

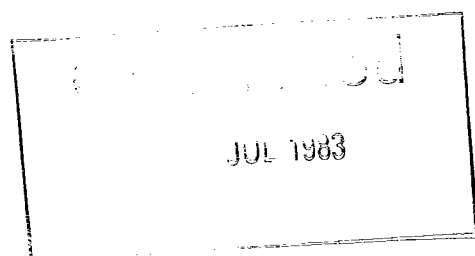


Specification for
**Piston rings up to 200 mm diameter for
reciprocating internal combustion engines**

**Part 1. Designs, dimensions, materials and
designations for single piece rings**

Spécification pour segments de piston jusqu'à 200 mm de diamètre
pour moteurs alternatifs à combustion interne
Partie 1. Segments en une pièce. Calculs, dimensions, matériaux et désignations

Spezifikation für Kolbenringe mit Durchmesser bis 200 mm für Kolbenmotoren
Teil 1. Einteilige Ringe. Berechnungen, Abmessungen, Werkstoffe und Bezeichnungen



BS 5341 : Part 1 : 1976

Contents

	Page		Page
Foreword		Inside front cover	9
Cooperating organizations		Back cover	9
Specification			
Section one. General		6. Closed gaps	9
1. Scope	1	7. Dimensions of side notch	9
2. References	1	8. Width of internal notch b_2 at nominal diameter d_1	9
3. Definitions	1	9. Depth of overlap for internal notch a_5	9
Section two. General survey of piston rings		10. Dimensions for internal bevel and internal step	10
4. General explanations	4	11. Typical machine finishes, surface textures and their symbols	10
5. Applications of piston rings	4	12. Values for barrelling and gauge width	11
6. Designations of piston rings	4	13. Dimensions for chromium inlaid peripheries	11
7. Marking of rings	5	14. Dimensions for molybdenum inlaid peripheries	12
8. Materials and their symbols	7	15. Dimensions of plain compression rings	13
9. Designs and their symbols	7	16. Dimensions of tapered compression rings	16
10. Intermediate sizes and oversizes for reboring	12	17. Dimensions of 15° Keystone (wedge) rings	19
11. Packing position	12	18. Dimensions of 6° Keystone (wedge) rings	22
12. Dimensions	12	19. Dimensions of Napier scraper rings	24
Section three. Plain compression rings	13	20. Dimensions of stepped scraper rings	29
Section four. Tapered compression rings	16	21. Dimensions of slotted oil control rings	34
Section five. 15° Keystone (wedge) rings	19	22. Dimensions of bevelled edge oil control rings	39
Section six. 6° Keystone (wedge) rings	21	23. Dimensions of double bevelled oil control rings	43
Section seven. Napier scraper rings	24	Figures	
Section eight. Stepped scraper rings	28	1. Nomenclature for piston ring types	2
Section nine. Slotted oil control rings	33	2. Nomenclature for piston and piston ring details	3
Section ten. Bevelled edge oil control rings	38	3. Difference in diameter $d_3 - d_4$	7
Section eleven. Double bevelled oil control rings	42	4. Negative point deflection	8
Tables		5. Tangential force	8
1. Symbols and definitions	5	6. Diametral force to diameter	8
2. Range of standard types of rings	6	7. Diametral force to closed gap	8
3. Typical materials and force factors	7	8. Joint with side notch	9
4. Ovality	7	9. Joint with internal notch	9
5. Negative point deflection	8	10. Compression ring with internal bevel	10
		11. Compression ring with internal step	10
		12. Periphery barrel faced	11
		13. Periphery inlaid with chromium	11
		14. Periphery inlaid with molybdenum	12
		15. Plain compression ring	13
		16. Tapered compression ring	16
		17. 15° Keystone (wedge) ring	17
		18. 6° Keystone (wedge) rings	21
		19. Napier scraper ring	24
		20. Stepped scraper ring	28
		21 (a). Slotted oil control ring	33
		21 (b). Arrangement of slots	37
		22. Bevelled edge oil control ring	38
		23. Double bevelled oil control ring	42

Foreword

This British Standard was prepared under the authority of the Mechanical Engineering Standards Committee and specifies, in metric units, the data for a complete range of rationalized sizes for standard types of piston rings for reciprocating internal combustion engines.

It has been prepared primarily to provide a basis for rationalization of sizes, materials and other characteristics of piston rings and incorporates current good practice used within the internal combustion engines industry. This standard supersedes BS 3627, 'Dimensions of compression and oil control rings and piston ring grooves for I.C. engines' (in imperial units) which however, will be retained until such time as it is no longer required by industry.

In the preparation of this standard consideration was given to the equivalent German DIN Standards for piston rings for automotive engineering.

The standard is prepared in five Parts. Other Parts of the standard (in course of preparation) are:

- Part 2 Designs, dimensions, materials and designations for multi-piece oil control rings
- Part 3 Quality requirements
- Part 4 Measuring and testing procedures
- Part 5 Ring grooves

British Standard Specification for

Piston rings up to 200 mm diameter for reciprocating internal combustion engines

Part 1. Designs, dimensions, materials and designations for single piece rings

Section one. General

1. Scope

This part of BS 5341 specifies nominal diameters, radial thicknesses, widths, closed gaps, forces, surface textures and other features of design applicable to various types of single piece compression, scraper and oil control piston rings from 30 mm to 200 mm diameter for both two and four stroke cycle spark and compression ignition reciprocating internal combustion engines.

It also specifies designation coding, materials, joint notches, peripheral shape, coatings, inlays and surface treatments, and applications of various types of rings.

NOTE. Unless otherwise stated, the dimensions specified in the standard are suitable for both liquid cooled and air cooled engines.

This Part of BS 5341 is composed of eleven sections. Sections one and two give general data on types of piston rings, materials, designs, designation, applications, and explanations and sections three to eleven give the basic range of sizes and specific data for each individual type of ring.

2. References

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

3. Definitions

For the purposes of this Part of BS 5341, the following definitions apply.

Nomenclature for piston ring types and for piston and ring details is given in figures 1 and 2.

3.1 single piece ring. A ring comprising only one part which is intended for assembly in a single ring groove.

3.2 multi-piece ring. A ring comprising two or more component parts which are intended for assembly in a single ring groove.

3.3 ring groove. The groove into which the piston ring is fitted.

3.4 compression ring. A ring intended primarily to prevent the leakage of gas past the piston in either direction.

3.5 oil control ring. A ring having oil return slots or equivalent and intended for scraping splashed oil from the cylinder wall and returning it to the sump.

3.6 scraper ring. A ring which does not have slots but which is intended primarily to scrape oil from the cylinder wall. It can also act as a lower compression ring.

3.7 nominal cylinder bore and ring diameter (symbol d_1). The minimum cylinder bore diameter.

3.8 bore gauge. A ring gauge having an inside diameter of nominal (minimum) cylinder bore diameter.

3.9 modulus of elasticity (E_n value). The nominal calculated value based on a ring test.

3.10 closed gap (symbol s_1). The gap at the butt ends of the ring, measured at standard temperature at the narrowest point of the gap, which the ring would have when fitted into a bore gauge of nominal (minimum) cylinder bore diameter, to allow for thermal circumferential expansion in service.

3.11 butting. That which occurs when the ends of the ring touch.

3.12 total free gap (symbol p). The distance between the butt ends of the ring in a free unstressed state measured at the inner edges of the butt ends.

3.13 effective free gap (symbol g_f). The total free gap minus the mean closed gap s_1 . It is the free gap used in the formulae for the calculations of E_n value, tangential and diametral forces and closing stress.

3.14 joint. The joint at the butt ends of the ring (see 9.6).

3.15 negative point deflection (toe-in) (symbol W). The deviation of the butt ends inside a true circle when the ring is restrained to the nominal diameter and is unsupported near the butt ends within a specified arc (see 9.2.2).

3.16 positive ovality (high points) (symbol V). The difference by which the diameter measured at the gap is greater than the diameter measured at 90° to the gap with the ring compressed to closed gap within a tape (see 9.2.1).

3.17 negative ovality (low points) (symbol Y). The difference by which the diameter measured at the gap is less than the diameter measured at 90° to the gap with the ring compressed to closed gap within a tape (see 9.2.1).

3.18 pressure pattern. The polar diagram of the radial pressure distribution around the circumference of the ring when closed in its nominal cylinder bore.

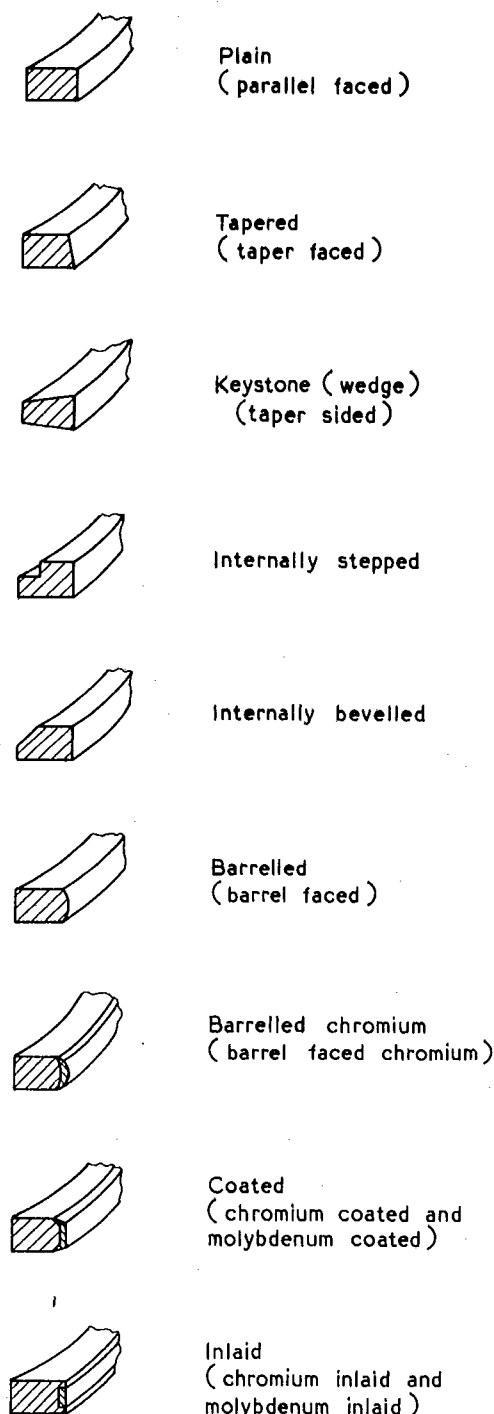
3.19 pin point or burry light. Intermittent pin points of bright light or hazy light, and not bright direct light.

3.20 DATUM surface. The plane on which the unloaded ring lies in its free state for measurements, except where otherwise specified.

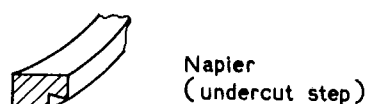
3.21 twist (dish). The deviation of the section of ring from the datum surface when ring is restrained to nominal diameter. It can be intentional (as in the case of asymmetrical rings, such as those internally stepped) or unintentional (as in the case of symmetrical rings, such as plain compression).

BS 5341 : Part 1 : 1976

(a) Compression rings



(b) Scraper rings



(c) Oil Control rings

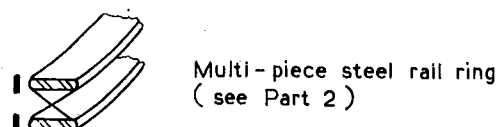
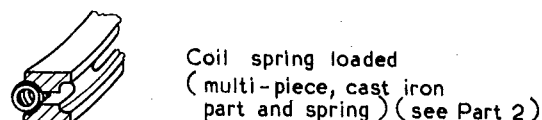
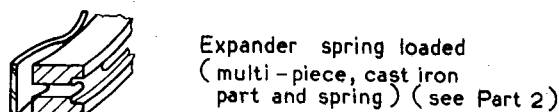
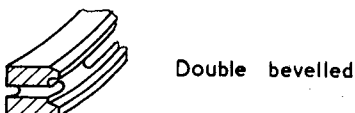


Figure 1. Nomenclature for piston ring types

3.22 wind. Circumferential twist or relative displacement of butt ends in the axial direction.

3.23 witness land. A small land of approximately 0.25 mm, lapped on the periphery of a taper faced ring or twist type ring, which can be just seen or witnessed around the circumference with normal vision.

3.24 sticking. The filling of the ring side clearance, resulting in the loss of free movement of the ring in its groove.

3.25 scuffing. The partial welding and tearing of the ring periphery and the cylinder bore resulting from breakdown of the oil film. Scuffed peripheries have a torn or smeared appearance, usually accompanied by a discoloration of the lacerated portions.

3.26 blowby. The escape of gas from the combustion chamber, past the rings and into the crankcase.

3.27 tangential and diametral force. See 9.4.

NOTE. Other terms which are not defined in clause 3 are, together with their symbols, given in Part 4* of this standard.

*In course of preparation.

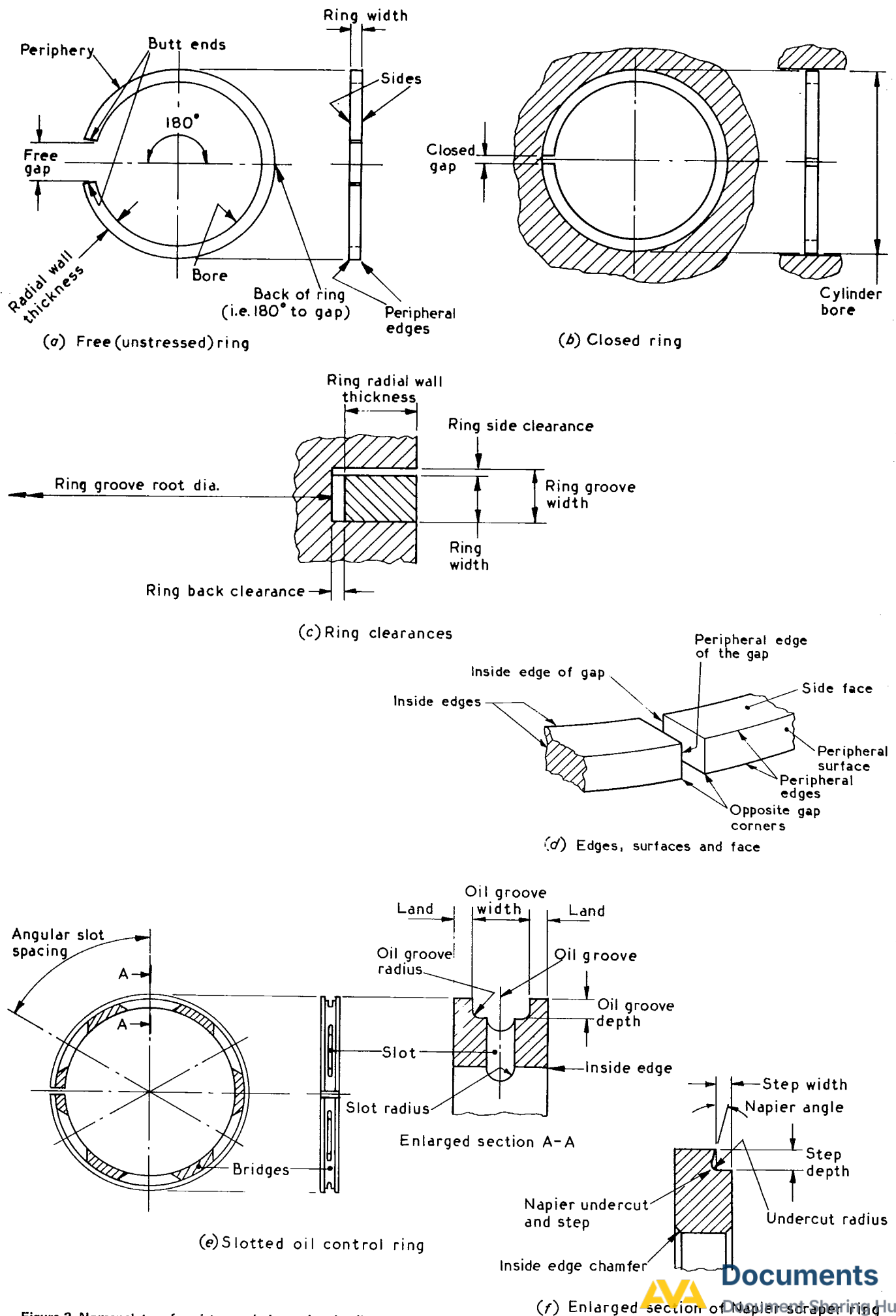


Figure 2. Nomenclature for piston and piston ring details

Section two. General survey of piston rings

4. General explanations

4.1 Grey cast iron is generally suitable for piston ring applications but is not always adequate for some piston rings, particularly in the top ring groove. Other materials which are employed have therefore been included in the standard and the most important data concerning these materials is given. Alternatively, improvement may be obtained by variation in machining or coating the ring periphery, and the variations are included in table 1.

4.2 Details on features of quality in piston rings such as permissible values for barrelling, radial land offsetting, axial joint displacement, etc. are specified in Part 3* of this standard.

4.3 All materials and designs are summarized in section two, which includes a tabular survey (table 2) of the ring types and also shows the limitations in their application. Thus, sections three to eleven for the various types of rings contain only the dimensional details and loads for the various ring cross sections.

4.4 This standard does not specify oversize dimensions of rings but specifies, in clause 10 of this Part, the methods to be adopted to obtain dimensions and characteristics of all intermediate sized rings, including oversize rings, not directly specified in the tables.

4.5 It is recognized that particular applications may necessitate requirements other than those given in this standard. In these cases it will be necessary to specify such details directly to the supplier. Except for such details, the remaining ring dimensions and characteristics shall comply with this standard.

4.6 The forces specified in sections three to eleven are for rings manufactured in as-cast grey cast iron (symbol UO). For rings manufactured in other materials, factors are given in table 3 by which the forces must be multiplied in order to obtain the required force for the material concerned.

In addition, for rings having certain additional features of design (i.e. internal step, internal bevel and/or molybdenum or chromium layer) factors are given in 9.7.2(b), 9.7.2(a) and 9.4.5 respectively by which these forces must also be multiplied in order to obtain the required force for the design features concerned.

4.7 The details specified in section two for the following parameters apply to all the rings shown in sections three to eleven inclusive:

designation
marking
material
manufacturing process
light tightness
tangential and diametral forces
closed gap
notches to prevent ring rotation
chamfering
surface finish

Reference should be made also to Parts 3* and 4* of this standard for information on piston ring quality requirements.

NOTE. It is recommended that inspection procedures should be based on BS 6000.

*In course of preparation.

5. Applications of piston rings

5.1 The tapered compression rings specified in section four serve to give an immediate seal and thus a shorter running-in period.

5.2 The Keystone (wedge) rings specified in sections five and six are used when parallel sided compression rings are subject to sticking in the ring groove.

5.3 The scraping effect of the rings specified in sections nine, ten and eleven becomes increasingly intense in the sequence from slotted oil control rings to double bevelled oil control rings.

5.4 For engines under a particularly high thermal load the closed gap may be selected from table 6. Stop pegs for preventing the ring from rotating should preferably be used only for piston rings which run across cylinder ports, e.g. in two stroke engines.

NOTE. Chromium plated piston rings are not suitable for use in chromium plated cylinder bores.

6. Designations of piston rings

6.1 The symbols for the various materials and designs are given in table 1 and clauses 8 and 9.

6.2 To designate piston rings complying with the requirements of this standard the following details shall be given in the sequence shown.

- (a) Type e.g. R-ring.
- (b) Size, $d_1 \times h_1$, e.g. 90 x 2.5.
- (c) The number of this British Standard, i.e. BS 5341.
- (d) A hyphen.
- (e) The material symbol given in table 3.
- (f) The symbol for the manufacturing process given in 9.1.
- (g) The symbol for the selected closed gap given in 9.5, if the closed gap differs from the closed gap given in the dimensional tables in the individual sections.
- (h) The symbol for the selected notch to prevent ring rotation given in 9.6.
- (j) The symbol for the selected edge features given in 9.7.
- (k) The symbol for the selected surface finish given in 9.8.

6.3 The following are examples of designations:

- (a) Designation for a plain compression ring complying with the requirements of section three of nominal diameter $d_1 = 90$ mm and ring width $h_1 = 2.5$ mm:
R-ring 90 x 2.5 BS 5341.
- (b) Designation for a compression ring as in (a) but made of spheroidal graphite cast iron (U6), cam turned round (FZ), minimum closed gap 0.3 mm (S4), inside edges chamfered (KI), periphery chromium coated with a thickness of coating of 0.06 mm min. and barrel faced (CLIB), phosphated all over (P):
R-ring 90 x 2.5 BS 5341 — U6 FZ S4 KI CLIB P.

6.4 Other examples of designations are given in sections three to eleven as appropriate.

Table 1. Symbols and definitions

Symbol	Definition	Relevant section or clause reference
R-ring	Plain compression ring	Section three
M-ring	Tapered compression ring	Section four
T-ring 15 °	15 ° Keystone (wedge) ring	Section five
T-ring 6 °	6 ° Keystone (wedge) ring	Section six
N-ring	Napier scraper ring	Section seven
Z-ring	Stepped scraper ring	Section eight
S-ring	Slotted oil control ring	Section nine
D-ring	Bevelled edge oil control ring	Section ten
G-ring	Double bevelled oil control ring	Section eleven
d_1	Nominal ring diameter	Sections three to eleven
h_1	Nominal ring width	Sections three to eleven
UO to U7	Materials	Clause 8
F	Cam turned	9.1(a)
V	Positive ovality	9.1(b)
Z	Round	9.1(c)
Y	Negative ovality	9.1(d)
N	Not cam turned	9.1(e)
W	Negative point deflection	9.1(f)
S1 to S9	Closed gap	9.5
T1 to T6	Joint with side notch	9.6.1
H1 to H4	Joint with internal notch	9.6.2
KA	Peripheral edges chamfered	9.7.1(a)
KI	Inside edges chamfered	9.7.1(b)
IF	Internal bevel	9.7.2(a)
IW	Internal step	9.7.2(b)
G	Ground finish	9.8.1

Table 1 (concluded)

Symbol	Definition	Relevant section or clause reference
FT	Fine turned finish	9.8.1
CT	Coarse turned finish	9.8.1
EF	Extra fine turned finish	9.8.1
L	Lapped finish	9.8.1
B	Periphery barrel faced	9.8.1.1
CL1 to CL3	Periphery coated with chromium	9.8.2.1(a) to (c)
C1 to C3	Periphery inlaid with chromium	9.8.2.2(a) to (c)
M1 to M3	Periphery inlaid with molybdenum	9.8.2.3(a) to (c)
ML1 to ML3	Periphery coated with molybdenum	9.8.2.4(a) to (c)
SNL	Periphery tin plated	9.8.2.5
SN	Tin plated all over	9.8.5.3
CUL	Periphery copper plated	9.8.2.6
CU	Copper plated all over	9.8.5.4
FE	Ferroxided all over	9.8.5.1
P	Phosphated all over	9.8.5.2

7. Marking of rings

The following markings apply to rings of 1.6 mm wall thickness and above. Marking of rings below 1.6 mm is at the choice of the supplier. Rings shall be marked on the side of the ring facing the combustion chamber with the following information.

- (a) A mark identifying the top side for the tapered compression rings specified in section four, Napier scraper rings, stepped scraper rings, double bevelled oil control rings and rings with internal bevel or step.

NOTE. The type of mark is subject to agreement between the supplier and the purchaser.

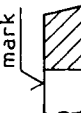
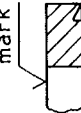
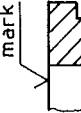
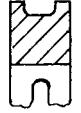
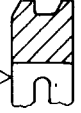
- (b) The supplier's symbol, or other form of identification agreed between the supplier and the purchaser.

- (c) Any other mark agreed between the supplier and the purchaser.

BS 5341 : Part 1 : 1976

Table 2. Range of standard types of rings

All dimensions are in millimetres.

Ring types		Compression rings				Scraper rings		Oil control rings		
Denomination		R-ring	M-ring*	T-ring 15°	T-ring 6°	N-ring*	Z-ring*	S-ring	D-ring	G-ring
Cross section										
Relevant section		Three	Four	Five	Six	Seven	Eight	Nine	Ten	Eleven
Nominal diameter d_1		30 to 200	30 to 200	82 to 200	70 to 200	30 to 200	30 to 200	50 to 200	50 to 200	50 to 200
Clause reference	Symbol †	Applicable for nominal diameter d_1								
8	U0	yes	yes	yes	yes	yes	yes	yes	yes	yes
	U1	yes	yes	yes	yes	yes	yes	yes	yes	yes
	U2	yes	yes	yes	yes	yes	yes			
	U3	yes	yes	yes	yes	yes	yes	yes	yes	yes
	U4	yes	yes	yes	yes	yes	yes	yes	yes	yes
	U5	yes	yes	yes	yes	yes	yes	yes	yes	yes
	U6‡	yes	yes	yes	yes					
	U7‡	yes	yes	yes	yes					
9.6	T and H	38 to 120	38 to 120	82 to 120	70 to 120					
9.7	KA	yes		yes	yes					
	IF	yes*	yes*	yes*	yes*	yes*	yes*			
	IW	yes*	yes*	yes*	yes*					
	B	yes		yes	yes					
	C...	yes		yes	yes					
9.8	CL..	yes	yes	yes	yes			yes		
	M	yes		yes	yes					
	ML..	yes		yes	yes					

* These rings should be fitted with the mark indicating the top side towards the combustion chamber.

† For explanation of symbols see table 1 and clauses 8 and 9.

‡ Coated rings only.

Table 3. Typical materials and force factors

Symbol	Material type	Typical modulus of elasticity (E_n) GN/m ² (=GPa)	Minimum ring tensile strength N/mm ² (=MPa)	Minimum bending strength N/mm ² (=MPa)	Minimum Brinell hardness*	Factor for force values
U0	Grey cast iron: as-cast	100	300	411	200	†
U1	Spun grey cast iron: as-cast	115	280	383	230	1.15
U2	Sintered iron	125	400	548	‡	1.25
U3	Cast iron: heat treated as required	150	430	589	255	1.5
U4	Cast iron: heat treated as required	160	500	685	230	1.6
U5	Cast iron: heat treated as required	160	600	822	270	1.6
U6	Spheroidal graphite iron: heat treated (coated)	160	925§	1265	260	1.6
U7	Steel specification No. 420S45 (BS 970 : Part 4)	200	—	—	—	1.6

*Brinell hardness HB2/120. The hardness values are averages from 3 measurements on one ring, one measurement at the joint, one 90° and one 180° away from the joint. HB hardness testing shall be carried out as specified in BS 240 : Part 1.

†The force values are given in tables 15 to 23.

‡No hardness is quoted for sintered iron because of its dependence on porosity.

§Measured by skin stress method.

NOTE. Methods of measurement for modulus of elasticity, bending strength and skin stress are given in Part 4|| of this standard.

8. Materials and their symbols

Table 3 gives examples of typical materials used for piston rings. It includes factors for obtaining forces (see also 9.4). These factors are multiplied by the force values given in the tables in sections three to eleven in order to obtain the correct force for the material concerned.

NOTE. Materials should be chosen in consultation with the piston ring supplier.

9. Designs and their symbols

9.1 Manufacturing process. The following symbols relate to the method of manufacture as indicated:

- (a) F : cam turned;
- (b) V : positive ovality;
- (c) Z : round;
- (d) Y : negative ovality;
- (e) N : not cam turned;
- (f) W : negative point deflection (not for petrol engine rings).

NOTE. The methods of manufacture specified above are not in any way an indication of the pressure pattern.

|| In course of preparation.

9.2 Ring shape

9.2.1 Ovality. Figure 3 and table 4 give the difference in diameters ($d_3 - d_4$), with the ring compressed in a flexible steel tape, 0.08 mm to 0.10 mm thick (and not clamped axially), to the closed gap as defined in clause 3.

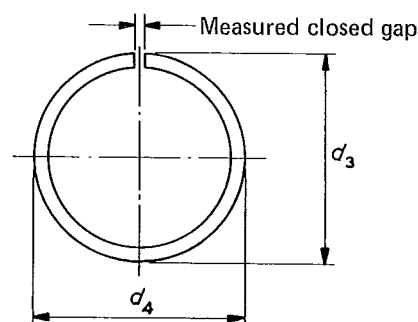


Figure 3. Difference in diameter $d_3 - d_4$

Table 4. Ovality

All dimensions are in millimetres.

Nominal diameter d_1	$d_3 - d_4$		
	Positive ovality	Round	Negative ovality
30 to 100	0 to +0.6	-0.3 to +0.2	0 to -0.5
102 to 200	0 to +1.0	-0.45 to +0.25	0 to -0.7

9.2.2 Negative point deflection. Negative point deflection is the deviation of the butt ends inside a true circle (see figure 4 and table 5) when restrained to nominal diameter unsupported near the ends over a specified arc θ .

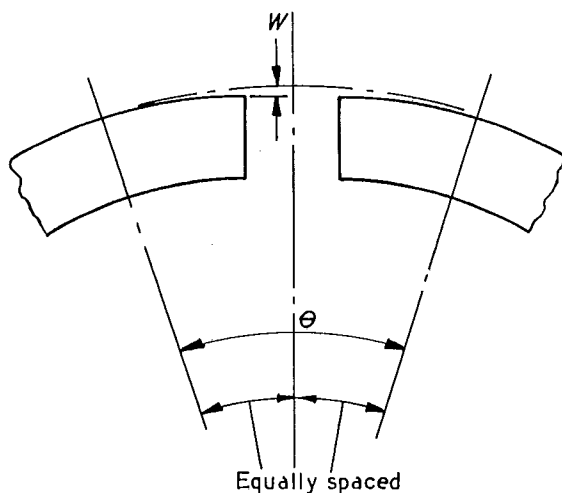


Figure 4. Negative point deflection

Table 5. Negative point deflection

All dimensions are in millimetres.

Nominal diameter d_1	Gauge angle θ	Negative point deflection W
30 to 200	$36 \pm 1^\circ$	-0.1 to -0.7

9.3 Light tightness

9.3.1 Other than the rings specified in 9.3.2, and unless otherwise agreed all rings shall be 100 % light tight when tested in accordance with Part 4* of this standard. However, for rings with negative point deflection, visible light shall be confined to within 18° either side of the ring gap.

9.3.2 The following designs with line contact are acceptable if, in the circumferential areas required to be light tight, there appears pin point or burry light:

- tapered compression rings
- Napier scraper rings
- stepped scraper rings
- internally bevelled rings
- internally stepped rings.

* In course of preparation.

9.3.3 In the case of rings treated as specified in 9.8.5, the light tightness of the periphery is measured before surface treatment.

9.4 Tangential force (preferred method for rings 50 mm diameter d_1 and above) and diametral force

9.4.1 F_t is the tangential force necessary to maintain the ring at the closed gap condition by means of a tangential pull on the ends of a circumferential steel tape as shown in figure 5. Part 4* of this standard specifies the method of applying the force.

9.4.2 F_d is the force, acting diametrically at 90° to the gap, necessary to maintain the ring at the nominal ring diameter condition measured in the direction of the force as shown in figure 6. Part 4* of this standard specifies the method of applying the force.

9.4.3 F_{ds} is the force, acting diametrically at 90° to the gap, necessary to maintain the ring at the closed gap condition, measured in the direction of the force as shown in figure 7. Part 4* of this standard specifies the method of applying the force.

NOTE. For piston rings with nominal diameter $d_1 \geq 50$ mm it is recommended that F_d and F_{ds} are used for production inspection only. To obtain reliable readings from diametral force measuring machines, it is necessary that the machine be calibrated against test rings the closing forces of which have been previously determined by the preferred tangential method, except for rings below 50 mm diameter when the diametral force F_d shall be used as specified.

9.4.4 The values for F_t and F_d given in tables 15 to 23 apply to as-cast grey cast iron with a typical modulus of elasticity (E_n) of 100 GN/m^2 (=GPa) (symbol U0).

For the other materials in table 3 the forces given in tables 15 to 23 shall be multiplied by the appropriate factors given in table 3.

9.4.5 For peripheral coated and inlaid rings, the forces F_t and F_d fall to 0.9 times the values given in tables 15 to 23.

Conversions

$F_d = 2.05 F_t$ for heat treated and as-cast materials.

$F_d = 2.15 F_t$ for spheroidal graphite cast irons and steel.

$F_{ds} = 2.63 F_t$.

9.5 Closed gap. The closed gap s_1 is related to the nominal (minimum) diameter d_1 .

Whenever the selected closed gap differs from the closed gap given in tables 15 to 23, the symbols in table 6 apply, the limits remaining as given in tables 15 to 23.

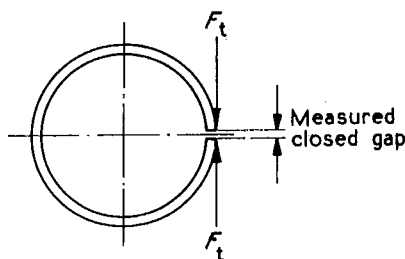


Figure 5. Tangential force

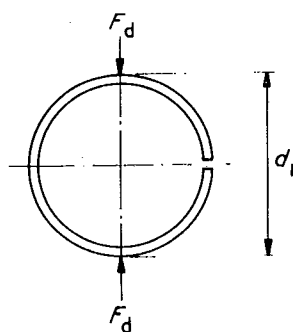


Figure 6. Diametral force to diameter

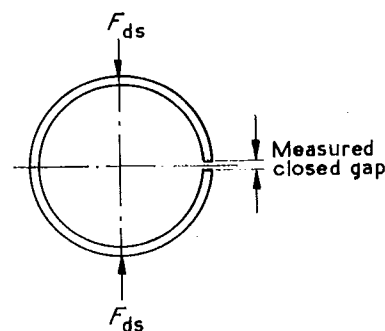


Figure 7. Diametral force to closed gap

The closed gaps given in tables 15 to 23 do not apply for rings in sintered iron, spheroidal graphite iron or in steel, as these materials have higher coefficients of thermal expansion than the other materials and consequently require larger closed gaps than those specified. These shall be as recommended by the supplier.

Table 6. Closed gaps (minimum closed gap; limits shall be as specified in the individual dimensional tables 15 to 23 depending on the type of ring and the nominal diameter).

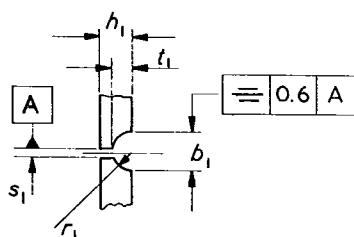
All dimensions are in millimetres.

Symbol	Closed gap s_1	Symbol	Closed gap s_1
S1	0.05	S6	0.5
S2	0.1	S7	0.6
S3	0.2	S8	0.8
S4	0.3	S9	1
S5	0.4		

9.6 Joint notches to prevent ring rotation

NOTE. It is essential that the diameter and location of stop pegs on pistons are chosen so that a clearance exists between the notch and the peg with the gap butted.

9.6.1 Joint with side notch. The dimensions of joints with side notches shall be as given in figure 8 and table 7.



All dimensions are in millimetres.

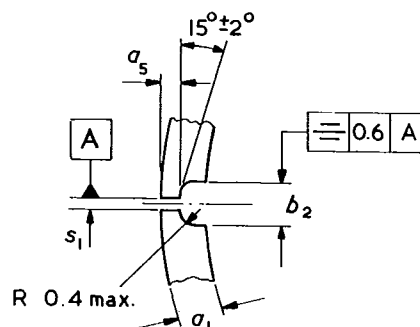
Figure 8. Joint with side notch

Table 7. Dimensions of side notch

All dimensions are in millimetres.

Symbol	b_1 $\begin{smallmatrix} +0.2 \\ -0.1 \end{smallmatrix}$	t_1 $\begin{smallmatrix} +0.15 \\ -0.00 \end{smallmatrix}$	r_1	$h_1 - (t_1 \text{ max.})$
T1	2.3	0.8	1.25	$h_1/3 \text{ min.}$
T2	2.5	1.1	1.25	
T3	3	1.5	1.5	
T4	3.7	1.8	1.8	
T5	4.7	2.3	2.3	
T6	5.7	2.8	2.8	

9.6.2 Joint with internal notch. The dimensions of joints with internal notches shall be as given in figure 9 and tables 8 and 9.



All dimensions are in millimetres.

Figure 9. Joint with internal notch

Table 8. Width of internal notch b_2 at nominal diameter d_1

All dimensions are in millimetres.

Symbol	b_2 $\begin{smallmatrix} +0.2 \\ -0.1 \end{smallmatrix}$
H1	2
H2	2.5
H3	3
H4	3.7

Table 9. Depth of overlap for internal notch a_s

All dimensions are in millimetres.

Wall thickness a_1	a_s ± 0.1	Wall thickness a_1	a_s ± 0.1
1.6 to 1.75	0.8	3.5 to 3.65	1.8
1.8 to 2.05	0.9	3.7 to 3.85	1.9
2.1 to 2.25	1.1	3.9 to 4.05	2
2.3 to 2.45	1.2	4.1 to 4.25	2.1
2.5 to 2.65	1.3	4.3 to 4.45	2.2
2.7 to 2.85	1.4	4.5 to 4.6	2.3
2.9 to 3.05	1.5	4.7 to 4.8	2.4
3.1 to 3.25	1.6	4.9 to 5	2.5
3.3 to 3.45	1.7		

9.7 Edge features. If none of the symbol features in 9.7.1 are specified, the edges of the rings shall be sharp (excepting chromium coated and molybdenum coated rings outer edges, see 9.8.2.1 and 9.8.2.4 respectively) but free from burrs.

9.7.1 Chamfers

(a) KA: *peripheral edges chamfered* (does not apply to chromium coated or molybdenum coated ring chamfers, see 9.8.2.1 and 9.8.2.4 respectively). For details of dimensions, see tables 15 to 23.

(b) KI: *inside edges chamfered*, for details of dimensions, see tables 15 to 23.

BS 5341 : Part 1 : 1976

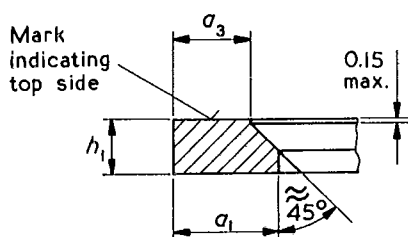
9.7.2 Internal bevel or step

(a) *IF: internal bevel* (see figure 10 and table 10).

Because of the internal bevel, the forces F_t and F_d are reduced to 0.8 to 0.9 (depending upon geometry of ring) times the values given in tables 15 to 20. When the ring is under stress, a small twist is imparted to it, and its lower edge should preferably make contact with the cylinder bore. These rings shall be marked with a mark indicating the top side.

(b) *IW: internal step* (see figure 11 and table 10).

Because of the internal step, the forces F_t and F_d are reduced to approximately 0.75 times the values given in tables 15 to 18. When the ring is under stress, a twist is imparted to it, and particularly over the rear half of the ring its lower edge must make contact with the cylinder bore. These rings shall be marked with a mark indicating the top side.

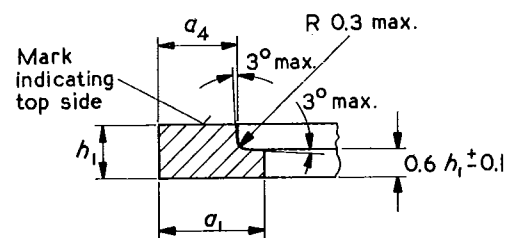


All dimensions are in millimetres.
Figure 10. Compression ring with internal bevel

Table 10. Dimensions for internal bevel and internal step

All dimensions are in millimetres

Nominal diameter d_1	a_3	a_4	Limits for a_3 and a_4
30 to 80	$0.8 \times a_1$ rounded to nearest 0.1	$0.6 \times a_1$ rounded to nearest 0.1	+0.0 -0.2
82 to 174			+0.0 -0.3
175 to 200			+0.0 -0.4



All dimensions are in millimetres.
Figure 11. Compression ring with internal step

Table 11. Typical machine finishes, surface textures and their symbols

Type of ring	Machine finish	Surface texture* $R_a \mu\text{m}$ (before surface treatment)	Symbol
Uncoated	Ground	0.8 max.	G
	Fine turned (0.12 mm feed)	0.8 to 4.0	FT
	Coarse turned (0.17/0.30 mm feed)	6.2 max.	CT
Chromium (before electroplating)	Extra fine turned (0.065 mm feed)	2.4 max.	EF
	Fine turned (0.12 mm feed)	0.8 to 4.0	FT
	Coarse turned (0.17/0.30 mm feed)	6.2 max.	CT
Chromium (after electroplating)	Lapped†	0.4 max.‡	L
	Ground	0.8 max.	G
Molybdenum or chromium (after spraying)	Ground or lapped	Surface texture is not specified as sprayed deposits may have an open structure and cannot be accurately measured.	—

*The surface texture (R_a) shall be measured as specified in BS 1134 : Part 1.

†Chromium plated plain compression rings and chromium plated Keystone (wedge) rings shall be lapped finished over the full width of periphery and around the full circumference (i.e. fully lapped), except when rings are required coarse turned, in which case peripheral crests only shall be lapped finished around the full circumference.

Chromium plated tapered compression rings shall be lapped finished around the full circumference, but only to show a witness land.

‡The surface texture specified applies only to chromium fully lapped periphery (finished over the whole circumference and over the full width of the periphery).

9.8 Surface finishes

9.8.1 Machining of periphery

9.8.1.1 B: *periphery barrel faced* (see figure 12, table 12). If radiusing or chamfering of the edges of the periphery is required, this shall not exceed $0.5 (h_1 - h_8)$ mm max.

For rings treated as specified in 9.8.5 the barrel values given in table 12 shall apply before surface treatment.

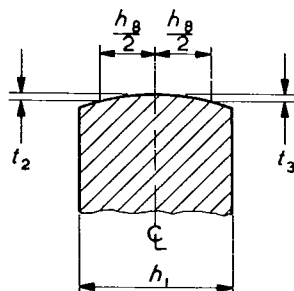


Figure 12. Periphery barrel faced

Table 12. Values for barrelling and gauge width

All dimensions are in millimetres.

Ring width h_1^*	Gauge width h_8	Barrel
		t_2 and t_3
1.5	0.8	0.003 to 0.012
2	1.2	
2.5	1.6	
3	2	0.005 to 0.016
3.5	2.4	
4	2.8	0.007 to 0.020
4.5	3.2	

*The values of the next smaller ring width are used for intermediate sizes.

9.8.2 Peripheral coatings and inlays

9.8.2.1 CL . . . : Periphery coated with chromium.

The edges of the periphery and at the joint shall be radiused or chamfered according to the supplier's choice before chromium plating.

- (a) CL1: thickness of coating 0.06 mm min.
- (b) CL2: thickness of coating 0.10 mm to 0.18 mm.
- (c) CL3: thickness of coating 0.16 mm to 0.25 mm.
- (d) CL . . . B: same design as for CL . . . , but barrel faced periphery.

9.8.2.2 C . . . : *Periphery inlaid with chromium* (see figure 13 and table 13). The peripheral edges at the joint shall be radiused or chamfered according to the supplier's choice before chromium plating.

- (a) C1: thickness of inlay 0.06 mm min.
- (b) C2: thickness of inlay 0.10 mm to 0.18 mm.
- (c) C3: thickness of inlay 0.16 mm to 0.25 mm.
- (d) C . . . B: same design as for C . . . , but barrel faced periphery.

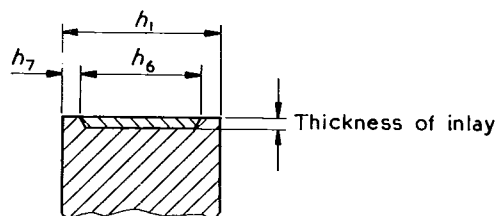


Figure 13. Periphery inlaid with chromium

Table 13. Dimensions for chromium inlaid peripheries

All dimensions are in millimetres.

Ring width h_1^*	Width of chromium inlay $h_6 \pm 0.1$	Minimum land width h_7
1.5	0.9	0.2
2	1.4	0.2
2.5	1.8	0.25
3	2.3	0.25
3.5	2.6	0.35
4	3.1	0.35
4.5	3.6	0.35

*The values of the next smaller ring width are used for intermediate sizes.

9.8.2.3 M . . . : *periphery inlaid with molybdenum* (see figure 14 and table 14). The peripheral edges at the joint shall be radiused or chamfered, according to the choice of the supplier, by 0.1 mm to 0.3 mm up to a ring width of 2 mm, and above this width by 0.2 mm to 0.4 mm.

- (a) M1: thickness of inlay 0.1 mm min.
 - (b) M2: thickness of inlay 0.15 mm min.
 - (c) M3: thickness of inlay 0.2 mm min.
 - (d) M . . B: same design as for M . . . , but barrel faced periphery.
- If a tolerance is required to be held, this shall be positive and not less than 0.20 mm and shall be specifically requested by the purchaser.

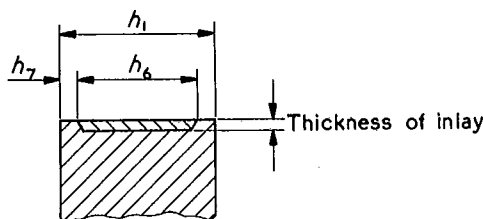


Figure 14. Periphery inlaid with molybdenum

Table 14. Dimensions for molybdenum inlaid peripheries

All dimensions are in millimetres

Ring width h_1 *	Width of molybdenum inlay $h_6 \pm 0.1$	Minimum land width h_7
1.5	0.9	0.2
2	1.4	0.2
2.5	1.8	0.25
3	2.3	0.25
3.5	2.6	0.35
4	3.1	0.35
4.5	3.6	0.35

*The values of the next smaller ring width are used for intermediate sizes.

9.8.2.4 ML . . . : periphery coated with molybdenum.

The edges of the periphery and the peripheral edges at the joint shall be radiused or chamfered, according to the choice of the supplier, by 0.1 mm to 0.3 mm up to a ring width of 2 mm, and above this width by 0.2 mm to 0.4 mm.

(a) ML1: thickness of coating 0.1 mm min.

(b) ML2: thickness of coating 0.15 mm min.

(c) ML3: thickness of coating 0.2 mm min.

(d) ML . . . B: same design as for ML . . . , but barrel faced periphery.

If a tolerance is required to be held, this shall be positive and not less than 0.20 mm and shall be specifically requested by the purchaser.

9.8.2.5 SNL: periphery tin plated. Thickness of coating 0.003 mm minimum.

9.8.2.6 CUL: periphery copper plated. Thickness of coating 0.003 mm minimum.

9.8.3 Machining of sides

9.8.3.1 The surface texture shall be $0.4 R_a \mu\text{m}$ max. for untreated diesel and $0.6 R_a \mu\text{m}$ max. for untreated petrol engine rings and for rings treated as specified in 9.8.5 (before surface treatment), except Keystone (wedge)

T-type rings where the surface texture on the taper sides shall be $0.8 R_a \mu\text{m}$ max. if ground and $1.6 R_a \mu\text{m}$ max. if turned.

9.8.4 Bore finish. The bore of the ring shall in all cases have a surface texture of $10 R_a \mu\text{m}$ maximum.

9.8.5 General surface treatment

9.8.5.1 FE: ferroxided all over. The thickness of the coating shall be 0.003 mm minimum*.

9.8.5.2 P: phosphated all over. The thickness of the coating shall be 0.002 mm minimum*.

NOTE. Phosphating is only applicable to iron or steel surfaces. Chromium and molybdenum sprayed rings may be phosphated without affecting the deposit.

9.8.5.3 SN: tin plated all over. The thickness of the coating shall be 0.002 mm minimum†.

9.8.5.4 CU: copper plated all over. The thickness of the coating shall be 0.002 mm minimum†.

9.9 Free gap. No free gaps are specified as these are determined by the forces given in tables 15 to 23 and by other considerations, such as materials etc. These may vary within 3 to 4 times the nominal radial wall thickness, but are more usually about 3.5 times the nominal radial wall thickness.

10. Intermediate sizes and oversizes for reboring

For intermediate sizes and oversizes for cylinder reboring for all the rings specified in sections three to eleven, the dimensions and characteristics (other than for d_2) of the next smaller diameter shall apply.

11. Packing position

Piston rings with marks indicating the top side shall be packed in rolls with the top sides upwards as indicated on the printed packing label.

12. Dimensions

Dimensions of the various types of piston rings are given in tables 15 to 23 and are shown in figures 15 to 23.

*The thickness of coating is achieved by half penetration or etching away of the original surface, and half surface build-up. Consequently, build-up shall be a minimum of 0.0015 mm for ferroxided rings and a minimum of 0.001 mm for phosphated rings. The maximum permissible addition to size of ring width h_1 when coated shall be 0.006 mm.

†Build-up only. The addition to the ring width h_1 when coated shall not exceed 0.006 mm.

Section three. Plain compression rings (R-rings) 30 mm to 200 mm nominal diameter

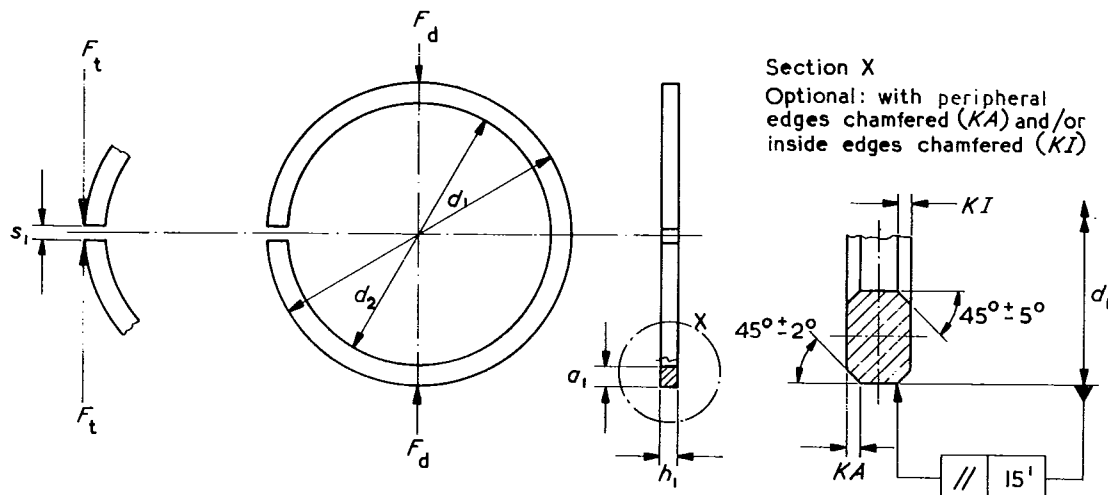


Figure 15. Plain compression ring

Example for ordering. The designation for a compression ring of nominal diameter $d_1 = 90$ mm, ring width $h_1 = 2.5$ mm, material spheroidal graphite cast iron (U6), cam turned round (FZ), minimum closed gap 0.3 mm (S4), inside edges chamfered (KI), periphery chromium coated with a thickness of coating of 0.06 mm min. and barrel faced (CLIB), phosphated all over (P) is as follows:

R-ring 90 x 2.5 BS 5341 – U6 FZ S4 KI CLIB P.

Table 15. Dimensions of plain compression rings

All dimensions are in millimetres.

Nominal diameter	Inside diameter	Radial wall thickness		Ring width			Closed gap*	Peripheral edges chamfered†	Inside edges chamfered†	Diametral force‡		
				h_1 —0.010 —0.025						F_d in newtons for h_1 shown in column		
				Columns						1	2	3
d_1	d_2	a_1	Limits	1	2	3	s_1	KA	KI	1	2	3
30	27.5	1.25	+0.10 —0.15 with max. variation of 0.15 around any ring	1.5	2	2.5	0.15 +0.20 —0.00	0.3 max.	0.3 max.	7.7	10.3	12.9
32	29.3	1.35								8.7	11.5	14.4
34	31.1	1.45								9.5	12.7	15.8
35	32.1	1.45								8.9	11.9	14.8
36	33.0	1.5								9.3	12.5	15.4
38	34.8	1.6								10.1	13.5	17.0
40	36.6	1.7					0.20 +0.20 —0.00	0.3 max.	0.3 max.	11.1	14.6	18.4
42	38.5	1.75								10.9	14.4	18.2
44	40.3	1.85								11.7	15.6	19.6
45	41.2	1.9								12.1	16.2	20.2
46	42.1	1.95					0.20 +0.20 —0.00	0.3 max.	0.3 max.	12.5	16.8	21.0
48	44.0	2.0								12.5	16.6	20.8

Nominal diameter	Inside diameter	Radial wall thickness		Ring width			Closed gap*	Peripheral edges chamfered†	Inside edges chamfered†	Tangential force‡		
				h_1 —0.010 —0.025						F_t in newtons for h_1 shown in column		
				Columns						1	2	3
d_1	d_2	a_1	Limits	1	2	3	s_1	KA	KI	1	2	3
50	45.8	2.1	+0.10 —0.20 with max. variation of 0.15 around any ring	1.5	2	2.5	0.20 +0.20 —0.00	0.3 max.	0.3 max.	6.5	8.6	10.8
52	47.6	2.2								6.9	9.2	11.5
53	48.5	2.25								7.0	9.5	11.8
54	49.4	2.3								7.3	9.7	12.1
55	50.4	2.3								7.0	9.4	11.7
56	51.3	2.35								7.2	9.6	12.1
58	53.1	2.45								7.6	10.2	12.7

*Unless otherwise specified (see 9.5)

†Only if specified. Otherwise, the edges shall be sharp, with the exception of chromium coated ring outer edges and molybdenum coated ring outer edges (see 9.7).

‡Limits on forces are $\pm 25\%$ for $d_1 < 50$ mm, and $\pm 20\%$ for $d_1 \geq 50$ mm.