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British Standard Specification for

Insulator and conductor fittings for overhead power lines

Part 4. Locking devices for ball and socket couplings of string insulator units: dimensions and tests

Accessoires pour les isolateurs et les conducteurs pour lignes aériennes
Partie 4. Dispositifs de verrouillage pour les assemblages à rotule des éléments de chaînes d'isolateurs

Freileitungsarmaturen
Teil 4. Sicherungsvorrichtungen für Klöppel–Pfannen–Verbindungen von Kettenisolatoren; Maße und Prüfung

British Standards Institution

Foreword

This Part of BS 3288 has been prepared under the direction of the Power Electrical Engineering Standards Committee. It is technically equivalent to IEC 372 : 1984, published by the International Electrotechnical Commission (IEC), except that the more compact British design of the size 28 coupling has been added as size 28B.

It is not envisaged that split-pins will be used in 28B couplings and the dimensions of the corresponding holes have not been included.

Apart from some essential editorial changes and the addition referred to above, the text of the IEC Publication is unchanged to facilitate future alignment with prospective CENELEC harmonization of IEC 372. For ease of production the text of the IEC publication has been used. Some terminology and certain conventions are not identical with those used in British Standards; attention is drawn especially to the following.

Where reference is made to items subject to agreement, this should be taken to indicate that the subject matter concerned is not inherently part of the requirements of the standard, but should be included in the purchase contract. Similarly, where a quantity is to be specified by the purchaser, e.g. the last paragraph of clause **5**, it should be included in the purchase contract.

Where the prescriptive 'shall' is used in a note, e.g. in the note to **8.2**, the statement is to be regarded as a requirement.

The comma has been used as a decimal marker. In British Standards it is current practice to use a full point on the baseline as the decimal marker.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

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British Standard Specification for

Insulator and conductor fittings for overhead power lines

Part 4. Locking devices for ball and socket couplings of string insulator units: dimensions and tests

SECTION ONE – GENERAL

1. Scope

This standard is applicable to locking devices used with ball and socket couplings of string insulator units and used with the corresponding metal fittings standardized in BS 3288 : Part 3 when they are supplied separately.

When these locking devices are supplied with an insulator or fitting, they shall be considered as an integral part of it. In this case, the relevant tests shall be included with those of insulators, as specified in BS 137 : Part 1. On request, a certificate shall be delivered confirming that the tests on locking devices as specified in this standard have been carried out. The locking devices are usually supplied with the insulators or corresponding metal fittings.

2. Object

The object of this standard is:

- to define the shapes and some standard dimensions for locking devices;
- to define the test methods for locking devices;
- to state the acceptance conditions for supply;
- to give other dimensions for guidance of manufacturing only.

The object of this standard does not include the specification of the nature of the material, but it is recommended that this material does not have a surface coating for corrosion protection. Moreover, the material shall not give rise to significant contact corrosion (chemical reaction) between the locking device and the ball and socket coupling.

3. Plan of the standard

The main part of this standard consists of the two following sections:

3.1 *Section Two: Dimensions and general rules*

Two types of locking devices are standardized, one using a split-pin, the other a W-shaped clip.

The first type requires a circular hole and the second a rectangular hole.

Two split-pins are proposed:

– *standard split-pin:* this split-pin is a tight-fit in the socket-hole;

– *alternative split-pin:* this split-pin is a loose fit in the socket-hole.

Note 1. — This alternative may be used by agreement between the manufacturer and the purchaser when the problems of stress corrosion are possible for the split-pin metal due to the permanent stress in the tight-fit system, e.g. when certain types of stainless steel are used.

The socket-hole into which the locking device fits is the same for both the standard and alternative split-pins, so it is possible to use the alternative split-pin in a socket designed for the standard split-pin.

See Clauses 5 and 6 for dimensions concerning split-pins.

See Clause 7 for dimensions concerning W-clips.

Note 2. — There are two alternative designs for the 28 mm ball and socket coupling. The one adopted by IEC is listed in this standard as "28", the more compact British design is listed as "28B". The 28B coupling is available only with a W-clip.

3.2 *Section Three: Tests*

The tests for locking devices are:

– visual examination;
– checking of dimensions;
– verification of resistance to bending;
– hardness test;
– corrosion resistance test (in some cases).

SECTION TWO – DIMENSIONS AND GENERAL RULES

4. Shape of the locking device

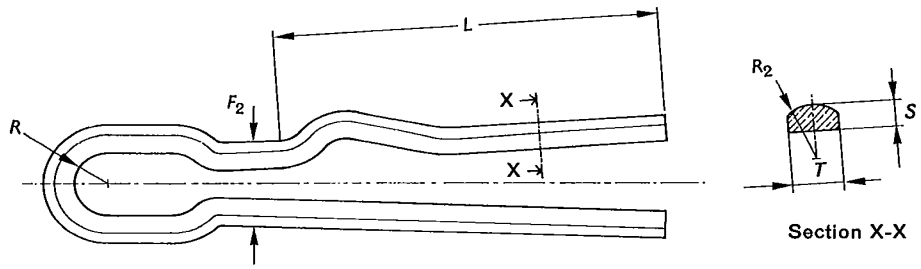
4.1 *Split-pin*

One of the legs of the split-pin has a hump and the free ends are bent outwards after insertion into the socket. These features provide two distinct positions for the split-pin when operated for locking and coupling, and complete withdrawal from the socket is effectively prevented (see Clause 8).

4.2 *W-clip*

The W-clip is so shaped that it will remain in two distinct positions when operated for coupling and locking. The shape of the W-clip is such that complete withdrawal from the socket when moving from the locking to the coupling position is prevented (see Clause 8).

5. Standard dimensions of the split-pins (standard and alternative type)



All dimensions are given in millimetres.

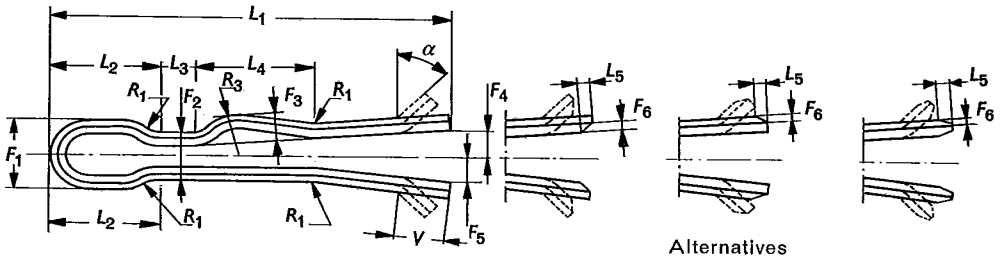
Standard couplings	Standard split-pins						Alternative split-pins[1]
	S	T	R_2	$F_{2\ min}$	R_{min}	L_{min}	$F'_{2\ max}$
11	$2,2 \pm 0,1$	$4,8^{+0,2}_{0}$	3,3	8,2	2,5	29	7,3
16A	$3,2 \pm 0,1$	$5,5^{+0,2}_{0}$	3,8	10,3	3	38	9,2
16B	$3,2 \pm 0,1$	$7,9^{+0,2}_{0}$	4,8	10,7	3	38	9,7
20	$3,2 \pm 0,1$	$7,0^{+0,2}_{0}$	4,8	10,7	3	49	9,7
24	$4,0 \pm 0,1$	$8,7^{+0,2}_{0}$	5,7	12,8	3,5	60	11,7
28[2]	$4,5 \pm 0,1$	$10,0^{+0,3}_{0}$	6,2	13,8	3,5	71	12,7
32	$5,2 \pm 0,1$	$11,5^{+0,3}_{0}$	7,2	15,8	3,5	81	14,7

[1] All the dimensions are the same as for standard split-pins, except the value F_2 replaced by F'_2.

[2] See Note 2 of Sub-clause 3.1.

The dimension L_{max} shall be specified by the purchaser of the split-pin (see Sub-clause 13.1.1.)

6. Other dimensions given for guidance of manufacturing only



All dimensions are given in millimetres.

Standard couplings	Standard split-pins												Alternative split-pins[1]
	F_1	F_3	F_4	F_5	L_1	L_2	L_3	L_4	L_5[2]	F_6[2]	R_3	V[2]	F'_3
11	11,9	4,5	3,5	2,5	55	16,0	4,6	16	2	1	6,0	8	5,2
16A	14,5	5,5	4,5	3,0	65	19,0	5,2	18	3	1,5	6,5	12	6,3
16B	16,4	5,5	4,5	3,5	65	18,5	6,5	22	3	1,5	8,5	12	6,2
20	16,4	6,0	4,5	3,5	80	22,5	6,5	22	3	1,5	8,5	12	6,7
24	20,0	7,0	7,0	4,0	100	29,5	7,7	28	4	2	10,0	12	7,8
28[3]	22,5	7,4	7,5	4,5	115	32,5	8,7	31	5	2	12,0	15	8,2
32	26,0	8,4	8,5	5,0	130	37,0	10,0	36	6	2,5	14,0	15	9,2

[1] All the dimensions are the same as for standard split-pins, except the value F_3 replaced by F'_3.

[2] Approximative values given when the split-pins are supplied on insulators or fittings. The angle α may vary from 35° to 50°.

[3] See Note 2 of Sub-clause 3.1.

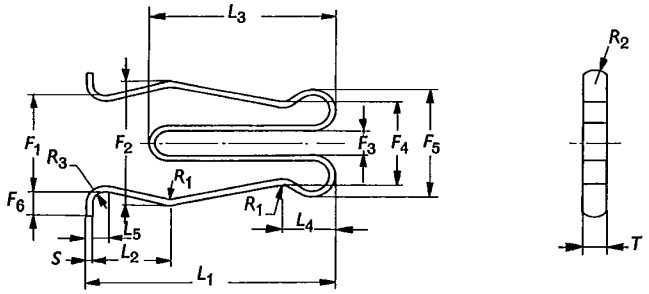
Notes 1. – The length L_2 may be reduced provided that the eye of the split-pin protrudes sufficiently to allow easy use of a live-line working tool to operate the split-pin. In this case, the total length L_1 shall be reduced correspondingly.

2. – The tips of split-pin legs may be cut straight or chamfered on one or both sides, as shown in the figure.

3. – The radius R_1 indicated in the figure is to be defined by agreement between the manufacturer and the purchaser.

4. – In order to make the bending of the split-pin legs easier, a notch can be made at a distance "V" from the tip of the legs.

7. Dimensions of the W-clip



All dimensions are given in millimetres.

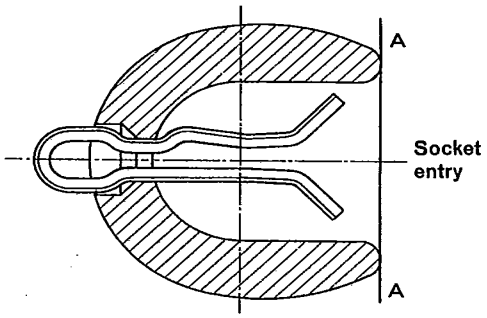
Standard couplings	F_1	F_2	F_3	F_4	F_5	F_6	L_1	L_2	L_3	L_4	L_5	R_1	R_2	$R_{3\,(max)}$	S	T
11	15	20	4	13	19	$4^{+0,6}_{0}$	37 ± 1,5	12	24 ± 1,5	8	3	2,5	3	1,5	$1,2^{+0,2}_{0}$	$4,8^{+0,2}_{0}$
16A	22	28	5	19	24	5^{+1}_{0}	50 ± 1,5	15,5	36 ± 1,5	10,5	3	2,5	3	2,5	$1,5^{+0,2}_{0}$	$5,5^{+0,2}_{0}$
16B	22	28	5	19	24	5^{+1}_{0}	50 ± 1,5	15,5	36 ± 1,5	10,5	3	2,5	4,5	2,5	$1,5^{+0,2}_{0}$	$7,9^{+0,2}_{0}$
20	22	30	5	19	24	5^{+1}_{0}	62 ± 1,5	15,5	42 ± 1,5	10,5	3	2,5	4,5	2,5	$2^{+0,2}_{0}$	$7,0^{+0,2}_{0}$
24	22	30	5	19	25	5^{+1}_{0}	72 ± 1,5	15,5	50 ± 1,5	10,5	3	2,5	5	2,5	$2^{+0,2}_{0}$	$8,7^{+0,2}_{0}$
28[1]	24	32	6	21	28	6^{+1}_{0}	83 ± 1,5	16	62 ± 1,5	12,5	4	3	6	3	$2,2^{+0,2}_{0}$	$10,0^{+0,2}_{0}$
28B[1]	22	30	5	19	25	5^{+1}_{0}	83 ± 1,5	15,5	53 ± 1,5	10,5	3	2,5	5	2,5	$2^{+0,2}_{0}$	$8,7^{+0,2}_{0}$
32	26	36	6	24	33	7^{+1}_{0}	96 ± 1,5	18	71 ± 1,5	16	4	3	7	3	$2,6^{+0,2}_{0}$	$11,5^{+0,2}_{0}$

[1] See Note 2 of Sub-clause 3.1.

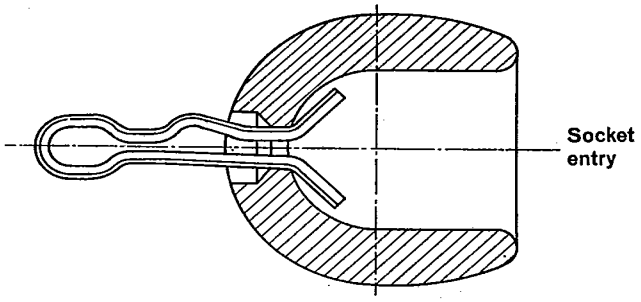
8. Method of using the locking devices

8.1 *Split-pin*

The split-pin is inserted through the hole and afterwards the legs are bent as shown in Clause 6. It can then be operated between the locking and coupling positions.



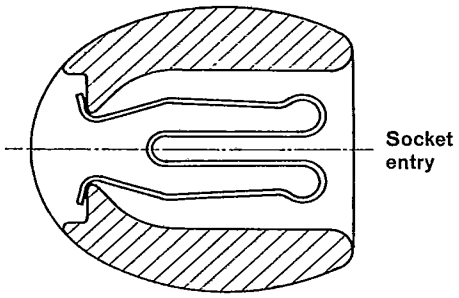
Split-pin in locking position



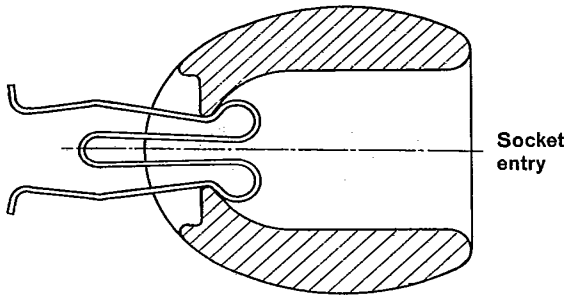
Split-pin in coupling position

8.2 *W-clip*

The W-clip is inserted through the socket entry and can be operated between the locking and coupling positions.



W-clip in locking position



W-clip in coupling position

Note.— A locking device shall never be separated from its socket and replaced by a locking device of different design even if, in both cases, the locking devices are in agreement with the height T_{min} prescribed in BS 3288 : Part 3.

SECTION THREE – TESTS

9. Classification of tests

The tests are divided into two groups:

– *Group I: qualification tests*
The qualification tests are made in order to verify the suitability of the type of material to be used in the manufacture of a locking device.

– *Group II: sample tests*
Sample tests are made in order to verify the quality of a manufacture; they are made on samples taken at random from each batch.

10. Tests in Group I (qualification tests)

Qualification tests consist of:

– hardness test;
– verification of resistance to bending (for split-pins only);
– corrosion resistance test.

They are each made on five samples of material. It shall not be necessary to repeat these tests if a certificate of the qualification test is available and if the locking-device manufacturer gives proof that the profiled material used is the same.

10.1 *Hardness test*

The hardness test shall be carried out according to BS 427 : Part 1 (Vickers test) for copper alloy locking devices and for steel locking devices. It shall be carried out on one of the flat surfaces of the locking device (the side opposite the rounding in the case of split-pin types). A series of three measurements shall be effected on each locking device. The average of the three measurements shall be greater than or equal to 150.

10.2 *Verification of resistance to bending*

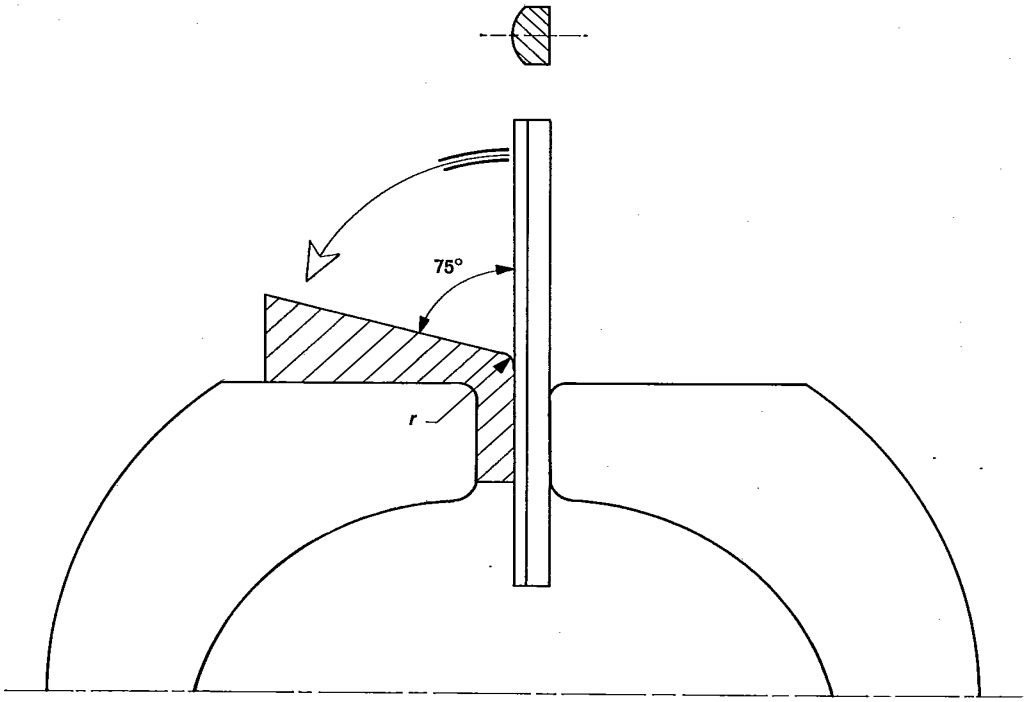
a) Split-pins

The test shall be carried out on a piece taken from the straight part of a leg of the split-pin, or on a sample selected from the profiled material from which the pins have been manufactured.

The test consists in bending the test piece around a specified radius, as shown in the figure hereinafter.

One end of the test piece is inserted into a vice, one of the jaws of which is covered with a lining piece made of steel with its surface at about 75° from the vertical position. By means of a wooden mallet, the test piece is bent against the inclined surface.

After this bending, no splits or cracks shall appear.



Standard couplings	11	16A	16B	20	24	28 [1]	32
r (mm)	2	3	4	4	5	6	7

[1] See Note 2 of Sub-clause 3.1.

b) W-clips

In this case, the bending test shall not be carried out. The visual examination indicated in sample tests is considered sufficient to check that bending in manufacture has not caused any cracks or incipient cracks, particularly in the region of the extremity F_6.

10.3 *Corrosion resistance test*

This test concerns stress corrosion cracking. This corrosion can only appear if there is, simultaneously, a mechanical stress associated with a corrosive atmosphere.

This test concerns neither external corrosion due to corrosive atmospheric conditions nor contact corrosion which can occur between different metals.

The need for a test for resistance to stress corrosion cracking depends on the material used for the manufacture of the locking devices.

For the following materials, no test is required:
- bronze and phosphor-bronze;
- copper alloys with not more than 15% zinc content having undergone a suitable stabilizing annealing treatment;
- austenitic stainless steels having undergone the standard thermal treatment on the original profile material.

For other materials, such as other types of stainless steels and copper alloys with more than 15% zinc content, a suitable test shall be agreed upon in advance by the manufacturer and the purchaser, avoiding, for copper alloys, methods requiring the use of mercury nitrate.

11. Tests in Group II (sample tests)

Sample tests are:

a) visual examination;

b) verification of dimensions;

c) hardness test;

d) verification of resistance to bending.

12. General rules for the visual examination *a)*

The inspection shall be made by attributes. The following control method shall be applied:

- single sampling;
- size of the sample as given in Table I;
- acceptable quality level (AQL):
  1.5% for the faults described in Item *a)* of Sub-clause 12.1,
  6.5% for the faults described in Item *b)* of Sub-clause 12.1;
- acceptance number K as given in Table I.

TABLE I

Number of locking devices in the lot N	Size of the sample n	Acceptance number K	
		AQL = 1.5%	AQL = 6.5%
$< N \leqslant 500$	50	$K = 2$	$K = 7$
$500 < N \leqslant 1200$	80	$K = 3$	$K = 10$
$1200 < N \leqslant 3200$	125	$K = 5$	$K = 14$
$3200 < N \leqslant 10000$	200	$K = 7$	$K = 21$
$10000 < N \leqslant 35000$	315	$K = 10$	$K = 21$
$35000 < N \leqslant 150000$	500	$K = 14$	$K = 21$

The lot shall be considered as complying with this standard if the number of defectives is less than or equal to the acceptance number K.

If the lot does not comply, it may be withdrawn and re-examined by the manufacturer. Following this, it may be submitted again for inspection.

Note. — A lot is the quantity of locking devices manufactured or produced under conditions which are presumed uniform and offered for acceptance. A batch, as defined in BS 137 : Part 1, may be divided into several lots to meet the above definition.

12.1 *Visual examination*

The locking device shall not have any defects prejudicial to satisfactory behaviour in service:

a) defects to which an AQL of 1.5% applies are surface cracking or incipient cracks;

b) defects to which an AQL of 6.5% applies are rough surface (orange-peel surface), blisters.

13. **General rules and tests for *b), c)* and *d)***

The rules concern:

- verification of dimensions (see Sub-clause 13.1);
- hardness test (see Sub-clause 13.2);
- verification of bending resistance (see Sub-clause 13.3).

The number p of locking devices selected for testing shall be the nearest whole number greater than the one given by the following formulae (N being the number of locking devices in the lot):

$N < 500$	p shall be subject of agreement between the parties
$500 \leqslant N \leqslant 20000$	$p = 2 + \frac{0.75\ N}{1000}$
$N > 20000$	$p = 10 + \frac{0.35\ N}{1000}$

The group of selected samples is submitted to the verification of dimensions test *b)*. Then it is divided into two equal parts, the first being used for the hardness test *c)*, the second for the bending test *d)*.

In the event of a sample failing to pass one of the above tests, a re-test procedure according to Clause 14 is permissible.

13.1 *Verification of dimensions*

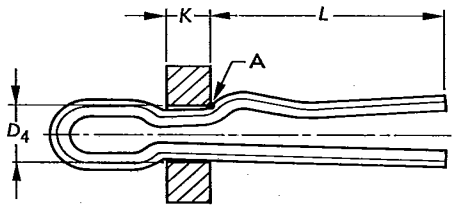
The dimensions of the locking devices shall conform to the requirements of Section Two of this standard.

13.1.1 *Split-pins*

For split-pins, the following dimensions shall be checked: S, T, F_2, R, L.

Verification of dimension L.

To check the dimensions L_{min} and L_{max}, the split-pin is placed in a jig as shown in the figure, the split-pin being in contact with A. The values for K and D_4 are given in the following table:



Standard Coupling	11	16A	16B	20	24	28[1]	32
K (mm)	3,5±0,6	4±0,7	5±1	5±1	6±1	7±1,2	8±1,4
D_4 (mm)	7,5±0,4	9,5±0,5	10±0,5	10±0,5	12±0,5	13±0,5	15±0,5

[1] See Note 2 of Sub-clause 3.1.

The split-pin, when in the locking position, shall not extend beyond the face of AA of the socket entry, as shown in the figure of Sub-clause 8.1, except that in the case of the standard coupling size 11, it is permissible for the split-pin to extend beyond the face AA by not more than 5 mm.

13.1.2 *W-clips*

For W-clips, all dimensions shall be checked.

It is important that, in forming the W-clips, extremity F_6 is approximately perpendicular to the axis when the clip is in the locking position.

The Appendix A shows the gauges which may be used to check the dimensions for W-clips.

13.2 *Hardness test*

The test shall be carried out as described in Sub-clause 10.1.

13.3 *Verification of resistance to bending (for split-pins only)*

The test shall be carried out as described in Sub-clause 10.2.

14. Re-test procedure

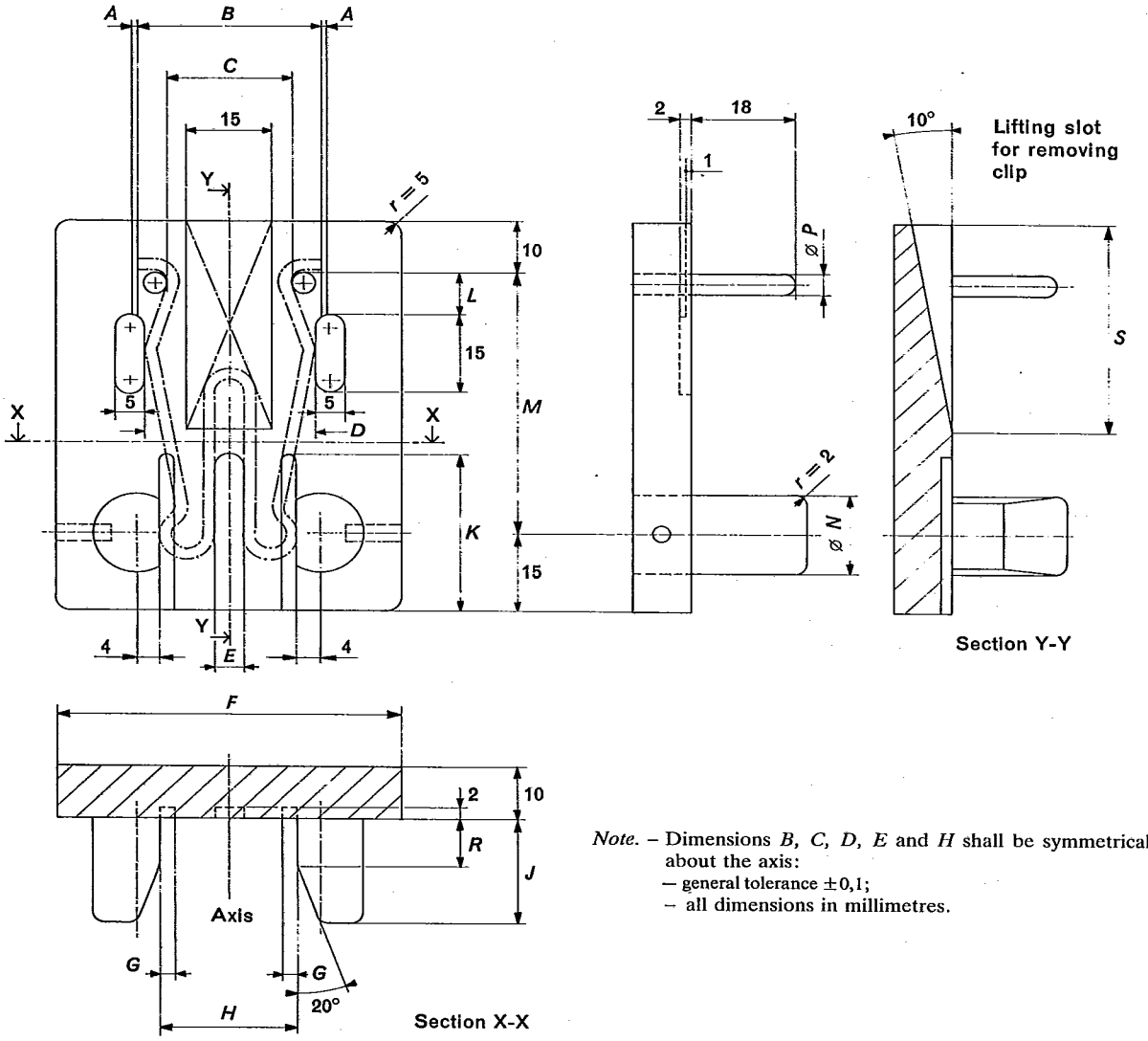
In the case of failure to meet the requirements of Sub-clause 13.1, agreement may be reached to withdraw the batch for further examination by the manufacturer. The tests of Sub-clause 13.1 may then be repeated, taking three times the number of samples originally submitted to these tests.

If only one locking device fails to comply with one of the tests given in Sub-clauses 13.2 and 13.3, a re-test concerning this test may be carried out, taking twice the number of samples originally submitted to this test.

If two or more locking devices fail to comply with one of the tests given in the above clauses, or if the result of the re-test is not satisfactory, the complete batch is considered as not complying with this standard.

APPENDIX A

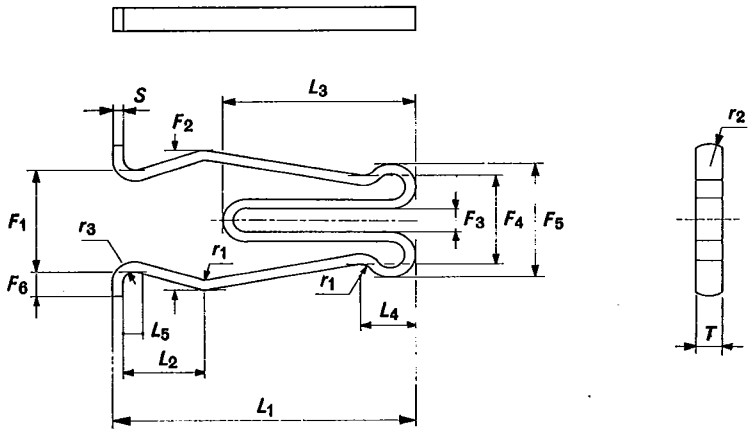
GAUGES FOR W-CLIPS



Note. – Dimensions *B*, *C*, *D*, *E* and *H* shall be symmetrical about the axis:
– general tolerance ±0,1;
– all dimensions in millimetres.

W-clip	*A*	*B*	*C*	*D*	*E*	*F*	*G*	*H*	*J*	*K*	*L*	*M*	*N*	*P*	*R*	*S*
11	0,6	23	15	20	4	50	3	19	18	24	4,5	32	12	3	9	32
16A	1	32	22	28	5	60	2,5	24	20	30	8	44	15	4	9	32
16B	1	32	22	28	5	60	2,5	24	20	30	8	44	15	4	9	32
20	1	32	22	30	5	60	2,5	24	20	30	8	55	15	4	9	40
24	1	32	22	30	5	60	3	25	20	30	8	65	15	4	9	42
28[1)]	1	36	24	32	6	65	3,5	28	22	30	8	75	15	5	12	42
28B[1)]	1	32	22	30	5	60	3	25	20	30	8	75	15	4	9	50
32	1	40	26	36	6	70	4,5	33	22	35	10	85	15	5	12	45

[1)] See Note 2 of Sub-clause 3.1.



Notes on the use of gauges for W-clips

1. The clip is mounted in the gauge in the position shown so that the nominal dimensions F_1 and F_5 are maintained by the pegs and stops respectively.

2. The grooves of width A correspond to the allowed tolerances of dimension F_6. The ends of the "ears" of the clip must lie within the zone defined by these grooves.

3. Dimension D corresponds to the nominal overall width F_2 of the clip. The two recesses allow comparison between the clip and the nominal dimension.

4. Dimension E corresponds to the nominal width F_3 of the internal loop. The recess allows comparison between the clip and the nominal dimension.

5. The recesses of width G correspond to the difference between the nominal dimensions F_4 and F_5. The internal edges of these recesses allow comparison between the clip and the nominal dimension F_4.

6. Comparison of the clip with the nominal dimensions L_1, L_2, L_3 and L_4 is made by direct measurement.

7. Dimensions S and T on the clip are verified by direct measurement.

Publications referred to

BS 137	Insulators of ceramic material or glass for overhead lines with a nominal voltage greater than 1000 V Part 1 Methods of test
BS 427	Method for Vickers hardness test Part 1 Testing of materials
BS 3288	Specification for insulator and conductor fittings for overhead power lines Part 3 Dimensions of ball and socket couplings of string insulator units

BS 3288 : Part 4 : 1989

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Association of Consulting Engineers
Association of Manufacturers Allied to the Electrical and Electronic Industry (BEAMA Ltd.)
British Cable Makers' Confederation
British Ceramic Research Ltd.
British Industrial Ceramic Manufacturers' Association
Department of Energy (Electricity Division)
Electrical and Electronic Insulation Association (BEAMA Ltd.)
Transmission and Distribution Association (BEAMA Ltd.)

The following bodies were also represented in the drafting of the standard, through subcommittees and panels:

Aluminium Federation
British Railways Board
Electricity Supply Industry in England and Wales
National Association of Malleable Ironfounders
Overhead Transmission Line Contractors

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