BRITISH STANDARD AEROSPACE SERIES

BS 2SP 91-92:
1973+A4:2015

Specification for

Carbon steel worm drive clamps for aircraft*

ICS 49.035
*Index form of title: CLAMPS, WORM DRIVE, CARBON STEEL, FOR AIRCRAFT

This British Standard, having been approved by the Aerospace Industry Standards Committee, was published under the authority of the Executive Board on 15 May 1973

The following BSI references relate to the work on this standard:
Committee reference ACE/14
Drafts for comment 72/33600
DC 13/30273384

ISBN 978 0 580 81034 3

Amendments issued since publication

Amd. No.	Date	Comments
1541	September 1974	
2012	June 1976	
5903	September 1988	
A4	January 2015	See Foreword

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Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 11 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.

Foreword

Publishing information

BS 2SP 91-92:1973+A4:2015 is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 31 January 2015. It was prepared by Technical Committee ACE/12, *Aerospace Fasteners and Fastening*. A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

BS 2SP 91-92:1973+A4:2015 supersedes BS 2SP 91-92:1973 (incorporating Amendments No.1, No.2 and No.3), which is withdrawn.

Information about this document

The standards specify dimensional requirements of carbon steel worm drive clamps for aircraft to ensure functional interchangeability, and include details of hydraulic and pneumatic tests to ensure adequate sealing when the clamps are used on hose connections. Provision is made for clamps with bands having serrations rolled or milled, without perforating the band, and for clamps having pierced serrations which penetrate through the band, each type being given a distinctive identification.

These standards represent the current thinking at the time of publication in the light of known or published or projected standards for inch based hoses or tubes, with equivalents inserted in order that clamps may be used for metric applications.

NOTE The values stated in inch units are to be regarded as the standard. Approximate metric units are shown alongside in parentheses or adjacent columns.

This document makes reference to the following standards:

British Standards:

BS 970-1, *Wrought steels in the form of blooms, billets, bars and forgings – Part 1: Carbon and carbon manganese steels, including free-cutting steels*.

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

BS 2F 67:1980, *Aerospace series – Specification for Hose for aviation fuel and engine lubricating oil for aeronautical purposes*.

BS EN 2133, *Aerospace series – Cadmium plating of steels with specified tensile strength ≤ 1 450 MPa, copper, copper alloys and nickel alloys.*

BS EN 10139, *Cold rolled uncoated mild steel narrow strip for cold forming – Technical delivery conditions*.

BS EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*.

MoD Defence Equipment and Support Standard:

Def Stan 03-19, *Electro-Deposition of Cadmium*

The start and finish of text introduced or altered by Amendment No.4 is indicated in the text by tags ⟦A4⟩ ⟨A4⟧. Minor editorial changes are not tagged. Previous amendments are not indicated.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its requirements are expressed in sentences in which the principal auxiliary verb is "shall".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 General requirements

1.1 Scope

These British Standards specify the dimensions, material, finish and test requirements for carbon steel worm drive clamps for aircraft.

A4 **CAUTION.** BS SP 91 and SP 92 clamps have cadmium as a plating material, which has been restricted and/or banned for use in many countries owing to environmental and health concerns; they should not be used in new product designs. Local officials should be consulted about any concerns on using cadmium-plated parts. A4

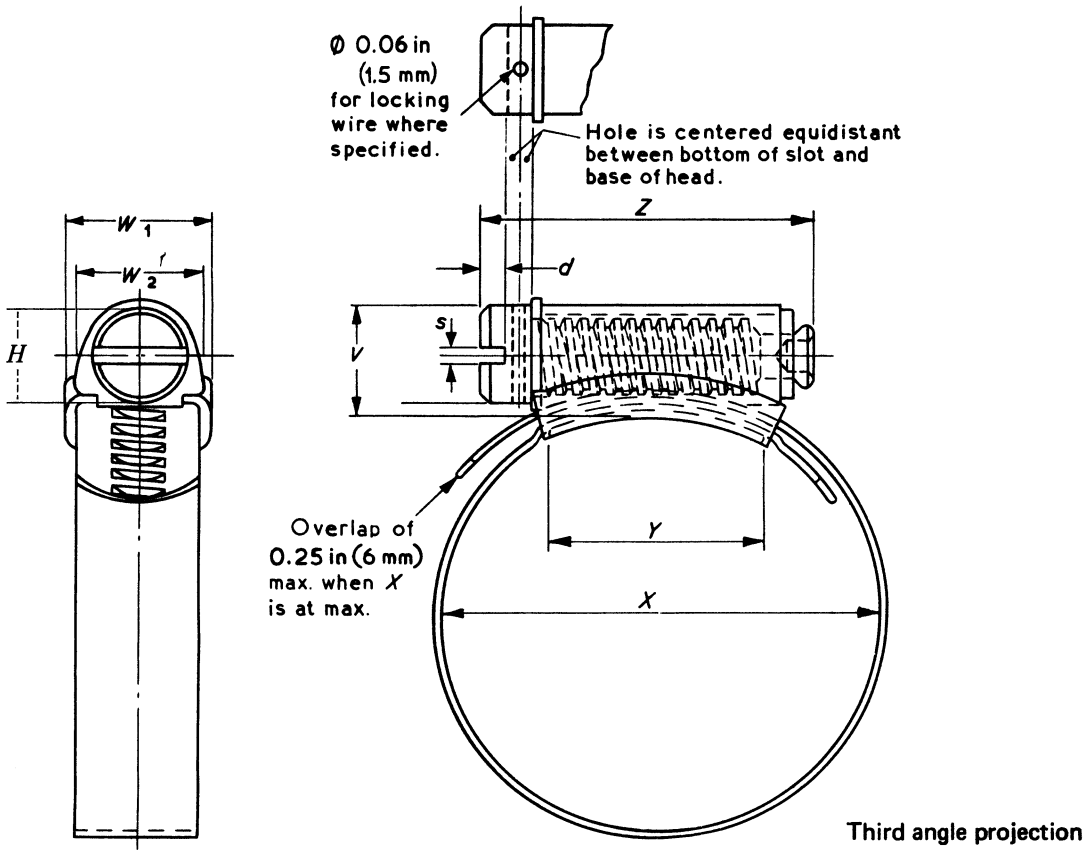
1.2 General principles

The clamp shall consist of a band with serrations rolled, milled or pierced across the longitudinal axis and extending in from one end. A screw with a thread of the same pitch as the serrations shall be retained in a suitable housing attached to the other end of the band, so that when the band is formed as shown in Figure 1 it will engage with the serrations. The loop so formed shall be capable of being tightened and slackened when the screw is turned, and shall be capable of easy fitment and removal.

1.3 Materials

1.3.1 The clamps shall be manufactured from the materials specified in Figure 2 and certified as such by the material supplier.

1.3.2 The band material shall comply with the tests specified in **2.6**.



Housing depth V = 0.55 in (14 mm) max.
Overall width W_1 = 0.625 in (16 mm) max.
Housing width W_2 = 0.55 in (14 mm) max.
Slot depth d = 0.094 in (2.4 mm) max.
Slot width s = 0.63 in (1.6 mm) max.
Head diameter H = 0.38 in (9.7 mm) max.

Figure 1 — Details of clamps

Table 1 — Dimensions of clamps

Clamp size	Working range diameter *X*				Housing length *Y*		Length *Z*	
	min.		max.		max.		max.	
	in	mm	in	mm	in	mm	in	mm
A	0.5	13	0.625	16	0.55	14	1.0	25
B	0.5	13	0.75	19	0.55	14	1.0	25
C	0.625	16	0.875	22	0.785	20	1.0	25
D	0.75	19	1.0	25	0.785	20	1.0	25
E	0.875	22	1.125	28	0.95	24	1.16	29
F	1.0	25	1.375	35	0.95	24	1.16	29
G	1.125	28	1.625	41	0.95	24	1.16	29
H	1.25	32	1.875	48	1.095	28	1.30	33
J	1.5	38	2.125	54	1.095	28	1.30	33
K	1.75	44	2.375	60	1.095	28	1.30	33
L	2.0	50	2.75	70	1.095	28	1.30	33
M	2.375	60	3.125	80	1.095	28	1.30	33
N	2.75	70	3.5	90	1.095	28	1.30	33
P	3.25	82	4.0	100	1.095	28	1.30	33
Q	3.75	95	4.5	115	1.095	28	1.30	33
R	4.125	105	5.0	125	1.095	28	1.30	33

NOTE Special sizes larger than the above range shall be designated by the MAXIMUM diameter in $^{1}/_{10}$ ths in, in increments of 0.5 in, e.g. 7 in (180 mm) will be Size 070 (see also **2.4.6**) and the working diameter range of these larger sizes shall be 1.0 in (25.4 mm).

1.4 Range of sizes and overall dimensions

The range of sizes and overall dimensions of the clamps shall be in accordance with those specified in Figure 1 and Table 1.

1.5 Band

1.5.1 The band shall have suitable provision for attachment of the housing at one end and transverse centrally disposed serrations at the other end, commencing at the end and extending for a length (depending upon the size of clamp) sufficient to enable the clamp to be tightened on the smallest assembly for which it is designed.

1.5.2 For BS SP 91 clamps, the serrations shall be rolled or milled; they shall not penetrate through the band. The serrations and the metal between them shall be of equal width, and such that the screw forms an adequate key in them when engaged. The dimensions of the band shall conform to those given in Figure 3a.

1.5.3 For BS SP 92 clamps the serrations shall be pierced through the band. The serrations and the gaps between them shall be of the form and dimensions shown in Figure 3b, and shall be such that the screw forms an adequate key in them when engaged. The dimensions of the band shall conform to those given in Figure 3b.

1.5.4 The internal surface of the band shall be smooth and all surfaces shall be free from burrs, projections and sharp edges.

1.6 Tightening device

1.6.1 The tightening device shall consist of a cheese head screw permanently retained in a housing firmly attached to one end of the band.

1.6.2 The clamps shall be capable of being tightened or slackened only by means of a screwdriver slot.

1.6.3 The following screw details shall apply.

1.6.3.1 The screw shall have a washer or retaining device attached to each end, or to a recess in the screw, to retain and adequately support the head of the screw and to prevent sideways or axial movement of the screw.

1.6.3.2 On clamps having bands with rolled or milled serrations, the screw shall have an 0.3125 in (8 mm) or larger nominal diameter. The thread shall be single start, right hand and of square or ACME type. For sizes A and B the screw may have an 0.25 in (6 mm) nominal diameter.

1.6.3.3 On clamps having bands with pierced serrations the screw shall have an 0.3125 in (8 mm) or larger nominal diameter. The thread shall be single start, right hand and of square or buttress type.

1.6.4 The housing shall hold the screw firmly in engagement with the serrations on the band. The housing shall be of rigid construction and shall not distort permanently when the test load is applied.

1.6.5 The housing shall be rigidly and securely attached to the band by riveting, welding and/or mechanical keying. The arrangement shall not permit any quick release device; the only method of releasing or loosening the clamp shall be by turning the screw in a counter-clockwise direction.

1.6.6 All parts of the clamps shall be cadmium plated in accordance with the latest issue of A4 *MoD Defence Equipment and Support Standard* Def Stan 03-19 or BS EN 2133. A4 When the housing is attached to the band by projection welding, the band and housing assembly shall be plated after the welding operation.

1.7 A4 Protective finish A4

Clamps shall be supplied in the plated and lubricated condition.

NOTE The lubricant is the anti seize compound applied during assembly.

1.8 Operation

1.8.1 The clamps shall expand automatically when the screw is turned in a counter-clockwise direction.

1.8.2 For clamps of sizes larger than F, after expanding until the band is disengaged from the screw, it shall be possible to open the clamp to provide a gap equal to the largest diameter for which the clamp is designed and so provide easy fitting or removal of the clamp by passing the clamp over the underlying assembly diameter.

1.8.3 The clamps shall be so designed that, when tightened on an assembly, they remain secure.

NOTE In some applications provision for locking wire may be specified. For details see Figure 1.

1.9 Identification and marking

Clamps shall be clearly and indelibly marked with the following minimum information:

1) Manufacturer's identification.

2) British Standard number (see Table 2).

3) Size of clamp, e.g. F.

4) Clamps may be supplied to special order with the head drilled to take locking wire. These will be identified by the letter "H", e.g. SP91HF.

Table 2 — Clamp identification

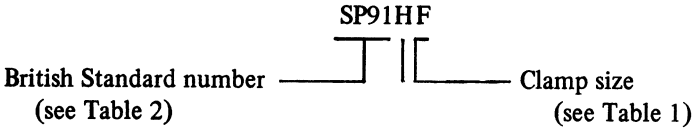
British Standard number	Type of clamp
SP91	Clamp having band with rolled or milled serrations
SP92	Clamp having band with pierced serrations

1.10 Information to be given in drawings for inspection purposes

Certain features of the clamps are defined in Figure 1 by maximum envelope dimensions and in Section 2 by functional test requirements. For inspection purposes however the Inspecting Authority[1)] shall be provided by the manufacturer with all the approved drawings[2)], with adequate dimensions and limits. No change shall be made to the approved drawings without the prior agreement of the Approving Authority[2)], and the Inspecting Authority shall have the right to require a complete series of tests to be made before accepting any clamp made to the specifications given on the new drawings.

1.11 Information to be given in drawings and schedules for call-up

Clamps shall be identified on drawings and for ordering purposes by the British Standard number, code letter for head drilling, and the clamp size, for example:



"H" denotes head drilled for lockwire (or dash "-" if undrilled)

2 Inspection and testing

2.1 General

The clamps shall comply with the inspection and testing requirements of this section. Tests shall be carried out to the satisfaction of the Inspecting Authority[1)], at whose discretion any clamp may be required to be submitted to all or any of the subsequent tests. The manufacturer shall satisfy the Inspecting Authority that adequate control is maintained throughout manufacture to ensure compliance with the approved drawings.

2.2 Inspection of clamps

Each clamp selected in accordance with **2.3** shall be inspected for compliance with the approved drawings prior to testing. If, however, any manufacturing defects are found during inspection of the sample the remainder of the batch shall receive 100 % inspection. From the clamps which pass this 100 % inspection a sample shall be selected for testing in accordance with **2.3**; if this sample passes the specified tests then those which had previously passed inspection shall be deemed to comply with this specification. Any failure to comply with the testing requirements shall be cause for rejection of the total quantity of clamps inspected as not complying with this specification.

2.3 Samples for inspection and testing

Before clamps are released by the manufacturers, the inspector shall take a random sample of the size required by Table 3. A random sample is one for which every clamp in the batch has an equal chance of being taken. Clamps shall be taken at random from the sample lot and allocated to each test (see **2.6** to **2.11**) in accordance with the quantities in Table 3.

Table 3 — Sample requirements

Size of batch of each size of clamp	Number of clamps in the sample required from each batch to comply with					
	2.6	2.7	2.8	2.9	2.10	2.11
Normal quantity production batch of not more than 500	1	8	The same 8 clamps as those used to comply with **2.7**	1	Not required	Not required
Normal quantity production batch of not more than 1 000	1	10	The same 10 clamps as those used to comply with **2.7**	2	Not required	Not required
Type approval test[a]	1	2	12	1	2	4

[a] This applies to a manufacturer seeking initial approval of his drawings.

[1)] A4 The Inspecting Authority should be agreed with the customer and might be a test laboratory. Users of this British Standard are advised to consider the desirability of selecting test laboratories that are accredited to BS EN ISO/IEC 17025 by a national or international accreditation body. A4

[2)] A4 Relevant manufacturer drawings should be approved by the customer prior to manufacture. A4

2.4 Testing of samples

2.4.1 One series of tests in accordance with Table 3 shall be made on each batch of clamps subject to a maximum quantity of 1 000 clamps in a batch and sampled in accordance with **2.3**. At the discretion of the Inspecting Authority the frequency of testing may be increased or decreased.

2.4.2 Unless otherwise stated a new clamp shall be used for each test; the number to be tested is indicated in Table 3.

2.4.3 All tests shall be carried out with the clamps in the lubricated condition.

2.4.4 Clamps tested under this clause shall not be subsequently released as complying with this specification but shall be segregated from the batch which they represent and eventually destroyed.

2.4.5 Clamps for type approval, to approve a new design or a new source of manufacture, shall be selected at random from batches of clamps which have been manufactured by the methods and techniques to be used for subsequent quantity production. The Inspection Authority will record the result of the type test by letter to the manufacturer.

2.4.6 Type approval and production tests for sizes larger than R. These tests shall be restricted to those specified in **2.6** and **2.7**.

2.5 Test apparatus

2.5.1 Details of suitable test apparatus to ensure that clamps comply with the requirements of **2.7**, **2.8**, **2.10** and **2.11** are shown in Figure 4, Figure 5 and Figure 6.

2.5.2 The hose to be used for the hydraulic tests shall be of the "ordinary" reinforced type suitable for aviation fuels and hot mineral oils (BS F 67, Type 3 or an agreed alternative).

2.5.3 The hose to be used for the air pressure test shall be of glass fibre with silicon impregnation having wall thickness up to approximately 0.1 in (2.5 mm) according to the pressure to be applied and capable of being used at temperatures up to 250 °C.

2.6 Tests on band material

2.6.1 The strip for manufacture of the band shall withstand without cracking:

1) bending across the width of the strip through 125° over a radius of 0.048 in (1.22 mm) and

2) bending along the centre line of the strip through 68° over a radius of 0.172 in (4.34 mm), the strip being bent back to the approximately flat condition in each case without visible signs of cracking or lamination.

These tests on the strip shall be made on each coil by pressing the strip into a lead block or on an approved bending jig. The lead block shall always be used to settle cases of dispute.

2.6.2 After plating, one band from each plating batch shall be subjected to bending across the width of the band, through an angle of 125° over a radius of 0.048 in (1.22 mm) and back to the flat condition.

The plating shall then be removed and the band examined. If the band so tested shows visible signs of cracking the test shall be repeated on three other bands taken from the same plating batch.

If one of these three bands shows visible signs of cracking, all the bands of that plating batch shall be deemed not to comply with this British Standard.

2.7 Screw torque

2.7.1 Tests shall be conducted on lubricated clamps to check the torque required to screw up and unscrew clamps when not assembled on a mandrel. For this purpose the torque values shall be as shown in Table 4. Should the values not conform to the values quoted in Table 4 the batch shall be deemed not to comply with this British Standard.

Table 4 — Screw torque values

Test condition	Torque	
	lbf in	N m
First screwing up	20 max.	2.25 max.
First unscrewing	20 max.	2.25 max.
At the next screwing up or unscrewing	5 min.	0.60 min.

2.8 Ultimate torque load

2.8.1 For these tests one half of the clamp sample shall be mounted on a rigid mandrel having a diameter equal to the maximum working diameter of the clamp. The remainder of the clamp sample shall be mounted on a rigid mandrel having a diameter equal to the minimum working diameter of the clamp.

2.8.2 Each clamp shall be tightened to the appropriate torque load shown in Table 5. The clamp shall then be slackened and visually examined. The housing, screw and band shall be free from damage and distortion. Each clamp shall then be retightened until failure or permanent deformation occurs such as would render it unserviceable. The torque load at failure shall be in excess of the relevant value shown in Table 5. In the event of any clamp failing to pass this test the whole batch represented by the sample shall be deemed not to comply with this British Standard. All clamps tested under this clause shall be destroyed by cutting through the band to avoid the possibility of reissue.

Table 5 — Maximum permitted torque values

Clamp size	Torque	
	lbf in	N m
A to B	40	4.50
C only	50	5.70
D to R	60	6.80

2.9 Opening test

For clamps of sizes F to R inclusive, this test shall be carried out on lubricated clamps, using a mandrel of outside diameter equal to the mean diameter of the working diameter range of the clamp. The test shall consist of a cycle of operations comprising complete assembly, tightening to the appropriate torque specified in Table 5, slackening and removing from the mandrel. Removal shall be by opening the clamp and passing it over the diameter of the mandrel. The cycle of operations shall be performed five times, following which there shall be no visible signs of damage or excessive distortion of the clamp.

2.10 Hydraulic pressure test

A hydraulic pressure test shall be conducted on a test joint assembly as shown in Figure 4 using a hose of outside diameter equal to or greater than the mean of the working diameter range of the clamp. The following conditions shall be observed:

1) *Sample.* The items to be tested shall comprise two of each size of clamp, the pressure test being conducted twice on each pair of clamps.

2) *Tightening torque.* The torque to be applied when tightening the clamps shall not exceed 75 % of the appropriate value specified in Table 5.

3) *Test procedure.* The hose and clamps shall be assembled on an unbeaded, externally smooth and polished metal mandrel as illustrated in Figure 4.

The fluid used for the test shall be water at room temperature. Pressure shall be applied gradually from an external source until leakage or other failure occurs, at which stage the pressure shall not be less than the appropriate value specified in Table 6.

Table 6 — Hydraulic pressure test values

Clamp size	Test pressure	
	lbf/in^2	kN/m^2
A	475	3 275
B	360	2 500
C	360	2 500
D	360	2 500
E	360	2 500
F	360	2 500
G	305	2 100
H	305	2 100
J	240	1 655
K	240	1 655
L	240	1 655
M	200	1 380
N	200	1 380
P	100	690
Q	100	690
R	100	690

2.11 Air pressure test

An air pressure test shall be conducted using the test apparatus shown in Figure 6 under the following conditions:

1) *Sample.* The items to be tested shall comprise two of each size of clamp (sizes D to R only).

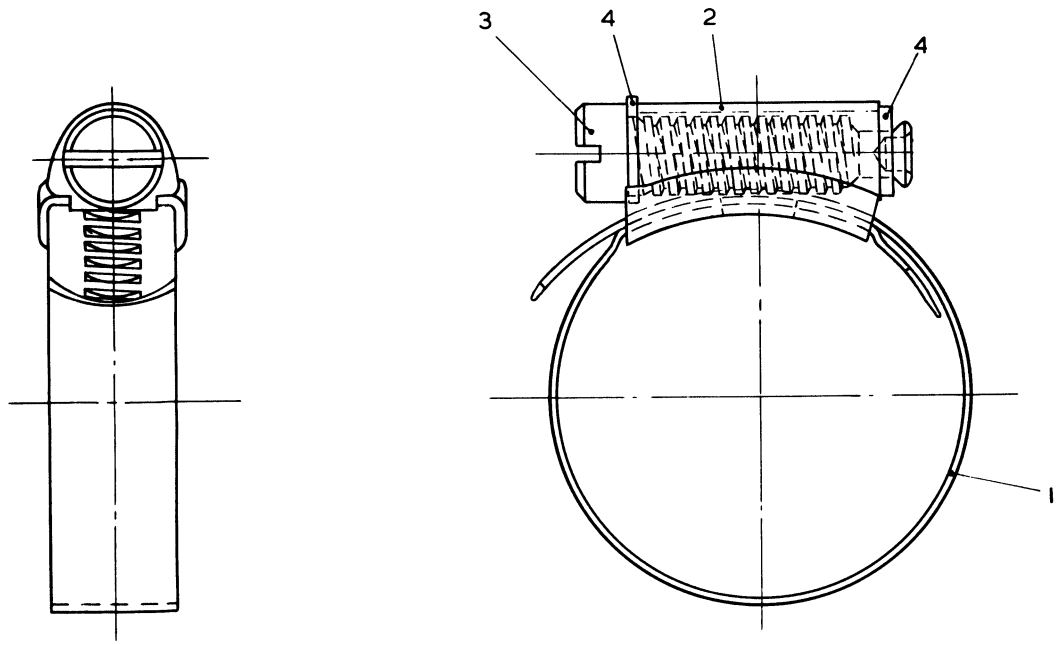
2) *Tightening torque.* The torque to be applied when tightening the clamp shall not exceed the appropriate value specified in Table 5.

3) *Procedure.* The hose and clamps shall be assembled on a pair of beaded, smooth and dry mandrels of outside diameter as specified in Table 7. A bedding tape may be used between the clamp and the hose.

Air pressure shall be gradually applied from an external source until the pressure reaches that specified in Table 7; all connections to the external source shall then be closed. After a period of ten minutes the pressure inside the reservoir shall not have decayed by more than 10 %.

Table 7 — Air pressure test values

Clamp size	Inside diameter of hose and outside diameter of mandrel		Air pressure	
	in	mm	lbf/in^2	kN/m^2
D	0.75	19	120	825
E	1.00	25	120	825
F	1.25	32	120	825
G	1.50	38	100	700
H	1.75	44	100	700
J	2.00	50	80	550
K	2.25	57	80	550
L	2.50	63	80	550
M	3.00	75	60	400
N	3.25	82	60	400
P	3.50	88	60	400
Q	4.00	100	50	350
R	4.50	113	40	275

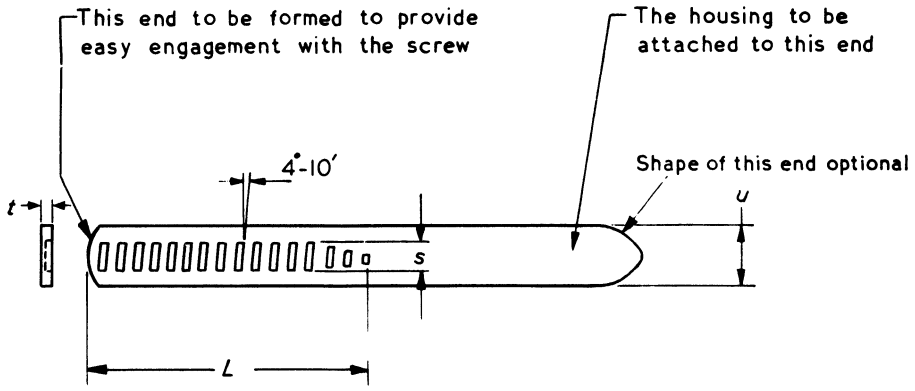


Third angle projection

Item number	Item	Material British Standard number
1	Band	BS 1449, En 2C/1[a] A4 or CS22 A4
2	Housing	BS 1449, En 2A A4 or CS4 or BS EN 10139 DC01A A4
3	Screw	BS 970, Pt. 1 (220MO7 or 240MO7)
4	Washer[b]	BS 1449, En 2 A4 or CS17 A4

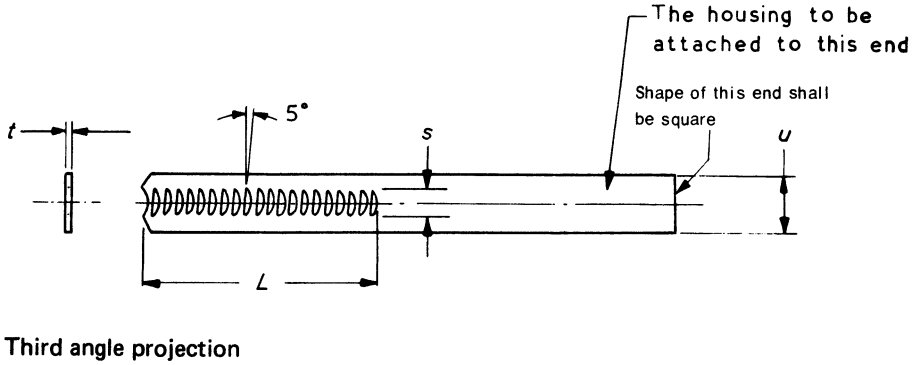
[a] The suffix /1 indicates that the material may be supplied to the special requirements stated on the approved drawing.
[b] Alternatively, a single combined thrust and retention washer may be used.

Figure 2 — Materials



Dimension *L*, length of serrations, to be of sufficient length to enable minimum and maximum values of diameter *X* (see Figure 1) to be obtained.

Figure 3a — Dimensions of band with rolled or milled serrations



Dimension *L*, length of serrations, to be of sufficient length to enable minimum and maximum values of diameter *X* (see Figure 1) to be obtained.

Figure 3b — Dimensions of band with pierced serrations

Dimension SP 91 & SP 92	in max.	mm max.
s	0.25	6.4
t	0.038	1.0
u	0.505	12.8

Figure 3 — Dimensions of bands

Dimension	in	mm
d_1	0.625	16
d_2	1.25	32
g	0.125	3

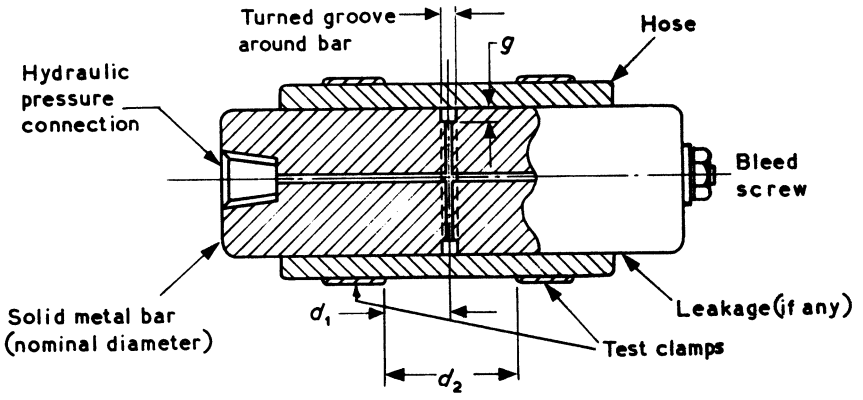


Figure 4 — Hydraulic pressure test

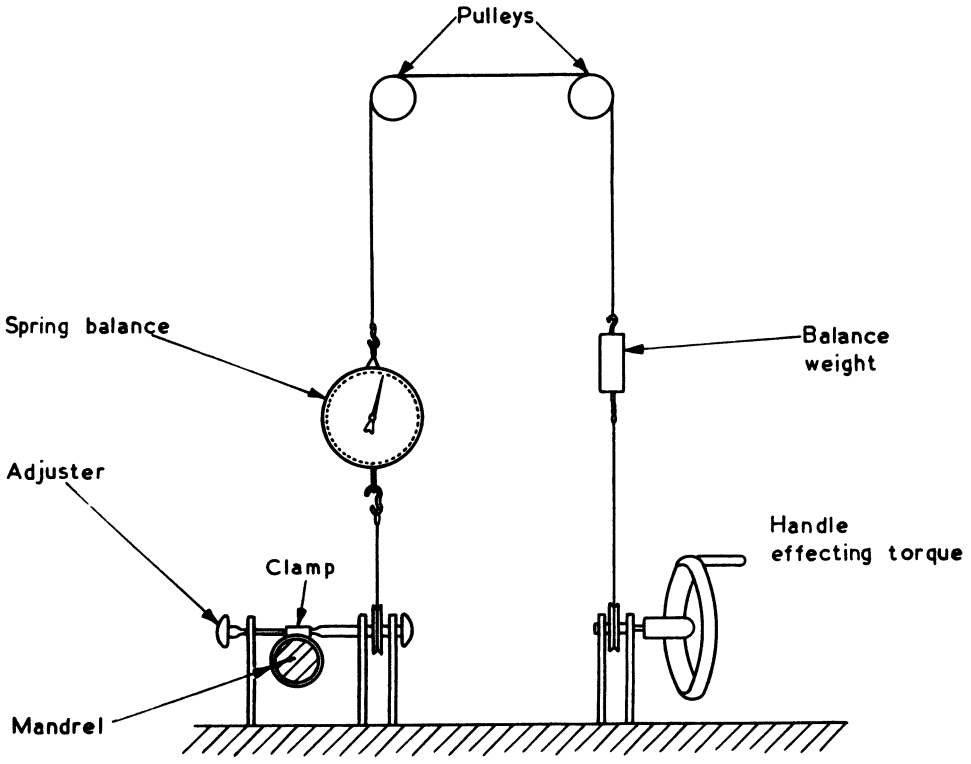
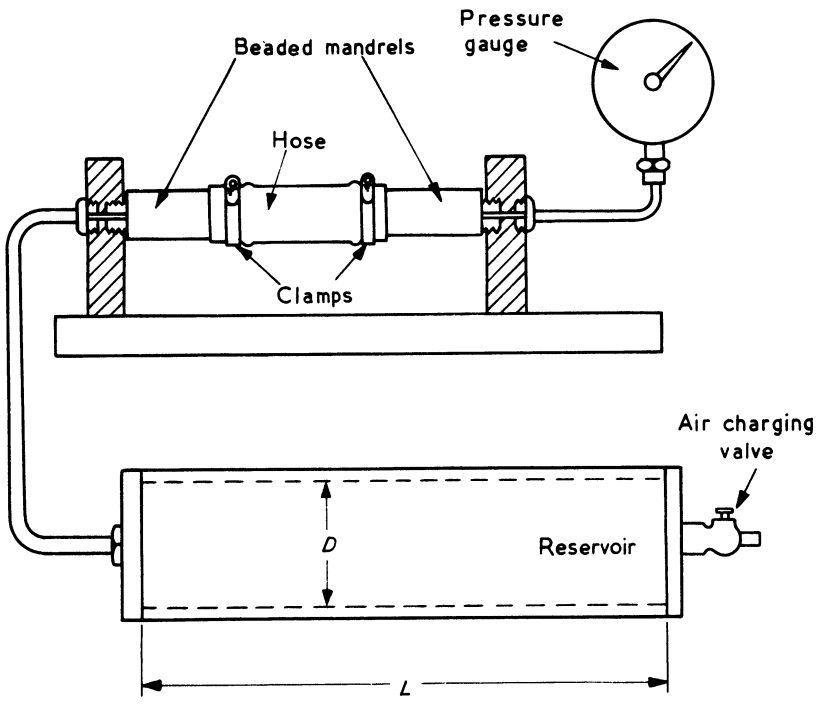
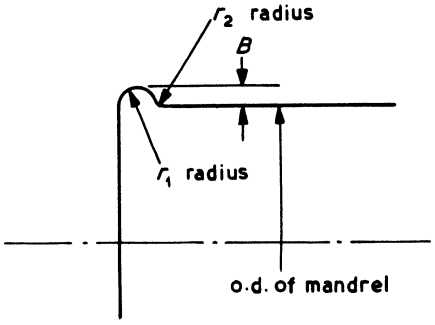


Figure 5 — Arrangement of test rig for torque testing





Dimension	in	mm
r_1	0.170	4.5
r_2	0.031	0.8

Details of bead on mandrels

Reservoir dimensions

Dimension	in	mm
L (approx.)	36	900
D (approx.)	4	100

Outside diameter of mandrel	Height of bead *B*	
	in	mm
Up to and including 1 in (25 mm)	0.047–0.057	1.2–1.5
Over 1 in (25 mm) up to and including 3 in (75 mm)	0.06–0.07	1.6–1.8
Over 3 in (75 mm) up to and including 4.5 in (115 mm)	0.094–0.104	2.4–2.6

Figure 6 — Arrangement of clamps and joints for air pressure test

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