

Specification for

Rotary form-relieved gear cutters —

Part 1: Diametral pitch

Confirmed
January 2011

Co-operating organizations

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

Admiralty	High Commission of India
Air Ministry	Institute of Marine Engineers
Associated Offices Technical Committee	Institute of Petroleum
Association of Consulting Engineers (Incorporated)	Institution of Civil Engineers
British Chemical Plant Manufacturers’ Association	Institution of Gas Engineers
British Compressed Air Society	Institution of Heating and Ventilating Engineers
British Electrical and Allied Manufacturers’ Association*	Institution of Mechanical Engineers
British Electricity Authority and Area Boards	Institution of Mechanical Engineers (Automobile Division)
British Engineers Association	Institution of Production Engineers*
British Internal Combustion Engine Manufacturers’ Association	Locomotive Manufacturers’ Association
British Iron and Steel Federation	Machine Tool Trades Association*
British Railways, The British Transport Commission	Ministry of Fuel and Power
Crown Agents for Oversea Governments and Administrations	Ministry of Labour and National Service (Factory Department)
D.S.I.R. — Mechanical Engineering Research Laboratory*	Ministry of Supply*
Engineering Equipment Users’ Association	Ministry of Transport
Gas Council	Ministry of Works
	National Physical Laboratory
	Radio Industry Council
	War Office

The Government departments and scientific and industrial organizations marked with an asterisk in the above list, together with the following scientific and industrial organizations, were directly represented on the committee entrusted with the preparation of this standard:—

British Gear Manufacturers’ Association	Parsons Marine Engineering Turbine
Milling Cutter and Reamer Trade Association	Research and Development Association
North East Coast Institution of Engineers and Shipbuilders	Society of Motor Manufacturers and Traders Ltd.

This British Standard, having been approved by the Mechanical Engineering Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 9 November 1954

© BSI 01-2000

The following BSI references relate to the work on this standard:—
Committee reference MEE/127
Draft for comment CT(MEE) 2228

ISBN 0 580 34124 0

Amendments issued since publication

Amd. No.	Date of issue	Comments
2154	April 1955	
2290	June 1977	Indicated by a sideline in the margin

Contents

	Page
Co-operating organizations	Inside front cover
Foreword	iii
1 Scope	1
2 Definitions	1
3 Gear tooth form	1
4 Cutter groups	3
5 Cutter dimensions	7
6 Cutter keyways	7
7 Arbors and keys	7
8 Marking	7
Appendix A Milled gears intended to mesh with generated gears	11
Appendix B Form relief	11
Appendix C Recommended arbors and keys for standard cutters	11
Appendix D Marking of cutters	12
Appendix E Ordering instructions	12
Appendix F Rotary gear cutters with $14\frac{1}{2}^\circ$ pressure angle	13
Appendix G	23
Appendix H Metric sizes for rotary form-relieved gear cutters	24
Figure 1 — Rotary form-relieved gear cutter	2
Figure 2 — 20° composite basic rack tooth profile for unit normal diametral pitch	4
Figure 3 — Cutters Nos. 1 to 8 — P.A. 20° — Table 2	5
Figure 4 — $14\frac{1}{2}^\circ$ composite (A.G.M.A. Standard) basic rack tooth profile for unit normal diametral pitch	14
Figure 5 — Cutters Nos. 1, $1\frac{1}{2}$, 2, $2\frac{1}{2}$ and 3 — P.A. $14\frac{1}{2}^\circ$ — Table 9 — Appendix F	15
Figure 6 — Cutters Nos. $3\frac{1}{2}$ and 4 — P.A. $14\frac{1}{2}^\circ$ — Table 10 — Appendix F	17
Figure 7 — Cutters Nos. $4\frac{1}{2}$, 5, $5\frac{1}{2}$, 6 and $6\frac{1}{2}$ — P.A. $14\frac{1}{2}^\circ$ — Table 11 — Appendix F	19
Figure 8 — Cutters Nos. 7, $7\frac{1}{2}$ and 8 — P.A. $14\frac{1}{2}^\circ$ — Table 12 — Appendix F	21
Table 1A — Standard cutter group (8 Cutters)	3
Table 1B — Special cutter group (15 Cutters)	3
Table 2 — Profile dimensions for 1 D.P. 20° P.A. rotary gear cutters	6
Table 3 — Limits of tolerances on standard chordal tooth thickness “CT”	6
Table 4 — Cutter diameters and bores	8
Table 5A — Widths of standard 20° pressure angle cutters	9
Table 5B — Limits of tolerance on width	9
Table 6 — Keyways	10
Table 7 — Reduction of tooth thickness of milled gear teeth for cutters of 1 D.P.	11
Table 8A — Diameters of arbors	11
Table 8B — Keys for arbors	12
Table 9 — Profile dimensions for 1 D.P. $14\frac{1}{2}^\circ$ P.A. rotary gear cutters, cutter numbers 1, $1\frac{1}{2}$, 2, $2\frac{1}{2}$, 3	16
Table 10 — Profile dimensions for 1 D.P. $14\frac{1}{2}^\circ$ P.A. rotary gear cutters, cutter numbers $3\frac{1}{2}$, 4	18
Table 11 — Profile dimensions for 1 D.P. $14\frac{1}{2}^\circ$ P.A. rotary gear cutters, cutter numbers $4\frac{1}{2}$, 5, $5\frac{1}{2}$, 6, $6\frac{1}{2}$	20

	Page
Table 12 — Profile dimensions for 1 D.P. $14\frac{1}{2}^{\circ}$ P.A. rotary gear cutters, cutter numbers 7, $7\frac{1}{2}$, 8	22
Table 13 — Equivalent pitches	23
Table 14 — Diameters and bores	24
Table 15 — Cutter keyways	25
Table 16 — Diameters of arbors	25
Table 17 — Keys for arbors	26

Foreword

This standard makes reference to the following British Standards:—

BS 2519, *Glossary of terms and notation for toothed gearing*.

BS 436:1940, *Machine cut gears. A. Helical and straight spur*.

This British Standard was prepared under the authority of the Mechanical Engineering Industry Standards Committee and forms part of a series of standards for gear-forming tools, of which the following have been published:—

BS 2007:1953, *Circular gear shaving cutters: Accuracy*.

BS 2062:1953, *Gear hobs*.

Others in the series will relate to pinion type gear cutters and rack type gear cutters.

This British Standard supersedes the tables relating to rotary form-relieved gear cutters included in BS 122:1938, “*Milling cutters and reamers*”. As a result of experience gained from the use of these tables, it became clear that the information they provide is insufficient to ensure uniformity in the manufacture of such cutters; and the amendments and recommendations referred to below have therefore been introduced in the present standard:

a) The British Standard pressure angle of 20° has been adopted since it leads to a well balanced compromise between strength, resistance to wear and quietness of running in gears. The composite basic rack tooth profile adopted (Figure 2) is designed to avoid undercutting in gears having a small number of teeth, and it provides also suitable tip relief in the teeth cut.

b) An odontograph diagram with table of dimensions for 1 D.P. cutters is provided for the setting out of the correct profiles of the full range of cutters used in rotary gear cutter practice for gears from a 12 tooth pinion to a rack. Values for cutter addendum and tooth thickness have been added to these tables.

c) A table giving limits of tolerances on standard tooth thickness has also been included.

NOTE An auxiliary table in Appendix A shows the amount of reduction necessary in chordal gear tooth thickness to enable a milled gear to mesh with a standard generated gear.

d) Amendments have been made to the sizes of bores and diameters. Tables of metric bores, diameters, keys and keyways have been provided in Appendix H.

e) A table of tolerances on the overall width of cutters has been included and the nominal widths have been altered in some cases.

f) It is recommended that the preferred pitches, cutter diameters and cutter bore diameters listed in the tables should be adopted wherever practicable. The bracketed sizes should be avoided wherever possible.

g) “Diametral pitch” has been used throughout this standard to define pitch; and it is recommended that this practice be adopted exclusively when referring to rotary gear cutters.

The equivalents in circular pitch and metric module of diametral pitches are given in Appendix G for reference.

$14\frac{1}{2}^\circ$ pressure angle cutters. As $14\frac{1}{2}^\circ$ pressure angle gears are still in fairly general demand for replacement and other purposes, Appendix F and Table 9, Table 10, Table 11, Table 12 have been added to this standard in order to ensure uniformity in the manufacture of such cutters.

Recommended ordering instructions, to be supplied by a purchaser, are given in Appendix E.

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 26, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

1 Scope

This British Standard applies to rotary form-relieved cutters for milling spur and helical gears within the range 1 to 30 diametral pitch.

Such cutters are deemed satisfactory for cutting gears intended to mesh together under conditions of service which are not severe.

NOTE It is not recommended that cutters designed in accordance with this standard be used for milling gears intended to mesh with generated gears. Where, however, it is found necessary to use milled gears for this purpose, a reduction in chordal thickness of the gear teeth is essential. (See Appendix A).

2 Definitions

a rotary form-relieved gear cutter

a circular milling cutter having on its periphery teeth of such form that it will cut out a single tooth space in a gear

form relief

the provision of a cutting clearance between the cutter teeth and the work (See Figure 1 and Appendix B.)

chordal tooth thickness (CT) of a cutter

the thickness measured at a distance (CA) from the top of the tooth based on the basic rack profile dedendum

the terms used in describing parts of rotary form-relieved cutters are illustrated in Figure 1. General terms relating to gears are given in BS 2519 “*Glossary of terms and notation for toothed gearing*”

3 Gear tooth form

Cutters shall be designed to cut gears corresponding to the 20° composite basic rack tooth profile shown in Figure 2.

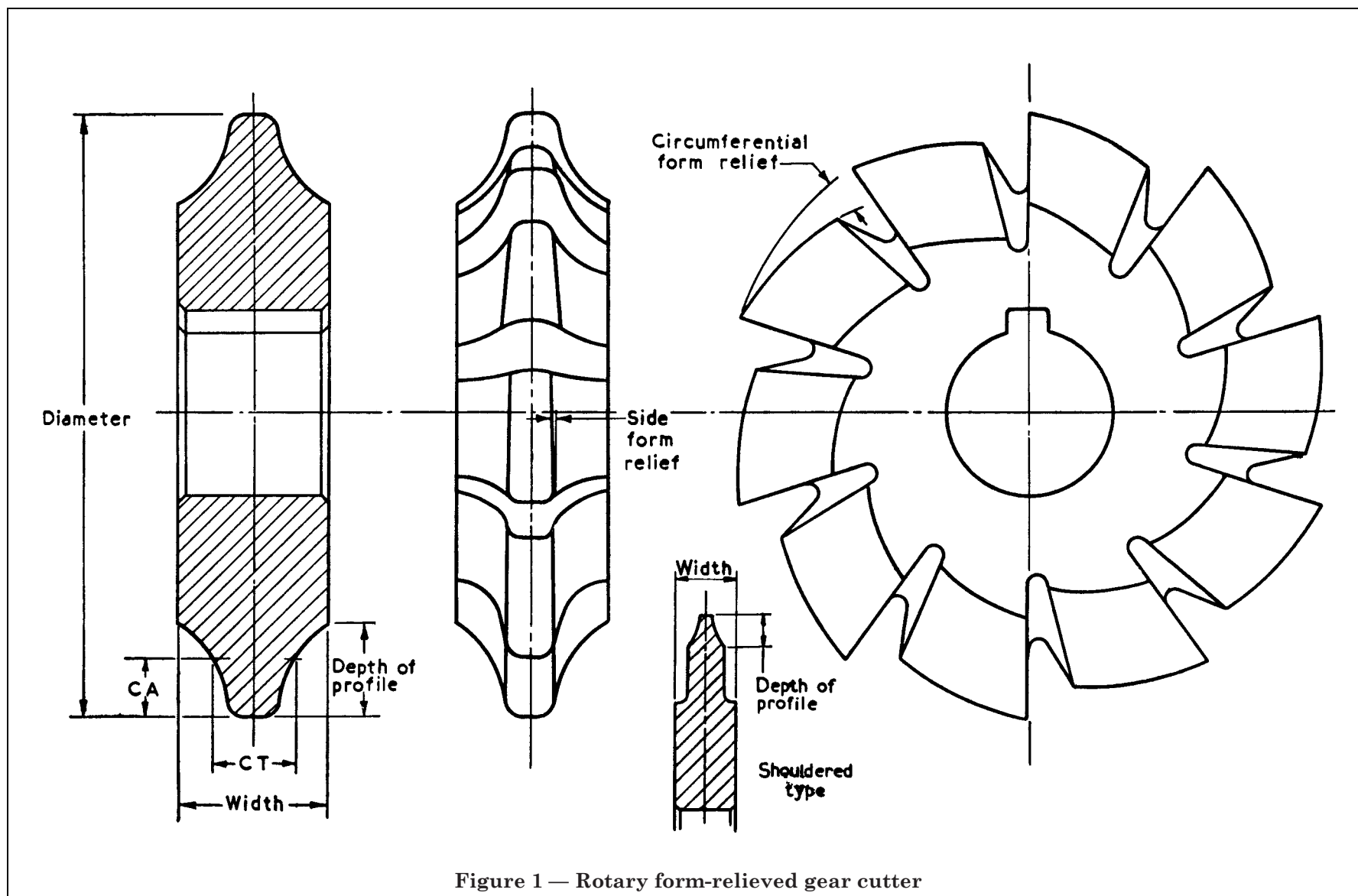


Figure 1 — Rotary form-relieved gear cutter

4 Cutter groups

a) *Standard cutter groups*. In accordance with rotary gear cutter practice, the standard group for any given pitch shall consist of eight cutters, numbered 1 to 8 inclusive, for milling gears having the numbers of teeth specified in the following table:—

Table 1A — Standard cutter group (8 Cutters)

Cutter number	Inclusive range of teeth for spur gears
1	135 to rack
2	55 to 134
3	35 to 54
4	26 to 34
5	21 to 25
6	17 to 20
7	14 to 16
8	12 and 13

It should be noted that the form of tooth obtained with any cutter is strictly correct only when the number of teeth of the gear is the smallest specified for the cutter.

b) *Special cutter group*. It is sometimes necessary to obtain a closer approximation to the correct tooth form for gears with intermediate numbers of teeth. To meet this requirement, intermediate (half size) values of cutters as given in Table 1B may be provided to sub-divide the standard group.

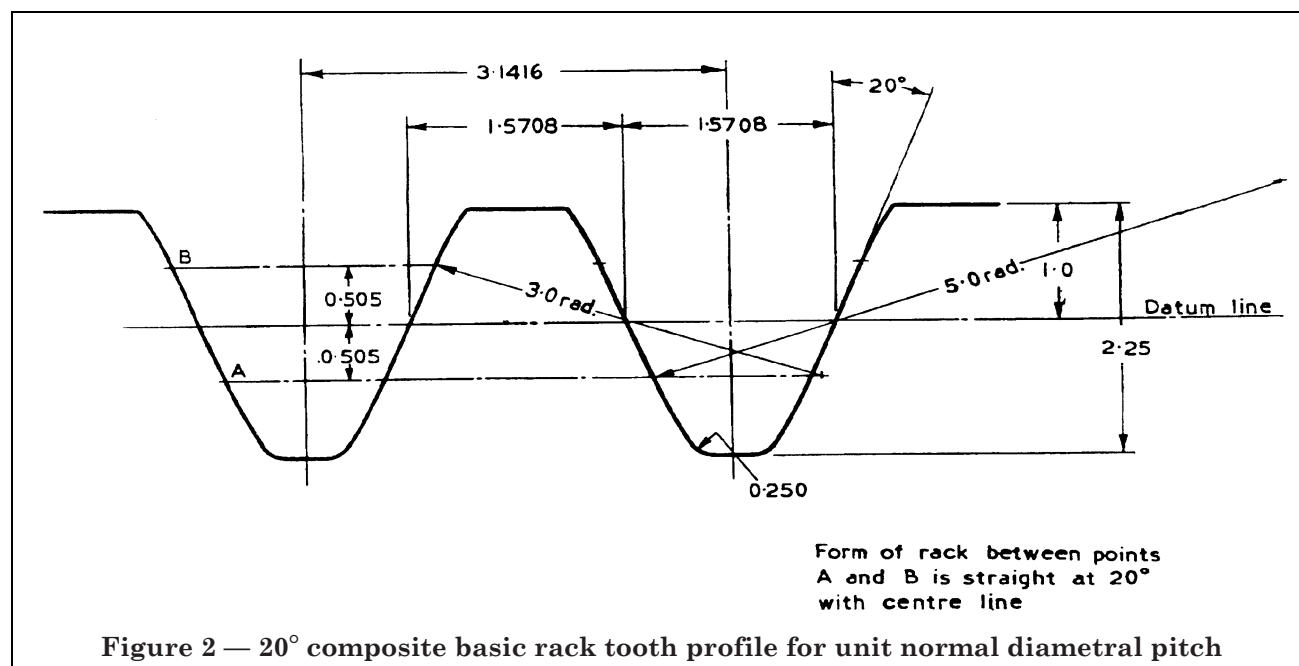
Table 1B — Special cutter group (15 Cutters)

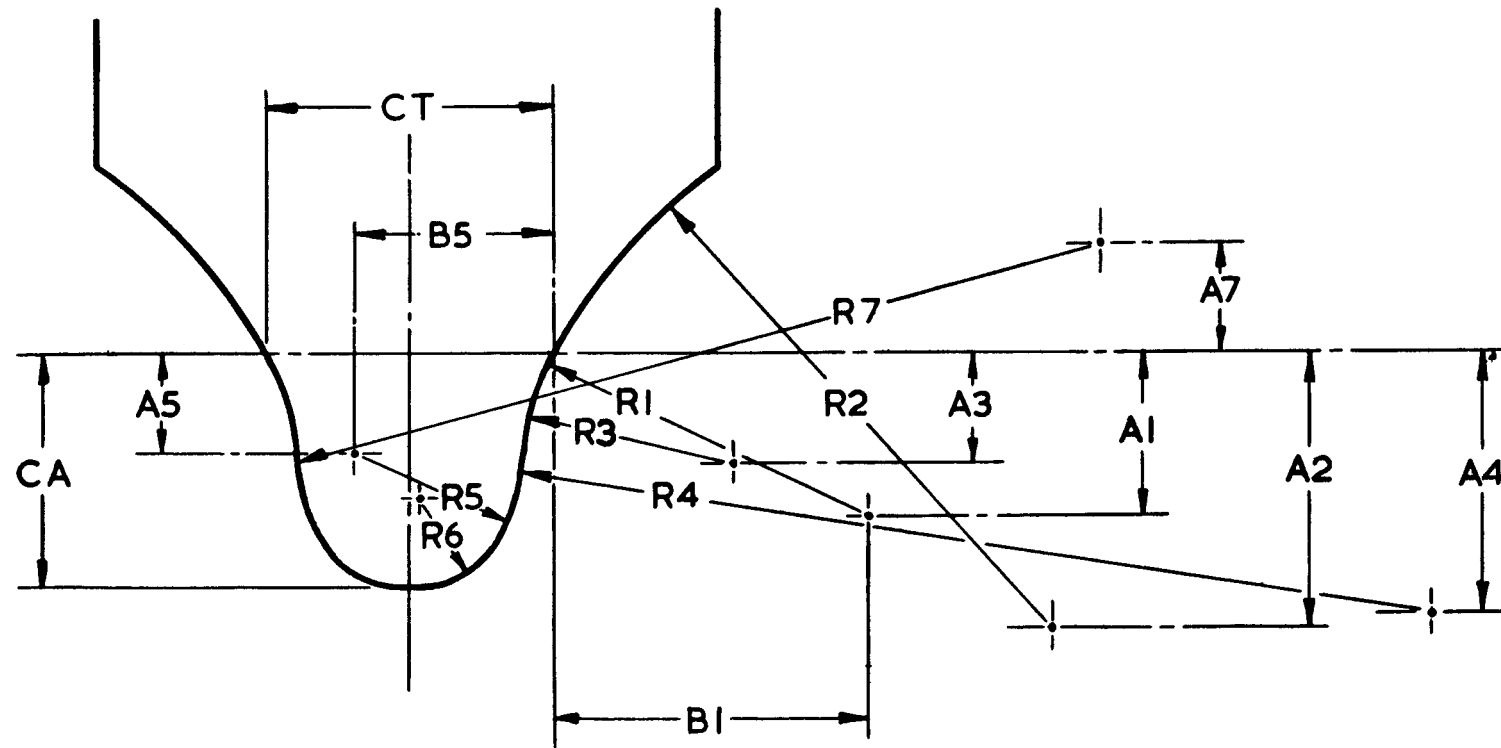
Cutter number	Inclusive range of teeth for spur gears
1	135 to rack
1½	80 to 134
2	55 to 79
2½	42 to 54
3	35 to 41
3½	30 to 34
4	26 to 29
4½	23 to 25
5	21 and 22
5½	19 and 20
6	17 and 18
6½	15 and 16
7	14
7½	13
8	12

In this case also the tooth form obtained is strictly correct only for gears with the smallest number of teeth specified.

NOTE For helical gears, the *virtual* number of teeth, calculated as " $t \sec^2 \sigma$ " should be used to select a cutter number, " t " being the actual number of teeth and " σ " the helix angle of the gear.

c) An odontograph diagram (Figure 3) for standard 20° pressure angle cutters is appended to Table 2 to enable the profile of each cutter in the standard and special groups to be accurately set out. The dimensions in the table are calculated for 1 D.P.: for any other pitch, the dimensions must be divided by the corresponding value of the diametral pitch. (See Figure 3.)





NOTE In setting out the profile, CT is marked on the datum line, and the centre of the arc of radius R1 is located by the co-ordinates A1 and B1. This arc does not necessarily pass through the intersection of the profile with the datum line.

Figure 3 — Cutters Nos. 1 to 8 — P.A. 20° — Table 2