

Issued 1990-06  
Cancelled 2008-06

Superseding J1998 APR1998

**Internal Combustion Engines—Piston Rings—  
Rectangular Rings With Narrow Ring Width**

This SAE Standard is equivalent to ISO Standard 6622/2 TR.

**1. Scope**—Differences, where they exist, are shown in Appendix A.

This SAE Standard specifies the essential dimensional features of R, B, and M rectangular piston ring types with narrow ring width.

Dimensional Tables 8 and 9 allow for the use of cast iron (Table 8) or steel (Table 9). Since the modulus of elasticity of steel rings is higher than that of cast iron rings, the fluctuation in the surface pressure will become greater if the free gap is set as the reference for force. Therefore, forces are set using the surface pressure as the reference, in order to minimize the effect of the fluctuation.

The requirements of this document apply to rectangular rings for reciprocating internal combustion engines up to and including 90 mm diameter for cast iron rings and up to and including 100 mm diameter for steel. They may also be used for piston rings of compressors working under similar conditions.

**1.1 Rationale**—SAE J1998 is being discontinued because the content of this standard is also contained in ISO 6622-2. Therefore, to eliminate duplication and confusion in coordinating the standards between ISO and SAE, this document will be discontinued. The SAE Piston and Ring Standards Committee will now continue to support ISO in updating the standards as appropriate.

SAE Technical Standards Board Rules provide that: "This report is published by SAE to advance the state of technical and engineering sciences. The use of this report is entirely voluntary, and its applicability and suitability for any particular use, including any patent infringement arising therefrom, is the sole responsibility of the user."

SAE reviews each technical report at least every five years at which time it may be reaffirmed, revised, or cancelled. SAE invites your written comments and suggestions.

Copyright © 2008 SAE International

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission of SAE.

TO PLACE A DOCUMENT ORDER:

Tel: 877-606-7323 (inside USA and Canada)  
Tel: 724-776-4970 (outside USA)  
Fax: 724-776-0790  
Email: CustomerService@sae.org  
<http://www.sae.org>

SAE WEB ADDRESS:

## 2. References

**2.1 Applicable Publications**—The following publications form a part of the specification to the extent specified herein. Unless otherwise indicated the latest revision of SAE publications shall apply.

2.1.1 SAE PUBLICATIONS—Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096-0001.

| SAE<br>DESIGNATION | ISO <sup>1</sup><br>EQUIVALENT |                                                                                                                                                                      |
|--------------------|--------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                    |                                | INTERNAL COMBUSTION ENGINES—PISTON RINGS                                                                                                                             |
| J1588              | 6621/1                         | Vocabulary                                                                                                                                                           |
| J1589              | 6621/2                         | Measuring principles                                                                                                                                                 |
| J1590              | 6621/3                         | Material specifications                                                                                                                                              |
| J1591              | 6621/4                         | General specifications                                                                                                                                               |
| J1996              | 6621/5                         | Quality requirements                                                                                                                                                 |
|                    |                                | INTERNAL COMBUSTION ENGINES—PISTON RINGS                                                                                                                             |
| J1997              | 6622/1                         | Rectangular rings                                                                                                                                                    |
| J1998              | 6622/2 TR                      | Rectangular rings with narrow ring width                                                                                                                             |
| J1999              | 6623                           | INTERNAL COMBUSTION ENGINES—PISTON RINGS—<br>SCRAPER RINGS                                                                                                           |
|                    |                                | INTERNAL COMBUSTION ENGINES—PISTON RINGS                                                                                                                             |
| J2000              | 6624/1                         | Keystone rings                                                                                                                                                       |
| J2001              | 6624/2 TR                      | Half keystone rings                                                                                                                                                  |
| J2002              | 6625                           | INTERNAL COMBUSTION ENGINES—PISTON RINGS—<br>OIL CONTROL RINGS                                                                                                       |
| J2003              | 6626                           | INTERNAL COMBUSTION ENGINES—PISTON RINGS—<br>COIL SPRING LOADED OIL CONTROL RINGS                                                                                    |
| J2004              | 6627 TR                        | INTERNAL COMBUSTION ENGINES—PISTON RINGS—<br>EXPANDER/SEGMENT OIL CONTROL RINGS                                                                                      |
| J2226              |                                | INTERNAL COMBUSTION ENGINES—PISTON RINGS—<br>STEEL RECTANGULAR RINGS                                                                                                 |
|                    | 1101                           | TECHNICAL DRAWINGS—Geometric tolerancing—Toler-<br>ancing of form, orientation, location and run-out—Generali-<br>ties, definitions, symbols indications on drawings |

1. TR refers to Technical Report

### 3. Ring Types and Designation Examples

#### 3.1 Type R—Straight Faced Rectangular Ring

##### 3.1.1 GENERAL FEATURES

NOTE—See Table 8 or Table 9 for dimensions and forces.

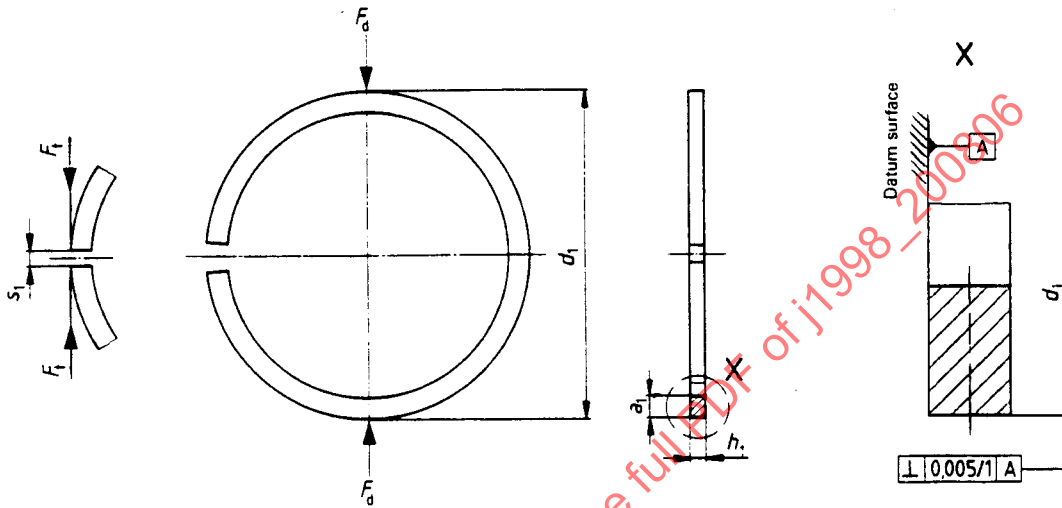


FIGURE 1—TYPE R

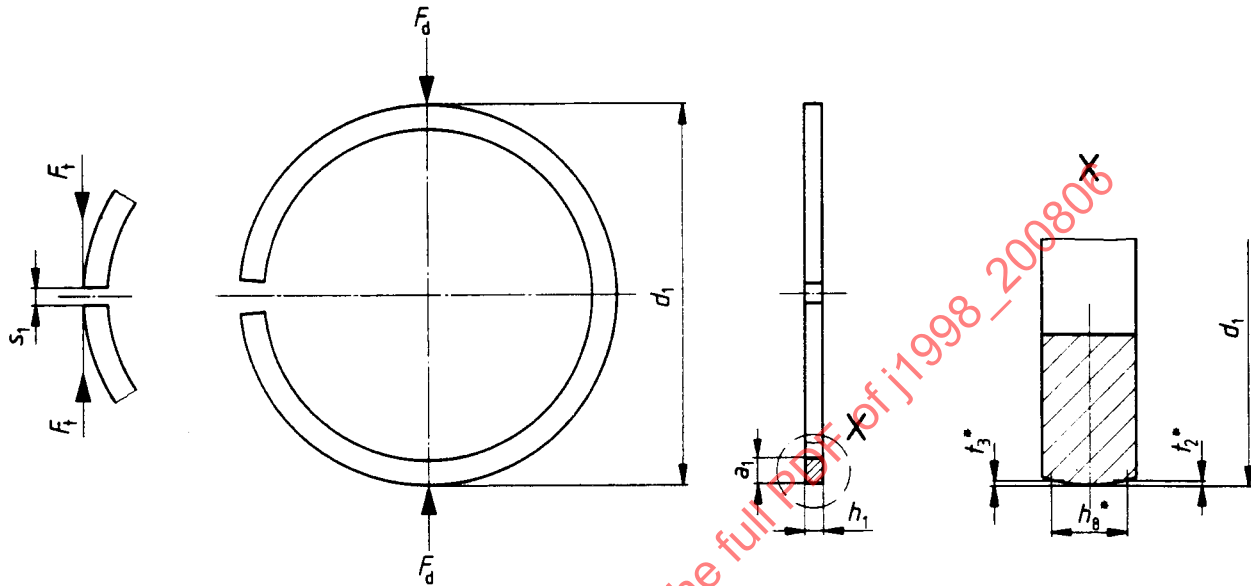
3.1.2 DESIGNATION EXAMPLE—Designation of a straight faced rectangular ring with narrow ring width of  $d_1 = 60$  mm nominal diameter,  $h_1 = 1.2$  mm ring width made of spheroidal graphite cast iron heat-treated (material subclass 51), general features as shown in Figure 1, and periphery chromium coated fully faced design 0.1 mm minimum thickness:

a. Piston ring SAE J1998 R-60 x 1.2-MC51/CR2

### 3.2 Type B—Barrel Faced Rectangular Ring

#### 3.2.1 GENERAL FEATURES

NOTE—See Table 8 or 9 for dimensions and forces.



\*See Table 1.

FIGURE 2—TYPE B

TABLE 1—GAUGE WIDTH ( $h_g$ ) AND BARREL DIMENSIONS

| Dimensions in millimeters |       |            |            |                         |
|---------------------------|-------|------------|------------|-------------------------|
| $h_1$                     | $h_s$ | $t_2, t_s$ | $t_2, t_s$ | Maximum Peak Off Center |
| 1.2                       | 0.6   | 0.001      | 0.013      | 0.2                     |
| 1.5                       | 0.8   | 0.002      | 0.016      | 0.25                    |

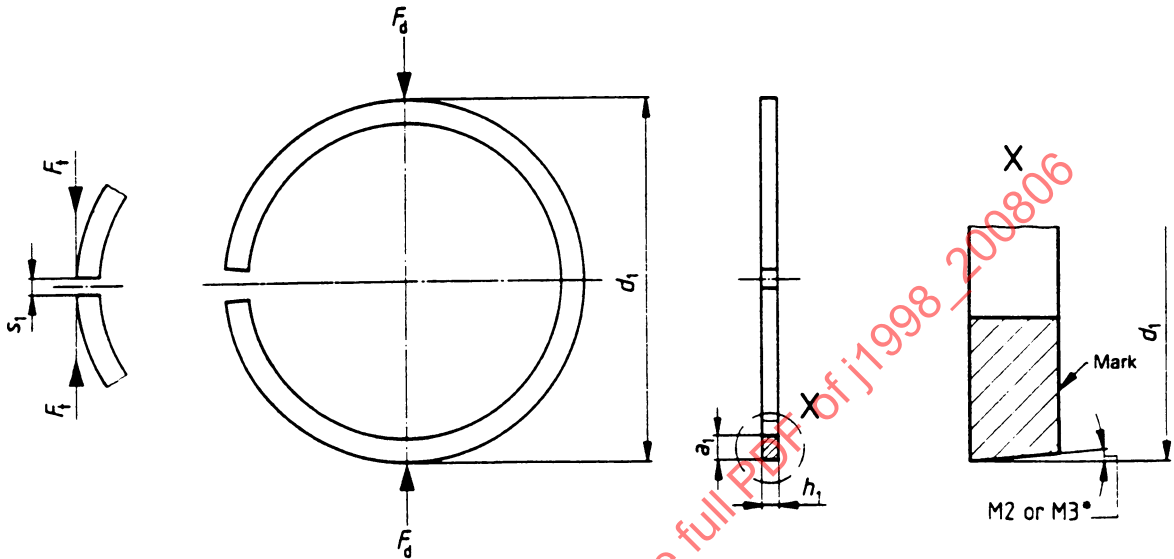
3.2.2 DESIGNATION EXAMPLE—Designation of a barrel faced rectangular ring with narrow ring width of  $d_1 = 60$  mm nominal diameter,  $h_1 = 1.2$  mm ring width made of steel (material subclass 62), general features as shown in Figure 2, and periphery chromium coated fully faced design 0.1 mm minimum thickness:

a. Piston ring SAE J1988 B-60 x 1.2-MC62/CR2

### 3.3 Type M—Taper Faced Rectangular Ring

#### 3.3.1 GENERAL FEATURES

NOTE—See Table 8 or 9 for dimensions and forces.



\*See Table 2.

FIGURE 3—TYPE M

TABLE 2—TAPER UNCOATED AND COATED RINGS (MOLYBDENUM OR CHROMIUM WITH TAPERED PERIPHERY GROUND)

| Taper | Tolerance <sup>(1)</sup> | Tolerance <sup>(1)</sup> | With IF or IW <sup>(2)</sup><br>(Top Side)<br>Tolerance <sup>(1)</sup> | With IF or IW <sup>(2)</sup><br>(Top Side)<br>Tolerance <sup>(1)</sup> |
|-------|--------------------------|--------------------------|------------------------------------------------------------------------|------------------------------------------------------------------------|
| M2    | 30'                      | +50'                     | 30'                                                                    | +60'                                                                   |
| M3    | 60'                      | 0                        | 60'                                                                    | 0                                                                      |

1. For coated rings with tapered periphery not ground, the tolerance shall be increased by 10' (e.g., M3 = 60': +60' for M-rings or -70' for M-rings with IF or IW).

0 0

2. IF and IW are explained in Figures 16 and 17.

3.3.2 DESIGNATION EXAMPLE—Designation of a taper faced rectangular ring with narrow ring width of  $d_1 = 60$  mm nominal diameter,  $h_1 = 1.2$  mm ring width made of spheroidal graphite cast iron, heat-treated (material subclass 51) general features as shown in Figure 3 with taper M3 = 60' and periphery chromium coated fully faced design 0.1 mm minimum thickness:

- a. Piston ring SAE J1998 M3-60 x 1.2-MC51/CR2

#### 4. Common Features

##### 4.1 Type R—Straight Faced Rectangular Ring

###### 4.1.1 UNCOATED RINGS

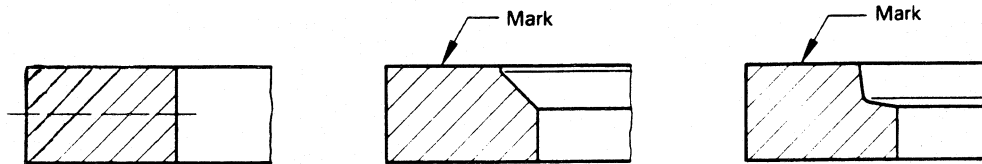


FIGURE 4—UNCOATED TYPE R RINGS

###### 4.1.2 COATED RINGS (CHROMIUM OR MOLYBDENUM)

###### 4.1.2.1 Fully Faced

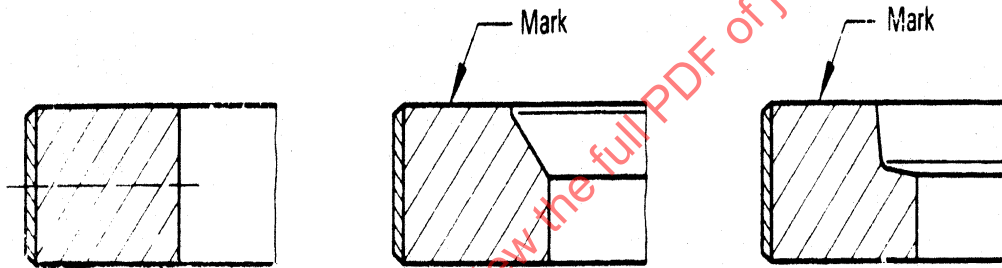


FIGURE 5—FULLY FACED COATED TYPE R RINGS

###### 4.1.2.2 Semi-Inlaid

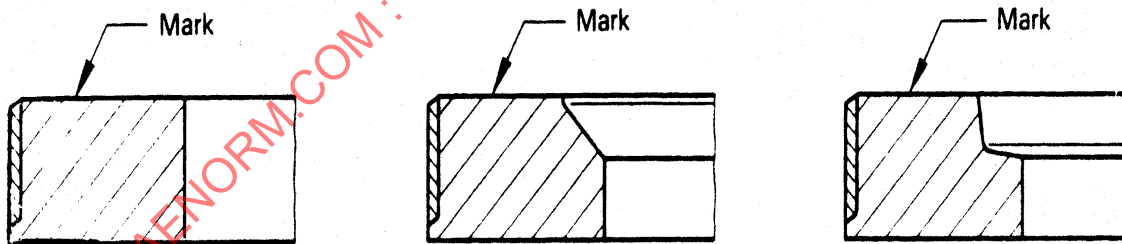


FIGURE 6—SEMI-INLAID COATED TYPE R RINGS

###### 4.1.2.3 Inlaid

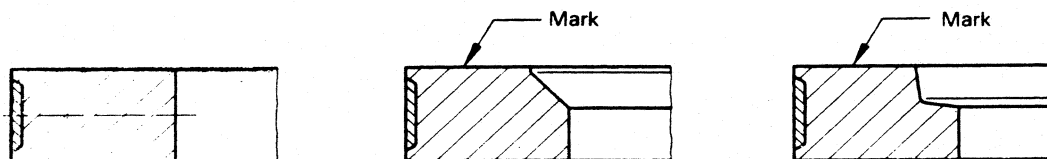


FIGURE 7—INLAID COATED TYPE R RINGS

## 4.2 Type B—Barrel Faced Rectangular Ring

### 4.2.1 UNCOATED RINGS

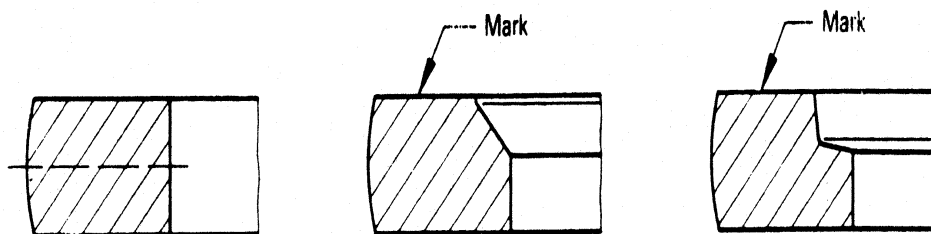


FIGURE 8—UNCOATED TYPE B RINGS

### 4.2.2 COATED RINGS (CHROMIUM OR MOLYBDENUM)

#### 4.2.2.1 Fully Faced

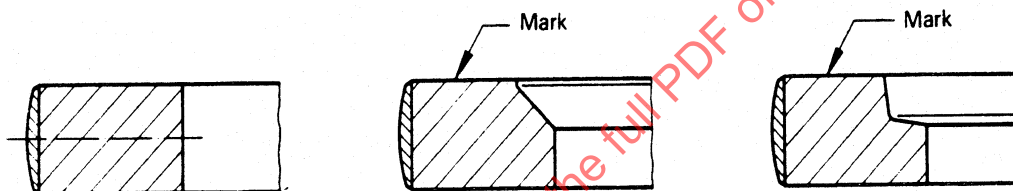


FIGURE 9—FULLY FACED COATED TYPE B RINGS

#### 4.2.2.2 Semi-Inlaid

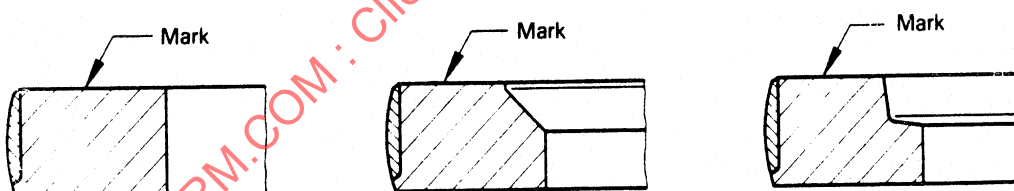


FIGURE 10—SEMI-INLAID COATED TYPE B RINGS

#### 4.2.2.3 Inlaid

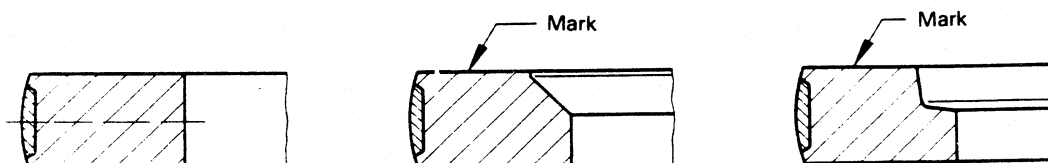


FIGURE 11—INLAID COATED TYPE B RINGS

### 4.3 Type M—Taper Faced Rectangular Rings

#### 4.3.1 UNCOATED RINGS

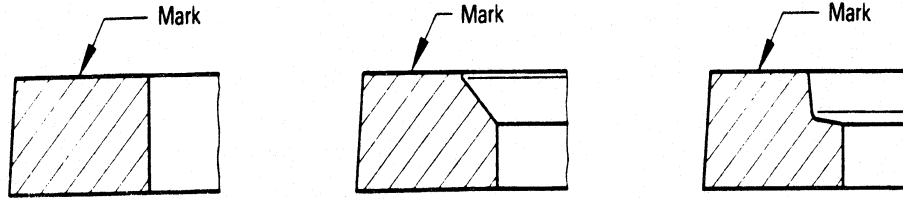


FIGURE 12—UNCOATED TYPE M RINGS

#### 4.3.2 COATED RINGS (CHROMIUM OR MOLYBDENUM)

##### 4.3.2.1 Fully Faced

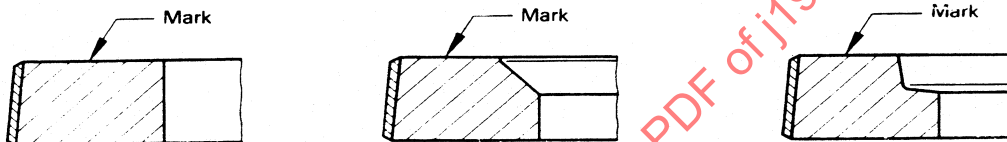


FIGURE 13—FULLY FACED COATED TYPE M RINGS

##### 4.3.2.2 Semi-Inlaid

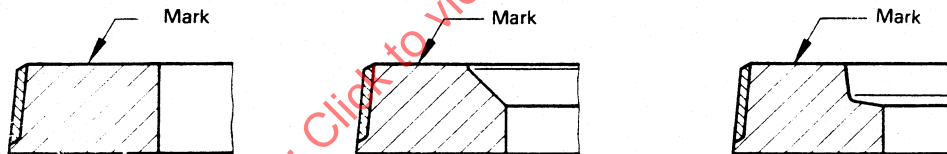


FIGURE 14—SEMI-INLAID COATED TYPE M RINGS

##### 4.3.2.3 Inlaid

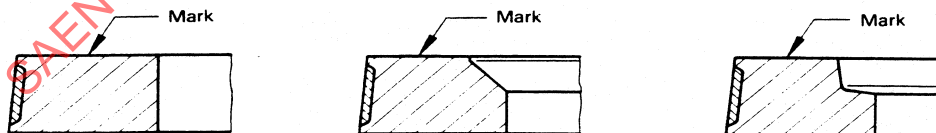


FIGURE 15—INLAID COATED TYPE M RINGS

## 4.4 R, B, and M Rings (Positive Twist Type)—Internal Bevel (Top Side) or Internal Step (Top Side)

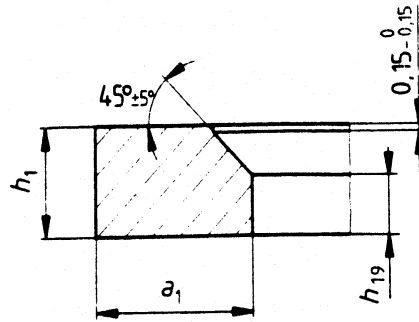


FIGURE 16—INTERNAL BEVEL (IF)

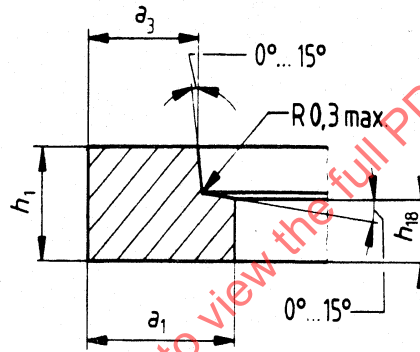


FIGURE 17—INTERNAL STEP (IW)

TABLE 3— $h_{18}$ ,  $h_{19}$ , AND  $a_3$  DIMENSIONS

| Dimensions in millimeters |                  |                               |                   |                    |
|---------------------------|------------------|-------------------------------|-------------------|--------------------|
| $d_1$                     | $h_{18}, h_{19}$ | $h_{18}, h_{19}$<br>Tolerance | $a_3$             | $a_3$<br>Tolerance |
| $30 \leq d_1 < 60$        | $0.6 \times h_1$ | 0<br>-0.25                    | $0.85 \times a_1$ | 0<br>-0.2          |
| $60 \leq d_1 \leq 100$    | $0.6 \times h_1$ | 0<br>-0.25                    | $0.9 \times a_1$  | 0<br>-0.3          |

## 4.5 Chamfered Edges (Cast Iron Rings)

### 4.5.1 R AND B RINGS—OUTSIDE CHAMFERED EDGES (KA)



FIGURE 18—OUTSIDE CHAMFERED EDGES (KA)

### 4.5.2 R, B, AND M RINGS—INSIDE CHAMFERED EDGES (KI)

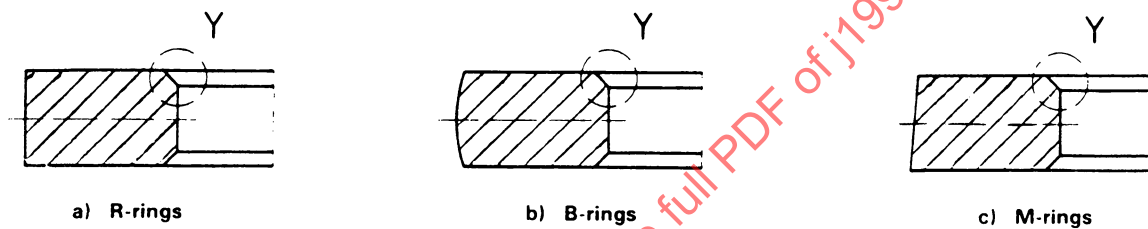


FIGURE 19—INSIDE CHAMFERED EDGES (KI)

### 4.5.3 R AND B RINGS—OUTSIDE AND INSIDE CHAMFERED EDGES (KA AND KI)

NOTE—See Table 4 for dimensions.



FIGURE 20—OUTSIDE AND INSIDE CHAMFERED EDGES (KA AND KI)

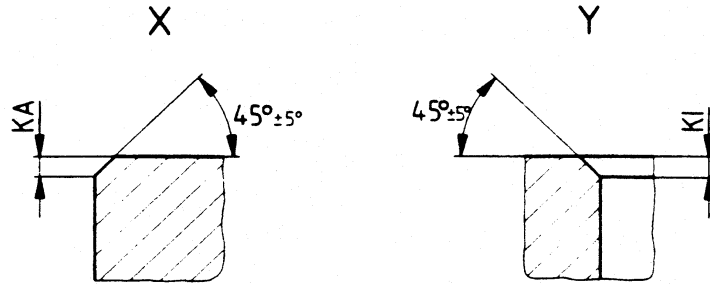


FIGURE 21—DETAILS OF FIGURES 18, 19, AND 20

TABLE 4—KA AND KI DIMENSIONS

| KA             | KI      |
|----------------|---------|
| $0.15 \pm 0.1$ | max 0.2 |

#### 4.6 R and B Steel Rings—Outside and Inside Rounded Edges



FIGURE 22—OUTSIDE AND INSIDE ROUNDED EDGES

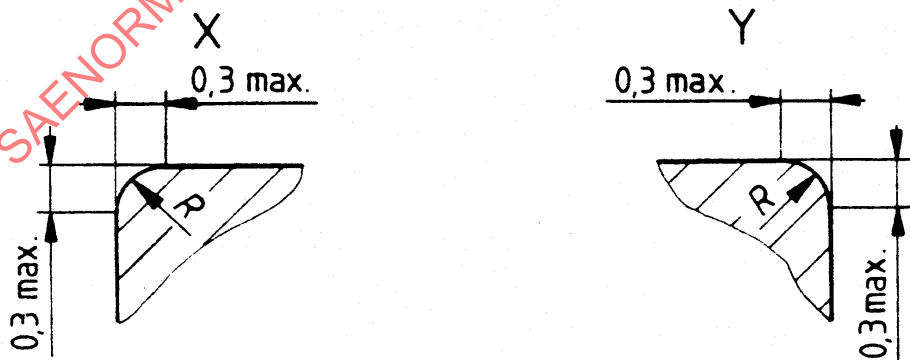


FIGURE 23—DETAILS OF FIGURE 22

#### 4.7 R, B, and M Rings (Fully Faced, Semi-Inlaid, and Inlaid)—Layer Thickness

NOTE—See Table 5 for dimensions.

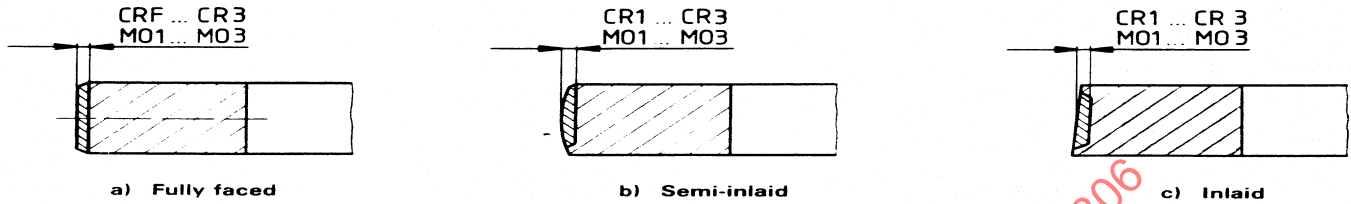


FIGURE 24—LAYER THICKNESS

TABLE 5—LAYER THICKNESS

| Dimensions in millimeters |                    |                  |
|---------------------------|--------------------|------------------|
| Chromium                  | Molybdenum         | Thickness<br>min |
| CRF                       | —                  | 0.005            |
| CR1                       | MO1                | 0.05             |
| CR2                       | MO2                | 0.1              |
| CR3 <sup>(1)</sup>        | MO3 <sup>(1)</sup> | 0.15             |

1. CR3 and MO3 apply to rings with nominal diameters of 50 mm or greater.

5. **Force Factors**—The tangential and diametral forces given in Table 8 shall be corrected when additional features and/or materials other than grey cast iron with a modulus of elasticity of 100 000 MPa are being used.

For common features, multiplier correction factors given in Tables 6 and 7 and the force correction factors given in SAE J1591 shall be used.

Also the tangential and diametral force given in Table 9 shall be corrected when additional features are being used.

**TABLE 6—FORCE CORRECTION FACTORS FOR R, B, AND M RINGS  
WITH FEATURES KA, KI, IF, IW, AND TAPER**

| Factor<br>KA | Factor<br>KI | Factor<br>Taper<br>M3 | Factor<br>IF | Factor<br>IW<br>$d < 60_1$ | Factor<br>IW<br>$d > 60_1$ | Factor<br>KA<br>and<br>KI | Factor<br>KA<br>and<br>Taper<br>M3 | Factor<br>KA<br>and<br>IF | Factor<br>KA and IW<br>$d_1 < 60$ | Factor<br>KA and IW<br>$d > 60_1$ |
|--------------|--------------|-----------------------|--------------|----------------------------|----------------------------|---------------------------|------------------------------------|---------------------------|-----------------------------------|-----------------------------------|
| 0.98         | 0.98         | 0.98                  | 0.87         | 0.77                       | 0.82                       | 0.96                      | 0.96                               | 0.85                      | 0.75                              | 0.8                               |

**TABLE 7—FORCE CORRECTION FACTORS FOR COATED R, B, AND M RINGS  
(FULLY FACED, SEMI-INLAID, AND INLAID TYPE)**

| $d_1$<br>mm            | Factor<br>CRF | Factor<br>CR1 | Factor<br>CR2/MO1 | Factor<br>CR3 | Factor<br>MO2 | Factor<br>MO3 |
|------------------------|---------------|---------------|-------------------|---------------|---------------|---------------|
| $30 \leq d_1 < 50$     | 1             | 0.81          | 0.7               | —             | 0.64          | —             |
| $50 \leq d_1 \leq 100$ | 1             | 0.9           | 0.85              | 0.81          | 0.81          | 0.75          |

## 6. Dimensions

TABLE 8—DIMENSIONS OF R, B, AND M RECTANGULAR RINGS  
WITH NARROW RING WIDTH MADE OF CAST IRON

| Nominal diameter<br>$d_1$ | Radial wall thickness |                                             | Ring width |                                                                               | Closed gap |           | Tangential force |           | Diametral force |           |
|---------------------------|-----------------------|---------------------------------------------|------------|-------------------------------------------------------------------------------|------------|-----------|------------------|-----------|-----------------|-----------|
|                           | $a_1$                 | Tolerance                                   | $h_1$      | Tolerance                                                                     | $s_1$      | Tolerance | $F_t$ , N        | Tolerance | $F_{dt}$ , N    | Tolerance |
| 30                        | 1,25                  | ± 0,15<br>Within<br>a ring:<br>0,15<br>max. | 1,2        | -0,01<br>-0,025<br><br>For<br>phosphated<br>PO<br>surface:<br>-0,005<br>-0,03 | 0,15       | +0,2<br>0 | —                | —         | 6               | ± 30 %    |
| 31                        | 1,3                   |                                             |            |                                                                               |            |           | 6,2              |           |                 |           |
| 32                        | 1,35                  |                                             |            |                                                                               |            |           | 6,7              |           |                 |           |
| 33                        | 1,4                   |                                             |            |                                                                               |            |           | 6,9              |           |                 |           |
| 34                        | 1,4                   |                                             |            |                                                                               |            |           | 6,5              |           |                 |           |
| 35                        | 1,45                  |                                             |            |                                                                               |            |           | —                |           | 6,9             |           |
| 36                        | 1,5                   |                                             |            |                                                                               |            |           | 7,1              |           |                 |           |
| 37                        | 1,55                  |                                             |            |                                                                               |            |           | 7,5              |           |                 |           |
| 38                        | 1,6                   |                                             |            |                                                                               |            |           | 7,7              |           |                 |           |
| 39                        | 1,65                  |                                             |            |                                                                               |            |           | 8,2              |           |                 |           |
| 40                        | 1,65                  |                                             |            |                                                                               |            |           | —                |           | 7,7             |           |
| 41                        | 1,7                   |                                             |            |                                                                               |            |           | 8,2              |           |                 |           |
| 42                        | 1,75                  |                                             |            |                                                                               |            |           | 8,4              |           |                 |           |
| 43                        | 1,8                   |                                             |            |                                                                               |            |           | 8,8              |           |                 |           |
| 44                        | 1,85                  |                                             |            |                                                                               |            |           | 9                |           |                 |           |
| 45                        | 1,9                   |                                             |            |                                                                               |            |           | —                |           | 9,2             |           |
| 46                        | 1,9                   |                                             |            |                                                                               |            |           | 9                |           |                 |           |
| 47                        | 1,95                  |                                             |            |                                                                               |            |           | 9,2              |           |                 |           |
| 48                        | 2                     |                                             |            |                                                                               |            |           | 9,7              |           |                 |           |
| 49                        | 2,05                  |                                             |            |                                                                               |            |           | 9,9              |           |                 |           |
| 50                        | 2,1                   |                                             |            |                                                                               |            |           | 4,8              | ± 30 %    | 10,3            |           |
| 51                        | 2,15                  |                                             |            |                                                                               |            |           | 4,9              |           | 10,5            |           |
| 52                        | 2,15                  |                                             |            |                                                                               |            |           | 4,7              |           | 10,1            |           |
| 53                        | 2,2                   |                                             |            |                                                                               |            |           | 4,9              |           | 10,5            |           |
| 54                        | 2,25                  |                                             |            |                                                                               |            |           | 5                |           | 10,8            |           |
| 55                        | 2,3                   |                                             |            |                                                                               |            |           | 5,2              |           | 11,2            |           |
| 56                        | 2,35                  |                                             |            |                                                                               |            |           | 5,4              |           | 11,6            |           |
| 57                        | 2,4                   |                                             |            |                                                                               |            |           | 5,5              |           | 11,8            |           |
| 58                        | 2,4                   |                                             |            |                                                                               |            |           | 5,3              |           | 11,4            |           |
| 59                        | 2,45                  |                                             |            |                                                                               |            |           | 5,5              |           | 11,8            |           |
| 60                        | 2,5                   |                                             |            |                                                                               |            |           | 5,6              |           | 12              |           |
| 61                        | 2,55                  |                                             |            |                                                                               |            |           | 5,7              |           | 12,3            |           |
| 62                        | 2,6                   |                                             |            |                                                                               |            |           | 5,9              |           | 12,7            |           |
| 63                        | 2,65                  |                                             |            |                                                                               |            |           | 6,1              |           | 13,1            |           |
| 64                        | 2,65                  |                                             |            |                                                                               |            |           | 5,9              |           | 12,7            |           |
| 65                        | 2,7                   |                                             |            |                                                                               |            |           | 6                |           | 12,9            |           |
| 66                        | 2,75                  |                                             |            |                                                                               |            |           | 6,2              |           | 13,3            |           |
| 67                        | 2,8                   |                                             |            |                                                                               |            |           | 6,3              |           | 13,3            |           |
| 68                        | 2,85                  |                                             |            |                                                                               |            |           | 6,5              |           | 14              |           |
| 69                        | 2,9                   |                                             |            |                                                                               |            |           | 6,6              |           | 14,2            |           |
| 70                        | 2,9                   |                                             |            |                                                                               |            |           | 6,4              |           | 13,8            |           |
| 71                        | 2,95                  |                                             |            |                                                                               |            |           | 6,6              |           | 14,2            |           |
| 72                        | 3                     |                                             |            |                                                                               |            |           | 6,7              |           | 14,4            |           |
| 73                        | 3,05                  |                                             |            |                                                                               |            |           | 6,9              |           | 14,8            |           |
| 74                        | 3,1                   |                                             |            |                                                                               |            |           | 7,1              |           | 15,3            |           |

This table is shown in ISO format. Commas represent decimal points.