

Circular flanges for pipes, valves and fittings (PN designated) —

**Part 3: Steel, cast iron and copper alloy
flanges —**

**Section 3.1 Specification for steel
flanges**

UDC 621.643.4 – 034.14:669.13:669.35:621.643.411.412.8:001.4:006.3/8

Committees responsible for this British Standard

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British Chemical Engineering Contractors' Association
 British Compressed Gases Association
 British Fluid Power Association
 British Foundry Association
 British Gas plc
 British Malleable Tube Fittings Association
 British Maritime Technology
 British Non-ferrous Metals Federation
 British Pump Manufacturers' Association
 British Steel Industry
 British Valve and Actuator Manufacturers' Association Ltd.
 Combustion Engineering Association
 Copper Development Association
 Department of Trade and Industry (National Engineering Laboratory)
 Ductile Iron Producers' Association
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 Engineering Equipment and Materials Users' Association
 GAMBICA (BEAMA Ltd.)
 High Pressure Pipework Consultative Committee
 Institution of Gas Engineers
 Institution of Mechanical Engineers
 Institution of Production Engineers
 Institution of Water and Environmental Management (IWEM)
 Water Authorities Association

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Foreword

This Section of BS 4504 has been prepared under the direction of the Piping Systems Components Standards Policy Committee and constitutes the first revision of BS 4504-1:1969 in respect of the steel flanges contained in that standard which will be withdrawn 12 months after the publication of this standard and BS 4504-3.2 for cast iron flanges. For Class designated steel flanges, reference should be made to BS 1560-3.1.

It was originally intended that BS 4504-1:1969 would be superseded by British Standards technically equivalent to (or identical with) International Standards for a single series of flanges when finalized by the International Organization for Standardization (ISO) technical committee ISO/TC 5/SC 10, Metallic flanges and their joints. However, the International Standard has not been finalized but this revision of BS 4504-1:1969 incorporates the principles of the international work. To align with the format of the ISO Standard, ISO 7005¹⁾ “*Metallic flanges*”, BS 4504-3 is published in three Sections:

- *Section 3.1: Steel flanges;*
- *Section 3.2: Cast iron flanges;*
- *Section 3.3: Copper alloy and composite flanges.*

The flanges specified in this Section of BS 4504 are intended to be interchangeable with, but not necessarily identical in every detail to, steel flanges manufactured to BS 4504-1:1969.

This Section of BS 4504 differs from BS 4504-1:1969 for the content covering the steel flange requirements in the following respects.

- a) Two new flange types are introduced, loose plate flange with weld-on plate collar and loose plate flange with weld-neck collar. These types of flanges are not necessarily manufactured in the UK at the time of publication of this Section of BS 4504 but they have been included because they will be specified in ISO 7005 to which this Section of BS 4504 should eventually align.
- b) To avoid possible confusion in giving descriptive names to flange types and flange faces, all flanges are designated by code numbers and flange facings by a letter which has been based on ISO 7005.
- c) Definitions for nominal size and nominal pressure are included and are in accordance with ISO 6708 and ISO 7268 respectively.
- d) The range of nominal pressure has been limited to PN 40 as agreed by the international committee ISO/TC 5/SC 10.
- e) The pressure/temperature ratings are in accordance with ISO 7005.
- f) Materials specified have been revised, new materials added (in particular for austenitic stainless steels and nickel steels) and reference is given to comparable ASTM²⁾ materials. In addition, reference is given to DIN³⁾ materials from which flanges are sometimes made. Generally, the range of materials correspond to those given in the draft ISO 7005.
- g) The dimensions of flanges given in BS 4504-1:1969 were based on DIN standards current at the time of publication. The essential DIN dimensions have been retained in this Section of BS 4504 but new types of flanges have been added which have dimensions based on the proposed ISO work.
- h) Tolerances have been included for a greater number of dimensions than heretofore. However, cognizance has been taken of the proposed tolerances for the international work and, in certain instances, tolerances are wider than those given in BS 4504-1:1969.
- j) Requirements for the surface finish of flange faces have been given in greater detail.

¹⁾ ISO 7005-1 is in preparation. ISO 7005-2 and ISO 7005-3 are published.

²⁾ American Society for Testing and Materials.

³⁾ Deutsches Institut für Normung.

k) A greater range of flange facings is included in this Section of BS 4504 to align with the draft International Standard. Flanges having the full range of facings are not necessarily manufactured in the UK at the time of publication of this Section of BS 4504.

l) Spot facing or back facing is in accordance with ISO 7005.

m) For threaded flanges, ANSI⁴⁾/ASME⁵⁾ B1.20.1 thread form is specified in addition to BS 21.

n) The marking of flanges is basically in accordance with the principles of ISO 7005 but limitations on the methods are included.

p) Appendix A is included which lists details of the information that should be supplied by the purchaser when ordering flanges.

q) Guidance notes and recommendations contained in BS 4504-1:1969 have been included in an informatory appendix to this Section of BS 4504. The Appendix (B) is not intended to be exhaustive.

r) Details of weld-end preparation are included for the first time (see Appendix C).

s) Details of minimum hub radius after back facing are given for the first time.

The various gasket types, dimensions, design characteristics and materials are outside the scope of this standard. For dimensions of gaskets reference should be made to BS 4865-1, BS 4865-2, BS 4865-3 and BS 4865-4.

For comparison purposes the code numbers used in this Section of BS 4504 are compared with the type numbers given in BS 4504:1969 in Appendix D.

Assessed capability. Users of this Section of BS 4504 are advised to consider the desirability of assessment and registration of a supplier's quality systems against the appropriate Part of BS 5750 by a third party certification body.

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 38, 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.

⁴⁾ American National Standards Institute.

⁵⁾ American Society of Mechanical Engineers.

1 Scope

This Section of BS 4504 specifies requirements for PN designated circular steel flanges in the ranges of nominal pressure PN 2.5 to PN 40 and nominal sizes up to DN 4000 of the types given in Table 1.

Table 1 — Types of steel flanges and ancillary components

Code no.	Description
101	Plate flange for welding
102	Loose plate flange with weld-on plate collar or for lapped pipe end
104	Loose plate flange with weld-neck collar
105	Blank flange
111	Weld-neck flange
112	Hubbed slip-on flange for welding
113	Hubbed threaded flange
121	Integral flange
132	Weld-on plate collar
133	Lapped pipe end
134	Weld-neck collar
NOTE Code numbers have been made non-consecutive to permit possible future additions.	

Additionally, dimensional requirements are given for ancillary components code numbers 132 to 134 (see Table 1) for use with code 102 and code 104 flanges.

This Section of BS 4504 specifies the types of steel flanges and their facings, dimensions, tolerances, threading, bolt sizes, flange face surface finish, marking, materials for bolting and flange materials together with associated pressure/temperature ratings.

Bolting materials for austenitic steel and nickel steel flanges (see 6.1), the weld end preparation of weld-neck (code 111) flanges and code 134 ancillary components (see 8.1) and the routine inspection and pressure testing of flanges are outside the scope of this standard but some guidance on maximum test pressure is given in Appendix B (see B.5).

NOTE The titles of the publications referred to in this standard are listed on page 38.

2 Definitions

For the purposes of this Section of BS 4504 the following definitions apply.

2.1

nominal size (DN)

a numerical designation of size which is common to all components in a piping system other than components designated by outside diameters or by thread size. It is a convenient round number for reference purposes and is only loosely related to manufacturing dimensions

NOTE 1 Nominal size is designated by the letters DN followed by the appropriate number.

NOTE 2 This definition is identical to that given in ISO 6708.

2.2

nominal pressure (PN)

a numerical designation which is a convenient round number for reference purposes

all equipment of the same nominal size (DN) designated by the same PN number shall have compatible mating dimensions

NOTE 1 The maximum allowable working pressure depends on materials, design and working temperatures, and should be selected from the tables of pressure/temperature ratings given in this standard.

NOTE 2 Nominal pressure is designated by the letters PN followed by the appropriate reference number.

NOTE 3 This definition is identical to that given in ISO 7268.

3 Ranges of nominal size (DN)

The ranges of nominal sizes from DN 10 to DN 4000 applicable to each flange type and for each PN designation shall be as given in Table 2.

4 PN designations and pressure/temperature ratings

4.1 PN designations

The range of PN designations shall be PN 2.5, PN 6, PN 10, PN 16, PN 25 and PN 40.

4.2 Pressure/temperature ratings

The pressure/temperature ratings of the flanges manufactured from the materials specified in Table 3, Table 4 and Table 5 shall be as given in Table 15, Table 16 and Table 17 for the applicable materials, and shall be the maximum allowable non-shock working gauge pressure at the temperatures shown.

NOTE 1 Linear interpolation is permitted for intermediate temperatures.

NOTE 2 The relevant pressures and temperature are those of the fluid in the pipework system.

NOTE 3 The pressure/temperature ratings of flanges depend upon the properties of the materials specified in Table 3, Table 4 and Table 5, as appropriate. For austenitic stainless steels the pressure/temperature ratings have been calculated using values of yield strength of 205 N/mm² or the 0.2 % proof stress.

NOTE 4 The rating of flanges is not necessarily the rating of the whole pipework system. Gasket materials can also impose limitations on the pressure/temperature rating of a flanged joint and the gasket manufacturer should be consulted when selecting the material of the gasket.

4.3 Rating of flanged joints

If two flanges in a flanged joint do not have the same pressure/temperature rating, the maximum permissible working pressure of the joint at any temperature shall not exceed the lower of the two pressure ratings.

5 Materials

5.1 Flange materials

Flanges shall be manufactured from materials given in Table 3, Table 4 or Table 5 as appropriate except that codes 111, 112 and 113 flanges shall be manufactured from a forging or steel casting.

NOTE 1 The materials given in Table 3, Table 4 and Table 5 are tabulated in groups having common pressure/temperature ratings as given in Table 15, Table 16 and Table 17.

NOTE 2 The purchaser should state in the enquiry and/or order if a certificate is required for the flange material (see Appendix A).

5.2 Requirements governing the use of ASTM materials

5.2.1 General. Flanges manufactured from materials conforming to ASTM specifications shall comply with the following additional requirements.

- a) For materials to ASTM A105
 - 1) When specified, all forgings shall be normalized.
 - 2) Sub-clauses 5.2.2.1, 5.2.2.2 and 5.2.2.3 shall apply.
- b) For materials ASTM A182
 - 1) The carbon content, by ladle analysis, of grades F304L and F316L shall not exceed 0.030 %.
 - 2) Sub-clause 5.2.2.3 shall apply.
- c) For materials to ASTM A387
 - 1) When specified, all flanges and flanged fittings shall be supplied in the normalized and tempered condition.
 - 2) Sub-clause 5.2.2.3 shall apply.

NOTE The purchaser should state any specific requirements for the heat treatment conditions on the enquiry and/or order (see Appendix A).

5.2.2 Carbon manganese steels

5.2.2.1 The carbon content, by ladle analysis, of the materials specified in 5.2.1 shall not exceed 0.23 % for plate and 0.25 % for forgings.

5.2.2.2 The carbon equivalent (CE₁), by ladle analysis, of the materials specified in 5.2.1 shall not exceed 0.42 where

$$CE_1 = C + \frac{Mn}{6}$$

The manufacturer shall ensure on a basis of regular production checks that the carbon equivalent (CE₂), by ladle analysis, does not exceed 0.45 where

$$CE_2 = C + \frac{Mn}{6} + \frac{Cr + Mo + V}{5} + \frac{Cu + Ni}{15}$$

5.2.2.3 The actual tensile strength of the steel of any component shall not exceed the minimum required by the relevant ASTM specification by more than 150 N/mm².

5.2.3 Chromium-molybdenum steels (applicable to material groups A5 and A6). For chromium-molybdenum steels the contents of carbon and residual elements shall be restricted as follows:

a) Carbon content

Steels with less than 2 % Cr (nominal):

0.17 % max. (plate)

0.20 % max. (forgings and castings)

Steels with more than 2 % Cr (nominal):

0.15 % max. (plate)

0.15 % max. (forgings and castings)

b) Residual elements

Copper 0.30 % max.

Nickel 0.40 % max.

Tungsten 0.10 % max.

Tin 0.03 % max.

5.3 Non-metallic materials

For flanges which are lined, or otherwise coated, with non-metallic materials and if the non-metallic materials come, or are likely to come, into contact with potable water then these materials shall comply with BS 6920-1.

NOTE Users should be aware that thread sealants or lubricants, for example, should also comply with BS 6920-1 if used in potable water applications.

6 Bolting

6.1 Materials, dimensions and finish for bolting of ferritic steel flanges shall be in accordance with BS 3692, BS 4190 or BS 4882 (metric series) selected in accordance with Table 15 b).

Free cutting steel for bolts, studbolts and nuts shall be restricted to the temperature range – 10 °C to 100 °C and be limited to pressure designations up to and including PN 16.

NOTE The selection of materials for bolting of flanges other than ferritic steel, is the responsibility of the user and reference should be made to BS 4882.

6.2 Studbolts shall be of the forms shown in BS 4882 except that the form shown in Figure 3(b) of BS 4882:1973 shall only apply to studbolts of other than alloy steel.

6.3 The mating surface of all bolt heads and nuts shall be full faced.

7 Repairs

Repairs by welding, unless prohibited by the applicable material standard, or product standard in the case of integral flanges, shall be in accordance with BS 2633, BS 5135 or BS 4570 as appropriate.

NOTE The welding procedure should be such as to produce a weld having characteristics in accordance with the parent material. Flanges should be heat treated after repair by welding when the material specification requires such treatment.

8 Dimensions

8.1 Flange dimensions

Dimensions, except for the diameter of shoulder, G (see note 4), of each type of flange for each PN shall be as given in Table 8 to Table 13, and as qualified by clause 10 and the notes to Table 8 to Table 13, if appropriate.

NOTE 1 It is incumbent upon the purchaser to specify in the enquiry and/or order if dimensions of flanges are to be affected by clause 10 and/or the notes to Table 8 to Table 13.

NOTE 2 A summary of the various types of flanges specified showing the nominal sizes (DN) applicable to each type and to each PN is given in Table 2.

NOTE 3 The details for the weld preparation for weld-neck flanges (code 111) and code 134 ancillary components are not a requirement of this standard but attention is drawn to Appendix C which gives details of various weld-end preparations and it is incumbent upon the purchaser to specify a particular weld-end preparation, if required. The weld-end preparation shown in Figure 12(a) or Figure 12(b) is the preparation normally supplied.

NOTE 4 The centre portion of the face of a blank flange (code 105) need not be machined provided that the diameter of the unmachined portion does not exceed the recommended shoulder diameter, G , given in Table 8 to Table 13.

8.2 Hubs

The hubs of slip-on for welding (code 112) and threaded (code 113) flanges shall be either:

- a) parallel; or
- b) have a draft angle of not greater than 7° on the outside surface for forging or casting purposes.

8.3 Threaded flanges

8.3.1 The threads of hubbed threaded flanges (code 113) shall be taper or parallel in accordance with BS 21 or taper to ANSI/ASME B1.20.1.

NOTE BS 21 parallel threads will be supplied unless the purchaser specifies otherwise (see Appendix A).

8.3.2 The thread shall be concentric with the axis of the flange and misalignment shall not exceed 5 mm/m.

Flanges shall be manufactured without a counterbore but to protect the threads the threads shall be chamfered to the major diameter of the thread at the back of the flange at an angle between 40° and 50° with the axis of the thread. The chamfer shall be concentric with the thread and shall be included in the measurement of the thread length provided that the chamfer does not exceed one pitch in length.

8.3.3 Gauging shall be in accordance with BS 21 or ANSI/ASME B1.20.1 as appropriate.

8.4 Bolt holes

Bolt holes shall be equally spaced on the pitch circle diameter and in the case of integral flanges, shall be positioned off-centre.

9 Flange facings

9.1 Range of facings

The range of flange facings and flange face designations are given in Figure 3. Dimensions of facings shall be as given in Figure 4 and Table 7.

For flange facings types B, D and F the transition from the edge of the raised face to the flange face shall be by:

- a) radius; or
- b) chamfer.

9.2 Lapped joints

For code 133 ancillary components for flanges the finished height of the facing shall be not less than the specified pipe thickness used. If a tongue or groove face is required the thickness of the lap remaining after machining the facing shall not be less than the specified thickness of the pipe used.

9.3 Facing finishes

9.3.1 All flange jointing faces shall be machine finished and when compared by visual or tactile means with reference specimens, shall be in accordance with the values given in Table 6.

NOTE 1 It is not intended that instrument measurements be taken on the faces themselves and the R_a and R_z values as defined in BS 1134 relate to the reference specimens.

NOTE 2 Requirements for special coatings or finishes should be stated in the enquiry and/or order so that an appropriate allowance may be incorporated in the machining of any relevant mating dimensions (see Appendix A).

9.3.2 Flat face, raised face and spigot/recess facings types A, B, E and F shall be machined to comply with the requirements of Table 6.

9.3.3 For tongue and groove and O-ring groove facings types C, D, G and H the gasket contact surfaces shall be machined to produce a surface finish in accordance with the values given in Table 6.

10 Spot facing or back facing of flanges

Any spot facing or back facing shall not reduce the flange thickness to less than the thickness specified. When spot facing is used the diameter shall be large enough to accommodate the outside diameter of the equivalent normal series of washers complying with BS 4320 for the metric bolt size being fitted. The bearing surfaces for the bolting shall be parallel to the flange face within the limits given in Table 14. When a flange is back faced a minimum fillet radius at the hub, $R_{\min}$ (see Figure 11), shall be maintained as given in Table 18.

11 Tolerances

Tolerances on dimensions of flanges shall be as given in Table 14.

12 Marking

12.1 Other than integral flanges

All flanges, other than integral, shall be marked as follows.

- Number of this British Standard, i.e. BS 4504⁶⁾.
- Flange code number, e.g. 112.
- Nominal pressure (PN), e.g. PN 40.
- Nominal size (DN), e.g. DN 150.
- Material designation. The material group or identification symbols given in Table 3, Table 4 and Table 5 shall be used, as appropriate.

f) Manufacturer's name or trade mark.

g) Cast number or melt identification or suitable quality control number traceable to the cast number.

h) Thread identification (see 12.2).

Example: BS 4504-111 – PN 16 – DN 400 – A2 – XXX – 12345

NOTE 1 Additionally, the type of flange face may be specified using the designations given in Figure 4.

Example: BS 4504-111/B – PN 16 – DN 400 – A2 – XXX – 12345

NOTE 2 Where a flange is subsequently used to form an integral part of a component and the component has a lower pressure rating than that of the flange, the lower rating should be clearly marked on the component.

12.2 Internal thread identification

Threaded flanges shall be marked to indicate the type of thread used.

Threads to BS 21 shall be designated by the letter Rc or Rp as appropriate followed by the nominal size, e.g. Rc 3/4. Threads to ANSI/ASME B1.20.1 shall be designated by the nominal size, number of threads per inch and the letters NPT, e.g. 3/4 – 14NPT.

12.3 Stamping

Where steel stamps are used, the marking shall be positioned on the rim of the flange.

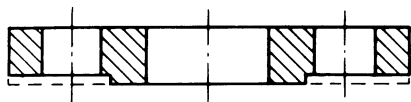
NOTE Care should be taken to ensure that steel stamp markings are not liable to cause cracks in the flange material.

12.4 Omission of markings

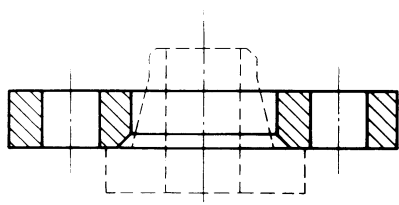
If a flange is too small to enable all the markings required in 12.1 to be marked on the flange, then some of the markings are permitted to be omitted. The order in which the markings are omitted shall be as follows.

- Size.
- Thread type and designation.
- PN designation.
- Manufacturer's name or trade mark.

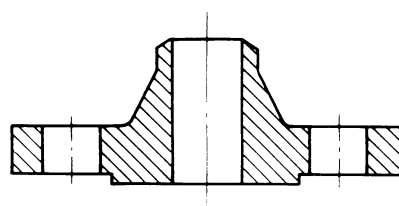
⁶⁾ Marking BS 4504, together with the flange code number, on or in relation to a product represents a manufacturer's declaration of conformity, i.e. a claim by or on behalf of the manufacturer that the product meets the requirements of this Section of BS 4504. The accuracy of the claim is therefore solely the responsibility of the person making the claim. Such a declaration is not to be confused with third party certification of conformity, which may also be desirable.



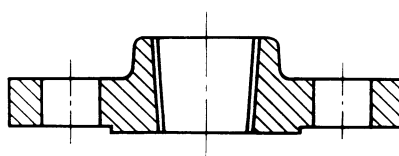
Code 101
Plate flange for welding



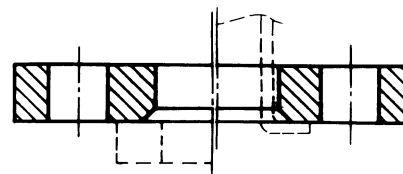
Code 104
Loose flange with welding
neck collar (see code 134)



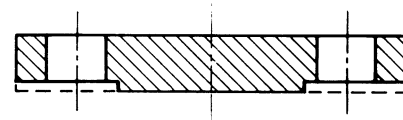
Code 111
Weld-neck flange



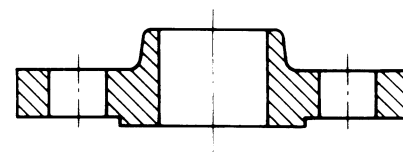
Code 113
Hubbed threaded flange



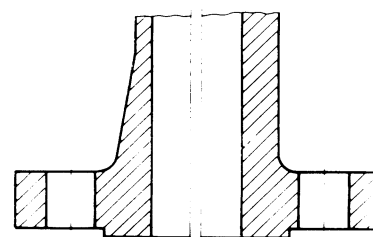
Code 102
Loose plate flange with weld-on
plate collar (see code 132) or
lapped pipe end (see code 133)



Code 105
Blank flange



Code 112
Hubbed slip-on flange for welding



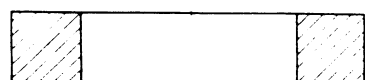
Code 121
Integral

NOTE 1 These sketches are diagrammatic only.

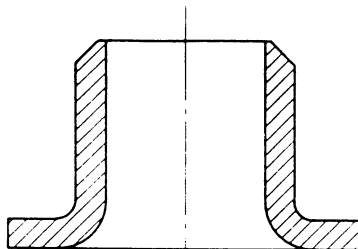
NOTE 2 Codes 101 to 105 inclusive comprise flanges that do not incorporate a hub or weld-neck. Codes 111 to 113 inclusive comprise flanges incorporating a hub or weld-neck manufactured from forgings or steel castings. Code 121 is an integral part of some other equipment or component.

NOTE 3 Flanges may be designated by code numbers or by descriptions.

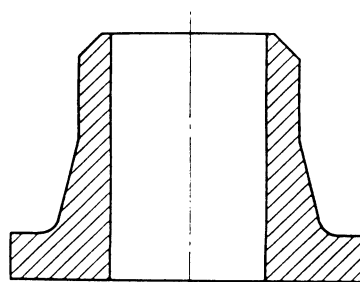
Figure 1 — Flange codes



Code 132
Weld-on plate collar



Code 133
Lapped pipe end



Code 134
Weld-neck collar

NOTE 1 These sketches are diagrammatic only.

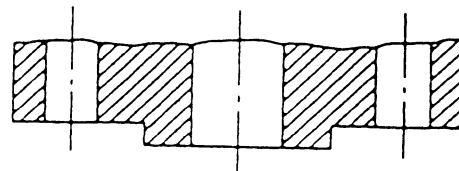
NOTE 2 Code 132 and code 133 are associated with code 102 flange. Code 134 is associated with code 104 flange.

NOTE 3 Flanges may be designated by code numbers or by descriptions.

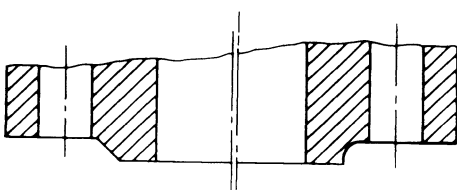
Figure 2 — Ancillary components for flanges. Codes 132 to 134



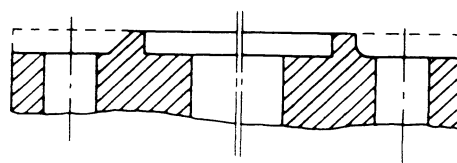
Type A
Flat face



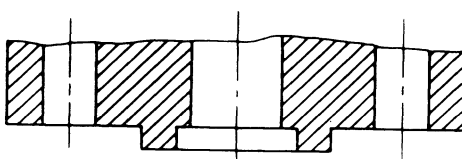
Type E
Spigot



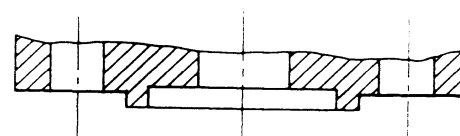
Type B
Raised face



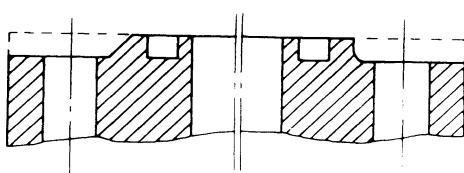
Type F
Recess



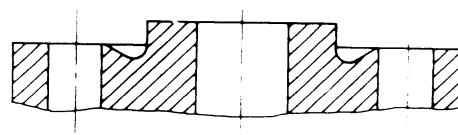
Type C
Tongue



Type G
O-ring recess



Type D
Groove



Type H
O-ring groove

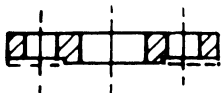
NOTE 1 The transition from the edge of the raised face to the flange face may be by radius or chamfer (see 9.1).

NOTE 2 Sketches designated A to H inclusive illustrate the various types of flange facings which may be used in conjunction with the flanges or components given in Figure 1 and Figure 2.

NOTE 3 Facings may be designated by type letters or by descriptions.

Figure 3 — Flange facings: types

Table 2 — Synoptic table

Flange and code no.	Table	DN PN	10	15	20	25	32	40	50	65	80	100	125	150	200	250	300	350	400	450	500	600	700	800	900	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																								
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	12	25	Use PN 40												x	x	x	x	x	x	x	x																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																											
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