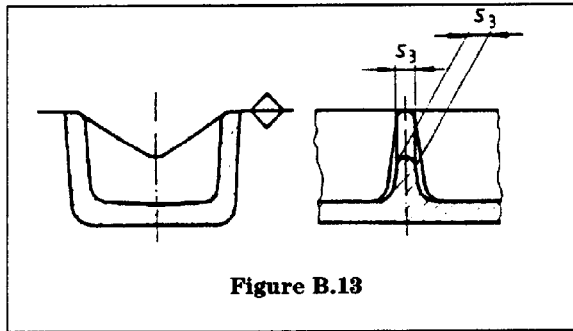


Figure B.13

B.3.5 Cores

The use of cores, which enable holes and recesses to be forged simultaneously, has the advantage of working the material more thoroughly, introducing more favourable grain/fibre flow, and reducing subsequent machining.

The recommendations for design shown in Figures B.14 and B.15 are for cores on one side, and in Figure B.16 and B.17 are for cores on both sides of a forging (for tolerances on core penetration see 6.7).

For transition radii see B.3.7

NOTE 1 For r see B.3.7 and Table B.4.

NOTE 2 For s_1 see B.3.2 and Table B.1

NOTE 3 $d \geq 25$ mm: for symmetrical parts $h \leq 1,5 d$;
for asymmetrical parts $h \leq 1,2 d$.

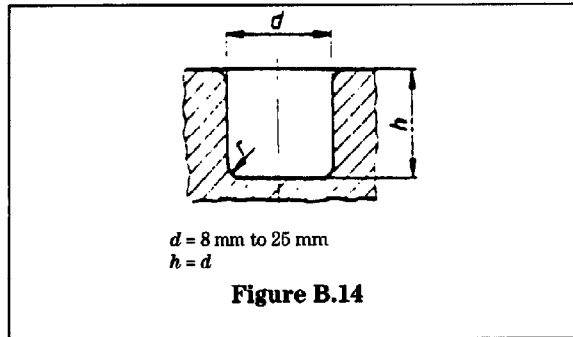


Figure B.14

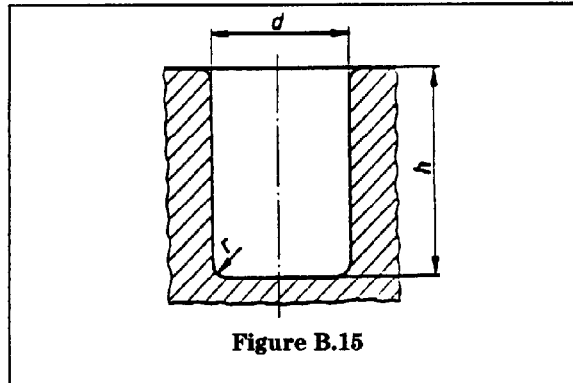


Figure B.15

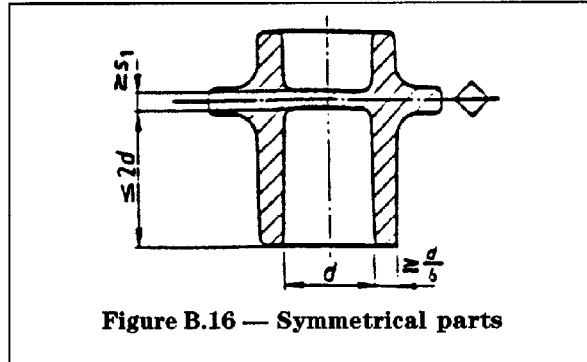


Figure B.16 — Symmetrical parts

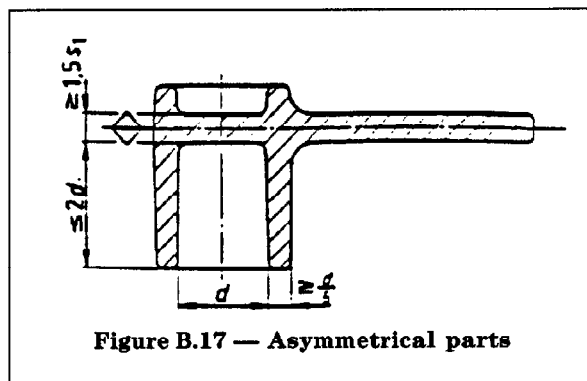


Figure B.17 — Asymmetrical parts

B.3.6 Flash

Flash occurs mainly where the dies part and to a lesser extent at discontinuities produced by inserts, pegs, punches, etc.

The flash generated at the die parting line is generally removed or trimmed as part of the production route. However, as the removal of flash due to deburring, punching or piercing (see G1 and G2 in Figure B.18) and die inserts, punches etc. (see G3 and G4 in Figure B.18) may require additional efforts and costs, it is recommended that their positions are located where they will be removed by any subsequent machining operation. If the position on a machine tooling surface cannot be avoided, then appropriate recessing of the machining work holders will be required (see Figure B.18).

To facilitate economic manufacture of forging tools, it is recommended that flash offsets which would require stepped die parting lines are avoided (see Figures B.19 and B.20). Positioning of the flash should also be such as to avoid adverse material flow which could lead to the formation of folds, laps, rupture etc. (see Figures B.21 and B.22).

B.3.7 Transition radii

It is recommended that all transition radii are uniform to facilitate the manufacture of dies (see Figures B.23 and B.24).

Examples of the relationship of forging features to the minimum recommended transition radii (see Table B.4) are given in Figures B.25 to B.29.

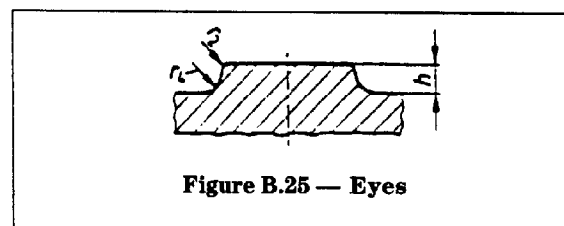
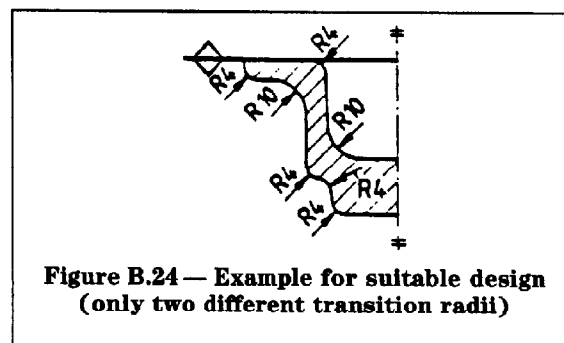
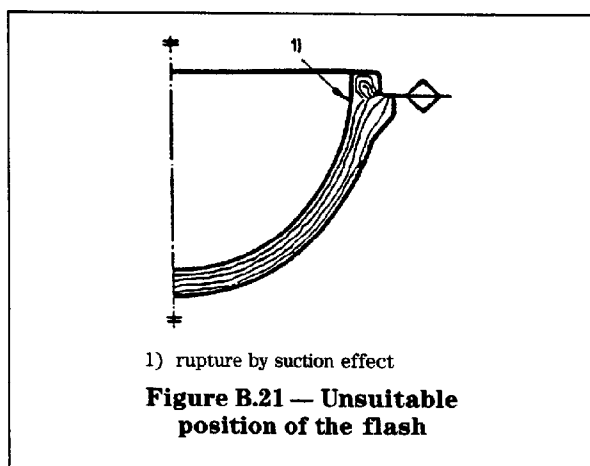
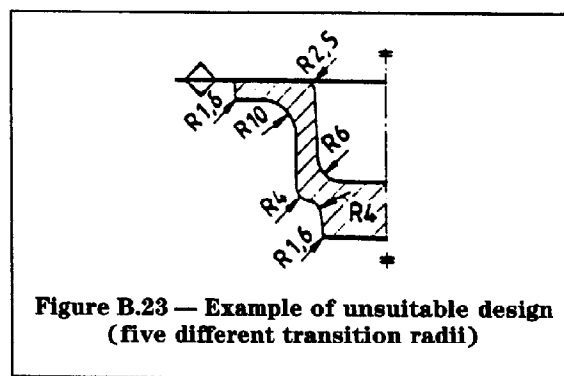
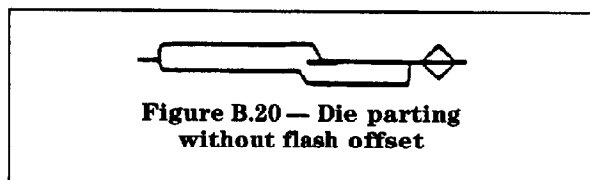
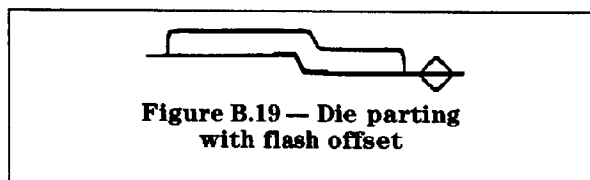
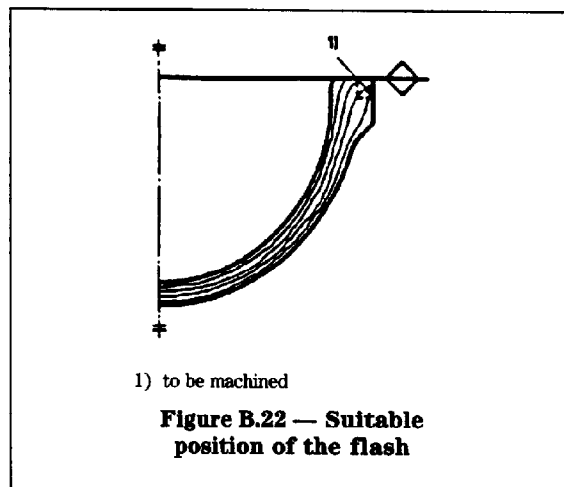
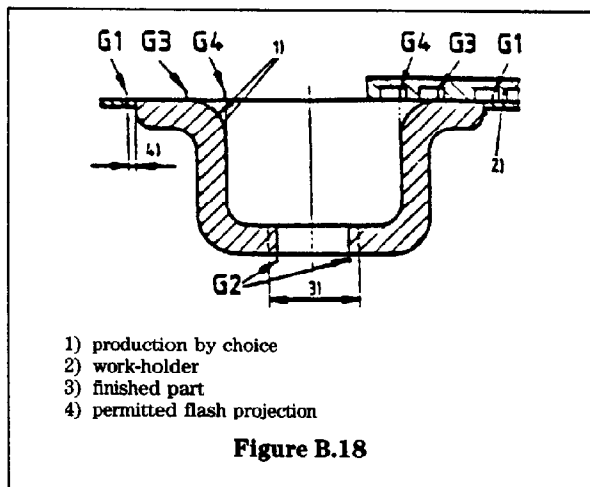


Table B.4 — Minimum transition radii

Dimensions in millimetres

Transition radii (see Figures 25 to 29)	Material group	Minimum transition radii for nominal dimension h						
		up to and including 4	over 4 up to and including 10	over 10 up to and including 25	over 25 up to and including 40	over 40 up to and including 63	over 63 up to and including 100	over 100
Corner radii r_2	I	0,5	1	1,6	2,5	4	6	10
	II	0,75	1,5	2,4	3,75	6	9	15
	III	1	2	3,2	5	6	9	15
Profile radii r_3	I	2,5	4	6	10	12	16	16
Fillet radii r_4	II	3,5	6	9	15	18	24	24
	III	5	8	12	18	18	24	24

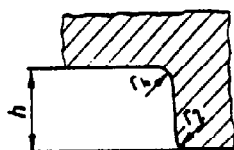


Figure B.26 — Corner radii



Figure B.27 — Flash zone

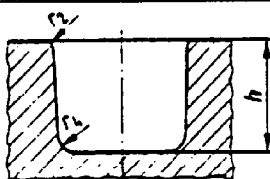


Figure B.28 — Cores

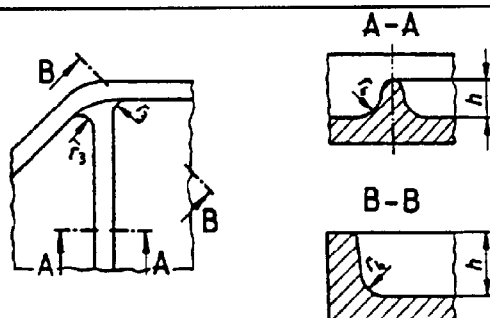


Figure B.29 — Ribs/webs

B.3.8 Tooling areas and tooling points for finish machining

B.3.8.1 If tooling areas are to be provided, particularly on conical parts difficult to clamp, it is possible to locate these either on the inside or on the outside area of the parts with a very slight draft. This should be limited to the smallest possible dimension a (see Figures B.30 and B.31 and Table B.5).

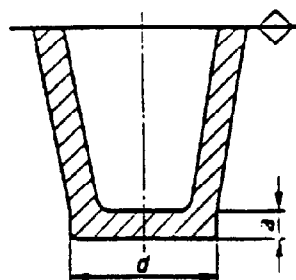


Figure B.30

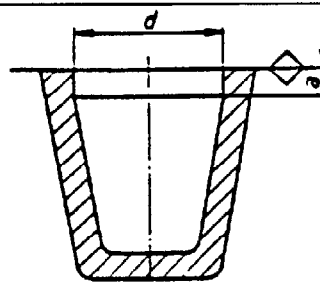


Figure B.31

B.3.8.2 Use of drill centers as tooling points should be avoided where they would adversely affect material flow or promote premature tool wear. The design of such tooling points should be agreed between the purchaser and the supplier.

Table B.5 — Tooling areas for finish machining

Material group	Maximum dimension a of tooling area for nominal dimension d				
	up to and including 25	over 25 up to and including 50	over 50 up to and including 100	over 100 up to and including 200	over 200
I	4	6	8	10	12
II	6	9	12	15	18
III	8	12	16	20	24

Dimensions in millimetres

B.3.9 Design for cross-sectional shapes

The recommended design of cross-sectional shapes and the relationships between height h , thickness s_1 and transition radii r is shown in Figures B.32 and B.33.

NOTE 1 Areas extending in the direction of die parting can be designed without drafts.

NOTE 2 For s_1 see B.3.2; for h , s_3 and r_1 see B.3.4; for r_2 and r_3 see B.3.7.

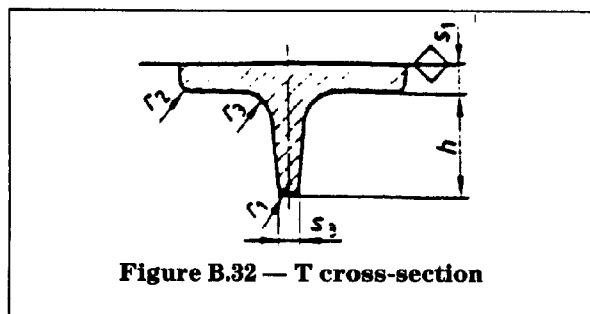


Figure B.32 — T cross-section

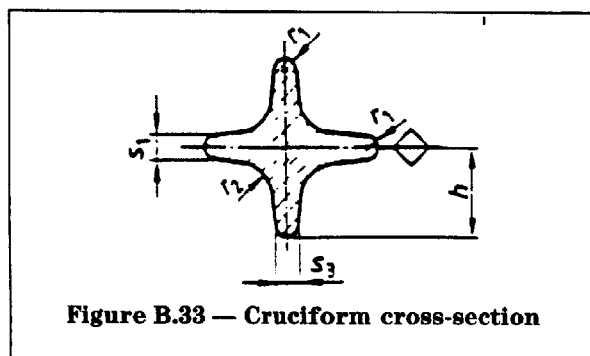


Figure B.33 — Cruciform cross-section

B.3.10 Recommended machining allowances and extra mass (EM)

Machining allowances are related to the shape and size of the forging as well as the manner of mounting for machining; therefore the tooling points or surfaces, especially for the first machining operation, should be indicated in the drawing submitted by the purchaser.

Machining allowances should be applied according to Table B.6; examples of which are given in Figure B.34.

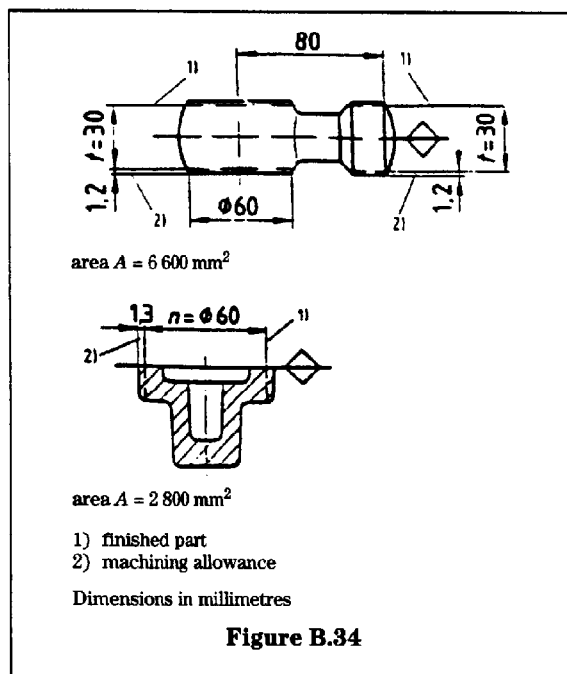


Figure B.34

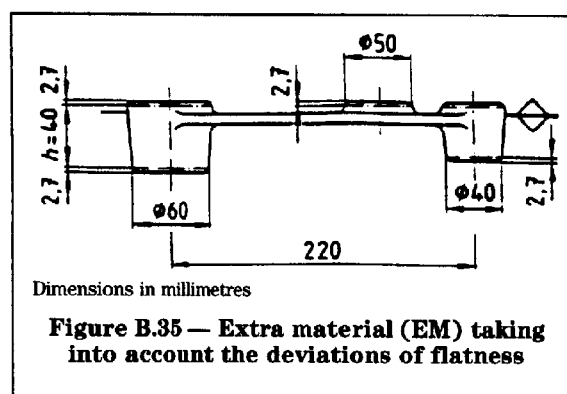


Figure B.35 — Extra material (EM) taking into account the deviations of flatness

Table B.6 — Machining allowances for drop or die forgings

Dimensions in millimetres

Nominal dimension		Dimension n within the die cavity (see Figure 1)	Machining allowance for dimensions t across the die parting line (see Figure 2) for area A in square millimetres				
over	up to and including	up to and including	up to and including 2 500	over 2 500 up to and including 5 000	over 5 000 up to and including 10 000	over 10 000 up to and including 20 000	over 20 000
—	50	1	1,1	1,1	1,2	1,3	1,4
50	120	1,3	1,4	1,4	1,5	1,6	1,6
120	250	1,6	1,8	1,9	2,0	2,0	2,1
250	500	2	2,4	2,5	2,5	2,5	2,5
500	—	3	3,1	3,1	3,1	3,1	3,1

The extra material (EM) per side of the forging is the total of the machining allowances (see Table B.6) plus the flatness tolerance (see 6.6.6) or the mismatch (see 6.6.3) as appropriate (see examples 1 and 2 in Figures B.35 and B.36).

EXAMPLE 1

A forging with area $A = 16\,200\text{ mm}^2$ and maximum dimension $n = 220\text{ mm} + 30\text{ mm} + 20\text{ mm} = 270\text{ mm}$:

The machining allowance according to Table B.6 ($n = 40\text{ mm}$, $A = 16\,200\text{ mm}^2$): 1,3 mm

The flatness tolerance according to 6.6.6, see Table 14: 1,4 mm

Extra material (EM) per side: 2,7 mm

EXAMPLE 2

A forging with area $A = 1\,964\text{ mm}^2$ and maximum dimension $n = 50\text{ mm}$:

The machining allowance according to Table B.7 ($n = 50\text{ mm}$): 1,0 mm

The mismatch according to 6.6.3: 0,3 mm

Extra material (EM) per side: 1,3 mm

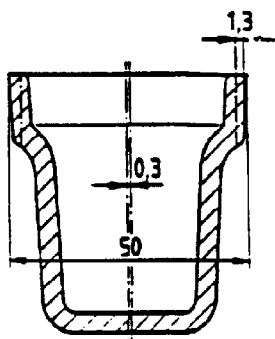
B.4 Guidelines for hand forgings

These guidelines are intended as a working basis for the design of hand forgings enabling the purchaser to take the specific manufacturing processes of the supplier into account. When a purchaser requires a hand forging of a complex shape which may be difficult to forge he should supply a drawing and consult the supplier.

B.4.1 General information

The use of hand forgings is recommended whenever:

- selected grain flow patterns are required in a forging to increase strength corresponding to actual stresses when in use, see Figures B.37 and B.38;
- single parts or a small number of the same parts are needed;
- it is inexpedient for configuration, cost or other reasons to produce the required parts from sheet, bars, extruded sections or castings etc. (see Figures B.39 and B.40).



Dimensions in millimetres

Figure B.36 — Extra material (EM) in case of mismatch

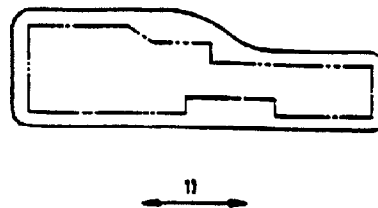
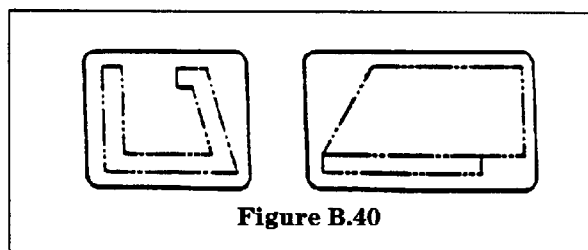
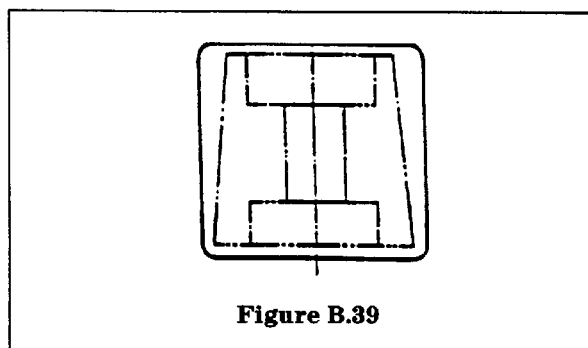
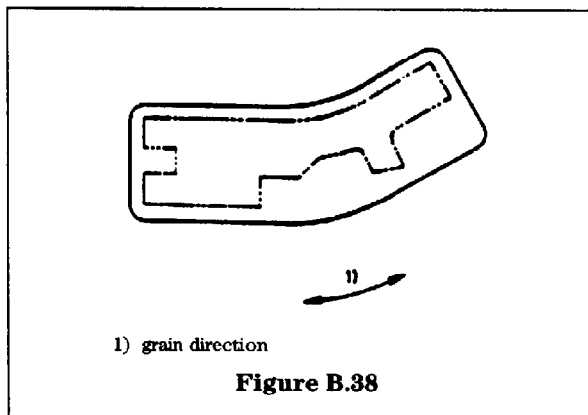


Figure B.37



Most hand forgings are produced by using simple standard tools, such as flat and profiled open dies, ensuring a wrought structure. They will have a surface which is typical of the manufacturing process. As hand forgings can only approach the finished-part contours, they need machining.

Parts having large area and small thickness are difficult to produce. Depending on the material and condition, they tend to distort during forging, heat-treatment and/or machining operations. In most cases it will therefore be necessary to straighten and machine such hand forgings carefully.

B.4.2 Section changes and transitions

Whenever possible, hand forgings should be free from any abrupt cross-sectional changes or transitions by providing sufficiently large transition radii and avoiding tight dimensional requirement.

B.4.3 Recommended machining allowances

As hand forgings can only be approximate to the final shape of the finished part, Table B.7 recommends values for machining allowances. These values are applicable for all dimensions of a hand forging. The value of the machining allowance is decided by reference to the largest nominal dimension n_{max} of a forging and its mass.

B.4.4 Extra material (EM) per side of forging

The extra material (EM) per side of the forging (see Figures B.41 and B.42) is the total of the machining allowances (see Table B.7) and the flatness tolerance (see 6.8.3 and Table 20), to ensure the dimensions of the finished part.

EXAMPLE

A forging with a mass of 30 kg and a length of 800 mm:

The machining allowance according to Table B.7: 8 mm

The flatness tolerance according to Table 20: 4 mm

Extra mass (EM) per side: 12 mm

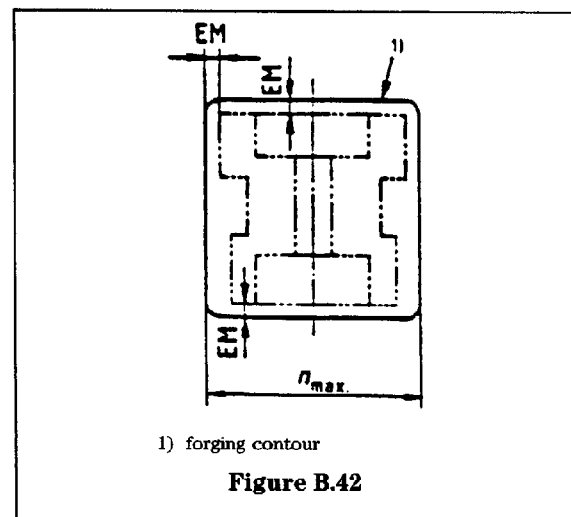
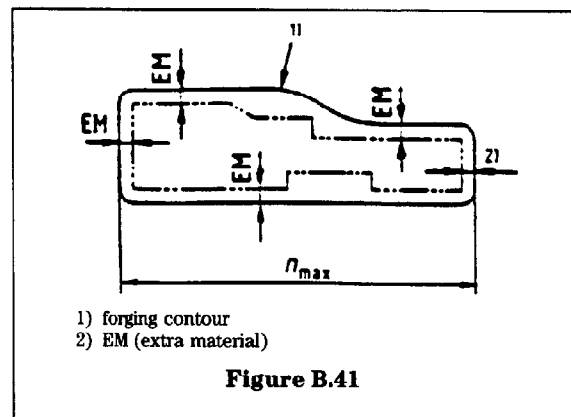


Table B.7 — Machining allowance for hand forgings

Dimensions in millimetres

Weight per piece kg		Machining allowance for largest nominal dimension $n_{\max}$ in millimetres				
over	up to and including	up to and including 250	over 250 up to and including 400	over 400 up to and including 630	over 630 up to and including 1 000	up to and including 1 600
—	20	3	5	6	8	10
20	50	4	5	8	8	10
50	100	—	8	8	10	12
100	250	—	10	10	12	15
250	500	—	10	10	12	15

Annex C (normative)**Determination of mean depth of dezincification****C.1 Introduction**

EN ISO 6509 specifies a method for the determination of the maximum depth of dezincification of a brass specimen. In accordance with the ruling given in 7.5.3 of EN ISO 6509:1995, the following procedure extends the method to cover the determination of the mean depth of dezincification, in order to verify conformity to the dezincification resistance acceptance criteria for CuZn36Pb2As (CW602N) grade B products.

The principle of the method, the reagents, materials and apparatus required and the procedure for the selection and preparation of the test pieces are all in accordance with EN ISO 6509.

C.2 Procedure

Having determined the maximum depth of dezincification in a longitudinal direction, in accordance with clause 7 of EN ISO 6509:1995 (see 8.5), carry out the following operations to determine the mean depth of dezincification.

Adjust the magnification of the microscope to suit the general depth of dezincification and use the same magnification for all measurements. Examine the entire length of the section for evaluation, in contiguous visual fields of the microscope.

NOTE To ensure the best accuracy of measurement, measure the largest number of contiguous fields at the greatest possible magnification.

Using the measuring scale incorporated in the microscope, measure and record the dezincification depth, i.e. the point of intersection of the scale and the dezincification front [see Figure C.1 a)], for each contiguous field. If the scale lies between two dezincified areas within the visual field, the dezincification depth shall be recorded as the point of intersection of the scale and an imaginary line joining the extremities of the two dezincification fronts adjacent to the scale [see Figure C.1 b)].

If there is no evidence of dezincification in the field examined, or only one dezincified area which does not intersect the scale, then record the dezincification depth of that field as zero [see Figure C.1 c)].

C.3 Expression of results

After measurement of all the contiguous fields along the entire length of the section for evaluation, calculate and report the mean dezincification depth as the sum of the measured depths for every field divided by the number of contiguous fields examined.

NOTE The locations for the measurement of dezincification depth, in three different cases, are marked X.

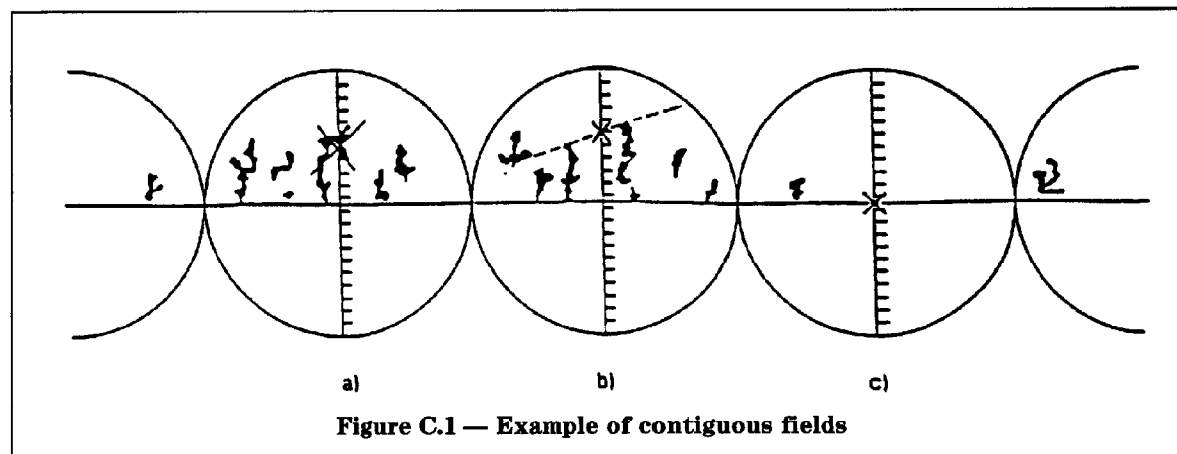


Figure C.1 — Example of contiguous fields

Annex ZA (informative)**Clauses of this European Standard
addressing essential requirements or
other provisions of EU Directives**

This European Standard has been prepared under a Mandate given to CEN by the European Commission and the European Free Trade Association and supports essential requirements of the EU Directive 97/23/EC.

WARNING Other requirements and other EU Directives may be applicable to the product(s) falling within the scope of this standard.

Relevant clauses of this standard are likely to support the essential requirements in clause 4 "Materials" of Annex I of the "Pressure equipment Directive" 97/23/EC.

Compliance with these clauses of this standard provides one means of conforming with the specific essential requirements of the Directive concerned and associated with EFTA requirements.

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12420:1999

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