BRITISH STANDARD

BS 3974-1:
1974

Incorporating
Amendment No. 1

Specification for

Pipe supports —

Part 1: Pipe hangers, slider and roller type supports

UDC 621.881:621.643.2

Co-operating organizations

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

Associated Offices Technical Committee
Association of Consulting Engineers
Association of Hydraulic Equipment Manufacturers Ltd
Association of Mining Electrical and Mechanical Engineers
British Compressed Air Society
British Electrical and Allied Manufacturers' Association
British Gas Corporation*
British Gear Manufacturers' Association
British Internal Combustion Engine Manufacturers' Association
British Mechanical Engineering Confederation
British Pump Manufacturers' Association
British Steel Industry*
Crown Agents for Oversea Governments and Administrations
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Department of the Environment
Department of Trade and Industry
Department of Trade and Industry — National Engineering Laboratory
Electricity Council, the Central Electricity Generating Board and the Area Boards in England and Wales*
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Federation of Manufacturers of Construction Equipment and Cranes
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Institution of Heating and Ventilating Engineers*
Institution of Mechanical Engineers
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Process Plant Association*
Railway Industry Association of Great Britain
Royal Institute of British Architects
Telecommunications Engineering Manufacturing Association

The scientific and industrial organizations marked with an asterisk in the above list, together with the following, were directly represented on the committee entrusted with the preparation of this British Standard.

British Marine Equipment Council
Council of British Manufacturers of Petrolcum Equipment
Heating and Ventilating Contractors' Association
High Pressure Pipework Consultative Committee
Institute of Plumbing

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Contents

Foreword

This British Standard is the metric revision of BS 3974-1, which was originally published in 1966 under the authorization of the Mechanical Engineering Industry Standards Committee and at the request of the Engineering Equipment Users' Association. Previously restricted to requirements for the design (including dimensions) and the manufacture of components for rod-type pipe hangers, this revised edition has been extended to meet the needs of industry and now includes requirements on the design and manufacture of components for slider and roller type supports, for pipes transporting fluids within a temperature range minus 20 °C to 470 °C.

The revised appendices provide recommendations on design considerations, data and formulae for pipework calculations and methods of fixing. To assist the user in the application of pipe supports, many illustrations of typical support assemblies from the Engineering Equipment Users' Association Handbook No. 18 have been included in a separate appendix.

A further Part of this series (BS 3974-2) will deal with pipe attachments to steelwork and masonry structures.

NOTE 1 Information concerning SI units is given in BS 350. "Conversion factors and tables", and in PD 5686 'The use of SI Units'.

NOTE 2 Attention is drawn to certification facilities offered by BSI; see the inside back cover of this standard.

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 52, 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.

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1 Scope

This British Standard specifies requirements for the design (including dimensions) and manufacture of components for pipe hangers, slider and roller type supports for uninsulated and insulated steel and cast iron pipes of nominal size 15 mm to 600 mm, used for transporting fluids within the temperature range – 20 °C to 470 °C.

Recommendations on design considerations, data and formulae for pipework calculations, methods of fixing and illustrations of typical pipe support assemblies are given in the appendices.

NOTE The titles of the British Standards referred to in this standard are listed on the inside back cover.

2 Definitions

For the purposes of this British Standard the following definitions apply:

1) anchor
a securing device to maintain in a pipeline a point fixed both in position and direction, under the design condition of temperature and loading

2) cold pull-up (cold draw)
a strain induced in a pipeline during erection to compensate for expansion or contraction under working conditions. This strain may be compressive or tensile depending upon the working temperature being below or above ambient

3) duckfoot
a device for transferring the axial load in a vertical pipeline at its lower extremity to a foundation or other fixtures

4) expansion loop
a device for absorbing the movement due to either temperature change or external force

5) expansion bellows
a device performing a similar function to an expansion loop, but employing a corrugated flexible element inserted in the pipeline

6) fittings
the component parts of a pipeline, other than the pipe. This collective term usually embraces bends, elbows, tees, unions, flanges and similar equipment

7) guide
a device used to restrict pipeline movement to a predetermined direction

8) hanger
a device for suspending a pipeline from a fixed point, and for maintaining the pipeline at a predetermined level, while allowing limited axial and lateral movement

9) loading
the total force on a securing device; it comprises the dead weight of the pipe, working or test fluid, fittings, valves and insulation. It also includes the forces due to thermal expansion or contraction, static and dynamic pressure, impact, wind, snow and ice

10) slider support
a device incorporating two flat or curved surfaces, one of which is attached to the pipe to allow for sliding movement, axially and laterally

11) roller support
a device on which the pipe rests incorporating a rotating member to allow longitudinal movement of the pipeline

12) spherical washer
a component used at the top of a sling rod to allow a limited amount of angular movement

13) Pivot anchor
a type of anchor that permits a pipe to swivel about a fixed point

14) sleeper
a type of support, usually placed on the ground in a pipe track or corridor

15) spring hanger
a type of pipe hanger, designed to adjust itself to changes in position as a result of changes in condition of the pipeline

16) support
a permanent device for retaining a pipeline in a particular manner or position

17) trestle
a framed structure, securely fixed, acting as a support for one or more pipelines elevated above ground

18) turnbuckle
A device using left and right hand screw threads to provide axial adjustments

NOTE See also BS 4429.

19) vapour seal
a barrier, impervious to water vapour, applied to the exterior surface of the insulation of a cold pipe

3 Materials

Components of pipe support assemblies shall be manufactured from the material specified in the schedule below and shall have mechanical properties to satisfy the design requirements specified in clause **4**. Other materials may be used providing they have equal or higher mechanical properties.

Schedule of materials

Component	Material reference
Pipe clips	BS 4360:Grade 43A BS 1501–151 Grade 26B BS 1501–161 Grade 26B
Clip bolts and load bolts	BS 4190:Grade 4.6 BS 3692:Grade 8.8
Sling rods, screwed machined eye, weldless eye nut	BS 4360:Grade 43A
Slider members and roller chairs	BS 4-1 BS 4360:Grade 43A
Cast rollers and spherical washers	BS 309 BS 310 BS 1452:Grade 10
Tubular rollers	BS 1387:Medium BS 1775:HFS 13 or HFW 13
Tubular distance pieces	BS 1387:Medium BS 1775:HFS 13 and HFW 13

4 Pipe hanger components

4.1 Components. A pipe hanger is an assembly comprising:

1) a pipe clip or one piece strap complete with load and clip bolts, and

2) a sling rod having a sling eye at the lower end and a spherical washer and nuts at the top end.

4.2 Pipe clips. Pipe clips are detailed for the full range of sizes and temperature given in clause **1** and are illustrated in Figure 7, Figure 8 and Figure 9, and their dimensions given in Table 7, Table 7a, Table 8 and Table 9.

For pipes up to and including 32 mm nominal size and loads up to 70 kgf, a one piece strap as illustrated in Figure 6 may be used up to a maximum temperature of 100 °C.

4.2.1 *Design.* For the purposes of this British Standard the design temperature for clips in direct contact with the pipe shall be that of the fluid in the pipe, but, where the clip is in contact with load-bearing insulation, the design temperature shall be that of the outer surface of this insulation.

Pipe clips are detailed in this standard for three temperature ranges designated as follows.

Range A: – 20 °C to 100 °C

Range B: – 20 °C to 400 °C

Range C: above 400 °C to 470 °C

Each range is divided into two load carrying series, light and heavy.

Pipe clips have been designed on the basis that they are in direct contact with the pipe but not tightened on to the pipe. To achieve this, distance pieces are mandatory on clips in Ranges B and C but are optional on Range A (see **4.4**).

The method by which pipe clips have been designed is set out in **A.3**.

The following stress levels have been used in the design.

Range A: 245 N/mm^2[a]. This stress being equal to yield at room temperature for steel complying with the requirements of BS 4360: Grade 43A.

Range B: 132 N/mm^2. This stress being equal to the 0.2 % proof stress at 400 °C for steel complying with the requirements of BS 1501–151 Grade 26B and BS 1501–161 Grade 26B.

Range C: 50 N/mm^2. This stress being equal to the mean stress to rupture in 1 000 00 hours at 470 °C divided by a factor of 1.4 for steel complying with the requirements of BS 1501–151 Grade 26B BS 1501–161 Grade 26B.

[a] 1 N/mm^2 = 1 MPa

Clips in Ranges A and B are designed on a factor of unity and on the assumption that the clip is in direct contact with the pipe. Any deformation of the clip will result in a redistribution of stress.

When load-bearing insulation is employed between a pipe and clip, deformation of the clip is not permitted and therefore the tabulated working loads shall be downrated by 20 % or, alternatively, the width of the clip (dimension *"B"*) shall be increased by 25 %.

When clips are subject to dynamic loading, this loading shall be added to the static load to obtain the total design load.

4.2.2 *Manufacture.* Dimensions of one piece straps and pipe clips in Range A are given Table 6 and Table 7 respectively. These components shall be made from steel complying with the requirements of BS 4360: Grade 43A.

Dimensions of pipe clips in Ranges B and C are given in Table 8 and Table 9 respectively. These clips shall be manufactured from steel complying with the requirements of BS 1501–151 Grade 26B or BS 1501–161 Grade 26B.

Pipe clips may be formed either hot or cold but consideration shall be given to the need to carry out heat treatment on cold formed clips of thickness 10 mm and over.

Where material for the manufacture of clips is cut from plate, the cut edges are to be ground smooth prior to forming.

4.3 Clip and load bolts. One piece straps and Range A and Range B pipe clips shall have clip and load bolts complying with the requirements of BS 4190, Grade 4.6 material.

Range C pipe clips shall have clip and load bolts complying with the requirements of BS 3692:Grade 8.8 material.

Locking nuts shall be fitted to all load bolts for Ranges B and C pipe clips. In addition it is recommended that locking nuts or locking washers be fitted to all other load and clip bolts wherever movement due to expansion, contraction, vibration or shock loading is expected.

4.4 Distance pieces Distance pieces for use in pipe clips (see **4.2.1**) shall be manufactured from steel tube (see clause **3**) of suitable bore to be a free fit on the clip bolt with ends cut square.

The length of the distance piece required for use with clips illustrated in Figure 7 shall be equal to the width of the sling rod eye and, for clips illustrated in Figure 8 and Figure 9, shall be equal to the width of the sling rod eye plus 3 mm.

4.5 Sling rods and sling rod eyes. Dimensions of sling rods and sling rod eyes shall be as given in Table 1, Table 2, Table 3 and Table 4.

Four types of eye, all of which are suitable for the temperature range specified in clause **1**, are illustrated as listed below.

Screwed machined eye	Figure 1
Weldless eye nut	Figure 2
Integral forged eye	Figure 3
Hot formed eye	Figure 4

The length of sling rods and the extent to which they are threaded at the top shall be such as to suit the individual pipe hanger requirements.

The top of each sling rod shall be fitted with 2 nuts and a spherical washer (see **4.6**).

Turnbuckles may be used for joining lengths of sling rod together and to provide a convenient method of adjusting the length of the sling rod.

4.5.1 *Design.* The safe working loads given in Table 1, Table 2 and Table 3 have been obtained by using a safety factor of 6.25 relative to the tensile strength of the material; the area taken is that at the root of the thread as defined in BS 3643-2.

The safe working loads given in Table 4 are based on a fibre stress of approximately 200 N/mm^2 in the loop and it should be noted that the safe working loads are considerably reduced.

Where the sling rods and sling rod eyes illustrated in Figure 1, Figure 2 and Figure 3 are used with pipe clips in Ranges A, B and C, the safe working load of the complete hanger shall be that given for the pipe clip. Where the sling rods with hot formed eyes illustrated in Figure 4 are used with pipe clips in Ranges A, B and C, the safe working load of the complete hanger shall be that given for the hot formed eye.

4.5.2 *Manufacture.* Sling rods and sling rod eyes shall be manufactured from the materials specified in clause **3**. All threads shall comply with the requirements of BS 3643-2, Classes 7H or 8g.

Sling rod eyes shall be manufactured by either:

1) making the eye separately from square bar (Figure 1), or a forging (Figure 2), and attaching to the rod by screwing and tack weld, or

2) forging the end of the rod into an integral eye (Figure 3), or

3) hot forming the end of the rod into a loop (Figure 4).

4.6 Spherical washers. Spherical washers are in general use and for this reason are included in the standard, but experience has shown that in a substantial number of cases, due to corrosion, dirt and paint, these components have failed to function.

4.6.1 *Manufacture.* Spherical washers shall be manufactured from good commercial quality steel or malleable cast iron as specified in clause **3**.

4.6.2 *Dimensions.*The dimensions of spherical washers shall be as given in Table 5.

4.7 Load bearing insulation

4.7.1 Various forms of load bearing insulants are available, examples being those based on asbestos, low temperature rubbers and hardwood. Consideration can be given to other synthetic materials. Advice should generally be sought from the manufacturers, particularly in respect of high and low temperature applications together with associated load bearing properties.

In the case of hardwood, cognizance should be taken of the corrosive interaction between wood and ferrous pipe, dependent on the acid and moisture content of the wood used.

4.7.2 Care shall be taken not to exceed the permitted compressive stress on the insulating material. The maximum calculated load shall be designed on the load area of the ring which is the curved area at the bottom of the pipe outside diameter contained by an angle of 90° (i.e. 45° on each side of the vertical centre line).

The total width shall be equal to that of the pipe clip. Where it is necessary to achieve this by the use of more than one layer of material, the layers shall be longitudinally bolted together. Where segmental rings are used, they shall be securely bolted together to give a total width equal to that of the pipe clip.

The bore diameter of the insulation shall be within 1 mm of the outside diameter of the pipe. The outside diameter of the insulation shall be equal to the specified bore diameter plus two radial thicknesses within a tolerance of ± 1.5 mm.

The pipe clip shall remain exposed and shall not be covered.

4.8 Constant effort supports (see A.2.2.2). The deviation in supporting effort, including friction, of constant effort supports shall not exceed ± 5 % of the specified load at any point in the travel required. Reduced deviation, where required, shall be agreed between the purchaser and the manufacturer but shall not be specified less than ± 2.5 %.

Deviation is the sum of the kinematic friction and a manufacturing tolerance factor. It is determined by a load test machine and shall be calculated by the equations:

$$\text{Deviation (+)} = \frac{\text{maximum load moving down} - \text{specified load}}{\text{specified load}} \times 100\ \%$$

$$\text{Deviation (–)} = \frac{\text{maximum load moving down} - \text{specified load}}{\text{specified load}} \times 100\ \%$$

All deviation tests shall be carried out with the constant effort unit supported in a similar manner to which it will be used in service.

Constant effort supports shall have provision for one site adjustment of a minimum of ± 20 % of the specified load. The specified load is that load which the purchaser requires the unit to be preset by the support manufacturer before dispatch from his works.

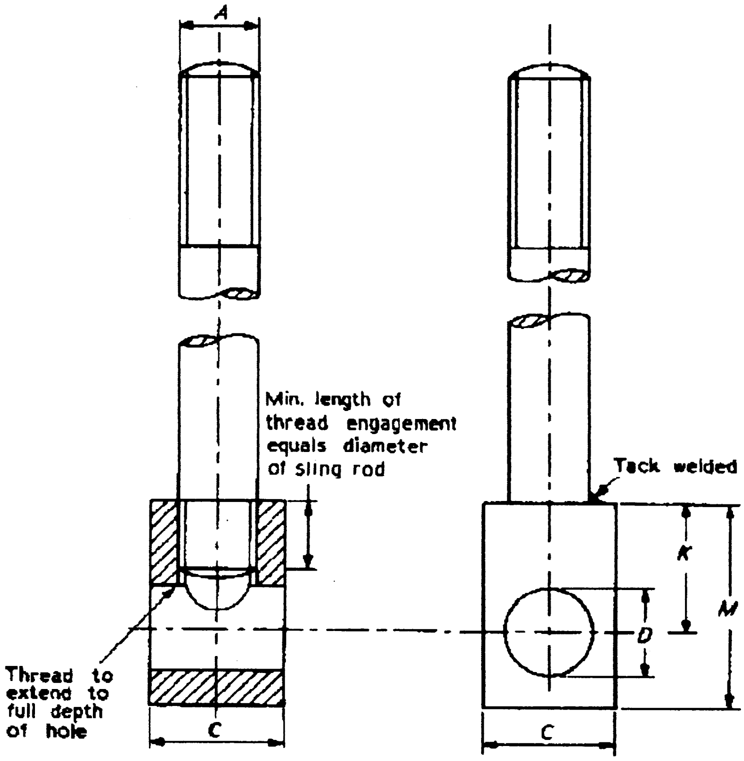


Figure 1 — Sling rod with screwed machined eye

Table 1 — Dimensions of sling rod with screwed machined eye

sling rod dia. *A*	*C*	*K*	*M*	*D* dia.	Safe working load
mm	mm	mm	mm	mm	kgf
8	22	16	25	10	230
10	22	19	30	12	360
12	22	22	35	14	530
16	28	28	45	18	1 010
20	32	35	55	22	1 580
24	38	40	65	26	2 280
30	50	52	85	33	3 650
36	55	60	95	39	5 340
42	70	70	110	45	7 400

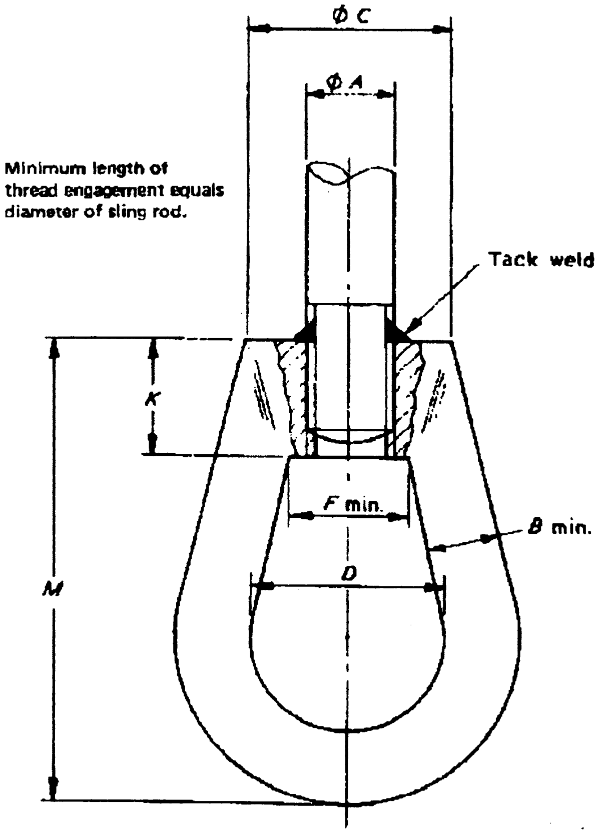


Figure 2 — Sling rod with weldless eye nut

Table 2 — Dimensions of sling rod with weldless eye nut

Sling rod dia. *A*	*D*	*B* min. (0.7 *A*)	*C* dia.	*F* min.	*K*	*M*	Safe working load
mm	mm	mm	mm	mm	mm	mm	kgf
8	25	6	32	12	16	64	230
10	25	7	32	14	16	64	360
12	30	9	38	16	18	73	530
16	30	12	38	20	18	73	1 010
20	40	14	45	24	25	102	1 580
24	50	17	50	28	28	124	2 280
30	75	21	70	34	38	146	3 650
36	75	26	70	40	38	146	5 340
42	100	30	80	46	45	180	7 400

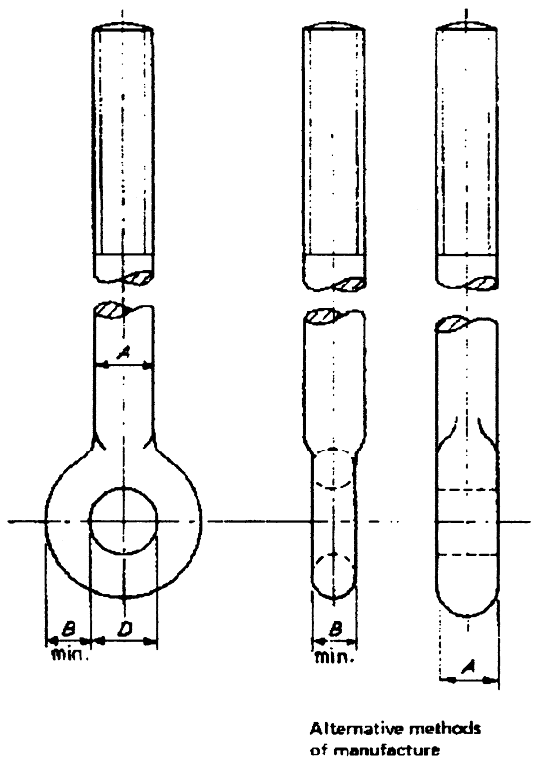


Figure 3 — Sling rod with integral forged eye

Table 3 — Dimensions of sling rod with integral forged eye

Sling rod dia.*A*	*D* dia.	*B* min. (0.7*A*)	Safe working load
mm	mm	mm	kgf
8	14	6	230
10	16	7	360
12	18	9	530
16	22	12	1 010
20	26	14	1 580
24	30	17	2 280
30	36	21	3 650
36	42	26	5 340
42	48	30	7 400

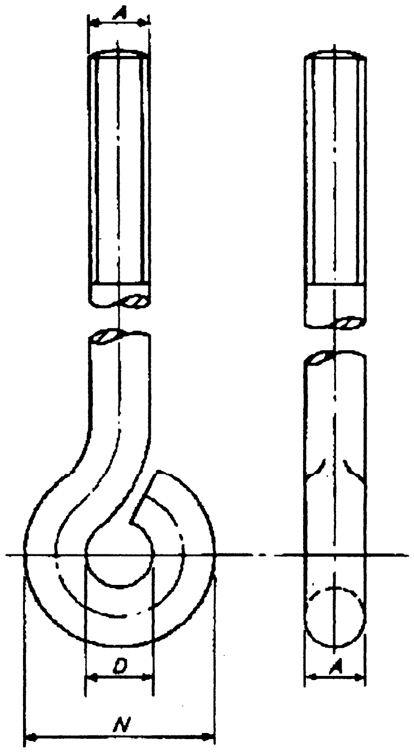


Figure 4 — Sling rod with hot formed eye

Table 4 — Dimensions of sling rod with hot formed eye

Sling rod dia.*A*	*D*	*N*	Safe working load
mm	mm	mm	kgf
8	10	26	70
10	12	32	105
12	15	39	160
16	19	51	285
20	24	64	430
24	28	76	660
NOTE The safe working loads given in Table 4 are those applicable to an open eye. The use of welding to close the eye shall not permit any increase in these working loads.			

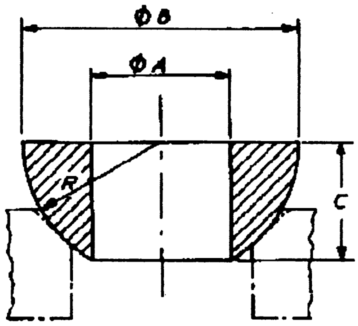


Figure 5 — Spherical washer

Table 5 — Dimensions of spherical washers

All dimensions in millimetres

Sling rod dia.	*A* dia.	*B* dia.	*C*	*R rad.*
10	12	24	10	12
12	15	30	13	15
16	19	38	16	19
20	24	48	21	24
24	28	56	24	28
30	35	70	30	35
36	42	84	36	42
42	48	96	42	48

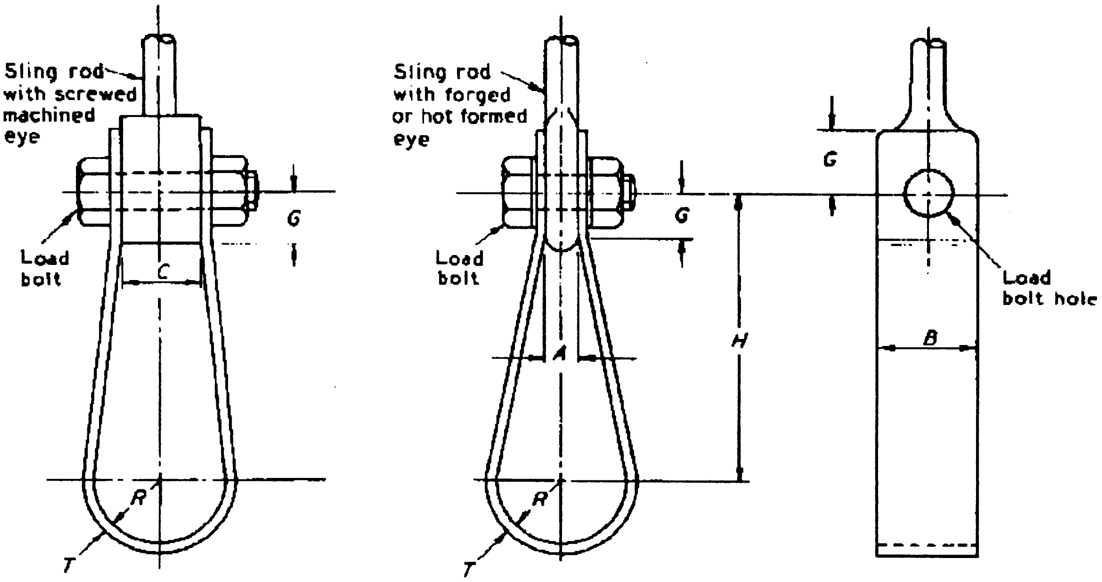


Figure 6 — One piece strap, Range A: – 20 °C to 100 °C

Table 6 — Dimensions of one piece strap (with screwed machined, forged and hot formed eye) for uninsulated steel pipe

Nominal pipe size	Pipe o.d.	Sling rod dia.	*C* or *A*	*R*	*B*	*T*	*G*	*H*	Load bolt hole	Load bolt	Safe working load
mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	mm	kgf
15	21.3	8	See	12	20	3	17	70	11	M8	70
20	26.9	8	Table 1,	14	20	3	17	75	11	M8	70
25	33.7	8	Table 3 and	17	20	3	17	75	11	M8	70
32	42.4	8	Table 4	22	20	3	17	80	11	M8	70

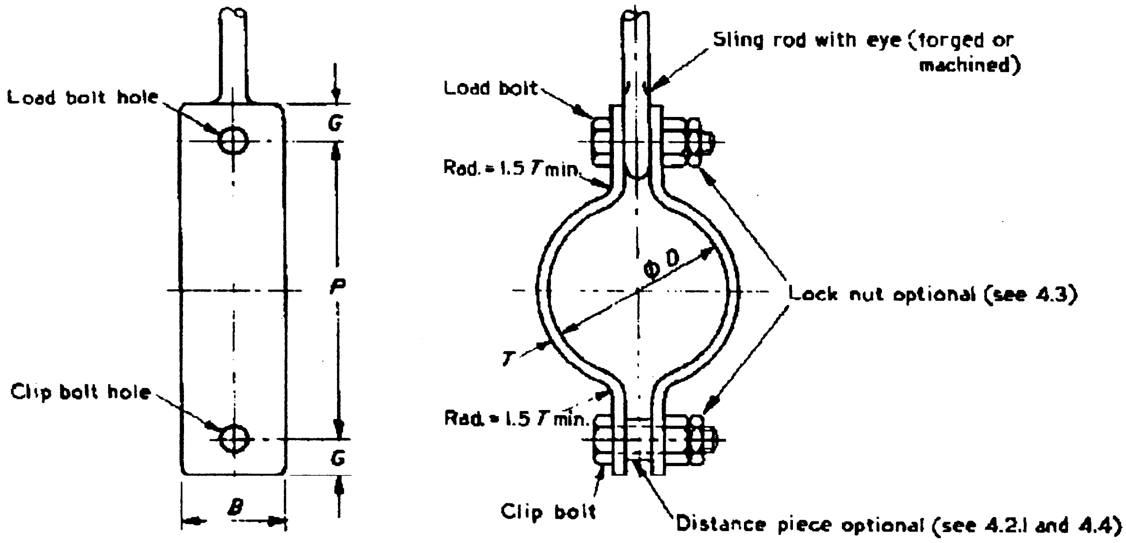


Figure 7 — Pipe clip for steel and cast iron pipes, Range A: – 20 °C to 100 °C (see Table 7 and Table 7a)

Table 7 — Dimensions of pipe clips for steel pipes, Range A: – 20 °C to 100 °C

Pipe size		Light series								Heavy series							
						Clip and load bolts								Clip and load bolts			
Nom. size	Outside dia.	Sling rod dia.	*D* dia.	Clip dimensions *B* × *T*	*P*	Bolt	Hole dia.	*G* min.	Safe working load	Sling rod dia.	*D* dia.	Clip dimensions *B* × *T*	*P*	Bolt	Hole dia.	*G* min.	Safe working load
mm	mm	mm	mm	mm	mm	mm	mm	mm	kgf	mm	mm	mm	mm	mm	mm	mm	kgf
15	21.3	USE HEAVY SERIES								10	23	35 × 5	65	M10	12	15	280
20	26.9									10	28	35 × 5	70	M10	12	15	280
25	33.7									10	36	35 × 5	75	M10	12	15	280
32	42.4									12	44	35 × 5	90	M12	15	18	280
40	48.3									12	50	35 × 5	95	M12	15	18	280
50	60.3									12	62	35 × 5	105	M12	15	18	280
65	76.1	12	80	35 × 5	125	M12	15	18	165	16	80	35 × 8	155	M16	19	24	450
80	88.9	12	92	35 × 5	135	M12	15	18	165	16	92	35 × 8	165	M16	19	24	450
100	114.3	12	118	35 × 5	170	M12	15	18	165	16	118	35 × 8	190	M16	19	24	450
125	139.7	16	144	35 × 5	195	M16	19	24	280	16	144	35 × 8	215	M16	19	24	450
150	168.3	16	172	35 × 5	225	M16	19	24	280	16	172	35 × 8	245	M16	19	24	450
175	193.7	16	198	35 × 8	270	M16	19	24	450	16	198	45 × 10	280	M16	19	24	900
200	219.1	16	224	35 × 8	295	M16	19	24	450	16	224	45 × 10	305	M16	19	24	900
225	244.5	16	248	35 × 8	320	M16	19	24	450	20	248	60 × 10	340	M20	24	30	1 350
250	273.0	16	278	35 × 8	350	M16	19	24	450	20	278	60 × 10	365	M20	24	30	1 350
300	323.9	20	330	45 × 10	420	M20	24	30	900	24	330	55 × 15	455	M24	28	36	1 800
350	355.6	24	362	55 × 10	460	M24	28	36	900	30	362	55 × 15	500	M30	35	45	2 250
400	406.4	24	412	60 × 15	535	M24	28	36	1 350	30	412	65 × 20	575	M30	35	45	2 700
450	457.0	30	464	65 × 20	625	M30	35	45	2 250	36	464	80 × 20	635	M36	42	54	3 600
500	508.0	30	516	65 × 20	675	M30	35	45	2 250	36	516	90 × 25	715	M36	42	54	4 500
550	559.0	30	566	65 × 20	725	M30	35	45	2 250	36	566	90 × 25	765	M36	42	54	4 500
600	610.0	30	618	80 × 20	780	M30	35	45	2 700	42	618	110 × 25	830	M42	48	63	5 900

Table 7a — Dimensions of pipe clips for cast iron pipes, Range A: – 20 °C to 100 °C

Pipe size		Light series								Heavy series							
Nom. size	Outside dia.	Sling rod dia.	D dia.	Clip dimensions B × T	P	Clip and load bolts: Bolt	Clip and load bolts: Hole dia.	G min.	Safe working load	Sling rod dia.	D dia.	Clip dimensions B × T	P	Clip and load bolts: Bolt	Clip and load bolts: Hole dia.	G min.	Safe working load
mm	mm	mm	mm	mm	mm		mm	mm	kgf	mm	mm	mm	mm		mm	mm	kgf
80	98	12	100	35 × 5	140	M12	15	18	165	16	100	35 × 8	165	M16	19	24	450
100	118	12	120	35 × 5	170	M12	15	18	165	16	120	35 × 8	190	M16	19	24	450
[a]150	170	16	172	35 × 5	225	M16	19	24	280	16	172	35 × 8	245	M16	19	24	450
[a]200	222	16	224	35 × 8	295	M16	19	24	450	16	224	45 × 10	305	M16	19	24	900
[a]250	274	16	278	35 × 8	350	M16	19	24	450	20	278	60 × 10	365	M20	24	30	1 350
[a]300	326	20	330	45 × 10	420	M20	24	30	900	24	330	55 × 15	455	M24	28	36	1 800
350	378	24	380	55 × 10	480	M24	28	36	900	30	380	55 × 15	520	M30	35	45	2 250
400	429	24	435	60 × 15	555	M24	28	36	1 350	30	435	65 × 20	595	M30	35	45	2 700
450	480	30	485	65 × 20	645	M30	35	45	2 250	36	485	80 × 20	655	M36	42	54	3 600
500	532	30	535	65 × 20	695	M30	35	45	2 250	36	535	90 × 25	735	M36	42	54	4 500
600	635	30	640	80 × 20	800	M30	35	45	2 700	42	640	110 × 25	850	M42	48	63	5 900

[a] These clips are identical with those for steel pipe of the same nominal size.

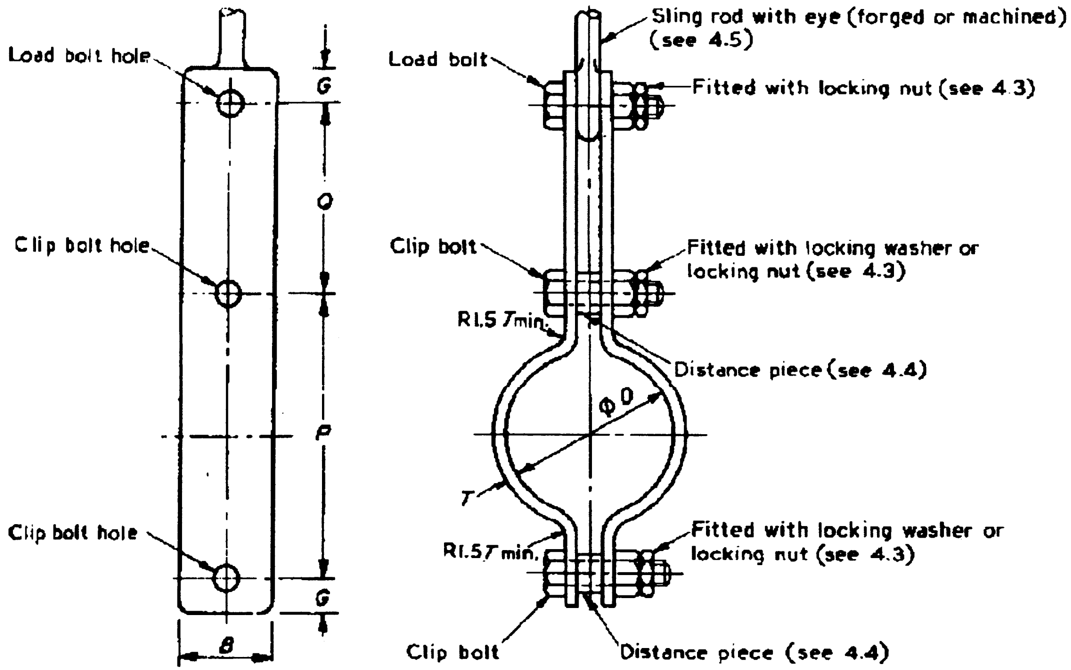


Figure 8 — Pipe clip for steel pipes, Range B: – 20 °C to 400 °C

Table 8 — Dimensions of pipe clips for steel pipes, Range B: – 20 °C to 400 °C

Pipe size		Light series									Heavy series								
Nom. size	Outside dia.	Sling rod dia.	*D* dia.	Clip dimensions *B* × *T*	*P*	*Q*	Clip and load bolts: Bolt	Clip and load bolts: Hole dia.	*G* min.	Safe working load	Sling rod dia.	*D* dia.	Clip dimensions *B* × *T*	*P*	*Q*	Clip and load bolts: Bolt	Clip and load bolts: Hole dia.	*G* min.	Safe working load
mm	mm	mm	mm	mm	mm	mm		mm	mm	kgf	mm	mm	mm	mm	mm		mm	mm	kgf
15	21.3	USE HEAVY SERIES									10	23	35 × 5	65	70	M10	12	15	280
20	26.9										10	28	35 × 5	70	70	M10	12	15	280
25	33.7										10	36	35 × 5	75	70	M10	12	15	280
32	42.4										12	44	35 × 5	90	70	M12	15	18	280
40	48.3										12	50	35 × 5	95	85	M12	15	18	280
50	60.3										12	62	35 × 5	105	80	M12	15	18	280
65	76.1	12	80	35 × 5	125	105	M12	15	18	165	16	80	35 × 8	155	90	M16	19	24	450
80	88.9	12	92	35 × 5	135	105	M12	15	18	165	16	92	35 × 8	165	95	M16	19	24	450
100	114.3	12	118	35 × 5	170	105	M12	15	18	165	16	118	35 × 8	190	95	M16	19	24	450
125	139.7	16	144	35 × 8	215	95	M16	19	24	280	16	144	35 × 8	215	95	M16	19	24	450
150	168.3	16	172	35 × 8	245	95	M16	19	24	280	16	172	35 × 8	245	95	M16	19	24	450
175	193.7	16	198	35 × 8	270	95	M16	19	24	280	20	198	45 × 10	288	85	M20	24	30	900
200	219.1	16	224	35 × 8	295	100	M16	19	24	280	20	224	45 × 10	315	95	M20	24	30	900
225	244.5	16	248	45 × 10	330	95	M16	19	24	450	20	248	55 × 15	365	85	M20	24	30	1 350
250	273.0	16	278	45 × 10	360	105	M16	19	24	450	20	278	55 × 15	390	90	M20	24	30	1 350
300	323.9	20	330	55 × 15	445	115	M20	24	30	900	24	330	65 × 20	475	115	M24	28	36	1 800
350	355.6	24	362	55 × 15	485	115	M24	28	36	900	30	362	65 × 20	525	115	M30	35	45	2 250
400	406.4	24	412	65 × 20	560	115	M24	28	36	1 350	30	412	90 × 25	600	115	M30	35	45	2 700
450	457.0	30	464	65 × 20	625	115	M30	35	45	1 800	36	464	90 × 25	660	115	M36	42	54	3 600
500	508.0	30	516	90 × 25	700	115	M30	35	45	2 700	36	516	100 × 30	740	115	M36	42	54	4 500
550	559.0	30	566	90 × 25	750	115	M30	35	45	2 700	36	566	100 × 30	790	115	M36	42	54	4 500
600	610.0	30	618	90 × 25	805	115	M30	35	45	2 700	42	618	100 × 35	880	115	M42	48	63	5 900

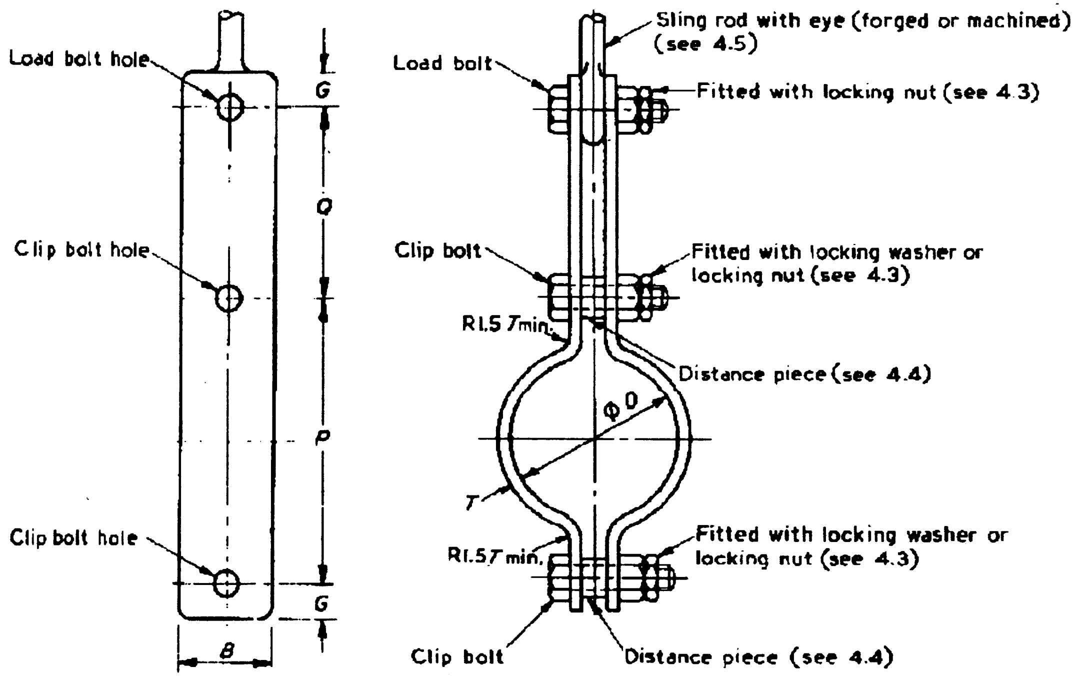


Figure 9 — Pipe clip for steel pipes, Range C: above 400 °C to 470 °C

Table 9 — Dimensions of pipe clips for steel pipes, Range C: above 400 °C to 470 °C

Pipe size		Light series									Heavy series								
Nom. size	Outside dia.	Sling rod dia.	*D* dia.	Clip dimensions *B* × *T*	*P*	*Q*	Clip and load bolts: Bolt	Clip and load bolts: Hole dia.	*G* min.	Safe working load	Sling rod dia.	*D* dia.	Clip dimensions *B* × *T*	*P*	*Q*	Clip and load bolts: Bolt	Clip and load bolts: Hole dia.	*G* min.	Safe working load
mm	mm	mm	mm	mm	mm	mm		mm	mm	kgf	mm	mm	mm	mm	mm		mm	mm	kgf
15	21.3	USE HEAVY SERIES									10	23	35 × 5	65	70	M10	12	15	280
20	26.9										10	28	35 × 5	70	70	M10	12	15	280
25	33.7	10	36	35 × 5	75	70	M10	12	15	90	10	36	35 × 8	95	60	M10	12	15	280
32	42.4	12	44	35 × 5	90	70	M12	15	15	90	12	44	35 × 8	110	60	M12	15	18	280
40	48.3	12	50	35 × 5	95	85	M12	15	15	90	12	50	35 × 8	115	75	M12	15	18	280
50	60.3	12	62	35 × 5	105	80	M12	15	15	90	12	62	35 × 8	125	70	M12	15	18	280
65	76.1	12	80	35 × 8	145	95	M12	15	18	165	16	80	35 × 8	155	90	M16	19	24	450
80	88.9	12	92	35 × 8	155	95	M12	15	18	165	16	92	35 × 8	165	95	M16	19	24	450
100	114.3	12	118	35 × 8	190	95	M12	15	18	165	16	118	45 × 10	200	90	M16	19	24	450
125	139.7	16	144	45 × 10	225	90	M16	19	24	280	16	144	45 × 10	225	90	M16	19	24	450
150	168.3	16	172	45 × 10	255	90	M16	19	24	280	16	172	45 × 10	255	90	M16	19	24	450
175	193.7	16	198	45 × 10	280	90	M16	19	24	280	20	198	55 × 15	315	75	M20	24	30	900
200	219.1	16	224	45 × 10	305	100	M16	19	24	280	20	224	55 × 15	340	80	M20	24	30	900
225	244.5	16	248	55 × 15	350	85	M16	19	24	450	20	248	65 × 20	390	70	M20	24	30	1 350
250	273.0	16	278	55 × 15	385	95	M16	19	24	450	20	278	65 × 20	415	80	M20	24	30	1 350
300	323.9	20	330	65 × 20	470	115	M20	24	30	900	24	330	90 × 25	505	115	M24	28	36	1 800
350	355.6	24	362	65 × 20	510	115	M24	28	36	900	30	362	110 × 25	550	115	M30	35	45	2 250
400	406.4	24	412	90 × 25	585	115	M24	28	36	1 350	30	412	120 × 30	625	115	M30	35	45	2 700
450	457.0	30	464	110 × 25	650	115	M30	35	45	1 800	36	464	120 × 35	710	115	M36	42	54	3 600
500	508.0	30	516	120 × 30	725	115	M30	35	45	2 250	36	516	110 × 45	815	115	M36	42	54	4 500
550	559.0	30	566	120 × 30	775	115	M30	35	45	2 250	36	566	110 × 45	865	115	M36	42	54	4 500
600	610.0	30	618	120 × 35	855	115	M30	35	45	2 700	42	618	130 × 50	955	115	M42	48	63	5 900

5 U-bolts, hook bolts and overstraps

5.1 General. U-bolts, hook bolts and overstraps shall be of the types detailed below and illustrated in Figure 10, Figure 11a and Figure 12 respectively.

1) U-bolt (not to grip the pipe), required where it is undesirable to restrict longitudinal movement (see Figure 10).

2) U-bolt (to grip the pipe), required where it is necessary to hold the pipe in all directions (see Figure 11a).

3) Hook bolt, required where it is necessary to steady the pipe (see Figure 11b).

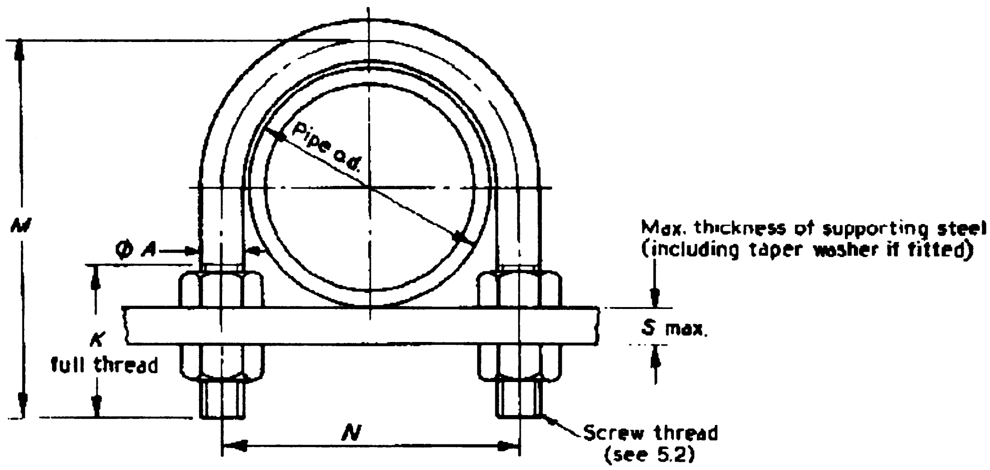
4) Overstrap as detailed in Figure 12.

5.2 Material and manufacture. All U-bolts, hook bolts and overstraps shall be manufactured from material complying with the requirements of BS 4360:Grade 43A.

Threads shall comply with the requirements of BS 3643– 2:Class 8g.

Nuts shall comply with the requirements of BS 4190: Grade 4 material. The top nuts in Figure 10 and the bottom nuts in Figure 11a and Figure 11b should preferably be of the “thin” type but this is not mandatory.

5.3 Dimensions. The dimensions of U-bolts (not to grip the pipe) shall be in accordance with those given in Table 10. The dimensions of U-bolts (to grip the pipe) and of hook bolts shall be in accordance with those given in Table 11 and the dimensions for overstraps shall be in accordance with those given in Table 12.



NOTE Where used on taper flanges of steelwork taper washers are to be provided.

Figure 10 — U-bolt (not to grip pipe)

Table 10 — Dimensions of U-bolts (not to grip pipe)

All dimensions in millimeters

Nom. pipe size	pipe o.d.	*A* dia.	*N*	*M*	*K*	*S* max.
Steel pipes						
15	21.3	8	40	45	25	10
20	26.9	8	45	55	30	10
25	33.7	8	50	60	30	10
32	42.4	8	60	70	30	10
40	48.3	10	65	85	40	16
50	60.3	10	80	100	40	16
65	76.1	12	95	120	50	19
80	88.9	16	110	140	55	19
100	114.3	16	140	165	55	19
125	139.7	16	165	190	55	19
150	168.3	20	195	225	65	19
175	193.7	20	220	250	65	19
200	219.1	20	250	275	65	19
225	244.5	20	275	300	65	19
250	273.0	20	305	335	75	22
300	323.9	20	355	385	75	22
350	355.6	24	390	425	80	22
400	406.4	24	440	475	80	22
450	457.0	24	495	525	80	22
500	508.0	24	545	575	80	22
550	559.0	24	595	625	80	22
600	610.0	24	645	675	80	22
Cast iron pipes						
80	98	16	120	150	55	19
[a]100	118	16	140	165	55	19
[a]150	170	20	195	225	65	19
[a]200	222	20	250	275	65	19
[a]250	274	20	305	335	75	22
[a]300	326	20	355	385	75	22
350	378	24	410	450	80	22
400	429	24	465	500	80	22
450	480	24	520	550	80	22
500	532	24	570	600	80	22
600	635	24	670	700	80	22

[a] These U-bolts are identical with the equivalent sizes for steel pipe.

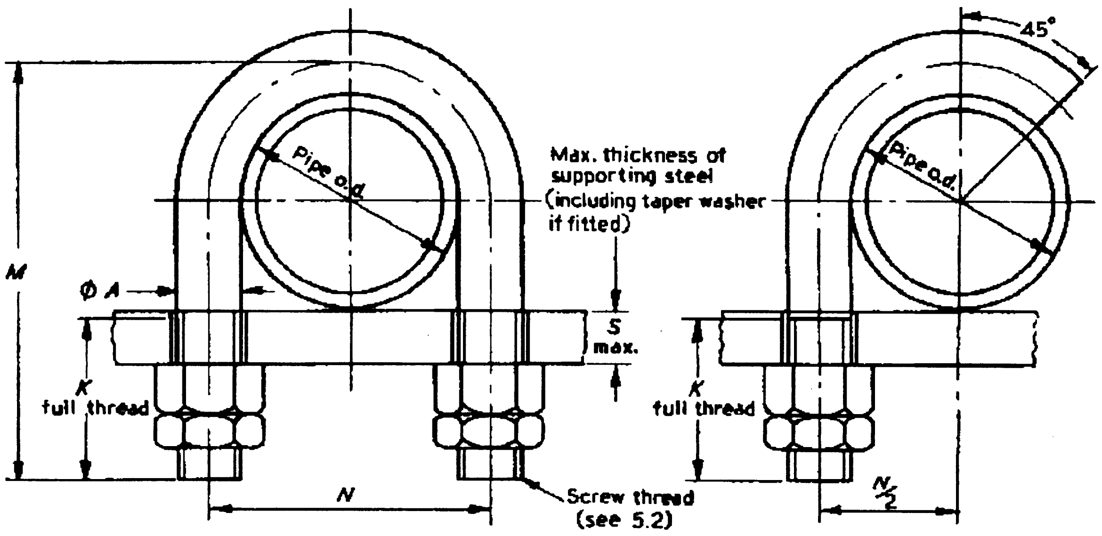


Figure 11a — U-bolt (to grip pipe) **Figure 11b — Hook bolt**

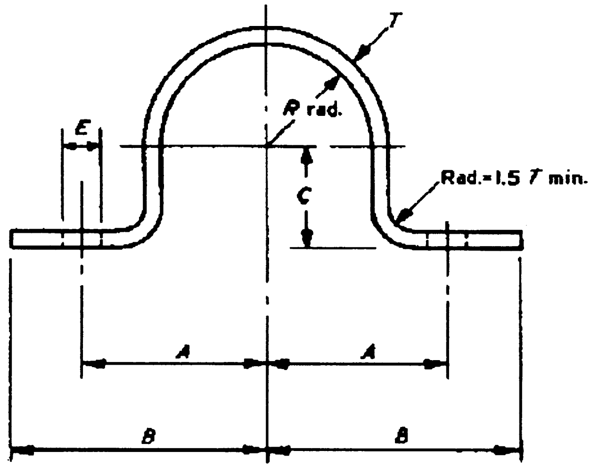


Figure 12 — Overstrap

Table 11 — Dimensions of U-bolts (to grip pipe) and hook bolts

All dimensions in millimeters

Nom. pipe size	pipe o.d.	*A* dia.	*N*	*M*	*K*	*S* max.
Steel pipes						
15	21.3	8	30	50	25	7
20	26.9	8	35	60	25	10
25	33.7	8	45	65	25	10
32	42.4	8	55	75	25	10
40	48.3	10	60	90	35	16
50	60.3	10	75	100	35	16
65	76.1	12	90	130	45	19
80	88.9	16	105	150	50	19
100	114.3	16	135	175	50	19
125	139.7	16	160	200	50	19
150	168.3	20	190	235	55	19
175	193.7	20	215	260	55	19
200	219.1	20	245	295	55	19
225	244.5	20	270	310	55	19
250	273.0	20	300	350	60	22
300	323.9	20	350	400	60	22
350	355.6	24	385	440	65	22
400	406.4	24	435	500	65	22
450	457.0	24	485	540	70	22
500	508.0	24	540	600	70	22
550	559.0	24	590	650	70	22
600	610.0	24	640	700	70	22
Cast iron pipes						
80	98	16	115	160	50	19
[a]100	118	16	135	175	50	19
[a]150	170	20	190	235	55	19
[a]200	222	20	245	295	55	19
[a]250	274	20	300	350	60	22
[a]300	326	20	350	400	60	22
350	378	24	405	460	65	22
400	429	24	455	520	65	22
450	480	24	505	560	70	22
500	532	24	560	620	70	22
600	635	24	660	720	70	22

[a] These U-bolts and hook bolts are identical with the equivalent sizes for steel pipe.

Table 12 — Dimensions of overstraps

All dimensions in millimetres

Nom. pipe size	Pipe o.d.	*A*	*B*	Steel size *W* × *T*	*C*	*R*	Hole *E*	Bolt dia.
15	21.3	53	91	35 × 5	10	11.5	12	10
20	26.9	55	93	35 × 5	13	14	12	10
25	33.7	57	95	35 × 5	16	18	12	10
32	42.4	64	102	35 × 8	20	22	15	12
40	48.3	79	117	35 × 8	23	25	15	12
50	60.3	81	119	35 × 8	29	31	15	12
65	76.1	89	127	45 × 10	36	40	19	16
80	88.9	99	137	45 × 10	43	46	19	16
100	114.3	108	146	45 × 10	55	59	19	16
125	139.7	119	160	60 × 10	68	72	24	20
150	168.3	136	174	60 × 10	82	86	24	20
175	193.7	155	195	55 × 15	95	99	24	20
200	219.1	170	210	55 × 15	107	112	24	20

6 Slider type supports

6.1 General. Slider supports consist of two main components, one being attached to the pipe line and fabricated from tee sections, channel sections or plate as shown in Figure 13 to Figure 16. The other component consists of a base member on which the item attached to the pipe rests and slides.

The tee or channel should be cut from rolled steel sections complying with the requirements of BS 4-1 or fabricated from plate in accordance with the requirements of BS 4360:Grade 43A.

Sliders for use with large pipes shall incorporate a radiused saddle to distribute the loads as shown in Figure 14.

For pipe lines having an outside diameter up to and including 273 mm, the tee section slider support is preferred, as it is lighter in weight than the channel type, and insulation is easier to apply.

For pipe lines having an outside diameter greater than 273 mm the channel section design is preferred for the following reasons.

1) During erection, the pipe can be laid in the channel section slider and need not be welded until all alignments and adjustments have been carried out.

2) When the pipe is required to be held from moving in a transverse direction, the channel section is stronger. In particular, the welds joining the channel to the pipe are not so highly stressed; they can, therefore, be lighter and also, being spaced further apart, are less likely to cause distortion.

3) When the design is such that strengthening gussets are required on the slider supports, the gussets in the fabricated channel form do not require shaping to the contour of the pipe, nor welding to it (see Figure 16a).

Guides shall be provided where necessary to prevent or limit movement (see Figure 37).

NOTE It is essential that care is taken in designing attachments to highly stressed piping systems in order that overstressing of the pipe does not occur due to restrained differential expansion between it and the slider foot.

6.2 Dimensions of slider and bearer. The width of the base of the slider support, independent of shape, shall be not less than 0.4 times the outside diameter of the pipe.

The depth of the slider support shall be such that there is a minimum clearance of 25 mm between the outside of the insulation and the bearing surface.

Where tracing or heating pipes are used, the depth of the fixed component may need to be increased to allow for the tracing pipe lines.

The length of the slider shall be such that it shall overlap the bearer at each end of its travel by 50 mm, or by 25 % of the calculated movement between minimum and maximum temperature, whichever is the greater. The length of the bearer shall be such that it accommodates lateral movement with the same margins on travel as specified for the slider (see Figure 17). The length of the slider and/or bearer shall allow for movement due to cold pull.

6.3 Low friction bearing pad. On certain pipelines it may be necessary to reduce the friction between the slider support and its bearing member to avoid excessive load on the pipe anchorage or buckling of the pipe. Anti-friction pads, of material such as polytetrafluoroethylene (PTFE) or impregnated composite metals, should be used. Before specifying such materials, the manufacturers should be consulted with regard to temperature limitations and load bearing capacity.

NOTE PTFE is electrically insulating and, in hazardous areas, additional earthing may be required against static electric discharges.

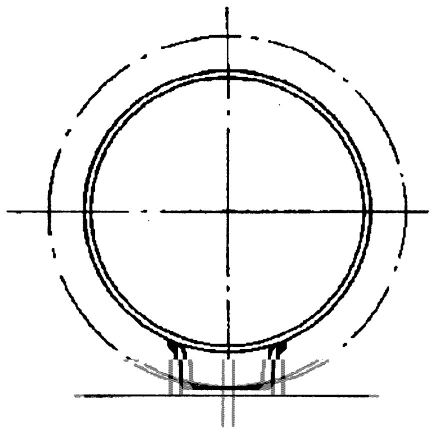


Figure 13 — Channel section slider support

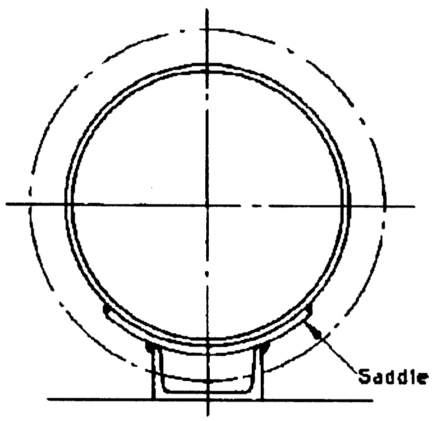


Figure 14 — Channel section slider support with saddle plate

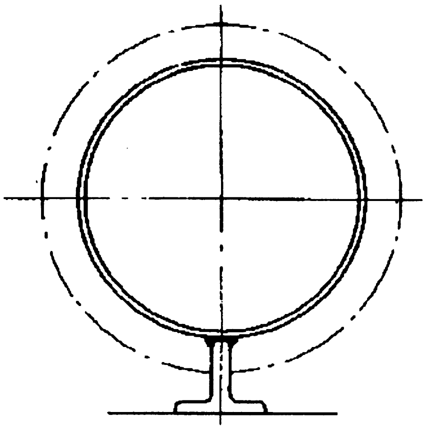
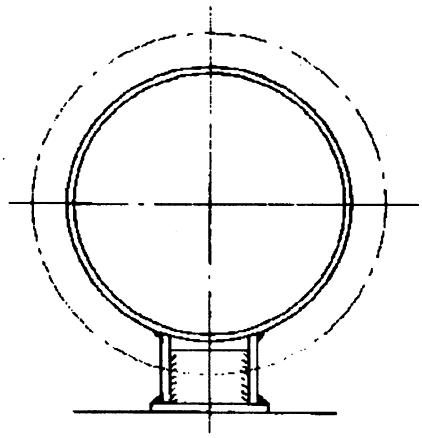
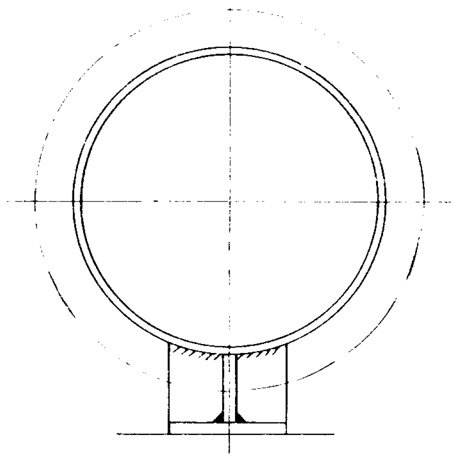


Figure 15 — Tee section slider support

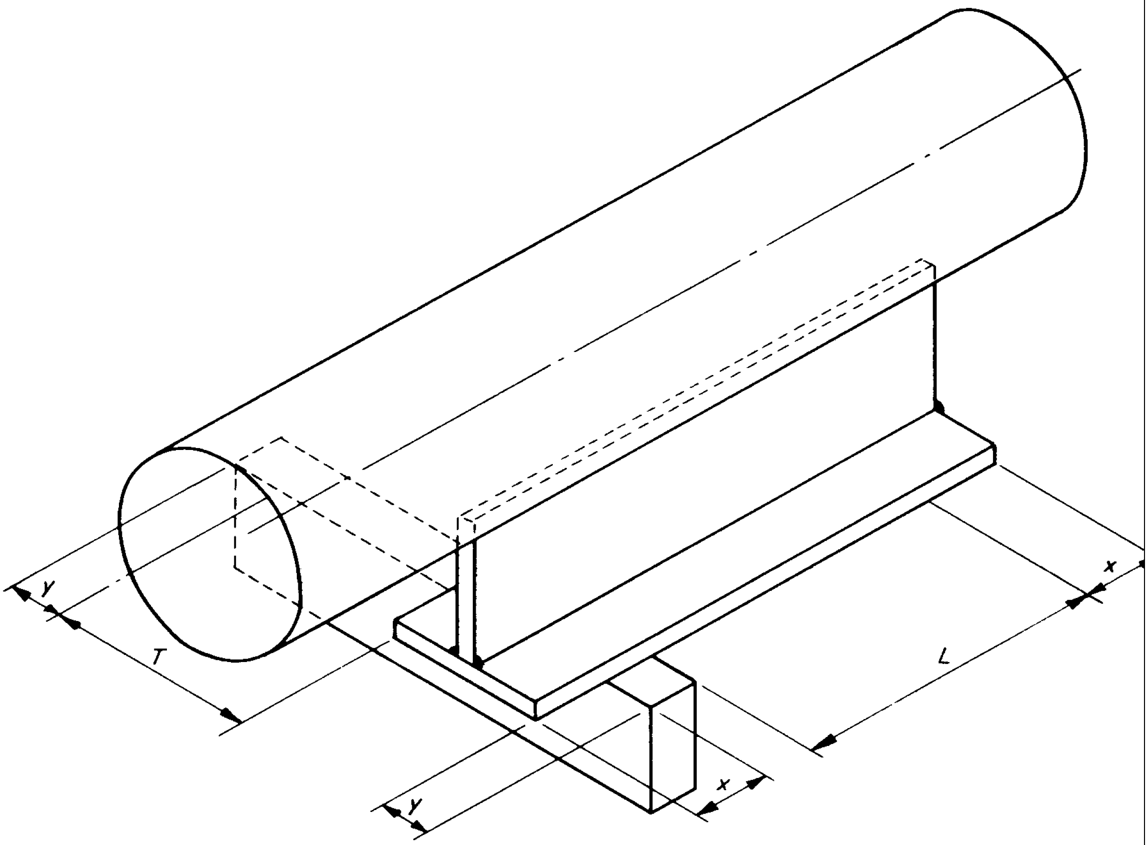


16 a



16 b

Figure 16 — Fabricated plate slider supports



L is the calculated longitudinal movement in millimetres
x is 0.25 *L* or 50 mm, whichever is the greater (after cold pull, if any, is applied)
T is the calculated transverse movement in millimetres
y is 0.25*T*, or 50 mm, whichever is the greater (after cold pull, if any, is applied)

Figure 17 — Illustration of overlap and movement of slider on bearer

7 Roller type supports

7.1 Roller supports are necessary under certain conditions and a simple parallel roller of limited application is specified for general use with pipe sizes up to 150 mm nominal bore. For other sizes and heavier duties, it is recommended the rollers be individually selected or designed for the particular application.

The use of simple roller supports is sometimes limited by the following factors.

1) Single roller supports cannot be used as guides to restrict lateral movement of pipes. The "waisted" or "hour glass" shaped rollers do not provide any substantial resistance to such movement. An assembly using two rollers fitted at 30° to 45° from the vertical centre line does, however, provide some resistance to lateral movements.

2) Rollers, unless fitted with a special design of bearing, frequently do not rotate, but the pipe slides on the face of the stationary rollers.

3) When pipelines are insulated, an additional bearing member which projects just beyong the maximum insulating thickness should be attached to the pipe. This will permit the insulation to be applied clear of the roller.

7.2 Dimensional requirements. The dimensions of the roller support assemblies shall be as illustrated in Figure 18, Figure 19 and Figure 20, and are suitable for supporting pipes up to 150 mm nominal size inclusive.

Rollers shall be supported on:

1) cast iron chair, of dimensions 127 mm × 50 mm,

2) rolled steel channel, of dimensions 102 mm × 51 mm, or

3) channel section formed from rolled steel flat of 10 mm thickness.

7.3 Manufacture. The rollers shall be made from the following materials:

1) malleable cast iron roller with integral cast spindle

2) cast iron roller with mild steel spindle

3) solid mild steel roller with integral spindle

4) Mild steel roller fabricated from tube and bar.

Any combination of roller and roller chair may be used.

The material shall conform to the standards given in the schedule of materials (see clause **3**).

8 Workmanship

All components shall be true to shape and free from burrs and sharp corners. All bolt holes shall be accurately located and free from distortion.

9 Inspection

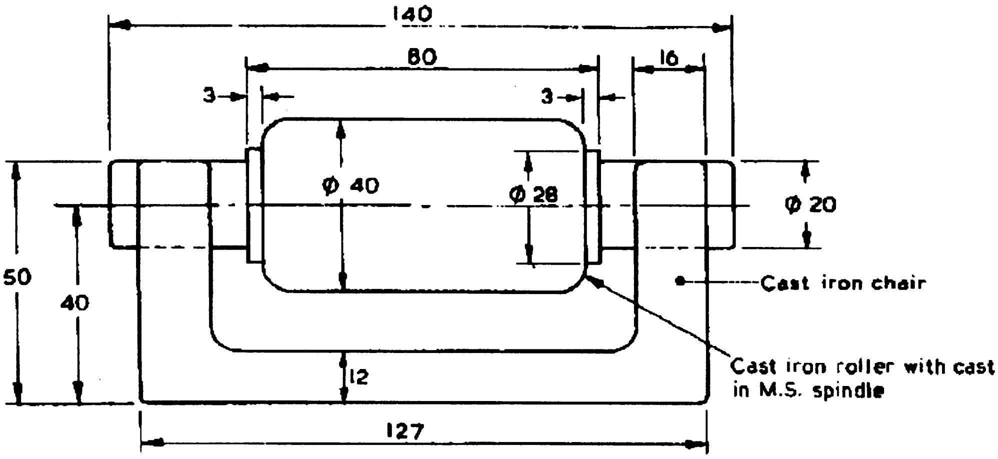
The purchaser or his representative, for the purpose of inspection, shall have access by arrangement at all reasonable times to those parts of the manufacturer's works where the components are being made.

10 Manufacturer's certificate

The purchaser shall, on request, be entitled to a certificate stating that the components comply with the requirements of this specification.

11 Packaging and identification

The purchaser shall indicate to the manufacturer or supplier, at the time of ordering, his requirements as to identification and packaging of all components.



All dimensions in millimetres

Figure 18 — Roller type support with cast iron roller and chair

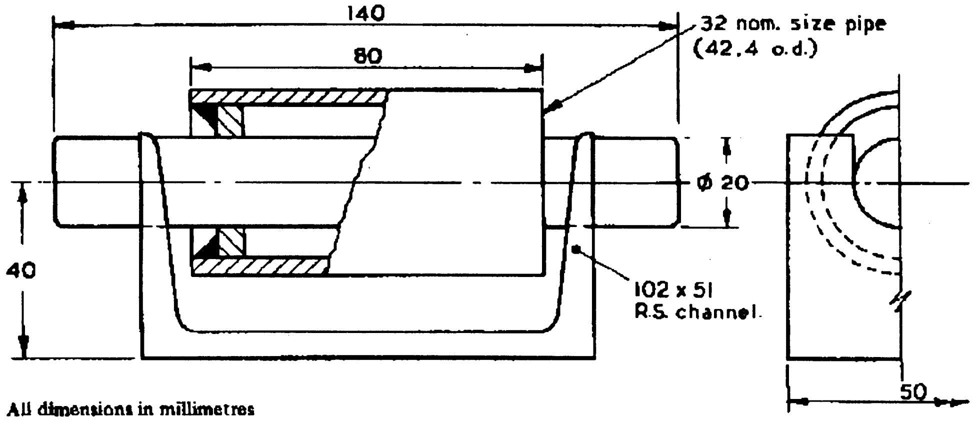


Figure 19 — Roller type support with fabricated roller and rolled steel channel chair

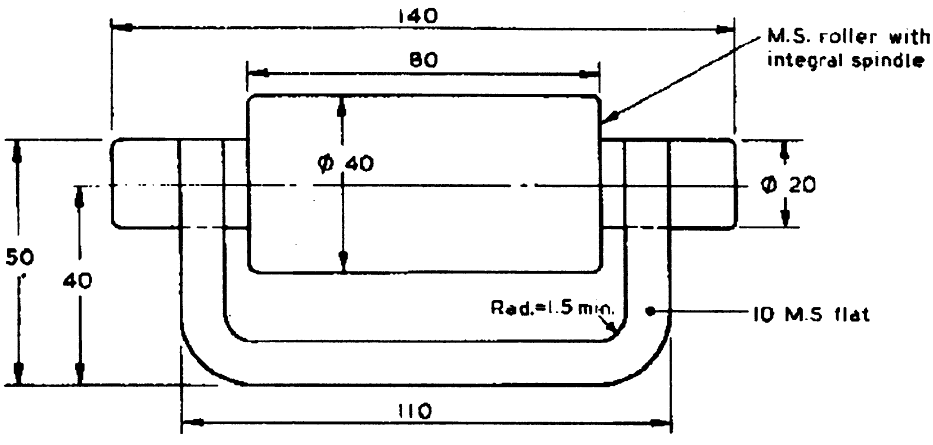


Figure 20 — Roller type support with mild steel roller and chair formed from rolled steel flat

Appendix A Design considerations

The primary aim in the design of pipe hangers and supports is to prevent the occurrence of excessive stresses in pipes or connected equipment by safe, adequate and economic means. It is not possible to devise standard designs for every application, as in many cases, for reasons of economy and convenience, supports are attached to existing structures. In such cases, spacing and details are predetermined largely by existing circumstances.

A.1 Requirements and limitations. All pipe supports should comply with accepted or approved safety requirements of a general nature with regard to the selection of materials, safety factors to be used in design, limitations in design and minimum dimensions, and selection of the correct type of equipment.

Such requirements may be summarized as follows.

1) *Selection of materials.* Steel should be used in preference to other materials, but cast iron may be used for compressive loads. Materials such as wood, except where employed as an insulant, should be used for temporary supports during erection only.

2) *Limitations on design and minimum dimensions.* Design limitations set by existing piping codes are of a general nature. These do not go beyond the requirements that supports should prevent excessive stresses, undue variations in supporting effort and excessive vibration. The proportions of piping supports should be sufficiently adequate, not only to comply with normal design requirements, but also to cope with atmospheric conditions (e.g. corrosion) and other conditions to which the supports may be subjected. Loads due to hydraulic testing, wind, ice, snow and maintenance work should all be taken into account. Where the temperature of supporting components may fall below – 20 °C, consideration should be given to the use of low-temperature steels particularly where part of the support is welded to the pipe itself.

3) *Selection of equipment.* There is usually little difficulty in selecting suitable supports when piping will not be subjected to temperature changes beyond the normal ambient range. In such cases it is only necessary to provide for vertical adjustment in order to level the pipeline after the piping is in place. Where temperature changes have to be allowed for, flexibility should be ensured in the pipeline by the use of suitable anchors, guides, rollers and spring hangers.

The designer of pipeline supports should exercise his knowledge, experience and preference to the best advantage within the framework of the foregoing requirements in order to provide equipment of ample strength at reasonable cost.

A.2 Design procedure. Time and expense of installation can be saved by careful and accurate assessment of the mass of the piping and of the associated equipment to be supported. A systematic design procedure is essential therefore and, if necessary, can be undertaken by computerized methods. This involves consideration of spans and location of supports, selection of the appropriate type of support, and installation factors. Notes on these are given in **A.2.1**, **A.2.2** and **A.2.3**.

A.2.1 *Spans and location of supports.* Beam formulae are used to calculate pipe deflections and bending stresses. Pipes are usually assumed to be simply supported or unrestrained rather than supported as beams with fixed ends. The recommended maximum spans for steel pipes given in Table 14 ensure that both the pipe deflections and the corresponding bending stresses are small and well within normal requirements. The deflections and stresses can be calculated from the data in Appendix B.

Recommended maximum spans for flanged cast iron pipes are shown in Table 16.

In order to provide support at positions of concentrated loads and changes of direction, it may be necessary to use smaller spans while, in other cases, it may be advisable to provide supports near the pipe joints. In some instances spans may be arranged to coincide with building columns to which it is convenient to attach supports, and sometimes it may be advisable to increase the pipe diameter over a part of the line in order to allow greater distances between supports.

Anchors are used where it is necessary to ensure fixed points for pipe loops or bends to absorb the thrust caused by thermal expansion or contraction. Anchors for bellows or slip expansion joints should be designed to withstand the force required to deflect the joint (which should be specified by the manufacturer), as well as friction force and the force due to pressure under operating conditions or test conditions if applicable.

Table 13 — Mass per metre run of steel pipe filled with fresh water and of insulation (density 200 kg/m^3)

Nominal pipe size	Mass of insulation		Mass of pipe and water									
	50 mm thick	25 mm thick	Pipe wall thickness (mm)									
			3.2	4.0	5.0	6.3	8.0	10.0	12.5	16.0	20.0	25.0
mm	kg/m	kg/m	kg/m	kg/m	kg/m	kg/m	kg/m	kg/m	kg/m	kg/m	kg/m	kg/m
20	2.4	0.8	2.2	2.5	2.9	3.4						
25	2.6	0.9	3.0	3.4	4.0	4.6	5.3					
40	3.1	1.2	4.9	5.6	6.5	7.5	8.8	10				
50	3.5	1.3	6.8	7.7	8.8	10.2	11.9	14	16			
65	4.0	1.6	9.6	11	12	14	16	19	22	25	29	
80	4.4	1.8			15	17	20	23	27	31	36	
100	5.2	2.2			22	25	28	33	38	44	51	58
125	6.0	2.6			30	33	38	43	50	58	67	77
150	6.9	3.0			40	44	50	56	64	75	86	99
200	8.5	3.8					74	83	93	108	123	142
250	10.1	4.7					104	115	129	147	167	192
300	11.7	5.5						150	166	188	213	243
350	12.7	6.0						174	192	216	244	277
400	14.3	6.8						215	236	264	296	335
450	15.9	7.6						260	283	316	352	397
500	17.5	8.4						310	336	372	413	463
600	20.7	10.0						421	452	496	546	606

NOTE 1 kg results in a force of 9.807 newtons (N).

Table 14 — Recommended maximum spans for straight run of steel pipes excluding fittings

Nominal pipe size (mm)	20	25	40	50	65	80	100	125	150	200	250	300	350	400	450	500	600
Span A (m)	2.5	3.0	3.5	4.0	4.5	5.5	6.0	6.5	7.0	8.5	9.0	10.0	10.0	10.5	11.0	12.0	14.0
Span B (m)	2.5	3.0	4.0	4.5	5.0	5.5	6.5	7.0	8.0	9.5	10.5	11.5	11.5	12.5	13.0	13.5	14.5

NOTE The spans A and B given in Table 14 are based on using the thinnest and thickest wall respectively, for which a mass of pipe and water is given in Table 13 with 50 mm thick lagging throughout. This ensures that the pipe bending stresses do not exceed 25 N/mm^2 due to self weight only.

Table 15 — Mass per unit length of flanged grey iron pipes when filled with water

Nominal pipe size	Length overall	Class 3 (BS 4622)	Class 4 (BS 4622)
		Mass	Mass
mm	m	kg	kg
80	3	75	81
100	3	98	107
150	3	174	189
200	4	353	380
250	4	502	541
300	4	678	727
350	4	881	
400	4	1 105	
450	4	1 353	
500	4	1 631	
600	4	2 260	

Table 16 — Recommended maximum spans for flanged grey iron pipes

Nominal pipe size	Standard length	Recommended maximum span
mm	m	m
80 to 150	3	6
200 to 600	4	8

A.2.2 *Selection of supports.* Figure 21 to Figure 46 illustrate various types of supports and anchors. It is essential, however, that the selection of the type most suited to a particular installation be left to the designer. The pipes should preferably be routed along those parts of buildings and structures where appropriate supports can be attached. The type of support will have to suit immediate local conditions and in practice will probably differ over the length of the pipe run. Pipes should preferably be grouped together where they cross open sites and should be fixed on common supports.

Where pipes are to be graded, it is usually more convenient to use supports which allow for adjustment during erection. If grading is unnecessary, the supports will need to be accurately levelled before the piping is erected.

It is preferred that angular movements of hangers should be limited where possible to 5° from the vertical, particularly where spherical washers are used.

Turnbuckles can be used for joining lengths of sling rod and they provide a convenient method of adjusting the length of the sling rod.

A form of spring support or sway brace is used to damp vibration, which is always undesirable in pipelines but is sometimes inherent in the system. It may be due to a number of causes varying from wind effects to the pulsations emanating from reciprocating pumps or compressors. Such vibrations are often difficult to isolate.

It is important to avoid the use of long unsupported lengths of pipe which cause objectionable resonance, though this can be minimized or eliminated by clamping pipes at suitable intervals. If this cannot be done, then damping can be effected by the use of spring or special hydraulic dampers, the application of which needs careful consideration, otherwise further vibrations may start up to worsen existing conditions.

Pipe guides are installed in order to allow longitudinal movements and to prevent unwanted transverse movement. They are generally used with anchors to direct the linear expansion or contraction of pipes. If pipes are laid on sleepers, guides should be provided at alternate points.

Sway bracing is used to reduce abnormal movement or shock, the cushioning effect being provided by opposing preloaded springs or tie rods as indicated in Figure 34. This form of bracing should be applied in two or more directional planes and its effect on pipe flexibility will have to be taken into account in the design of the pipe system.

Coil springs should be incorporated in the support design where the movement of the pipe is in the upward and downward direction, care being taken to ensure that the change in supporting effort between hot and cold conditions is not excessive.

Spring hangers are illustrated in Figure 32, Figure 33 and Figure 42 and may be incorporated in either horizontal or vertical pipelines. Their correct functioning depends on a proper balance between the mass of the pipeline under working conditions and the supporting effort.

Springs should be provided with stops to prevent large deflections which might cause excessive spring stresses unless the spring has been designed so that it is within the allowable stresses even when all coils are closed solid. The springs should also be provided with means to prevent misalignment or buckling. They should be designed for the maximum working load at the point of attachment on to the pipe. In the case of a steam, gas or air main subject to hydraulic test, the support components should be designed to take the additional load but the spring should be locked or gagged to avoid transmitting this additional load to the coils.

Springs for use with the hangers should be fabricated in accordance with the requirements of BS 1408 and BS 1726-1. Precautions should be taken to ensure that the working parts of spring hangers are always free to move.

A.2.2.1 *Variable load support spring hangers (Figure 32 and Figure 33).* In this type of hanger the mass to be supported is transferred directly from the hanger rod to a helical spring or springs. Such an assembly may be used where the calculated pipe movement is small, but it suffers from the drawback of all such spring arrangements, i.e., the supporting effort varies with the spring deflection.

This type, therefore, should be used only when the range of pipe movement limits the variation in supporting effort to a small figure. It is usual in such cases, to employ spring hangers that are designed or selected for a maximum variation in supporting effort of 25 % between hot and cold positions.

Two typical variable support assemblies are illustrated in Figure 32 and Figure 33.

A.2.2.2 *Constant effort support spring hangers.*(Figure 36) Where large vertical expansion or contraction movement occurs, and it is essential that no change in supporting effort be exerted on the pipework or attachment steelwork, constant effort supports may be employed. The hangers ensure that the applied load at the point of support is just balanced throughout the whole range of pipe movement. This feature helps to minimize out-of-balance forces due to deadweight or supporting effort where the piping connects to anchors and/or equipment.

A number of hanger designs are available that, by means of spring assemblies coupled with compensating devices, keep the supporting effort substantially constant (see Figure 36).

A.2.3 *Installation factors.* Supports, with the exception of springs, will have to be designed to carry the loading caused by the most severe combination of any of the following:

1) mass of the pipe, including operating or testing medium, insulation and associated equipment,

2) expansion and contraction,

3) reaction due to pumping effects and discharge to atmosphere where this may occur,

4) wind, snow or ice loads.

In some cases the following may also affect the design of supporting equipment:

5) method of attachment to existing steelwork,

6) additional loads which may arise from future extensions or be imposed during erection or maintenance,

7) corrosion,

8) clearance or head room required at railways, roads, walkways or tunnels.

A.3 Design analysis of pipe clips. To establish the stress level in a pipe clip of the shape shown in Figure 7, Figure 8 and Figure 9, it was necessary to determine the bending moment distribution through the clip when subjected to loads.

It was considered that if the pipe clips were bolted tight on to the pipe then the load would vary according to the degree of tightening applied to the clip bolts and the clip stress level, therefore, would be indeterminate. To enable a realistic analysis to be made, the clip dimensions were established (see Table 7, Table 8 and Table 9) and distance pieces between the half clips incorporated to ensure that the two clip halves could not be tightened onto the pipe being supported.

For the purposes of the analysis, it was considered that any deformation of the pipe clip would cause the clip to form on to the bottom half of the pipe but would pull the top half of the clip away from the pipe. The design philosophy is therefore that the top half of the clip is pulled upwards away from the anchored positions at the 180° centre line.

It was considered that the analysis would be most readily accomplished if an approach, generally used for the assessment of irregular shapes, could be used, and for this reason pipework flexibility analysis was used to establish a "thrust line" (i.e. line of zero bending) and from this zero position bending moment distribution throughout the clip shape was ascertained as also was the tensile load through the attachment bolt.

A computer program for pipework flexibility analysis was available and was used to establish moment levels throughout the complete range of clips covered by the standard. To ensure that stress levels as defined in **4.2.1** were not exceeded, due allowance was made for stress intensification at the clip neck radius. Subsequent tests on a strain gauged clip subjected to a predetermined load have shown a good result in comparison with the theoretical levels.

Appendix B Data and formulae for pipework calculations

The data and formulae in this appendix, although relating mainly to the design of the pipework itself, may have to be taken into account when considering the pipe supports.

B.1 Loads on pipes

1) *Maximum bending stresses between pipe supports* are given by the following expressions.

Single span simply supported:

$$f_{\text{max.}} = \frac{D}{I}\left(\frac{wL^2}{160} + \frac{WL}{80}\right) \text{ at mid span}$$

Continuous beam:

$$f_{\text{max.}} = \frac{D}{I}\left(\frac{wL^2}{240} + \frac{WL}{160}\right) \text{ at supports}$$

Where $f_{\text{max.}}$ is maximum bending stress (N/mm^2)

D is outside diameter of pipe (mm)

I is second moment of area (cm^4)

L is span (m)

w is distributed weight of pipe including contents (N/m)

W is any concentrated load acting at centre of span (N).

NOTE For a simply supported pipe with a uniformly distributed load over the whole span, the maximum bending stress may be calculated from:

$$f_{\text{max.}} = \frac{M}{Z} = \frac{wL}{8Z}$$

Where $f_{\text{max.}}$ is maximum bending stress (N/mm^2)

M is maximum bending moment (Nm)

Z is section modulus (cm^3)

w is total uniformly distributed load (N)

L is span (m)

2) *Maximum deflection between pipe supports* is given by the following expressions.

Single span simply supported:

$$\delta_{max.} = \frac{10^5}{EI}\left(\frac{5}{384}wL^4 + \frac{1}{48}WL^3\right) \text{at mid span}$$

Continuous beam:

$$\delta_{max.} = \frac{10^5}{EI}\left(\frac{1}{384}wL^4 + \frac{1}{192}WL^3\right) \text{at mid span}$$

Where $\delta_{max.}$ is maximum deflection (mm)

E is Young's modulus of elasticity (N/mm^2)

I is second moment of area (cm^4)

L is span (m)

w is distributed weight of pipe including contents (N/m)

W is any concentrated load acting at centre of span (N)

NOTE For a simply supported pipe with a uniformly distributed load over the whole span, the maximum deflection may be calculated from:

$$\delta_{max.} = \frac{5wL^3}{384EI} \times 10^5$$

Where $\delta_{max.}$ is maximum deflection (mm)

w is total uniformly distributed load (N)

L is span (m)

E is Young's modulus of elasticity (N/mm^2)

I is second moment of area (cm^4)

3) *Wind load on pipes.* If it be assumed that pipes in an exposed position are subject to a wind velocity of 50 m/s, the wind loads will be as follows:

Height of pipes above ground	Wind load on total projected area of piping surface including insulation if fitted
m	N/m^2 (= Pa)
up to 5	up to 570
above 5 to 20	above 570 to 685
above 20 to 40	above 685 to 725

NOTE As pipes are circular, the wind loads given in the table are only 60 % of those for flat surfaces.

For calculation of the precise wind loading, reference should be made to CP 3:Chapter V-2.

Appendix C Recommendations on methods of fixing

C.1 Fixing of supports. Where pipe supports are to be attached to a structure it is necessary to ensure that the structure is suitable for carrying the loading.

C.2 Fixing to steelwork

1) Supports should be attached, where possible, by means of clips or clamps designed to withstand the effects of vibration and other live loads.

2) Where the design of the steel work permits, and where agreed, supports may be attached to steel work members by drilling and bolting, or by welding. Where welding is employed, full details should be specified. The burning of holes in steelwork members is to be avoided.

C.3 Fixing to brickwork, concrete or stone work. Suitable methods of fixing are

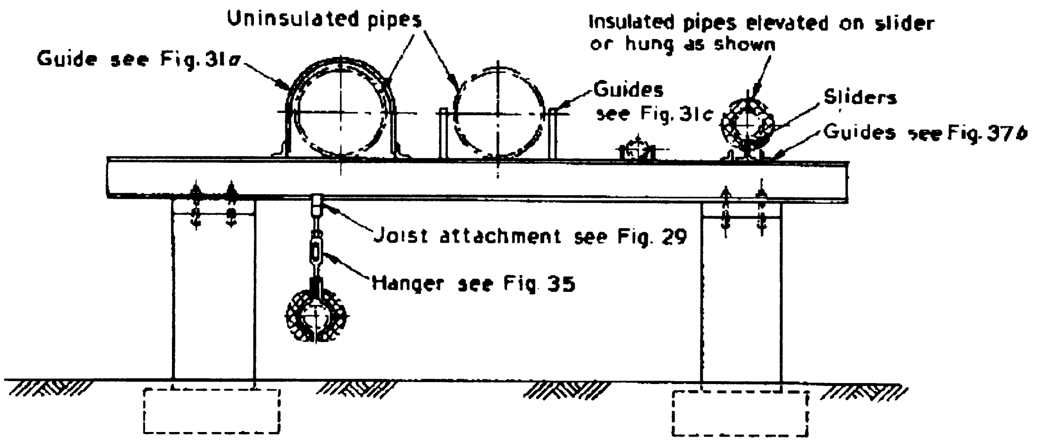
1) Masonry bolts

2) Rag bolts

3) Sleeved bolts, (passing through the wall) with wall plates where required

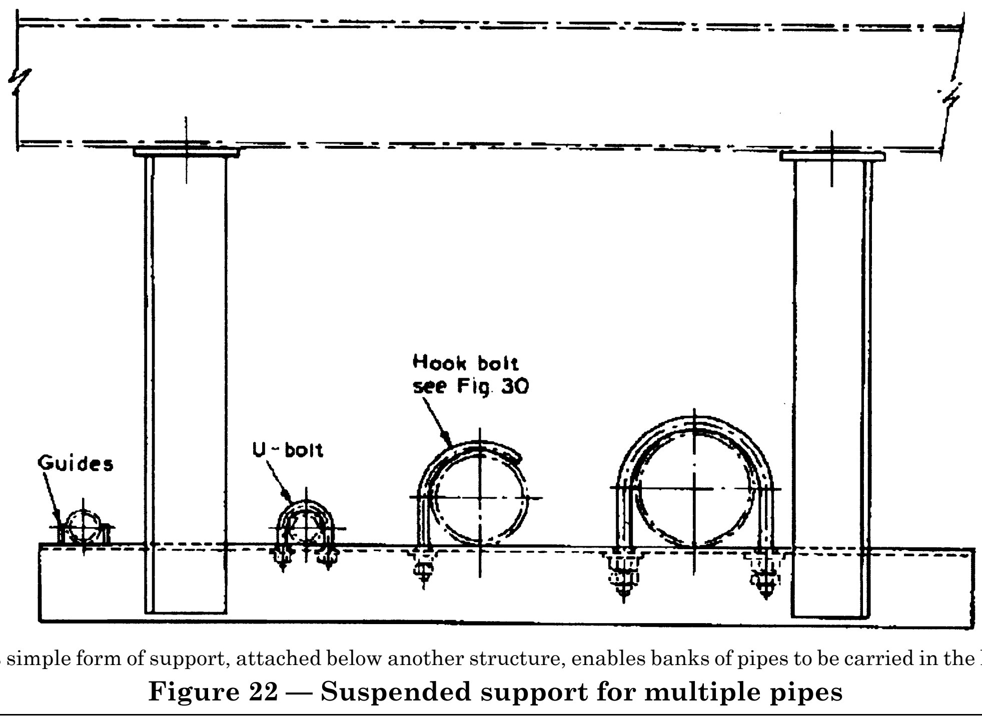
4) Steelwork members built into brickwork or masonry.

Appendix D Illustrations of typical pipe support assemblies



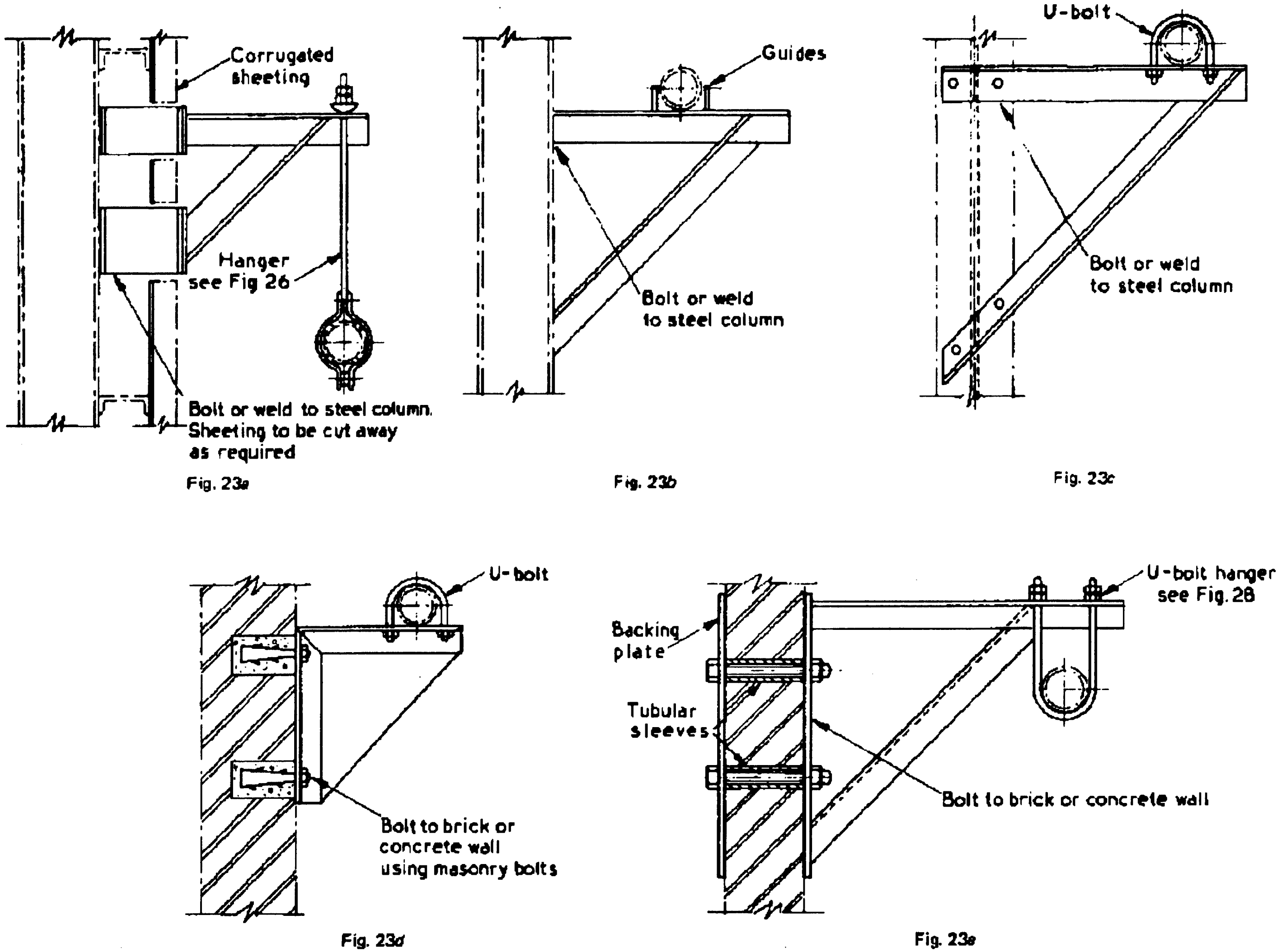
NOTE For carrying multiple runs of pipelines at low levels.

Figure 21 — Low-level trestle for multiple pipes



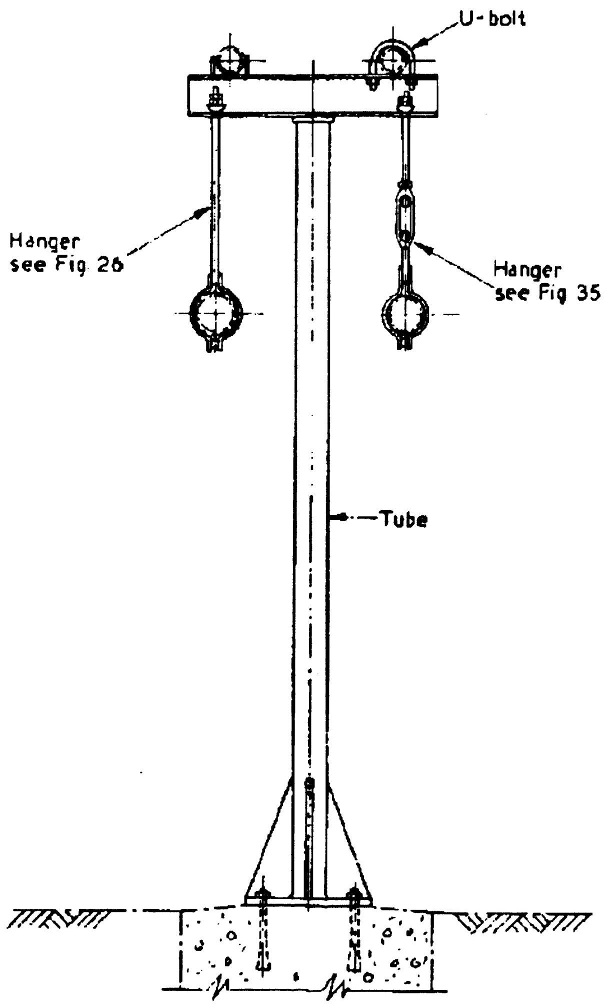
NOTE This simple form of support, attached below another structure, enables banks of pipes to be carried in the horizontal plane.

Figure 22 — Suspended support for multiple pipes



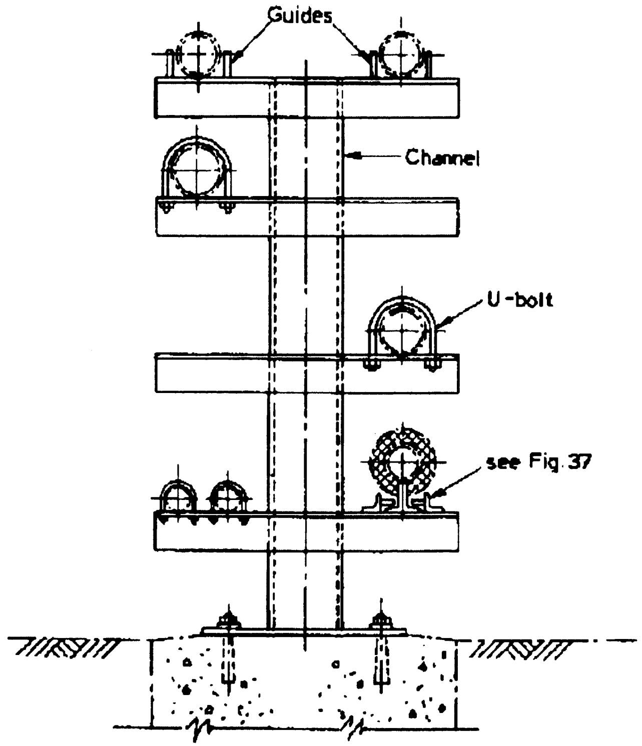
NOTE For attachment to structures or buildings to carry single or multiple runs of pipes.

Figure 23 — Typical pipe support brackets



NOTE Suitable for supporting a few small pipes at high level. As far as possible pipe weights should be balanced and axial thrust avoided.

Figure 24 — Single tubular support



NOTE This is an economical and simple structure for carrying multiple runs of horizontal pipe.

Figure 25 — Multiple support for horizontal pipes

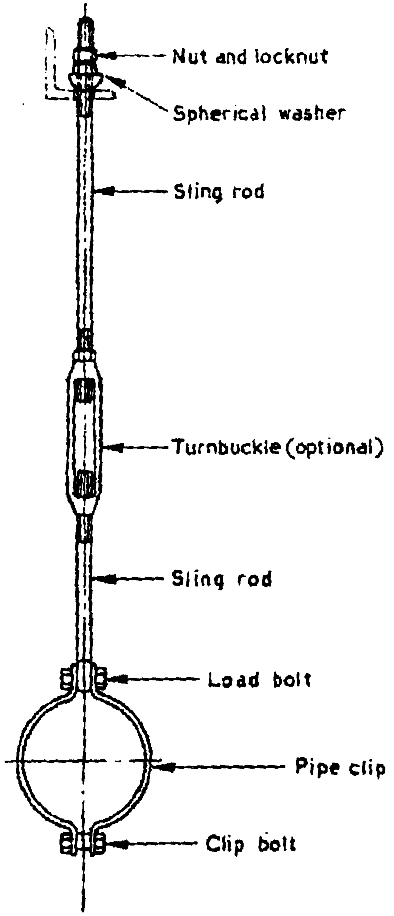
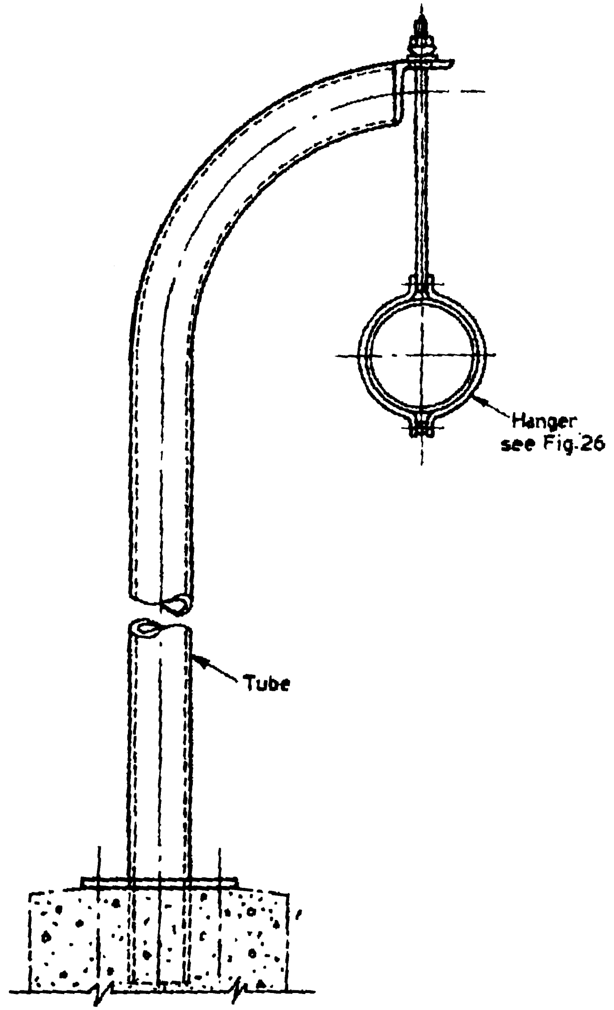


Figure 26 — Hanger for uninsulated pipes



NOTE For suspending elevated runs of single pipe.

Figure 27 — Tubular support for a single pipe

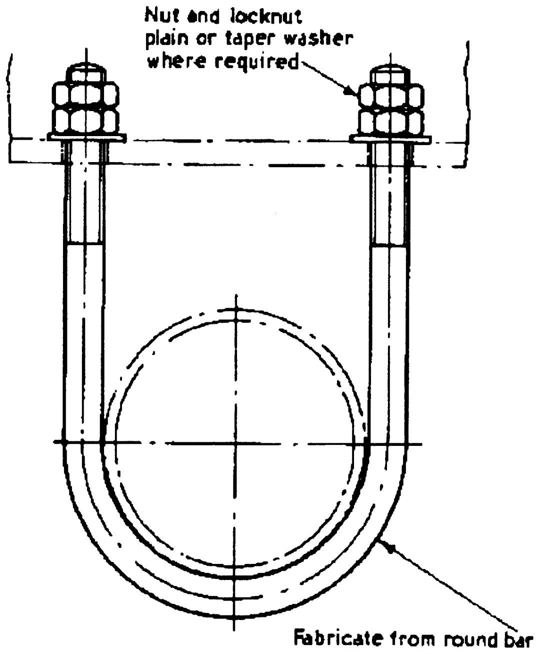


Figure 28 — U-bolt hanger

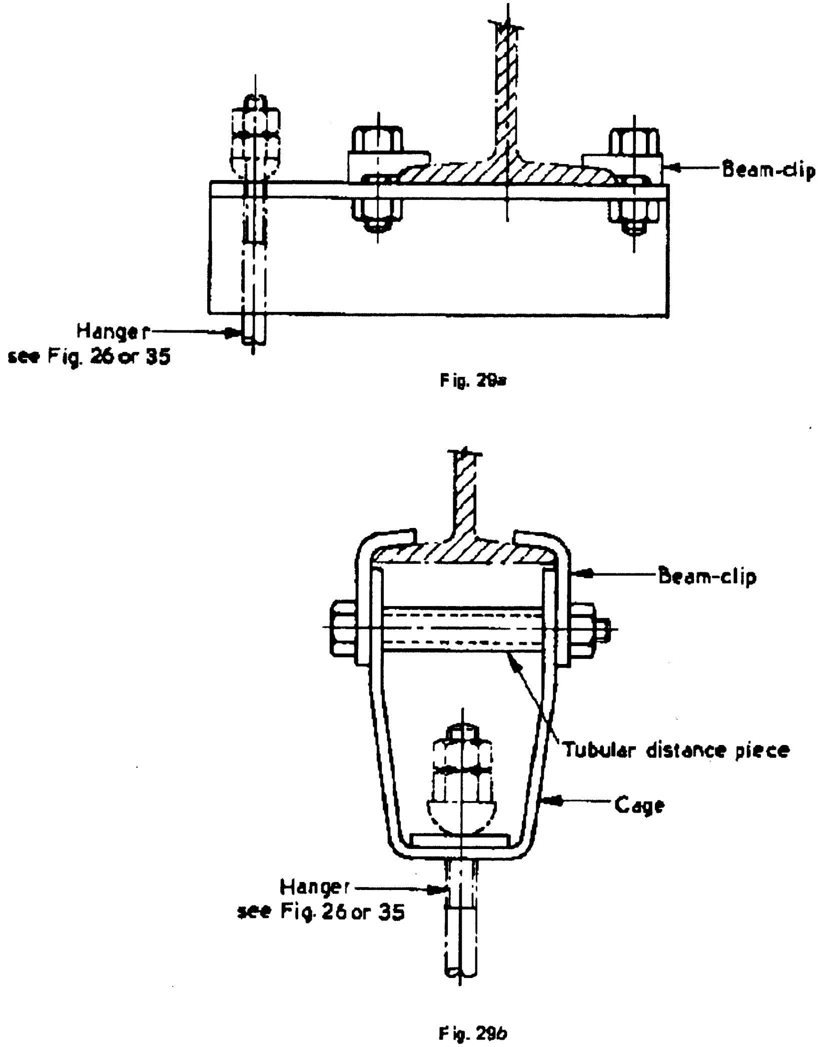


Figure 29 — Typical beam attachment for pipe hangers

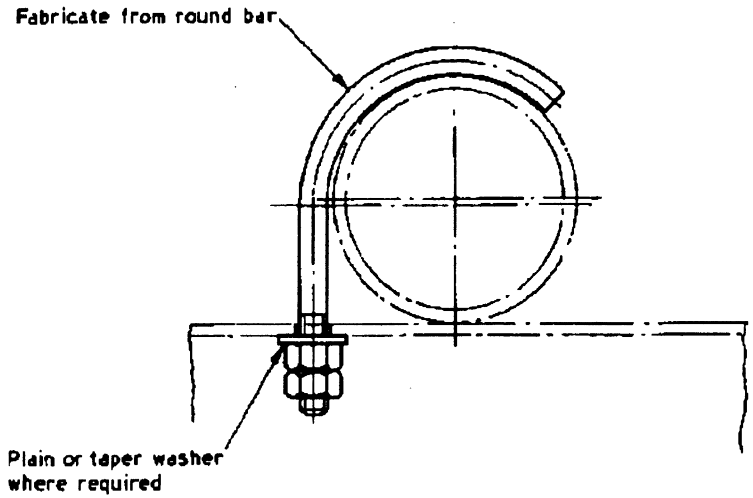
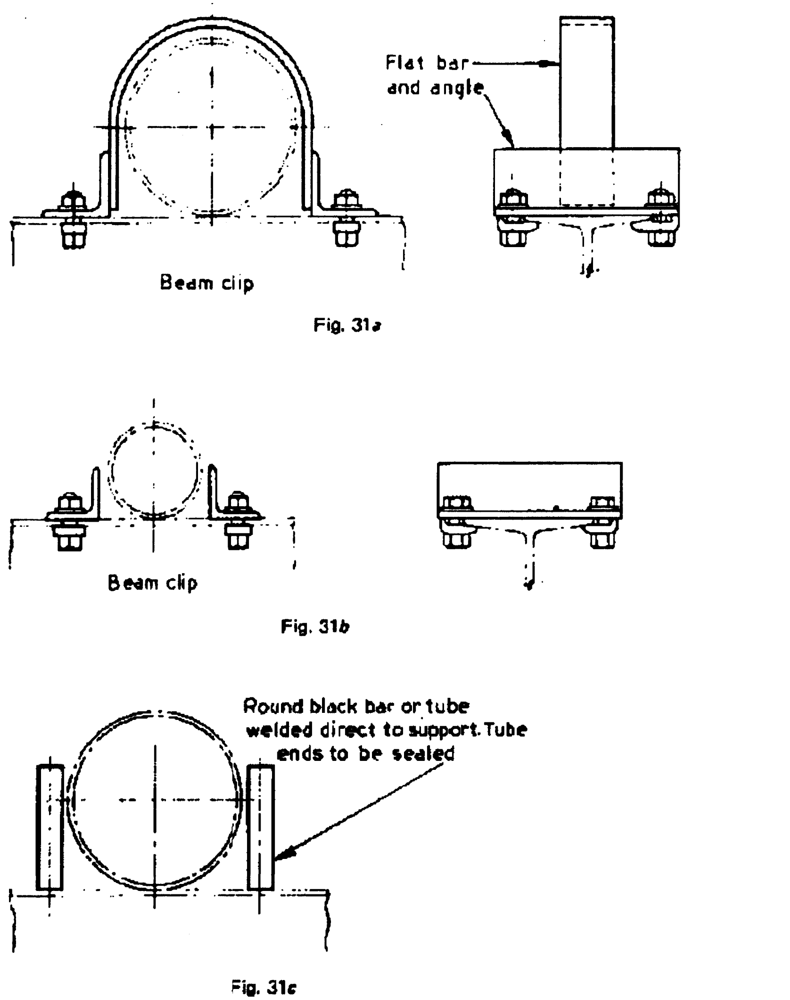
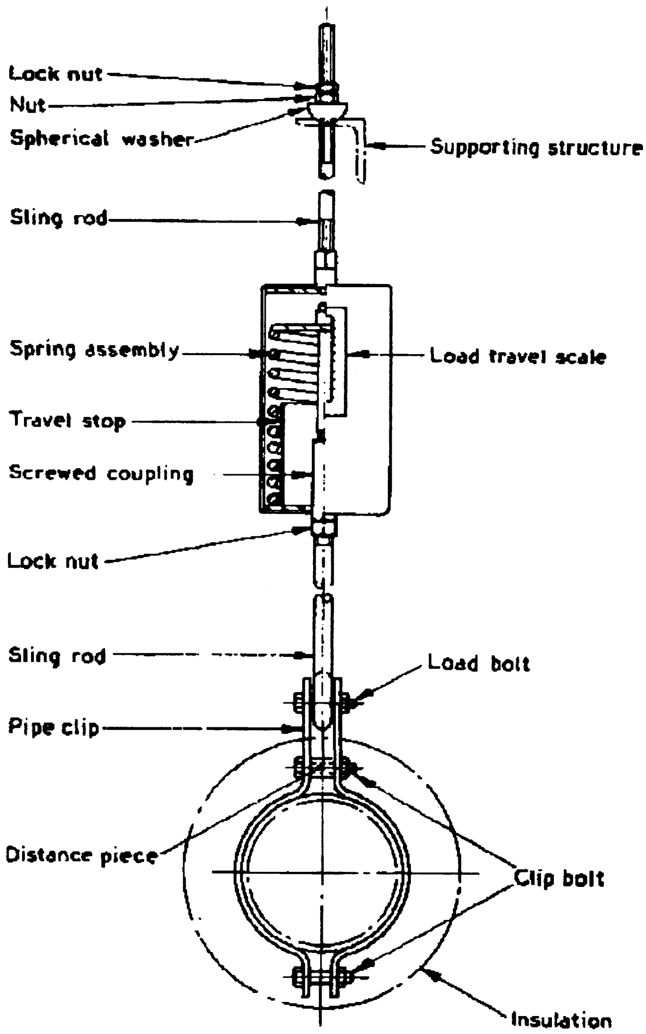


Figure 30 — Hook bolt



NOTE Showing various methods of limiting lateral yet permitting axial movement

Figure 31 — Pipe guides for uninsulated pipes



NOTE A variable load-spring type support used to accommodate positional changes of a pipe line, resulting from thermal expansion, but it should only be used where load changes are relatively small. The spring housing carries the full load on the hanger–see alternative arrangement shown in Figure 33.

Figure 32 — Typical spring hanger assembly

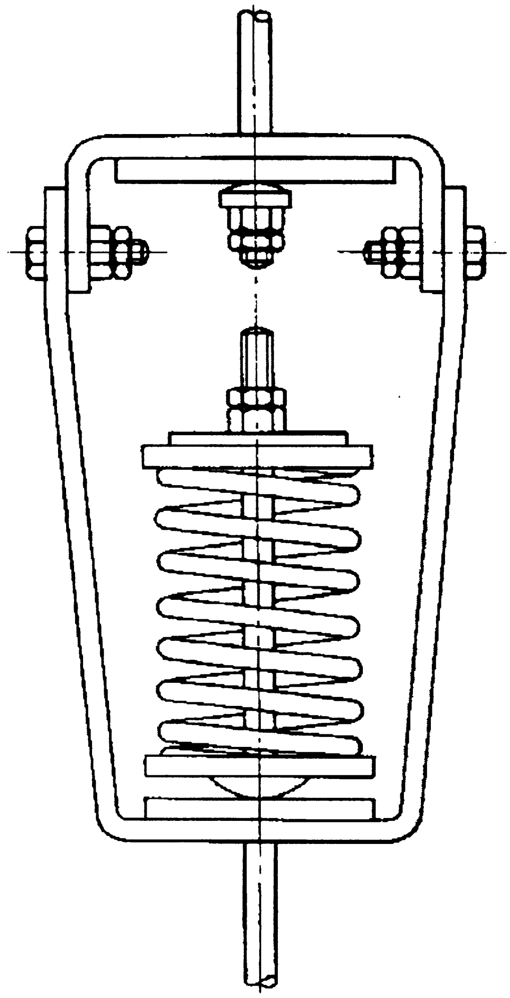
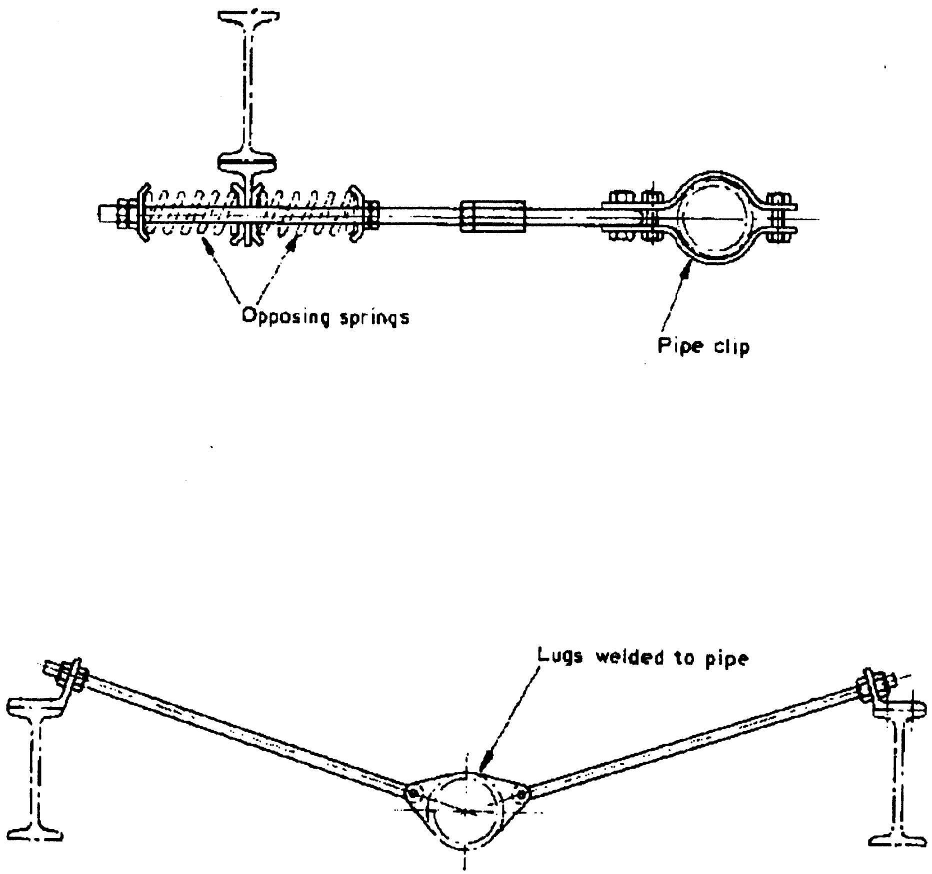


Figure 33 — Spring hanger (alternative arrangement to that shown in Figure 32)



NOTE Methods of securing pipework in order to prevent swayland to reduce vibration.

Figure 34 — Typical bracing arrangements

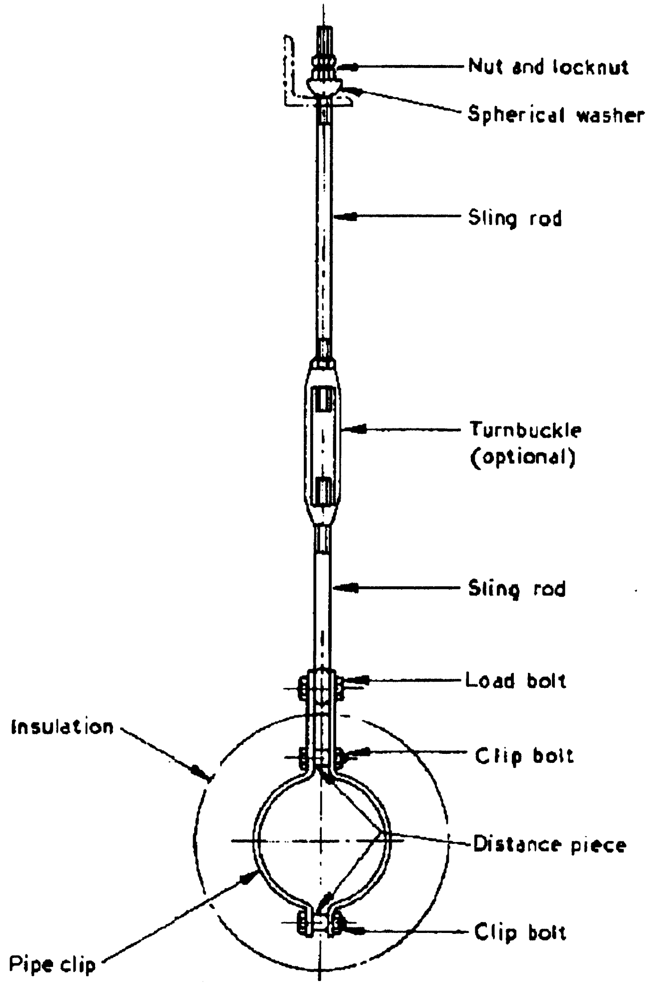


Figure 35 — Hanger for supporting hot insulated pipes

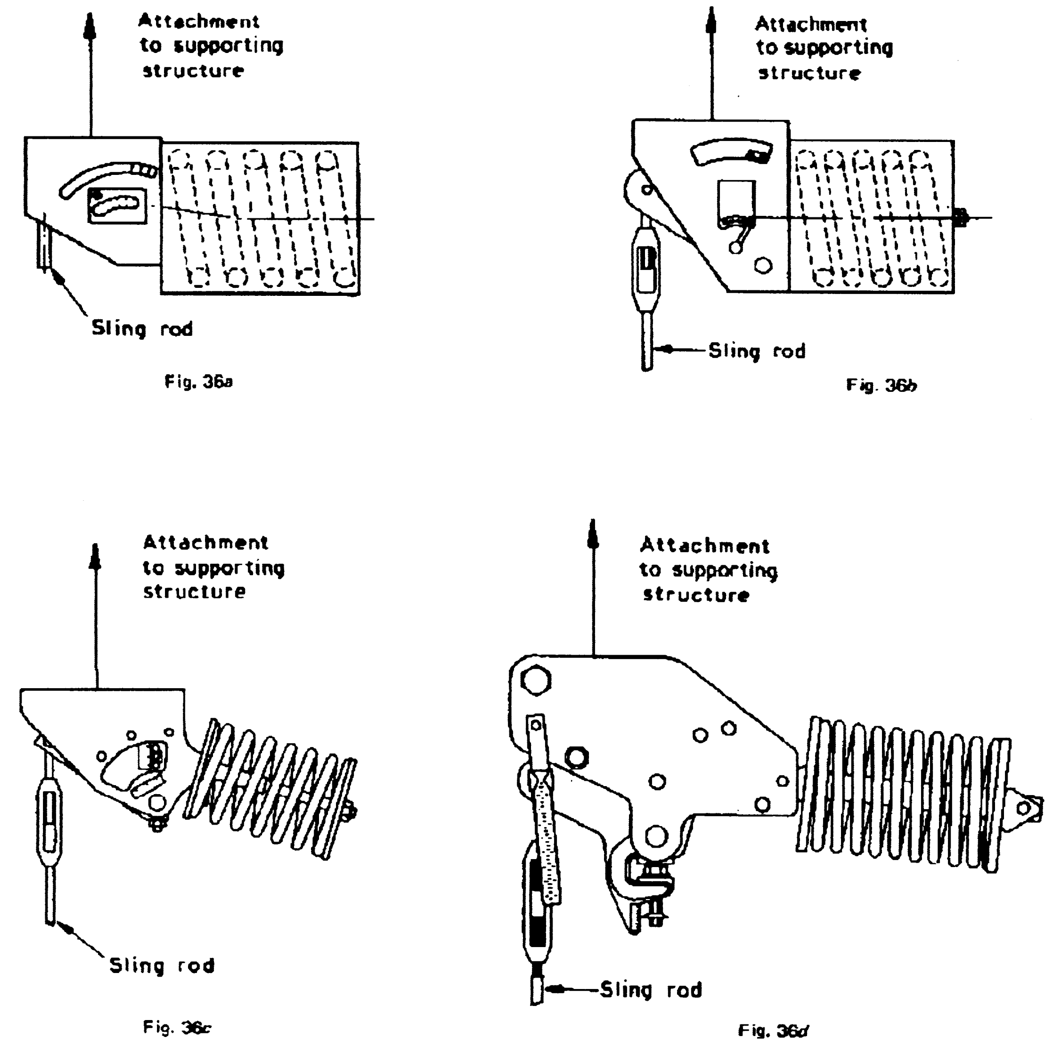


Figure 36 — Constant load type spring hangers

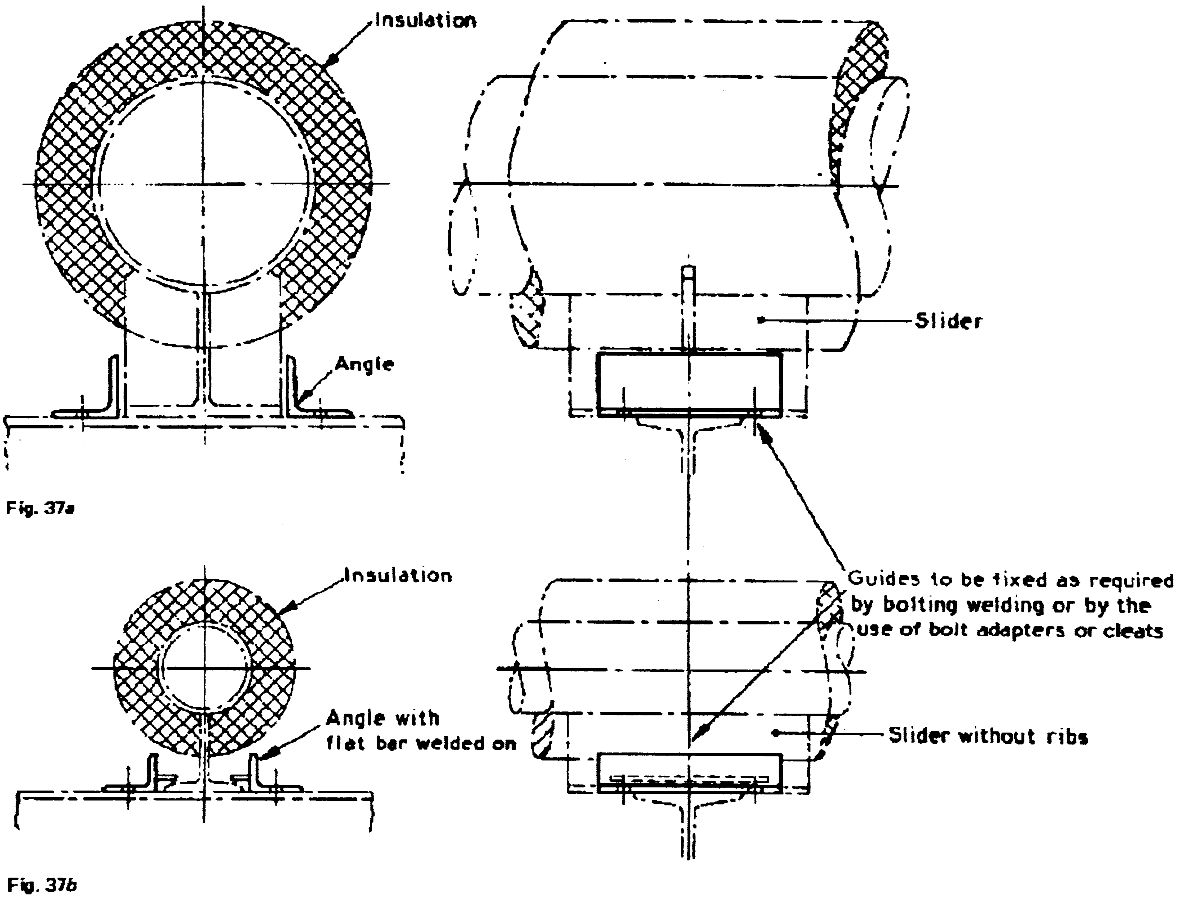


Figure 37 — Pipe guides for insulated hot pipes

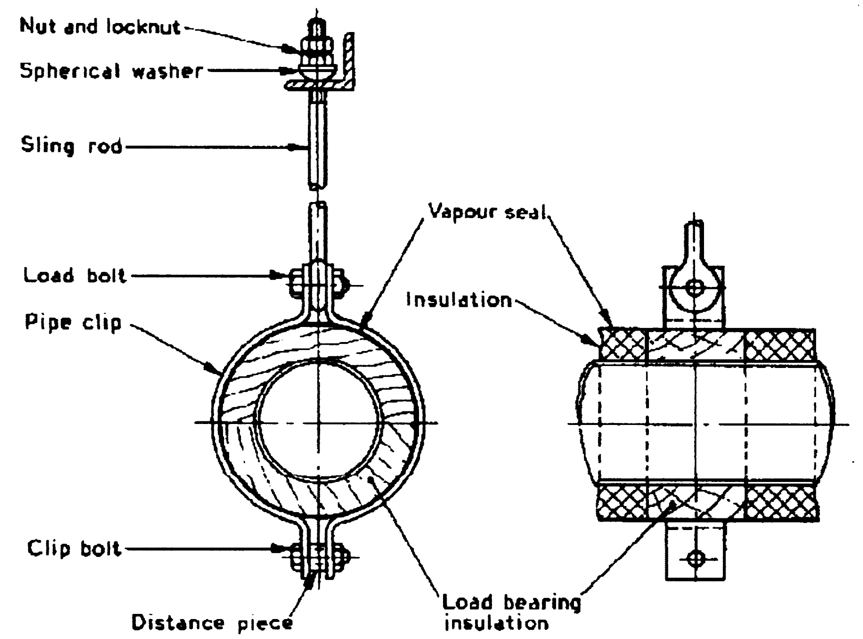


Figure 38 — Hanger for insulated cold pipes

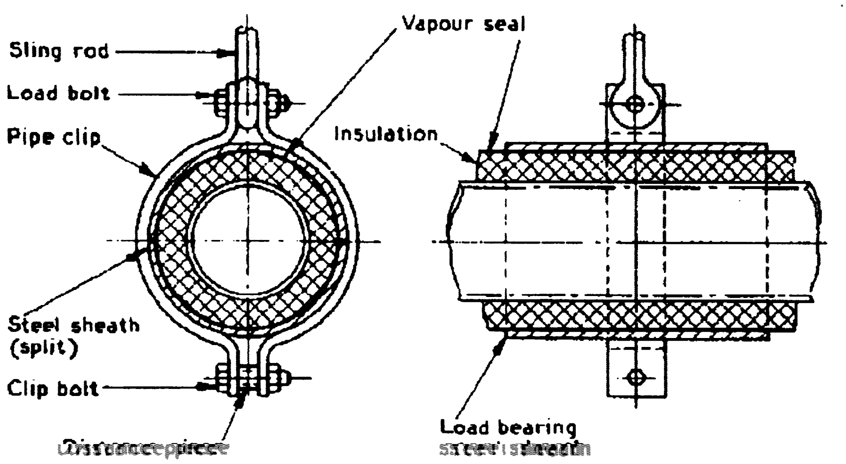
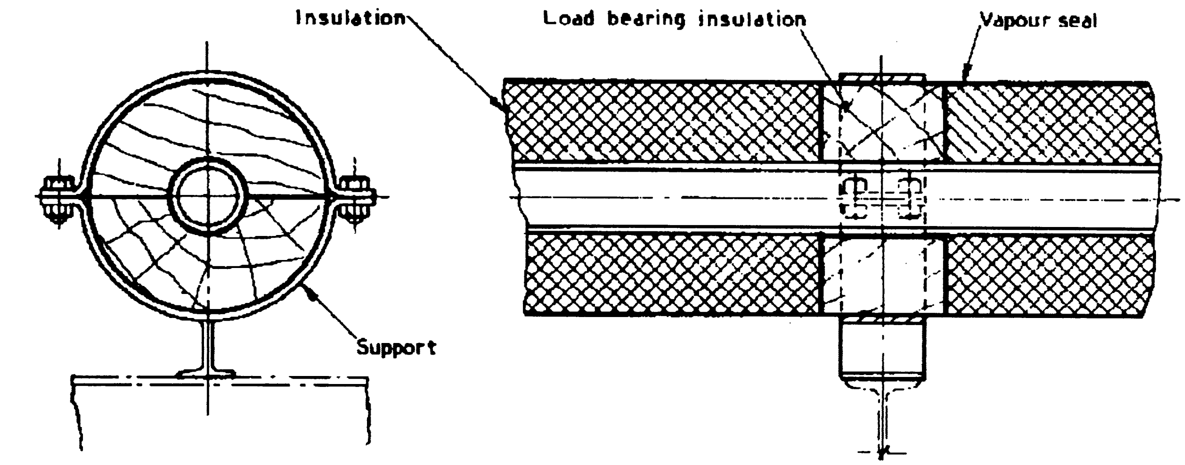
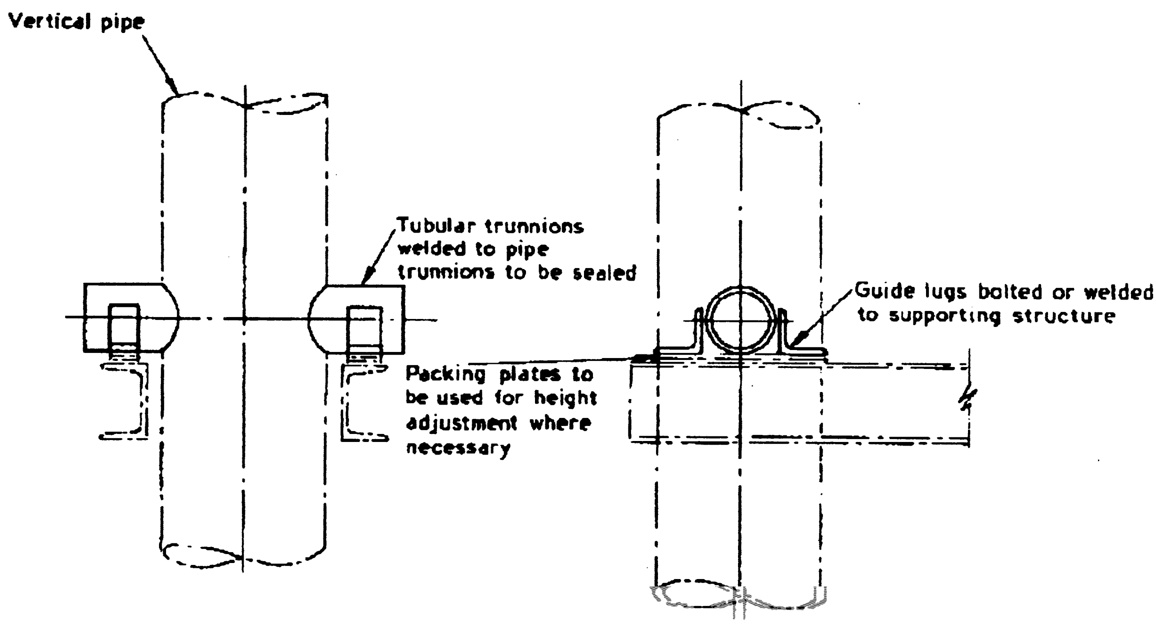


Figure 39 — Hanger for insulated cold pipes



NOTE An economical and effective method of supporting an insulated cold pipe.

Figure 40 — Typical support for insulated cold pipe



NOTE A method which carries the weight of heavy runs of vertical piping, permitting some freedom of movement.

Figure 41 — Trunnion support for uninsulated vertical pipes

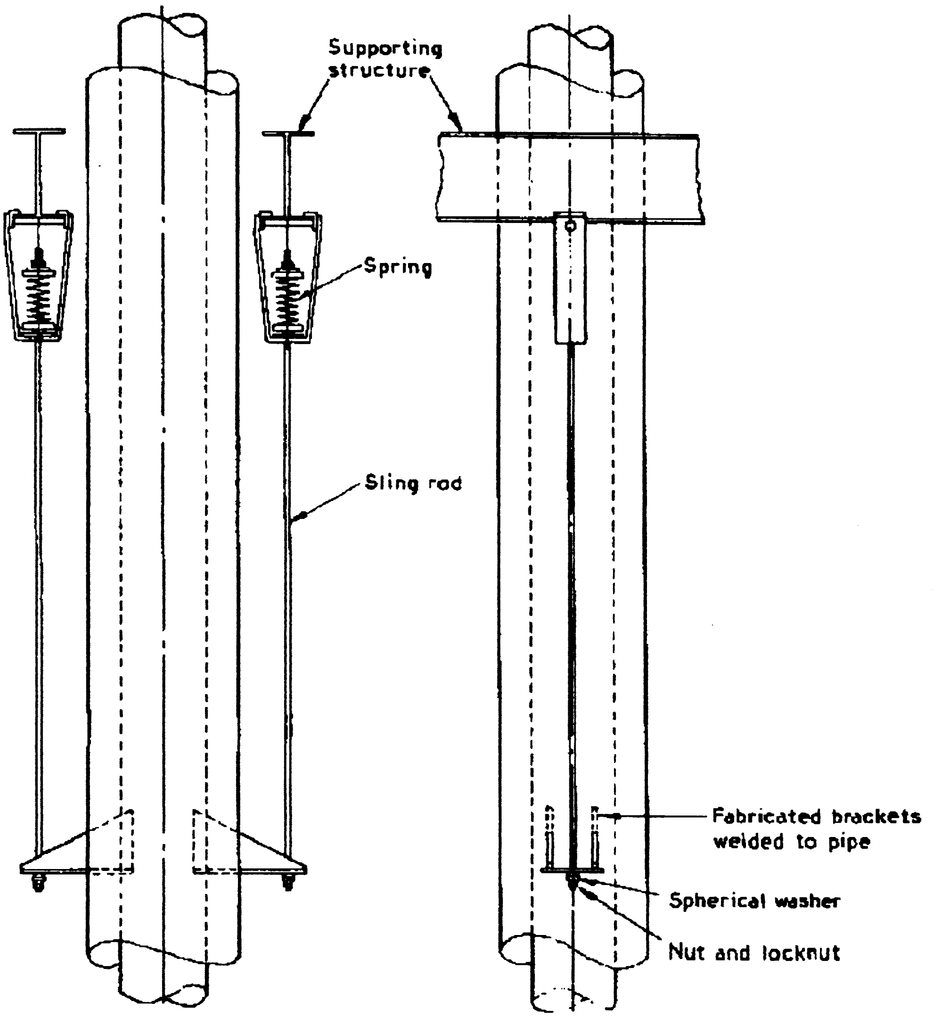
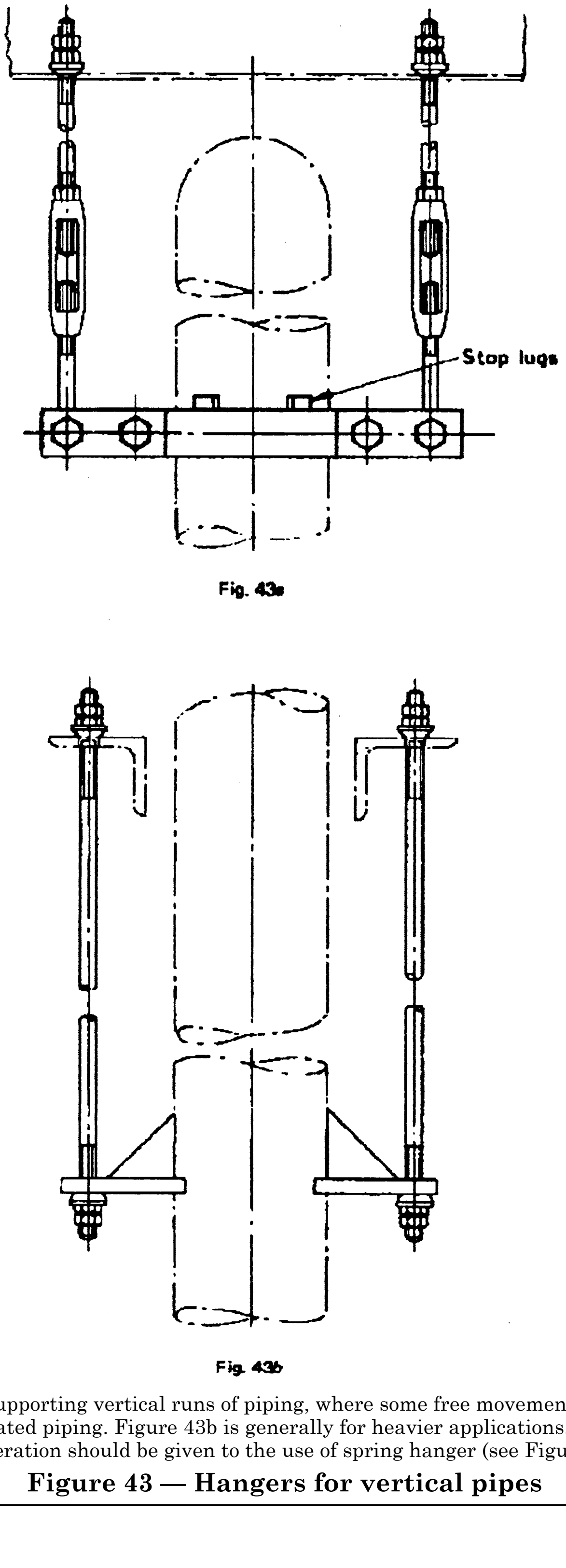
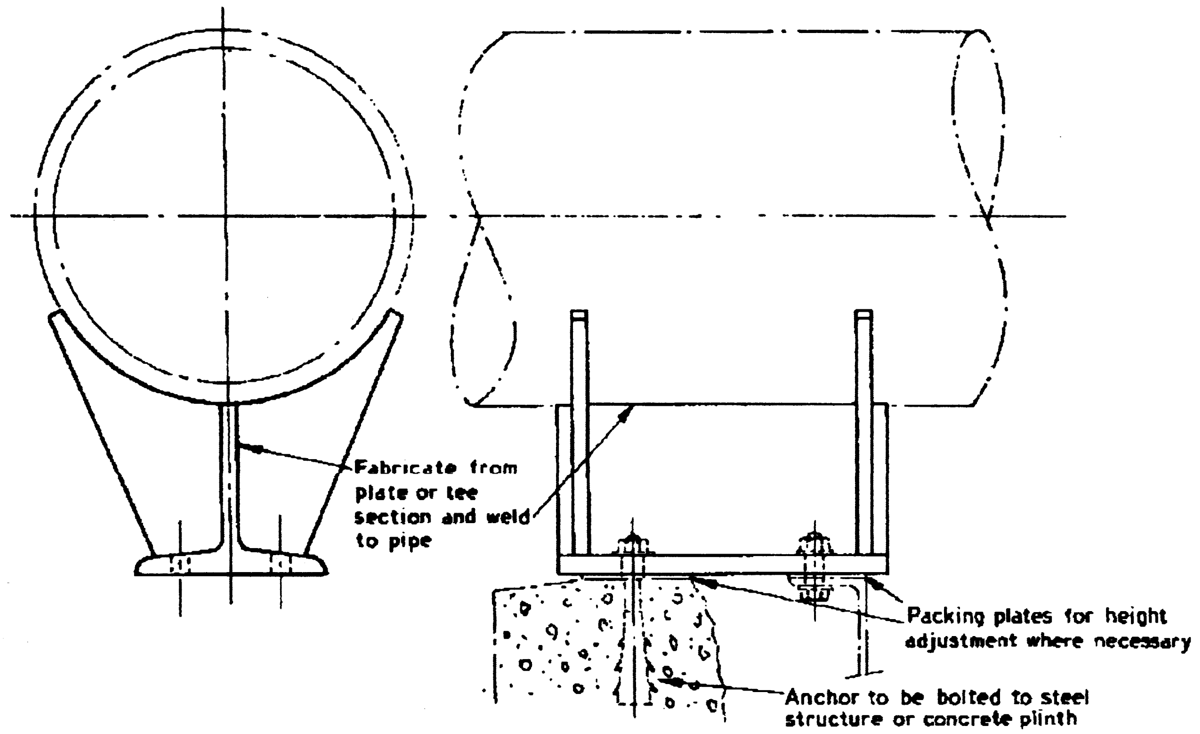


Figure 42 — Spring hanger for vertical pipes (variable load type)



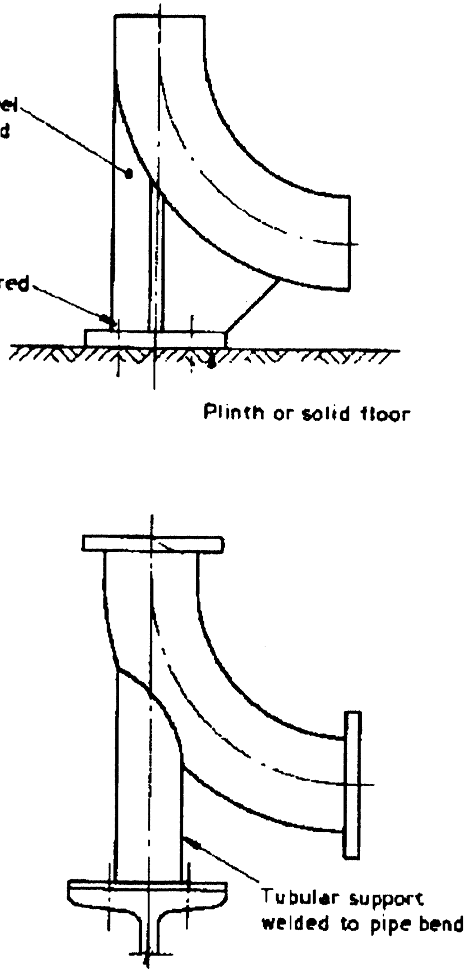
NOTE Alternative methods of supporting vertical runs of piping, where some free movement is desirable. They are suitable for use with the insulated or uninsulated piping. Figure 43b is generally for heavier applications. Where supports may be necessary on the same run of piping, consideration should be given to the use of spring hanger (see Figure 42).

Figure 43 — Hangers for vertical pipes



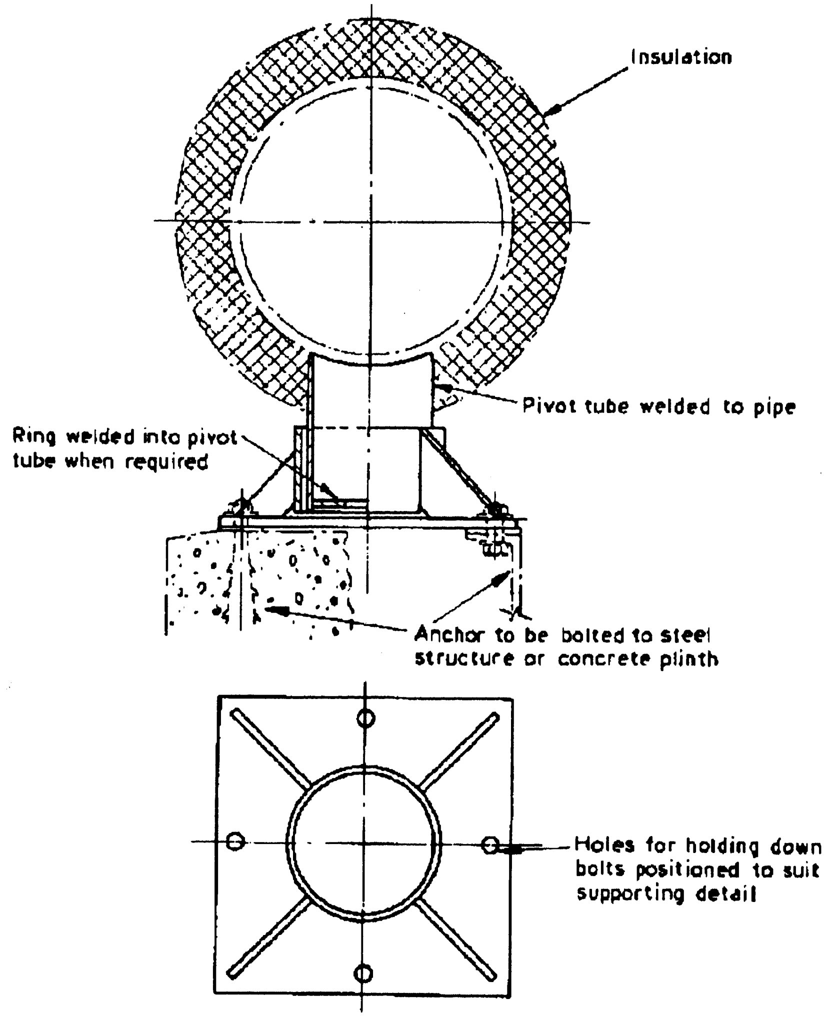
NOTE Provides an integral rigid restraint, which prevents movement in any direction. The anchor should be welded to the pipe and firmly bolted down before any cold draw is applied.

Figure 44 — Anchor for insulated or uninsulated pipes



NOTE Alternative method of supporting or anchoring pipework at the point where direction changes from the vertical to the horizontal.

Figure 45 — Typical duckfoot supports



NOTE This type of anchor restricts of movement in axial and lateral directions, but allows rotation. It is not intended as a pipe support and it is essential that there be a clearance between the bottom of the pivot tube and socket base.

Figure 46 — Pivot anchor for insulated hot pipe

Publications referred to

This standard makes reference to the following British Standards and Code of Practice:

BS 4, *Structural steel sections.*
BS 4-1, *Hot rolled sections.*
BS 309, *Whiteheart malleable iron castings.*
BS 310, *Blackheart malleable iron castings.*
BS 1387, *Steel tubes and tubulars suitable for screwing to BS 21 pipe threads.*
BS 1408, *Patented cold drawn steel spring wire.*
BS 1452, *Grey iron castings.*
BS 1501, *Steels for fired and unfired pressure vessels. Plates.*
BS 1501-1, *Carbon and manganese steels.*
BS 1726, *Guide to the design and specification of coil springs.*
BS 1726-1, *Helical compression springs.*
BS 1775, *Steel tubes for mechanical, structural and general engineering purposes.*
BS 3643, *ISO metric screw threads.*
BS 3643-2, *Limits and tolerances for coarse pitch series threads.*
BS 3692, *ISO metric precision hexagon bolts, screws and nuts.*
BS 4190, *ISO metric black hexagon bolts, screws and nuts.*
BS 4360, *Weldable structural steels.*
BS 4429, *Rigging screws and turnbuckles.*
BS 4622, *Grey iron pipes and fittings.*
CP 3, *Code of basic data for the design of buildings.*
CP 3:*Chapter V, Loading Part 2 Wind loads.*

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