BRITISH STANDARD

BS 3237:1960

Incorporating Amendment No. 1

Specification for

Light and medium rolling stock for mineral haulage in mines

Confirmed January 2011

Co-operating organizations

The Colliery Requisites Industry Standards Committee, under whose supervision this British Standard was prepared, consists of representatives from the following Government department and scientific and industrial organizations:

Association of Mining, Electrical & Mechanical Engineers
British Electrical and Allied Manufacturers' Association
British Iron and Steel Federation*
Cable Makers' Association
Federation of Associations of Colliery Equipment Manufacturers
Institution of Electrical Engineers
Institution of Mechanical Engineers
Institution of Mining Engineers
Mechanical Handling Engineers' Association
Ministry of Power*
National Association of Colliery Managers*
National Coal Board*

The Government department 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 British Standard:

Pit Tub and Mine Car Manufacturers' Association
British Steel Founders' Association
and certain individual companies

This British Standard, having been approved by the Colliery Requisites Industry Standards Committee and endorsed by the Chairman of the Engineering Divisional Council, was published under the authority of the General Council on 31 March 1960

The following BSI references relate to the work on this standard:
Committee reference CRE/7
Draft for comment CZ(CRE) 6238

ISBN 0 580 34408 8

Amendments issued since publication

Amd. No.	Date of issue	Comments
5178	March 1964	Indicated by a sideline in the margin

Contents

Foreword

This standard makes reference to the following British Standards:

BS 4, *Dimensions and properties of channels and beams for structural purposes.*

BS 4A, *Dimensions and properties of equal angles, unequal angles and T-bars for structural purposes.*

BS 15, *Structural steel.*

BS 18, *Tensile testing of metals.*

BS 240, *Brinell hardness testing, Part I.*

BS 309, *Whiteheart malleable iron castings.*

BS 350, *Conversion factors and tables.*

BS 860, *Table of approximate comparison of hardness scales.*

BS 1452, *Grey iron castings.*

BS 1473, *Wrought aluminium and aluminium alloys. Rivet, bolt and screw stock for forging.*

BS 1476, *Wrought aluminium and aluminium alloys. Bars, rods and sections.*

BS 1477, *Wrought aluminium and aluminium alloys. Plate.*

BS 1610, *Verification of testing machines, Part 1.*

BS 1718, *Tolerances for steel drop forgings and upset forgings.*

BS 2772, *Iron and steel for colliery haulage and winding equipment — Part 2: Wrought steel.*

BS 2902, *Higher tensile steel chain slings and rings, links alternative to rings, egg links and intermediate links.*

BS 2903, *Higher tensile steel hooks for chains, slings, blocks and general engineering purposes.*

BS 2994, *Cold rolled steel sections.*

BS 3032, *Higher tensile steel shackles.*

BS 3100, *Steel castings for general engineering purposes.*

The need for a British Standard to deal with the principles of design and the specification of certain major components of mineral haulage rolling stock generally known in British coal mining as “pit tubs”, “trams”, or “hutches” was agreed by the BSI Technical Committee initially charged with preparing a revision of BS 413, “*Steel tub wheels (fixed, running and self-oiling) for use in mines*”. BS 413 has now been withdrawn in favour of this more comprehensive standard.

In preparing standard requirements for the complete vehicle, care has been taken to avoid detail that would unnecessarily restrict design. Hence the specifications for bodies, underframes and certain items of drawgear deal mainly with design principles and basic requirements essential to a product of good quality.

As the standard may have application for mineral haulage other than within collieries, the terms mentioned above have not been used, preference being for a more general classification as “rolling stock”, but with a definite limit of capacity.

In the interests of improved standardization, the range of wheel sizes for both fixed and loose wheels, has been considerably reduced compared with the present National Coal Board specification, by eliminating the $^{1}/_{4}$ in. increments of size. A new series of wheel numbers has therefore been introduced. It is intended that the British Standard numbers will gradually replace the National Coal Board numbers through the medium of purchasing based on this standard. In the tables of wheel and axle dimensions are also given recommended maximum loads on four wheels, not previously specified.

In view of the limited use of wheels with outside journals, details are given only of the inside journal type, but the wheels in either case should comply with this standard.

The Committee gave careful consideration to the "falling and deformation" test for wheels specified in BS 413, and referred to in the National Coal Board specification. In view of the doubtful value of these tests, the more stringent requirements of the present specification for wheels, and the fact that the tests have not been called for by the purchaser, these tests have been omitted from the new standard.

The hooks for drawgear are of trapezoidal cross-section, similar in design to hooks in other British Standards. Full account has been taken of the conditions operating in haulage drawgear. The trapezoidal design affords an optimum cross-section providing maximum strength at minimum weight and, when made in quantity, is cheaper to produce than other designs. In the appendices to this standard, design formulae are given not only for hooks but also for links, rings and shackles to assist makers in efficient design.

The Committee desires to record its indebtedness to the Engineering Division of the National Physical Laboratory[1)] for the theoretical investigations and the large amount of experimental work which formed the basis of the section dealing with hooks.

NOTE Where metric equivalents have been given, the figures in British units are to be regarded as the standard. The metric conversions are approximate. More accurate conversions should be based on the tables in BS 350, Part 1, "*Conversion factors and tables*".

Summary of pages

This document comprises a front cover, an inside front cover, pages i to iv, pages 1 to 38 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)] Now the National Engineering Laboratory, East Kilbride, Glasgow.

1 Scope

This British Standard covers materials, basic design requirements, and constructional details, including specifications for individual components, for small and medium rolling stock with capacities below 60 cu. ft (1.7 m^3) employing fixed wheels, or loose wheels not incorporating precision bearings.

Part 1: Bodies and Underframes

Section 1. Bodies

2 General

Bodies shall be either of the riveted, or sectional bolted, or welded type, at the option of the purchaser. The bodies shall be of basically rectangular shape, and of either flat bottom or well bottom type according to requirements.

3 Materials

a) *Steel bodies*. The materials shall be generally of mild steel, to BS 15, "*Structural steel, Quality 1*". The side, end, and bottom plate thicknesses shall be in the range of $^1/_8$ in. (3.2 mm) up to $^1/_4$ in. (6.3 mm) inclusive, in any required combination; unless special conditions necessitate the use of plate of greater thicknesses. If required, the plates may be made of accepted corrosion-resisting and/or abrasion-resisting steels, or of mild steel galvanized after fabrication.

b) *Aluminium alloy bodies*. Sections shall comply with HE 30-WP or HE-30W of BS 1476[2)]. Plates shall comply with HP 30-WP or HP 30-W of BS 1477[3)]. Both sections and plates shall be used in the same range of thicknesses as for steel. Rivet bolt and screw stock shall comply with HR 30-W in BS 1473[4)].

Where steel bolts or screws are used, these shall have a suitable non-ferrous coating.

Where aluminium and steel are combined in the same design, the one must be insulated from the other to avoid galvanic corrosion. If steel rivets are used, the holes in the aluminium alloy members should be treated with an insulating material and, after the rivet has been driven, the head of the rivet and the surrounding metal should be thoroughly cleaned and coated with insulating material. Wherever practicable, however, aluminium rivets should be used.

4 Design and construction

a) *Basic design requirements*. The design shall be such as to provide the following relationships of basic length and height:

i) The length of the drawbar shall be at least 2 in. (50.8 mm) less than the length over the buffers;

ii) the length of the body shall be at least 4 in. (101.6 mm) less than the length over the buffers;

iii) the wheel base shall be not less than $^1/_3$ of the length over the buffers;

iv) the overall dimensions of the body, in relation to the rail gauge and wheel base, shall be such as to maintain stability when running on the track.

b) *Construction*. In all types of body, the vertical corners shall be well rounded or bevelled, and the lapping of the side and end plates shall be so arranged as to give the minimum of projection. The top edge of the body shall be of a bevelled or rounded contour. The welded body may be reinforced at the top by suitable angles, the toes of which shall be continuously welded to the plates. In any form of reinforcement of the top edge, adequate provision shall be made for continuation of the reinforcement at the vertical joints between the plates.

The bodies shall be as free as possible from internal projections. Stiffening corrugations running round the body are, however, permissible and shall be designed to give an unrestricted flow of material without sharp changes in section which could form a possible build-up of corrosive matter.

The bodies shall be either riveted or bolted to the underframes and internal reinforcing flats or plates shall be welded to the bottom plate to ensure sufficient bearing area in relation to the diameter of the fastening bolt or rivet. Where absolute cleanliness of the interior is required, internal reinforcement may be omitted and bodies may be welded to frames, or may have cleats welded outside the body for riveting or bolting to the underframe.

Where vehicles are to be used on over-rope or over-chain haulage systems, the upper edges of the end plates shall be fitted with renewable wearing strips.

Ancillary handling equipment shall be well within the confines of the buffers.

[2)] BS 1476, "*Wrought aluminium and aluminium alloys, bars, rods and sections*".
[3)] BS 1477, "*Wrought aluminium and aluminium alloys. Plate*".
[4)] BS 1473, "*Wrought aluminium and aluminium alloys. Rivet, bolt and screw stock for forging*".

c) *Finish*. Bodies shall be so designed and constructed that there are no sharp edges liable to cause personal injury.

Section 2. Underframes

5 Materials

a) *Steel underframes*. The materials shall be generally of mild steel, to BS 15,"*Structural steel, Quality 1*". Longitudinal members of steel underframes shall be of standard section channels to BS 4[5] wherever practicable, although channel sections formed from plate, flat, or strip can be used if necessary and shall be not less than $^1/_4$ in. (6.3 mm) thickness. Other members shall be of rolled steel channel to BS 4 or angle to BS 4A[6]; or of cold rolled steel section to BS 2994[7], or of suitable pressed, steel section (see note below).

b) *Aluminium alloy underframes*. Sections shall comply with HE 30-WP or HE 30-W of BS 1476. Plates shall comply with HP 30-WP or HP 30W of BS 1477. Channel sections formed from plate, flat or strip can be used if necessary. Sections and plates shall be in the same range of thickness as for steel. Rivet bolt and screw stock shall comply with HR 30-W in BS 1473.

Where steel bolts and nuts are used, these shall have a suitable non-ferrous coating. Alternatively, high-tensile aluminium alloy bolts and nuts may be specified by the purchaser.

Where aluminium and steel are combined in the same design, the one must be insulated from the other to avoid galvanic corrosion. If steel rivets are used, the holes in the aluminium alloy members should be treated with an insulating material and, after the rivet has been driven, the head of the rivet and the surrounding metal should be thoroughly cleaned and coated with insulating material.

Timber underframes. Timber underframes shall be made from well-seasoned oak and shall be straight-grained, free from knots, shakes and other flaws.

6 Construction

a) *Steel and aluminium alloy underframes*. The underframes shall be braced or stiffened to prevent twisting.

In all types of underframe, buffer faces shall be either of steel or of reinforced construction in the case of aluminium alloy, and shall be either riveted, bolted or welded to the main underframe member, or formed from that member. To absorb buffing shocks, timber, rubber pads or springs, or proprietary units of like kind, may be inserted between the buffer face and the main underframe member.

Pedestal stops shall be provided on the longitudinal members to resist shear on bolts or rivets where used.

b) *Timber frames*. The cross bars shall be morticed and tenoned into the main underframe members and lateral steel tie rods shall be fitted.

The buffers shall be faced either with steel caps in the form of pressings, fabrications, or castings, or with steel hoops driven on and securely fixed to the ends of the main members to prevent the timber splitting.

c) *False axles*. Where vehicles are used in circuits incorporating power-operated equipment, it is recommended that, where practicable, false axles be used, such to be securely attached to the longitudinal underframe members.

d) *Locking nuts*. Where bolts are used for securing drawbars and pedestals, the nuts shall be effectively locked.

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[5] BS 4, "*Dimensions and properties of channels and beams for structural purposes*".
[6] BS 4A, "*Dimensions and properties of equal angles, unequal angles, and T-bars for structural purposes*".
[7] BS 2994, "*Cold rolled steel sections*".
NOTE It is recommended that designs of pressed steel section should conform to the appropriate design in BS 2994.

Part 2: Wheels, Axles and Pedestals

Section 1. Wheels

7 Materials

The material for fixed or loose wheels shall be cast steel, either carbon steel or pearlitic manganese steel, or alternatively, for fixed wheels only, austenitic manganese steel, as may be specified by the purchaser. Castings shall comply with the mechanical properties specified in the composite BS 3100, "*Steel castings for general engineering purposes*" as quoted below from the relative individual specifications contained therein:

a) *Carbon steel castings:* BS 592, "*Carbon steel castings for general engineering purposes*", Grade C.

Tensile strength	35 ton/sq. in. (55 kg/mm^2) minimum.
Yield stress, or 0.5 per cent proof stress	17.5 ton/sq. in. (28 kg/mm^2) minimum.
Elongation (Gauge length $4\sqrt{A}$)	15 per cent minimum.

b) *Pearlitic manganese steel*. BS 1456 "*1 1/2 per cent manganese steel castings*" Grade B.

Tensile strength	45/55 ton/sq. in. (71 to 87 kg/mm^2).
Yield stress	60 per cent of tensile strength, minimum.
Elongation (Gauge length $4\sqrt{A}$)	15 per cent minimum.

c) *Austenitic manganese steel castings:* BS 1457, "*Austenitic manganese steel castings*". (11 per cent manganese, minimum).

Initial hardness	229 HB maximum.

d) *Tests*. Where mechanical tests[8)] are required, they shall be specified by the purchaser, at the time of enquiry and order: test pieces shall be cast separately from, but heat treated with, the castings they represent.

8 Dimensions and weights

The nominal size of wheel is the diameter measured at the root of the flange (see Dimension A of Figure 1, Figure 2 and Figure 3).

The dimensions of wheels shall comply, as appropriate, with the requirements of:

Table 1 and Figure 1 for fixed wheels.

Table 2 and Figure 2 for loose (self-oiling) wheels.

Table 3 and Figure 3 for loose wheels of the non-precision bearing type.

Fixed wheels shall comply also with the value of approximate weight given in Table 1.

NOTE The recommended maximum loads on four wheels, for both fixed and loose type wheels, are provided in Table 1, Table 2 and Table 3. Where abnormally severe working conditions are anticipated by the purchaser, an increase in axle diameter may be necessary.

9 Heat treatment

a) *Carbon steel and pearlitic manganese steel castings*. All castings shall be supplied in the heat-treated condition. The heat treatment shall consist of annealing, annealing and normalizing, normalizing and tempering, or hardening and tempering, either at the discretion of the manufacturer or as specified in the order, and shall be carried out at suitable temperatures to give the required mechanical properties.

b) *Austenitic manganese steel castings*. All castings shall be supplied in the heat treated condition, having been water quenched from a temperature of not less than 1 000 °C (1 830 °F).

10 Fettling and dressing

All castings shall be properly fettled and dressed, and all surfaces shall be satisfactorily cleaned for inspection purposes.

8) NOTE For austenitic manganese steel, bend tests only will be provided as agreed between purchaser and manufacturer.

11 Freedom from defects

All castings shall be free from cracks and other injurious defects (see Clause **12**).

12 Repairs to castings

Minor defects which will not affect the mechanical strength or the performance of any wheel may be rectified by welding, when the manufacturer is able by doing so to provide a satisfactory casting.

13 Permissible eccentricity

The total variation from true running of the periphery of the wheel, when mounted on the axle, shall not exceed $^{3}/_{16}$ in. (4.8 mm) (fixed wheel), or $^{3}/_{32}$ in. (2.4 mm) (loose wheel) when measured as shown in Figure 4a or Figure 4b respectively.

14 Marking

Each wheel shall have cast in the back of the flange, the following information in recessed characters not less than $^{3}/_{8}$ in. (9.5 mm):

a) the manufacturer's identification mark.

b) the letter "C", "PM" or "M" to indicate carbon steel, 1.5 per cent manganese steel or austenitic manganese steel respectively, and

c) the wheel number (see Table 1, Table 2 and Table 3).

For example, wheel No. 10 in Table 1, in carbon steel, made by "X and Y Ltd." shall be marked "X and Y C 10".

Section 2. Axles

15 Materials

a) *Quality*. Axles shall be made from rolled, forged or bright drawn steel, at the supplier's option, and shall have the following mechanical properties:

Tensile strength	35 tons/sq. in. (55 kg/mm^2) minimum.
Elongation	15 per cent minimum.

b) When tests are required by the purchaser, these shall be specified on the enquiry and order. One per cent of the axle bars shall, in such case, be selected indiscriminately from the bulk for testing purposes. Test pieces shall conform to BS 18[9)], Table 1 (gauge length = $4\sqrt{A}$) and shall exhibit the above properties.

16 Dimensions

The dimensions of axles shall comply as appropriate, with the requirements of:

Table 1 and Figure 1 for fixed wheels.

Table 2 and Figure 2 for loose (self-oiling) wheels.

Table 3 and Figure 3 for loose wheels of the non-precision bearing type.

17 Straightness

The maximum departure from straightness of any axle shall not exceed $^{1}/_{16}$ in. (1.6 mm) when measured from a flat surface.

9) BS 18, "*Tensile testing of metals*".

Section 3. Pedestals

18 Materials

i) The material for pedestals shall comply with one of the following at the option of the purchaser:

a) Cast carbon steel complying with the mechanical properties specified in Clause **7** a) of this standard.

b) Grey cast iron to BS 1452[10], Grade 14 or 17.

c) Whiteheart malleable iron castings to BS 309[11], Grade 2.

ii) The material of detachable guards, where used, shall be steel.

19 Dimensions

The design of the pedestal shall comply with one of the alternative designs shown in Table 4, as requested by the purchaser, and the dimensions shall comply with the dimensions in the table appropriate to the axle diameter. To meet severe conditions, designs may include ribs between the leg and the base. In such cases, the requirements of minimum dimensions given in the table shall still apply.

NOTE Care must be taken in design to ensure that the axle guard, whether integral or detachable, and/or bolts, nuts and rivets associated therewith, do not interfere with any gear which may be located in the tracks between the pedestals, after all tolerances on wheels, pedestals and rails have been taken into account.

[10] BS 1452, "*Grey iron castings*".

[11] BS 309, "*Whiteheart malleable iron castings*".

Part 3: Drawgear

Section 1. General design, construction and testing

20 Drawgear assembly

Mineral haulage drawgear shall preferably consist of a continuous drawbar with couplings, of suitable design, at each end. As alternatives, the drawgear may consist of short drawbars at each end, or may be of the spring-mounted type. The terminals of the drawgear normally consist of shackles and pins, links and hooks or any combination of those components. (See Figure 7 and Figure 8).

The drawbar shall be attached to the underframe by means of bolts or rivets, preferably through the body. Attachment shall not be by welding.

21 Principles and requirements of design

Forged drawgear should avoid sudden changes of section, thickness and/or shape.

For all types of use and application, a straight pull through the axis of the main drawbar is desirable (Section A "Bodies", Clause **4**, of this standard provides design data for the length of bodies and buffers to meet this requirement).

In drawgear with forged hook or eye terminations, the link or shackle when applied should pull in line with the axis of the drawbar.

Similarly any drawgear, as above, incorporating links welded into an eye behind the hook, or using shackles and pins fitted into the eye, should be so designed that the pull is in line with the axis of the drawbar.

The couplings should be flexible to allow free movement on sharp curves, should be securely connected to the drawbar and, whenever practicable, easily replaceable.

The ends of the drawbar should be such that there is no fouling when tubs are buffered together and there is no locking on sharp curves.

Where a straight pull on the drawbar is not possible, e.g. with well-bottom tubs, any change in direction should be on an easy curvature with no sharp bends; such drawbars should be fully supported by, or secured to, the chassis.

Drawbars, of lapped design shall have the lapped portion riveted and/or side-welded on both sides, using one of the methods specified in Clause **23**.

The drawbars when completed, of whatever construction, shall have a higher static strength than the other components, taking into account the effect of drilled holes.

Drawgear assembly design has been based on a static factor of safety of not less than 7, as applied to the hook. In determining the maximum weight of a train of vehicles which may be attached to a particular size of hook on a given haulage installation, the user should have proper regard to the conditions of service, such as the gradient, speed, the dynamic loading due to acceleration, deceleration and shock, and the frictional resistance of the vehicles.

22 Materials

Components for drawgear shall be made from 1.5 per cent manganese steel to BS 2772-2[12)]. If requested by the purchaser, a certificate of test and chemical analysis shall be provided.

23 Welding

All welding of drawbars and couplings shall be carried out by either of the following methods:

a) Automatic flash-butt welding;

b) Atomic hydrogen welding;

The welds shall be smoothly finished all round and care shall be taken to avoid porosity and to ensure penetration and fusion throughout.

Where filler rods are used, these shall be of such a composition that the deposited weld metal shall approximate to the composition of the parent metal.

[12)] BS 2772, "*Iron and steel for colliery haulage and winding equipment*", Part 2, "*Wrought steel*".

24 Heat treatment

After forging and welding operations have been completed, all components of drawgear shall be subjected to one of the following heat treatments as agreed between the purchaser and the manufacturer.

a) Normalizing by heating uniformly until the whole of the metal, has attained a temperature between 870 °C and 910 °C, (1 598 °F and 1 670 °F). They shall then be withdrawn from the furnace and allowed to cool in still air.

b) Normalizing as a) above, and tempering at a suitable temperature, normally between 550 °C and 660 °C, (1 022 °F and 1 220 °F).

c) Hardening and tempering by heating to a temperature between 870 °C and 910 °C, (1 598 °F and 1 670 °F), followed by quenching in oil or water, and tempering at a suitable temperature, normally between 550 °C and 660 °C, (1 022 °F and 1 220 °F).

Details of the heat treatment which has been given to the components of drawgear by the manufacturer shall be endorsed on the certificate of test, or on Form 86 (see Clause **28** Appendix B).

25 Quality marking

Each component of drawgear shall be legibly marked on a non-vital part as follows:

a) Normalized, or normalized and tempered, components with the mark "M".

b) Hardened and tempered components with the mark "OM".

The mark shall be enclosed in a circle.

The letters used shall be of the following sizes:

Safe working load of drawgear component	Size of figure
tons	in.
Up to and including 2 (2 tonnes)	$^1/_8$ (3 mm)
Over 2	$^3/_{16}$ (5 mm)

Care shall be taken that the indentation is neither too sharp nor excessive in depth. (See also Clauses **37** and **44** for marking of hooks).

26 Workmanship

The drawbars shall be free from laps, galls and other patent defects.

27 Testing

The complete drawgear shall be submitted to a proof load $2^1/_2$ times the designed safe working load and a certificate of test shall be supplied. If requested by the purchaser at the time of enquiry or order, a specimen drawgear shall be submitted to ultimate tensile strength tests.

28 Certificate of test and examination

If requested, the supplier shall provide certificates of test and examination in the form shown in Appendix B with every consignment of components of drawgear.

For the purpose of this standard, Docks Regulations Prescribed Form No. 86 is acceptable provided that it is endorsed in Column 2 by the maker or supplier that the components of drawgear comply in all respects with BS 3237.

29 Spring-loaded drawgear

Where drawgear of the spring-loaded type is used, the above provisions shall apply and, to ensure that the frame takes all the working stresses, the drawgear shall be designed to meet the following requirements:

a) The resilient units shall not be stressed beyond their rated capacity.

b) The drawgear retaining components incorporated in the chassis shall be of greater capacity than the required drawbar pull.

Section 2. Hooks

Notes on design

Hooks to the following specification will give a static factor of safety of not less than 7. The static factor of safety of 7 has been chosen as the practical limit which gives hooks of manageable proportions for manual operation. Special requirements of haulage, as opposed to lifting, have been taken into account in the design of these hooks.

To ensure the factor of 7, it has been necessary to design the hooks on the basis of an extreme fibre (tensile) stress of 12 tons per sq. in. (19 kg/mm^2) at the rated safe working load, as compared with 16 tons per sq. in. (25 kg/mm^2) which was allowed for higher tensile steel hooks, to BS 2903[13)]. Proof loads of $2^1/_2$ times the rated safe working load have been specified.

The static factor of safety is for guidance only, and, in conjunction with the rated safe working loads, Table 5, provides the user with information as to the approximate ultimate static strength of the hook (see Clause **39**).

30 General

British Standard hooks, hereinafter referred to as "the hooks" shall conform in all respects to the requirements herein laid down.

The hooks are of trapezoidal section and may be hand-forged or drop-forged.

Those for use with links shall have eyes conforming to Figure 5; those for use with shackles shall have eyes conforming to Figure 5A.

The range of safe working loads is from $1^1/_2$ tons to 3 tons (1.5 to 3 metric tonnes).

NOTE Instances may arise for which hooks outside the range specified may be required. Such hooks can be designed from the information given in Appendix D. The use of the term "British Standard Hook" as applied to these hooks is, however, restricted to the actual hook sizes and forms laid down in Table 5 and Figure 5.

31 Rating

The hooks shall be rated according to the safe working loads given in Table 5.

32 Material

The hooks shall be made from 1.5 per cent manganese steel conforming to the requirements specified in BS 2772, "*Iron and steel for colliery haulage and winding equipment*", Part 2, "*Wrought steel*".

33 Form and dimensions

The form of the hook shall be in accordance with Figure 5, and the dimensions shall be in accordance with Table 5. (When so specified, the eyes shall be in accordance with Figure 5A).

NOTE The forged dimensions of the hooks are proportional to each other and are related to the internal diameter of the hook (Figure 5, dimension C). The proportions are given to two places of decimals at the head of each column in Table 5.

34 Tolerances on dimensions

a) *Tolerances for drop-forged hooks*. The tolerances on drop-forged hooks shall be the relevant "DF" tolerances specified in BS 1718, "*Tolerances for steel drop forgings and upset forgings*". The "close" thickness tolerances included in Table DFI of that standard shall not apply.

b) *Tolerances for hand-forged hooks*. Hand-forged dimensions shall not be less than the values in Table 5, and shall not exceed these by more than the following amounts:

$33^1/_3$ per cent on the radius, dimension Z Figure 5.

$7^1/_2$ per cent on all other dimensions.

In all cases dimension C shall be as nearly as possible exact to size.

35 Workmanship

The hooks shall be free from patent defect and shall be cleanly forged in such a manner that the macroscopic flow lines follow the body outline of the hook.

If the eye is formed subsequent to forging, the blank shall be provided with a centring indent.

[13)] BS 2903, "*Higher tensile steel hooks for chains, slings, blocks and general engineering purposes*".

36 Heat treatment

All hooks shall be subjected to one of the following heat treatments as agreed between the purchaser and the manufacturer:

a) Normalizing by heating uniformly until the whole of the metal has attained a temperature between 870 °C and 910 °C, (1 598 °F and 1 670 °F). They shall then be withdrawn from the furnace and allowed to cool in still air.

b) Hardening and tempering by heating to a temperature between 870 °C and 910 °C, (1 598 °F and 1 670 °F) followed by quenching in oil or water, and tempering at a suitable temperature, normally between 550 °C and 660 °C, (1 022 °F and 1 220 °F).

Details of the heat treatment which has been given to the hooks by the manufacturer shall be endorsed on the test certificate, or on Form 86 (see Clause **45** and Appendix B).

37 Quality marking

Each hook shall be legibly marked on a non-vital part as follows:

a) Normalized hook with the mark "M".

b) Hardened and tempered hook with the mark "OM".

The mark shall be enclosed in a circle. (For size of mark, see Clause **44**).

38 Hardness test

The hooks shall have a maximum Brinell hardness of 217 HB.

Where practicable, the test shall be made in accordance with BS 240, "*Brinell hardness testing, Part 1, Methods and tables for Brinell hardness testing*", using a 10 mm diameter ball, and a load of 3 000 kg.

The surface on which the impression is to be made shall be obtained by filing, grinding or smooth machining.

Suitable precautions should be taken to ensure that the surface tested is representative of the material, and that its hardness is not affected by decarburization, carburization, or by the method used for the preparation of the test surface.

If another method of hardness testing is employed, conversion shall be made in accordance with BS 860, "*Table of approximate comparison of hardness scales*".

39 Destruction test

If required by the purchaser in the enquiry and order, a sample hook shall be selected by the representative of the purchaser and opened out by the application of a test load.

The hook shall, at any load less than seven times the rated safe working load, neither fracture nor so distort as to be incapable of retaining the load.

40 Proof test

Each hook forging covered by this standard shall, after manufacture and subsequent heat treatment, be subjected to a proof load of two and one half times the safe working load (Column 1, Table 5), which it shall withstand without showing a permanent set exceeding one-quarter of one per cent of the distance a. b. (see Figure 5B). After removal of the proof load and determination of the permanent set (if any), each hook shall be thoroughly examined by a competent person and shall be deemed to comply with the standard only if found free from patent defect.

Prior to the application of the proof load, each hook shall bear a centre punch mark at position b. from which a scribed line shall be trammelled to position a. (see Figure 5B). After removal of the load, the hook shall be re-scribed with the trammel unaltered, and the difference (if any) between the two scribed lines shall be the amount of permanent set.

The testing machine used shall be at least equal to the requirements of Grade "B" of BS 1610[14)]. (See Appendix C of this standard).

[14)] BS 1610, "*Verification of testing machines*", Part 1.

41 Additional tests

If, in addition to the destruction test of the sample hook referred to in Clause **39**, and the proof testing of the finished hook specified in Clause **40**, the purchaser requires further tests or chemical analyses, such further tests shall be clearly stipulated in the enquiry and order and, if so desired, the samples shall be selected by a person representing or approved by the purchaser.

42 Testing facilities

Unless otherwise required by the purchaser, the manufacturer shall supply the necessary labour and appliances for the tests required by this standard. In the absence of facilities at his own works for making the specified tests, the manufacturer shall bear the cost of carrying out the required tests at a public test house.

43 Inspection

The representative of the purchaser shall have access at any reasonable time to those parts of the works of the manufacturer where production of these hooks is taking place. He shall be at liberty to inspect the hooks at any stage of manufacture. He shall also be at liberty to inspect the testing machine and method of examination, and to reject any hooks being made to his order which do not comply with the requirements of this standard.

44 Identification marking

Unless otherwise specified by the purchaser, each hook shall, after testing, be permanently and legibly marked on a non-vital part with the safe working load given in Table 5 (see Figure 5B) and also (on the reverse side of the hook) with such individual marks or symbols as will allow identification with the manufacturer's certificate of test and examination.

The figures used shall be of the following sizes:

Safe working load of hook	Size of figure
ton	in.
Up to and including 2 (2 tonnes)	$^{1}/_{8}$ (3 mm)
Over 2	$^{3}/_{16}$ (5 mm)

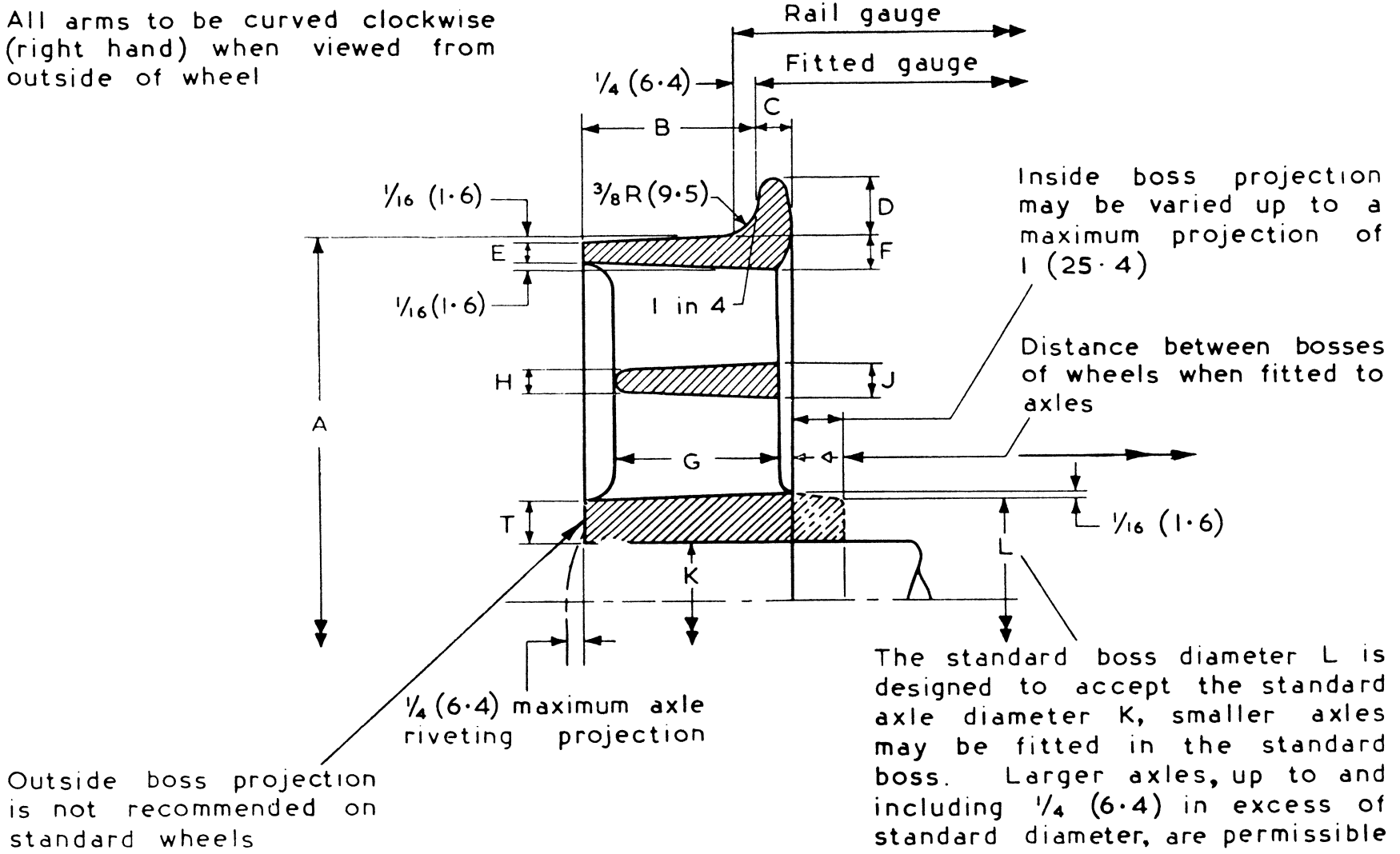
Care shall be taken that the indentation is neither too sharp nor excessive in depth.

45 Certificate of test and examination

If requested, the supplier shall provide certificates of test and examination in the form shown in Appendix B with every consignment of hooks.

Certificates giving the results of any additional tests (see Clause **41**) which have been carried out shall also be provided by the supplier, and where any complementary British Standard stipulates the form of the certificate that shall be given, the results shall be given in that form.

For the purpose of this standard, Docks Regulations Prescribed Form No. 86 is acceptable provided that it is endorsed in column 2 by the maker or supplier that the hooks comply in all respects with BS 3237.



(Key to dimensions in Table 1)
All dimensions are in inches unless otherwise stated
(millimetre equivalents in parentheses)

Figure 1 — Fixed wheels

Table 1 — Dimensions for fixed wheels

(For approximate metric equivalents see Appendix F, Table 6)

Type	B.S.I. wheel no.	Dia. on tread	Width of tread	Thickness of flange	Depth of flange	Thickness of tread		Arms				Axle dia.	Boss dia.	Boss thickness	Approx. weight of wheel with no boss projection	Recommended maximum load[a] on 4 wheels and 2 axles
								Width	Thickness		No. curved					
		A	B	C	D	E	F	G	H	J		K	L	T		
		in.	in.	in.	in.	in.	in.	in.	in.	in.		in.	in.	in.	lb	ton
Light	1	8	2	7/16	3/4	5/16	7/16	2	1/4	3/8	5	1 3/8	2 1/2	9/16	13 1/2	7/8
Heavy	2	8	2 1/4	1/2	3/4	5/16	7/16	2 1/8	5/16	7/16	5	1 1/2	2 5/8	9/16	16	1 1/4
Light	3	8 1/2	2	7/16	3/4	5/16	7/16	2	1/4	3/8	5	1 3/8	2 1/2	9/16	14 1/2	7/8
Heavy	4	8 1/2	2 1/4	1/2	3/4	5/16	7/16	2 1/8	5/16	7/16	5	1 1/2	2 5/8	9/16	17 1/4	1 1/4
Light	5	9	2	7/16	3/4	5/16	7/16	2	1/4	3/8	5	1 3/8	2 1/2	9/16	15 1/2	7/8
Heavy	6	9	2 1/4	1/2	7/8	5/16	7/16	2 1/8	5/16	7/16	5	1 1/2	2 5/8	9/16	18 1/2	1 1/4
Light	7	9 1/2	2	7/16	3/4	5/16	7/16	2	1/4	3/8	5	1 3/8	2 1/2	9/16	16 1/4	7/8
Heavy	8	9 1/2	2 1/4	1/2	7/8	5/16	7/16	2 1/8	5/16	7/16	5	1 1/2	2 5/8	9/16	19 1/4	1 1/4
Light	9	10	2 1/4	1/2	7/8	5/16	7/16	2 1/4	5/16	7/16	6	1 1/2	2 5/8	9/16	21	1 1/4
Medium	10	10	2 1/2	9/16	7/8	3/8	1/2	2 3/8	5/16	7/16	6	1 5/8	2 7/8	5/8	26 1/4	1 5/8
Heavy	11	10	2 3/4	5/8	7/8	7/16	9/16	2 5/8	3/8	1/2	6	1 3/4	3 1/8	11/16	31 1/2	1 7/8
Light	12	10 1/2	2 1/4	1/2	7/8	5/16	7/16	2 1/4	5/16	7/16	6	1 1/2	2 5/8	9/16	22	1 1/4
Medium	13	10 1/2	2 1/2	9/16	7/8	3/8	1/2	2 3/8	5/16	7/16	6	1 5/8	2 7/8	5/8	27	1 5/8
Heavy	14	10 1/2	2 3/4	5/8	7/8	7/16	9/16	2 5/8	3/8	1/2	6	1 3/4	3 1/8	11/16	33 1/2	1 7/8
Light	15	11	2 1/4	1/2	7/8	3/8	1/2	2 1/4	5/16	7/16	6	1 1/2	2 5/8	9/16	24	1 1/4
Medium	16	11	2 1/2	9/16	7/8	7/16	9/16	2 3/8	3/8	1/2	6	1 3/4	3 1/8	11/16	31	1 5/8
Heavy	17	11	3	11/16	1	1/2	5/8	3	7/16	9/16	6	2	3 1/2	3/4	42	1 7/8
Light	18	11 1/2	2 1/4	1/2	7/8	3/8	1/2	2 1/4	5/16	7/16	7	1 1/2	2 5/8	9/16	26 1/2	1 1/4
Medium	19	11 1/2	2 1/2	9/16	7/8	7/16	9/16	2 3/8	3/8	1/2	7	1 3/4	3 1/8	11/16	33	1 5/8
Heavy	20	11 1/2	3	11/16	1	9/16	11/16	3	7/16	9/16	7	2	3 1/2	3/4	47	1 7/8
Light	21	12	2 1/4	1/2	7/8	3/8	1/2	2 1/4	5/16	7/16	7	1 1/2	2 5/8	9/16	28	1 1/4
Medium	22	12	2 1/2	5/8	1	7/16	9/16	2 1/2	3/8	1/2	7	1 3/4	3 1/8	11/16	38	1 7/8
Heavy	23	12	3	3/4	1 1/8	5/8	3/4	3	1/2	5/8	7	2 1/4	4	7/8	56	4

[a] Assuming rail gauge of 24 inches.

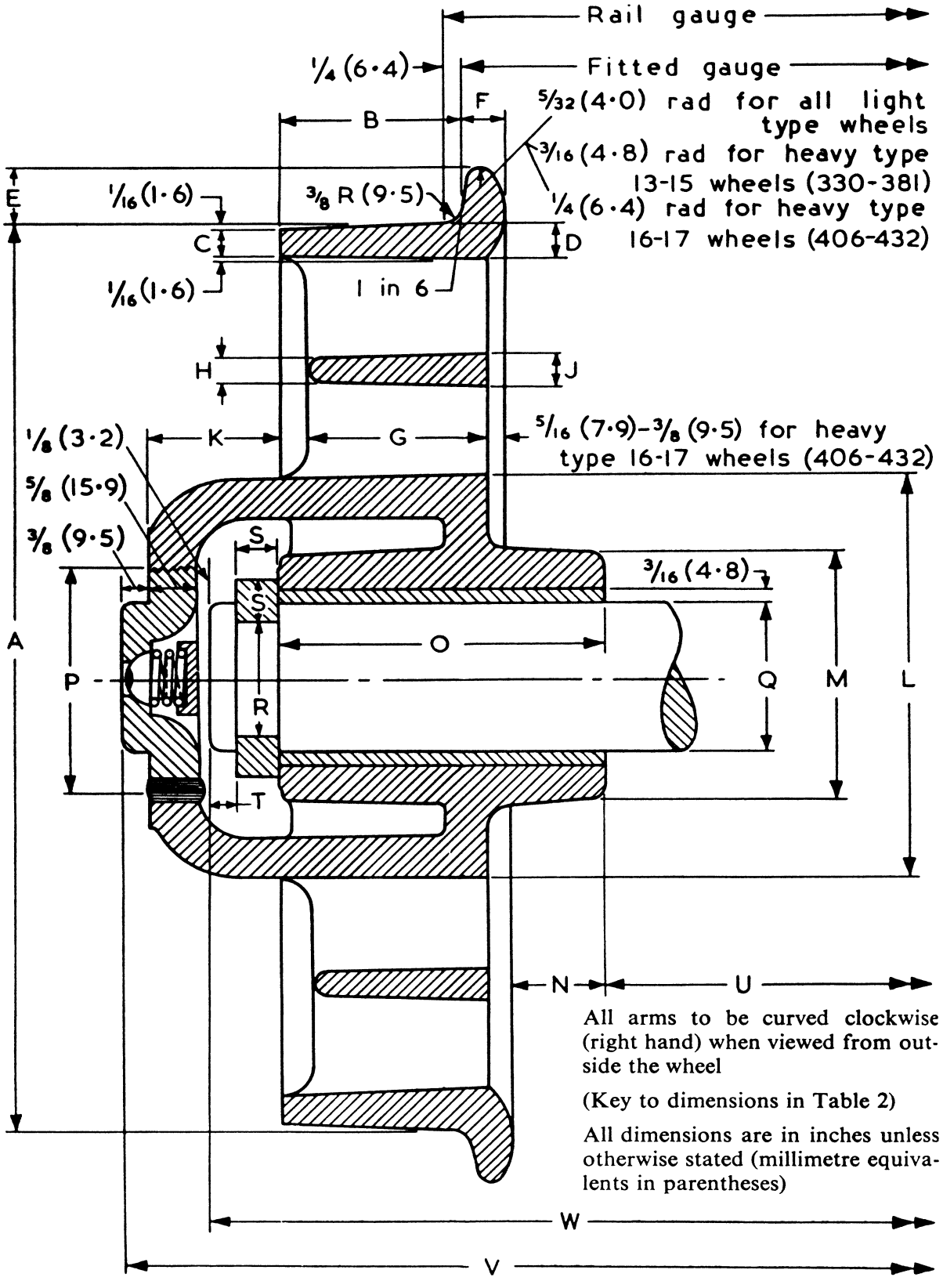


Figure 2 — Loose (self-oiling) wheels

Table 2 — Dimensions for loose (self-oiling) wheels

(For approximate metric equivalents see Appendix F, Table 7)

Type	B.S.I. wheel no.	Tread				Flange		Arms				Hub		Back boss bearing cap				Axle		Collar	Shoulder	[a]Between bosses	Overall length	Axle length	Recommended maximum load[b] on 4 wheels and 2 axles
		Dia.	Width	Thickness		Depth	Thickness	Width	Thickness		No. curved	Projection	Dia.	Dia.	Projection (Min.)	Length (Min.)	Dia. B.S.P. Size	Diameter		Square section	Thickness				
		A	B	C	D	E	F	G	H	J		K	L	M	N	O	P	Q	R	S	T	U	V	W	
		in.	in.	in.	in.	in.	in.	in.	in.	in.		in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	ton
Light	51	9	$2\frac{1}{2}$	$\frac{5}{16}$	$\frac{7}{16}$	$\frac{3}{4}$	$\frac{7}{16}$	2	$\frac{1}{4}$	$\frac{5}{16}$	6	$1\frac{5}{8}$	$4\frac{1}{2}$	$2\frac{3}{4}$	$\frac{9}{16}$	$3\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{8}$	$\frac{1}{2}$	$\frac{3}{8}$	R.G. – $2\frac{1}{2}$	R.G. + $8\frac{1}{2}$	R.G. + $6\frac{1}{4}$	$1\frac{1}{4}$
Light	52	10	$2\frac{1}{2}$	$\frac{5}{16}$	$\frac{7}{16}$	$\frac{3}{4}$	$\frac{7}{16}$	$2\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{16}$	6	$1\frac{5}{8}$	$4\frac{1}{2}$	$2\frac{3}{4}$	$\frac{9}{16}$	$3\frac{1}{2}$	$2\frac{1}{4}$	$1\frac{1}{2}$	$1\frac{1}{8}$	$\frac{1}{2}$	$\frac{3}{8}$	R.G. – $2\frac{1}{2}$	R.G. + $8\frac{1}{2}$	R.G. + $6\frac{1}{4}$	$1\frac{1}{4}$
Light	53	11	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{15}{32}$	$2\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	6	$1\frac{5}{8}$	5	$3\frac{1}{8}$	$1\frac{1}{32}$	4	$2\frac{1}{4}$	$1\frac{3}{4}$	$1\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{8}$	R.G. – $3\frac{1}{2}$	R.G. + $8\frac{1}{2}$	R.G. + $6\frac{1}{4}$	$1\frac{3}{4}$
Light	54	12	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{15}{32}$	$2\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	7	$1\frac{3}{4}$	$5\frac{3}{8}$	$3\frac{1}{2}$	$1\frac{17}{32}$	$4\frac{1}{2}$	$2\frac{1}{2}$	2	$1\frac{1}{2}$	$\frac{9}{16}$	$\frac{7}{16}$	R.G. – $4\frac{1}{2}$	R.G. + $8\frac{3}{4}$	R.G. + $6\frac{1}{2}$	$1\frac{3}{4}$
Light	55	13	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{2}$	1	$\frac{1}{2}$	$2\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	7	$1\frac{3}{4}$	$5\frac{3}{8}$	$3\frac{1}{2}$	$1\frac{1}{2}$	$4\frac{1}{2}$	$2\frac{1}{2}$	2	$1\frac{1}{2}$	$\frac{9}{16}$	$\frac{7}{16}$	R.G. – $4\frac{1}{2}$	R.G. + $8\frac{3}{4}$	R.G. + $6\frac{1}{2}$	$2\frac{1}{4}$
Heavy	56	13	$2\frac{3}{4}$	$\frac{1}{2}$	$\frac{5}{8}$	$1\frac{1}{8}$	$\frac{5}{8}$	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{2}$	7	$1\frac{3}{4}$	$5\frac{3}{8}$	$3\frac{3}{4}$	$1\frac{5}{8}$	5	$2\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$\frac{9}{16}$	$\frac{7}{16}$	R.G. – 5	R.G. + $9\frac{1}{4}$	R.G. + 7	$3\frac{3}{4}$
Light	57	14	$2\frac{3}{4}$	$\frac{13}{32}$	$\frac{17}{32}$	1	$\frac{1}{2}$	$2\frac{1}{2}$	$\frac{11}{32}$	$\frac{13}{32}$	7	$1\frac{3}{4}$	$5\frac{3}{8}$	$3\frac{1}{2}$	$1\frac{1}{4}$	$4\frac{1}{2}$	$2\frac{1}{2}$	2	$1\frac{1}{2}$	$\frac{9}{16}$	$\frac{7}{16}$	R.G. – 4	R.G. + $9\frac{1}{4}$	R.G. + 7	$2\frac{1}{2}$
Heavy	58	14	$2\frac{3}{4}$	$\frac{9}{16}$	$\frac{11}{16}$	$1\frac{1}{8}$	$\frac{5}{8}$	$2\frac{5}{8}$	$\frac{7}{16}$	$\frac{9}{16}$	7	$1\frac{3}{4}$	$5\frac{3}{8}$	$3\frac{3}{4}$	$1\frac{5}{8}$	5	$2\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$\frac{9}{16}$	$\frac{7}{16}$	R.G. – 5	R.G. + $9\frac{1}{4}$	R.G. + 7	4
Light	59	15	$2\frac{3}{4}$	$\frac{7}{16}$	$\frac{9}{16}$	1	$\frac{17}{32}$	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{7}{16}$	7	$1\frac{3}{4}$	$5\frac{3}{8}$	$3\frac{1}{2}$	$1\frac{7}{32}$	$4\frac{1}{2}$	$2\frac{1}{2}$	2	$1\frac{1}{2}$	$\frac{9}{16}$	$\frac{7}{16}$	R.G. – 4	R.G. + $9\frac{1}{4}$	R.G. + 7	$2\frac{3}{4}$
Heavy	60	15	3	$\frac{9}{16}$	$\frac{11}{16}$	$1\frac{1}{8}$	$\frac{5}{8}$	$2\frac{7}{8}$	$\frac{7}{16}$	$\frac{9}{16}$	7	$1\frac{3}{4}$	$5\frac{3}{8}$	$3\frac{3}{4}$	$1\frac{3}{8}$	5	$2\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$\frac{9}{16}$	$\frac{7}{16}$	R.G. – $4\frac{1}{2}$	R.G. + $9\frac{3}{4}$	R.G. + $7\frac{1}{2}$	4
Light	61	16	$2\frac{3}{4}$	$\frac{7}{16}$	$\frac{9}{16}$	1	$\frac{17}{32}$	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{7}{16}$	7	$1\frac{3}{4}$	$5\frac{3}{8}$	$3\frac{1}{2}$	$1\frac{7}{32}$	$4\frac{1}{2}$	$2\frac{1}{2}$	2	$1\frac{1}{2}$	$\frac{9}{16}$	$\frac{7}{16}$	R.G. – 4	R.G. + $9\frac{1}{4}$	R.G. + 7	$2\frac{3}{4}$
Heavy	62	16	3	$\frac{5}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$\frac{3}{4}$	3	$\frac{1}{2}$	$\frac{5}{8}$	7	$1\frac{3}{4}$	$5\frac{3}{8}$	$3\frac{3}{4}$	$1\frac{1}{4}$	5	$2\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$\frac{9}{16}$	$\frac{7}{16}$	R.G. – $4\frac{1}{2}$	R.G. + $9\frac{3}{4}$	R.G. + $7\frac{1}{2}$	4
Light	63	17	3	$\frac{7}{16}$	$\frac{9}{16}$	1	$\frac{17}{32}$	$2\frac{3}{4}$	$\frac{3}{8}$	$\frac{7}{16}$	7	$1\frac{3}{4}$	$5\frac{7}{8}$	$3\frac{3}{4}$	$1\frac{15}{32}$	5	$2\frac{3}{4}$	$2\frac{1}{4}$	$1\frac{3}{4}$	$\frac{9}{16}$	$\frac{7}{16}$	R.G. – $4\frac{1}{2}$	R.G. + $9\frac{3}{4}$	R;G. + $7\frac{1}{2}$	$2\frac{3}{4}$
Heavy	64	17	3	$\frac{5}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$\frac{3}{4}$	3	$\frac{1}{2}$	$\frac{5}{8}$	7	$1\frac{3}{4}$	$5\frac{7}{8}$	4	$1\frac{3}{4}$	$5\frac{1}{2}$	3	$2\frac{1}{2}$	2	$\frac{9}{16}$	$\frac{7}{16}$	R.G. – $5\frac{1}{2}$	R.G. + $9\frac{3}{4}$	R.G. + $7\frac{1}{2}$	$5\frac{1}{2}$

[a] With minimum dimensions "N" and "O".
[b] Assuming Rail Gauge of 24 inches.

(R.G. = Rail Gauge)

Table 3 — Dimensions for loose wheels — non-precision bearing type

(For approximate metric equivalents see Appendix F, Table 8)

Type	B.S.I. wheel no.	Tread				Flange		Arms			No. curved	Boss				Axle		Between bosses	Overall length	Recommended maximum load on 4 wheels and 2 axles
		Dia.	Width	Thickness		Depth	Thickness	Width	Thickness			Outside projection	Length	Dia.	Inside projection	Journal	Axle			
		A	B	C	D	E	F	G	H	J		K	L	M	N	P	Q	U	V	
		in.	in.	in.	in.	in.	in.	in.	in.	in.		in.	in.	in.	in.	in.	in.	in.	in.	ton
Light	51	9	$2\frac{1}{2}$	$\frac{5}{16}$	$\frac{7}{16}$	$\frac{3}{4}$	$\frac{7}{16}$	2	$\frac{1}{4}$	$\frac{5}{16}$	6	$1\frac{3}{16}$	$5\frac{7}{16}$	$4\frac{1}{8}$	$1\frac{5}{16}$	$1\frac{1}{2}$	$1\frac{5}{8}$	R.G. – 4	R.G. + $6\frac{7}{8}$	$1\frac{1}{4}$
Light	52	10	$2\frac{1}{2}$	$\frac{5}{16}$	$\frac{7}{16}$	$\frac{3}{4}$	$\frac{7}{16}$	$2\frac{1}{8}$	$\frac{1}{4}$	$\frac{5}{16}$	6	$1\frac{3}{16}$	$5\frac{7}{16}$	$4\frac{1}{8}$	$1\frac{5}{16}$	$1\frac{1}{2}$	$1\frac{5}{8}$	R.G. – 4	R.G. + $6\frac{7}{8}$	$1\frac{1}{4}$
Light	53	11	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{15}{32}$	$2\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	6	$1\frac{3}{16}$	$5\frac{7}{16}$	$4\frac{1}{8}$	$1\frac{9}{32}$	$1\frac{5}{8}$	$1\frac{3}{4}$	R.G. – 4	R.G. + $6\frac{7}{8}$	$1\frac{3}{4}$
Light	54	12	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{3}{4}$	$\frac{15}{32}$	$2\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	7	$1\frac{9}{16}$	6	$4\frac{1}{2}$	$1\frac{15}{32}$	$1\frac{3}{4}$	2	R.G. – $4\frac{3}{8}$	R.G. + $7\frac{5}{8}$	$1\frac{3}{4}$
Light	55	13	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{2}$	1	$\frac{1}{2}$	$2\frac{1}{4}$	$\frac{5}{16}$	$\frac{3}{8}$	7	$1\frac{9}{16}$	6	$4\frac{1}{2}$	$1\frac{7}{16}$	$1\frac{3}{4}$	2	R.G. – $4\frac{3}{8}$	R.G. + $7\frac{5}{8}$	$2\frac{1}{4}$
Heavy	56	13	$2\frac{3}{4}$	$\frac{1}{2}$	$\frac{5}{8}$	$1\frac{1}{8}$	$\frac{5}{8}$	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{1}{2}$	7	$1\frac{5}{16}$	6	$4\frac{3}{4}$	$1\frac{5}{16}$	2	$2\frac{1}{4}$	R.G. – $4\frac{3}{8}$	R.G. + $7\frac{5}{8}$	$3\frac{3}{4}$
Light	57	14	$2\frac{3}{4}$	$\frac{13}{32}$	$\frac{17}{32}$	1	$\frac{1}{2}$	$2\frac{1}{2}$	$\frac{11}{32}$	$\frac{13}{32}$	7	2	$7\frac{1}{8}$	$4\frac{1}{2}$	$1\frac{7}{8}$	$1\frac{3}{4}$	2	R.G. – $5\frac{1}{4}$	R.G. + 9	$2\frac{1}{2}$
Heavy	58	14	$2\frac{3}{4}$	$\frac{9}{16}$	$\frac{11}{16}$	$1\frac{1}{8}$	$\frac{5}{8}$	$2\frac{5}{8}$	$\frac{7}{16}$	$\frac{9}{16}$	7	2	$7\frac{1}{8}$	$4\frac{3}{4}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	R.G. – $5\frac{1}{4}$	R.G. + 9	4
Light	59	15	$2\frac{3}{4}$	$\frac{7}{16}$	$\frac{9}{16}$	1	$\frac{17}{32}$	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{7}{16}$	7	2	$7\frac{1}{8}$	$4\frac{1}{2}$	$1\frac{27}{32}$	$1\frac{3}{4}$	2	R.G. – $5\frac{1}{4}$	R.G. + 9	$2\frac{3}{4}$
Heavy	60	15	3	$\frac{9}{16}$	$\frac{11}{16}$	$1\frac{1}{8}$	$\frac{5}{8}$	$2\frac{7}{8}$	$\frac{7}{16}$	$\frac{9}{16}$	7	$1\frac{3}{4}$	$7\frac{1}{8}$	$4\frac{3}{4}$	$1\frac{3}{4}$	2	$2\frac{1}{4}$	R.G. – $5\frac{1}{4}$	R.G. + 9	4
Light	61	16	$2\frac{3}{4}$	$\frac{7}{16}$	$\frac{9}{16}$	1	$\frac{17}{32}$	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{7}{16}$	7	2	$7\frac{1}{8}$	$4\frac{1}{2}$	$1\frac{27}{32}$	$1\frac{3}{4}$	2	R.G. – $5\frac{1}{4}$	R.G. + 9	$2\frac{3}{4}$
Heavy	62	16	3	$\frac{5}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$\frac{3}{4}$	3	$\frac{1}{2}$	$\frac{5}{8}$	7	$1\frac{3}{4}$	$7\frac{1}{8}$	$4\frac{3}{4}$	$1\frac{5}{8}$	2	$2\frac{1}{4}$	R.G. – $5\frac{1}{4}$	R.G. + 9	4
Light	63	17	3	$\frac{7}{16}$	$\frac{9}{16}$	1	$\frac{17}{32}$	$2\frac{3}{4}$	$\frac{3}{8}$	$\frac{7}{16}$	7	$1\frac{3}{4}$	$7\frac{1}{8}$	$4\frac{1}{2}$	$1\frac{27}{32}$	2	$2\frac{1}{4}$	R.G. – $5\frac{1}{4}$	R.G. + 9	$2\frac{3}{4}$
Heavy	64	17	3	$\frac{5}{8}$	$\frac{3}{4}$	$1\frac{1}{8}$	$\frac{3}{4}$	3	$\frac{1}{2}$	$\frac{5}{8}$	7	$1\frac{3}{4}$	$7\frac{1}{8}$	5	$1\frac{5}{8}$	$2\frac{1}{4}$	$2\frac{1}{2}$	R.G. – $5\frac{1}{4}$	R.G. + 9	$5\frac{1}{2}$

The figures in the table are for central loading based on the load lines being fixed at rail gauge + 1 in.

The position of the boss can be varied up to $\frac{3}{4}$ in. either way. Any variation in the position of the boss will alter dimensions "U", "V", "N" and "K".

The effective length of the rollers in the bearing should have a length between the limits of 25 per cent and 30 per cent of the wheel diameter (A), to prevent wheel wobble.

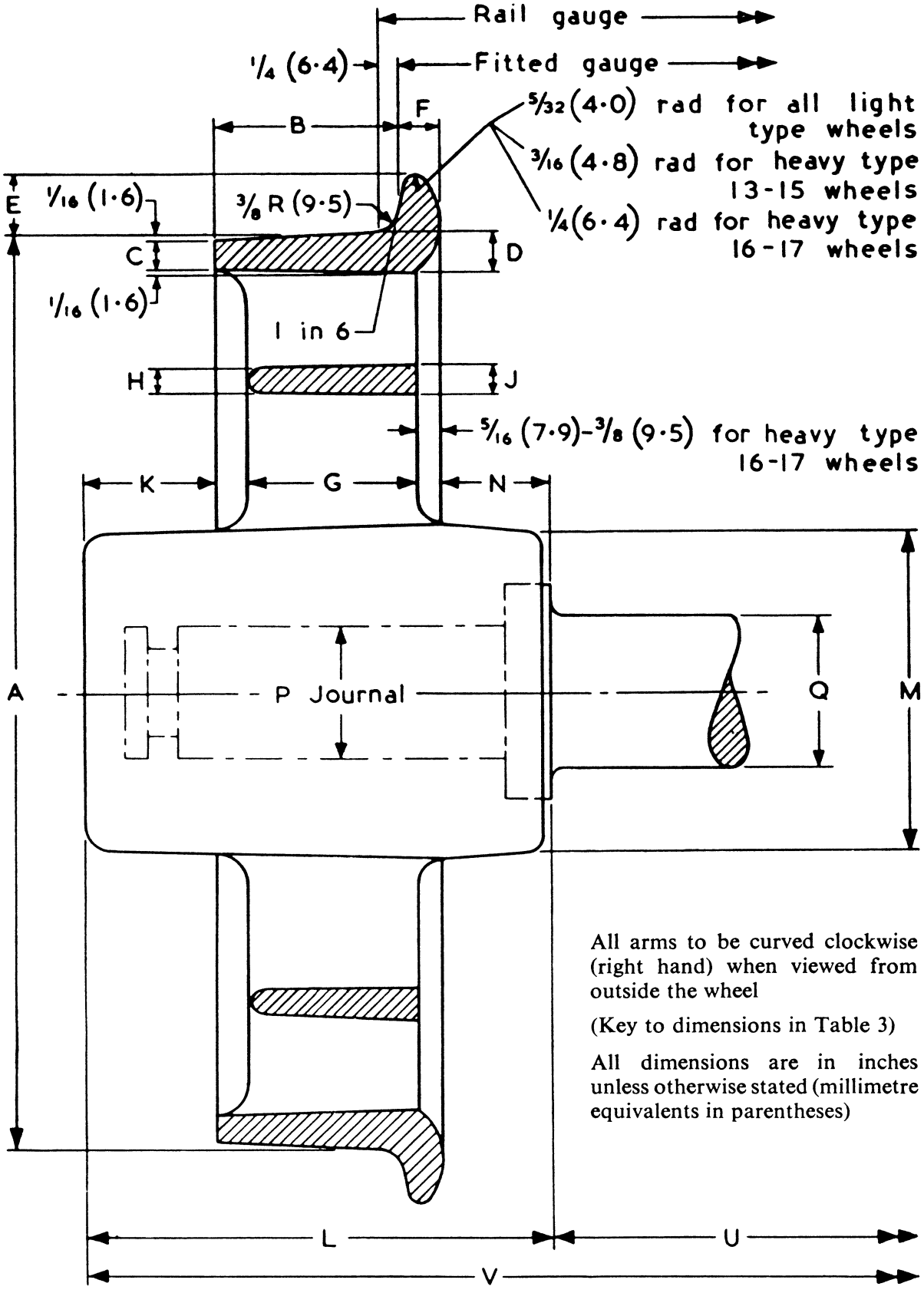
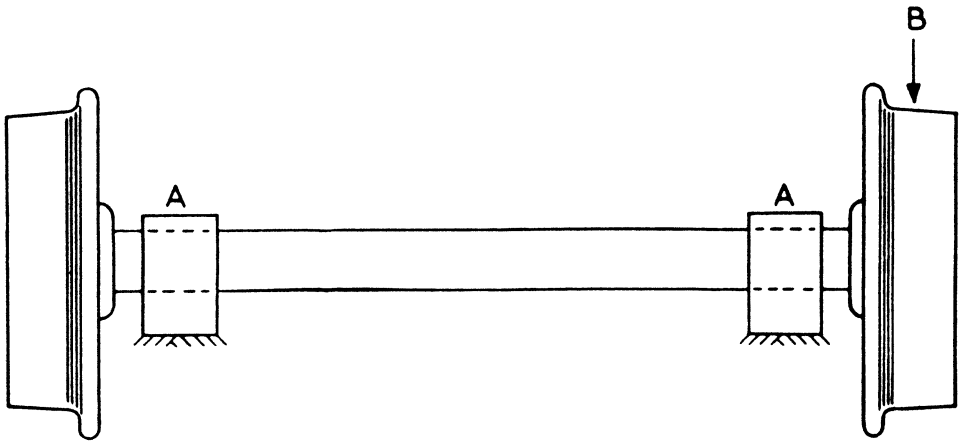
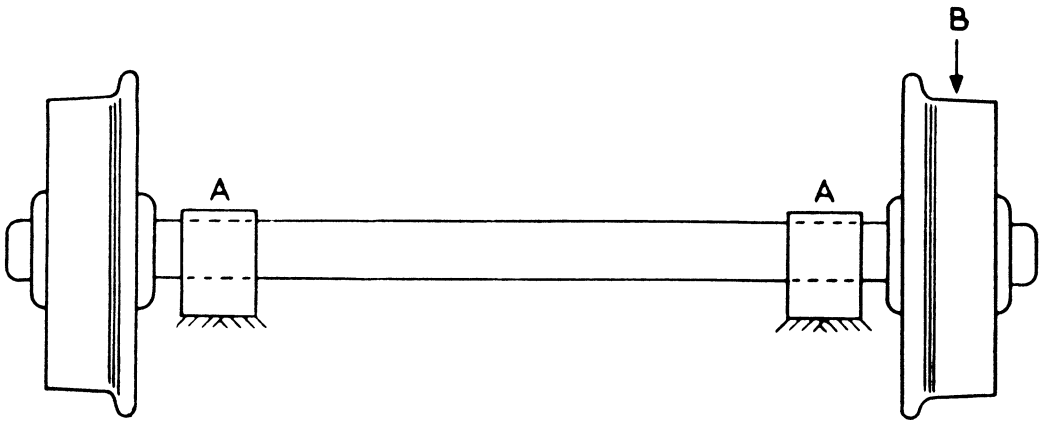


Figure 3 — Loose wheels, non-precision bearing type



Axles supported and free to rotate in V-blocks A-A placed at points approximating to the position of the pedestals. When the wheel is rotated through one revolution the distance between the tread and a fixed point, B, situated approximately opposite the mid-line of the tread, must not vary by more than $^{3}/_{16}$ in. (4.8 mm).

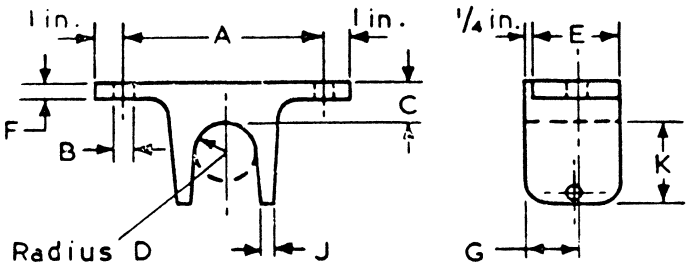
Figure 4a — Method of testing fixed wheels for true running



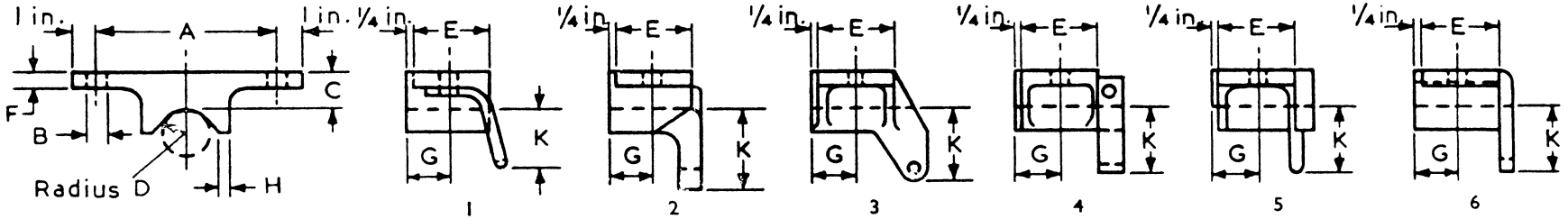
Generally as 4 *a* except that axles would be clamped and wheels only rotated. Variation not to exceed $^{3}/_{32}$ in. (2.4 mm).

Figure 4b — Method of testing loose wheels for true running

Table 4 — Dimensions for pedestals



FOR USE WITH LOOSE WHEELS AND AXLES



FOR USE WITH FIXED WHEELS AND AXLES (Alternative designs 1 – 6)

Axle dia.	Bolt hole centres (distance)	Bolt hole dia.	[a]Rise	Radius	Width	Base thickness		Hole to wheel face	Greaser clearance (minimum)	Jaw thickness		Leg thickness		Maximum dimension from crown of bearing to extremity of guard
						Cast steel and malleable iron	Cast iron			Cast steel and malleable iron	Cast iron	Cast steel and malleable iron	Cast iron	
	A	B	C	D	E	F		G		H		J		K
in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
$1\frac{3}{8}$	$4\frac{1}{2}$	$\frac{11}{16}$	1	$\frac{3}{4}$	$2\frac{1}{2}$	$\frac{3}{8}$	$\frac{5}{8}$	$1\frac{1}{2}$	$2\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2}$	$2\frac{5}{8}$
$1\frac{1}{2}$	5	$\frac{11}{16}$	1	$\frac{13}{16}$	$2\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{2}$	$2\frac{1}{4}$	$\frac{1}{4}$	$\frac{3}{8}$	$\frac{3}{8}$	$\frac{1}{2}$	$2\frac{3}{4}$
$1\frac{5}{8}$	$5\frac{1}{2}$	$\frac{11}{16}$	$1\frac{1}{4}$	$\frac{7}{8}$	$2\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{2}$	$2\frac{1}{2}$	$\frac{5}{16}$	$\frac{7}{16}$	$\frac{7}{16}$	$\frac{9}{16}$	$2\frac{7}{8}$
$1\frac{3}{4}$	6	$\frac{11}{16}$	$1\frac{1}{4}$	$\frac{15}{16}$	$2\frac{1}{2}$	$\frac{1}{2}$	$\frac{3}{4}$	$1\frac{1}{2}$	$2\frac{1}{2}$	$\frac{5}{16}$	$\frac{7}{16}$	$\frac{7}{16}$	$\frac{9}{16}$	3
2	6	$\frac{13}{16}$	$1\frac{1}{4}$	$1\frac{1}{16}$	3	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{3}{4}$	$2\frac{3}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$3\frac{1}{4}$
$2\frac{1}{4}$	7	$\frac{13}{16}$	$1\frac{1}{2}$	$1\frac{3}{16}$	3	$\frac{5}{8}$	$\frac{7}{8}$	$1\frac{3}{4}$	$2\frac{3}{4}$	$\frac{3}{8}$	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{5}{8}$	$3\frac{1}{2}$

Where pedestals are fitted with renewable bearing pads the above represents the outside dimensions of fitted bearing pads.

[a] In special cases these dimensions may be increased by $\frac{1}{4}$ in.

(For approximate metric equivalents see Appendix F, Table 9)

Table 5 — Dimensions for eye hooks, trapezoidal section, for use with links or shackles

Safe working load		Proof load		C	A	B	D	E	F	F_1	G	H	J	K	L
W		2.5 *W*		= 1.1 $\sqrt{W}$	= 3.29 *C*	= 2.43 *C*	= 1.75 *C*	= 1.57 *C*	= 1.14 *C*	= 1.71 *C*	= 1.71 *C*	= 1.24 *C*	= 0.79 *C*	= 1.57 *C*	= 0.93 *C*
ton	cwt	ton	cwt	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	10	3	15	$1\frac{3}{8}$	$4\frac{1}{2}$	$3\frac{5}{16}$	$2\frac{3}{8}$	$2\frac{1}{8}$	$1\frac{9}{16}$	$2\frac{3}{8}$	$2\frac{3}{8}$	$1\frac{11}{16}$	$1\frac{1}{8}$	$2\frac{1}{8}$	$1\frac{1}{4}$
2	0	5	0	$1\frac{9}{16}$	$5\frac{3}{16}$	$3\frac{13}{16}$	$2\frac{3}{4}$	$2\frac{7}{16}$	$1\frac{13}{16}$	$2\frac{3}{4}$	$2\frac{3}{4}$	$1\frac{15}{16}$	$1\frac{1}{4}$	$2\frac{7}{16}$	$1\frac{7}{16}$
2	10	6	5	$1\frac{3}{4}$	$5\frac{3}{4}$	$4\frac{1}{4}$	$3\frac{1}{16}$	$2\frac{3}{4}$	2	3	3	$2\frac{3}{16}$	$1\frac{3}{8}$	$2\frac{3}{4}$	$1\frac{5}{8}$
3	0	7	10	$1\frac{15}{16}$	$6\frac{3}{8}$	$4\frac{11}{16}$	$3\frac{3}{8}$	3	$2\frac{3}{16}$	$3\frac{3}{8}$	$3\frac{3}{8}$	$2\frac{3}{8}$	$1\frac{1}{2}$	3	$1\frac{3}{4}$

Safe working load		Proof load		M	N	O	Q	Q_1	R	S	T	U	V	X	Z
W		2.5 *W*		= 0.81 *C*	= 1.43 *C*	= 0.82 *C*	= 0.82 *C*	= 0.54 *C*	= 0.67 *C*	= 0.50 *C*	= 0.71 *C*	= 0.29 *C*	= 0.32 *C*	= 0.04 *C*	= 0.15 *C*
ton	cwt	ton	cwt	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
1	10	3	15	$1\frac{1}{8}$	2	$1\frac{1}{8}$	$1\frac{1}{8}$	$\frac{3}{4}$	$\frac{15}{16}$	$\frac{11}{16}$	1	$\frac{3}{8}$	$\frac{7}{16}$	$\frac{1}{16}$	$\frac{3}{16}$
2	0	5	0	$1\frac{1}{4}$	$2\frac{1}{4}$	$1\frac{5}{16}$	$1\frac{5}{16}$	$\frac{7}{8}$	$1\frac{1}{16}$	$\frac{13}{16}$	$1\frac{1}{8}$	$\frac{7}{16}$	$\frac{1}{2}$	$\frac{1}{16}$	$\frac{1}{4}$
2	10	6	5	$1\frac{7}{16}$	$2\frac{1}{2}$	$1\frac{7}{16}$	$1\frac{7}{16}$	$\frac{15}{16}$	$1\frac{3}{16}$	$\frac{7}{8}$	$1\frac{1}{4}$	$\frac{1}{2}$	$\frac{9}{16}$	$\frac{1}{16}$	$\frac{1}{4}$
3	0	7	10	$1\frac{9}{16}$	$2\frac{3}{4}$	$1\frac{9}{16}$	$1\frac{9}{16}$	$1\frac{1}{16}$	$1\frac{5}{16}$	1	$1\frac{3}{8}$	$\frac{9}{16}$	$\frac{5}{8}$	$\frac{1}{16}$	$\frac{5}{16}$

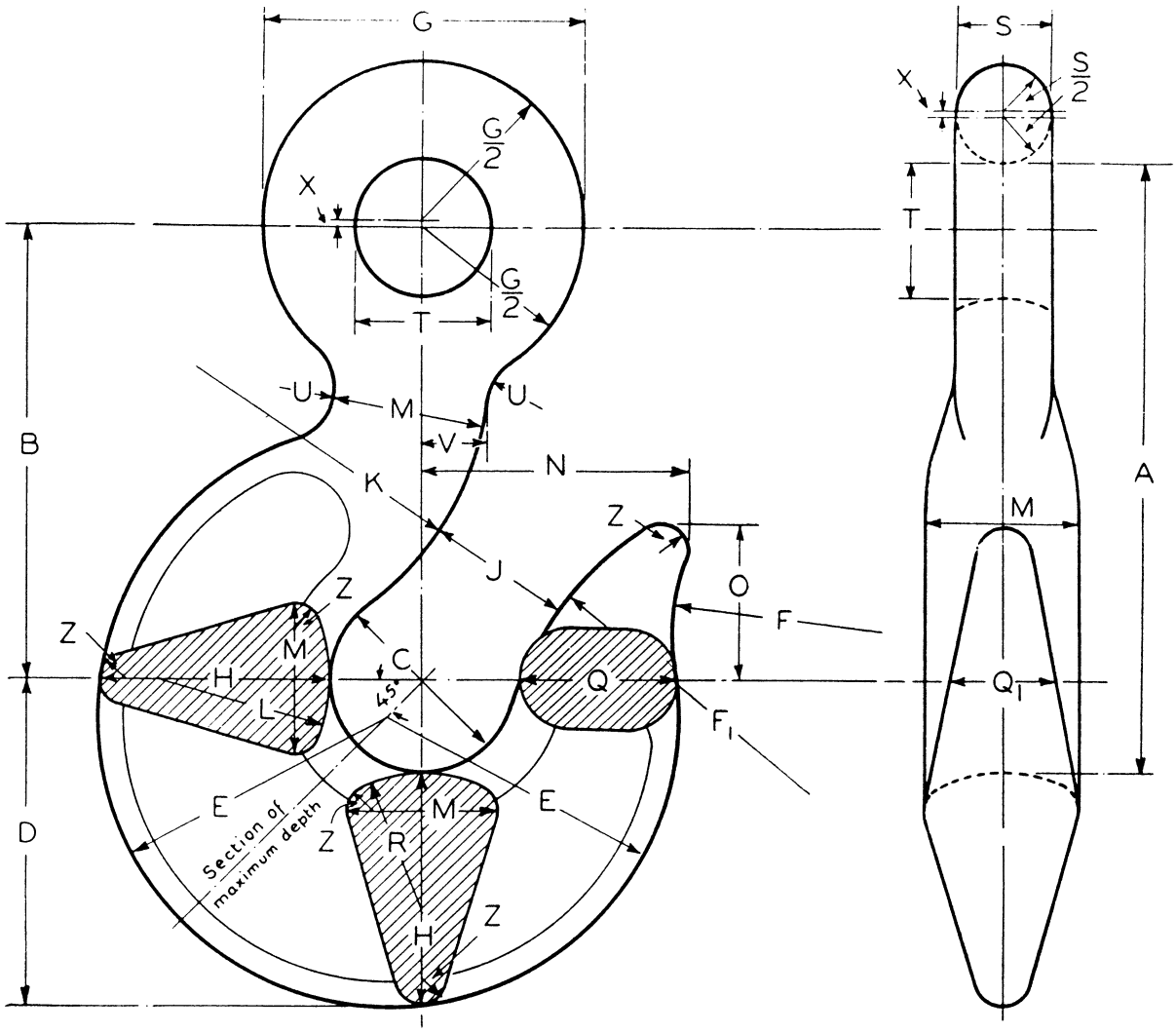


Figure 5 — Eye hooks, trapezoidal section, for use with mineral haulage drawgear

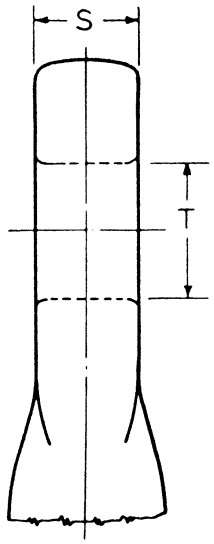


Figure 5A — Alternative eye for use with shackle pins

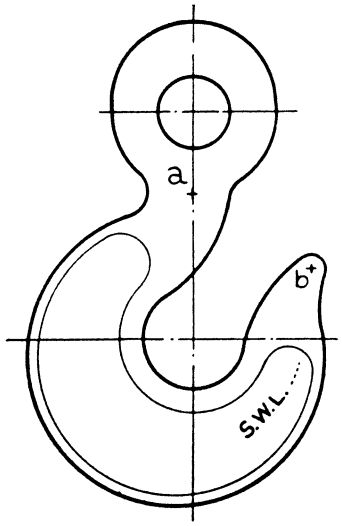


Figure 5B — Measuring points for proof testing, and marking position
(See clauses **40** and **44**)

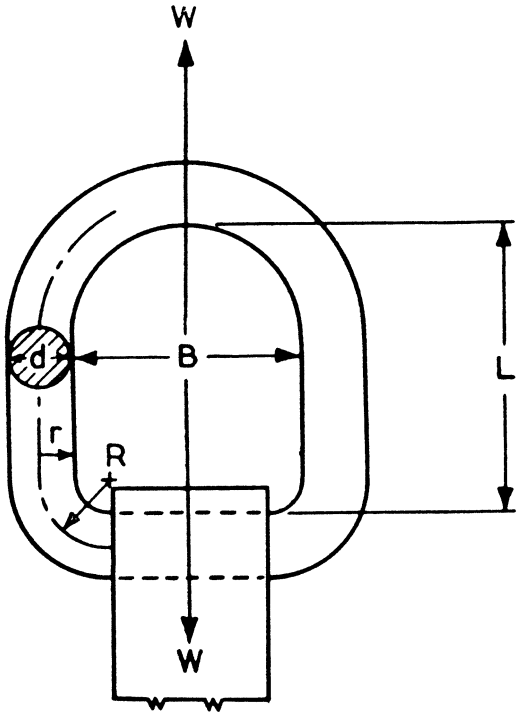


Figure 6 — Dee links

NOTE The weld (or welds in the case of the flash-butt process) should be in either of the straight sides and not in any of the radii or in the lower straight part of a link, in order to avoid a welded joint occurring at a point of maximum stress.

(For notes on design, see Appendix E)

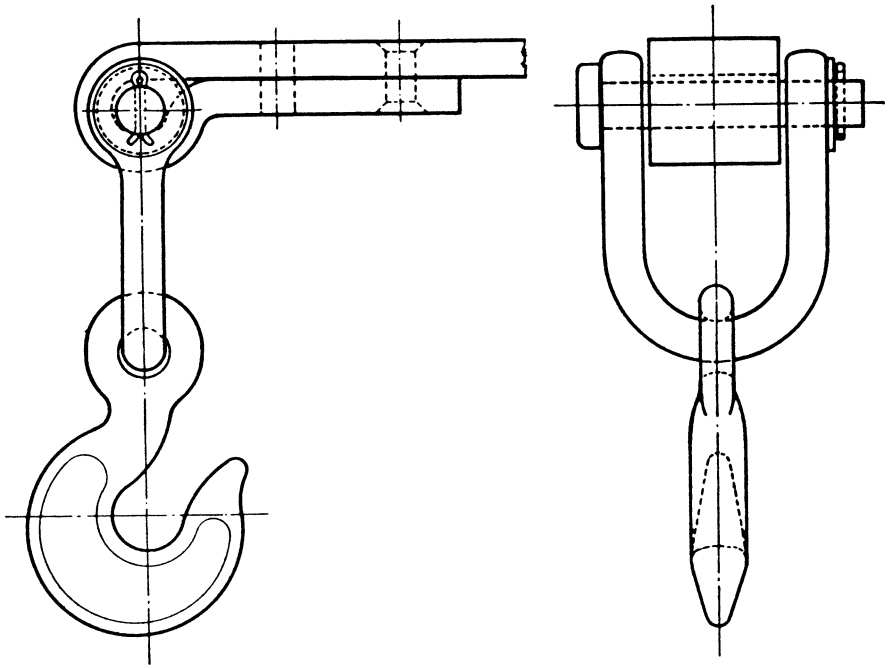


Figure 7 — Typical coupling unit with hook and Dee shackle

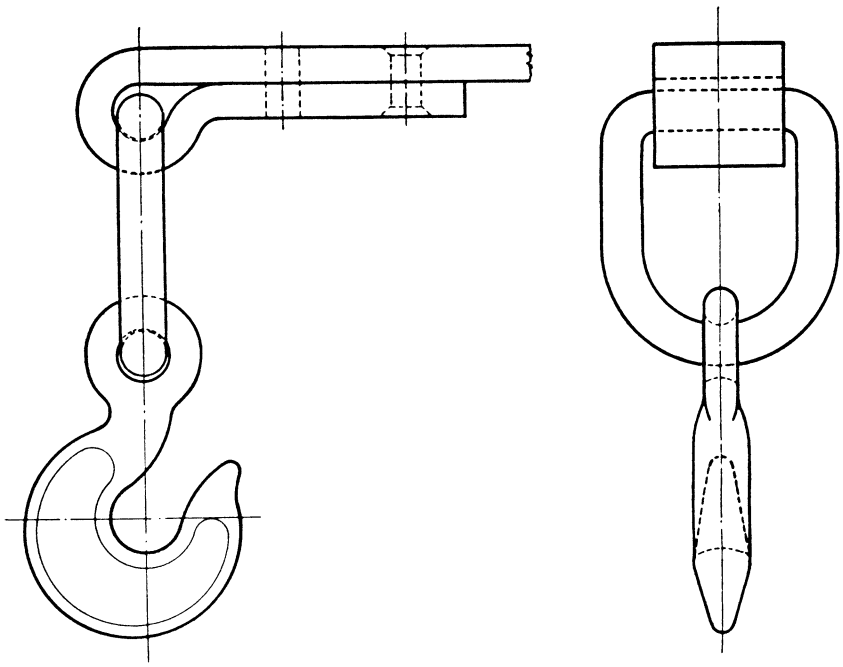


Figure 8 — Typical coupling unit with hook and Dee link

Appendix A Wheels, axles and pedestals particulars to be supplied with enquiry and order

1. Whether wheels and axles, or wheels only, are required. (A pair of wheels and axles comprises two wheels and one axle; a set of wheels and axles comprises four wheels and two axles).	Applicable in all cases.
2. The number of this British Standard.	
3. Whether carbon steel, pearlitic manganese steel, or austenitic manganese steel wheels are required. State also if tests of material quality are required.	
4. Wheel number (see Clause **14** and Table 1, Table 2 and Table 3).	
5. Axle diameter (the standard axle diameter given in the Tables should be specified whenever possible).	
6. Distance between bosses when fitted to axle.	Additional particulars applicable when wheels and axles are required.
7. Track rail gauge.	
8. Diameter of cast hole.	Additional particulars for fixed wheels applicable when wheels only are required.
9. Boss projection.	
10. Method of fitting (required for checking purposes in conjunction with the axle diameter).	
11. Pedestal number and mating axle diameter.	Additional particulars applicable when pedestals are required.
12. Rise required. (Dimension “C” of Table 4).	

Appendix B Certificate of test and examination of drawgear

1	2	3	4		5	
Distinguishing mark	**Description**	**Number tested**	**Proof load applied**		**Safe working load**	
			ton	cwt	ton	cwt

Particulars of heat treatment to which the drawgear has been subjected, stating temperatures and methods of cooling:

.....

.....

We hereby certify that the drawgear described above complies in all respects with BS 3237:1960, and that it was subjected to the appropriate proof load and subsequently examined by a competent person.

Signature.....

Date.....

Appendix C Requirements for testing machines

1. The accuracy of the machine shall be in accordance with BS 1610[15)], Part 1, Table 4, Grade A or Grade B. In no case shall the plus or minus tolerance of the testing machine used exceed 5 per cent of the proof load applied.

2. Machines measuring the load by levers and weights or by pendulum shall be verified and adjusted as necessary by a competent independent person at intervals not greater than one year. For machines measuring the load other than by levers and weights or by pendulum, the interval shall be not greater than three months.

3. A signed certificate of the last examination shall be prominently displayed adjacent to the machine.

4. Adequate facilities shall be provided, with suitable lighting, for the purpose of examining the components of drawgear after they are proof tested.

15) BS 1610, "*Verification of testing machines*".

Appendix D Design formula for 1.5 per cent manganese steel hooks (See Figure 5)[16)]

The specified hooks comprise a geometrically similar series, designed to induce an equal stress at the intrados of the principal section (i.e. at the inside of the mid-section at the back of the hook) under the rated safe working load.

The internal diameter C (inches) and the safe working load W (tons) are related by the formula $C = 1.1 \sqrt{W}$. Although the corresponding ratio of C/H comes below the limit of the formula for calculating dimension H, as published in earlier British Standards for hooks, the formula is still applicable and will give accurate results within the limits stated.

The trapezoidal cross section specified is the closest practical approximation to the theoretical optimum triangular section. The principal cross section (at the back of the hook) and the vertical cross section (at the bottom of the hook) are equal and similar in form, with the exception of the crown radius at the vertical cross section, which is somewhat smaller to accommodate links or other similar components used for coupling up to the hook. The maximum cross section is situated midway between the principal and vertical cross sections, and is 8 per cent to 10 per cent greater in depth.

Under test to destruction it is found that the increased depth at the maximum cross section greatly adds to the stability of the hook after appreciable deformation has taken place.

Since the hooks covered by this standard are designed for severe and continuous working conditions, and are proof tested to $2^1/_2$ times the rated safe working load, it has been found desirable to limit the maximum extreme fibre stress to 12 tons/sq. in. (19 kg/mm^2) at the rated safe working load, as against a nominal design stress of 16 tons/sq. in. (25 kg/mm^2) for higher tensile steel hooks to BS 2903[17)], which are designed for normal working conditions.

Cases may arise where a hook is required with an internal diameter C, differing from $C = 1.1 \sqrt{W}$. Such hook sections can be designed within the range $C = 1.0 \sqrt{W}$ to $C = 3.0 \sqrt{W}$, to give similar stress rating to that of the standard hooks, provided that the following rules and approximate formula are observed:

a) The section must be geometrically similar to the specified hook section.

b) $H = 1.25 \sqrt{W} + 0.10\,C$.

where:

H = depth at principal cross section, inches.

C = internal diameter of hook, inches.

W = safe working load, tons.

c) The depth of the principal cross-section (at the back of the hook) and of the vertical cross-section (at the bottom of the hook) shall be equal.

The depth of the section midway between the principal and vertical sections must exceed that of the principal and vertical sections by not less than 8 per cent.

All other proportions of such hooks must be based upon those of the specified hooks, and the quality of the material, and the heat treatment given must comply with the requirements of this standard.

Appendix E Design formulae for 1.5 per cent manganese steel links, rings and shackles (See Figure 6, Figure 7 and Figure 8)

When considering the designs of such components as links, rings and shackles, the term "factor of safety" in respect of static strength has little meaning, since under static loading, these components deform so much before they fail that it is scarcely possible to relate the load at failure to the original form of the component.

For this reason, it is more satisfactory to base the safe working loads on a design stress, rather than on a static factor of safety, although the latter is an extremely valuable check on design calculations.

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16) See H. J. GOUGH, H. L. COX and D. G. SOPWITH, Design of crane hooks and other components of lifting gear. *Proc. Instn. Mech. Engrs.*, **128** (1934), 253.

17) BS 2903, "*Higher tensile steel hooks for chains, slings, blocks and general engineering purposes*".

The formulae and stress values given in this appendix are based on the design data contained in BS 2902, "*Higher tensile steel chain slings*", and in BS 3032, "*Higher tensile steel shackles*": thus, the stress values relating to proof loads which are given in these standards, are divided by $2^1/_2$ to obtain appropriate stress values for calculating the safe working loads of 1.5 per cent manganese steel (higher tensile steel) links, rings and shackles for mineral haulage drawgear.

Information in regard to heat treatment is given in Clause **24**, and manufacturing details etc., supplementing those already given, will be found in BS 2902 and in BS 3032.

a) *Shackles*. Shackles for mineral haulage drawgear, made from 1.5 per cent manganese steel, and proof loaded to $2^1/_2$ times the rated safe working load, may be designed by the use of the following formulae.

The pin and the body are treated separately, and the lower of the two values (2*a*) or (2*b*) is taken as the safe working load, for substitution in (1) when estimating the diameter, *D*, of the pin.

Formula for the Pins of Shackles

$$W = \frac{0.393\, f\, D^3}{w + d} \qquad (1)$$

where:

W = safe working load, tons.
D = diameter of pin, inches.
d = diameter of material in body, inches.
w = opening in jaw, inches.
f = nominal extreme fibre stress at safe working load, ton/sq. in.
= 17 ton/sq. in.

If throughout its working life, the shackle jaw is to be filled by an attached lug, and the load is equally distributed on the pin, it may be assumed in the application of formula (1) that the opening in the jaw = 0.6 *w*.

Formula (1) for the safe working load of the pin is applicable without limit to the value of *w*/*d*.

Formulae for the Bodies of Shackles

Side of Body (*intrados fibres*).

$$W = \left(\frac{0.372\, f\, d^3}{2r - w + 1.2\, d}\right) \quad \left(\frac{2r}{2r + 0.5\, d}\right) \qquad (2a)$$

Crown of Body (*extrados fibres*).

$$W = \left(\frac{0.400\, f\, d^3}{w + d}\right) \quad \left(\frac{2r + d}{2r + 0.4\, d}\right) \qquad (2b)$$

In the case of the bodies of dee shackles, $2r = w$. When w lies between d and 1.36 d, formula (2*a*) is applicable and reduces to:

$$W = \frac{0.310\, f\, d^2\, w}{w + 0.5\, d}$$

When w is greater than 1.36 d, formula (2*b*) is applicable and reduces to:

$$W = \frac{0.400\, f\, d^3}{w + 0.4\, d}$$

where:

W = safe working load, tons.

d = diameter of material in body, inches.

$2r$ = opening in shackle body, inches.

w = opening in jaw, inches.

f = nominal extreme fibre (tensile) stress at safe working load, ton/sq. in.
= 19.2 ton/sq. in.

These formulae originated by the National Physical Laboratory are based on two possible conditions of loading:

a) Load at centre of pin, reactions taken at inside edges of holes.

b) Load at centre of pin, reactions taken at centre of length of holes.

This is the probable condition when the shackle has become somewhat worn.

In the case of the pin, condition b) is the more severe: in the case of the body, either of the conditions a) or b) may be the more severe, according to the proportions of the shackle.

For this reason, two formulae, (2*a*) and (2*b*) are given for the safe working load of the body. These represent for $2r/d$ greater than unity, very close approximations (within about 2 per cent) to the more complicated expressions derived from the theory of curved beams.

b) *Links and rings*. Links and rings for mineral haulage drawgear, made from 1.5 per cent manganese steel, and proof loaded to $2^1/_2$ times the rated safe working load, may be designed by the use of the following formulae, developed by the National Physical Laboratory.

The errors involved in the use of the formulae are negligible in practice (less than 4 per cent in the worst case, and in general less than 2 per cent).

Formulae for Links and Rings

$$W = \left(\frac{0.224\, f\, d^3}{B + 0.4\, d}\right) \left(1.75 + \frac{B + d}{L + d}\right) \qquad (3)$$

for values of L greater than 2.55 d.

where for links:

W = safe working load, tons.

d = diameter of material, inches.

L = internal length of link, inches.

B = internal breadth of link, inches.
(For egg links, use the value at the large end).

f = nominal extreme fibre (tensile) stress at safe working load, ton/sq. in.
= 16 ton/sq. in.

The tensile stress, f, to which formula (3) relates, is that set up in the extreme fibres at the extrados in the line of the load.

When L is less than 2.55 d, the tensile stress in the extreme fibres at the intrados at the ends of the straight sides of a link is greater than that in the extreme fibres at the extrados in the line of the load, and the safe working load must be correspondingly reduced. This is effected by multiplying formula (3) by the reduction factor $0.22\ (2 + L/d)$.

For rings of internal diameter D formula (3) reduces to:

$$W = \frac{0.616\, f\, d^3}{D + 0.4\, d}$$

where for rings:

W = safe working load, tons.
d = diameter of material, inches.
D = internal diameter of ring, inches.
f = nominal extreme fibre (tensile) stress at safe working load, ton/sq. in.
= 12.8 ton/sq. in.

This formula is again restricted to values of D/d greater than 2.55. If D/d is less than 2.55, the maximum tensile stress occurs in the extreme fibres at the intrados of the section of the ring, midway between the two loading points, and the value of W must be multiplied by the reduction factor 0.22 $(2 + D/d)$.

Formula for Dee Links

Dee links (Figure 6) can be considered as a limiting case of the ordinary link and an adaptation of formula (3) may be used. When loaded as shown in Figure 6:

$$W = \left(\frac{0.224\, f\, d^3}{B + 0.4\, d}\right) \left(1.9 + \frac{B + d}{L + d}\right) \qquad (4)$$

for values of $\frac{L}{d}$ greater than 3

$\frac{B}{d}$ from $2^1/_2$ to $6^1/_2$

$\frac{r}{R}$ less than 0.7

where: (see Figure 6).

W = safe working load, tons.
d = diameter of material, inches.
L = internal length of link, inches.
B = internal breadth of link, inches.
f = nominal extreme fibre (tensile) stress at safe working load, ton/sq. in.
= 16 ton/sq. in.

When designing Dee links, loaded as shown in Figure 6, it is recommended that the intrados radii at the ends of the straight lower limb be not less than $^1/_4$ of the bar size, $(r/R = 0.66)$, and preferably not less than $^1/_3$ of the bar size, $(r/R = 0.60)$.

Appendix F Approximate metric dimensions

Table 6 — Metric equivalents of dimensions and recommended maximum loads for fixed wheels in Table 1. (See Figure 1)

Type	B.S.I. wheel no.	Diameter on tread	Width of tread	Thickness of flange	Depth of flange	Thickness of tread	
		A	B	C	D	E	F
		mm	mm	mm	mm	mm	mm
Light	1	203.2	50.8	11.1	19.0	7.9	11.1
Heavy	2	203.2	57.2	12.7	19.0	7.9	11.1
Light	3	215.9	50.8	11.1	19.0	7.9	11.1
Heavy	4	215.9	57.2	12.7	19.0	7.9	11.1
Light	5	228.6	50.8	11.1	19.0	7.9	11.1
Heavy	6	228.6	57.2	12.7	22.2	7.9	11.1
Light	7	241.3	50.8	11.1	19.0	7.9	11.1
Heavy	8	241.3	57.2	12.7	22.2	7.9	11.1
Light	9	254.0	57.2	12.7	22.2	7.9	11.1
Medium	10	254.0	63.5	14.3	22.2	9.5	12.7
Heavy	11	254.0	69.8	15.9	22.2	11.1	14.3
Light	12	266.7	57.2	12.7	22.2	7.9	11.1
Medium	13	266.7	63.5	14.3	22.2	9.5	12.7
Heavy	14	266.7	69.8	15.9	22.2	11.1	14.3
Light	15	279.4	57.2	12.7	22.2	9.5	12.7
Medium	16	279.4	63.5	14.3	22.2	11.1	14.3
Heavy	17	279.4	76.2	17.5	25.4	12.7	15.9
Light	18	292.1	57.2	12.7	22.2	9.5	12.7
Medium	19	292.1	63.5	14.3	22.2	11.1	14.3
Heavy	20	292.1	76.2	17.5	23.4	14.3	17.5
Light	21	304.8	57.2	12.7	22.2	9.5	12.7
Medium	22	304.8	63.5	15.9	25.4	11.1	14.3
Heavy	23	304.8	76.2	19.0	28.6	15.9	19.0

[a] Assuming rail gauge of 609.6 mm.

Table 6 — Metric equivalents of dimensions and recommended maximum loads for fixed wheels in Table 1. (See Figure 1)

Arms				Axle diameter	Boss diameter	Boss thickness	Approximate weight of wheel with no boss projection	Recommended maximum load[a] on 4 wheels and 2 axles
Width thickness			No. curved					
G	H	J		K	L	T		
mm	mm	mm		mm	mm	mm	kg	kg
50.8	6.4	9.5	5	34.9	63.5	14.3	6	889
54.0	7.9	11.1	5	38.1	66.7	14.3	7	1 270
50.8	6.4	9.5	5	34.9	63.5	14.3	7	889
54.0	7.9	11.1	5	38.1	66.7	14.3	8	1 270
50.8	6.4	9.5	5	34.9	63.5	14.3	7	889
54.0	7.9	11.1	5	38.1	66.7	14.3	8	1 270
50.8	6.4	9.5	5	34.9	63.5	14.3	7	889
54.0	7.9	11.1	5	38.1	66.7	14.3	9	1 270
57.2	7.9	11.1	6	38.1	66.7	14.3	10	1 270
60.3	7.9	11.1	6	41.3	73.0	15.9	12	1 651
66.7	9.5	12.7	6	44.4	79.4	17.5	14	1 905
57.2	7.9	11.1	6	38.1	66.7	14.3	10	1 270
60.3	7.9	11.1	6	41.3	73.0	15.9	12	1 651
66.7	9.5	12.7	6	44.4	79.4	17.5	15	1 905
57.2	7.9	11.1	6	38.1	66.7	14.3	11	1 270
60.3	9.5	12.7	6	44.4	79.4	17.5	14	1 651
76.2	11.1	14.3	6	50.8	88.9	19.0	19	1 905
57.2	7.9	11.1	7	38.1	66.7	14.3	12	1 270
60.3	9.5	12.7	7	44.4	79.4	17.5	15	1 651
76.2	11.1	14.3	7	50.8	88.9	19.0	21	1 905
57.2	7.9	11.1	7	38.1	66.7	14.3	13	1 270
63.5	9.5	12.7	7	44.4	79.4	17.5	17	1 905
76.2	12.7	15.9	7	57.2	101.6	22.2	25	2 064

Table 7 — Metric equivalents of dimensions and recommended maximum loads for (self-oiling) wheels in Table 2. (See Figure 2)

Type	B.S.I. wheel no.	Tread				Flange		Arms				Hub		Back boss bearing cap	
		Dia.	Width	Thickness		Depth	Thickness	Width	Thickness		No. curved	Projection	Dia.	Dia.	Projection (min.)
		A	B	C	D	E	F	G	H	J		K	L	M	N
		mm	mm	mm	mm	mm	mm	mm	mm	mm		mm	mm	mm	mm
Light	51	228.6	63.5	7.9	11.1	19.0	11.1	50.8	6.4	7.9	6	41.3	114.3	69.8	14.3
Light	52	254.0	63.5	7.9	11.1	19.0	11.1	54.0	6.4	7.9	6	41.3	114.3	69.8	14.3
Light	53	279.4	63.5	9.5	12.7	19.0	11.9	57.2	7.9	9.5	6	41.3	127.0	79.4	26.2
Light	54	304.8	63.5	9.5	12.7	19.0	11.9	57.2	7.9	9.5	7	44.4	136.5	88.9	38.9
Light	55	330.2	63.5	9.5	12.7	25.4	12.7	57.2	7.9	9.5	7	44.4	136.5	88.9	38.1
Heavy	56	330.2	69.8	12.7	15.9	28.6	15.9	63.5	9.5	12.7	7	44.4	136.5	95.2	41.3
Light	57	355.6	69.8	10.3	13.5	25.4	12.7	63.5	8.7	10.3	7	44.4	136.5	88.9	31.8
Heavy	58	355.6	69.8	14.3	17.5	28.6	15.9	66.7	11.1	14.3	7	44.4	136.5	95.2	41.3
Light	59	381.0	69.8	11.1	14.3	25.4	13.5	63.5	9.5	11.1	7	44.4	136.5	88.9	31.0
Heavy	60	381.0	76.2	14.3	17.5	28.6	15.9	73.0	11.1	14.3	7	44.4	136.5	95.2	34.9
Light	61	406.4	69.8	11.1	14.3	25.4	13.5	63.5	9.5	11.1	7	44.4	136.5	88.9	31.0
Heavy	62	406.4	76.2	15.9	19.0	28.6	19.0	76.2	12.7	15.9	7	44.4	136.5	95.2	31.8
Light	63	431.8	76.2	11.1	14.3	25.4	13.5	69.8	9.5	11.1	7	44.4	149.2	95.2	37.3
Heavy	64	431.8	76.2	15.9	19.0	28.6	19.0	76.2	12.7	15.9	7	44.4	149.2	101.6	44.4

Table 7 — Metric equivalents of dimensions and recommended maximum loads for (self-oiling) wheels in Table 2. (See Figure 2)

Back boss bearing cap		Axle collar shoulder			Thickness	Between bosses[a]	Overall length	Axle length	Recommended maximum load[b] on 4 wheels and 2 axles
Length (min.)	Dia. B.S.P. size	Diameter		Square section					
O	P	Q	R	S	T	U	V	W	
mm	mm	mm	mm	mm	mm	mm	mm	mm	kg
88.9	57.2	38.1	28.6	12.7	9.5	RG – 63.5	RG + 215.9	RG + 158.8	1 270
88.9	57.2	38.1	28.6	12.7	9.5	RG – 63.5	RG + 215.9	RG + 158.8	1 270
101.6	57.2	44.4	34.9	12.7	9.5	RG – 88.9	RG + 215.9	RG + 158.8	1 778
114.3	63.5	50.8	38.1	14.3	11.1	RG – 114.3	RG + 222.2	RG + 165.1	1 778
114.3	63.5	50.8	38.1	14.3	11.1	RG – 114.3	RG + 222.2	RG + 165.1	2 286
127.0	69.8	57.2	44.4	14.3	11.1	RG – 127.0	RG + 235.0	RG + 177.8	3 810
114.3	63.5	50.8	38.1	14.3	11.1	RG – 101.6	RG + 235.0	RG + 177.8	2 540
127.0	69.8	57.2	44.4	14.3	11.1	RG – 127.0	RG + 235.0	RG + 177.8	4 064
114.3	63.5	50.8	38.1	14.3	11.1	RG – 101.6	RG + 235.0	RG + 177.8	2 794
127.0	69.8	57.2	44.4	14.3	11.1	RG – 114.3	RG + 247.6	RG + 190.5	4 064
114.3	63.5	50.8	38.1	14.3	11.1	RG – 101.6	RG + 235.0	RG + 177.8	2 794
127.0	69.8	57.2	44.4	14.3	11.1	RG – 114.3	RG + 247.6	RG + 190.5	4 064
127.0	69.8	57.2	44.4	14.3	11.1	RG – 114.3	RG + 247.6	RG + 190.5	2 794
139.7	76.2	63.5	50.8	14.3	11.1	RG – 139.7	RG + 247.6	RG + 190.5	5 588

(R.G. = Rail gauge)

[a] With minimum dimensions N and O.

[b] Assuming rail gauge of 609.6 mm.

Table 8 — Metric equivalents of dimensions and recommended maximum loads for loose wheels (non-precision bearing type) in Table 3. (See Figure 3)

Type	B.S.I. wheel No.	Tread				Flange		Arms			No. curved
		Dia.	Width	Thickness		Depth	Thickness	Width	Thickness		
		A	B	C	D	E	F	G	H	J	
		mm	mm	mm	mm	mm	mm	mm	mm	mm	
Light	51	228.6	63.5	7.9	11.1	19.0	11.1	50.8	6.4	7.9	6
Light	52	254.0	63.5	7.9	11.1	19.0	11.1	54.0	6.4	7.9	6
Light	53	279.4	63.5	9.5	12.7	19.0	11.9	57.2	7.9	9.5	6
Light	54	304.8	63.5	9.5	12.7	19.0	11.9	57.2	7.9	9.5	7
Light	55	330.2	63.5	9.5	12.7	25.4	12.7	57.2	7.9	9.5	7
Heavy	56	330.2	69.8	12.7	15.9	28.6	15.9	63.5	9.5	12.7	7
Light	57	355.6	69.8	10.3	13.5	25.4	12.7	63.5	8.7	10.3	7
Heavy	58	355.6	69.8	14.3	17.5	28.6	15.9	66.7	11.1	14.3	7
Light	59	381.0	69.8	11.1	14.3	25.4	13.5	63.5	9.5	11.1	7
Heavy	60	381.0	76.2	14.3	17.5	28.6	15.9	73.0	11.1	14.3	7
Light	61	406.4	69.8	11.1	14.3	25.4	13.5	63.5	9.5	11.1	7
Heavy	62	406.4	76.2	15.9	19.0	28.6	19.0	76.2	12.7	15.9	7
Light	63	431.8	76.2	11.1	14.3	25.4	13.5	69.8	9.5	11.1	7
Heavy	64	431.8	76.2	15.9	19.0	28.6	19.0	76.2	12.7	15.9	7

NOTE 1 The figures in the table are for central loading based on the load lines being fixed at rail gauge + 25.4 mm.
NOTE 2 The position of the boss can be varied up to 19.0 mm either way. Any variation in the position of the boss will alter dimensions U, V, N and K.

Table 8 — Metric equivalents of dimensions and recommended maximum loads for loose wheels (non-precision bearing type) in Table 3. (See Figure 3)

Boss				Axle		Between bosses	Overall length	Recommended maximum load on 4 wheels and 2 axles
Outside projection	Length	Dia.	Inside projection	Journal dia.	Axle dia.			
K	L	M	N	P	Q	U	V	
mm	mm	mm	mm	mm	mm	mm	mm	kg
30.2	138.1	104.8	33.3	38.1	41.3	RG – 101.6	RG + 174.6	1 270
30.2	138.1	104.8	33.3	38.1	41.3	RG – 101.6	RG + 174.6	1 270
30.2	138.1	104.8	32.5	41.3	44.4	RG – 101.6	RG + 174.6	1 778
39.7	152.4	114.3	37.3	44.4	50.8	RG – 111.1	RG + 193.7	1 778
39.7	152.4	114.3	36.5	44.4	50.8	RG – 111.1	RG + 193.7	2 286
33.3	152.4	120.6	33.3	50.8	57.2	RG – 111.1	RG + 193.7	3 810
50.8	181.0	114.3	47.6	44.4	50.8	RG – 133.4	RG + 228.6	2 540
50.8	181.0	120.6	44.4	50.8	57.2	RG – 133.4	RG + 228.6	4 064
50.8	181.0	114.3	46.8	44.4	50.8	RG – 133.4	RG + 228.6	2 794
44.4	181.0	120.6	44.4	50.8	57.2	RG – 133.4	RG + 228.6	4 064
50.8	181.0	114.3	46.8	44.4	50.8	RG – 133.4	RG + 228.6	2 794
44.4	181.0	120.6	41.3	50.8	57.2	RG – 133.4	RG + 228.6	4 064
44.4	181.0	114.3	46.8	50.8	57.2	RG – 133.4	RG + 228.6	2 794
44.4	181.0	127.0	41.3	57.2	63.5	RG – 133.4	RG + 228.6	5 588

NOTE 3 The effective length of the rollers in the bearing should have a length between the limits of 25 per cent and 30 per cent of the wheel diameter, A, to prevent wheel wobble.

Table 9 — Metric equivalents of dimensions of pedestals for use with fixed or loose wheels and axles, in Table 4

Axle dia.	Bolt hole centres (distance)	Bolt hole dia.	Rise	Radius	Width	Base thickness	
						Cast steel[a] mall. iron	Cast iron
	A	B	C	D	E	F	
mm	mm	mm	mm	mm	mm	mm	mm
34.9	114.3	17.5	25.4	19.0	63.5	9.5	15.9
38.1	127.0	17.5	25.4	20.6	63.5	12.7	19.0
41.3	139.7	17.5	31.8	22.2	63.5	12.7	19.0
44.4	152.4	17.5	31.8	23.8	63.5	12.7	19.0
50.8	165.1	20.6	31.8	27.0	76.2	15.9	22.2
57.2	177.8	20.6	38.1	30.2	76.2	15.9	22.2

NOTE Where pedestals are fitted with renewable bearing pads, the above represents the outside dimensions of fitted bearing pads.

[a] In special cases these dimensions may be increased by 6.4 mm.

Table 9 — Metric equivalents of dimensions of pedestals for use with fixed or loose wheels and axles, in Table 4

Hole to wheel face	Greaser clearance (min)	Jaw thickness		Leg thickness		Maximum dimension from crown of bearing to extremity of guard
		Cast steel[a] mall. iron	Cast iron	Cast steel[a] mall. iron	Cast iron	
G		H		J		K
mm	mm	mm	mm	mm	mm	mm
38.1	57.2	6.4	9.5	9.5	12.7	66.7
38.1	57.2	6.4	9.5	9.5	12.7	69.8
38.1	63.5	7.9	11.1	11.1	14.3	73.0
38.1	63.5	7.9	11.1	11.1	14.3	76.2
44.4	69.8	9.5	12.7	12.7	15.9	82.6
44.4	69.8	9.5	12.7	12.7	15.9	88.9

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