

CONFIRMED
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Specification for

Keys and keyways

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Contents

	Page
Co-operating organizations	Inside front cover
Foreword	ii
1 Scope	1
2 Materials	1
3 The application of keys and keyways	1
a) Parallel keys	1
b) Taper keys	1
c) Tangential keys	2
d) Woodruff keys	2
4 Dimensions and tolerances of parallel and taper keys and keyways	2
5 Dimensions and tolerances of Woodruff keys and keyways	3
6 Dimensions of tangential keys and keyways	16
7 Dimensions of keys and keyways for marine tailshafts	17
8 Keys and keyways for tapered shaft ends	19
Appendix A Preferred lengths of keys	20
Appendix B Approximate equivalents of metric and inch units	22
Figure 1 — Variation in keyway depth in taper shaft	19
Figure 2 — Types of key and position of keyway in shaft	18
Table 1 — Rectangular parallel keys, keyways and keybars	4
Table 2 — Square parallel keys, keyways and keybars	6
Table 3 — Rectangular taper keys and keyways, gib-head or plain	9
Table 4 — Square taper keys and keyways, gib-head or plain	10
Table 5 — Woodruff keys and keyways	12
Table 6 — Comparison of Woodruff key numbers (Whitney, British and American)	14
Table 7 — Tangential keys	16
Table 8 — Rectangular parallel keys for marine tailshafts	17
Table 9 — Preferred lengths of plain keys, rectangular or square section, parallel or taper	20
Table 10 — Preferred lengths of gib-head keys rectangular or square section	21

Foreword

This standard makes reference to the following British Standards:

BS 308, *Engineering drawing practice*.

BS 350, *Conversion factors and tables*.

BS 970, *Wrought steels*.

BS 1916, *Limits and fits for engineering*.

The standardization of keys and keyways was first considered by the Engineering Standards Committee (the original name and form of the present BSI). As a result Standard Specification No. 46, dealing only with rectangular parallel keys, keybars and keyways, was published in 1909.

In subsequent revisions, other types of keys were added to the standard and Parts 2 and 3 of BS 46 were prepared for parallel splines and taper pins respectively. Parts 2 and 3 have since been further revised and Part 2 has been published as BS 2059.

This revision of BS 46-1 for Keys and keyways has been prepared under the authority of The Mechanical Engineering Industry Standards Committee in response to requests for larger manufacturing tolerances. The various types of keys and keyways now have consistent dimensions and tolerances for each size as far as possible, and this will enable a standard range of cutters to be used for the machining of the various types of keyways. The increased tolerances recommended in this standard may entail more fitting of keys into keyways than was envisaged in the 1953 edition. This is inevitable with an increase in tolerance on the keys and keyways. Careful consideration has been given to various requests for increases in tolerances and also for decreases in tolerances but the Committee have come to the conclusion that the tolerances now given are those most acceptable to industry at the present time.

The Committee responsible for this revision of BS 46-1, gave earnest consideration to the specification of limits and fits to BS 1916 for the keys and keyways specified. It was decided not to introduce these limits and fits as the key and keyway standard does not represent finished articles for prescribed conditions of assembly. It recommends dimensions and tolerances from which required fits can be obtained by fitting to meet most design requirements. The Committee was influenced in reaching this decision by the absence of a standard range of cutters for machining to BS 1916 and the non-availability of keybar to these limits at the time the revision of this standard was being prepared. This decision will be reviewed in the light of circumstances existing when further revision is contemplated.

The principle of the dimensions and tolerances recommended is to provide for each key to be retained in the shaft rather more securely than in the mating hub but this can be varied to meet special applications within the dimensional limits recommended in this standard.

The tables of preferred key lengths given in Appendix A have been revised to conform with present-day requirements and the key sizes have been brought into accord with Table 1, Table 2, Table 3 and Table 4.

Whilst the details of radii and chamfers are not a mandatory part of this specification the recommendations shown are in graduated steps of nominal value instead of by formulae, as with the formulae of former issues a special cutter radius was required for each size of keyway. Each radius recommended now applies to a range of keyway sizes.

Owing to the difficulties of obtaining keybar in thirty-seconds of inch, keys formerly of these sizes have been replaced by those which are more readily available. Minor changes in the range of shaft sizes have been made to accommodate this.

The revised table for keys and keyways for marine tailshafts has been compiled by the British Shipbuilding Research Association from a survey of the current practice of British shipbuilding and marine engineering firms and from theoretical and experimental studies.

The table of Woodruff keys and keyways has been extended into the range of smaller sizes to meet requirements for instrument and similar purposes. To facilitate the changeover to the recommended Woodruff key designation as shown in Table 5, the obsolete key and cutter numbers have been given in Table 6.

The notes relating to keys and keyways for tapered shaft ends have been retained unaltered.

A requirement has been stated for tangential keys and the Type A tangential key of the 1929 issue of BS 46 has been reinserted in this revision.

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.

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Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 24, 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 British Standard relates to the following:

- a) Rectangular parallel keys and keyways.
- b) Square parallel keys and keyways.
- c) Rectangular taper keys and keyways, plain and gib-head.
- d) Square taper keys and keyways, plain and gib-head.
- e) Woodruff keys and keyways.
- f) Tangential keys and keyways.
- g) Keys and keyways for marine tailshafts.
- h) Keys and keyways for tapered shaft ends.

Decimal values in the tables have been rounded off to three significant figures.

NOTE This specification is based on British units. For the convenience of users approximate equivalents in metric units are given in Appendix B. More accurate conversions should be obtained from the tables in BS 350 "Conversion factors and tables".

2 Materials

- a) Keys and keybar complying with Table 1 to Table 7 of this British Standard shall be manufactured from steel to En 6A, En 8 or En 9 of BS 970, "Wrought Steels," and those complying with Table 8 from steel to En 4 or En 5. It is recommended that En 6A and En 8 steels should be cold drawn for keys in sections up to 2 in. square and hot rolled [En 8 in condition NGC 1 (Normalized)] for larger sections, and that En 9 steels should not be cold drawn for keys of sections larger than $\frac{3}{4}$ in. square.
- b) Bright keybar is not normally available in sections over 1½ in.

3 The application of keys and keyways

As it is not possible to foresee the combination of design considerations for any given application, the selection of the proper type of key must rest with the design authority. The following are general recommendations for use when circumstances permit and when keying is preferred to other methods of transmitting torque (e.g. splines).

- a) *Parallel keys.* For use for transmitting unidirectional torques on transmissions not subject to heavy starting loads and where periodic withdrawal or sliding of the hub member may be required. In many instances, particularly couplings, a gib-head cannot be accommodated, and there is insufficient room to drift out the key from behind. In these cases it is necessary to withdraw the component over the key and a parallel key is essential. Parallel square and rectangular keys are normally side fitting with top clearance and are usually retained in the shaft rather more securely than in the hub.
 - i) *Rectangular.* The general purpose key for shafts greater than 1 in. diameter.
 - ii) *Square.* For use with shafts up to and including 1 in. diameter or for shafts up to 6 in. diameter where it is desirable to have a greater key depth than is provided by rectangular keys.

In cases of stepped shafts the larger diameters are usually required by considerations other than torque e.g. resistance to bending. Where components such as fans, gears, impellers etc., are attached to the larger shaft diameter, the use of a key smaller than standard for that diameter may be permissible. As this results in unequal disposition of the key in the shaft and its related hub the dimensions H and h must be recalculated to maintain the T/2 relationship.

- b) *Taper keys.* For transmitting heavy unidirectional, reversing or vibrating torques and in applications where periodic withdrawal of the key may be a necessity.

For transmitting unidirectional torques taper keys are top fitting, but may be top and side fitting where required.

For transmitting reversing or vibratory torques taper keys may be top and side fitting where required. In this case the keyway in the hub should have the same width value as the keyway in the shaft (i.e., Columns 8 and 9 of Table 3 and Table 4).

Taper keys cannot be used in applications requiring a sliding hub member.

i) *Rectangular and square*. Taper keys of rectangular section are for general purposes and are of less depth than square keys.

Taper keys of square section are for use with shafts up to and including 1 in. diameter or for shafts up to 6 in. diameter where it is desirable to have greater key depth.

ii) *Gib-head*. Gib-heads are provided to facilitate the withdrawal of keys.

iii) *Plain*. Where little or no protuberance is permissible.

c) *Tangential keys*. For the transmission of reversing torque, usually under conditions of heavy loading.

d) *Woodruff keys*. For light applications, or angular location of associated parts on tapered shaft ends.

These keys are not recommended for other applications, but if so used corner radii in the shaft and hub keyways are advisable to reduce stress concentration.

4 Dimensions and tolerances of parallel and taper keys and keyways

The dimensions and tolerances for key and keyway widths given in Table 1, Table 2, Table 3 and Table 4 are based on the width of the key W and provide a fitting allowance. The fitting allowance is designed to permit an interference between the key and the shaft keyway and a slightly easier condition between the key and the hub keyway.

The maximum and minimum values in Table 1, Table 2, Table 3 and Table 4 are based on the following:

Width of key and keybar, W = Nominal size with a plus tolerance.

Width of keyway in shaft, W_s = Nominal size with a minus tolerance.

Width of keyway in hub, W_h = Nominal size with a plus tolerance.

Minimum width of key = Maximum width of keyway in shaft.

a) *Parallel keys and keyways*.

i) The dimensions and tolerances for side-fitting keys of rectangular parallel section, and for the appropriate keybar and keyways shall be as given in Table 1.

ii) The dimensions and tolerances for side-fitting keys of square parallel section and for the appropriate keybar and keyways shall be as given in Table 2.

b) *Taper keys and keyways*.

i) The dimensions and tolerances for taper keys of rectangular section with or without gib-heads shall be as given in Table 3. [See also Clause 3 b)].

ii) The dimensions and tolerances for taper keys of square section with or without gib-heads shall be as given in Table 4. (See also Clause 3 b)].

iii) The basic taper for all taper keys and keyways in hubs shall be 1 in 100.

c) *Depth of keyways*. The depth of the keyway shall be obtained by measuring from the circumference of the shaft diametrically opposite, or from the bore of the hub to the root of the keyway along the centre line diametrically opposite and shall not be measured from the side corner. The method of dimensioning keyways in shafts and hubs on drawings should conform to the recommendations of BS 308, "Engineering drawing practice." To obtain the dimensions for recording on the drawing, the keyway depths and tolerances shall be applied to the basic shaft diameter.

d) *Radii and chamfers*. Corner radii are recommended for keyways, as stress concentration in corners may lead to failure. Keys and keybar are not normally chamfered or radiused in the condition as supplied, but this may be done at the time of fitting, or, by arrangement between the purchaser and the manufacturer, during manufacture.

Radii and chamfers are shown as nominal values in columns of Table 1, Table 2, Table 3 and Table 4. The chamfer on the key should in each case be of the minimum value to clear the actual radius in the keyway.

NOTE In the case of shrink and heavy force fits it may be found necessary to depart from the width and depth tolerances laid down for keys and keyways.

Any variation in the width of keyway must be such that the greatest width is at the end from which the key enters.

Any variation in the depth of keyway must be such that the greatest depth is at the end from which the key enters.

Any variation in the thickness of the key must be such that the greatest thickness is at the end from which the key is driven.

This specification does not take account of misalignment and or offset greater than that provided for in the size tolerance. In the case of shrink and heavy force fits, true alignment must be ensured.

5 Dimensions and tolerances of woodruff keys and keyways

The dimensions and limits of tolerances for British Standard Woodruff keys and keyways shall be as shown in Table 5. Provision is made in Table 5 for an optional alternative design of Woodruff key which differs from the normal form in its depth as shown at H in the sketch and Table.

a) *The designation of Woodruff key numbers.* The following system is applied to Woodruff keys and Woodruff key cutters. The British and American designations are identical. Each key is designated by three or more significant digits. The last two digits give the nominal diameter in eighths of an inch. The digit or digits preceding the last two give the nominal width (thickness) in thirty-seconds of an inch.

Thus No. 204 refers to a key $\frac{2}{32} \times \frac{4}{8}$ in., or $\frac{1}{16}$ in. thick $\times \frac{1}{2}$ in. diameter, similarly, 1210 refers to a key $\frac{12}{32} \times \frac{10}{8}$ in., or $\frac{3}{8}$ in. thick $\times 1\frac{1}{4}$ in. diameter.

b) *Depth of keyway.* The depth of a Woodruff keyway shall be measured along the centre line from the periphery of the shaft, or the circumference of the hub bore, to the root of the keyway. The depth of the keyway in a tapered shaft shall be measured normal to the shaft surface. (This is illustrated in BS 308, "Engineering drawing practice").

Note on keys for larger shafts

The sizes of shafts shown in Table 1, Table 2, Table 3 and Table 4 of this standard are those for which the respective types of keys are considered to be normally appropriate. For larger shafts, it is considered that tangential keys, multiple keys or splines would be more appropriate.

However, if it is decided to use single parallel keys on shafts larger than those considered normal for such keys in this standard, the following formulae may be applied to establish (nominal) values related to the shaft diameter "d". (For the purposes of the tables, "d" is the diameter of the largest shaft for each key size i.e. "d" corresponds to column 2 of the tables. For intermediate shaft diameters or shaft diameters larger than those of the tables, H should, of course, be calculated from (iii), using for "d" the nominal shaft diameter.)

i) Key width $W = \frac{d}{4}$

ii) Key thickness $T = \frac{d}{6}$ for Table 1 and Table 3
or $= \frac{d}{4}$ for Table 2 and Table 4

(In Table 1 and Table 3, T has in some sizes been rounded off to maintain the inch fractional sizes.)

iii) Keyway depth in shaft $H = \frac{T}{2} + \frac{d}{2} - \sqrt{\frac{d^2}{4} - \frac{W^2}{4}}$

iv) For parallel keys, keyway depth in hub $h = (T - H) + X$

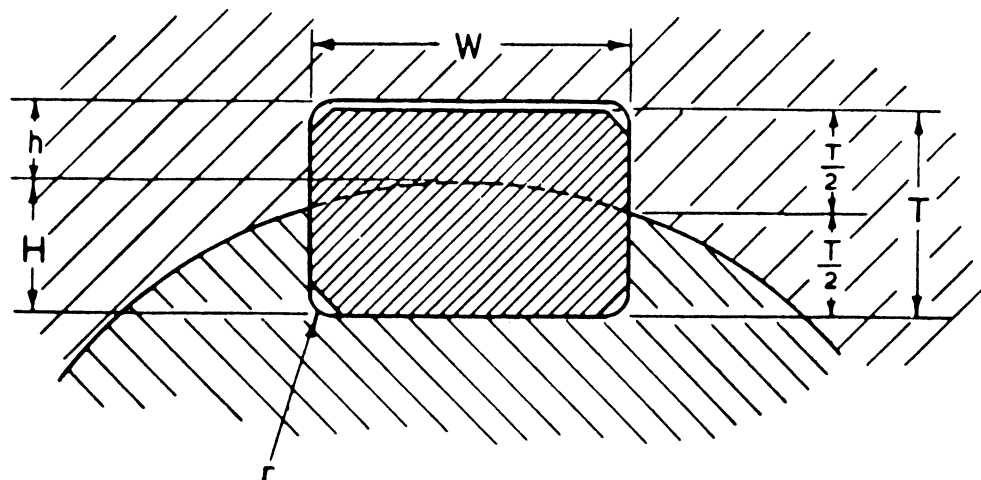
where X is a clearance such that

$$X \text{ min.} = H \text{ min.} + h \text{ min.} - T \text{ max.}$$

$$X \text{ max.} = H \text{ max.} + h \text{ max.} - T \text{ min.}$$

The incremental pattern by which the tolerances (and clearance X) increase with shaft size may be seen from an inspection of the tables, but it should be noted that a point will be reached at which any further increase in tolerance (with increase in shaft size) would be neither necessary in manufacture nor acceptable in use.

Table 1 — Rectangular parallel keys, keyways and keybars



All dimensions are in inches.

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Diameter of shaft		Key size W × T	Key				Keyway in shaft				Keyway in hub				Nominal Keyway radius & key chamfer r ^a	Keybar			
Over	Up to and including		Width W		Thickness T		Width W _s		Depth H		Width W _h		Depth h			Width W		Thickness T	
			Max.	Min.	Max.	Min.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.		Max.	Min.	Max.	Min.
1	1 ¹ / ₄	5 ⁵ / ₁₆ × 1 ¹ / ₄	0.314	0.312	0.253	0.250	0.311	0.312	0.146	0.152	0.312	0.313	0.112	0.118	0.010	0.314	0.312	0.253	0.250
1 ¹ / ₄	1 ¹ / ₂	3 ³ / ₈ × 1 ¹ / ₄	0.377	0.375	0.253	0.250	0.374	0.375	0.150	0.156	0.375	0.376	0.108	0.114	0.010	0.377	0.375	0.253	0.250
1 ¹ / ₂	1 ³ / ₄	7 ⁷ / ₁₆ × 5 ⁵ / ₁₆	0.440	0.438	0.315	0.312	0.437	0.438	0.186	0.192	0.438	0.439	0.135	0.141	0.020	0.440	0.438	0.315	0.312
1 ³ / ₄	2	1 ¹ / ₂ × 5 ⁵ / ₁₆	0.502	0.500	0.315	0.312	0.499	0.500	0.190	0.196	0.500	0.501	0.131	0.137	0.020	0.502	0.500	0.315	0.312
2	2 ¹ / ₂	5 ⁵ / ₈ × 7 ⁷ / ₁₆	0.627	0.625	0.441	0.438	0.624	0.625	0.260	0.266	0.625	0.626	0.185	0.191	0.020	0.627	0.625	0.441	0.438
2 ¹ / ₂	3	3 ³ / ₄ × 1 ¹ / ₂	0.752	0.750	0.503	0.500	0.749	0.750	0.299	0.305	0.750	0.751	0.209	0.215	0.020	0.752	0.750	0.503	0.500
3	3 ¹ / ₂	7 ⁷ / ₈ × 5 ⁵ / ₈	0.877	0.875	0.629	0.625	0.874	0.875	0.370	0.376	0.875	0.876	0.264	0.270	0.062	0.877	0.875	0.629	0.625
3 ¹ / ₂	4	1 × 3 ³ / ₄	1.003	1.000	0.754	0.750	0.999	1.000	0.441	0.447	1.000	1.001	0.318	0.324	0.062	1.003	1.000	0.754	0.750
4	5	1 ¹ / ₄ × 7 ⁷ / ₈	1.253	1.250	0.879	0.875	1.248	1.250	0.518	0.524	1.250	1.252	0.366	0.372	0.062	1.253	1.250	0.879	0.875