

Specification for

Worm gearing —

Part 1: Imperial units

UDC 621.833.38

Confirmed January 2011

NO COPYING WITHOUT BSI PERMISSION EXCEPT AS PERMITTED BY COPYRIGHT LAW

BSI
Documents

AVA

Document Sharing Hub

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*	Engineering Equipment Users' Association
Air Ministry	Gas Council
Associated Offices' Technical Committee	High Commission of India
Association of Consulting Engineers	Institute of Marine Engineers
(Incorporated)*	Institute of Petroleum
Association of Mining Electrical and	Institution of Civil Engineers
Mechanical Engineers*	Institution of Gas Engineers
British Chemical Plant Manufacturers'	Institution of Heating and Ventilating Engineers
Association	Institution of Mechanical Engineers*
British Compressed Air Society	Institution of Mechanical Engineers (Automobile
British Electrical and Allied Manufacturers'	Division)
Association*	Institution of Production Engineers*
British Engineers' Association*	Locomotive and Allied Manufacturers'
British Gear Manufacturers' Association*	Association of Great Britain
British Internal Combustion Engine	Machine Tool Trades Association*
Manufacturers' Association	Ministry of Labour (H.M. Factory Inspectorate)
British Iron and Steel Federation	Ministry of Power
British Railways Board*	Ministry of Public Building and Works
Crown Agents for Oversea Governments and	Ministry of Transport
Administrations	National Coal Board
D.S.I.R. — National Engineering Laboratory*	National Physical Laboratory (D.S.I.R.)
Electricity Council, The Generating Board and	Radio Industry Council
the Area Boards in England and Wales	War Office*

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

Admiralty-Vickers Gearing Research Association	North East Coast Institution of Engineers and Shipbuilders
Institution of Engineering Inspection	Sheffield University
Manufacturers of Worm Gears	Society of British Aircraft Constructors Ltd.
Milling, Cutter and Reamer Association	Society of Motor Manufacturers and Traders Ltd.
Ministry of Aviation	
National Association of Lift Makers	
National Federation of Engineers Tool Manufacturers	

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 25 April 1963

© BSI 04-2000

First published February 1937
First revision April 1963

The following BSI references relate to the work on this standard:
Committee reference MEE/17
Draft for comment A(MEE) 3326

ISBN 0 580 34579 3

Amendments issued since publication

Amd. No.	Date	Comments
5919	October 1966	
4364	September 1983	

Contents

	Page
Co-operating organizations	Inside front cover
Foreword	iii
1 Scope	1
2 General Information on worm gear elements	1
a) Module	1
b) Axial pitch and normal pitch designations	1
c) Diameter factor q	1
d) Worm gear designations	1
3 Notation	2
4 Form of threads and teeth	3
a) Standard worm thread surfaces	3
b) Basic rack	3
c) Undercutting of worm threads	4
d) Thread thickness	4
e) Wormwheel teeth and entry gaps	4
f) Wormwheel tooth fillet	4
g) Face width of wormwheel	4
5 Formulae for calculation of dimensions	5
a) Limiting values of centre distance for given values of t , T , q and m	5
b) Limiting values of m for given values of C , t , T and q	5
c) Formulae for detail dimensions of worm and wheel	5
d) Rim section	6
6 The general system of worm gear design	8
a) Obtaining suitable values of t , T , q and m	8
b) Standard axial modules	8
c) Standard diameter factors (q)	8
d) Determinations of t and T	8
e) Guidance for determination of q	8
f) Procedure for selecting standard worms	8
7 Tables and dimensions of standard worms and wheels	9
a) Tables of worm gear designations	9
i) Standard centre distances for industrial worm gears	9
ii) Standard centre distances for axle transmission gears	9
b) Examples of worm gear designations	9
c) Detail dimensions of worms and wheels	9
8 Tolerances	16
a) Worms:	16
i) runout of tip diameter	16
ii) pitch tolerances	16
iii) profile tolerances	16
iv) thread thickness tolerances	16
b) Wormwheels: pitch tolerances	17
9 Normal backlash	17
10 Working temperature	17
11 Efficiency and lubrication	18
12 Irreversibility	18
13 Information to be given on drawings by the purchaser	18

	Page
Appendix A Load capacity	21
A.1 Determination of load capacity	21
A.2 Determination of equivalent running time for loading conditions other than a steady load	22
A.3 Momentary overload capacity	23
A.4 Axle transmission gears	23
Appendix B Examples of calculations	25
Appendix C Design procedure based on axial pitch of worm	32
Appendix D Procedure for the design of worms to suit standard diametral pitch cutting tools corresponding to the normal pitch of the worm	33
Chart 1 — Maximum positive value of addendum modification coefficient for 1 module (k_{w1})	34
Chart 2 — Maximum negative value of addendum modification coefficient for 1 module (k_{w2})	34
Chart 3 — Determination of q for worm speeds up to 300 rev/min	35
Chart 4 — Determination of q for maximum efficiency for any worm speed	36
Chart 5 — Coefficient of friction of worm gears	37
Chart 6 — Speed factors for worm gears (for wear) (X_c)	38
Chart 7 — Speed factors for worm gears (for strength) (X_b)	39
Chart 8 — Expected life factors for strength and wear	40
Figure 1a — Normal section of basic rack (dimensioned in terms of axial module)	3
Figure 1b — Normal section of basic rack (dimensioned in terms of normal pitch)	4
Figure 2 — Entry gap in wormwheel teeth	4
Figure 3 — Wormwheel rim section	6
Figure 4 — Wormwheel rim section	6
Figure 5 — Wormwheel rim section	7
Figure 6a & Figure 6b — Minimum thickness of wormwheel rim section	7
Figure 7 — Wormwheel rim section	7
Figure 8	19
Figure 9	20
Table 1 — Examples of designations $t/T/q/m$ for industrial worm gears for all worm speeds	10
Table 2 — Examples of designations $t/T/q/m$ for industrial worm gears for speeds up to 300 rev/min	11
Table 3 — Recommended numbers of worm threads t and wheel teeth T for axle transmission worm gears	12
Table 4 — Dimensions of standard worms of unit axial module	13
Table 5 — Worm gear zone factors Z	24
Table 6 — Stress factors for worm gears S_b and S_c	24
Table 7 — Duty factor K	25

Foreword

This standard makes reference to the following British Standards:

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

BS 1498, *Gear hobbing machines for turbines and similar drives.*

BS 1916, *Limits and fits for engineering.*

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

BS 3013, *Gear hobbing machines for small precision gears.*

BS 3538, *Hobbing machines for general purposes.*

This British Standard supersedes the 1937 edition and has been prepared under the authority of the Mechanical Engineering Industry Standards Committee.

This revision differs from the previous edition mainly in the following details:

- 1) A method of design is given for worm gears of most types and sizes.
- 2) The form of basic rack is now specified and is similar to that given in BS 436.
- 3) A fixed number of preferred centre distances, ratios, axial modules and diameter factors (d/m) is recommended with a view to minimizing the number of tools required. A list of second choice centre distances is also given. This standard also illustrates the method of preparing designs based on existing worm wheel hobs designated by axial pitches as well as designs of worms produced by standard diametral pitch cutting tools corresponding to the normal pitch of the worm.
- 4) A system of depth modification applicable to worms of high lead angle is given to ensure adequate crest width of the hob and to avoid the undesirable condition of the base diameter being greater than the diameter of the worm clearance cylinder.
- 5) Rules are given for the selection of t , T and q and standard modules are divided into "first choice" and "second choice" to facilitate close approximation to desired condition; limiting values are given for variation in centre distance with the same object.
- 6) The formulae for allowable loads have been revised, the permissible load for strength having been greatly increased. These are now given in an appendix to the standard.

NOTE 1 The units given in this standard are British units. BS 350, "Conversion factors and tables" should be consulted when it is desired to make conversions to metric units.

NOTE 2 In place of the customary, but incorrect, use of the pound as a unit of force, the unit called a pound-force (abbreviation lbf) has been used in this standard. This is the force which, when acting on a body of mass one pound gives it an acceleration equal to that of standard gravity.

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 40 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 worm gearing and comprises cylindrical involute helicoid worms and worm wheels conjugate thereto, the dimensions of which are expressed in inches. Four classes of gears are provided which are related to function and precision. The range of modules is given in convenient steps from 0.052 to 1.

This standard does not refer to pairs of cylindrical gears connecting non-parallel axes known as crossed helical gears.

2 General information on worm gear elements

a) *Module*. Axial modules in inch units are specified and a series of standard modules is listed in Clause 6 b).

The lists of modules and diameter factors provide for a range of standard worms which is considered sufficiently wide for most requirements. Certain modules are “preferred” in order to encourage the smallest practicable range of tools. In order to help in the case of restricted conditions a list of “second choice” modules is also given.

b) *Axial pitch and normal pitch designations*. It is recognized that existing hobs not made to this specification will continue to be used. In order that these may be employed in a manner consistent with this specification the method of application is given in Appendix C and Appendix D.

c) *Diameter factor q* . Choice of worm diameter is limited by considerations of strength and efficiency. Since the efficiency of the gear increases as the worm diameter is reduced the worm diameter should be as small as possible consistent with adequate strength at the root section of the worm. Charts are provided for guidance for selecting suitable worm diameters (see Table 4).

The worm reference diameter is the product of the module and the diameter factor q . For a given value of q the reference diameter is therefore $d_f = qm$.

Standard values of q in this specification are given in Clause 6 c).

The larger worm diameter factors from 12 upwards are seldom required except when the worm is bored. In such cases it is recommended that the thickness of metal below the thread be approximately equal to the depth of the thread.

The reference diameter of a worm is equal to qm and is thus similar to the reference diameter of a spur gear having q teeth and m module. In the same way, the centre distance of a pair of worm gears (unless extended or closed) is equal to that of a pair of spur gears having q and T teeth, i.e.

$$C = 0.5 m(q + T)$$

It is also to be noted that the calculation of the tip diameter of a worm is analogous to that of a spur gear with q teeth and m module. In the detail system of design, the worm addendum is always equal to the module and the tip diameter of a worm is found from

$$d_a = m(q + 2)$$

The lead angle of the worm thread at the reference cylinder is found from:

$$\tan \lambda = t/q$$

In the general design system defined, a restricted range of q values is recommended. This ensures geometric similarity between all worms having the same values of t and q . From any given combination of t and q , all angular dimensions of a worm can be calculated, and all linear dimensions will be proportional to the selected modules. Tables are included giving detail dimensions of worms of unit axial module for combinations of t with standard values of q .

d) *Worm gear designations*. A pair of worm gears is defined by the designation, written in the brief form $t/T/q/m$, and this information, together with the centre distance C is sufficient to enable all detail dimensions to be calculated from formulae or tables provided.

For example a designation 3/38/8/0.30 at 7-inch centres, signifies a 38-tooth wheel working at 7-inch centre distance with a 3-start worm of 0.30-inch axial module and of diameter factor 8.

3 Notation

The terms and symbols given below are generally in accordance with those given in BS 2519, "*Glossary of terms and notation for toothed gearing*".

The notations used are as follows:

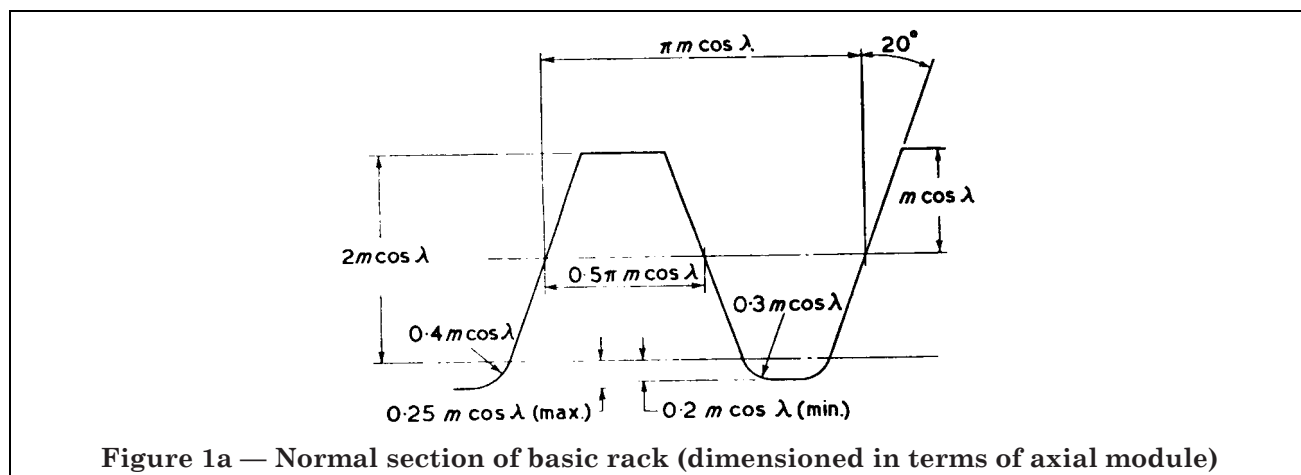
a	Worm thread addendum
b	Worm thread dedendum
c	Clearance
C	Centre distance
d_a	Worm tip diameter
d_f	Worm reference circle diameter
d_o	Base diameter of involute helicoid
d_r	Worm root diameter
D_f	Wormwheel reference circle diameter
D_a	Wormwheel tip diameter
D_r	Wormwheel root diameter
D_t	Wormwheel throat diameter
f_p	Length of worm
F_e	Wormwheel effective face width
g	Constant chord thickness
G	Gradient factor
h	Constant chord height
k_w	Wheel addendum modification coefficient
K	Duty factor
l_r	Length of root of wormwheel teeth
L	Lead of worm threads
L_{ap}	Axial distance between any two points at the same radial distance from the worm axis
m	Axial module
m_a	Normal module
M	Maximum engine torque
M_w	Torque on wormwheel
n	Rev/min of worm
N	Rev/min of wormwheel
p_n	Normal pitch
p_a	Axial pitch
q	Diameter factor
r_t	Wormwheel throat radius
r	Rolling radius of tyre
R_1	Gearbox ratio for lowest road speed
R_2	Rear axle ratio
R_g	Gear ratio
S_{bp}	Bending stress factor: worm
S_{bw}	Bending stress factor: wormwheel
S_{cp}	Surface stress factor: worm
S_{cw}	Surface stress factor: wormwheel
t	Number of threads in worm

T	Number of teeth in wormwheel
U	Period of time for load cycle
U_b	Equivalent running time per cycle for strength
U_c	Equivalent running time per cycle for wear
U_{bw}	Equivalent running time for strength
U_{cw}	Equivalent running time for wear
U_{eb}	Total equivalent running time for strength
U_{ec}	Total equivalent running time for wear
V_s	Rubbing speed
W_l	Load on driving axle
W	Gross laden weight of vehicle
X_{bp}	Speed factor for strength: worm
X_{bw}	Speed factor for strength: wormwheel
X_{cp}	Speed factor for wear: worm
X_{cw}	Speed factor for wear: wormwheel
Z	Zone factor
Σ	Shaft angle
λ	Lead angle of worm thread
λ_o	Base lead angle of worm thread
μ	Coefficient of friction
ψ_n	Normal pressure angle
ϕ	Angle of friction
θ	The number of degrees in the smaller angle between the plane containing the axis and one point, and the plane containing the axis and the other point.

4 Form of threads and teeth

a) *Standard worm thread surfaces.* These are involute helicoids with a normal pressure angle of 20 degrees at the reference circle diameter $d_f = qm$.

b) *Basic rack.* A normal section of the basic rack is shown in Figure 1a and is dimensioned in terms of the axial module, and in Figure 1b in terms of the normal pitch. The working depth, tooth thickness and pressure angle are similar to those of the BS 436¹⁾ basic rack (Figure 5 of BS 436:1940) but the clearance may vary from $0.2 m \cos \lambda$ to $0.25 m \cos \lambda$ according to the method of manufacture.



¹⁾ BS 436, "Machine cut gears. A. Helical and straight spur."

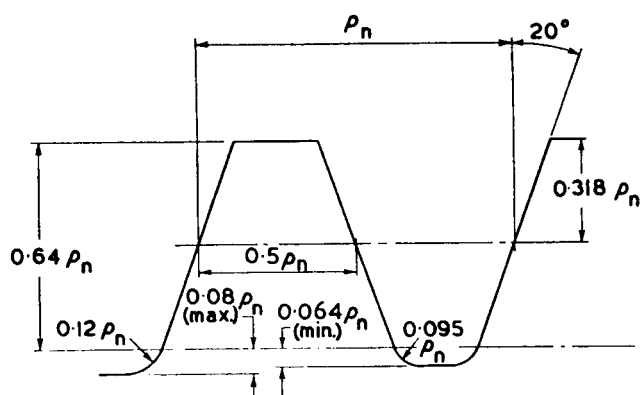


Figure 1b — Normal section of basic rack (dimensioned in terms of normal pitch)

Sharp edges shall be removed from the tips of the worm threads.

c) *Undercutting worm threads.* Certain worms with large lead angles would have undercut threads and/or too narrow thread crests unless modified. In such cases by withdrawal of the basic rack the root diameter and thread thickness are increased and the dedendum decreased but the tip diameter and reference addendum remain unaltered. Formulae for calculating the necessary dimensions are given in Clause 5 c), and depth reduction is allowed for in the tables of dimensions of standard worms.

d) *Thread thickness.* The thread thickness can be gauged on the “constant chord” for which tabulated values are included in Table 4.

e) *Wormwheel teeth and entry gaps.* The wormwheel teeth are of the form indicated by Definition 1116 of BS 2519.²⁾ “Entry gap” is permitted giving a light load contact similar to that shown in Figure 2.

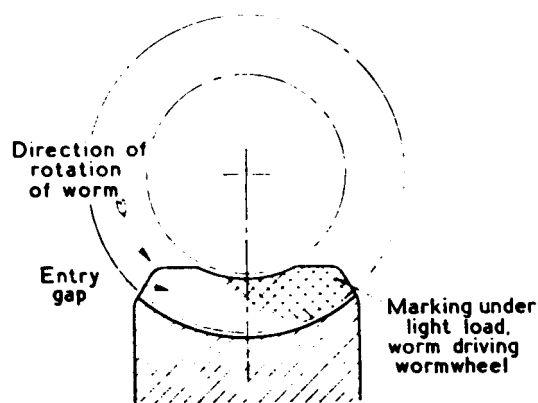


Figure 2 — Entry gap in wormwheel teeth

f) *Wormwheel tooth fillet.* This shall be such as would be generated by a hob having a radius at its tip not less than $0.25m \cos \lambda$ or $0.08p_n$, and not exceeding $0.3m \cos \lambda$ or $0.095p_n$.

It shall be optional to remove sharp edges from the tips of the worm wheel teeth.

g) *Face width of wormwheel.* The effective face width is equal to $2m \sqrt{q + 1}$, or the actual face width, whichever is the lesser.

²⁾ BS 2519, “Glossary of terms and notation for toothed gearing”

5 Formulae for calculations of dimensions

a) *Limiting values of centre distance for given values of t , T , q and m .*

$$C(\text{max.}) = 0.5m (T + q + 2k_{w1}) \text{ where } k_{w1} \text{ is taken from Chart 1}$$

$$C(\text{min.}) = 0.5m (T + q - 2k_{w2}) \text{ where } k_{w2} \text{ is taken from Chart 2}$$

b) *Limiting values of m for given values of C , t , T and q .*

$$m(\text{max.}) = \frac{2C}{T + q - 2k_{w1}}$$

$$m(\text{min.}) = \frac{2C}{T + q + 2k_{w1}}$$

c) *Formulae for detail dimensions of worm and wheel.*

Worm

$$\tan \lambda = t/q$$

$$d_f = qm$$

$$a = m$$

$${}^a b = \begin{matrix} m (2.2 \cos \lambda - 1) \text{ min.} \\ m (2.25 \cos \lambda - 1) \text{ max.} \end{matrix}$$

$${}^a c = \begin{matrix} (0.2 m \cos \lambda) \text{ min.} \\ (0.25 m \cos \lambda) \text{ max.} \end{matrix}$$

$$d_a = d_f + 2a = m (q + 2)$$

$$d_r = d_f - 2b$$

$$L = \pi tm$$

$$\psi_a = 20^\circ$$

$$\cos \lambda_o = \cos \lambda \cos \psi_a$$

$$d_o = \frac{L}{\pi \tan \lambda_o}$$

$$f_p = 14 m \cos \lambda$$

$${}^a g = m (0.7444 \cos \lambda + 0.6428)$$

$$h = m - \frac{g}{2} \tan 20^\circ$$

Wheel

$$D_f = 2C - d_f$$

$$D_t = 2C - (d_r + 2c)$$

$$D_r = 2C - (d_a + 2c)$$

$$D_a(\text{min.}) = D_t + 0.4 m$$

$$D_a(\text{max.}) = D_t + m$$

$$r_t = 0.5 (d_r + 2c)$$

$${}^a c = \begin{matrix} (0.2 m \cos \lambda) \text{ min.} \\ (0.25 m \cos \lambda) \text{ max.} \end{matrix}$$

$$F_e = 2 m \sqrt{q+1}$$

$$m = \frac{p_a}{\pi}$$

$$m_n = m \cos \lambda$$

$$p_a = \pi m$$

$$p_n = p_a \cos \lambda$$

$$l_r = (d_a + 2c) \sin^{-1} \left[\frac{F_a}{(d_a + 2c)} \right] \text{ where the angle is in radians.}$$

^a *Clearance.* The clearance is given maximum and minimum values.

For new designs based on the module system the clearance should be made to the minimum value given. If it is desired to use tools made to the depths given in BS 436^c for cutting the worm threads the maximum clearance may be adopted when the cutting is a finishing process, but if the cutting of the worm is used as a pregrinding process the clearance may be reduced to not less than the stated minimum.

^b *Depth reduction.* Depth reduction is necessary on all worms on which the worm wheel throat would, from the above formulae, lie within the base circle of the worm. Those worms with a standard q value equal to or less than that given below for a given number of threads, require a depth reduction.

$$t = 3 \quad 4 \quad 5 \quad 6 \quad 7$$

$$q = 6.5 \quad 7 \quad 7.5 \quad 8 \quad 8$$

in such cases of depth reduction the formulae marked ^b become

$$b = \frac{1}{2}(d_f - d_o) + c$$

$$g = 2.0298 m \cos \lambda - 0.3214 (d_f - d_o)$$

^c BS 436, "Machine cut gears. A. Helical and straight spur".

d) *Rim section.* Some typical wheel rim sections and methods of attachment are shown in Figure 3 – Figure 7 in which the sides of the rim are chamfered, the chamfer extends at least to the roots of the wheel teeth and the corners are provided with a radius equal to $0.5 m$.

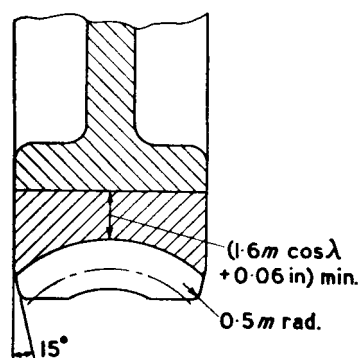


Figure 3 — Wormwheel rim section

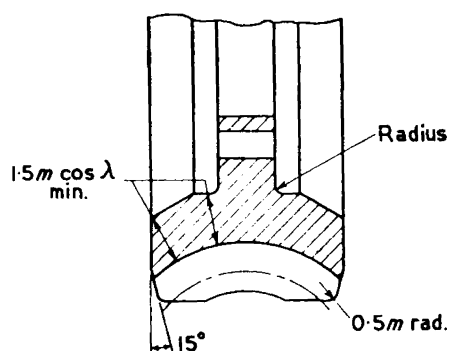


Figure 4 — Wormwheel rim section

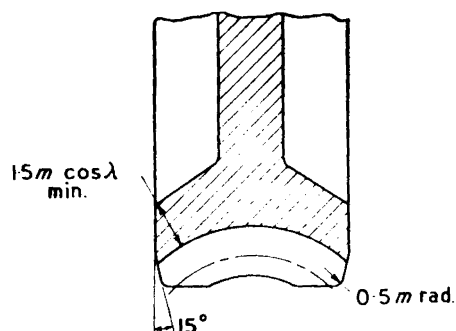


Figure 5 — Wormwheel rim section

Rim shrunk and
pegged to centre.
Pegs should not en-
croach into minimum
thickness of rim as
shown

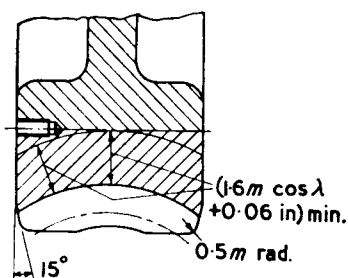


Figure 6a

Rim shrunk and
bolted to centre.
Bolt should not en-
croach into minimum
thickness of rim as
shown

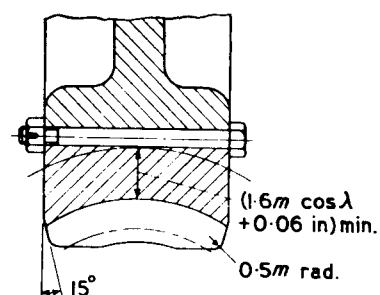


Figure 6b

Figure 6a & Figure 6b — Minimum thickness of wormwheel rim section

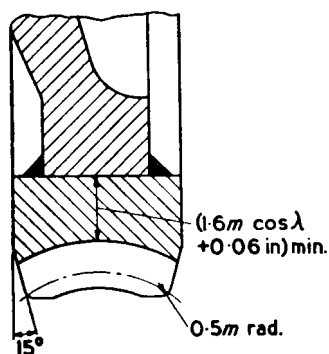


Figure 7 — Wormwheel rim section

6 The general system of worm gear design

a) *Obtaining suitable values of t , T , q and m .* This section deals with the general method of obtaining suitable values of $t/T/q/m$ and C for new designs. In Clause 7, tables of centre distances and designations are given for standard designs.

b) *Tables of standard axial modules.* Standard values of m are given below:

Preferred axial modules

0.052 0.06 0.068 0.076 0.084 0.092 0.1
0.12 0.14 0.16 0.18 0.2 0.22 0.24 0.26 0.28
0.34 0.38 0.42 0.46 0.5 0.54 0.58 0.62
0.68 0.76 0.84 0.92 1.0

Second choice axial modules

0.056 0.064 0.072 0.08 0.088 0.096
0.11 0.13 0.15 0.17 0.19 0.21 0.23 0.25 0.27 0.29
0.32 0.36 0.4 0.44 0.48 0.52 0.56 0.6
0.65 0.72 0.8 0.88 0.96

c) *Diameter factor q .* Standard values of the factor q are given below:

6, $6\frac{1}{2}$, 7, $7\frac{1}{2}$, 8, $8\frac{1}{2}$, 9, $9\frac{1}{2}$, 10, 11, 12, 13, 14, 17, 20.

d) *Determination of t and T .* For industrial gears, t is taken as the nearest whole number to

$$\frac{7 + 12\sqrt{C}}{R_g}$$

T is then the next whole number below $R_g t$ except in the case of single thread worms when $T = R_g$; but in exceptional cases where difficulty might arise in using a standard pitch or module, it may be selected as the next whole number above $R_g t$. T shall not be less than 17.

For axle transmission worm gears, t is taken as the nearest whole number to $\frac{7 + 8\sqrt{C}}{R_g}$ (see Table 3 for complete list).

e) *Guidance for determination of q .* Preliminary guidance to the choice of q is given in Chart 4 which may be used for any speed of worm; the value of q shall be as small as possible except where low reversed efficiency is desired (see Clause 12). At speeds below 300 rev/min when some reduction of efficiency may be accepted in order to increase the worm bending strength Chart 3 may be used. On both charts the required value of q is plotted against centre distance C and teeth in wheel T . Each value of q covers a limited area on the charts. This method of choosing q provides a preliminary design which must be checked for worm shaft bending stress and if necessary another value q may be chosen to keep the bending stress within suitable limits taking into account the bearing span.

For axle transmission gears the value of q should be determined from Chart 4.

f) *Procedure for selecting standard worms.*

Given the ratio R_g and the centre distance C :

Find t and T from Clause 6 d).

Find q from Clause 6 e).

Find the maximum and minimum values of m from Clause 5 b).

If there is a standard "first choice" module between these limits then this is selected.

If there is no standard "first choice" module between these limits and if the centre distance cannot be altered, the calculation is repeated, making one of the following variations in the order given, and noting that the procedure for multi-thread worms is different from that for single thread worms.

Right-hand worm threads should be used whenever possible.

Multi-thread worms.

- i) T may be selected as the next whole number above $R_g t$ instead of the next whole number below $R_g t$.
- ii) Try a "second choice" module with the first value of T previously obtained.
- iii) Try a "second choice" module with the increased value of T obtained under i).

Single thread worms.

- i) T may be reduced by 1, and if this still fails to enable a “first choice” module to be selected, T may be increased by 1.
- ii) Try a “second choice” module with the original value of T , or failing this try values of T one less or one more than the original value.

It is only in unusual cases where actual gear diameters are closely restricted that a standard module cannot be used. In such cases it is recommended that a module exactly midway between the nearest “first choice” and the nearest “second choice” can be used.

7 Tables and dimensions of standard worms and wheels

a) In Table 1 (for all worm speeds) and in Table 2 (for worm speeds up to 300 rev/min) examples of worm gear designations are tabulated against preferred standard centre distances and ratios in terms of $t/T/q/m$ for industrial worm gears. Table 3 applies to axle transmission worm gears.

- i) *Standard centre distances (in inches) for industrial worm gears.*

Preferred centre distances.

$1\frac{1}{8}$, $1\frac{1}{3}$, $1\frac{3}{4}$, $2\frac{1}{4}$, 3, 4, 5, 6, 7, 8, 9, $10\frac{1}{2}$, 12, 14, 17, 20, 24, 28.

Second choice centre distances.

$1\frac{1}{4}$, $1\frac{5}{8}$, 2, $2\frac{1}{2}$, $3\frac{1}{2}$, $4\frac{1}{2}$, $6\frac{1}{2}$, $7\frac{1}{2}$, $8\frac{1}{2}$, $9\frac{1}{2}$, 10, 13, 15, $16\frac{1}{2}$, 18.

- ii) *Standard centre distances for axle transmission worm gears.*

3, $3\frac{1}{4}$, $3\frac{1}{2}$, $3\frac{3}{4}$, 4, $4\frac{1}{2}$, 5, $5\frac{1}{2}$, 6, $6\frac{1}{2}$, 7, $7\frac{1}{2}$, 8, $8\frac{1}{2}$, 9, 10.

b) *Examples of worm gear designations.* Table 1 gives examples of designations for standard industrial worm gears suitable for all speeds but, where greater load capacity at worm speeds of 300 rev/min and less is desired, Table 2 may be used.

Data for axle transmission worm gears is given in Table 3 and values of q may be obtained from Chart 4.

c) *Detail dimensions of worms and wheels.* All worms having the same combination of t and q are geometrically similar, and their linear dimensions are proportional to the module m .

Table 4 gives worm dimensions for single to 14 start worms and diameter factors from 6 to 20 inclusive in terms of unit axial module in respect of the following elements:

d_a , d_r , d_o , c , g , h , λ , λ_o , p_n .

All linear dimensions are to be multiplied by the module m .

The necessary gear element dimensions for the worm wheel may be obtained from Clause 5 c).