BRITISH STANDARD

BS 4073:1966

Incorporating Amendment Nos. 1 and 2

Specification for

Heavy 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 and Mechanical Engineers
British Electrical and Allied Manufacturers' Association
British Iron and Steel Federation*
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:

British Steel Founders' Association
National Association of Drop Forgers and Stampers
Pit Tub and Mine Car Manufacturers' Association

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 22 November 1966

The following BSI references relate to the work on this standard:
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Amendments issued since publication

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1391	April 1974	Indicated by a sideline in the margin

Contents

Foreword

This standard makes reference to the following British Standards:

BS 4, *Structural steel sections — Part 1: Hot-rolled sections.*

BS 15, *Mild steel for general structural purposes.*

BS 18, *Methods for tensile of metals.*

BS 24, *Railway rolling stock material — Part 3A: Laminated springs and spring steel — Part 3B: Helical and volute springs and spring steels — Part 6: Steel slabs, plates, sections, bars and rivets for locomotive boilers, locomotives, carriages and wagons.*

BS 275, *Dimensions of rivets ($^1/_2$ in to $1^3/_4$ in diameter).*

BS 639, *Covered electrodes for the manual metal-arc welding of mild steel and medium-tensile steel.*

BS 693, *General requirements for oxy-acetylene welding of mild steel.*

BS 729, *Zinc coatings on iron and steel articles.*

BS 970, *Wrought steels (Blooms, billets, bars and forgings).*

BS 1449, *Steel plate, sheet and strip.*

BS 1452, *Grey iron castings.*

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

BS 1476, *Wrought aluminium and aluminium alloys for general engineering purposes. Bars and sections.*

BS 1477, *Wrought aluminium and aluminium alloys for general engineering purposes. Plate.*

BS 1663, *Higher tensile steel chain Grade 40 (short link and pitched or calibrated) for lifting purposes.*

BS 1806, *Dimensions of toroidal sealing rings ("O" seals and their housings).*

BS 1856, *General requirements for the metal-arc welding of mild steel.*

BS 2772, *Iron and steel for colliery haulage and winding equipment — Part 2: Wrought steel — Part 3: 1.5 percent manganese steel castings for mine car couplers.*

BS 2901, *Filler rods and wires for inert-gas arc welding — Part 1: Gas-shielded tungsten-arc welding — Part 2: Wires for gas-shielded metal-arc welding.*

BS 2994, *Cold rolled steel sections.*

BS 3019, *General recommendations for manual inert-gas tungsten-arc welding — Part 1: Wrought aluminium, aluminium alloys and magnesium alloys.*

BS 3032, *Higher tensile steel shackles.*

BS 3100, *Steel castings for general engineering purposes: which includes.*

BS 592, *Carbon steel castings for general engineering purposes.*

BS 1456, *$1^1/_2$ per cent manganese steel castings.*

BS 1457, *Austenitic manganese steel castings.*

BS 3134, *Dimensions of tapered roller bearings.*

BS 3571, *General recommendations for manual inert-gas metal arc-welding — Part 1: Aluminium and aluminium alloys.*

BS 3673, *Spring retaining rings — Part 1: Carbon steel circlips.*

This British Standard has been prepared under the authority of the Colliery Requisites Industry Standards Committee, with the purpose of stating principles of design and specifying certain major components of mineral haulage rolling stock (60–200 ft^3 capacity), generally known as "mine cars", in coal mines in the United Kingdom. The specification is complementary to BS 3237 (which deals with light and medium rolling stock of capacity below 60 ft^3, for mineral haulage in mines) and it is designed to cover a range of heavy rolling stock incorporating suspension gear, couplers and buffing gear, and wheel and axle assemblies (embodying taper roller bearings); also ancillary equipment such as tippler and retarder brackets, and brakes. Drop bottom and side tipping types, and special purpose vehicles such as containers operating on restricted circuits, are excluded. However, it is recommended that components from this standard be utilized for such vehicles, where applicable.

Comprehensive dimensions for a range of 21 cars are given in Table 1 and the preferred sizes representing general colliery usage in the U.K. are indicated.

In preparing standard requirements for the complete vehicle, care has been taken to avoid detail that would unnecessarily restrict design. Hence, the specification for components deals mainly with design principles and basic requirements essential to a product of good quality.

No provision is made for nipples for the pressure greasing of wheels (Figure 4 and Figure 5); it is modern practice to grease the bearings during original assembly and only to renew the grease at planned maintenance periods.

Attention is drawn to the serious hazard inherent in the use of aluminium or aluminium alloy in incendive atmospheres, particularly in mines in which the use of lamps or lights, other than permitted lights, is unlawful.

NOTE Where metric equivalents have been given (see Appendix D), 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"*.

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, an inside back cover and a back cover.

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

1 Scope

This British Standard provides specification of materials, basic design requirements and constructional details, including specifications for individual components, for heavy rolling stock of "solid bottom" design, with capacities within the range 60 to 200 ft^3, having approximate tonnage capacities of $1^1/_2$ to 5 tons of coal, or 3 to 10 tons of stone (see Clause **2**). Vehicles are of the type employing resilient suspension and having loose wheels incorporating precision bearings.

The dimensions and other requirements of the main components are presented on a basis of alternatives permissible for each size/load combination, so that selection may be made to produce an overall design, made up of standardized parts, as required for particular purposes or service conditions. This standard provides for rolling stock designed to carry different kinds of bulk materials, such as metalliferous ores, as well as for rolling stock primarily designed for coal or stone.

Part 1. General requirements

2 Capacities

The standard provides for the following nominal capacities of rolling stock:

Volumetric capacities (nominal values)	Approx. equivalent payload capacities	
	Coal	Stone
ft^3	ton	ton
60	$1^1/_2$	3
80	2	4
100	$2^1/_2$	5
120	3	6
140	$3^1/_2$	7
160	4	8
200	5	10

NOTE Coal payload equivalents are based on a nominal 40 ft^3 to the ton and stone at 20 ft^3 to the ton, assuming "flush" loading in each case.

The average weight/bulk ratio of different materials varies and the exact payload of the vehicle should be determined from figures obtained locally.

3 Vehicle types and dimensions

Table 1 provides alternative dimensions for the vehicle, for each nominal capacity, to afford satisfactory selection for a given requirement.

4 Designation (car reference)

Designation of vehicles shall be on the following basis, to provide car reference numbers:

i) The number of this British Standard, i.e. BS 4073, followed by:

ii) The appropriate car serial number from column (1) of Table 1, followed by:

iii) The relevant estimated capacity (ft^3) from column (2) of Table 1, e.g. BS 4073/11/102.

5 General finish and protective coating

Unless otherwise specified by the purchaser, *a* all surfaces of the car shall be cleaned and have the scale removed; and *b*, two coats of white paint, approved by the purchaser, shall be applied outside, and one applied inside, the body.

6 Inspection

The manufacturer shall maintain and make available all relevant records of quality control, inspection and testing of the items concerned (including calibration certificates for testing machines) and, if requested, shall supply copies to the purchaser or his representative.

7 Marking

Marking additional to that specified in Clause **4** shall be at the option of the manufacturer or, alternatively, as agreed between manufacturer and purchaser.

Table 1 — Car dimensions

(1) Car serial number	(2) Estimated capacity	(3) Rail gauge		Body dimensions (external)						(7) Height above rail unladen)		(8) Length over engaged couplers		(9) Wheel base	
				(4) Width		(5) Depth		(6) Length							
	ft^3	ft	in	ft	in	ft	in	ft	in	ft	in	ft	in	ft	in
1	60	2	0	3	0	2	9	7	3	3	$11^3/_4$	8	0	3	0
2	61	2	6	3	3	2	8	7	3	3	$10^3/_4$	8	0	3	0
3[a]	62	2	6	3	3	3	2	6	3	4	$4^3/_4$	7	0	2	6
4	81	2	0	3	0	3	0	9	3	4	$4^3/_4$	10	0	3	9
5	85	3	0	3	9	2	6	9	3	3	$8^3/_4$	10	0	3	9
6[a]	83	2	6	3	3	3	2	8	3	4	$6^3/_4$	9	0	3	6
7	80	3	0	3	9	3	0	7	3	4	$4^3/_4$	8	0	3	0
8	100	2	6	3	6	2	10	10	3	4	$2^3/_4$	11	0	4	3
9	100	3	0	3	9	2	8	10	3	4	$0^3/_4$	11	0	4	3
10	100	2	6	3	6	3	2	9	3	4	$6^3/_4$	10	0	3	9
11	102	3	0	3	9	3	0	9	3	4	$4^3/_4$	10	0	3	9
12[a]	102	3	0	4	0	3	2	8	3	4	$6^3/_4$	9	0	3	6
13[a]	122	2	6	3	6	3	2	11	3	4	$6^3/_4$	12	0	4	6
14	124	3	0	3	9	3	0	11	3	4	$4^3/_4$	12	0	4	6
15	121	3	0	4	0	3	0	10	3	4	$4^3/_4$	11	0	4	3
16	134	2	6	3	6	3	2	12	6	4	$6^3/_4$	13	3	5	0
17[a]	138	3	0	4	0	3	2	11	3	4	$6^3/_4$	12	0	5	0
18	160	3	0	4	0	2	4	12	3	4	$8^3/_4$	13	0	5	0
19	162	3	0	4	0	3	8	11	3	5	$0^3/_4$	12	0	4	6
20	201	3	0	4	0	4	2	12	3	5	$6^3/_4$	13	0	5	0
21	200	3	0	4	0	3	10	13	3	5	$2^3/_4$	14	0	5	6

NOTES on Table 1

1. *Designation*
Details for compiling the designation, including car serial number are stated in Clause **4**.

2. *Rail gauge*
For any car specified for a rail gauge of 2 ft 0 in or 2 ft 6 in, a rail gauge of 2 ft 3 in may be substituted, provided that the body width exceeds the rail gauge by at least 9 in and not more than 12 in.
Where any car is required to run on track having a rail gauge which is not included in Table 1, the width of the underframe should be suitably modified.

3. *Body dimensions*
When designing cars for a capacity between the standard values given in Table 1, the designer should use the dimensions of the nearest suitable standard design, and should adjust the depth only in order to provide the capacity required. Where *increase* in depth is necessary, this should not exceed 4 in, to ensure stability of the car. For the carriage of stone or ores, the standard dimensions of width and length may be used with a reduced dimension for depth, possibly one-half.
Where the top edge of the car body is bent inwards to accommodate external top edge stiffeners, the car capacities as given in Table 1 will be affected.

4. *Height*
The height given in column 7 is the distance from rail level to the top of the car when the car is unladen.

5. *Length over buffers/couplers*
See Figure 1 showing "engagement length" and "full overall length".
The length over buffer couplers is the length over buffers with buffers and drawbars unstrained, or the length between engagement centres in the case of automatic couplings. The distance between two car bodies, when coupler faces are buffed together and the springs are unstrained, is a minimum of 9 in (see columns 7 and 9). Alternatively, in exceptional cases, e.g. wide cars on small radius curves, this distance may be 12 in or 15 in. For vehicles with automatic couplers, the maximum overall disengaged length shall not exceed the engagement length by more than $4^1/_2$ in.

6. *Wheel base*
The wheel base shall be not less than 40 per cent of the body length indicated in column 6.

7. *Track*
Where the track involves small radius curves and steep gradients, details should be stated at the time of the enquiry and order. Care should be taken to ensure that the centre of gravity of the laden vehicle will be appropriate to prevent tipping or overturning.

[a] Indicates car sizes representing general colliery usage in the United Kingdom.

Part 2. Bodies and underframes

Section 1. Bodies

8 General

Bodies shall be of basically rectangular shape and of flat bottom design and shall be welded or riveted, at the option of the purchaser.

Bodies shall be designed and constructed so that there are no sharp edges or projections liable to cause personal injury.

9 Materials

Bodies shall be generally of mild steel to BS 15[1)], but by agreement with the purchaser they may be of accepted corrosion and/or abrasion resisting steels; mild steel galvanized after manufacture; or of aluminium alloy. When aluminium alloys are used the plate shall comply with grade HP 30-WP or HP 30-W of BS 1477[2)] and sections with grade HE 30-WP or HE 30-W of BS 1476[3)].

Galvanizing shall conform to the requirements of BS 729[4)], except that where an alternative thickness of coating is required, it shall be specified in the enquiry and order.

Electrodes for welding mild steel shall comply with the requirements of BS 639[5)]. Filler rods for welding aluminium alloys shall comply with BS 2901[6)], either Part 1 or Part 2 according to the welding process.

Steel rivets shall comply with BS 15[1)]. Aluminium alloy rivets shall be of material to grade HR 30-W of BS 1473[7)].

10 Dimensions

The side, end and bottom plate thickness shall be not less than $^{3}/_{16}$ in. The dimension of angle sections shall conform to BS 4, Part 1[8)].

11 Design and construction

a) ***Basic design requirements***. 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.

The interior of the body shall be free from wheel hoods, well bottoms and corrugations, except that where additional stiffness is required in the longer cars there may be incorporated single centrally disposed corrugations in the side plates.

At all corners, i.e. at the junction of any two planes, there shall be a minimum internal radius of $4^{1}/_{2}$ in.

b) ***Construction***.

i) *Joints*. All joints shall be of the lap or butt welded type, appropriate to particular requirements, the laps being arranged to give maximum protection for user personnel, i.e. side plates shall be on the outside of the joint between sides and bottom, and on the outside of the joint between sides and ends. In welded construction the minimum amount of lap shall be 1 inch and, in riveted construction, equivalent to four times the rivet diameter.

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1) BS 15, *"Mild steel for general structural purposes"*.

2) BS 1477, *"Wrought aluminium and aluminium alloys for general engineering purposes. Plate"*.

3) BS 1476, *"Wrought aluminium and aluminium alloys for general engineering purposes. Bars and sections"*.

4) BS 729, *"Zinc coatings on iron and steel articles"*.

5) BS 639, *"Covered electrodes for the manual metal-arc welding of mild-steel and medium-tensile steel"*.

6) BS 2901, *"Filler rods and wires for inert-gas arc welding"*. Part 1, *"Gas-shielded tungsten-arc welding"*; Part 2, *"Wires for gas-shielded metal-arc welding"*.

7) BS 1473, *"Wrought aluminium and aluminium alloys for general engineering purposes Rivet, bolt and screw stock for forging"*.

8) BS 4, *"Structural steel sections"*. Part 1, *"Hot rolled sections"*.

ii) *Welded construction*. The assembled unit shall be arc welded in accordance with BS 1856[9] or BS 3019[10], Part 1 or BS 3571[11], Part 1 as appropriate.

All welds, both inside and outside, shall be continuous and made with a single pass, the size of the fillet being equivalent to the thickness of the thinnest plate, at the joint.

iii) *Riveted construction*. The plates at the joint shall be firmly drawn together and held by the use of service bolts, there being a service bolt in every third or fourth hole. The pitch of rivets shall be not less than four times the rivet diameter nor greater than 4 in plus four times the plate thickness. On work of this class it is the practice to use $^1/_2$ in diameter rivets conforming to BS 275[12] at a pitch of 4 in to $4^1/_2$ in. The holes for the rivets shall be punched or drilled and shall not exceed the diameter of the rivets by more than $^1/_{16}$ in. The rivets shall be heated uniformly without burning or excessive scaling and shall be of sufficient length to produce a head of the necessary size. The rivet heads inside the body shall be flattened in form and, where extra smoothness is required, they may be countersunk.

iv) *Reinforcement*. The body shall, at the top edge, be reinforced, by one of the following methods:

A. By unequal angle sections continuously welded to the inside, all the way round the body, by the toes of the angles, to form a triangular section, the wider flange being on the underside of the angle section. The welds shall be made with a single pass, the size of each weld being equivalent to the thickness of the plate. The size of the angle shall be normally in accordance with the following dimensions:

Capacity of car	Size of angle stiffener
60 ft^3 up to and including 80 ft^3	3 in × 2 in × $^1/_4$ in
above 80 ft^3 up to and including 200 ft^3	4 in × $2^1/_2$ in × $^1/_4$ in

By agreement between purchaser and manufacturer, the size of the angle may be varied to meet unusual conditions.

B. By folding over the body plates inwards to form an angular section equivalent in size to the appropriate dimensions given above, the wider flange being on the underside and the edge continuously welded.

C. By riveting a rolled steel flat or angle, of adequate strength, all round the outside of the body. Normally these stiffeners should not project beyond the width of the body, the size of the rivets being $^1/_2$ in diameter and pitched at approximately 6 in. This riveting procedure shall be as outlined for the riveting of joints in the body plates.

In any form of reinforcement of the top edge, adequate provision shall be made for continuation of the reinforcements at the vertical joints between the plates.

Section 2. Underframes

12 Materials

The materials shall be mild steel to BS 15[13], Grade 1. Longitudinal members shall be of standard channel section to BS 4[14], Part 1. Other components such as headstocks and intermediate cross members, coupler housings, tippler and retarder brackets, and hornguides shall be formed from rolled steel channel or angle to BS 4[14], Part 1, or of cold rolled steel section to BS 2994[15], or of suitable pressed mild steel section.

Welding electrode materials shall be as specified for the body.

Where false axles are required, they shall be of solid round section steel having a tensile strength within the range of 35/40 tonf/in^2, except that in special cases they may be of rolled steel channel to BS 4[14], Part 1, or of other suitable form.

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[9] BS 1856, *"General requirements for the metal-arc welding of mild steel"*.

[10] BS 3019, *"General recommendations for manual inert-gas tungsten-arc welding"*. Part 1, *"Wrought aluminium, aluminium alloys and magnesium alloys"*.

[11] BS 3571, *"General recommendations for manual inert-gas metal-arc welding"*. Part 1, *Aluminium and aluminium alloys"*.

[12] BS 275, *"Dimensions of rivets ($^1/_2$ in to $1^3/_4$ in diameter)"*.

[13] BS 15, *"Mild steel for general structural purposes"*.

[14] BS 4, *"Structural steel sections"*. Part 1, *"Hot-rolled sections"*.

[15] BS 2994, *"Cold rolled steel sections"*.

13 Design and construction

a) ***Basic design requirements***. The underframes shall be of rigid welded design, suitable for carrying the maximum payload imposed by the respective body capacities, and shall be suitable for adequately absorbing, without permanent deformation, the severe forces imposed upon them in normal service. The principal load carrying members are the longitudinal members referred to as "solebars"; the size of channel section shall be based upon the load to be carried and shall take into consideration the type of suspension gear used (see Clause **26**), also the type of coupling and buffing gear to be fitted (see Clause **28**).

b) ***Construction***. The underframe shall be of all-welded construction and built up from two rolled steel channel solebars, with suitable headstocks and crossbars positioned to suit coupling requirements and connecting the solebars and coupler housings. For cars above 80 ft^3 capacity and up to and including 200 ft^3, additional cross-members shall be positioned in the frame, the ends of the members being connected to the solebars. False axles shall be carried through their anchorage members, to provide mechanical interference between the mating parts such that the securing welds are relieved of shear stress when in operation.

Welding shall be carried out in accordance with BS 1856[16)]. All welds, where practicable, shall be made in the flat position, shall be continuous, and be of adequate strength to meet service conditions.

Tippler engagement and retarder brackets, where required, shall be securely fastened to the longitudinal members. (For details of the components, see Clause **37**).

Where the suspension requires horn guides, these shall be securely welded to the underframe. The design of horn guides is subject to variation according to the type of suspension used. A typical illustration of horn guides for use with laminated springs, and/or rubber block springing, is shown in Figure 2 and Figure 3.

Mine cars which are to be mechanically engaged by rams, creepers or retarders shall be fitted with false axles located as near to the car axles as practicable. The false axles shall, where practicable, be welded directly to the outer horn guide brackets. Where the position of the false axles makes it impracticable to fix them to the horn guide brackets, suitable separate brackets shall be provided. False axles shall be positioned to give the specified minimum clearance between the underside of these members and the head of the rail, when the cars are unladen.

All components shall be accurately made to templates, and positioned in a locating jig, to ensure that other components such as wheels, axles and axle-boxes, and coupler units can be interchangeably fitted after welding operations have been carried out, also to ensure that any future replacements for these items can be fitted and that they will operate satisfactorily.

Section 3. Attachment of body to underframe

14 Method of attachment

Bodies shall be either welded or riveted to the underframes, at the option of the purchaser and, in either method of attachment, the joint formed shall be of adequate strength in relation to the pulling and buffing loads likely to be met in service.

a) ***Welding.*** Welding electrode materials shall be as specified for the body.

The operation of welding shall be performed in the flat position, and the welds shall be of the fillet type, the size of the fillet being equivalent to the thickness of the body bottom plate. Welding shall be carried out in accordance with BS 1856[16)], or BS 3019[17)], Part 1, or BS 3571[18)], Part 1, as appropriate.

At the discretion of the manufacturer, or as required by the purchaser, welds may be continuous or intermittent, being evenly positioned along the edges of the solebars, headstocks and crossbars, to spread the shearing stresses set up in service.

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16) BS 1856, *"General requirements for the metal-arc welding of mild steel"*.

17) BS 3019, *"General recommendations for manual inert-gas tungsten-arc welding"*. Part 1, *"Wrought aluminium, aluminium alloys and magnesium alloys"*.

18) BS 3571, *"General recommendations for manual inert-gas metal-arc welding"*. Part 1, *"Aluminium and aluminium alloys"*.

b) ***Riveting.*** Steel rivets shall comply with BS 15[19] and be of a diameter not less than $^{5}/_{8}$ in; the holes in the body and frame shall be not more than $^{1}/_{16}$ in greater than the rivet diameter.

The rivets shall be positioned along the solebars, headstocks and crossbars to spread the shearing stresses set up by the pulling and buffing impacts met in service.

The rivet heads may have a flattened form inside the body, or may be countersunk, at the option of the purchaser.

c) ***Angle cleats.*** If preferred, the body may be attached to the frame by means of angle cleats welded or riveted to the body and riveted to the webs of the frame channel members.

d) ***Insulation — aluminium/steel.*** Where an aluminium alloy body is to be attached to a mild steel underframe, these components shall be insulated from each other to avoid galvanic corrosion. Steel rivets shall be used and, before riveting, the holes in the aluminium alloy members shall be treated with a suitable insulating material, such as a phosphoric acid type etch primer. After the rivet has been driven, the head of the rivet and surrounding metal shall be thoroughly cleaned and coated with insulating material.

[19] BS 15, *"Mild steel for general structural purposes".*

Part 3. Wheels and axles

Section 1. Wheels

15 Materials and mechanical properties

a) ***Cast wheels.*** The materials for castings shall be selected from the range specified below:

i) *Carbon steel castings:* BS 592[20], Grade C.

ii) *Pearlitic manganese steel castings:* BS 1456[20], Grade B.

iii) *Austenitic manganese steel castings:* BS 1457[20], (11 per cent manganese, minimum. Initial hardness 229 HB maximum).

Where mechanical tests[21] 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.

b) ***Forged wheels.*** The materials for forgings shall be selected from the range specified below:

i) BS 970[22]; 080A35, 080A37, 080A40, 080A42 or 080M46, for wheels "as forged", and having a tread profile hardness within the range 152/223HB.

ii) BS 970[22]; 080A40, for wheels through hardened and tempered, and having a hardness within the range 201/255HB.

iii) BS 970[22]; 080A32, for wheels locally hardened on the tread profile, and having a tread hardness within the range 201/255HB.

16 Dimensions and weights

The wheel diameter is the diameter measured at the root of the flange, i.e. where the tread meets the radius between tread and flange (see Figure 4 and Figure 5).

The dimensions of wheels shall comply with Figure 4 or Figure 5, as appropriate.

17 Heat treatment of cast wheels

a) ***Carbon steel and pearlitic manganese steel castings.*** All castings shall be supplied suitably heat treated to give the required mechanical properties specified in the relevant standard. The method of heat treatment shall be at the discretion of the manufacturer, unless otherwise stipulated by the purchaser.

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.

18 Fettling and dressing

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

19 Freedom from defects

All castings shall be free from cracks and other injurious defects.

20 Rectification of castings

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

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[20] Contained in the composite Standard BS 3100, *"Steel castings for general engineering purposes"*.

[21] For austenitic manganese steel, mechanical tests, where required, will be limited to bend tests, the details being agreed between purchaser and manufacturer.

[22] BS 970, *"Wrought steels (Blooms, billets, bars and forgings)"*.

21 Eccentricity in the machined condition

The wheel tread profile shall be machined smooth. The eccentricity of the wheel tread, when rotated about the axle or journal centre shall not exceed ± 0.010 in[23] when measured on radius.

22 Marking

Each wheel shall have the following information cast or forged in recessed characters of a size not less than $^3/_8$ in, in the back of the flange:

i) The manufacturer's identification mark.

ii) The letters "C", "PM", "M" or "F" to indicate carbon steel, 1.5 per cent manganese steel, austenitic manganese steel or forged steel respectively.

Section 2. Axles

23 Materials

a) ***Quality.*** Axles shall be made from rolled or forged steel and shall have not less than the following mechanical properties:

Tensile strength	35 tonf/in^2
Elongation	13 per cent

A steel complying with BS 970[24], 080M40 (normalized condition) is suitable for this purpose.

b) When tests are required by the purchaser, this shall be stated in the enquiry and order. One per cent of the axle bars shall in such case be selected at random from the bulk, for testing purposes. Test pieces shall conform to BS 18[25], Table 1 (gauge length = 5.65 $\sqrt{S_o}$) and shall exhibit the above properties.

24 Dimensions

Axles shall comply with the dimensions stated in Figure 6.

Section 3. Wheel and axle assemblies

25 Wheel and axle assemblies

a) ***Wheel bearings.*** The wheels shall be provided with tapered roller bearings of adequate capacity to withstand the axial and radial loads likely to be encountered in service. Dimensions and capacity ratings of a suitable range are given in Table 2 and Appendix A.

The bearings shall be packed with a suitable lime or lithium based grease.

Table 2 — Wheel, axle and bearing sizes

Total laden weight	Recommended wheel dia.	Axle dia	Journal dia.	Bearing		
				Bore	O/dia.	Abutment width
ton	in	in	in	in	in	in
5	12 or 14	$2^1/_2$	$2^1/_4$	$2^1/_4$	$4^1/_4$	$1^3/_{32}$
$4^1/_2$	12 or 14	$2^3/_4$	$2^1/_2$	$2^1/_2$	$4^7/_{16}$	$1^3/_{16}$
6	14	3	$2^3/_4$	$2^3/_4$	$4^7/_8$	$1^3/_{16}$
$7^1/_2$	14	$3^1/_4$	3	3	$5^1/_2$	$1^7/_{16}$
$9^1/_2$	14	$3^1/_2$	$3^1/_4$	$3^1/_4$	$5^1/_2$	$1^7/_{16}$
$11^1/_2$	14	$3^3/_4$	$3^1/_2$	$3^1/_2$	6	$1^9/_{16}$

[23] In the case of austenitic steel to BS 1457 (contained in the composite standard BS 3100, *"Steel castings for general engineering purposes"*), the wheel tread profile shall be ground and this tolerance may be increased to ± 0.020 in.

[24] BS 970, *"Wrought steels (Blooms, billets, bars and forgings)"*.

[25] BS 18, *"Methods for tensile testing of metals"*.

NOTE 1 The bearing sizes given in the above table are for bearings in general use with existing mine car designs and for use as replacement bearings.
For new designs, attention is drawn to the table in Appendix A which gives selected bearings from BS 3134[26].
NOTE 2 For total laden weights above this range, the design should be subject to agreement between manufacturer and purchaser.

b) ***Assemblies.*** Wheels and axles shall be assembled as shown in Figure 7. The axles shall be machined to provide the appropriate journal for the wheel bearings and axle boxes (see Figure 8), and the ends of the axle shall be threaded to provide for the fitting of suitable circular retaining nuts, each secured by means of a standard split pin. The wheel and axle assembly shall be closed at its outer ends by means of steel or malleable iron hub caps (see Figure 9), each retained in position by means of a spring circlip complying with BS 3673[27] and fitted with a suitable "O" ring complying with BS 1806[28]. On the inside of the assembly, labyrinth seals or, alternatively, metal insert seals of appropriate design shall be fitted, each retained in position by means of a mild steel thrust collar of suitable fit on the axle.

[26] BS 3134, *"Dimensions of tapered roller bearings"*.

[27] BS 3673, *"Spring retaining rings"*. Part 1, *"Carbon steel circlips"*.

[28] BS 1806, *"Dimensions of toroidal sealing rings* ("O" seals and their housings)".

Part 4. Suspension gear

26 General design and construction

a) ***General.*** The method of suspension shall be by one of the following methods as agreed between manufacturer and purchaser in the enquiry and order:

i) Steel laminated or helical springs.

ii) Combination springs of steel and rubber.

iii) Rubber blocks.

iv) Rubber shear/compression devices.

The purchaser shall supply to the manufacturer, at the time of enquiry and order, full details of the track and operating conditions (e.g. average rail length, gradients, curve radii, acceleration, deceleration, running speeds, and any special operating factors) to be catered for in the design.

b) ***Principles and requirements of design.***

i) *Principles.* It is recommended that the manufacturer should, on the information supplied by the purchaser, so design the suspension that the oscillations induced in operation are clear of any critical frequencies. The component parts should be designed for adequate life in fatigue, due allowance being made for the dynamic loads induced by service conditions.

All component parts shall be interchangeable and be so designed that assembly can be effected without the use of special tools and that maintenance, repair and replacement may easily be accomplished.

Component parts normally should not be "handed"; but where "handing" is unavoidable, the component should, where possible, be so designed that incorrect assembly is either impracticable or patently obvious.

ii) *Steel springs.* Steel springs may be of the simple (straight line load/deflection curve) or differential (compounded straight line load/deflection curve) type.

iii) *Rubber springs.* Rubber spring components, whether of the direct compression or shear/compression type, may be bonded to suitable steel locating plates.

iv) *Horn guides.* Horn guides shall be steel castings, or fabricated from plate or rolled sections and preferably welded to, and forming part of the underframes. Bearing faces of cast steel horn guides shall be machined.

v) *Axle boxes.* Axle boxes may be cast or fabricated and provision should be made in the design to secure the axle against rotation when used with rubber suspension. The bores of the axle boxes should be machined. Where rubber block springing is used, the external shape of the axle box may need to be modified.

c) ***Materials.***

i) Cast horn guides and axle boxes shall be made of materials which comply with BS 592[29] Grade C.

ii) Fabricated horn guides and axle boxes, keep plates, and rubber-spring locating plates, shall comply with BS 15[30] Grade 1.

d) ***Welding.*** Welding shall be by gas or electric-arc, in accordance with BS 693[31] or BS 1856[32] respectively.

e) ***Assembly.*** Before final assembly the leaf contact faces of laminated steel springs shall be suitably lubricated.

For protection against corrosion during transit, metal parts shall be given a coat of transparent lacquer, or other suitable protective coating.

f) ***Marking.*** The following details shall be stamped on the buckle of laminated steel springs, or on the end coil of helical springs.

i) The makers' trade name or identification mark.

ii) Type number, i.e. the maximum static weight in cwts for which the spring unit has been designed.

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[29] Contained in the composite Standard BS 3100, *"Steel castings for general engineering purposes"*.

[30] BS 15, *"Mild steel for general structural purposes"*.

[31] BS 693, *"General requirements for the oxy-acetylene welding of mild steel"*.

[32] BS 1856, *"General requirements for metal-arc welding of mild steel"*.

iii) Date of manufacture.

iv) Patent No. (if applicable).

In the case of coil springs, and where space is limited, the marking need only be sufficient to allow subsequent identification of the supplier and the date of manufacture.

g) ***Proof testing.*** Not less than five samples shall be selected from each lot of 50 spring assemblies, or from each manufacturing batch if less than 50, for proof testing.

Each complete spring assembly to be tested shall be suitably mounted in a loading device of known operating characteristics and then progressively loaded, in predetermined steps, to not less than the maximum designed load; the deflection being measured at each progressive step of the applied load. The results shall be compared with the design curve included in the tender.

The springs shall be deemed to comply with the contract if the observed results lie within ± 5 per cent of the design curve figures.

Where the test results show random scatter in excess of ± 5 per cent of the design figure the springs shall be deemed not to comply with this specification.

27 Springs

a) ***Rubber springs.*** Rubber suspension springs shall comply with the following requirements:

i) *Material.* Either natural or synthetic rubber may be used.

If of natural rubber, the compound shall consist of the base elastomer and carbon black, together with the necessary processing and curing agents. It shall be free from reclaim, crumb or inorganic filler and shall be compounded for good resilience and low set characteristics.

Rubber springs shall be fire, oil and acid resistant.

NOTE Where mine waters are highly alkaline or highly acidic it is recommended that the purchaser should notify the manufacturer to this effect, in order that the rubber compounder may take appropriate action at the time of manufacture.

ii) *Marking.* The following details shall be moulded on the rubber elements:

A. Part number, or other indication of rated load.

B. Manufacturer's trade mark.

C. Symbol of date of manufacture.

iii) *Load deflection.* Tests shall be taken, by the manufacturers, on each design of rubber spring pack to prove the declared load-deflection characteristics.

The tests shall be as follows:

In order to condition the rubber, the spring packs shall be loaded by at least three applications of the test load, applied as rapidly as possible. The test load shall be not less than twice the normal static load.

The test load shall then be applied again to the spring packs and the deflections from the free positions noted. The deflections at the static load should also be noted and the spring packs shall be deemed to comply with the specification if they are within ± 15 per cent of the specified deflections at the static load.

Alternatively, at the option of the manufacturer, the same test, but using a given deflection, can be carried out.

Where rubber pads are bonded to steel plates the load shall be held for not less than 20 seconds while the bond is inspected. The bond shall show no sign of defect.

No marginal tolerances are permissible.

iv) *Design testing.* The manufacturer shall conduct tests on each design to satisfy the purchaser that the design fulfills the declared characteristics. Also, the manufacturer shall include in his tender a design copy of the load/deflection graph for the springs which he proposes to supply.

v) *Sample testing.* If requested by the purchaser, at the enquiry stage, static tests shall be taken on one per cent of the components supplied, to verify uniformity of the rubber and/or bonding.

b) ***Steel laminated springs.*** The material for the spring leaves shall comply with, at least, BS 970[33], 250A61; water hardening steel shall not be used.

The material for the buckles shall comply with Grade 9 of BS 24[34], Part 3A.

The material for the rivets shall comply with Grade 651 of BS 24[34], Part 6.

i) *General requirements.*

A. All burrs shall be removed from the ends of each leaf.

B. All rivet holes shall be countersunk, on the tension side of each leaf, to a depth of $^{1}/_{16}$ in (1.6 mm) at 45°.

C. Buckles, which shall be of the solid type, shall be hot pressed on to the springs (simultaneously on all four sides) when assembled, to ensure a tight fit. Any welding shall be confined to the boss only. Rivet holes shall be countersunk and finished flush, in order that the pedestal stool shall have full bearing area.

D. Where specified by the purchaser and agreed by the manufacturer, the springs shall be given anti-corrosion treatment.

ii) *Decarburization.* Decarburization of the surface (total plus partial) shall not exceed a depth of 0.010 in (0.25 mm). Total decarburization shall not exceed a depth of 0.002 in (0.05 mm).

iii) *Hardness.* Each spring leaf shall have a Brinell hardness within the range 388/444HB; this shall be checked on the compression side of the leaf.

iv) *Bend test (fracture).* Sample tempered leaves shall be checked in a bend test, as follows:

Up to and including 0.36 in (9.14 mm) thick: bend around a centrally applied $^{1}/_{2}$ in (12.70 mm) diameter pin.

Over 0.36 in (9.14 mm) thick: bend around a centrally applied $^{3}/_{4}$ in (19.05 mm) diameter pin.

Each sample shall bend 35° without fracture, when tested between 10 in (254 mm) support centres; or, alternatively, shall bend 25° without fracture when tested between 6 in (152 mm) support centres (see Appendix C).

c) ***Steel coil springs.*** Steel coil springs shall comply with BS 24[22], Part 3B Helical and volute springs and spring steels.

[33] BS 970, *"Wrought steels (Blooms, billets, bars and forgings)".*

[34] BS 24, *"Railway rolling stock material".* Part 3A, *"Laminated springs and spring steels"*; Part 3B, *"Helical and volute springs and spring steels"* and Part 6, *"Steel slabs, plates, sections, bars and rivets".*

Part 5. Coupler and buffer gear (including coupler housings)

28 General design

Mineral haulage drawgear for heavy rolling stock shall preferably consist of central combination buffer coupling units, so resilient in action as to absorb service shocks under both pulling and buffing loads.

When built into the underframes of the rolling stock the units or terminal elements shall be able to articulate in any required direction so as to accommodate the relative movement or changes of gradient and curves.

All buffer and drawgear components should be of simple design, should avoid sudden changes of section thickness and/or shape, and have adequate strength to withstand service conditions associated with the operation of underground mineral haulage trains.

The drawbar and buffer heads, when completed, should have a higher static strength than the connecting components, if any. Such connecting components should be securely fastened to the main unit and be easily replaceable.

Safety of operation is of the utmost importance and it is essential that the buffer coupling units fitted are designed against accidental uncoupling.

It is recommended that, for couplers using steel springs, stops should be arranged either in the buffer coupler unit itself, or in the underframe, to safe-guard against the resilient units being stressed beyond their rated capacity. Where rubber drawgear units are used, stops are not normally recommended.

In constructing the underframes care shall be taken to ensure that the necessary working clearances between the coupler assemblies and frame housing are correct for the design and in accordance with the requirements and recommendations laid down by the coupler manufacturers, to ensure safe and satisfactory operation.

The coupler housing and drawgear retaining components incorporated in the underframe shall be so arranged as to facilitate easy removal of the complete buffer coupling unit, for servicing.

The tensile and compressive strength of the coupler housing and drawgear retaining components shall be greater than the rated ultimate capacity of the coupler and drawgear unit.

The type and size of couplers to be used on any installation of cars shall be agreed between manufacturer and purchaser. (See Appendix B.)

29 Materials

Materials shall be at the discretion of the manufacturer, with the exception of the following:

Components	Materials
a) Cast components (fully stressed).	Castings complying with BS 2772[a], Part 3. In the case of special applications an alloy steel having a tensile strength of 40 tonf/in^2 (min) may be used, as agreed between purchaser and manufacturer.
b) i) Forged components (fully stressed).	Forgings complying with BS 2772[a], Part 2. 1.5 per cent manganese steel or steel having a tensile strength within the range of 50/70 tonf/in^2.
ii) Other forged components.	Forgings complying with BS 970[b], 080M40.
c) Non-fully stressed components.	Mild steel complying with BS 970[b], 070M20. Other materials complying with appropriate British Standards.
d) Shock absorbing components.	i) Steel coil springs shall comply with BS 24[c], Part 3B, the precise grade(s) to be agreed between manufacturer and purchaser.
	ii) Steel laminated springs iii) Rubber springs } shall comply with Clause **27** of this specification.

NOTE In the above context, "fully stressed" components are those which, in service, are liable to sustain maximum loads.

[a] BS 2772, *"Iron and steel for colliery haulage and winding equipment"*. Part 2, *"Wrought steel"* and Part 3, *"1.5 per cent manganese steel castings for mine car couplers"*.

[b] BS 970, *"Wrought steels (Blooms, billets, bars and forgings)"*.

[c] BS 24, *"Railway rolling stock material"*. Part 3B, *"Helical and volute springs and spring steels"*.

30 Construction

All welding of components of buffer couplings shall be carried out by one or other of the following methods:

i) Automatic flash welding.

ii) Atomic hydrogen welding.

iii) Inert-gas arc welding.

It shall be the responsibility of the manufacturer to select, from the list above, a method suitable to the size of material to be joined. It shall also be the responsibility of the manufacturer to ensure that such method of welding is suitable to the material, and that the technique is kept under adequate control. The weld shall be smoothly finished all round and care shall be taken to ensure a sound and homogeneous weld throughout the section.

All welding of castings shall comply with BS 2772[35)], Part 3.

In the case of automatic flash welding, there shall be no forging back of any precipitated metal, which should be removed to provide a smooth finish without undercut.

Inert-gas arc welding is also permissible for welding elements into place, and where failure of the weld would have no adverse effect on the strength of the drawgear.

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

31 Heat treatment

Heat treatment shall be in accordance with the requirements of the following British Standards:

Forgings: BS 2772[a], Part 2.

Castings: BS 2772[a] Part 3, or as appropriate when alloy steel castings are used. [See item a) of Clause **29**.]

[a] BS 2772, *"Iron and steel for colliery haulage and winding equipment"*. Part 2, *"Wrought steel"*, and Part 3, *"1.5 per cent manganese steel castings for mine car couplers"*.

32 Rectification of castings

a) ***Approval.*** It shall be agreed between manufacturer and purchaser, at the time of inquiry and order, which of the following conditions shall apply:

i) No castings shall be rectified or welded.

ii) No castings shall be rectified or welded without the previous sanction of the purchaser or his representative.

iii) Castings may be rectified by welding where the manufacturer is able by so doing to provide a sound casting.

b) ***Welding.*** All welding shall be carried out in accordance with Appendix B of BS 2772[35)], Part 3.

Castings shall normally be welded in the heat treated condition and sub-sequently stress relieved at a temperature lower than the tempering temperature, but not more than 50 degC lower.

33 Workmanship

The finishing of holes in drawgear components shall be by drilling or coring; if initial punching is carried out, this shall not cause any fault in the finished edges of the hole.

34 Testing of coupler assemblies

a) ***Routine destruction test.*** The manufacturer shall test to progressive destruction one coupler from each production batch of 200 and shall produce, on request by the purchaser, a certificate to this effect, giving the details of load applied. All coupler assemblies so tested shall withstand an ultimate breaking load of at least eight times the rated static working load.

[35)] BS 2772, *"Iron and steel for colliery haulage and winding equipment"*. Part 2, *"Wrought steel"*, and Part 3, *"1.5 per cent manganese steel castings for mine car couplers"*.

b) ***Proof test***. If required by the purchaser, 1 per cent of the couplers in each order shall be proof tested to $2^1/_2$ times the static working load and under such test no component shall register permanent extension in excess of 3 per cent in length and/or 1 per cent deformation in width.

c) ***Additional tests (optional).*** If required by the purchaser, and specified in the enquiry and order, two sample couplers shall be selected by the representative of the purchaser and shall be tested to progressive destruction.

Where required by the purchaser, and specified in the enquiry and order, magnetic crack detection testing and radiographic examination shall be performed on the components, and a certificate or report shall be provided to the purchaser.

35 Coupler operating gear

Where couplers are fitted with operating gear the following features shall be observed:

a) Each coupler shall be provided with a suitable operating gear which shall be positive in action and be constructed to lock in both the engaged and disengaged positions. It shall be so designed and constructed as to ensure full articulation of the coupler without constraint.

b) All parts shall be of sufficient rigidity and cross-sectional area to maintain their relative positions and designed functions throughout the estimated life of the car.

c) All pin joints and fulcrums shall be designed to avoid twisting and binding in operation. All bearings shall be designed to maintain uniform loading throughout the system and to ensure smoothness of action, in order that the operator may immediately sense any malfunction in the mechanism.

d) Means may be incorporated in the mechanism to effect any adjustment of the system necessary to ensure proper operation, or to take up slackness due to wear. Adjusting units shall be capable of being locked at the setting position, and be shakeproof.

e) Where springs are incorporated in the design they shall be of the coil type and operate in compression. Means shall be provided in the spring mounting to contain the spring in the event of failure, so that any loss of effort is confined to a minimum number of coils.

f) The operating handles shall be situated at the ends of the car and be readily accessible from either side of the track. They shall be positioned at waist level (approximately 3 ft 6 in above sleeper level) and at a distance of not more than 1 ft 0 in inward from the side of the car body. They shall be sufficiently clear of the car body and shields, and be so designed, as to provide a good handhold without the possibility of the operator becoming trapped or sustaining injury. At no time shall the handles protrude beyond the side of the car.

g) The operating gear shall, as far as is practicable, be covered by guard plates having thickness of not less than $^1/_4$ in. The plates shall be sufficiently stayed and secured to the body, to ensure that the gear is fully protected against incipient malfunction due to incidental damage. Plates shall be removable for inspection and maintenance purposes.

h) Engagement and fulcrum brackets shall be secured to the body by positive and shakeproof means, e.g. where bolts are used for this purpose they shall be provided with either self-locking nuts or other means of locking acceptable to the purchaser.

j) All joints and fulcrum points of the system shall be provided with means of lubrication.

k) Eyebolts shall be solid forged; shackles and pins shall comply with BS 3032[36)].

l) Where chains are incorporated in the design they shall be in accordance with BS 1663[37)]. Where possible, means shall be provided to maintain them in tension at all positions of operation, but at no time shall there be slackness in excess of that necessary to ensure safe operation.

NOTE 1 Maintenance of operating gear should be given high priority when the cars are in service; where coupler manufacturers issue special instructions these should be rigidly adhered to, in order to ensure the highest degree of operational efficiency, and safety to personnel.

The engagement and fulcrum brackets should be so positioned on the end of the car that they permit of no interference of the operating handle with the operating handle of a mating car, when in a train and on a track curve with the cars in both the drawn and buffed conditions.

[36)] BS 3032, *"Higher tensile steel shackles"*.

[37)] BS 1663, *"Higher tensile steel chain Grade 40 (short link and pitched or calibrated) for lifting purposes"*.

NOTE 2 With varying designs of automatic couplers the space available between ends of cars may best be determined by a scale diagrammatic set-out of coupled cars on the most adverse track curve to be negotiated.

36 Inspection

All coupler operating gear supplied in accordance with this specification shall be inspected by the manufacturer to ensure that the designed functions, clearances, engagements and operating features comply with the intent and purpose of the design.

On the written application of the purchaser the manufacturer shall provide full facilities permitting the purchaser's engineer to inspect such proportion of the order as may be deemed necessary. The facilities provided shall include provision for inspection when in train and at maximum angles of articulation.

Part 6. Ancillary requirements

37 Engagement brackets

a) ***Tippler and/or retarder brackets.*** Where required, brackets shall be incorporated in the underframe for engagement with tipplers and/or brake type retarders. Typical arrangements are shown in Figure 2 and Figure 3.

The brackets shall be so designed and constructed as to provide mechanical contact between the component parts, in order to relieve the welding of undue stress during use. To ensure correct positioning and alignment it is recommended that bracket dimensions and positions be checked by means of suitable gauges.

b) ***Ram and/or creeper brackets.*** Where cars are to be mechanically engaged underneath by rams and/or creepers, they shall be fitted, for this purpose, with cross members which shall be located adjacent to and parallel with the main axles. Unless otherwise specified the cross members shall be constructed from either round solid or tubular section material.

The section adopted shall be of adequate strength to sustain, without permanent deformation, the repeated application of the accelerating and decelerating forces of the rams, throughout the estimated life of the car. The ends of the cross members shall pass through the horn guide plates, or other attachment, in order that mechanical interference shall be maintained and that the securing means be relieved of any undue stresses due to impact.

38 Brakes

Hand brakes, where fitted, shall be for parking purposes only, and shall be adequate for such duty and gradient as shall be agreed between manufacturer and purchaser. The hand lever will normally be at the end of the car and shall be so designed and located as to avoid possible injury to the operator. Provision shall be made to include an adequate operating lever locking device to ensure that, when applied, the brakes cannot become accidentally released. A locking device shall also be included to ensure that when the hand lever is in the OFF position, no brake trailing occurs.

The general design of the brake operating system shall be so arranged that the overall mechanical advantage will remain as constant as possible throughout the travel of the handlever and that all unnecessary changes of direction in the linkage are eliminated, thus ensuring minimum dissemination of effort, and maximum maintenance of overall efficiency.

Where springs are used in the system they shall, where possible, be of the compression type and be so arranged as to fail to safety, i.e. with the brakes in the ON position.

Arrangements are to be included for making adjustments to compensate for service wear of the brake shoes; the various brake components shall be of adequate strength to avoid undue deformation under service conditions. All working parts, where necessary, shall be protected against incidental damage, and be provided with adequate means of lubrication.

All components such as brake handles, guards, levers, links, pull rods and beams shall be made from mild steel which is not of inferior quality to BS 970[38], 040A12, or from an equivalent quality of plate, sheet or strip to BS 1449[39] (as appropriate.)

Brake shoes or blocks shall be made from grey cast iron which is of a quality not inferior to BS 1452[40], Grade 12, or alloy cast iron, or other suitable material as may be agreed between manufacturer and purchaser.

All materials shall comply with the relevant British Standard or be of an equivalent grade and quality, as agreed between purchaser and supplier.

The 3-in minimum clearance above rail level stipulated in the notes in Table 1 shall also apply to the components of any brake fitted.

39 Identification plates

a) A plate showing the maker's name and car reference number shall be secured to the outside of one of the longitudinal members of the underframe.

b) A plate showing the colliery reference number with 3-in high figures shall be attached on each end of the body, near the side. Alternatively, this reference number may be formed by welding.

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[38] BS 970, *"Wrought steels (Blooms, billets, bars and forgings)".*

[39] BS 1449, *"Steel plate, sheet and strip".*

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

Appendix A British Standard bearings

Total laden weight	Recommended wheel dia.	*B*[a] dia.	*A*[a] dia.	Bearings to BS 3134[b]		
				Cone bore	Cup outside dia.	Abutment width
ton	in	in	in	in	in	in
3	12 or 14	$2^1/_2$	$2^1/_4$	2.25	4.125	1.1875
$4^1/_2$	12 or 14	$2^3/_4$	$2^1/_2$	2.50	4.4375	1.1875
6	14	3	$2^3/_4$	2.75	5.0	1.4375
$7^1/_2$	14	$3^1/_4$	3	3.0	5.5115	1.4375
$9^1/_2$	14	$3^1/_2$	$3^1/_4$	3.25[c]	5.5115[c]	1.4375[c]
$11^1/_2$	14	$3^3/_4$	$3^1/_2$	3.50	6.0	1.5625

[a] The dimensions in these two columns relate to Figure 6.
[b] BS 3134, *"Dimensions of tapered roller bearings"*.
[c] This size of bearing is not included in BS 3134.

Appendix B Strength of coupler

The ultimate tensile breaking load shall be not less than the value obtained from the following formula:

$L = 5\ W\ (\sin \alpha + 0.125 \cos \alpha)$

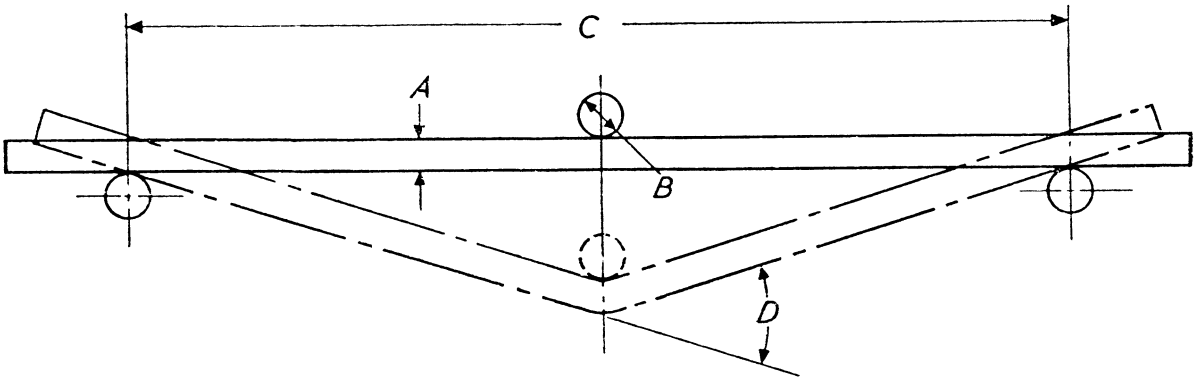
where L = Ultimate tensile breaking load (tons)
W = Dead weight of the train (tons)
α = Maximum angle of track to the horizontal.

For main and tail haulage, the strength of the coupler shall be not less than the nominal breaking strength of the strongest rope in the installation.

In the case of cars used in conjunction with locomotives, the minimum tensile breaking load of the drawgear of the attached rolling stock shall be not less than twice the weight on the driving wheels of the locomotive, or loco-motives, where two are used in tandem for tight couplings, or $2^1/_2$ times that weight in the case of loose couplings. The minimum tensile breaking load of the drawgear of the locomotive itself shall never be less than $2^1/_2$ times the weight on the driving wheels of the locomotive, or locomotives, where two are used in tandem.

Tight couplings are any couplings which incorporate spring-type drawgear and which have a designed clearance of not more than 2 inches between the buffing faces.

Appendix C Details of leaf bend test for mine car springs [See Subclause **27** b) iv)]



Thickness of sample leaf *A*			Central pin diameter *B*		Support centres *C*		Bend angle without fracture *D*
	in	mm	in	mm	in	mm	
Up to and including					10	254.0	35°
	0.36	9.1	0.50	12.70	6	152.4	25°
Over	0.36	9.1	0.75	19.05	10	254.0	35°
					6	152.4	25°

Appendix D

Metric equivalents

in	mm	in	mm	in	mm
0.01	0.25	2	50.80	6	152.40
0.02	0.50	$2^{1}/_{4}$	57.15	$6^{1}/_{4}$	158.75
0.12	3.04	$2^{3}/_{8}$	60.36	$6^{3}/_{8}$	161.92
0.15	3.81	$2^{1}/_{2}$	63.50	$6^{5}/_{8}$	168.27
		$2^{5}/_{8}$	66.67	$6^{3}/_{4}$	171.45
$^{1}/_{16}$	1.58	$2^{3}/_{4}$	69.85	$6^{7}/_{8}$	174.62
$^{3}/_{16}$	4.76	$2^{7}/_{8}$	73.02		
$^{1}/_{4}$	6.35			$7^{1}/_{8}$	180.97
$^{5}/_{16}$	7.93	3	76.20	$7^{1}/_{2}$	190.50
$^{3}/_{8}$	9.52	$3^{1}/_{8}$	79.37		
$^{13}/_{32}$	10.31	$3^{1}/_{4}$	82.55	8	203.20
$^{7}/_{16}$	11.11	$3^{3}/_{8}$	85.72		
$^{1}/_{2}$	12.70	$3^{1}/_{2}$	88.90	9	228.60
$^{9}/_{16}$	14.29	$3^{5}/_{8}$	92.07	$9^{3}/_{4}$	247.65
$^{5}/_{8}$	15.87	$3^{3}/_{4}$	95.25		
$^{11}/_{16}$	17.46			12	304.80
$^{3}/_{4}$	19.05	4	101.60	$12^{3}/_{4}$	323.85
$^{13}/_{16}$	20.64	$4^{1}/_{4}$	107.95		
$^{7}/_{8}$	22.22	$4^{3}/_{8}$	111.12	14	355.60
$^{15}/_{16}$	23.81	$4^{7}/_{16}$	112.71	$14^{1}/_{4}$	361.95
		$4^{1}/_{2}$	114.30	$14^{3}/_{4}$	374.65
1	25.40	$4^{7}/_{8}$	123.82		
$1^{3}/_{32}$	27.78			15	381.00
$1^{1}/_{8}$	28.57	5	127.00		
$1^{3}/_{16}$	30.16	$5^{3}/_{8}$	136.52	$16^{1}/_{4}$	412.75
$1^{1}/_{4}$	31.75	$5^{1}/_{2}$	139.70	$16^{3}/_{4}$	425.45
$1^{3}/_{8}$	34.92	$5^{11}/_{16}$	144.46		
$1^{7}/_{16}$	36.51	$5^{3}/_{4}$	146.05	18	457.20
$1^{9}/_{16}$	39.69				
$1^{3}/_{4}$	14.45				
$1^{7}/_{8}$	47.62				

Metric equivalents

ft	in	m
1	0	0.3
2	0	0.61
2	3	0.69
2	6	0.76
2	8	0.81
2	9	0.84
2	10	0.86
3	0	0.91
3	2	0.97
3	3	0.99
3	4	1.02
3	6	1.07
3	8	1.12
3	$8^3/_4$	1.14
3	9	1.14
3	10	1.17
3	$10^3/_4$	1.19
3	$11^3/_4$	1.21
4	0	1.22
4	$0^3/_4$	1.24
4	$1^3/_4$	1.27
4	2	1.27
4	$2^3/_4$	1.29
4	3	1.3
4	$4^3/_4$	1.34
4	6	1.37
4	$6^3/_4$	1.39
4	$7^3/_4$	1.42
4	$8^3/_4$	1.44
4	$10^3/_4$	1.49
5	0	1.52
5	$0^3/_4$	1.54
5	$2^3/_4$	1.6
5	6	1.7
5	$6^3/_4$	1.7
6	3	1.9

ft	in	m
7	0	2.13
7	3	2.21
8	0	2.44
8	3	2.51
9	0	2.74
9	3	2.82
10	0	3.05
10	3	3.12
11	0	3.35
11	3	3.43
12	0	3.66
12	3	3.73
13	0	3.96
13	3	4.04
14	0	4.27

ft^3	m^3
102	2.89
103	2.92
104	2.95
120	3.4
121	3.43
122	3.46
123	3.48
124	3.5
128	3.62
134	3.8
138	3.92
160	4.53
162	4.6
165	4.67
200	5.66
201	5.7

lb	kg
10.22	4.6
12.41	5.6
16.48	7.5

$tonf/in^2$	kgf/mm^2
35	55.12
40	62.99
50	78.74
70	110.24

ft^3	m^3
20	0.57
40	1.13
60	1.7
61	1.73
62	1.76
80	2.27
81	2.3
82	2.32
83	2.35
85	2.41
100	2.83
101	2.86

ton	tonne
$1^1/_2$	1.52
2	2.03
$2^1/_2$	2.54
3	3.05
4	4.06
$4^1/_2$	4.57
5	5.10
6	6.10
$7^1/_2$	7.62
8	8.13
$9^1/_2$	9.65
10	10.2
$11^1/_2$	11.68

Appendix E Information to be provided with enquiry and order

When ordering rolling stock to this specification the purchaser should give at least the following information:

a) The number of this British Standard, i.e. BS 4073.

b) Serial number of car required (see Table 1).

c) Details of any special finish and protective coating required (see Clause **5**).

d) Distance between centres of dummy axles.

e) Limiting dimensions, if any.

f) Whether cars are intended for operation on steep gradients or with sharp track curves; if so, details are to be provided.

g) Mineral(s) to be carried.

h) Materials to be used for the bodies (see Clause **9**).

k) Whether car bodies are to be of welded or riveted construction (see Clause **8**).

l) Method of attachment of body to the underframe (see Clause **14**).

m) Material to be used for wheels (see Clause **15**).

n) Type of suspension gear required (see Clause **26**).

p) Details of sample testing required [see Subclause **27** a) v)].

q) If steel laminated springs are required, whether these are to be given anti-corrosion treatment [see item i)D of Subclause **27** b)].

r) Type and size of coupler required (see Clause **28**).

s) Whether a proof test and additional tests on coupler assemblies will be required [see Subclauses **34** b) and c)].

t) Whether coupler operating gear is required (see Clause **35**).

u) Whether facilities for inspection of assembled couplers, by the purchaser's representative, are required (see Clause **36**).

v) Details of any tippler, creeper or retarder brackets required [see Subclauses **37** a) and b)].

w) Whether brakes and brake operating gear are required.

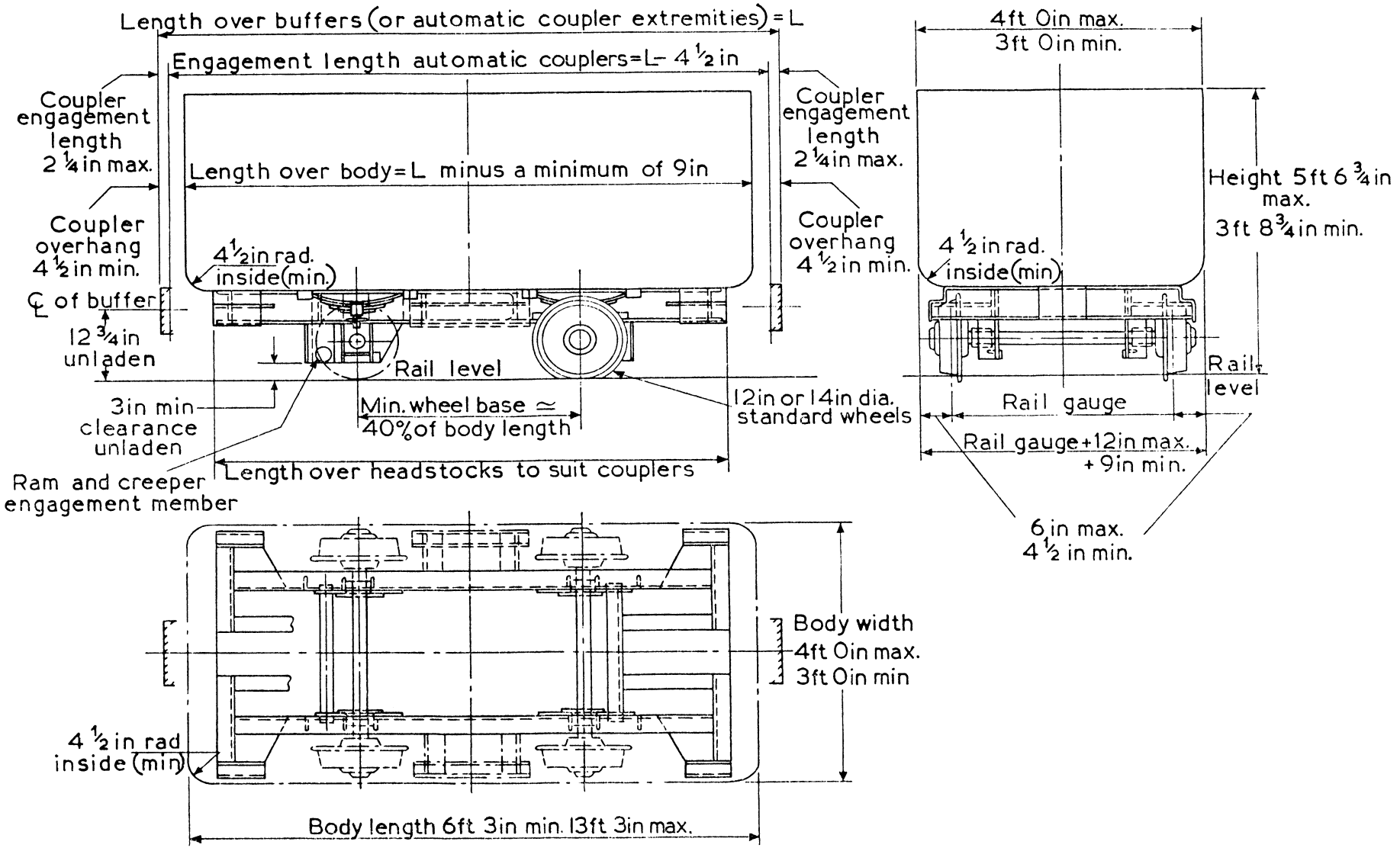


Figure 1 — Typical mine car

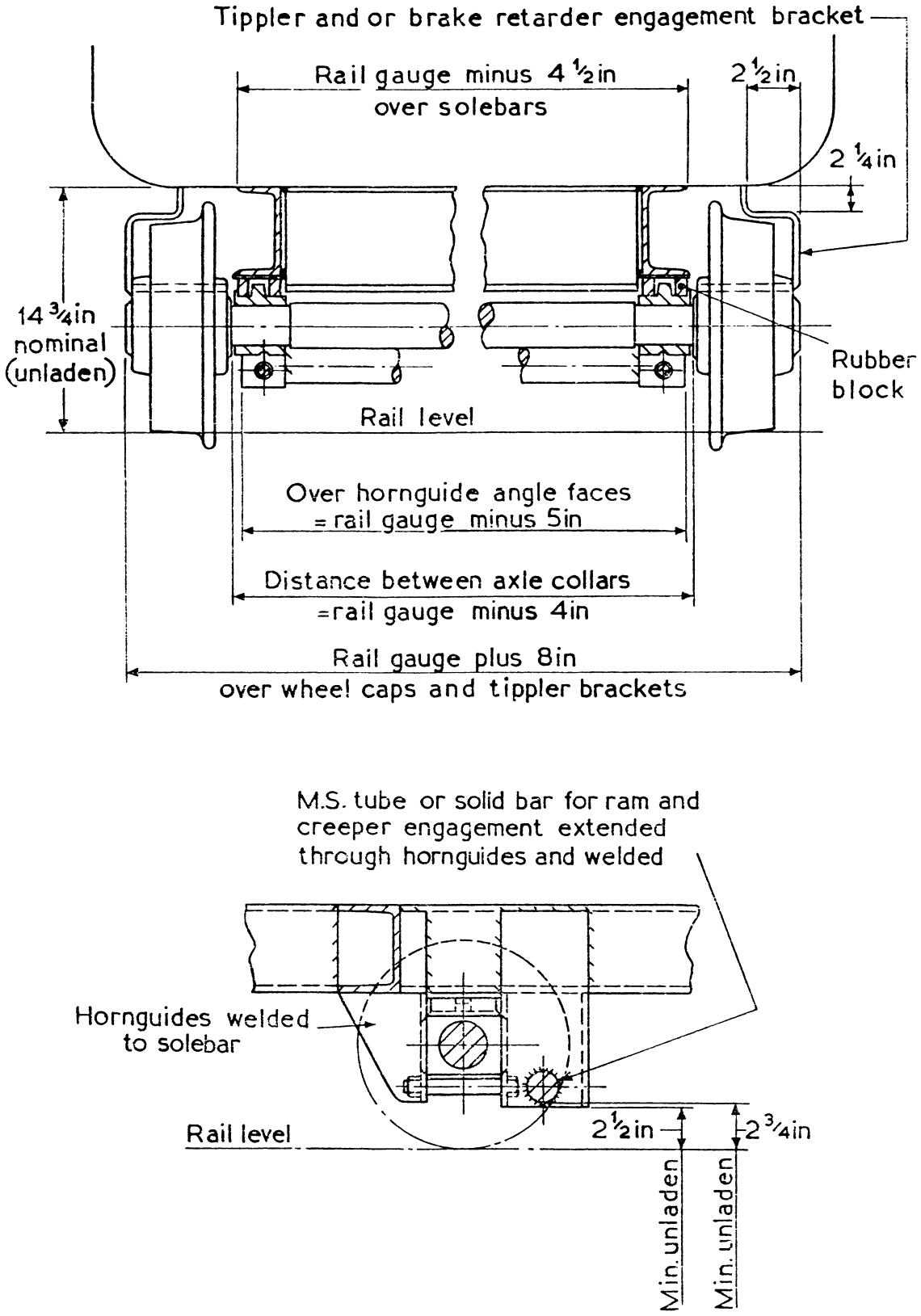


Figure 2 — Details of underframe, ram, creeper and tippler engagement assembly (mine car capacity 60–81 ft³)

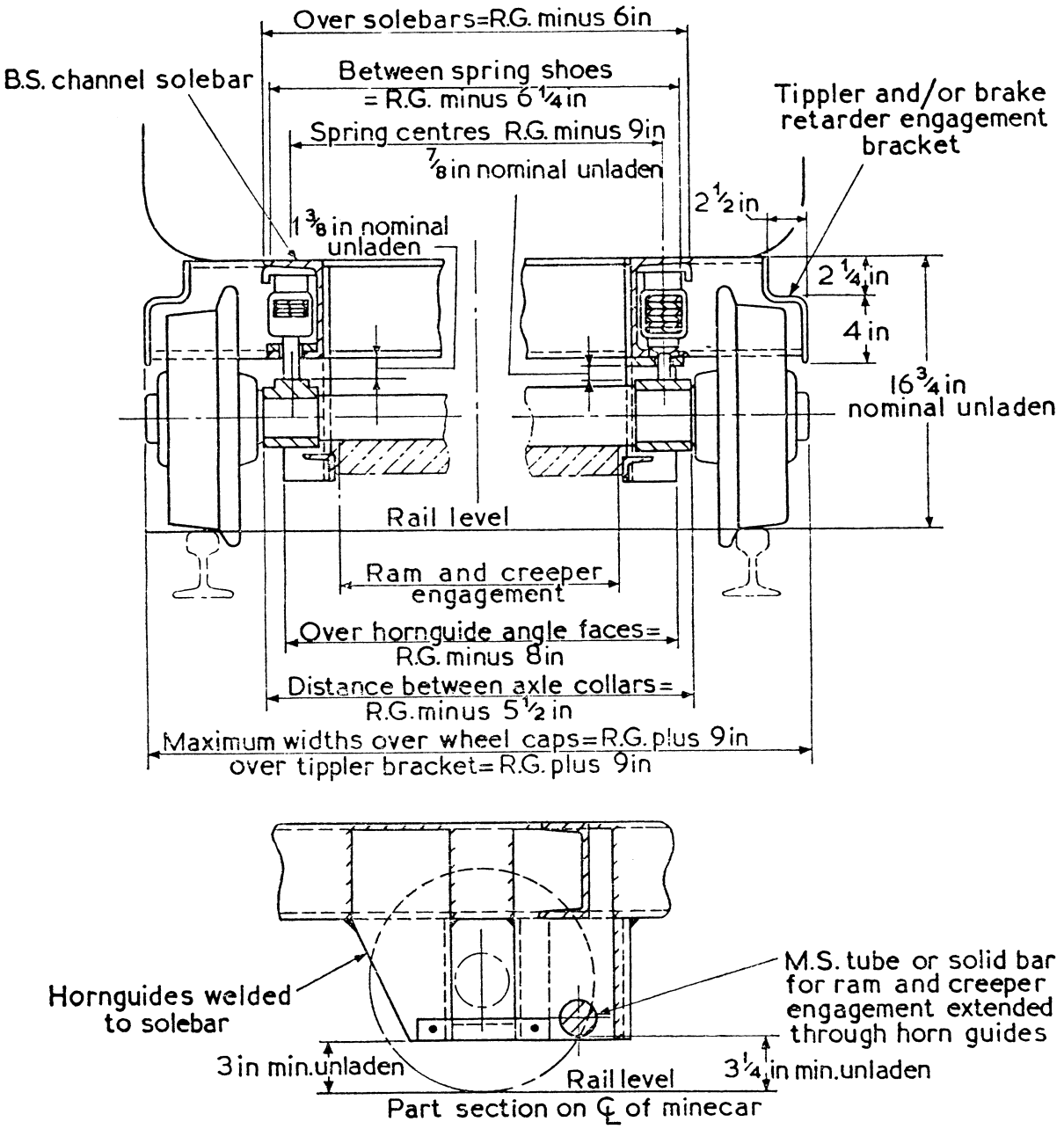
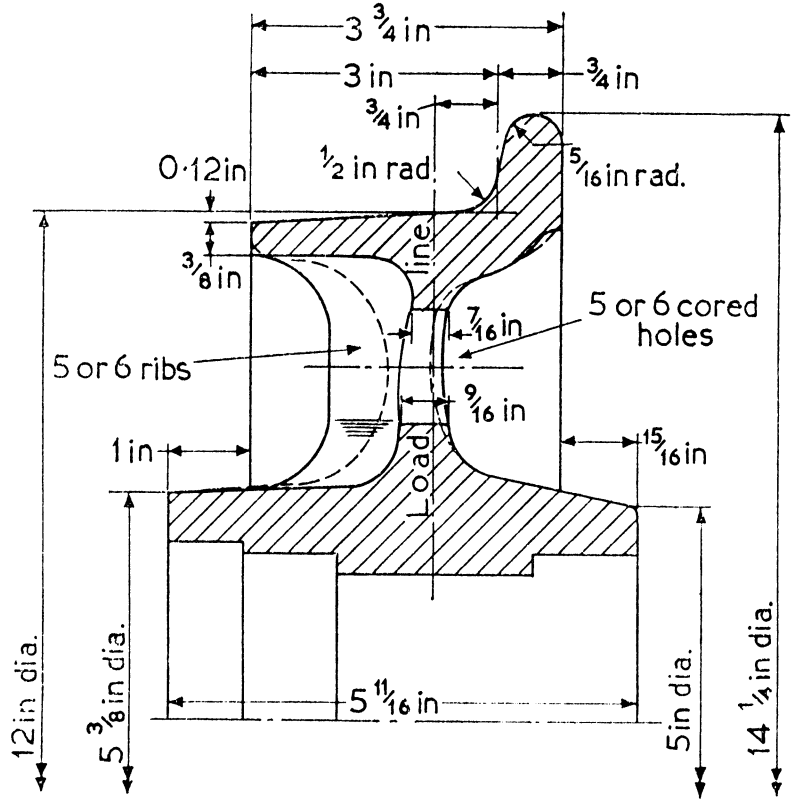
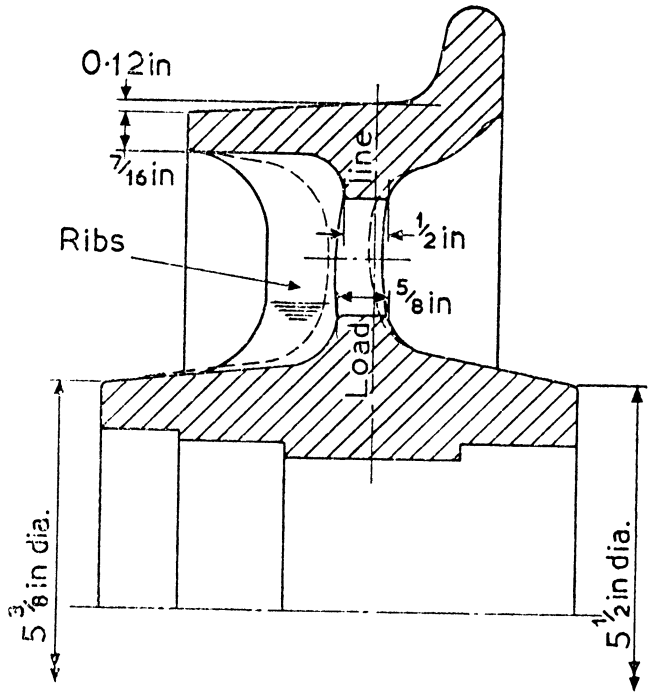


Figure 3 — Details of underframe, ram, creeper and tippler engagement assembly (mine car capacity 82–138 ft³)



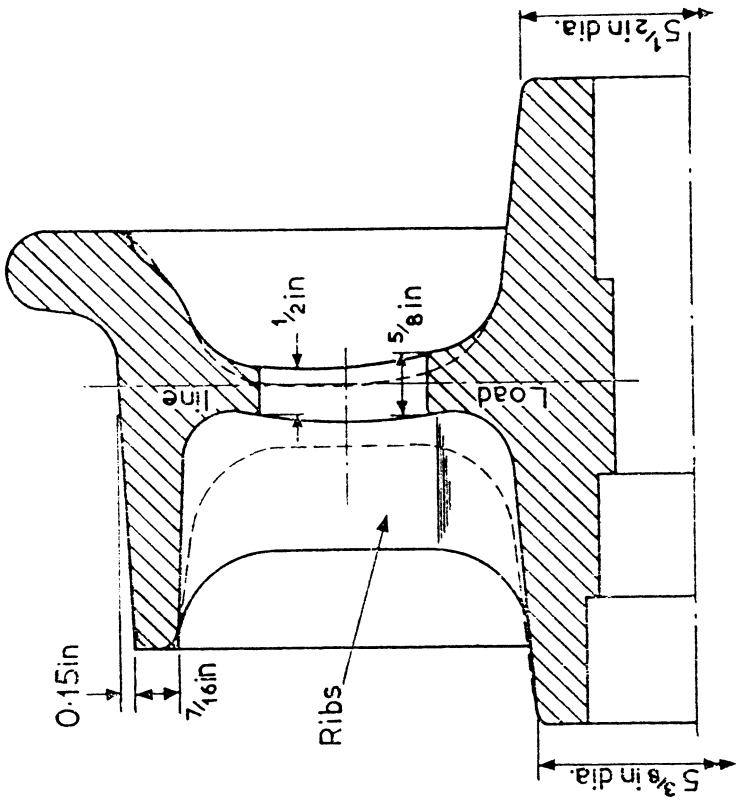
For 3 tons laden weight



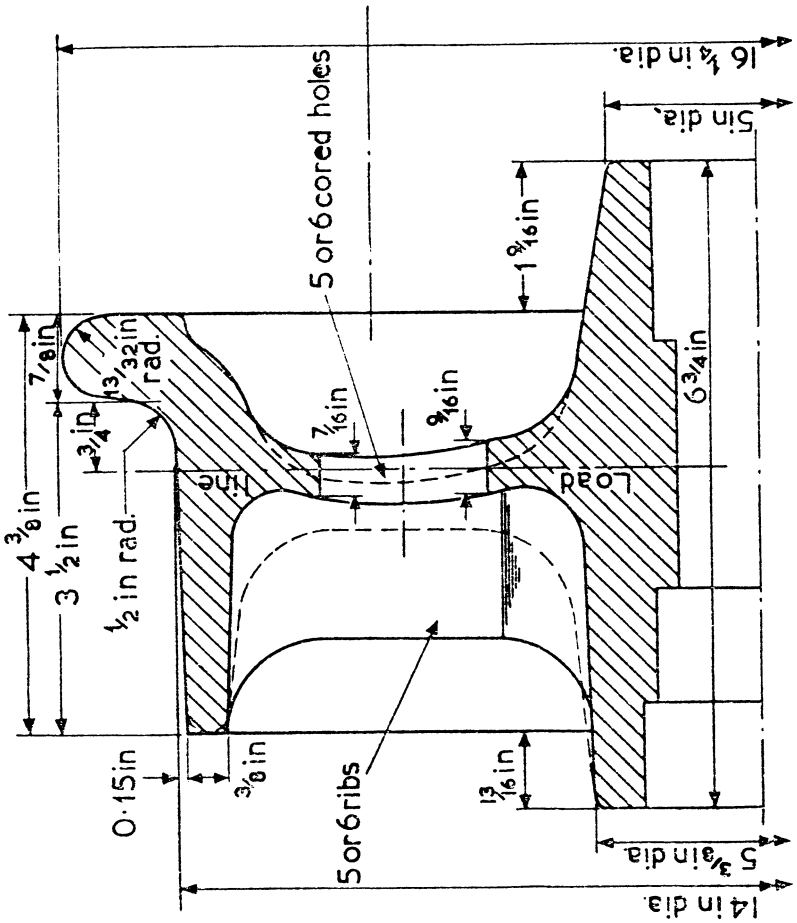
For 4½ tons laden weight

NOTE 1 Full lines show wheels as castings, dotted lines indicate the design of wheels as forgings.
NOTE 2 When austenitic steel is used the hub thickness may be increased by 1 in max. to accommodate a mild steel bush for machining purposes.

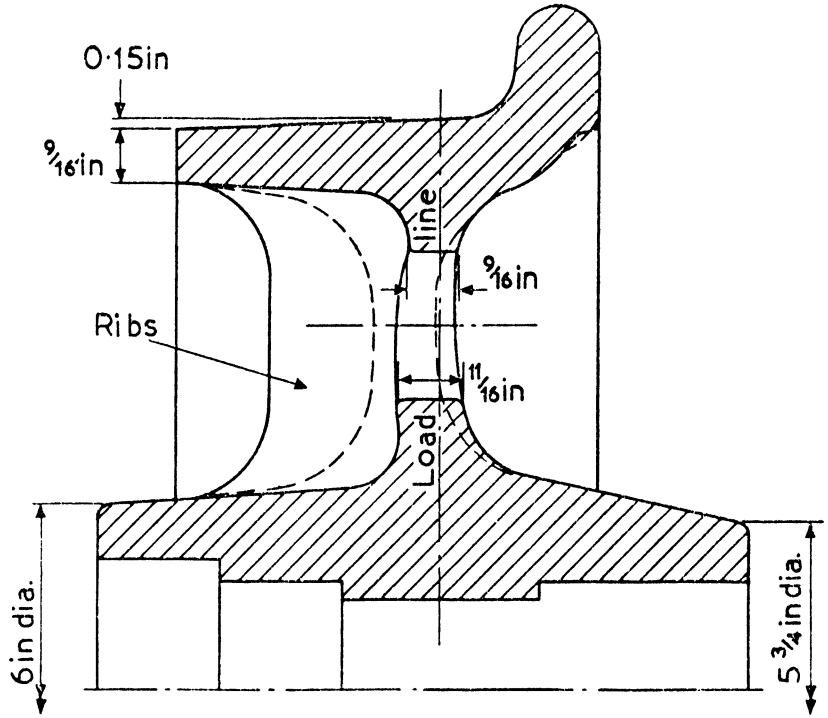
Figure 4 — 12 in dia. mine car wheels



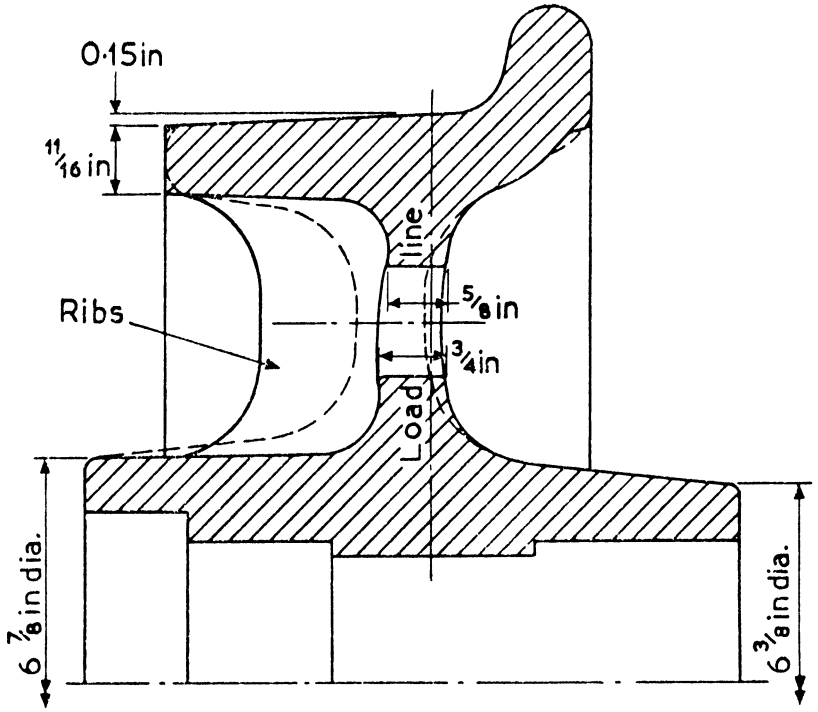
For 4½ tons laden weight



For 3 tons laden weight



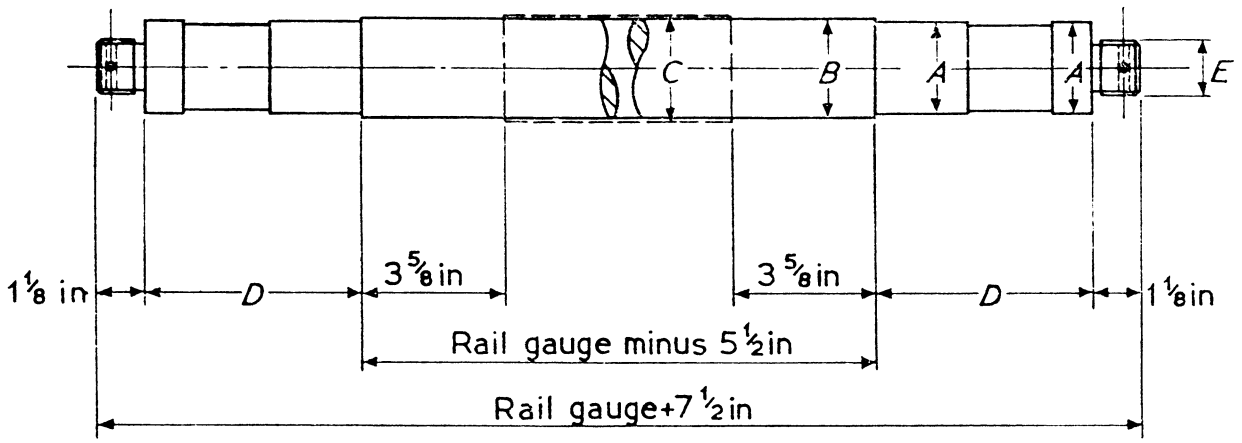
For 6 tons laden weight



For 7½ tons laden weight

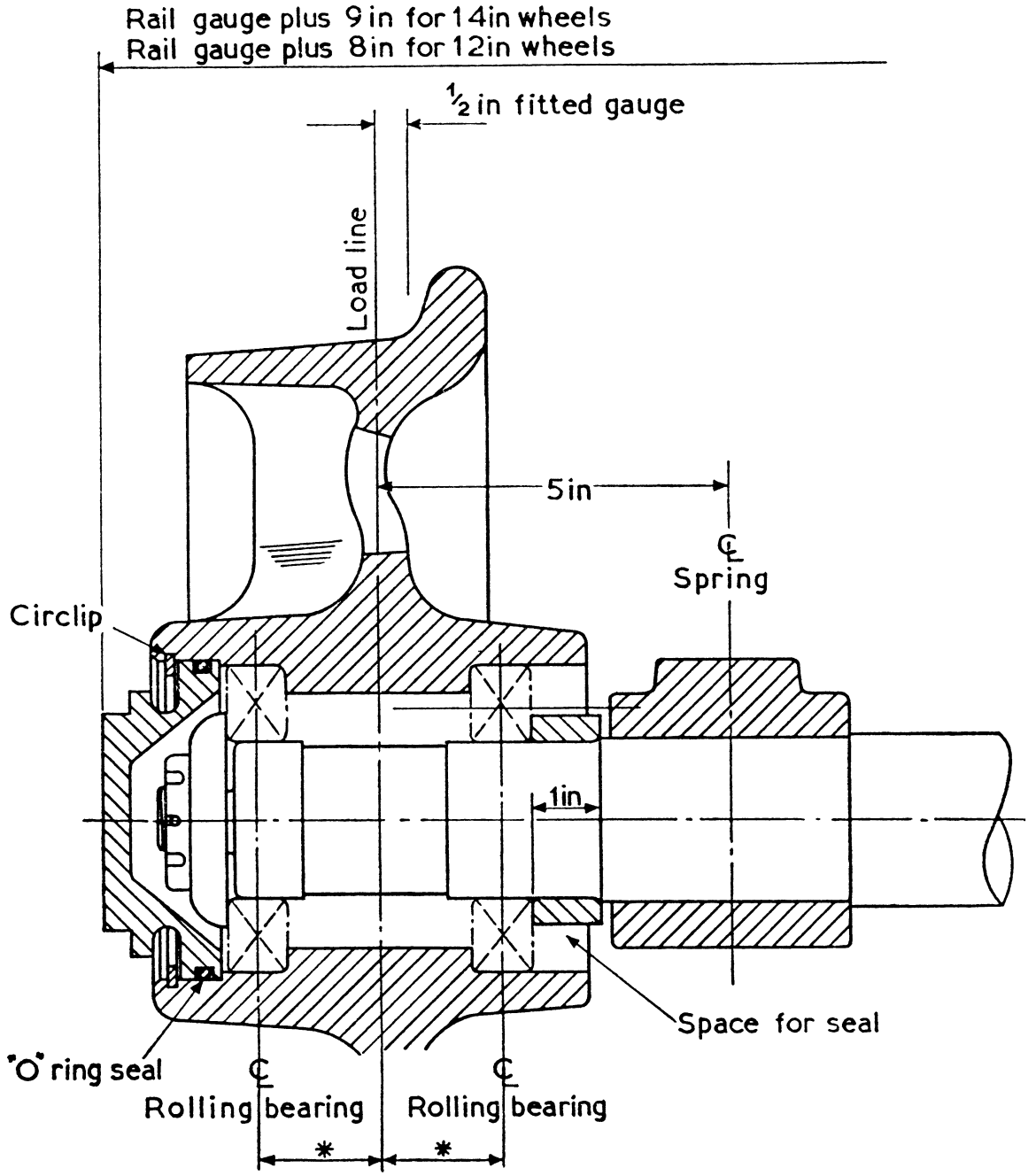
NOTE 1 Full lines show wheels as castings, dotted lines indicate the design of wheels as forgings.
NOTE 2 When austenitic steel is used the hub thickness may be increased by 1 in max. to accommodate a mild steel bush for machining purposes.

Figure 5 — 14 in dia. mine car wheels



Total laden weight	*A* dia. nom.	*B* dia. nom.	*C* dia.	*D* dia.	*E* dia.	Rail gauge	
ton	in	in		in		ft	in
						2	0
3	$2^1/_4$	$2^3/_8$	Not	$5^3/_8$	1 in B.S.P.	2	6
			less			3	0
$4^1/_2$	$2^1/_2$	$2^5/_8$	than	$5^3/_8$	1 in B.S.P.	2	6
6	$2^3/_4$	$2^7/_8$	*B*	$5^3/_8$	$1^1/_4$ in B.S.P.	3	0
$7^1/_2$	3	$3^1/_8$	dia.	$5^3/_8$	$1^1/_2$ in B.S.P.	3	0
$9^1/_2$	$3^1/_4$	$3^3/_8$		$5^3/_8$	$1^1/_2$ in B.S.P.	3	0
$11^1/_2$	$3^1/_2$	$3^5/_8$		$5^3/_8$	$1^1/_2$ in B.S.P.	3	0

Figure 6 — Details of mine car axles



* Bearings are equally spaced about load line.

Figure 7 — Typical mine car wheel and axle assembly

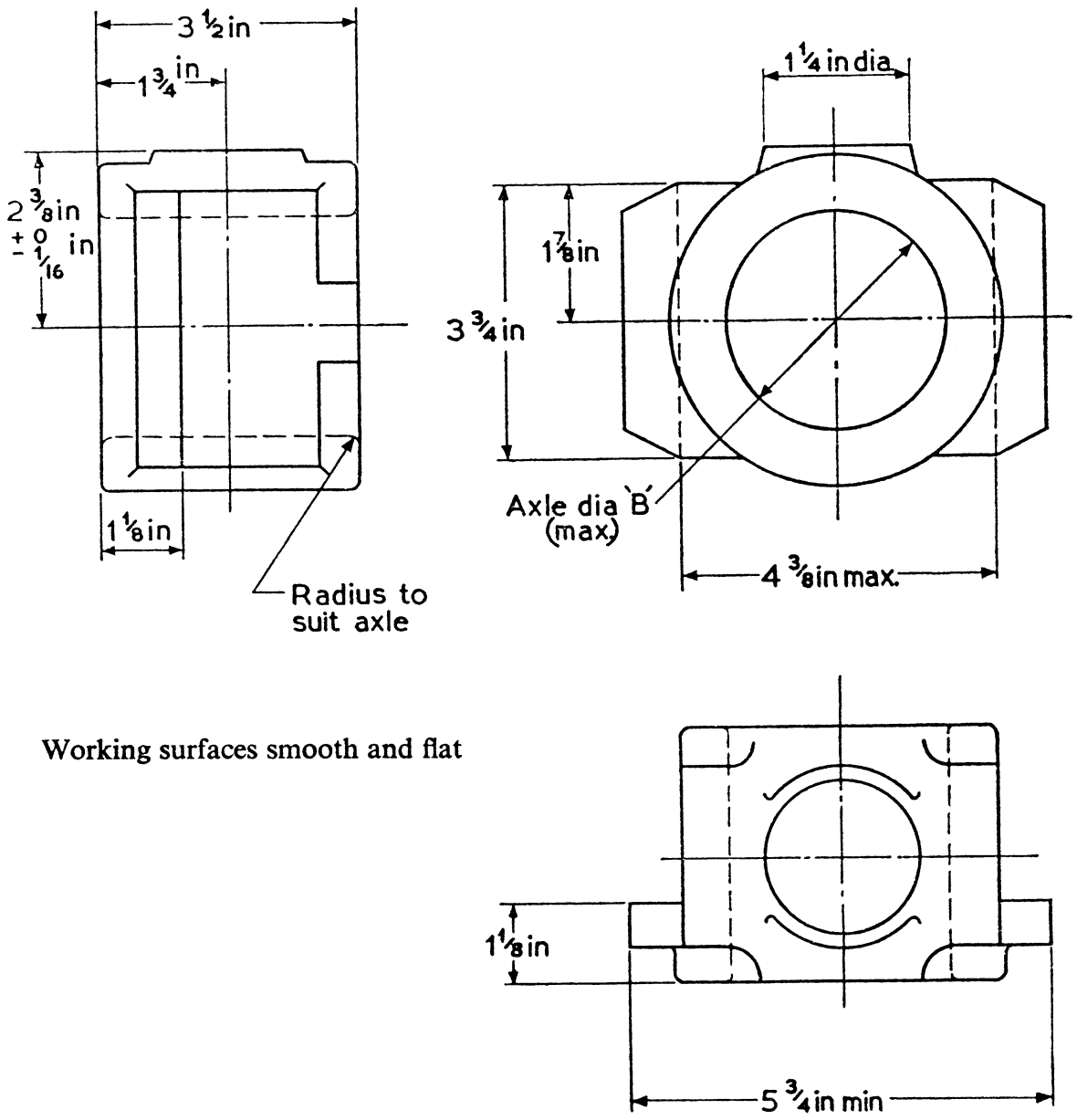


Figure 8 — Details of mine car axlebox for steel laminated springs

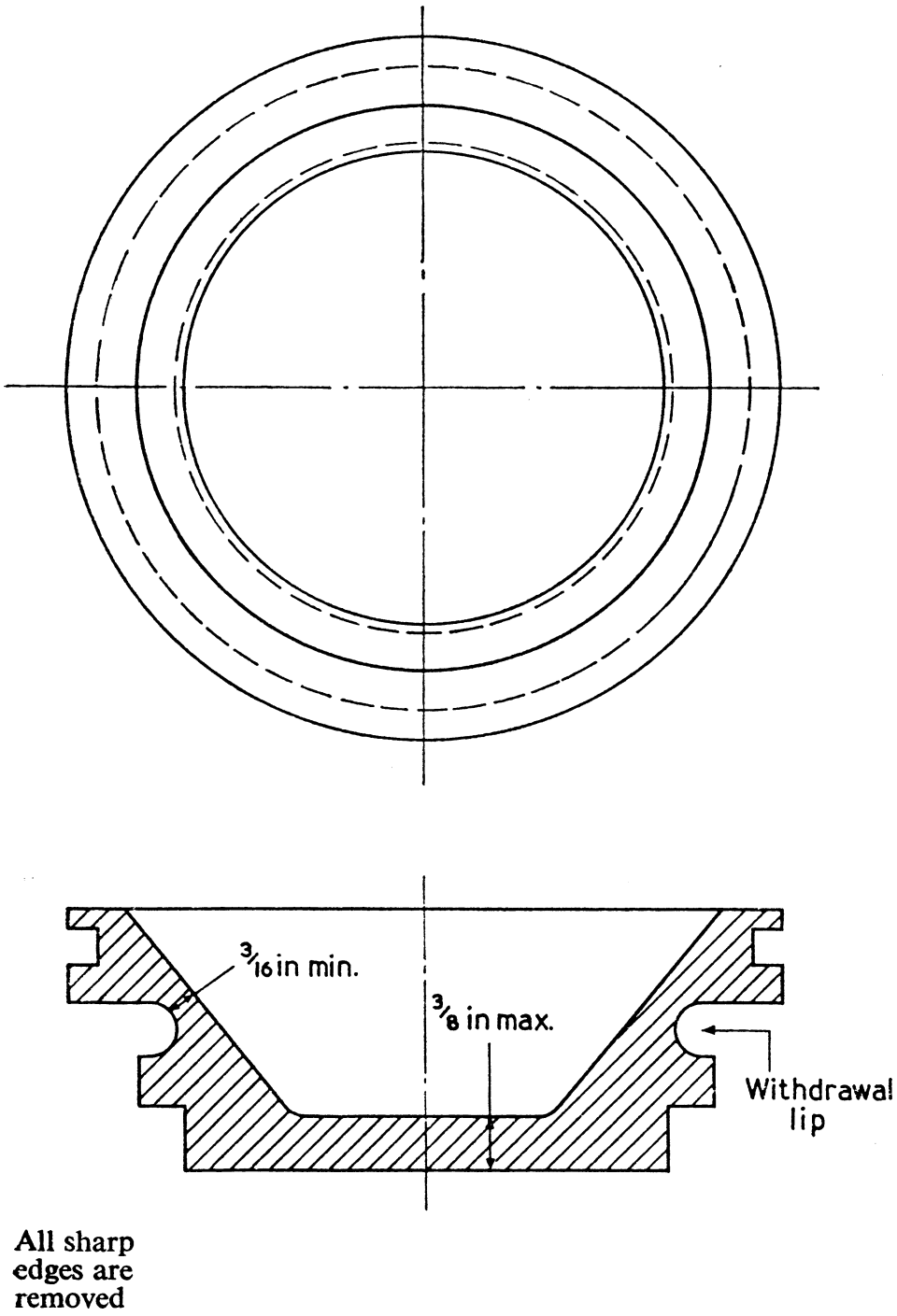


Figure 9 — Details of mine car hub cap

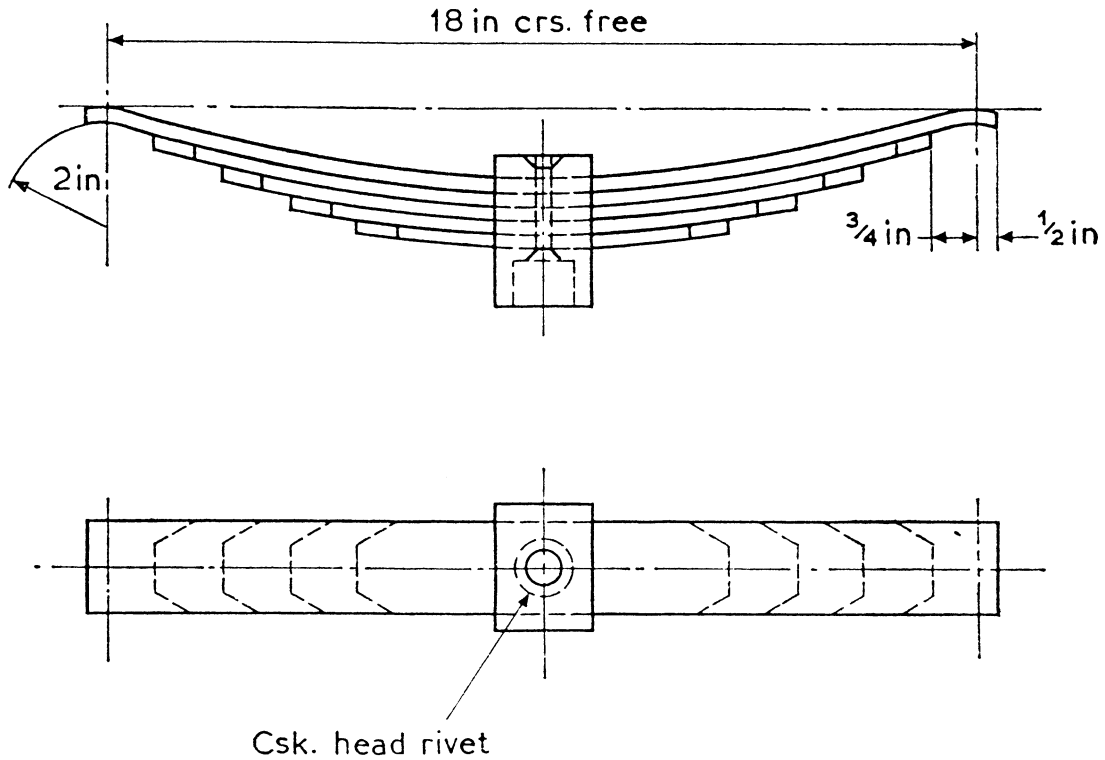
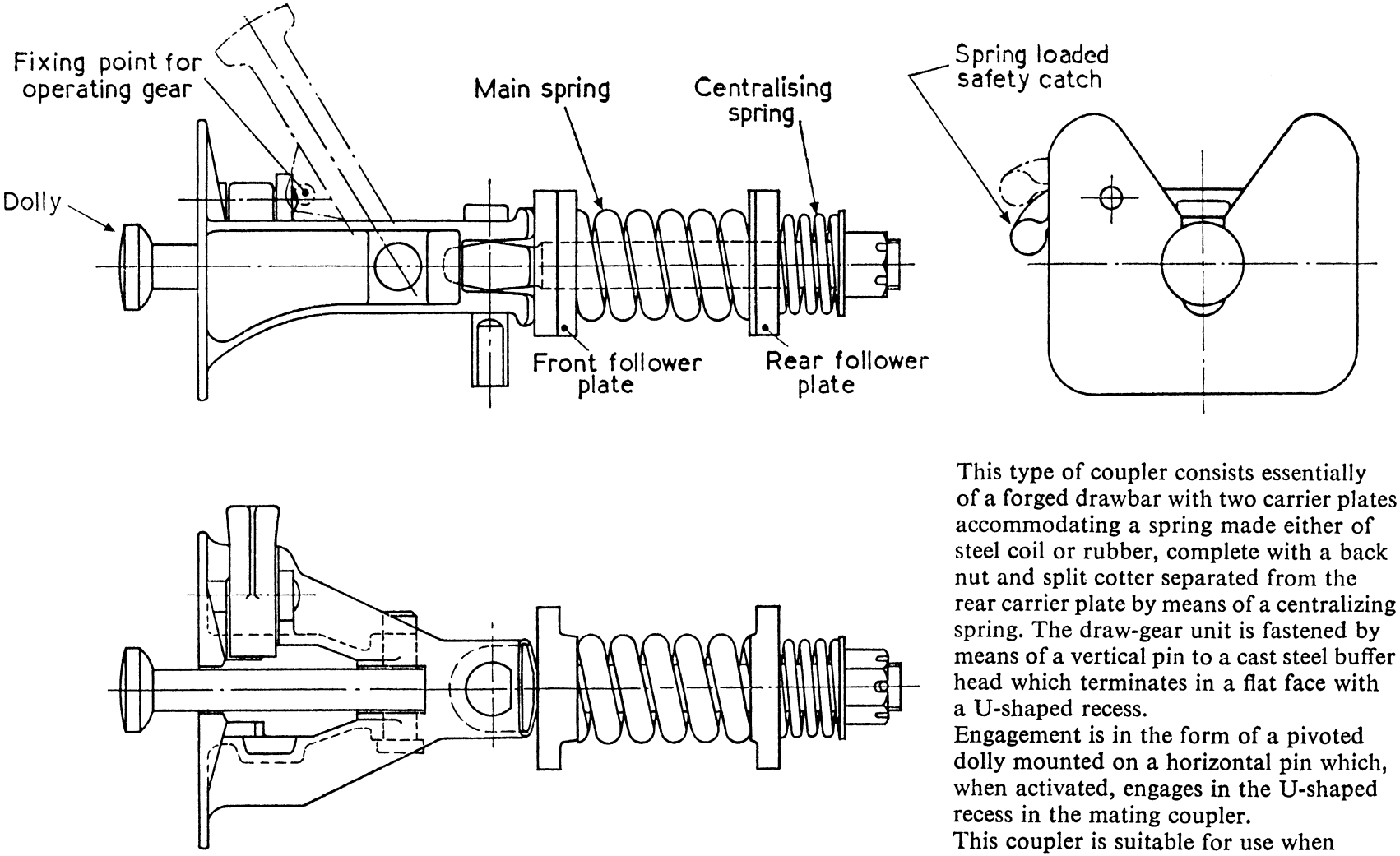
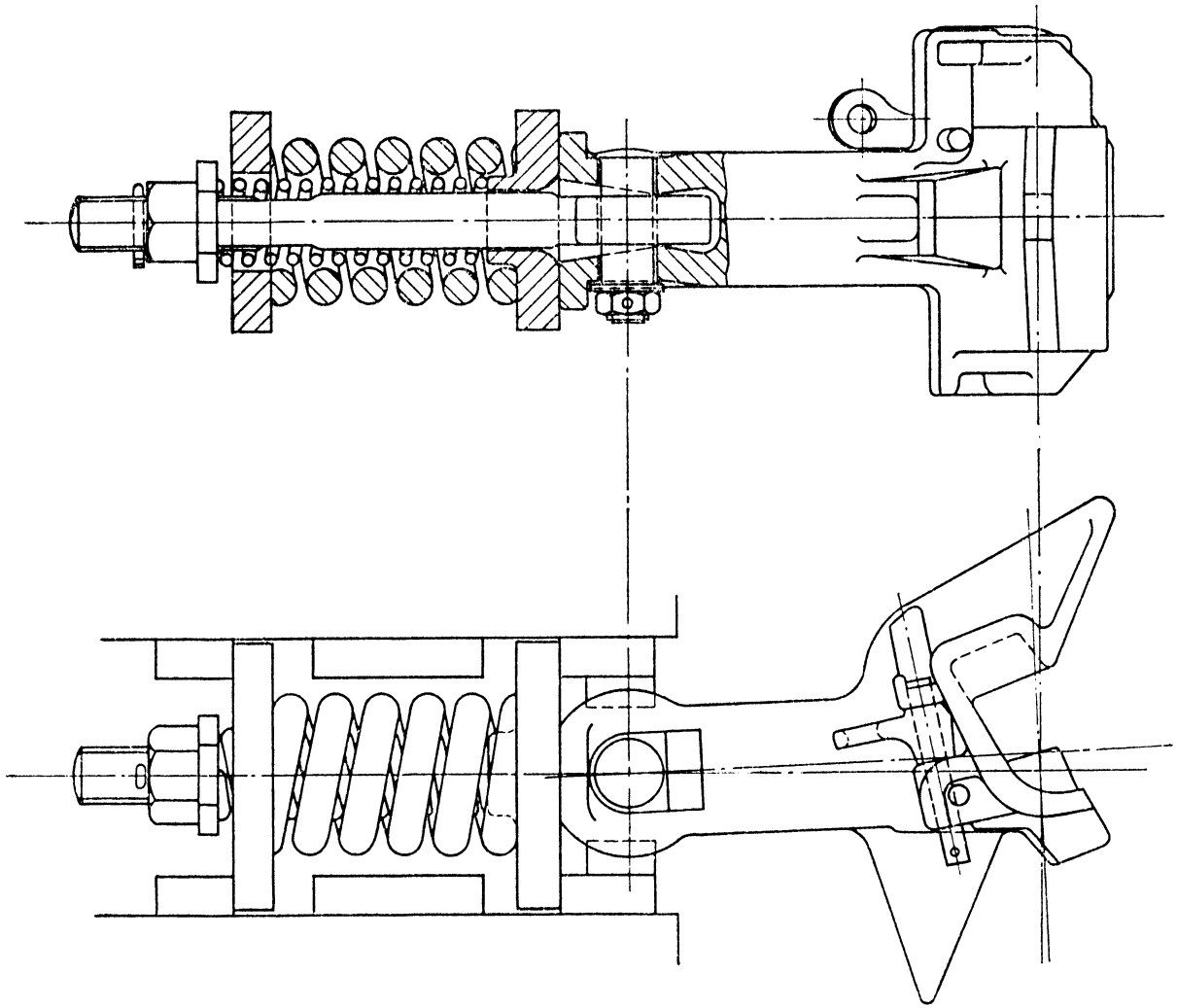


Figure 10 — Typical mine car spring for a maximum total load of $5^1/_4$ ton



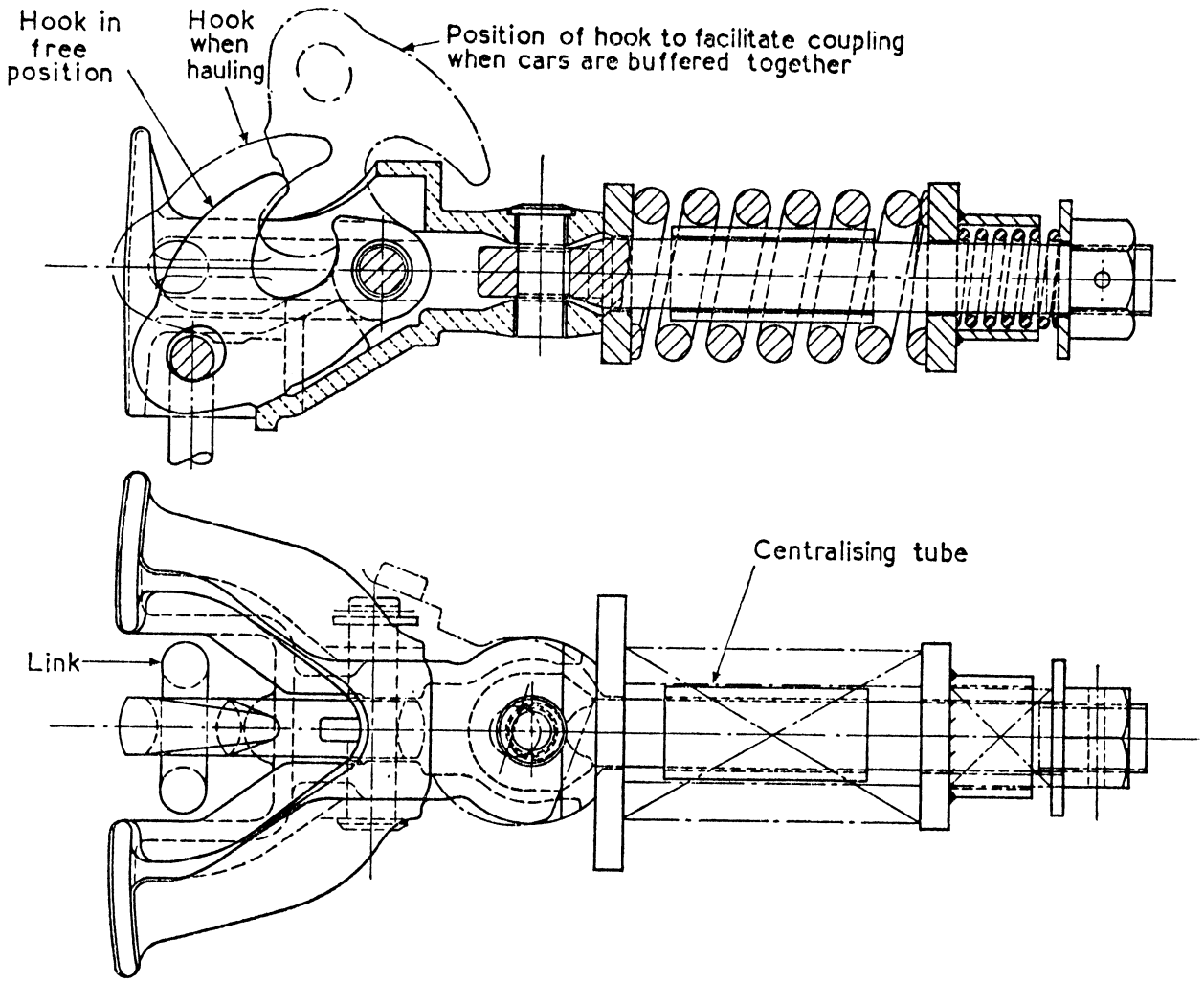
This type of coupler consists essentially of a forged drawbar with two carrier plates accommodating a spring made either of steel coil or rubber, complete with a back nut and split cotter separated from the rear carrier plate by means of a centralizing spring. The draw-gear unit is fastened by means of a vertical pin to a cast steel buffer head which terminates in a flat face with a U-shaped recess.
Engagement is in the form of a pivoted dolly mounted on a horizontal pin which, when activated, engages in the U-shaped recess in the mating coupler.
This coupler is suitable for use when tipping individual cars in a coupled train.

Figure 11 — Typical semi-automatic "dolly" type coupler operated from either side by gear mounted on both ends of the car



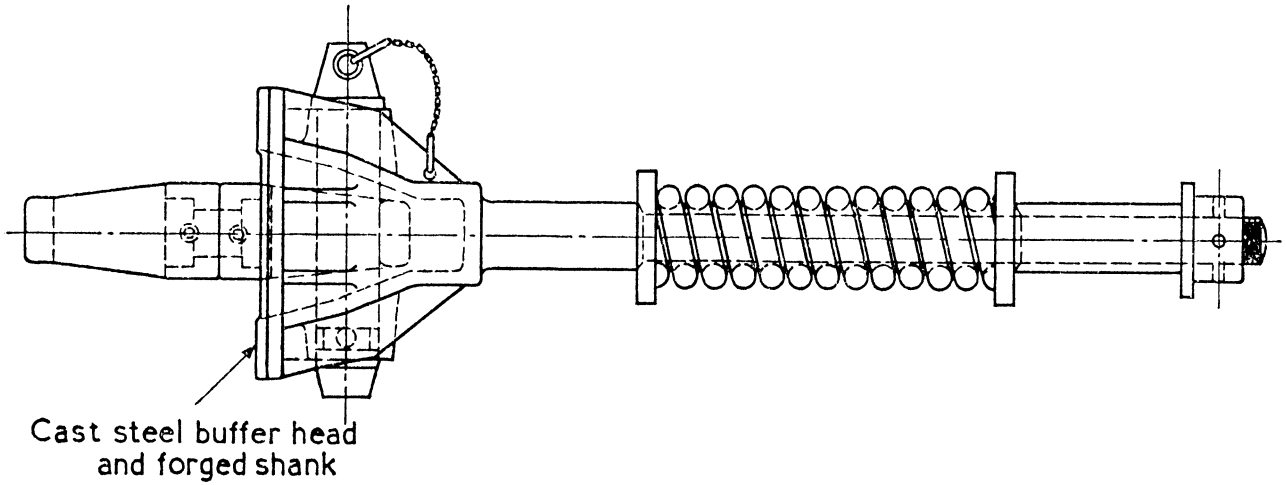
This type of coupler consists essentially of a forged drawbar and two follower plates accommodating a spring made either of steel coil or rubber, complete with a back nut and split cotter separated from the front and rear follower plates by means of a centralizing spring.
This drawgear unit is fastened by means of a vertical pin to a cast steel buffer head which terminates in two faces inclined at an angle of 70° to each other.
Engagement is effected automatically when the cars are buffed together; for disengagement the unlocking of one coupler by means of the operating gear uncouples both and permits the couplers to part. The type shown is not suitable for tipping individual cars in coupled trains, but a design is available for this purpose.

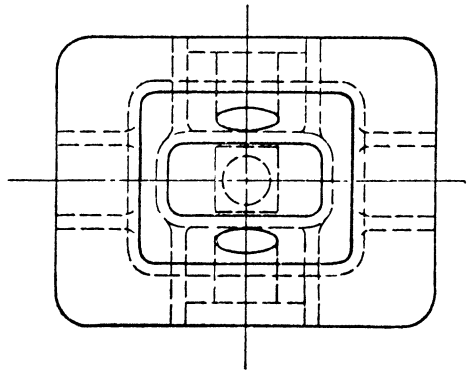
Figure 12 — Typical fully automatic coupler activated from either side by gear mounted on both ends of the car

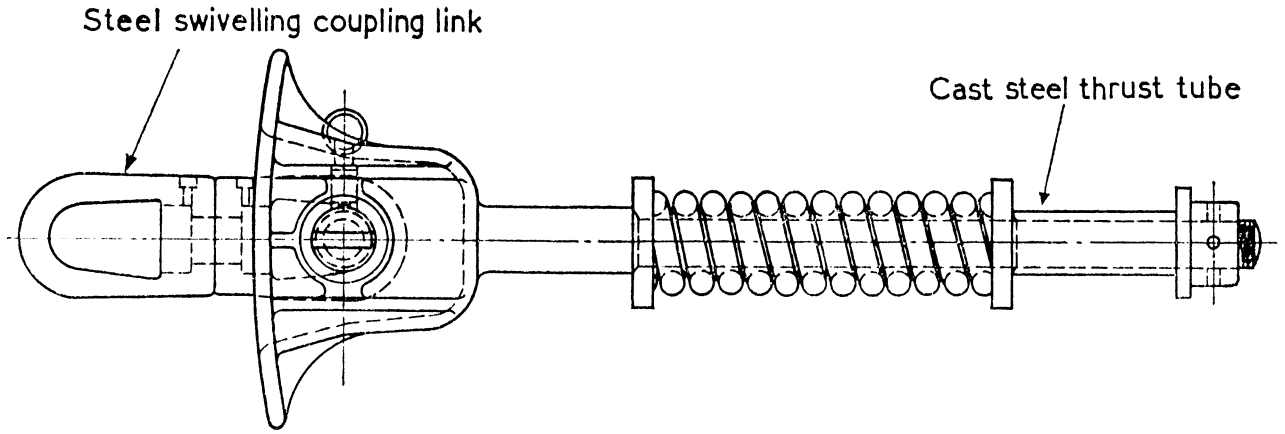


This coupler consists essentially of a forged drawbar terminating in a back nut and split cotter. The drawbar has two carrier plates accommodating a helical coil spring in which is fitted a centralizing tube. The back nut is separated from the rear carrier plate by means of a centralizing spring surrounded by a distance tube welded to the carrier plate. The drawbar is attached, by means of a vertical pin, to a cast steel head with a curved front face and a U-shaped aperture.
Engagement is effected by means of a cast or forged hook in the centre of the U-shaped recess mounted on a horizontal pivot pin carrying a link which engages in the hook of the mating coupler.

Figure 13 — Typical hook and link coupler

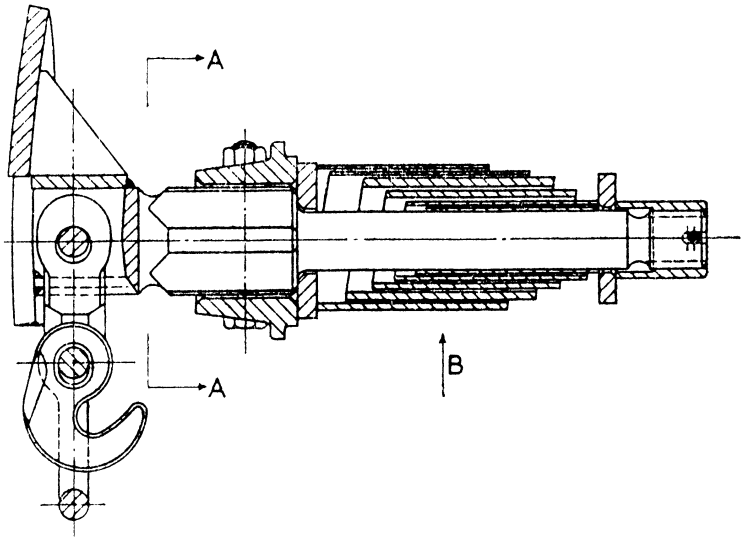


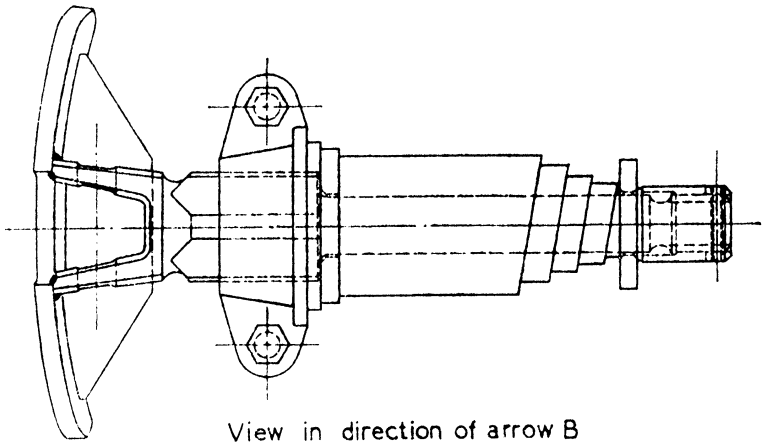


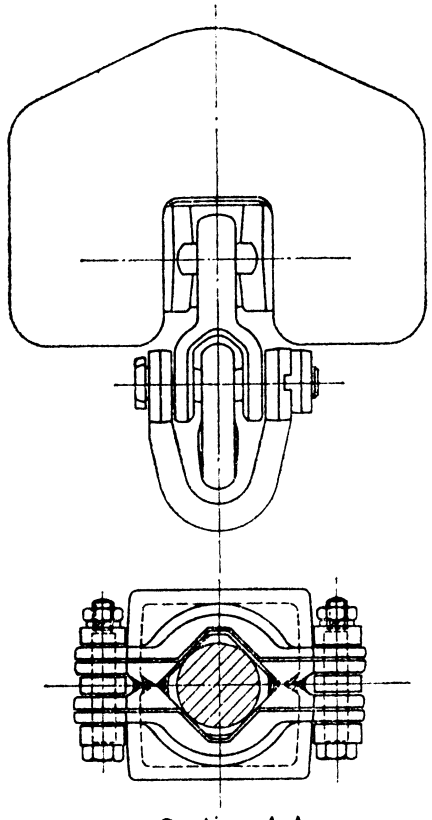


This type of coupler consists essentially of a cast steel coupler head and drawbar which accommodates a coil steel spring. The drawbar terminates in a screwed shank and back-nut.
The coupler head terminates in a curved face and incorporates a swivel ' D ' coupling which is locked in position by means of a vertical plunger.
Engagement is effected by the swivel ' D ' of one coupler engaging the locking plunger of the mating coupler.

Figure 14 — Typical non-articulating head type coupler with swivel "D" coupling link







This type of coupler consists essentially of a forged drawbar integral with a cast steel buffer head with a curved face. This drawbar terminates in a back nut split pin and incorporates two carrier plates accommodating either a helical or volute steel or rubber spring. A distance piece welded to the rear carrier plate forms the centralizing medium.

A coupling ' D ' shackle mounted on a horizontal pin passing through the bulk head is designed to give a line of pull through the axis of the drawbar.

On the shackle is a special hook with a large eye which also accommodates a ring. The hook of one coupler engages with the ring of the mating coupler.

Figure 15 — Typical non-articulating head type coupler with shackle and hook couplings

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British Standards

The following are available on application:
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