

Drills and reamers —

Part 4: Specification for dimensions of reamers

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- Institution of Production Engineers
- Machine Tool Industry Research Association
- Society of British Aerospace Companies Limited
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Foreword

This revision of this British Standard has been prepared under the direction of the Mechanical Engineering Standards Committee.

The standard for milling cutters and reamers was first published in 1920, and subsequent editions were issued in 1931 and 1938. When it was again revised, in 1952, the standard was separated into two Parts, Part 1 relating to milling cutters and Part 2 to reamers, countersinks and counterbores.

A further revision was carried out in 1964 to take account of the work of the International Organization for Standardization (ISO), in which agreement had been reached on hand reamers, long flute machine reamers and chucking reamers in both inch and metric units.

This revision has been prepared to take account of further ISO work that has been completed since 1964 and is primarily in metric units, the intention being eventually to phase out reamers made to inch dimensions.

However, it is recognized that reamers with cutting diameters in inch units will be required for some time to come. Where practicable, therefore, preferred inch sizes for cutting diameters are retained (see Appendix C). Nevertheless, in the interests of rationalization, all other dimensions are in metric measurement, allowing the same blanks to be used for both inch and metric cutting reamers.

This general principle applies to the more popular types, viz. hand, long-flute machine and machine chucking reamers. It cannot however be applied in the case of inch shell reamers (where the taper of the bore is different) or to inch hand or inch machine taper pin reamers (where the taper of the reamer is different). In these cases the existing inch dimensions from the tables in BS 122-2:1964 have been retained (see Appendix C).

Machine jig reamers, parallel shank and Morse taper shank socket reamers for Brown and Sharpe tapers, parallel bridge reamers and centre reamers have been omitted from the standard since there is now virtually no demand for them. Four-flute shell drills with taper bore have also been omitted.

Whereas the British Standard on reamers, counterbores and countersinks has previously been published as a Part of BS 122 "*Milling cutters*", there is not now considered to be any great affinity between these areas of work. This revision is published as a Part of BS 328 "*Drills and reamers*", the other Parts being:

- *Part 1: Twist drills;*
- *Part 2: Centre drills;*
- *Part 3: Core drills;*
- *Part 5: Countersinks and counterbores.*

The 1983 revision of Part 5 of BS 328 superseded clauses **21**, **22** and **23** of BS 122-2:1964 and this Part 4 of the revision supersedes the remaining clauses; BS 122-2:1964 is therefore withdrawn.

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 42, 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.

1 Scope

This Part of this British Standard specifies the dimensions of the following commonly used types of reamer:

- hand reamers
- long-flute machine reamers¹⁾ with Morse taper shanks
- machine chucking reamers¹⁾
- shell reamers
- socket reamers
- hand taper pin reamers
- machine taper pin reamers
- bridge reamers

A method of calculating tolerances for special reamers is given in Appendix A. Appendix B shows the values of certain of the limits of tolerance specified, extracted from BS 4500-1. Appendix C specifies preferred inch sizes of cutting diameters for various types of reamer, and Appendix D shows tables of dimensions set out as functions of reamer diameter, i.e. "general tables".

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

2 Nomenclature

There are certain important differences between the reamer nomenclature that has been traditional in the United Kingdom and that used on the Continent of Europe. In particular, the two types of reamer known in the United Kingdom by the names in the left-hand column below have been known on the Continent by the names in the centre column. In order to avoid confusion, the names shown in the right-hand column have been adopted by ISO, and they are also used throughout this British Standard.

Traditional United Kingdom name	Traditional Continental name	Name adopted by ISO
Chucking reamer	Machine reamer	Machine chucking reamer
Parallel machine reamer	Long-fluted machine reamer	Long-flute machine reamer

3 Terms and definitions

NOTE This clause is closely based on ISO 5420. The numbers in Figure 1 to Figure 9 link the features within the figures to the subclauses in the text; they are unchanged from those in ISO 5420.

For the purposes of this Part of BS 328 the following definitions apply. Definitions of particular types of reamer are given in the appropriate clause in which the dimensions of those reamers are specified.

3.1 axis

the longitudinal centre line of the reamer

NOTE See Figure 1.

3.2 shank

the portion of the reamer by which it is held and driven

NOTE See (a) of Figure 1 for taper shank, (b) of Figure 1 for parallel shank with hand square and (c) of Figure 1 for parallel shank.

3.3 shank length

the length of the portion of the reamer that starts after the recess behind the flutes and extends to the end of reamer

NOTE See Figure 1.

3.4 tang

the flattened end of a taper shank intended to fit into the slot in the socket and to be used for ejection purposes

NOTE See Figure 1(a).

3.5 size of square

the dimension across the flats of the squared portion at the extreme end of a parallel hand shank

NOTE See Figure 1(b).

3.6 length of square

the length of the squared portion at the extreme end of a parallel hand shank

NOTE See Figure 1(b).

3.7 body

that portion of the reamer extending from the entering end of the reamer to the commencement of the shank

NOTE See Figure 1.

3.8 recess

the cylindrical portion with reduced diameter in the body

NOTE See Figure 1.

¹⁾ See clause 2

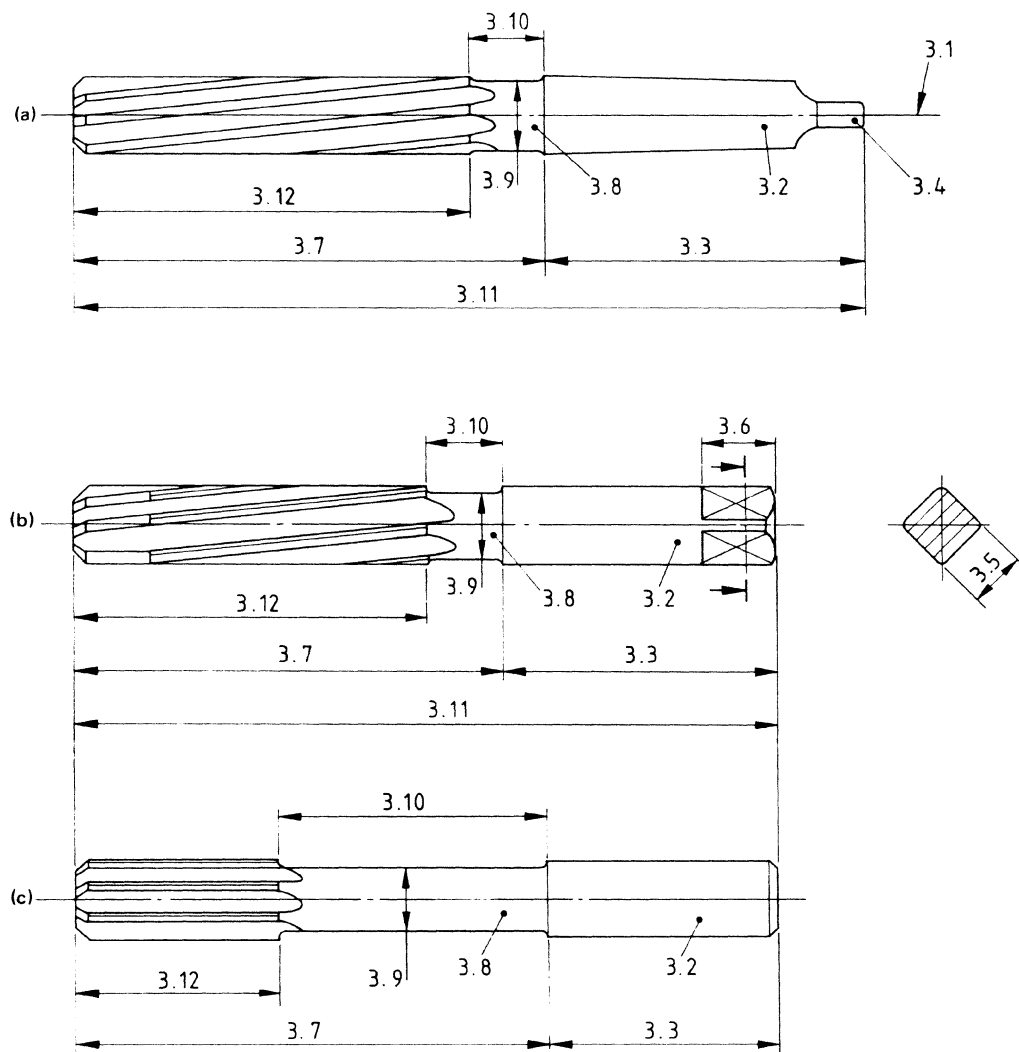


Figure 1 — Principal elements of reamers

3.9**recess diameter**

the diameter of the cylindrical portion of the body which is reduced

NOTE See Figure 1.

3.10**recess length**

the length of the cylindrical portion with reduced diameter in the body

NOTE See Figure 1.

3.11**overall length**

the length over the extreme ends of the entering end and of the shank, excluding the length of external centres, if any

NOTE See Figure 1.

3.12**cutting edge length**

the axial length of that portion of the fluted body provided with primary clearances or circular lands and including the taper (3.13) and bevel leads (3.17, 3.18)

NOTE See Figure 1.

3.13**taper lead**

that portion of the reamer extending from the entering end to the point where the diameter measured over the lands reaches the cutting diameter of the tool

NOTE 1 See Figure 2(b).

NOTE 2 In the USA the taper lead is termed a "starting taper".

3.14**taper lead length**

the length, measured axially, of the taper lead (3.13)

NOTE See Figure 2(b).

3.15**taper lead angle**

the angle between the reamer axis (3.1) and the projection of the major cutting edge (3.31) in the plane passing through the reamer axis and the corner (3.35)

NOTE See Figure 2(b).

3.16**included angle of taper lead**

the angle formed by the cutting edges of the taper lead (3.13)

NOTE See Figure 2(b).

3.17**non-cutting bevel lead**

the angular portion, if any, at the entering end of a hand reamer that facilitates the entry of the reamer into the hole

NOTE 1 See Figure 2(b).

NOTE 2 In the USA a non-cutting bevel lead is termed a "bevel".

3.18**cutting bevel lead**

the angular cutting portion at the entering end of a machine reamer to facilitate the entry of the reamer into the hole

NOTE 1 See Figure 2(a).

NOTE 2 The cutting bevel lead is not provided with a circular land (3.28).

NOTE 3 In the USA a cutting bevel lead is termed a "chamfer".

3.19**bevel lead length**

the length measured axially, of the bevel lead (3.17, 3.18)

NOTE 1 See Figure 2.

NOTE 2 In the USA the bevel lead length is termed the "chamfer length".

3.20 Bevel lead angle**3.20.1****bevel lead angle (non-cutting)**

the angle formed by the bevel lead (3.17) and the hand reamer axis (3.1)

NOTE 1 See Figure 2(b).

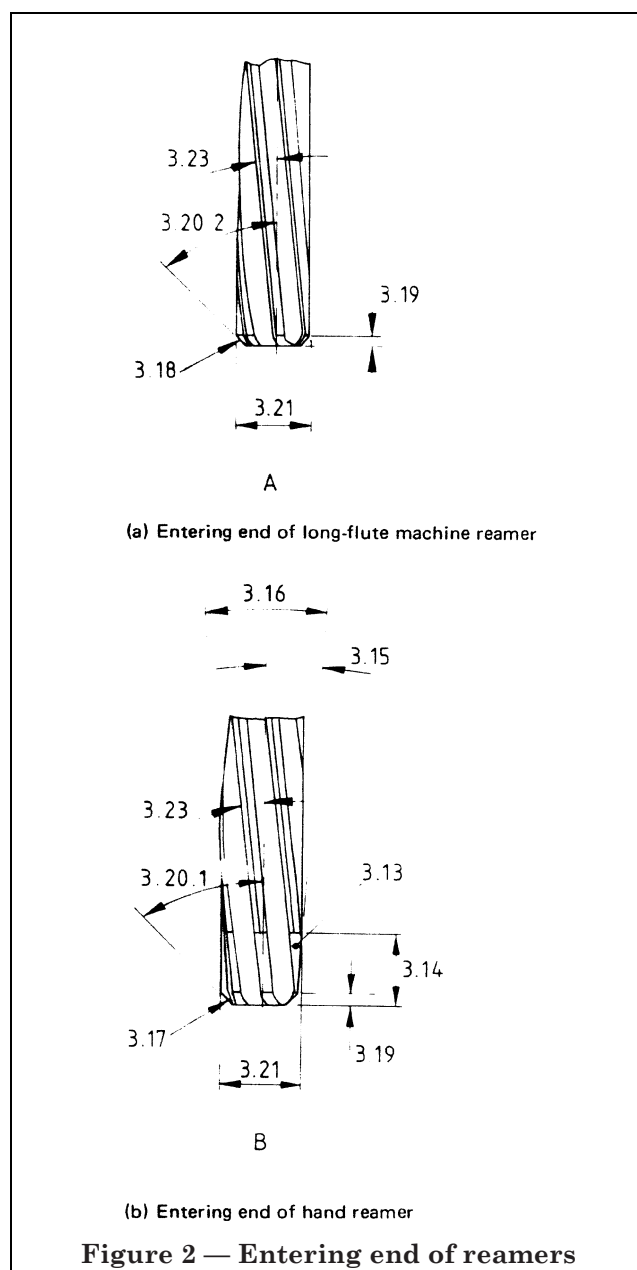
NOTE 2 In the USA the bevel angle (non-cutting) is termed the "bevel angle".

3.20.2**bevel lead angle (cutting)**

the angle between the reamer axis (3.1) and the projection of the major cutting edges (3.31) in the plane containing the reamer axis and the corner (3.35)

NOTE 1 See Figure 2(a).

NOTE 2 In the USA the bevel lead angle (cutting) is termed the "chamfer angle".



3.21 cutting diameter

the diameter of the reamer at the entering end immediately after the bevel (3.18) or taper lead (3.13)

NOTE See Figure 2.

3.22 back taper

the reduction in cutting diameter (3.21) from the cutting end towards the shank

3.23 helix angle

the angle between the minor cutting edge (3.32) and the reamer axis (3.1)

NOTE See Figure 2.

3.24 Rotation of cutting

3.24.1 right-hand cutting reamer

a reamer that rotates in a clockwise direction when viewed on the rear end of the reamer (counter-clockwise when viewed on the entering end)

3.24.2 left-hand cutting reamer

a reamer that rotates in a counter-clockwise direction when viewed on the rear end of the reamer (clockwise when viewed on the entering end)

3.25 flute

a groove in the body (3.7) of the reamer, straight or helical and right-handed or left-handed, that permits the removal of chips and the passage of the cutting fluid

NOTE See Figure 3.

3.26 fluted land

that portion of the body (3.7) not cut away by the flutes

NOTE 1 A fluted land includes both the circular land (3.28) and the clearance (3.29) (see Figure 3).

NOTE 2 In the USA a fluted land is termed a "land".

3.27 width of fluted land

the distance between the minor cutting edge of a land and the heel (3.34), measured at right angles to the helix angle (3.23)

NOTE See Figure 3.

3.28 circular land

the cylindrical leading surface of a fluted land (3.26)

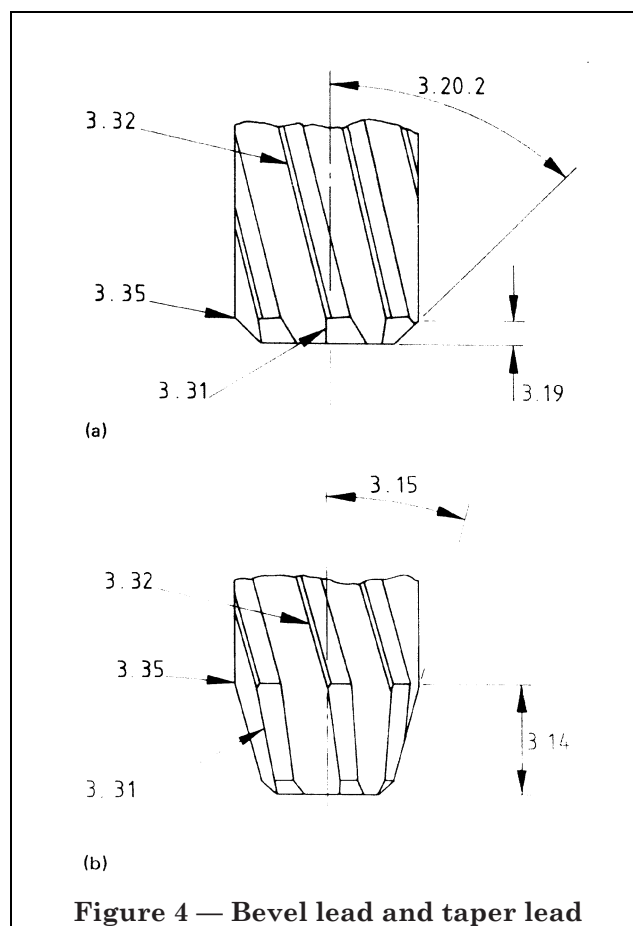
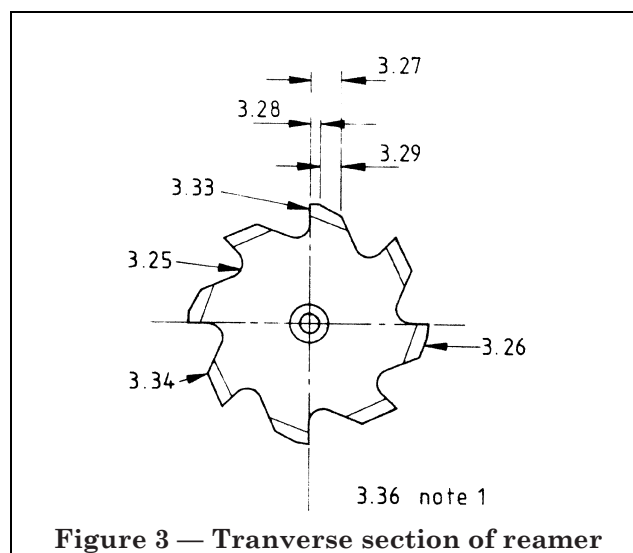
NOTE 1 See Figure 3.

NOTE 2 In the USA a circular land is termed a "margin".

3.29 clearance

that portion of the fluted land (3.26) removed to provide clearance behind the circular land (3.28)

NOTE See Figure 3.



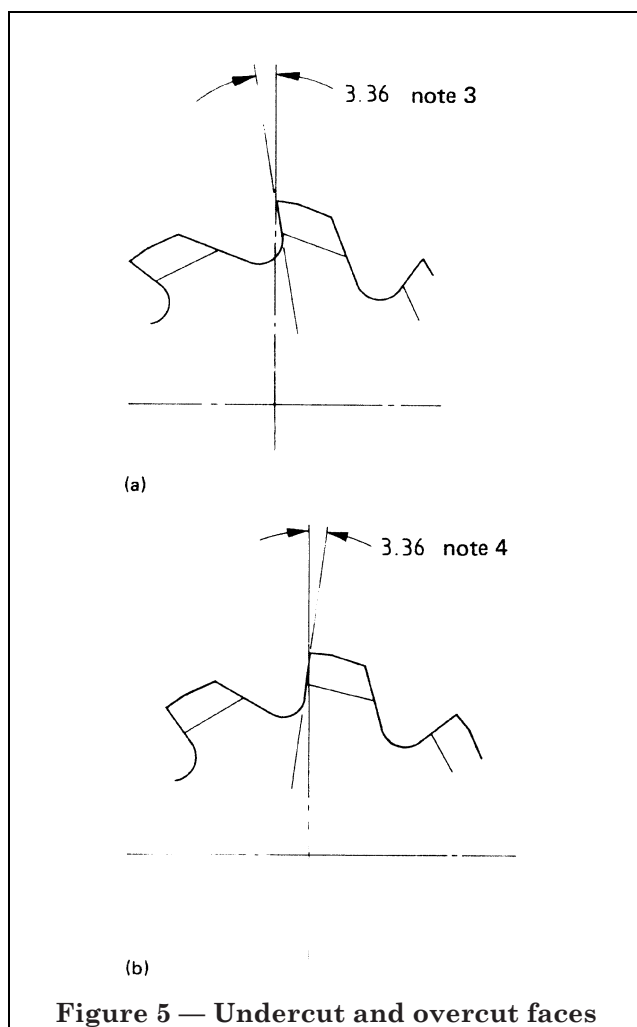


Figure 5 — Undercut and overcut faces

3.30**lead normal clearance α_n**

the angle formed by the lead flank and the plane tangential to the major cutting edge (3.31) containing the direction of primary motion at the selected point, measured in a plane perpendicular to the major cutting edge

NOTE See Figure 6.

3.31**major cutting edge**

the cutting edge formed by the intersection of a flute (3.25) and the taper lead (3.13) or of a flute and the bevel lead (3.18)

NOTE See Figure 4.

3.32**minor cutting edge**

the cutting edge formed by the intersection of a flute (3.25) and the circular land (3.28)

NOTE See Figure 4.

3.33**face**

the portion of the flute surface that is adjacent to the cutting edge and on which the chip impinges as it is cut from the workpiece

NOTE See Figure 3.

3.34**heel**

the edge formed by the intersection of the surface left by the provision of the clearance (3.29) and the flute (3.25)

NOTE See Figure 3.

3.35**corner**

the intersection of the major cutting edge (3.31) and the minor cutting edge (3.32)

NOTE See Figure 4.

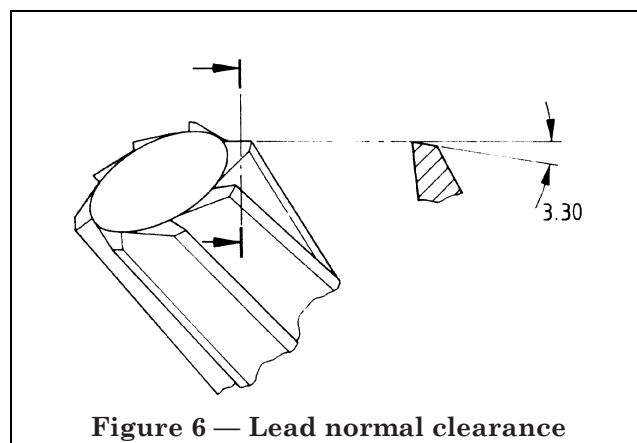


Figure 6 — Lead normal clearance

3.36**rake angle γ_p**

the angle between a face (3.33) and the plane passing through the reamer axis (3.1) and the corner (3.35), measured at the corner in a plane perpendicular to the reamer axis

NOTE 1 See Figure 5.

NOTE 2 If the face (3.33) and the plane coincide, the angle is 0° and the face is termed *radial* (see Figure 3).

NOTE 3 If the angle formed by the face (3.33) and the plane falls behind the plane in relation to the direction of primary motion, then the rake angle is positive, and the face is termed *undercut* [see Figure 5(a)].

NOTE 4 If the angle formed by the face (3.33) and the plane falls in front of the plane in relation to the direction of primary motion, then the rake angle is negative, and the face is termed *overcut* [see Figure 5(b)].

NOTE 5 The term in ISO 5420 is "back rake angle".

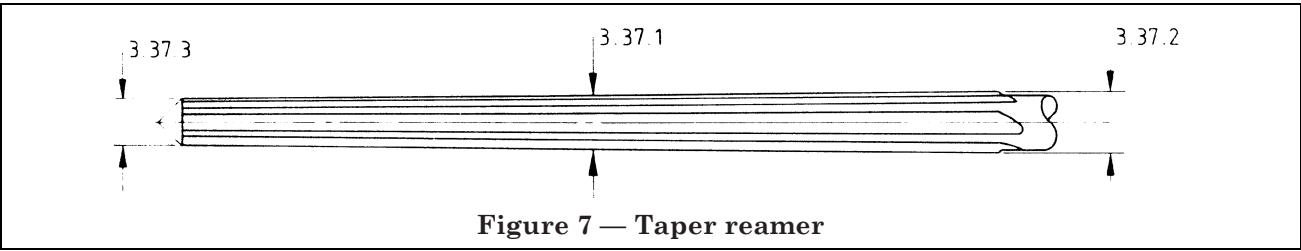


Figure 7 — Taper reamer

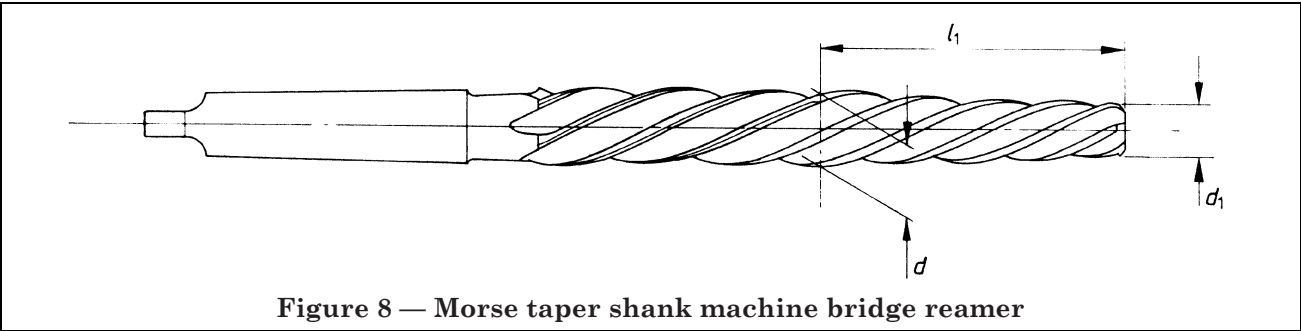


Figure 8 — Morse taper shank machine bridge reamer

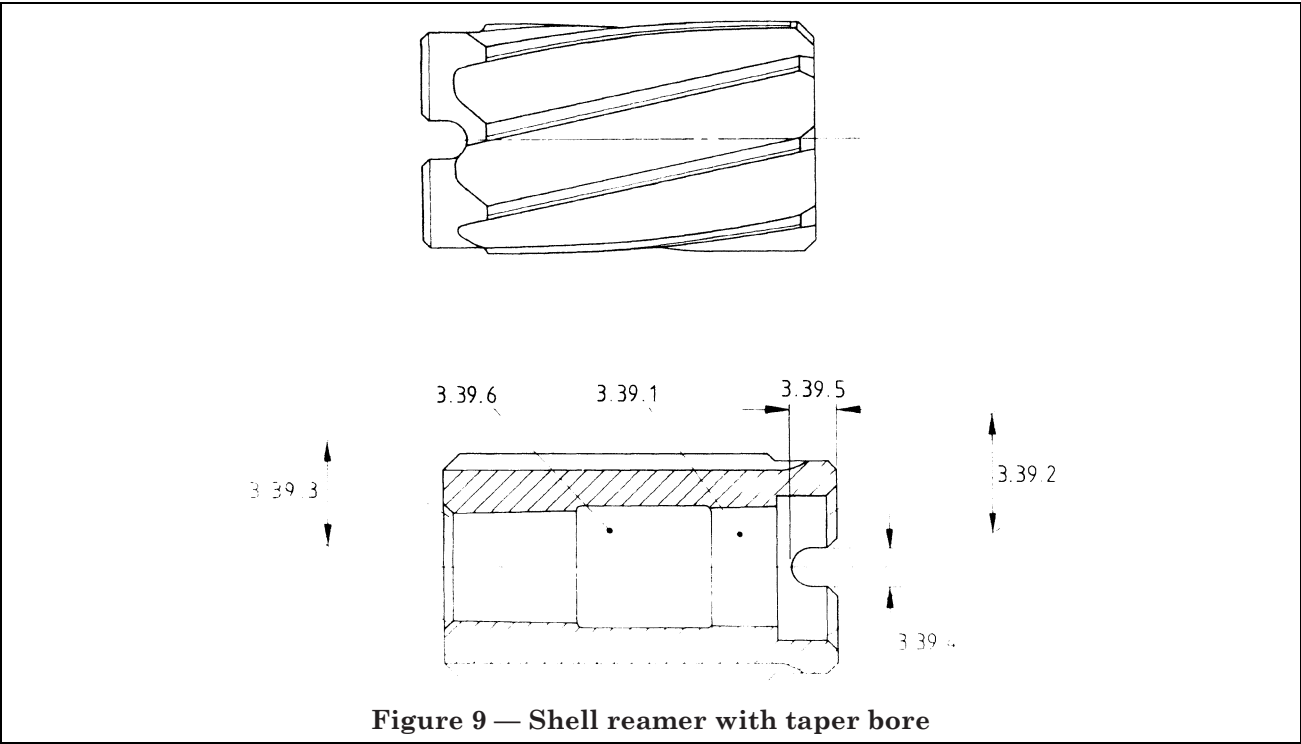


Figure 9 — Shell reamer with taper bore

3.37 Taper reamers

NOTE See Figure 7.

3.37.1 included angle of taper

the angle formed by the cutting edges of a taper reamer, usually expressed quantitatively in the form of a ratio, e.g. 1 : 50

3.37.2 large end diameter

the maximum diameter over the cutting edges of a taper reamer

3.37.3 small end diameter

the minimum diameter over the cutting edges of a taper reamer

3.38**machine bridge reamer**

a reamer for use in shipbuilding, structural work and plate work, having parallel cutting edges and either straight or helical flutes, integral with a Morse taper shank

NOTE See Figure 8 for the nominal diameter of the reamer (d), for the diameter of the small end of the taper (d_1) and the tapered cutting edge length (l_1).

3.39 Shell reamer with taper bore

NOTE See Figure 9.

3.39.1**taper bore**

the bore of a shell reamer which locates the reamer on its mounting arbor

3.39.2**large end diameter of the bore**

the maximum diameter of the taper bore (3.39.1) of a shell reamer, measured at the intersection of the taper with the rear face of the reamer

3.39.3**small end diameter of the bore**

the smallest diameter of the taper bore (3.39.1) of a shell reamer at the entering end of the reamer, measured at the intersection of the taper with the face of the reamer at its entering end

3.39.4**driving slot width**

the width of the slot in the rear end of the reamer

3.39.5**driving slot depth**

the overall depth of the slot measured from the rear end of the reamer to the root of the slot

3.39.6**recess**

a clearance diameter provided in the taper bore (3.39.1)

4 General dimensions**4.1 General**

4.1.1 The general dimensions of a reamer are those other than its cutting diameter.

4.1.2 A reamer other than a shell reamer shall have a parallel shank, a parallel shank with driving square or a Morse taper shank as specified in clauses 6 to 15.

4.1.3 Separate series of general dimensions are specified for each of the types of reamer listed in clause 1. With certain exceptions, the general dimensions for any one type of reamer are the same for reamers with preferred (metric) cutting diameters (see Table 2 to Table 13), for those with fractional (inch) cutting diameters (see Table 21 to Table 28), and for those with non-preferred cutting diameters (see Table 29 to Table 33).

The exceptions are socket reamers (which are only made in the sizes shown in Table 8 and Table 9), taper reamers (which are only made in the sizes shown in Table 10, Table 11, Table 12, Table 27 and Table 28) and machine bridge reamers [which are not made in fractional (inch) sizes]. Separate series of general dimensions are specified for shell reamers with metric cutting diameters and those with inch cutting diameters.

4.1.4 The general dimensions of reamers shall comply with the requirements specified in 4.2 to 4.5.

Except where a particular direction of cutting is specified in clauses 6 to 15, reamers complying with this standard may be right-hand cutting or left-hand cutting.

Reamers with preferred (metric) diameters (see Table 2 to Table 13), those with inch diameters (see Table 21 to Table 28) and those with non-preferred diameters (see Table 29 to Table 33) are all within the scope of this standard.

4.2 Parallel shanks

4.2.1 Diameter. The diameters of parallel shanks shall be as given in Table 2, Table 5, Table 8, Table 10 and Table 11 in clauses 6, 9, 11, 13 and 14. The tolerance on the diameter shall be as shown in those clauses.

NOTE For purposes of comparison these tolerances may be summarized as follows:

Hand reamers (see clause 6)	f8
Machine chucking reamers with parallel shanks (see clause 9)	h9
Parallel shank socket reamers (see clause 11)	h9
Hand taper pin reamers (see clause 13)	h11
Machine taper pin reamers (see clause 14)	h9

4.2.2 Square. The dimensions of driving squares shall comply with Table 2, Table 8 and Table 10 in clauses 6, 11 and 13. The tolerances on the width across flats of driving squares, including errors of form, shall be h12.

NOTE 1 These driving square dimensions are in accordance with ISO 237.

NOTE 2 For details of tolerances such as "h12", see BS 4500-1. For convenience, the appropriate values of this and similar tolerances are repeated in Appendix B to this Part of this British Standard.

4.3 Morse taper shanks. Morse taper shanks shall comply with BS 1660 (Table 3, Table 4, Table 7, Table 9, Table 12 and Table 13 in clauses 7, 8, 10, 12, 14 and 15).

4.4 Lengths

4.4.1 The overall length and cutting edge length of reamers shall be as given in Table 2 to Table 13 and in clauses 6 to 15. The tolerances on lengths for hand reamers, long flute machine reamers, machine chucking reamers and machine bridge reamers shall be as given in Table 1 (see also the note to 9.2).

Table 1 — Tolerances on lengths

Overall length <i>L</i> or cutting edge length <i>l</i>		Limits of tolerance
Over	Up to and including	
mm	mm	mm
6	30	± 1.0
30	120	± 1.5
120	315	± 2.0
315	1 000	± 3.0

4.4.2 In special cases the lengths of reamers and their shank dimensions may be chosen from the next larger or the next smaller length. The tolerances specified in this clause shall then apply to the selected dimension.

4.5 General dimensions of reamers with non-preferred diameters

4.5.1 When non-preferred diameters of hand reamers, long-flute machine reamers, machine chucking reamers or machine bridge reamers are specially required, they shall have cutting edge and overall lengths, and driving squares or Morse taper shanks where applicable, as specified in Table 29 to Table 33 (see Appendix D). Dimensions of shell reamers with non-preferred diameters shall be as given in Table 6 (millimetre series) and Table 25 (inch series).

4.5.2 When non-preferred diameters of other types of reamer are specially required, they shall, except as regards cutting diameters, have the same general dimensions as the next larger preferred size.

5 Cutting dimensions

5.1 Preferred diameters. The preferred diameters of reamers shall be as shown in Table 2 to Table 6 and Table 8 to Table 13. The preferred diameters of reamers with cutting diameters specified in inches shall be as shown in Table 21 to Table 25, Table 27 and Table 28 (see Appendix C).

5.2 Tolerances on cutting diameter. The limits of tolerance on the cutting diameter (measured immediately behind the bevel or taper lead) shall be as specified in 6.5, 7.5, 8.5, 9.5, 10.5, 11.5, 12.5, 13.5, 14.5 and 15.5.

NOTE 1 For purposes of comparison, these tolerances may be summarised as follows:

Hand reamers (see clause 6);	} m6
Long-flute machine reamers (see clause 7);	
Machine chucking reamers with taper shanks (see clause 8);	
Machine chucking reamers with parallel shank (see clause 9);	
Shell reamers with taper bore (see clause 10);	} k11
Machine bridge reamers with Morse taper shank (see clause 15).	

NOTE 2 In the case of hand reamers, long-flute machine reamers, machine chucking reamers and shell reamers it is not practicable to standardize reamer limits to suit each of the grades of hole provided for in BS 4500-1, and the limits adopted for their cutting diameters have been chosen as likely to meet the most general demand of users working to BS 4500-1. They are intended to produce H8 holes and, by selection, will also be suitable for H7 holes²⁾.

NOTE 3 To facilitate the manufacture of special reamers it is recommended that a standard method should be used to determine the limits of tolerance on their cutting diameters. Details of this method are given in Appendix A.

6 Hand reamers

6.1 Definition. A reamer having virtually parallel cutting edges, with taper and bevel lead, integral with a parallel shank of the nominal diameter of the cutting edges, and with a driving square on the end of the shank (see Figure 10).

6.2 General dimensions and shank (see Table 2). The diameter of the parallel shank shall be equal to the nominal diameter of the reamer, with a tolerance of f8. The tolerance on the across flats dimension of the driving square shall be h12 (for values of these tolerances see Appendix B). For tolerances on lengths see 4.4. When non-preferred diameters are specially required, see Table 29 for the appropriate dimensions.

6.3 Flutes. Both right-hand and left-hand cutting reamers are in conformity with this standard, but unless otherwise ordered, a reamer shall be supplied for right-hand cutting with left-hand helical flutes. To facilitate accurate measurement of the diameter, cutting edges shall be diametrically opposite each other.

6.4 Preferred diameters. Preferred diameters shall be as given in Table 2.

6.5 Tolerance on cutting diameter. The tolerance on the cutting diameter shall be m6.

²⁾ For an explanation of the ISO system of limits and fits, including the tolerances H8 and H7, see BS 4500.

NOTE For values of this tolerance see Appendix B.

6.6 Bevel lead. The angle shall be 45° .

6.7 Taper lead. The taper lead angle shall be approximately 1° , and the length of the taper shall be $1\frac{1}{2}$ times the diameter of the reamer or 20 mm, whichever is the smaller.

NOTE Back taper on the cutting diameter is recommended; the amount of back taper should not exceed the amount of tolerance for the diameter concerned.

6.8 Long taper lead reamers. When required, long taper lead reamers, similar in all respects to parallel head reamers except that the cutting edges are tapered, shall have four-fifths of the flute length tapered and one-fifth parallel, sizes under 16 mm diameter having a taper of approximately 1 in 96, and sizes 16 mm diameter and above having a taper of approximately 1 in 64 (see Figure 11).

Table 2 — Hand reamers. Preferred diameters and related dimensions

Cutting diameter <i>d</i>	Cutting edge length <i>l</i>	Overall length <i>L</i>	Driving square		Cutting diameter <i>d</i>	Cutting edge length <i>l</i>	Overall length <i>L</i>	Driving square	
			<i>a</i> (h12)	<i>l</i> ₄				<i>a</i> (h12)	<i>l</i> ₄
1.5	20	41	1.12	4	22	107	215	18.00	22
1.6	21	44	1.25		23				
1.8	23	47	1.40		24				
2.0	25	50	1.60		25	115	231	20.00	24
2.2	27	54	1.80		26				
2.5	29	58	2.00		27	124	247	22.40	26
2.8	31	62	2.24	5	28				
3.0					30				
3.5	35	71	2.80	6	32	133	265	25.00	28
4.0	38	76	3.15		34	142	284	28.00	31
4.5	41	81	3.55		35				
5.0	44	87	4.00	36	152				
5.5	47	93	4.50	7		38			
6.0						40			
7.0	54	107	5.60	8		42	163	326	35.50
8.0	58	115	6.30	9	44				
9.0	62	124	7.10	10	45				
10.0	66	133	8.00	11	46	174	347	40.00	42
11.0	71	142	9.00	12	48				
12.0	76	152	10.00	13	50				
13.0					52	184	367	45.00	46
14.0	81	163	11.20	14	55				
15.0					56				
16.0	87	175	12.50	16	58				
17.0					60				
18.0	93	188	14.00	18	62	203	406	56.00	56
19.0					63				
20.0	100	201	16.00	20	67				
21.0					71				

NOTE 1 The diameters in bold type should be used whenever possible.

NOTE 2 Table 2 is based on a table from ISO 236-I, except that that International Standard uses the symbol l for L , and l_1 for l_4 .