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Specification for

Unified precision hexagon bolts, screws, & nuts (UNC & UNF Threads) Normal series

UDC 621.882.2.082.3

Co-operating organizations

The Mechanical Engineering Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government departments and scientific and industrial organizations:

Admiralty*
Air Ministry
Associated Offices' Technical Committee
Association of Consulting Engineers (Incorporated)
Association of Mining Electrical and Mechanical Engineers
British Chemical Plant Manufacturers' Association
British Compressed Air Society
British Electrical and Allied Manufacturers' Association*
British Gear Manufacturers' Association
British Internal Combustion Engine Manufacturers' Association*
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National Coal Board
National Physical Laboratory (D.S.I.R.)*
Radio Industry Council
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The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following were directly represented on the Committee entrusted with the preparation of this standard:

Agricultural Engineers' Association
Association of Hydraulic Equipment Manufacturers
Bright Bolt & Nut Manufacturers Association
Bright Steel Bar Association
British Constructional Steelwork Association
British Cycle & Motor Cycle Industries Association Limited
Council of British Manufacturers of Petroleum Equipment
Electronic Engineering Association
Heat Treated Bolt Association
Institute of Iron & Steel Wire Manufacturers
Ministry of Aviation
Oil Companies Materials Association
Post Office
Rolled Thread Screw Association
Screw Manufacturers Association
Society of Motor Manufacturers & Traders Ltd.
Washer Manufacturers' Association
Individual manufacturers

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Foreword

This standard makes reference to the following British Standards:

BS 18, *Methods for tensile testing of metals.*

BS 131, *Methods for notched bar tests — Part 1: The Izod impact test on metals.*

BS 240, *Methods of Brinell hardness test — Part 1: Testing of metals.*

BS 860, *Table of approximate comparison of hardness scales.*

BS 919, *Screw gauge limits and tolerances — Part 1: Gauges for screw threads of Unified form.*

BS 969, *Plain limit gauges: Limits and tolerances.*

BS 970, *Specification for wrought steels for mechanical and allied engineering purposes — Part 1: General inspection and testing procedures and specific requirement for carbon, carbon manganese, alloy and stainless steels.*

BS 1574, *Split cotter pins.*

BS 1580, *Unified screw threads — Parts 1 and 2: Diameters $^1/_4$ in and larger.*

BS 3111, *Specification for steel wire for cold forged fasteners and similar components — Part 1: Carbon and low alloy steel.*

When BS 1768 was first issued in 1951, its publication marked an important stage in the development of the Unified screw thread system established in accordance with the agreement reached by the United Kingdom with the United States and Canada at the Ottawa Conference of 1945 and ratified by the Declaration of Accord signed by representatives of those three countries in November, 1948.

It was recognized at that time that effective adoption of the system depended very largely on the provision of commonly used types and sizes of fasteners, the general features of which would be unified as well as the threads. As a first step, two standards for hexagon bolts, screws and nuts were published: BS 1768 for the Unified precision normal series, and BS 1769 for the Unified black heavy series.

BS 1768 was restricted at that time to sizes up to and including 1 inch but the many requests received for an extension of the standard have long indicated that this range was inadequate for the needs of industry and this edition accordingly provides for sizes up to and including 2 inches.

It should be mentioned that this extension of the Unified range is also in accordance with agreement reached with the U.S.A. and Canada at a further ABC Conference held in Ottawa in June, 1960, and that an ISO Recommendation now in course of preparation for hexagon bolts, screws and nuts will include the range of Unified normal hexagons for nominal sizes up to $1^1/_2$ inches.

In revising the standard, the opportunity has been taken to deal more fully with material and manufacture. In addition to specifying materials for cold forged bolts, screws and nuts and offering guidance in the selection of materials for those produced by other methods, the standard now includes full details of the tests to be employed for determining the mechanical properties of the fasteners. Reference is also made to the control of decarburization and rolling laps.

Special attention is drawn to an important feature of this revision, namely the replacement of Grade R bolts which had a tensile range of 45 to 55 tonf/in^2 with Grade S bolts having a minimum tensile strength of 50 tonf/in^2 which is more nearly in line with both American and continental practice.

It is recognized that a transition period will necessarily ensue during which stocks of both grades will be held by manufacturers and either may be offered when bolts in this tensile range are ordered.

Washers have been excluded from this standard as they are now covered by BS 3410, *"Metal washers for general engineering purposes."*

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 34, 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 covers the Normal series of Unified precision hexagon bolts, screws and nuts having Unified screw threads in a range of nominal sizes from $^1/_4$ in to 2 in inclusive. The dimensional requirements of this standard apply both to ferrous and non-ferrous bolts, screws and nuts. Mechanical properties are given only in respect of steel bolts, screws and nuts, and the finishes in which they are normally supplied are described in Clause **3**.

NOTE It is considered that the range of nominal sizes included in this standard is adequate for most of the applications for which this series is likely to be employed, but for the convenience of users requiring larger sizes, the formulae from which the proportions for bolt heads and nuts are derived are given in Appendix F.

2 Material and manufacture

a. *General.* In order to provide for the different methods of manufacture by which bolts, screws and nuts to this standard may be produced, a choice of materials is given.

Bolts, screws and nuts in sizes up to and including $^3/_4$ in nominal size are most commonly produced by cold forging from wire; larger sizes are generally produced by hot forging. Bolts, screws and nuts can also be produced by machining from hexagon bars.

Bolts and screws produced by cold forging shall, except in the case of bolts and screws bright finished to Grade A (see Table 4, Appendix A) be heat-treated after forging.

Bolts, screws and nuts produced by hot forging or by turning from bars, and cold formed nuts shall be heat-treated when this is necessary to give the requisite mechanical properties specified in Clauses **4** and **6** and Appendix A.

b. *Cold forged bolts and screws.* The choice of material used to manufacture bolts and screws by cold forging shall normally be at the discretion of the manufacturer. The finished products shall comply with the requirements for physical properties as set out in Clause **4** and in Table 4 of Appendix A.

If, however, the purchaser wishes to specify the composition of the material to be used, this shall be the subject of agreement with the manufacturer.

c. *Cold forged nuts and hot forged bolts, screws and nuts.* The material to be used for cold forged nuts or hot forged bolts, screws and nuts depends to a large extent on the size of the product. Unless otherwise stipulated by the purchaser, the choice of material shall therefore be left to the manufacturer provided that the finished products satisfy the requirements for mechanical properties set out in Clauses **4** and **6** and in Table 4 and Table 6 of Appendix A, but recommendations on suitable materials are given for guidance in Table 8 and Table 10 of Appendix B.

d. *Bolts, screws and nuts machined from bars.* Table 9 and Table 10 of Appendix B give a selection of steels from BS 970 which are among those suitable for particular grades of bolts, screws and nuts. Unless otherwise stipulated by the purchaser, the choice of material shall be left to the manufacturer provided that the finished products satisfy the requirements for mechanical properties set out in Clauses **4** and **6** and in Table 4 and Table 6 of Appendix A.

e. *Decarburization.* As normally manufactured from wire of ordinary quality, a proportion of threads produced on forged bolts and screws by rolling may have some surface decarburization (principally at crests of threads). For highly stressed bolt applications, the definition and degree of such decarburization shall be negotiated between manufacturer and user. For bolts of strength Grade T and greater, the depth of decarburization, measured from the crest, shall not exceed 33 per cent of the height of the threads. Complete freedom from any decarburization is achieved by shank grinding after heat treatment and before thread rolling; if this is required, it shall be the subject of negotiation between manufacturer and user.

f. *Rolling laps.* When threads are produced by rolling, small laps are commonly present at the crests and are generally of a magnitude which is not detrimental to the performance of the bolt.

A lap formed at the crest of the thread perpendicular to the axis of the bolt shall not be considered a cause for rejection if the depth of the lap does not exceed 33 per cent of the depth of the thread.

Bolts of Grades T, V and X shall be free from laps in the thread flank below the effective diameter. Laps in the flanks above the effective diameter shall not have a depth greater than 33 per cent of the thread depth.

3 Finish

a. *General.* The bolts, screws and nuts shall be cleanly finished, sound and free from defects.

b. *Types of finish.* Steel precision bolts, screws and nuts are normally supplied with the following finishes:

i) *Heat treated bolts and screws.* The surfaces of these bolts and screws are customarily dull black from heat treatment, although the manufacturer may machine some of the surfaces of the larger size bolts and screws after heat treatment.

ii) *Bright finished bolts and screws.* This term is used to describe bolts and screws which are machined on all surfaces or which have a finish on the hexagons produced by bright drawing and regarded as a machined finish.

iii) *Nuts.* These may be bright on all surfaces or dull black where heat treated.

iv) *Special finishes.* If steel bolts, screws or nuts are required bright all over, the purchaser should state this in his enquiry and order.

If the purchaser requires bolts, screws or nuts of steel or other material to be coated, he should state the type of coating required in his enquiry and order.

4 Mechanical properties of steel bolts and screws

Steel bolts and screws shall meet the requirements for mechanical properties specified in Table 4 of Appendix A.

NOTE For guidance concerning the comparison of strength grades of BS 1768 and BS 970-1:1983 see Table 4A.

a. *Tensile strength and proof stress.* The tensile strength and the proof stress shall be determined by the methods of test described in Clause **5**.

b. *Minimum elongation.* Test specimens for the measurement of elongation shall be machined from the shank of the bolt to the dimensions for standard round test specimens as given in BS 18 *"Tensile testing of metals"* and shall be concentric with the axis of the bolt. They shall be tested in accordance with the standard procedure as given in BS 18.

NOTE The minimum elongation values in Table 4 are based on a gauge length of $4\sqrt{\text{Area}}$; BS 18 now specifies a gauge length of $5.65\sqrt{\text{Area}}$, but values appropriate to this length are not yet available for the higher grades of steel. The former gauge length and its associated values have therefore been retained in this standard for the time being and a suitable amendment will be issued when the necessary information can be supplied.

c. *Minimum Izod impact value.* Test specimens for Izod impact test shall be machined from the bolt to the dimensions specified for standard test pieces in BS 131-1, "*The Izod impact test on metals*" and shall be tested in accordance with the standard procedure as given in BS 131-1.

Where an Izod test is not practicable, a nicked fracture test may be substituted.

d. *Hardness.*

i) *General.* A hardness test on bolts and screws is not part of the requirements of this standard, but Brinell hardness values are given for guidance in Table 4 of Appendix A.

ii) *Method of test.* The Brinell hardness test is carried out in accordance with the method specified in BS 240 *"Method of Brinell hardness test"* Part 1 and is made on the top of the head or on the point of the bolt or screw.

5 Tensile strength and proof stress of bolts and screws

a. *Tensile strength.* The tensile test on a bolt or screw shall be carried out as follows:

An ordinary nut or its equivalent in the form of an adaptor shall be screwed on to the bolt or screw so as to be clear of the run-out of the thread towards the head and also clear of any imperfect threads at the point, the load shall then be applied to the head and to the nut or adaptor.

b. *Proof stress.* The proof stress for bolts shall be determined as follows:

i) *Method of test.* The proof stress for bolts or screws shall be determined with a straight full size threaded bolt or screw. The bolt or screw shall be placed in a suitable testing machine with the threaded end of the bolt or screw in a threaded grip or in a nut. The grips of the testing machine shall be self-aligning to avoid side thrust (see Figure 16 in Appendix C).

The bolt or screw shall be screwed into the grip or nut to the thread run-out of the bolt or screw and then unscrewed six full threads. The bolt or screw shall be subjected to the proof stress for bolts and screws specified in Column 3 of Table 4 in Appendix A by applying the appropriate load as given in Table 5, Appendix A and maintaining for ten seconds and then releasing.

ii) *Method of measurement.* Measurement of the specimens subjected to the proof stresses for bolts or screws shall be performed in the following manner:

The overall length of the bolt or screw shall be measured at its true centre line with an instrument capable of measuring changes in length of 0.0001 in.

After the bolt or screw has been stressed in accordance with the provisions of i) of this clause, its length shall again be measured. There shall be no permanent elongation of the bolts or screws, but to allow for errors of determination between consecutive measurements of bolt or screw length, this condition is considered to have been achieved if the measurement is within ± 0.0005 in of that made before loading.

NOTE The preferred method of carrying out this test is to measure the length between conical centres on the centre line of the bolt or screw which has been set up on the mating centres of the anvils of the measuring fixture; the head or shank of the bolt or screw should be marked so that it can be placed in the same position for all measurements.

6 Grading and mechanical properties of steel nuts

a. *Grading.* Nuts shall be graded as follows:

GRADE 0. Nuts suitable for use with bolts, Grades A, B and P.

The nuts shall be capable of withstanding a proof load, based on the minimum tensile strength of Grade P Bolts, as laid down in Table 4, Column 2.

GRADE 1. Nuts suitable for use with Bolts Grade S.

These nuts shall be capable of withstanding a proof load, based on the minimum tensile strength of Grade S Bolts, as laid down in Table 4, Column 2.

GRADE 3. Nuts suitable for use with Bolts Grade T.

These nuts shall be capable of withstanding a proof load, based on the minimum tensile strength of Grade T Bolts, as laid down in Table 4, Column 2.

GRADE 5. Nuts suitable for use with Bolts Grades V and X.

These nuts shall be capable of withstanding a proof load, based on the minimum tensile strength of Grade X Bolts, as laid down in Table 4, Column 2.

b. *Mechanical properties.*

i) *Proof load.*

Nuts 1 *in diameter and under.* These nuts shall meet the requirements for proof load specified in Table 6. They shall be tested in accordance with the method described in Clause **7**.

Nuts over 1 *in diameter.* As equipment of sufficient capacity may not be readily available for nuts in this range, they shall meet the requirements for hardness specified in sub-clause c) below.

c. *Hardness.*

i) *Nuts over* 1 *in diameter.* Nuts of diameters over 1 in shall be subjected to a hardness test and their hardness shall not be less than that specified below:

Brinell Hardness

Grade 0 Nuts–120 HB 10/3 000 min.
Grade 1 Nuts–180 HB 10/3 000 min.
Grade 3 Nuts–230 HB 10/3 000 min.
Grade 5 Nuts–270 HB 10/3 000 min.

ii) *Nuts up to and including* 1 *in diameter.* For nuts up to and including 1 in diameter, a hardness test is not part of the requirements of this standard but for general guidance Brinell hardness values are given below:

Birnell Hardness
Grade 0 Nuts–120/235 HB 10/3 000
Grade 1 Nuts–163/240 HB 10/3 000
Grade 3 Nuts–183/300 HB 10/3 000
Grade 5 Nuts–270/335 HB 10/3 000

iii) *Preparation of specimens.* The preparation of test specimens and the method of testing shall be in accordance with BS 240 "*Method of Bridell hardness test*." If Vickers or Rockwell methods are used, reference should be made to BS 860 "*Table of approximate comparison of hardness scales*" for appropriate values.

The test shall be made on the end faces of the nuts.

d. *Assembly testing of nuts.* When nuts up to and including $^3/_4$ in diameter are torque tested to destruction they shall not fail by splitting of the wall.

7 Proof load for nuts

a. *Method of test* (see Figure 17 in Appendix C). The proof load for nuts shall be determined by assembling the sample nut on a hardened threaded mandrel as specified in sub-clause b) below. A load axial with the mandrel and equal to the proof load for nuts specified in Table 6 shall be applied against the nut. The nut shall satisfactorily resist this load without stripping and should be removable by the fingers after the test. If the threads of the mandrel are damaged during the test the test shall be discarded.

b. *Test mandrel.* The test mandrel shall have a hardness of not less than 365 HV30. It shall be threaded to Class 3A tolerances in accordance with BS 1580, *"Unified screw threads"*, except that the major diameter shall be equal to the minimum major diameter as specified in the standard subject to a plus tolerance of 0.002 in.

8 Dimensions

The bolts, screws and nuts shall conform to the dimensions and tolerances given in Table 1 to Table 3 inclusive and Clauses **9** to **15** inclusive.

9 Length of bolts and screws

a. The nominal length of a bolt or screw shall be the distance from the underside of the head to the extreme end of the shank including any chamfer or radius.

NOTE The nominal lengths of bolts and screws normally stocked are given in Appendix D.

b. The permissible tolerance on the nominal length shall be as given below:

Nominal length	Diameter	Tolerance of length
in	in	in
Up to and including 1	Up to and including $^3/_4$	$+ 0 - {}^1/_{32}$
	Over $^3/_4$	$+ 0 - {}^1/_{16}$
Over 1 up to and including 2	Up to and including $^3/_4$	$+ 0 - {}^1/_{16}$
	Over $^3/_4$	$+ 0 - {}^1/_{8}$
Over 2 up to and including 6	Up to and including $^3/_4$	$+ 0 - {}^3/_{32}$
	Over $^3/_4$	$+ 0 - {}^3/_{16}$
Over 6	All diameters	$+ 0 - {}^3/_{16}$

10 Ends of bolts and screws

The ends of bolts and screws may, at the option of the manufacturer, be finished with either a 45° chamfer to a depth slightly exceeding the depth of thread or a radius approximately equal to $1^1/_4$ times the nominal diameter of shank. When bolts and screws are made with rolled threads the lead formed at the end of the bolt by the thread rolling operation may be regarded as providing the necessary chamfer to the end, no other machining operation being necessary, and the end shall be reasonably square with the centre line of the shank.

11 Screw threads

a. *General.* The screw threads on bolts, screws and nuts up to and including 1 inch nominal size shall be Unified coarse (UNC) or Unified fine (UNF) in accordance with BS 1580, *"Unified screw threads,"* as specified by the purchaser. The screw threads on bolts, screws and nuts in nominal sizes above 1 in shall be Unified coarse (UNC) in accordance with BS 1580. If a finer thread is required on bolts, screws and nuts in nominal sizes above 1 in, it is recommended that the 8-thread series be used.

b. *Bolts and screws.* The screw threads may be either cut or rolled at the option of the manufacturer and shall conform to the limits and tolerances for Class 2A specified in BS 1580.

c. *Nuts.* The screw threads shall conform to the limits and tolerances for Class 2B specified in BS 1580.

d. *Gauging of screw threads.* Screw threads shall be gauged in accordance with the system recommended in BS 919-1, *"Gauges for screw threads of Unified form."* The NOT GO effective diameter screw plug gauge used for checking nuts shall be of the low addendum form specified in that standard.

12 Length of thread

a. *Bolts.* The length of thread on bolts shall be the distance from the end of the bolt (including any chamfer or radius) to the leading face of a screw ring gauge which has been screwed as far as possible on to the bolt by hand.

The minimum thread length shall be twice the diameter plus $^1/_4$ in for lengths up to and including 6 in, and twice the diameter plus $^1/_2$ in for lengths over 6 in.

Bolts that are too short for minimum thread lengths shall be threaded as screws and shall be designated screws.

NOTE The shortest designated lengths for bolts are tabulated for guidance in Appendix D.

b. *Screws.* Screws shall be threaded to permit of a screw ring gauge being screwed by hand to within a distance from the underside of the head not exceeding two and a half times the pitch for diameters up to and including 1 in and three and a half times the pitch for diameters over 1 in.

c. *Tolerances.*

i) *Tolerance on bolt thread length.* The tolerance on thread length shall be plus $^3/_{16}$ in or $2^1/_2$ threads, whichever is the greater, for all lengths.

ii) *Tolerance on eccentricity.* Tolerance on eccentricity (including out of parallelism) of thread in relation to body for sizes up to and including $^3/_4$ in shall be 0.010 in for each inch of length when measured in a sleeve gauge. For sizes over $^3/_4$ in, total eccentricity shall be the subject of agreement between manufacturer and purchaser.

NOTE Details of the sleeve gauge referred to above are given in Appendix C.

13 Nuts, squareness of thread to face

The axis of the thread of the nut shall be square to the face of the nut subject to the "squareness tolerance" specified in Table 2, Column 13.

The nut shall be screwed by hand on to a gauge having a truncated taper thread until the thread of the nut is tight on the thread of the gauge. A sleeve sliding on a parallel extension of the gauge, and which has a face of diameter equal to the minimum distance across flats of the nut and exactly at 90° to the axis of the gauge shall be brought into contact with the leading face of the nut. With the sleeve in this position it shall not be possible for a feeler gauge of thickness equal to the "squareness tolerance" to enter anywhere between the leading face of the nut and the face of the sleeve (see Figure 20 in Appendix C).

14 Chamfering, washer facing and countersinking

a. *Bolts and screws.* Bolts and screw heads shall have a chamfer of approximately 30° on their upper faces and, at the option of the manufacturer, a washer face or full bearing face on the underside.

b. *Nuts* i) Ordinary nuts, thick ordinary nuts, slotted nuts and thick slotted nuts shall have a chamfer of 30° on their upper faces and at the option of the manufacturer, a similar chamfer or a washerface on their lower faces.

ii) Lock nuts shall have a chamfer of approximately 30° on both faces.

iii) All nuts shall be countersunk on the bearing face at an included angle of 120 ± 10°; the diameter of the countersink shall not exceed the nominal major diameter of the thread (see Figure 11).

With the exception of slotted nuts, all hexagon nuts chamfered at both ends shall also have a countersink as above at both ends of the thread.

NOTE The option referred to in sub-clauses a) and b) above shall apply unless the purchaser in his enquiry and order specifically states that he requires one of the alternatives available.

Attention is drawn to the fact that these alternative methods of finishing the underside of bolt and screw heads and the lower face of nuts are associated both with the nominal size and the particular method of manufacture. A request by the purchaser for a specific type of finish limits the manufacturing processes available and it is therefore recommended that the purchaser avoids making such a request unless circumstances fully justify it.

15 Split-pin holes an slots

Bolts with split-pin holes will be supplied only when specially ordered. The purchaser should state, in his enquiry and order, Dimension J (see Figure 1).

A tolerance of $+ {}^{1}/_{32}$ in $- 0$ shall be permissible on the specified Dimension J.

The maximum "off-centre" distance between the centreline of the split-pin hole in bolts and the axis of the thread is given in Table 1, Column 18. This shall be checked by means of a screwed ring gauge with appropriate slot and a plain plug gauge which shall be a Go gauge in the minimum split-pin hole (see Figure 21 in Appendix C).

The maximum "off-centre" distance between the centreline of the slots in slotted nuts and the axis of the tapped hole is given in Table 3, Column 13. This shall be checked by means of a screwed plug gauge with appropriate slot and a plain plug gauge which shall be a Go gauge in the minimum slot (see Figure 22 in Appendix C).

NOTE For full dimensional and other requirements of split cotter pins, reference should be made to BS 1574, "*Split cotter pins.*"

16 Marking

a. *Bolts and screws.* i) Bolts and screws shall have the appropriate grade letter (see Table 4, Appendix A) marked on the head. The letter shall be either indented or embossed, but if embossed the letter shall not project more than $^{1}/_{64}$ in.

ii) All bolts and screws shall be identified as "Unified" by means of the application of either of the following features, full details of which are given in Appendix E.

A circular recess in the upper surface of the head or,

A line of contiguous circles indented on one or more of the flats of the hexagon and parallel to the axis of the bolt or screw.

b. i) Nuts (see Clause **6**) shall have the appropriate grade number indented on one of the flats of the hexagon or on the non-bearing face.

ii) All nuts shall be identified as "Unified" by means of the application of one of the following features, full details of which are given in Appendix E:

A circular groove of semi-circular section indented in the non-bearing face, or

A line of contiguous circles indented on one or more of the flats of the hexagon and parallel to the axis of the nut, or

A recess in the non-bearing face of the nut.

The last named method of identification is for use on washer-faced nuts only.

c. *Manufacturer's trade mark.* Bolts, screws and nuts shall be marked with the manufacturer's identification (trade) mark.

17 Inspection and testing

The manufacturer shall take the necessary steps to ensure that the requirements specified in this standard are fulfilled, but if, in addition, the purchaser desires the manufacturer to certify or demonstrate that the bolts, screws, and nuts comply with this standard, the details and cost of any further inspection entailed shall be the subject of agreement between the purchaser and the manufacturer.

Table 1 — Unified hexagon head bolts and screws — Normal series

(Third Angle Projection)

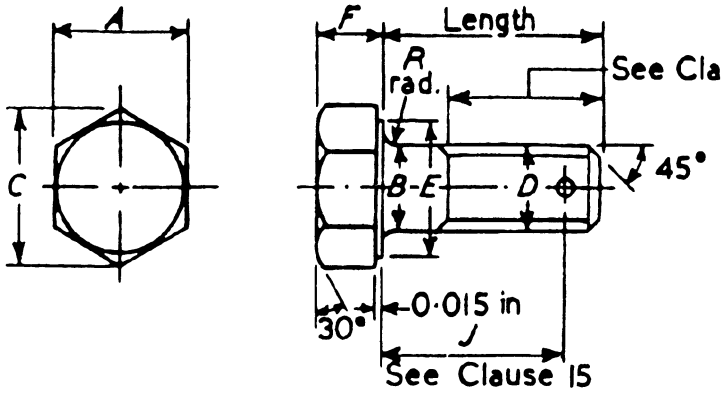


Figure 1 — Hexagon head bolt, washer faced

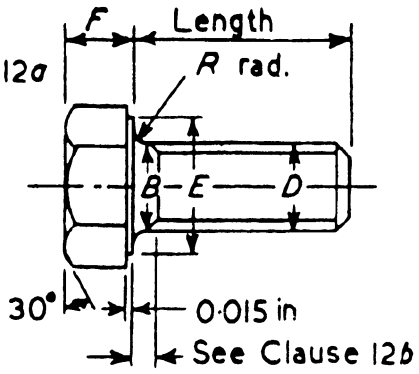


Figure 2 — Hexagon head screw, washer faced

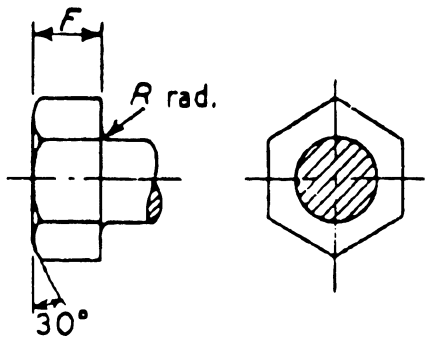


Figure 3 — Full bearing

Alternative type of head permissible on bolts and screws

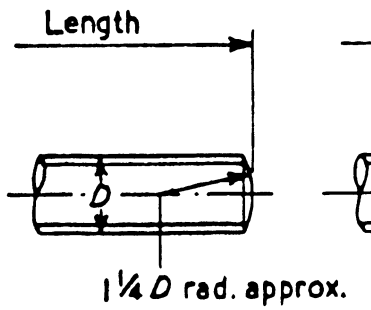


Figure 4 — Rounded end

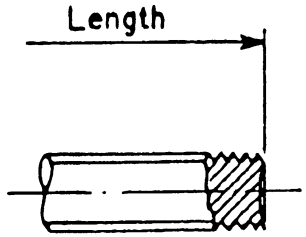


Figure 5 — Rolled thread end

Alternative types of end permissible on bolts and screws

Table 1 — Unified hexagon head bolts and screws — Normal series

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Nominal size *D*	**Number of threads per inch**		**Diameter of unthreaded portion of shank** *B*		**Width across flats** *A*		**Width across corners** *C*	**Diameter of washer face** *E*		**Thickness of head** *F*		**Radius under head** *R*		**Split cotter pin holes. See clause 15**			
														Diameter of hole		**Drill sizes**	**Maximum off-centre distance between centre line of hole and thread**
	UNC	**UNF**	**Max.**	**Min.**	**Max.**	**Min.**[b]	**Max.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**	**Max.**	**Min.**		
in			in	in	in	in	in	in	in	in	in	in	in	in	in	mm	in
1/4	20	28	0.250 0	0.246 5	0.437 5	0.430 5	0.505	0.421	0.411	0.163	0.153	0.025	0.015	0.084	0.079	2.00	0.006
5/16	18	24	0.312 5	0.309 0	0.500 0	0.493 0	0.577	0.483	0.473	0.211	0.201	0.025	0.015	0.100	0.095	2.40	0.006
3/8	16	24	0.375 0	0.371 5	0.562 5	0.554 5	0.650	0.545	0.535	0.243	0.233	0.025	0.015	0.117	0.112	2.85	0.006
7/16	14	20	0.437 5	0.433 5	0.625 0	0.617 0	0.722	0.605	0.595	0.291	0.281	0.025	0.015	0.117	0.112	2.85	0.007
1/2	13	20	0.500 0	0.496 0	0.750 0	0.742 0	0.866	0.730	0.720	0.323	0.313	0.025	0.015	0.152	0.146	3.70	0.007
[a]9/16	12	18	0.562 5	0.558 5	0.812 5	0.804 5	0.938	0.792	0.782	0.371	0.361	0.045	0.020	0.152	0.146	3.70	0.008
5/8	11	18	0.625 0	0.619 0	0.937 5	0.929 5	1.083	0.918	0.908	0.403	0.393	0.045	0.020	0.184	0.177	4.50	0.008
3/4	10	16	0.750 0	0.744 0	1.125 0	1.115 0	1.300	1.100	1.090	0.483	0.463	0.045	0.020	0.184	0.177	4.50	0.009
7/8	9	14	0.875 0	0.867 0	1.312 5	1.300 5	1.515	1.285	1.275	0.563	0.543	0.065	0.040	0.184	0.177	4.50	0.009
1	8	12	1.000 0	0.992 0	1.500 0	1.488 0	1.732	1.473	1.463	0.627	0.597	0.095	0.060	0.222	0.213	5.40	0.010
1 1/8	7	See clause 11	1.125 0	1.117 0	1.687 5	1.657 5	1.948	1.641	1.625	0.718	0.678	0.095	0.060	0.222	0.213	5.40	0.010
1 1/4	7		1.250 0	1.242 0	1.875 0	1.830 0	2.165	1.813	1.797	0.813	0.773	0.095	0.060	0.254	0.244	6.20	0.011
[a]1 3/8	6		1.375 0	1.365 0	2.062 5	2.017 5	2.382	2.001	1.985	0.878	0.838	0.095	0.060	0.254	0.244	6.20	0.011
1 1/2	6		1.500 0	1.490 0	2.250 0	2.205 0	2.598	2.188	2.172	0.974	0.934	0.095	0.060	0.290	0.280	7.10	0.011
1 3/4	5		1.750 0	1.740 0	2.625 0	2.565 0	3.031	2.543	2.527	1.134	1.074	0.095	0.060	0.353	0.343	8.70	0.012
2	4 1/2		2.000 0	1.990 0	3.000 0	2.940 0	3.464	2.918	2.902	1.263	1.203	0.095	0.060	0.353	0.343	8.70	0.015

NOTE In the case of the 7/16 in and 9/16 in bolt heads, the width across flats is 1/16 in smaller than that of the corresponding nuts. This is in accordance with the American Standard from which these sizes are derived.

[a] To be dispensed with wherever possible.

[b] When bolts from 1/4 in to 1 in nominal size are hot forged, the tolerance on the width across flats shall be two and a half times the tolerance shown in the table.

Table 2 — Unified hexagon ordinary nuts, thick ordinary nuts and lock nuts — Normal series
(Third Angle Projection)

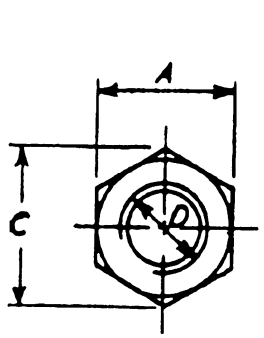


Figure 6 — Double chamfered

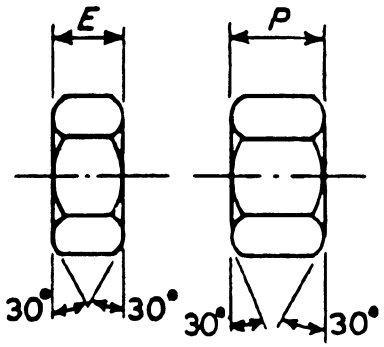


Figure 7 — Thick double chamfered

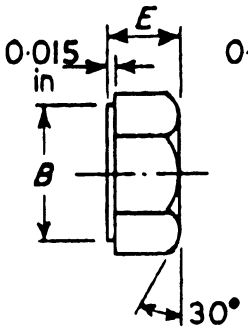


Figure 8 — Washer faced

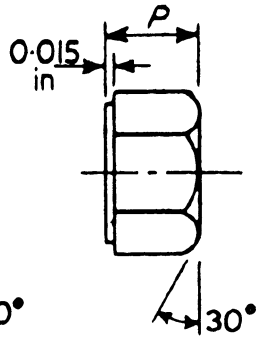
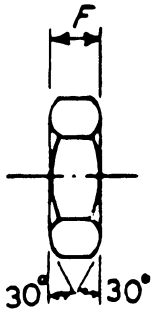


Figure 9 — Thick washer faced



Figutre 10 — Hexagon lock nut

Alternative types of hexagon ordinary and thick ordinary nuts permissible

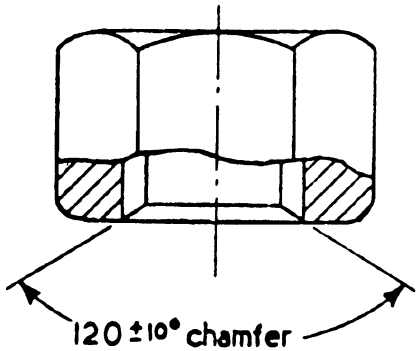


Figure 11 — Enlarged view of nut countersink
[see clause **14** b]

Table 2 — Unified hexagon ordinary nuts, thick ordinary nuts and lock nuts — Normal series

1	2	3	4	5	6	7	8	9	10	11	12	13
Nominal size	Width across flats		Width across corners	Diameter of washer face		Thickness						Tolerance on squareness of thread to face of nut
						Ordinary nuts		Thick ordinary nuts		Lock nuts		
D	*A*		*C*	*B*		*E*		*P*		*F*		
	Max.	Min.	Max.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.
in	in	in	in	in	in	in	in	in	in	in	in	in
1/4	0.437 5	0.430 5	0.505	0.421	0.411	0.224	0.214	0.286	0.276	0.161	0.151	0.007
5/16	0.500 0	0.493 0	0.577	0.483	0.473	0.271	0.261	0.333	0.323	0.192	0.182	0.009
3/8	0.562 5	0.554 5	0.650	0.545	0.535	0.333	0.323	0.411	0.401	0.224	0.214	0.010
7/16	0.687 5	0.679 5	0.794	0.668	0.658	0.380	0.370	0.458	0.448	0.255	0.245	0.011
1/2	0.750 0	0.742 0	0.866	0.730	0.720	0.442	0.432	0.567	0.557	0.317	0.307	0.013
[a]9/16	0.875 0	0.867 0	1.010	0.855	0.845	0.489	0.479	0.614	0.604	0.349	0.339	0.013
5/8	0.937 5	0.929 5	1.083	0.918	0.908	0.552	0.542	0.724	0.714	0.380	0.370	0.014
3/4	1.125 0	1.115 0	1.300	1.100	1.090	0.651	0.631	0.822	0.802	0.432	0.412	0.017
7/8	1.312 5	1.300 5	1.515	1.285	1.275	0.760	0.740	0.916	0.896	0.494	0.474	0.020
1	1.500 0	1.488 0	1.732	1.473	1.463	0.874	0.844	1.015	0.985	0.562	0.532	0.020
1 1/8	1.687 5	1.657 5	1.948	1.641	1.625	0.989	0.949	1.176	1.136	0.629	0.589	0.024
1 1/4	1.875 0	1.830 0	2.165	1.813	1.797	1.087	1.037	1.275	1.225	0.744	0.694	0.024
[a]1 3/8	2.062 5	2.017 5	2.382	2.001	1.985	1.197	1.147	1.400	1.350	0.806	0.756	0.026
1 1/2	2.250 0	2.205 0	2.598	2.188	2.172	1.311	1.251	1.530	1.470	0.874	0.814	0.026
1 3/4	2.625 0	2.565 0	3.031	2.543	2.527	1.530	1.470	—	—	0.999	0.939	0.030
2	3.000 0	2.940 0	3.464	2.918	2.902	1.754	1.684	—	—	1.129	1.059	0.030

NOTE In the case of the 7/16 in and 9/16 in nuts, the width across flats is 1/16 in larger than that of the corresponding bolt heads. This is in accordance with the American Standards from which these sizes are derived.

[a] To be dispensed with wherever possible.

[b] When nuts from 1/4 in to 1 in nominal size are hot forged, the tolerance on width across flats shall be two and a half times the tolerance shown in the table.

Table 3 — Unified hexagon slotted nuts and thick slotted nuts — Normal series

(Third Angle Projection)

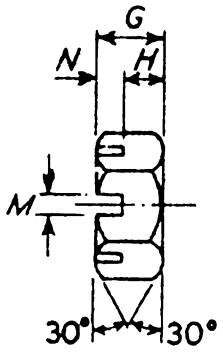


Figure 12 — Double chamfered

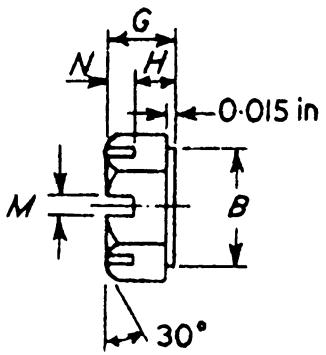


Figure 13 — Washer faced

Alternative types of hexagon slotted nuts

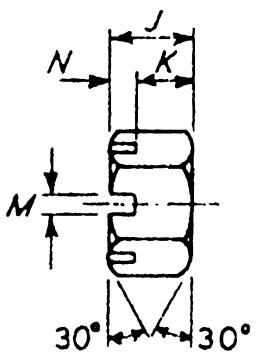


Figure 14 — Double chamfered

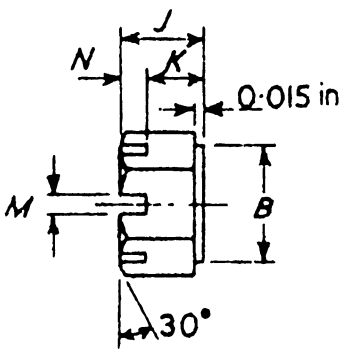


Figure 15 — Washer faced

Alternative types of hexagon thick slotted nuts

Table 3 — Unified hexagon slotted nuts and thick slotted nuts — Normal series

1	2	3	4	5	6	7	8	9	10	11	12	13	14
Nominal size *D*	Slotted nuts				Thick slotted nuts				Slotted nuts and thick slotted nuts			Maximum off-centre distance between centre line of slot and tapped hole	Tolerance on squareness of thread to face of nut
	Thickness *G*		Lower face of nut to bottom of slot *H*		Thickness *J*		Lower face of nut to bottom of slot *K*		Width of slot *M*		Depth of slot *N*		
	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Max.	Min.	Nom.		Max.
in	in	in	in	in	in	in	in	in	in	in	in	in	in
1/4	0.224	0.214	0.161	0.151	0.286	0.276	0.224	0.214	0.088	0.078	0.062	0.012	0.007
5/16	0.271	0.261	0.177	0.167	0.333	0.323	0.239	0.229	0.104	0.094	0.094	0.012	0.009
3/8	0.333	0.323	0.224	0.214	0.411	0.401	0.302	0.292	0.135	0.125	0.109	0.012	0.010
7/16	0.380	0.370	0.255	0.245	0.458	0.448	0.333	0.323	0.135	0.125	0.125	0.014	0.011
1/2	0.442	0.432	0.302	0.292	0.567	0.557	0.427	0.417	0.166	0.156	0.141	0.014	0.013
[a]9/16	0.489	0.479	0.333	0.323	0.614	0.604	0.458	0.448	0.166	0.156	0.156	0.017	0.013
5/8	0.552	0.542	0.364	0.354	0.724	0.714	0.536	0.526	0.198	0.188	0.187	0.017	0.014
3/4	0.651	0.631	0.432	0.412	0.822	0.802	0.604	0.584	0.198	0.188	0.219	0.022	0.017
7/8	0.760	0.740	0.510	0.490	0.916	0.896	0.666	0.646	0.198	0.188	0.250	0.022	0.020
1	0.874	0.844	0.593	0.563	1.015	0.985	0.734	0.704	0.260	0.250	0.281	0.027	0.020
1 1/8	0.989	0.949	0.661	0.621	1.176	1.136	0.848	0.808	0.260	0.250	0.328	0.027	0.024
1 1/4	1.087	1.037	0.728	0.678	1.275	1.225	0.916	0.866	0.322	0.312	0.359	0.032	0.024
[a]1 3/8	1.197	1.147	0.806	0.756	1.400	1.350	1.009	0.959	0.322	0.312	0.391	0.032	0.026
1 1/2	1.311	1.251	0.889	0.829	1.530	1.470	1.108	1.048	0.385	0.375	0.422	0.037	0.026
1 3/4	1.530	1.470	1.030	0.970	—	—	—	—	0.448	0.438	0.500	0.037	0.030
2	1.754	1.684	1.176	1.106	—	—	—	—	0.448	0.438	0.578	0.042	0.030

NOTE In the case of the 7/16 in and 9/16 in nuts, the width across flats is 1/16 in larger than that of the corresponding bolt heads. This is in accordance with the American Standard from which these sizes are derived.

[a] To be dispensed with wherever possible.

For widths across flats, widths across corners, and diameter of washer face, see Table 2.

Appendix A Mechanical properties of finished steel hexagon head bolts and screws and hexagon nuts

Table 4 — Bolts and screws
(See clauses **4** and **5**)

1	2	3	4	5	6	7	8
Grade	**Properties of finished bolts**						
	Minimum tensile strength	**Stress for proof load**	**Minimum elongation on a gauge length $4\sqrt{\text{area}}$**	**Minimum Izod impact value**			**Brinell hardness numbers**
				Diameter or width across flats			
	(see NOTE 1)	**(see Table 5)**	**(see NOTE 2)**	**Up to $^{3}/_{4}$ in**	**Over $^{3}/_{4}$ in up to and including 1 $^{1}/_{8}$ in**	**Over $1^{1}/_{8}$ in**	**[see Clause 4 d)]**
	tonf/in^2	tonf/in^2	per cent	ft lbf	ft lbf	ft lbf	HB10/3 000
A	28	—	10/14 (see NOTE 3)	—	—	—	—
B	28	—	17	—	—	—	—
P	35	20	15	20	15	10	152/240
S	50	38	18	35	30	20	223/310
T	55	41	16	35	30	20	248/335
V	65	49.5	14	35	30	20	293/370
X	75	60	12	15	15	10	341/410

NOTE 1 The cross sectional area of the thread used in calculation is obtained by the following formula.

$$\text{Area} = \pi\left(\frac{\text{Basic effective diameter}^{a} + \text{basic minor diameter}^{a}}{4}\right)^{2}$$

NOTE 2 BS 18 now specifies a gauge length of $5.65\sqrt{\text{Area}}$, but elongation values appropriate to this length are not yet available for the higher grades of steel. The values in Column 4 have therefore been retained pending further information on this subject.

NOTE 3 For Grade A bolts or screws the minimum elongation shall be 10 per cent for $^{1}/_{4}$ in and $^{5}/_{16}$ in nominal sizes and 14 per cent for all other sizes up to and including 2 in.

[a] As specified for the thread in question in BS 1580 *"Unified screw threads."*

Table 4A — Comparison of strength grades of BS 1768 and BS 970 (for guidance only)

Grade	Tensile strength		
	BS 1768		BS 970–1:1983
	min.	min.	
	tonf/m²	N/mm²	N/mm²
P	35	541	550 – 700
S	50	772	775 – 925
T	55	849	850 – 1 000
V	65	1 004	1 000 – 1 150
X	75	1 158	1 150 – 1 300

Table 5 — Proof loads for bolts and screws

(see Column 2 of Table 4)

Nominal size of bolt or screw	Stress area		Grade P		Grade S		Grade T		Grade V		Grade X	
			Proof stress 20 tonf/in²		Proof stress 38 tonf/in²		Proof stress 41 tonf/in²		Proof stress 49.5 tonf/in²		Proof stress 60 tonf/in²	
			Proof load									
	UNC	UNF	UNC	UNF	UNC	UNF	UNC	UNF	UNC	UNF	UNC	UNF
in	in²	in²	ton	ton	ton	ton	ton	ton	ton	ton	ton	ton
1/4	0.0324	0.0368	0.648	0.736	1.231	1.398	1.328	1.509	1.603	1.822	1.944	2.208
5/16	0.0532	0.0587	1.064	1.174	2.021	2.230	2.181	2.406	2.633	2.905	3.192	3.522
3/8	0.0786	0.0886	1.572	1.772	2.986	3.367	3.222	3.633	3.890	4.385	4.716	5.316
7/16	0.1078	0.1198	2.156	2.396	4.097	4.552	4.420	4.911	5.335	5.929	6.468	7.188
1/2	0.1438	0.1612	2.876	3.224	5.466	6.127	5.896	6.610	7.119	7.980	8.628	9.672
9/16	0.184	0.205	3.68	4.10	6.992	7.791	7.544	8.407	9.107	10.15	11.04	12.30
5/8	0.229	0.258	4.58	5.16	8.702	9.804	9.389	10.58	11.33	12.77	13.74	15.48
3/4	0.338	0.375	6.76	7.50	12.84	14.25	13.86	15.38	16.73	18.57	20.28	22.50
7/8	0.467	0.513	9.34	10.26	17.74	19.49	19.14	21.03	23.12	25.39	28.02	30.78
1	0.612	0.667	12.24	13.34	23.26	25.34	25.09	27.35	30.30	33.01	36.72	40.02
1 1/8	0.771	—	15.42	—	29.30	—	31.61	—	38.17	—	46.26	—
1 1/4	0.978	—	19.56	—	37.16	—	40.10	—	48.41	—	58.68	—
1 3/8	1.166	—	23.32	—	44.31	—	47.80	—	57.72	—	69.96	—
1 1/2	1.418	—	28.36	—	53.89	—	58.15	—	70.20	—	85.08	—
1 3/4	1.92	—	38.4	—	72.97	—	78.72	—	95.04	—	115.2	—
2	2.52	—	50.4	—	95.76	—	103.3	—	124.7	—	151.2	—

Stress area × proof stress = proof load

Table 6 — Proof loads for nuts[1)]

(See clause **6**)

Nominal size of nut	Stress area of bolts		Grade 0 nuts		Grade 1 nuts		Grade 3 nuts		Grade 5 nuts	
			For use with bolts of grades A, B, P		For use with bolts of grade S		For use with bolts of grade T		For use of bolts of grades V, X	
			Min. tensile of grade P bolts 35 tonf/in²		Min. tensile of grade S bolts 50 tonf/in²		Min. tensile of grade T bolts 55 tonf/in²		Min. tensile of grade X bolts 75 tonf/in²	
			Proof load							
	UNC	UNF	UNC	UNF	UNC	UNF	UNC	UNF	UNC	UNF
in	in²	in²	ton	ton	ton	ton	ton	ton	ton	ton
1/4	0.0324	0.0368	1.134	1.288	1.620	1.840	1.782	2.024	2.430	2.760
5/16	0.0532	0.0587	1.862	2.054	2.660	2.935	2.926	3.228	3.990	4.402
3/8	0.0786	0.0886	2.751	3.101	3.930	4.430	4.323	4.873	5.895	6.645
7/16	0.1078	0.1198	3.773	4.193	5.390	5.990	5.929	6.589	8.085	8.985
1/2	0.1438	0.1612	5.034	5.643	7.190	8.060	7.911	8.869	10.78	12.09
9/16	0.184	0.205	6.440	7.176	9.200	10.25	10.12	11.28	13.80	15.37
5/8	0.229	0.258	8.015	9.031	11.45	12.90	12.60	14.19	17.17	19.35
3/4	0.338	0.375	11.83	13.12	16.90	18.75	18.59	20.63	25.35	28.12
7/8	0.467	0.513	15.97	17.96	23.35	25.65	25.68	28.21	35.02	38.47
1	0.612	0.667	21.42	23.34	30.60	33.35	33.67	36.68	45.90	50.02
Stress area × min. tensile strength of bolt = proof load of nuts										

[1)] The proof load values in this table apply only to ordinary nuts and thick ordinary nuts and not to lock-nuts or slotted nuts.

Appendix B Materials

In Table 7, Table 8, Table 9 and Table 10, for comparisons between EN No. steels and the 6-digit designations see Appendix D of BS 970-1:1983.

Table 7 — Examples of suitable material for cold forged bolts and screws

The following table is for guidance only; grades of steel shown and ruling sections are not mandatory.

The finished products shall satisfy the requirements for physical properties set out in Clause **4** and Table 4 of Appendix A.

Grade	Nominal size of bolt or screw[a]	Material[b]
A and B	All sizes	Good commercial quality low carbon steel
P	Up to and including 1 in	BS 970 — EN 2, A to D BS 970 — EN 5 BS 3111 — Type 0 BS 3111 — Type 1 BS 3111 — Type 9
S	Up to and including $^{7}/_{8}$ in	BS 3111 — Type 1
	Up to and including 1 in	BS 3111 — Type 2 BS 3111 — Type 3 BS 3111 — Type 9 BS 3111 — Type 10
T	Up to and including $^{1}/_{2}$ in	BS 3111 — Type 1
	Up to and including 1 in	BS 3111 — Type 2 BS 3111 — Type 3 BS 3111 — Type 9 BS 3111 — Type 10
V	Up to and including $^{3}/_{8}$ in	BS 3111 — Type 1
	Up to and including $^{3}/_{4}$ in	BS 3111 — Type 2 BS 3111 — Type 3 BS 3111 — Type 9
	Up to and including 1 in	BS 3111 — Type 5 BS 3111 — Type 7 BS 3111 — Type 10
X	Up to and including $^{3}/_{8}$ in	BS 3111 — Type 2
	Up to and including $^{5}/_{8}$ in	BS 3111 — Type 3
	Up to and including $^{3}/_{4}$ in	BS 3111 — Type 5 BS 3111 — Type 7 BS 3111 — Type 10

[a] Limiting ruling section.
[b] BS 970-1:1983.
BS 3111-1:1977.

Table 8 — Materials for hot forged bolts and screws

The following table is given for guidance only and the grades of steel and the limiting ruling sections listed here are not mandatory. Unless otherwise stipulated, the final choice of the materials used to provide the physical properties given in Appendix A will be left to the manufacturer. (See Clause **2**).

When materials selected from this table are used, the mechanical properties referred to above are obtained by oil quenching and tempering at a suitable temperature.

Grade	Nominal size of bolt or screw[a]	Material to BS 970[b]
A and B	All sizes	Good commercial quality low carbon steel
P	Up to and including 2 in	EN 5 EN 7 EN 8
S	Up to and including $^1/_2$ in	EN 5C
	Up to and including $^3/_4$ in	EN 8
	Up to and including $^7/_8$ in	EN 15
	Up to and including 1 in	EN 12 EN 18 EN 111
	Up to and including 2 in	EN 16 EN 17 EN 19 EN 24 EN 25 EN 26 EN 100 EN 110
T	Up to and including $^1/_2$ in	EN 8 EN 15
	Up to and including $^7/_8$ in	EN 12
	Up to and including 1 in	EN 18 EN 111
T	Up to and including 2 in	EN 16 EN 17 EN 19 EN 24 EN 25 EN 26 EN 100 EN 110

[a] Limiting ruling section.
[b] BS 970-1:1983. Mechanical properties relating to steels specified in BS 970-1 are for steels subjected to bulk heat treatment; significantly higher properties will be obtained by heat treatment in the finished component form.

Table 8 — Materials for hot forged bolts and screws

Grade	Nominal size of bolt or screw[a]	Material to BS 970[b]
V	Up to and including $^3/_8$ in	EN 8
	Up to and including $^1/_2$ in	EN 15
	Up to and including $^5/_8$ in	EN 12
	Up to and including $^3/_4$ in	EN 18
		EN 111
	Up to and including $^7/_8$ in	EN 16
	Up to and including $1^1/_8$ in	EN 17
		EN 19
		EN 100
		EN 110
	Up to and including 2 in	EN 24
		EN 25
		EN 26
X	Up to and including $^1/_2$ in	EN 12
	Up to and including $^5/_8$ in	EN 16
		EN 17
		EN 18
		EN 111
	Up to and including $^3/_4$ in	EN 100
	Up to and including 1 in	EN 19
		EN 110
	Up to and including $1^1/_8$ in	EN 24
	Up to and including 2 in	EN 25
		EN 26

[a] Limiting ruling section.
[b] BS 970-1:1983. Mechanical properties relating to steels specified in BS 970-1 are for steels subjected to bulk heat treatment; significantly higher properties will be obtained by heat treatment in the finished component form.

Table 9 — Materials for bolts and screws turned from bar

The following table is given for guidance only and the grades of steel and limiting ruling sections listed here are not mandatory. Unless otherwise stipulated, the final choice of the materials used to provide the physical properties given in Appendix A will be left to the manufacturer (see Clause **2**).

Grade	Width across flats[a]	Material to BS 970 [b]
A	Up to and including $1^1/_2$ in	EN 1A
	Up to and including 3 in	EN 7A
B	Up to and including 3 in	EN 3B
P	Up to and including $1^3/_4$ in	EN 7
	Up to and including 3 in	EN 8
S	Up to and including $2^1/_2$ in	EN 18S
	Up to and including 3 in	EN 16S
T	Up to and including $2^1/_2$ in	EN 16T
	Up to and including 3 in	EN 17T
V	Up to and including $2^1/_2$ in	EN 24V
	Up to and including 3 in	EN 25V EN 26V
X	Up to and including $1^1/_8$ in	EN 24X
	Up to and including $2^1/_2$ in	EN 25X
	Up to and including 3 in	EN 26X

[a] Limiting ruling section.
[b] Appendix C of BS 970-1:1983.

Table 10 — Materials for nuts

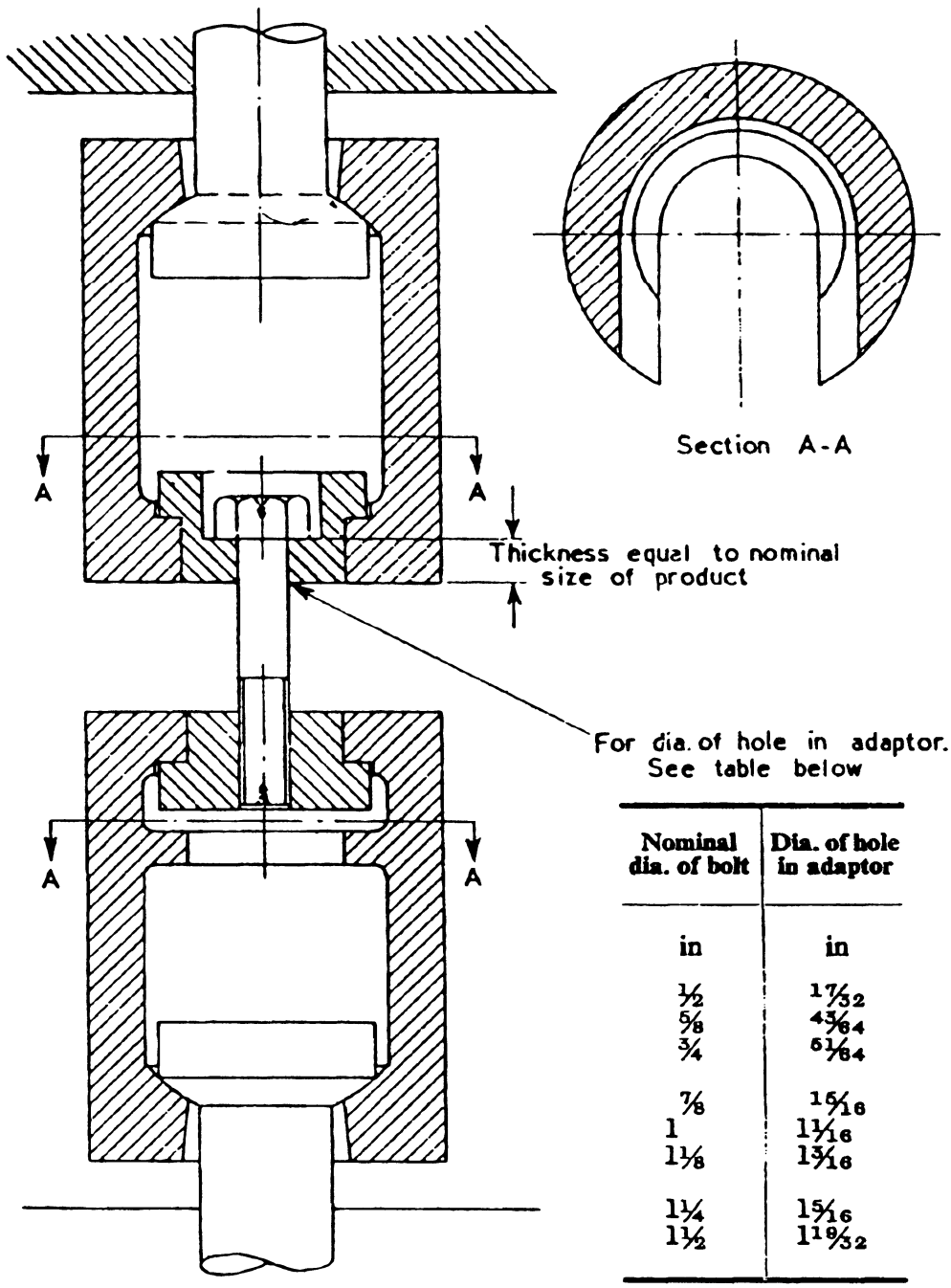
The following table is given for guidance only and the grades of steel listed here are not mandatory. Unless otherwise stipulated, the final choice of the materials used to give the physical properties specified for the finished nuts in Clause **6** and Table 6 will be left to the manufacturer.

Grade	Cold formed	Hot forged	Turned from the bar
0	Good commercial quality steel	Good commercial quality steel	Good commercial quality steel
1	EN 2A to D	EN 3, EN 5	EN 1A, EN 7
	EN 5	EN 8	EN 8M
3	EN 5	EN 5, EN 8	EN 7, EN 8M
	BS 3111, Type 1		EN 15M
	BS 3111, Type 9		
5	EN 5	EN 8, EN 12	EN 8M, EN 15M
	BS 3111, Type 1	EN 15, EN 16	EN 16M
	BS 3111, Type 9		

Appendix C Testing fixtures and recommended gauges

Testing Fixtures

C.1 Proof load test for bolts and screws. *Clause 5.*

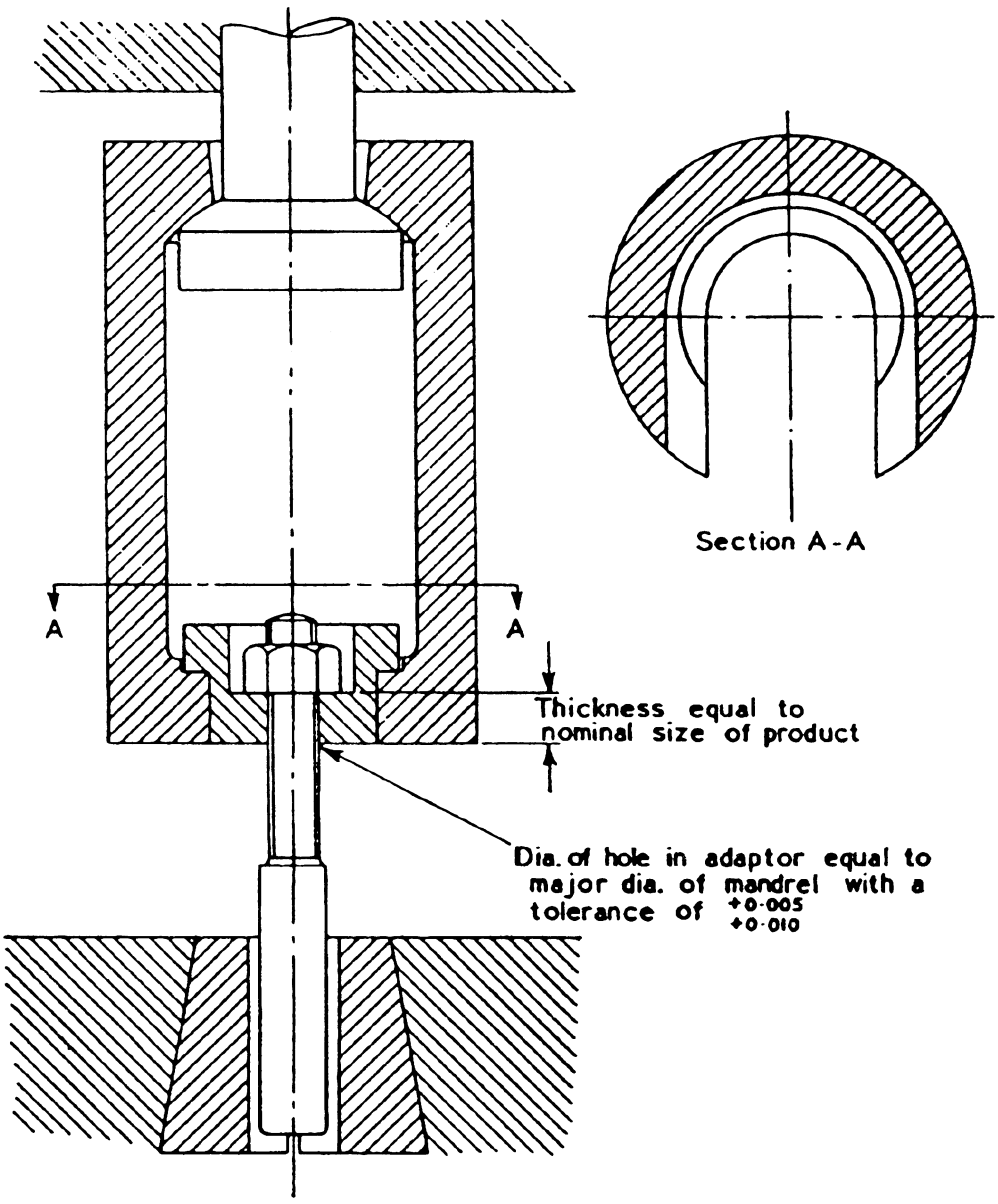


Nominal dia. of bolt	Dia. of hole in adaptor
in	in
½	17/32
5/8	43/64
¾	51/64
7/8	15/16
1	1 1/16
1 1/8	1 3/16
1 1/4	1 5/16
1 ½	1 19/32

Adaptors to have a hardness of 270/320 HV30

Figure 16

C.2 Proof load test for nuts. *Clause* ***6****.*



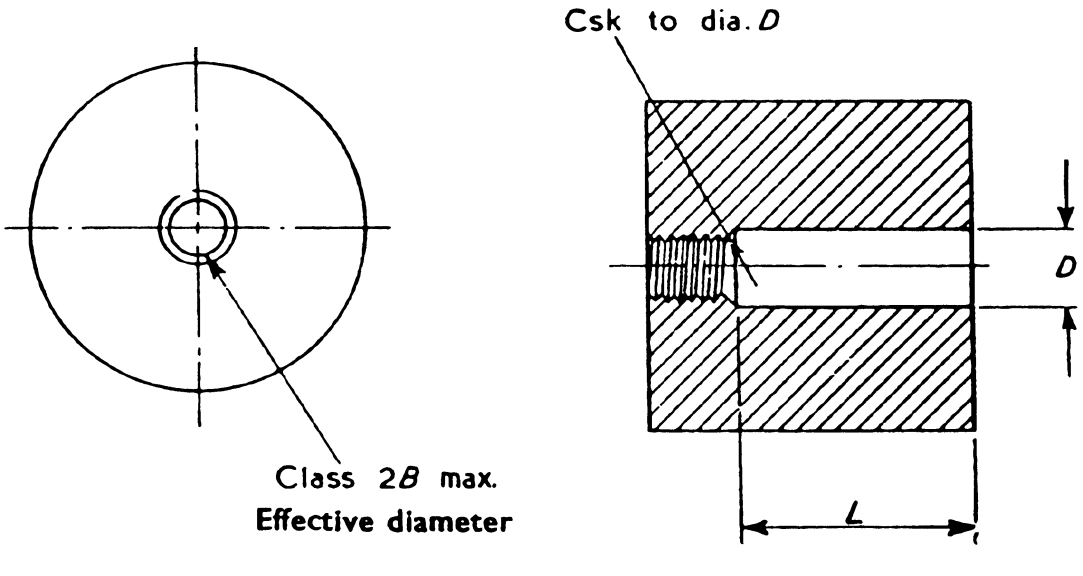
Adaptors to have a hardness of 270/320 HV30
Mandrel to have a hardness of 365/425 HV30

Figure 17

Recommended Gauges

Details of gauges suitable for checking various features of the bolts, screws and nuts specified in this standard are given below. They are offered for guidance and do not form part of the requirements of this standard.

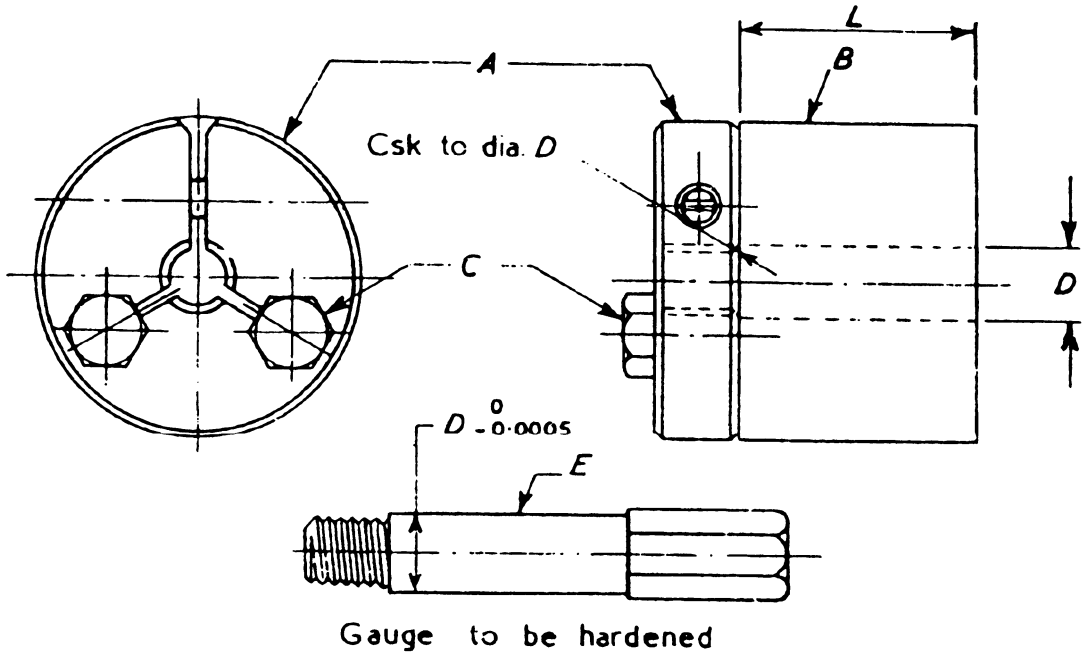
C.3 Eccentricity. *Clause 12 c* ii).



***D*—Max. dia. of screw plus clearance allowance.**
***L*—Length of bolt or screw minus one diameter.**

Figure 18

Optional construction



A **Ring gauge set to Class 2B max. effective dia.**
B **Sleeve.**
C **Attachment screws.**
D **Dia. of hole in sleeve = max. bolt or screw dia. plus clearance allowance.**
E **Positioning and setting plug; threads—Class 2B max. effective dia. for adjusting ring gauge and centring sleeve.**
L **Length of sleeve = length of bolt or screw minus one diameter.**

Figure 19

Two types of sleeve gauges for checking eccentricity of thread in relation to body are illustrated above.

The optional type shown in Figure 19 permits the use of different length sleeves to accommodate different bolt lengths.

The ring Gauge *A* in this type is centred in position on sleeve *B* by means of positioning plug *E* and secured by means of attachment screws *C*. This plug also sets the ring gauge to the maximum effective diameter. The internal diameter *D* of the sleeve equals the nominal diameter of the bolt or screw plus the concentricity tolerance. The sleeve should extend beyond the last thread of the bolt or screw to be inspected but should not exceed 3 inches in length. Failure of the bolt or screw to enter the ring gauge or interference between the sleeve and bolt while engaging the ring gauge indicates excessive eccentricity between the thread and the body.

C.4 Squareness of thread to face of nut. *Clause 13.*

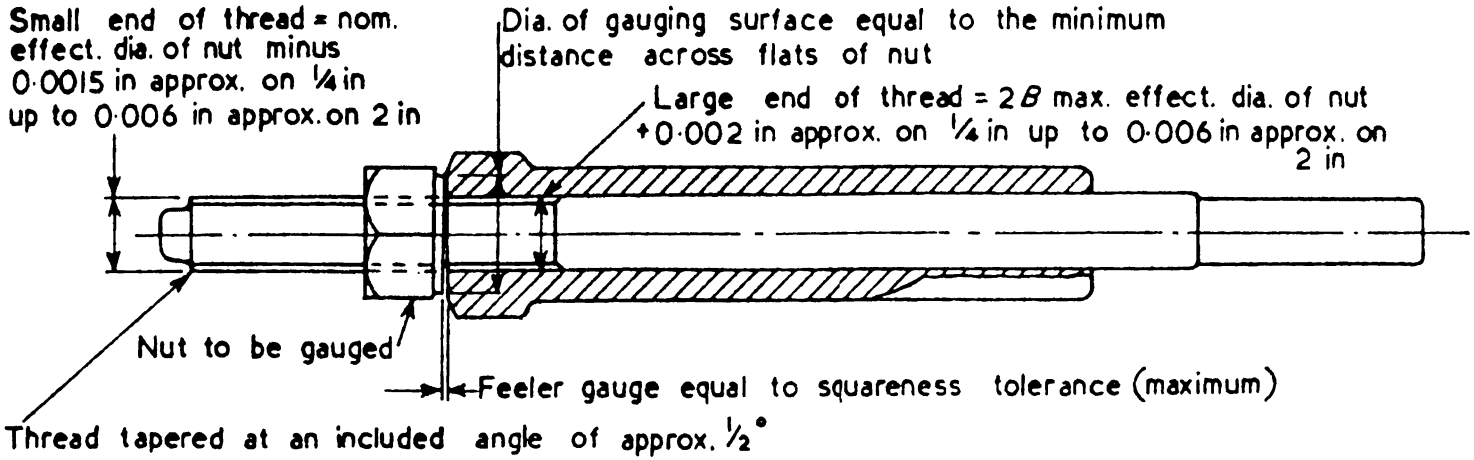


Figure 20

C.5 Off-centre distance between centre line of split pin hole in bolt and axis of thread (Figure 21) and off centre distance between centre line of slots in slotted nuts and axis of tapped hole (Figure 22) *Clause* ***15***.

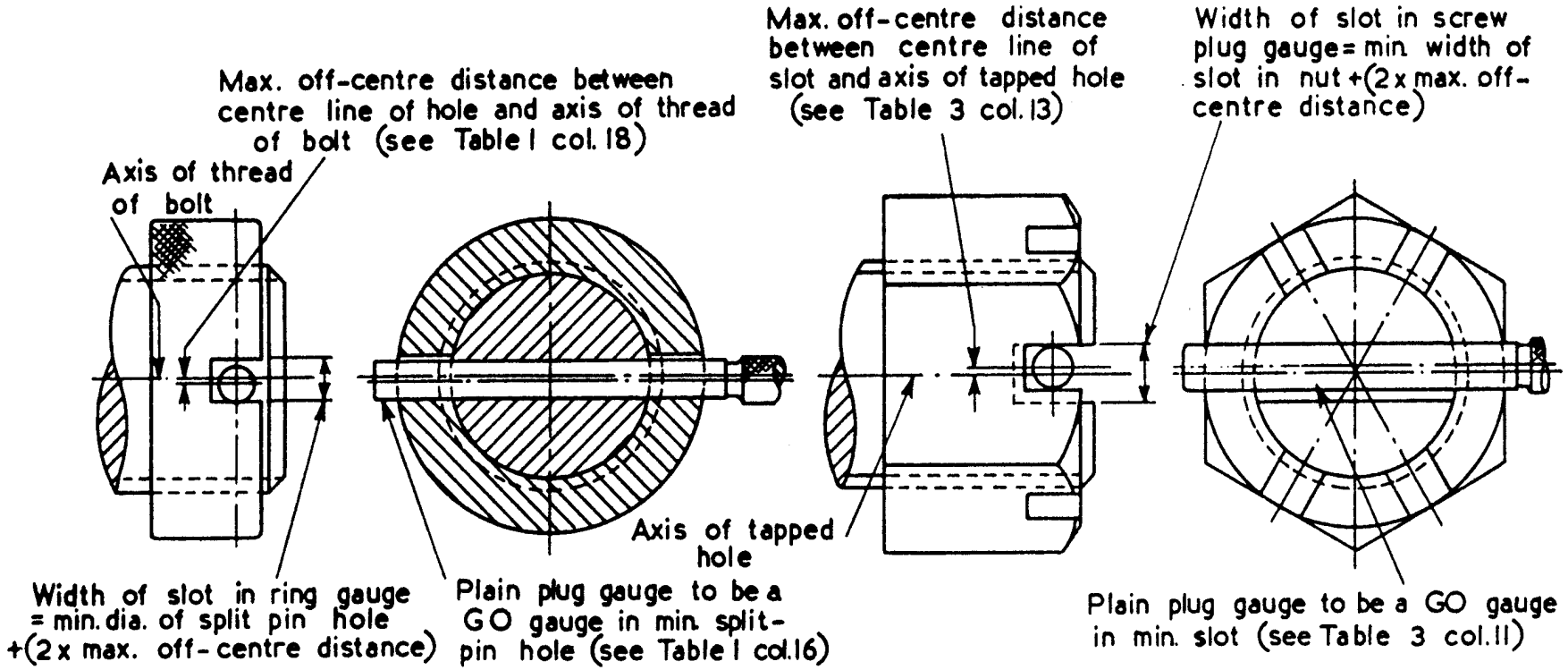


Figure 21 **Figure 22**

It is recommended that the screw ring gauge and the screw plug gauge illustrated above be made to the tolerances specified for screw gauges in BS 919-1, "*Gauges for screw threads of Unified form*", and the plain plug gauges to the tolerances for plug gauges specified in BS 969, "*Tolerances for plain limit gauges*."

It is also recommended that the width of the slots in both the screw ring gauge and the screw plug gauge be made to the tolerances for gap gauges specified in BS 969. These tolerances should cover both the width of slot and the off-centre distance.

Appendix D Standard sizes of unified precision steel hexagon head bolts and screws and shortest lengths designated as bolts — Normal series

NOTE The sizes listed in Table 11 to Table 14 inclusive represent those which are expected to be in greatest demand and which are most likely to be stocked by bolt and nut manufacturers.

Table 11 — Grade A bright hexagon bolts

Nominal size *D*	Nominal length in inches													
	$1^1/_4$	$1^1/_2$	$1^3/_4$	2	$2^1/_4$	$2^1/_2$	$2^3/_4$	3	$3^1/_2$	4	$4^1/_2$	5	$5^1/_2$	6
$^1/_4$	X	X	X	X	X	X	X	X	X	—	—	—	—	—
$^5/_{16}$	X	X	X	X	X	X	X	X	X	X	—	—	—	—
$^3/_8$	—	X	X	X	X	X	X	X	X	X	X	X	—	—
$^7/_{16}$	—	X	X	X	X	X	X	X	X	X	X	X	—	—
$^1/_2$	—	—	X	X	X	X	X	X	X	X	X	X	X	X
$^5/_8$	—	—	—	X	X	X	X	X	X	X	X	X	X	X
$^3/_4$	—	—	—	—	X	X	X	X	X	X	X	X	X	X
$^7/_8$	—	—	—	—	—	X	X	X	X	X	X	X	X	X
1	—	—	—	—	—	—	—	X	X	X	X	X	X	X

For shorter lengths see Table 12 for Screws. See also Table 15 for shortest lengths designated as bolts.

Table 12 — Grade A Bright Hexagon Screws

Nominal size *D*	Nominal length in inches												
	$^1/_2$	$^5/_8$	$^3/_4$	1	$1^1/_4$	$1^1/_2$	$1^3/_4$	2	$2^1/_4$	$2^1/_2$	3	$3^1/_2$	4
$^1/_4$	X	X	X	X	X	X	—	—	—	—	—	—	—
$^5/_{16}$	X	X	X	X	X	X	X	X	—	—	—	—	—
$^3/_8$	—	—	X	X	X	X	X	X	—	—	—	—	—
$^7/_{16}$	—	—	—	X	X	X	X	X	—	—	—	—	—
$^1/_2$	—	—	—	X	X	X	X	X	—	—	—	—	—
$^5/_8$	—	—	—	—	X	X	X	X	X	X	X	—	—
$^3/_4$	—	—	—	—	—	X	X	X	X	X	X	—	—
$^7/_8$	—	—	—	—	—	—	—	—	X	X	X	X	X
1	—	—	—	—	—	—	—	—	—	X	X	X	X

Table 13 — Grade S heat treated hexagon bolts

Nominal size *D*	Nominal length in inches																
	1 1/8	1 1/4	1 3/8	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/4	3 1/2	4	4 1/2	5	5 1/2	6
1/4	X	X	X	X	X	X	X	X	X	X	X	X	X	—	—	—	—
5/16	—	X	X	X	X	X	X	X	X	X	X	X	X	X	X	—	X
3/8	—	—	X	X	X	X	X	X	X	X	X	X	X	X	X	—	X
7/16	—	—	—	X	X	X	X	X	X	X	X	X	X	X	X	—	X
1/2	—	—	—	—	X	X	X	X	X	X	X	X	X	X	X	X	X
5/8	—	—	—	—	—	X	X	X	X	X	X	X	X	X	X	X	X
3/4	—	—	—	—	—	—	X	X	X	X	X	X	X	X	X	X	X
7/8	—	—	—	—	—	—	—	X	X	X	X	X	X	X	X	X	X
1	—	—	—	—	—	—	—	—	X	X	X	X	X	X	X	X	X

For shorter lengths see Table 14 for Screws. See also Table 15 for shortest lengths designated as bolts.

Table 14 — Grade S heat treated hexagon screws

Nominal size *D*	Nominal length in inches														
	1/2	5/8	3/4	7/8	1	1 1/4	1 1/2	1 3/4	2	2 1/4	2 1/2	2 3/4	3	3 1/2	4
1/4	X	X	X	X	X	X	X	—	X	X	X	X	X	—	—
5/16	—	X	X	X	X	X	X	—	X	X	X	X	X	X	X
3/8	—	—	X	X	X	X	X	—	—	—	—	—	—	—	—
7/16	—	—	X	X	X	X	X	X	X	X	X	X	X	X	X
1/2	—	—	—	X	X	X	X	X	X	X	X	X	X	X	X
5/8	—	—	—	—	—	X	X	X	X	X	X	X	X	X	X
3/4	—	—	—	—	—	—	X	X	X	X	X	X	X	X	X
7/8	—	—	—	—	—	—	X	X	X	X	X	X	X	X	X
1	—	—	—	—	—	—	—	—	X	X	X	X	X	X	X

Table 15 — Shortest lengths designated as bolts
(See Clause **12** a)

Nominal size *D*	**Shortest length of bolt**
in	in
1/4	1 1/8
5/16	1 1/4
3/8	1 3/8
7/16	1 1/2
1/2	1 5/8
9/16	1 7/8
5/8	2
3/4	2 1/4
7/8	2 1/2
1	2 3/4
1 1/8	3 1/4
1 1/4	3 1/2
1 3/8	4
1 1/2	4 1/4
1 3/4	4 3/4
2	5 1/2

Appendix E Details of identification marking for unified hexagon bolts, screws & nuts (see Clause 16)

NOTE All dimensions given are for the guidance of the manufacturer and are not part of the requirements of the standard.
NOTE The groove is approximately midway between the major diameter of the thread and the flats of the hexagon. The groove shall not exceed 0.020 in wide and 0.010 in deep.

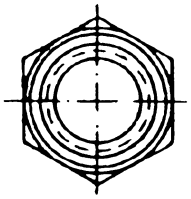


Figure 23 — Ordinary nut and thick nut with indented groove

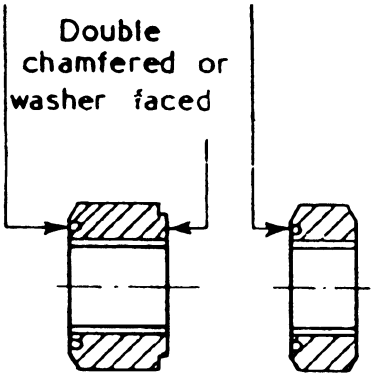


Figure 24 — Lock nut with indented groove

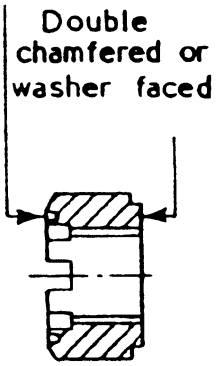
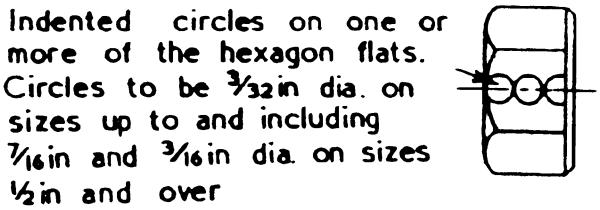
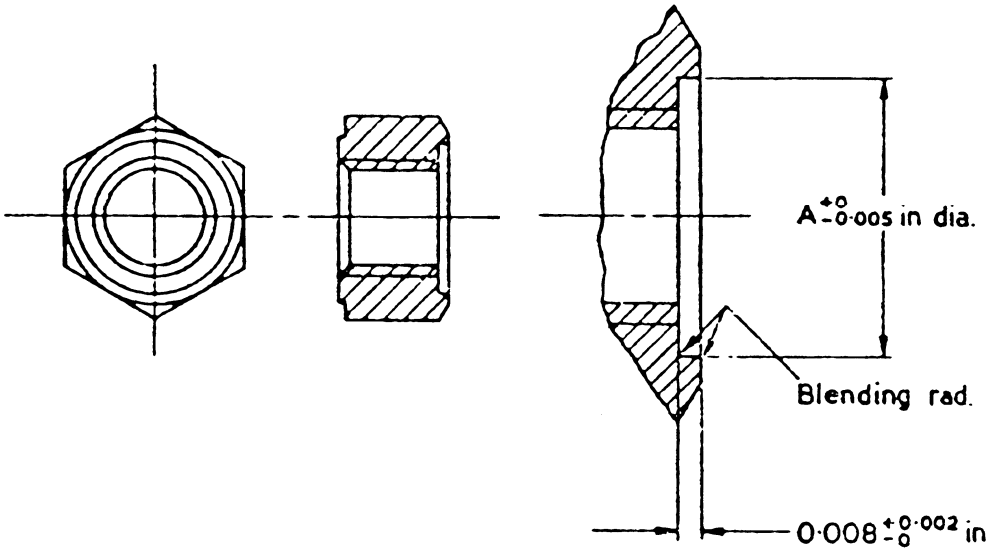


Figure 25 — Slotted nut and thick slotted nut with indented groove



NOTE For convenience an ordinary nut only is illustrated.

Figure 26 — Ordinary nut, thick nut, lock, slotted or thick slotted nut with indented circles



Nominal dia.	*A* dia.
in	in
1/4	0.345
5/16	0.408
3/8	0.470
7/16	0.563
1/2	0.626
9/16	0.719
5/8	0.782
3/4	0.938
7/8	1.093

Figure 27 — Washer faced

Figure 28 — Enlarged part section through recess

Alternative methods of identification permissible on nuts.

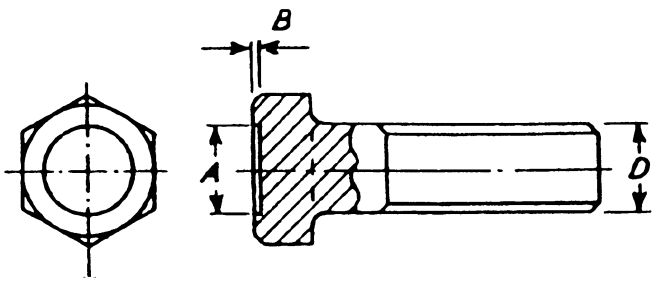


Figure 29 — Bolt or screw with recess

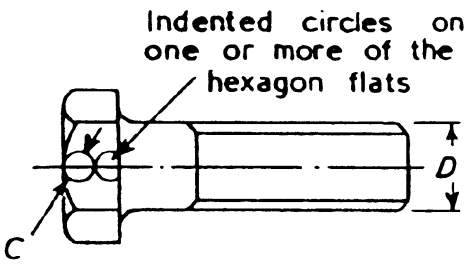


Figure 30 — Bolt or screw with indented circles

Alternative methods of identification permissible on bolts and screws

1	2	3	4	5	6
Nominal size *D*	**Recess**				**Indented circles**
	Diameter *A*		**Depth** *B*		**Diameter** *C*
	max.	**min.**	**max.**	**min.**	**nom.**
in	in	in	in	in	in
$^1/_4$	$^1/_4$	$^3/_{16}$	0.008	0.005	$^3/_{32}$
$^5/_{16}$	$^5/_{16}$	$^1/_4$	0.008	0.005	$^3/_{32}$
$^3/_8$	$^3/_8$	$^5/_{16}$	0.008	0.005	$^3/_{32}$
$^7/_{16}$	$^7/_{16}$	$^3/_8$	0.013	0.010	$^3/_{32}$
$^1/_2$	$^1/_2$	$^7/_{16}$	0.013	0.010	$^3/_{16}$
$^9/_{16}$[a]	$^9/_{16}$	$^1/_2$	0.013	0.010	$^3/_{16}$
$^5/_8$	$^5/_8$	$^9/_{16}$	0.018	0.015	$^3/_{16}$
$^3/_4$	$^3/_4$	$^{11}/_{16}$	0.018	0.015	$^3/_{16}$
$^7/_8$	$^7/_8$	$^{13}/_{16}$	0.018	0.015	$^3/_{16}$
1	1	$^{15}/_{16}$	0.018	0.015	$^3/_{16}$
$1^1/_8$	$1^1/_8$	$1^1/_{16}$	0.030	0.020	$^1/_4$
$1^1/_4$	$1^1/_4$	$1^3/_{16}$	0.030	0.020	$^1/_4$
$1^3/_8$[a]	$1^3/_8$	$1^5/_{16}$	0.030	0.020	$^1/_4$
$1^1/_2$	$1^1/_2$	$1^7/_{16}$	0.030	0.020	$^1/_4$
$1^3/_4$	$1^3/_4$	$1^{11}/_{16}$	0.030	0.020	$^1/_4$
2	2	$1^{15}/_{16}$	0.030	0.020	$^1/_4$

[a] To be dispensed with wherever possible.

Appendix F Formulae

For dimensions of hexagons for standard bolts, screws and nuts reference should always be made to Table 1, Table 2 and Table 3. The proportions of hexagons for bolts, screws and nuts in intermediate sizes and sizes larger than 2 in should be derived from the formulae extracted from the American Standard and given below. Tolerances may be extrapolated from Table 1, Table 2 or Table 3 as appropriate.

Bolts and screws heads			
Width across flats		**Height of head**	
Nominal size D	**Width**	**Nominal size** D	**Height**
in	in	in	in
$\frac{1}{4}$	$1\frac{1}{2}\,D + \frac{1}{16}$	$\frac{1}{4}$ to $\frac{7}{8}$	$\frac{5}{8}\,D$
$\frac{5}{16}$ to 4	$1\frac{1}{2}\,D$	1 to $1\frac{7}{8}$	$\frac{5}{8}\,D - \frac{1}{84}$
—	—	2 to $2\frac{3}{4}$	$\frac{5}{8}\,D - \frac{1}{32}$
—	—	3	$\frac{5}{8}\,D$
—	—	$3\frac{1}{4}$ to $3\frac{3}{4}$	$\frac{5}{8}\,D - \frac{1}{16}$
—	—	4	$\frac{5}{8}\,D$

Nuts				
	Width across flats		**Thickness of nut**	
	Nominal size D	**Width**	**Nominal size** D	**Thickness**
	in	in	in	in
Ordinary and slotted	$\frac{1}{4}$	$1\frac{1}{2}\,D + \frac{1}{16}$	$\frac{1}{4}$ to $\frac{5}{8}$	$\frac{7}{8}\,D$
	$\frac{5}{16}$ to 3	$1\frac{1}{2}\,D$	$\frac{3}{4}$ to $1\frac{1}{8}$	$\frac{7}{8}\,D - \frac{1}{64}$
			$1\frac{1}{4}$ to 2	$\frac{7}{8}\,D - \frac{1}{32}$
			$2\frac{1}{4}$ to 3	$\frac{7}{8}\,D - \frac{1}{64}$
Lock	$\frac{1}{4}$	$1\frac{1}{2}\,D + \frac{1}{16}$	$\frac{1}{4}$ to $\frac{5}{8}$	(See Table)
	$\frac{5}{16}$ to 3	$1\frac{1}{2}\,D$	$\frac{3}{4}$ to $1\frac{1}{8}$	$\frac{1}{2}\,D + \frac{3}{64}$
			$1\frac{1}{4}$ to 2	$\frac{1}{2}\,D + \frac{3}{32}$
			$2\frac{1}{4}$	$\frac{1}{2}\,D + \frac{5}{64}$
			$2\frac{1}{2}$ to 3	$\frac{1}{2}\,D + \frac{13}{64}$
Thick and thick slotted	$\frac{1}{4}$	$1\frac{1}{2}\,D + \frac{1}{16}$	(See Table)	
	$\frac{5}{16}$ to $1\frac{1}{2}$	$1\frac{1}{2}\,D$		

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