Chapter 5

INSTALLATION AND SERVICING OF LOW-TENSION CABLES AND AIRCRAFT WIRING SYSTEMS

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Introduction

1. Aircraft electrical supplies are distributed to the equipment by various types of cable, which have been developed to fulfil in the most efficient manner the needs of each particular service. Different systems of wiring layout may be employed; certain standard systems are described in A.P.4343C, Vol. 1, Book 3, Sect. 5, though considerable variations may be encountered. The relevant Aircraft Handbook gives details of the wiring layout for a particular aircraft.

DESCRIPTION

Cables

2. The general electrical power distribution, apart from ignition circuits and H.T. radio supplies, is made by means of various types of low-tension cable, as described in different chapters of A.P.4343C, Vol. 1, Book 3, Sect. 5. These cables may be made up of one or more conductors, insulated from one another, bound together, and protected in various ways from mechanical and chemical damage, and from normal wear and tear.

3. The conductor, which is the electrical connecting medium, generally consists of a number of tinned copper or aluminium wires, bunched or stranded together and covered with polychloroprene, rubber, or other insulation. This insulated conductor is called the core of the cable. Two-core cable for aircraft installation is normally flat, the two cores being placed side by side in the covering, but single or multi-core cable or two-core cable for ground trailing use is normally round. This shape is achieved by using " worming," usually thick threads of soft cotton, as a packing between and round the cores to build them up into circular form over which the protective covering is applied.

4. Cables of various types for general purposes, cables with variously assembled cores for specific purposes, special purpose cables, and cables with special protection for particular services are all available. Provision is made for easy identification of the circuit for which each cable is used. Multi-core cables, for example, may have the outer layer of the insulation of each core distinctively coloured in red, blue, green, yellow, white, black, brown or combinations of these colours. This enables the circuit for which each core is used to be quickly identified, and is useful in tracing a circuit for removal, renewal, or modification.

Component parts of wiring systems

5. All component parts of particular wiring systems, such as plugs, sockets, terminal blocks, junction boxes, etc., are described either under the appropriate wiring system, or in separate chapters in A.P.4343C, Vol. 1, Book 3, Sect. 5. Certain other small items, which have not been covered in a separate chapter, nor included under a particular wiring system since they are of general application, are described in the following paragraphs.

Sleeves

6. Many various types of identification and marker sleeves are available, made from different materials and in different forms. Of these, Helsyn sleeves are made of neoprene-based synthetic material. Helvin sleeves of P.V.C., and Hellermann sleeves of mineralised rubber. Since Helvin and Helsyn sleeves are resistant to oil, gasoline, etc., they are used frequently for protection of cables exposed to such liquids. Helvin sleeves are not so elastic as those made from rubber, but are used extensively as cable marker sleeves.

7. These sleeves may be single, each in a range of lengths and internal diameter, or of the Helvin split form as shown in (6) of fig. 5, which has been designed to provide oil and waterproof conditions where cables emerge from a ferrule. ◀ Details of certain recently developed ranges of sleeving will be found in A.P.4343C, Vol. 1, Book 3, Sect. 5. ▶

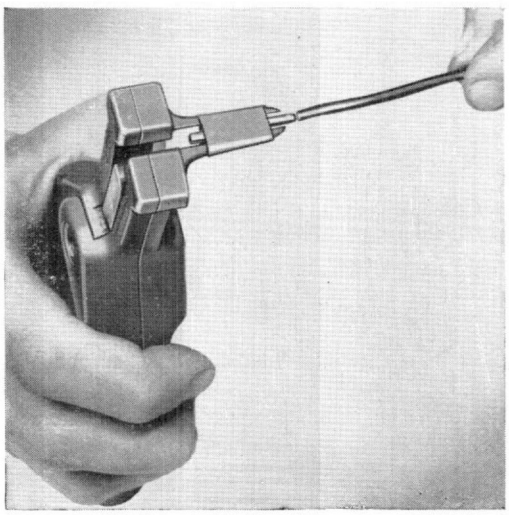

Fig. 1. Fitting marker sleeve

8. Sleeves are most easily fitted using a sleeve-fixing tool (*fig.* 1). This is in three sizes, as follows:

Size	*Type*	*Ref. No.*
Small	S	1C/7020
Medium	K	1C/5862
Large	L	1C/5863

The prongs of the tool should be lightly oiled with Hellerine lubricant (Ref. No. 34B/356) or silicone compound MS4 (Ref. No. 33C/1172) to facilitate the fitting of sleeves. Hellerine is preferable as it evaporates eventually, whereas silicone compound MS4 is persistent.

Note . . .

It is important that no other lubricant should be used for this purpose, nor for the lubrication of cables to facilitate the assembly of water sealing glands, pressure bungs, etc.; severe deterioration of the insulation may be caused by other lubricants.

Grommets

9. Ranges of Helsyn and rubber grommets are available, and are used for the direct entry of single or multi-core cables into junction boxes, or other items of equipment where chafing might otherwise occur. Sleeved grommets are expanded on to the cable with the sleeve-fixing tool, and the complete assembly is screwed into the relevant hole in the box or panel. A dummy grommet is also available to seal unused holes.

INSTALLATION

10. Where low voltages are used and relatively high currents are flowing, it is essential in aircraft wiring to use cables capable of carrying the load; otherwise, the drop in voltage over a length of cable may be such that the apparatus will not operate efficiently.

11. Cables are tested in various ways to ensure their efficient operation in service. Effects of exposure to weather, sea-water, and dampness can be largely overcome by weather-proofing. Exposure to acid or other injurious conditions should be avoided where possible. Where it is not possible to avoid running cables near the oil filters, vents or over-flows, adequate protection must be provided, preferably by P.V.C. sleeving; if ester based ◀ fluids are liable to be encountered, Helsyn 150 ▶ sleeving must be used.

12. Serious trouble may arise if water is allowed to percolate into conduits or junction boxes. The screened cable is not waterproof, and should not be exposed to rain, or splashes. If screened cable installed in such a position is not protected by a P.V.C. outer cover, it should be wrapped with oil-resisting tape, or sprayed with waterproof paint.

13. Cables connecting to equipment should, wherever possible, be arranged to run downwards from the item of equipment, but if this is not possible, the cables must be turned downwards immediately after leaving the point of entry. Where cables leave the conduit at a cut ferrule, water may run into the conduit, in which case the end of the conduit should be sealed by filling the space in and around the cables with compound B.I.C.C. No. 391 (Ref. No. 33C/9109209) and wrapping it with oil resisting tape.

14. Continuous vibration, undue stretching, and over-loading must also be avoided. Where cables are taken through bulkheads, fairings, fabrics and the like, the holes must have suitable grommets or bushes fitted to prevent chafing. Conduits through which cables are to be drawn must have clean smooth edges, and their ends should be flared or bell-mouthed to prevent abrasion of the cable-covering on the sharp edges.

15. The fixing of cables, ducts, cleats, etc., must not involve any drilling or modification of the aircraft structure which would be liable to weaken it. Cables must be adequately supported throughout their whole length, and loops, slackness or straining must be avoided. When connected to terminal blocks, cables

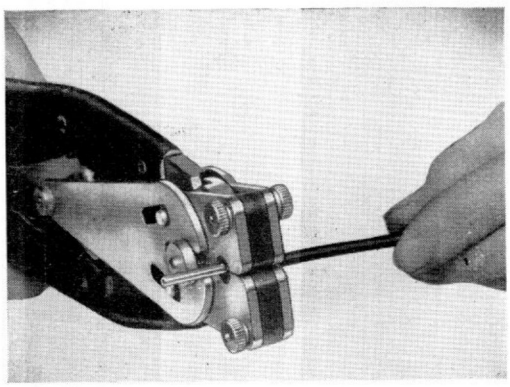

Fig. 2. Crimping operation

should be cut approximately 2 in. longer than the minimum necessary, to allow for renewal at the connection point in case of breakage, and be anchored as close as possible to the terminal block.

16. Care must be taken when cutting lengths of cable, making up cable assemblies, or drawing into conduits, to avoid twisting which might result in kinking and consequent damage to the conductors. This is particularly applicable with flat twin-core cables.

17. Cables for power services must not be run in common ducts with radio, ignition, or similar circuits, and must be separated from these as far as space permits.

18. Joints are not permissible in any cables, except in special cases, and no looping is allowed. Where a cable passes between two components of the aircraft, as, for example, between fuselage and planes, or between fin and rudder, provision is made for disconnecting the cables. Terminal blocks, plugs and sockets, etc., fixed in accessible positions, may be installed for this purpose.

Preparation of cable ends

19. The preferred method of making the cable termination is by means of crimping (*fig.* 2), whereby a suitable plug pin, socket insert, ferrule or lug is firmly secured to the conductor, so ensuring good electrical contact. In certain circumstances, as described in para. 34 to 36, it may be necessary to make a soldered connection. Further information on the preparation of cable ends is given in Chap. 6 of this Section.

Crimping

20. Various methods of crimping, using different types of termination, are employed, depending on the type and rating of cable and the form of connection required. These may be classified as follows:

(1) Indent crimping of S.B.A.C. type ferrules and lugs, originally used on cables of the "cel," "vin" and "rubber" ranges.

(2) Indent crimping of Plessey quick-release tags, plugs and sockets.

(3) Hexagon crimping of lugs, used on Pren, Nyvin, etc.

21. Although the indent crimping of S.B.A.C. type ferrules and lugs was primarily applicable to cables of the "cel," "vin" and "rubber" ranges, it can also be used in conjunction with Pren and other cables. Equivalent strandings of the conductors of various cables are given in Table 1, and comparable data for aluminium cables in Table 2. Details of corresponding cable sizes under the American system of identification, which includes Nyvin, Tersil, Efglas and all future types of cable, will be found in Chap. 1 of this Section.

TABLE 1

Equivalent stranding of copper conductors

Cable group	Rating (amp.)				Conductor		No. and dia. of strands					
	Vin, cel, rubber	Pren, Nypren	Fire-red Firedet	P.T.F.E., Glasil	Max. dia. (in.)	Area (sq. in.)	0·006	0·0076	0·012	0·018	0·036	0·044
C 1	2·5	4			0·033	0·0006	19	14				
C 2		6		4	0·041	0·0009		19				
C 3	4				0·048	0·0010		23	9			
C 4	7	9	7	9	0·052	0·0015		33				
		12			0·061	0·0018		40	16	7		
							(P.	T.F.E.	37)			
C 5	12	18		12	0·078	0·0032		70	28			
C 6	19	24		18	0·096	0·0050		110	44			
C 7		35		24	0·122	0·0082			73			
C 8		50		35	0·167	0·0133			120			
								(P.T.	F.E.1	19)		
C 9	37				0·162	0·0145			135	60		
C10		70		50	0·218	0·0206			182			
C11		100			0·272	0·0335			294			
C12	64				0·312	0·0400			368	163		
C13		135		100	0·345	0·0525				203		
C14	83	150			0·384	0·0630				248	61	
C15		170		150	0·432	0·0818				323		
C16	138	200			0·490	0·106				416		61
C17		230		200	0·548	0·1315				513		
C18		280			0·615	0·1700				666		

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Table 2

Stranding of aluminium conductors

Cable group	Rating (amp.)	Conductor		No. and dia. of strands 0·020
	Prenal, Nyprenal	Max. dia. (in.)	Area (sq. in.)	
A1	35	0·160	0·0130	41
A2	50	0·211	0·0222	70
A3	70	0·262	0·0333	105
A4	100	0·330	0·0534	168
A5	135	0·418	0·0845	266
A6	150	0·478	0·1088	342
A7	170	0·535	0·1325	418
A8	200	0·587	0·1690	532

S.B.A.C. type ferrules and lugs

22. The components of the S.B.A.C. wiring system are described and illustrated in A.P.4343C, Vol. 1, Book 3, Sect. 5, Chap. 2. There are two hand crimping tool kits available, No. 1 (Ref. No. 5H/94), for crimping ferrules and ferrule adapters from 4 to 37 amp., and No. 2 (Ref. No. 5H/102), for crimping heavy-duty ferrule adapters and cable lugs from 64 to 138 amp. The dies are listed in Appendix 1 to the chapter quoted above, and the terminations to be used with the various cable sizes are listed in Table 3.

Table 3

Terminations used with indent crimping

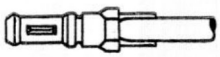
Cable group	Termination						Cable stripping dimensions (in.)
	Ferrule	Plug pin	Socket insert	Tag or lug	Outer thimble	Inner sleeve	
C1	S.B.A.C. 5H/25					Double conductor	$\frac{5}{8}$
C2, C3	5H/24						$\frac{5}{16}$
C4	5H/25						$\frac{5}{16}$
C5	5H/119						$\frac{5}{16}$
C6	5H/26						$\frac{5}{16}$
C6	5H/31						$\frac{5}{16}$
C1		5X/3238				Double conductor	$\frac{5}{8}$
C1		5X/3240				Double conductor	$\frac{5}{8}$
C1			5X/3237		5X/3149	Double conductor	$\frac{5}{8}$
C1			5X/3239		5X/3149	Double conductor	$\frac{5}{8}$
C2, C3		5X/3238				5X/3148	$\frac{5}{16}$
C2, C3		5X/3240				5X/3148	$\frac{5}{16}$
C2, C3			5X/3237		5X/3149	5X/3148	$\frac{5}{16}$
C2, C3			5X/3239		5X/3149	5X/3148	$\frac{5}{16}$
C4		5X/3238					$\frac{5}{16}$
C4		5X/3240					$\frac{5}{16}$
C4			5X/3237		5X/3149		$\frac{5}{16}$
C4			5X/3239		5X/3149		$\frac{5}{16}$

Table 3—Terminations used with indent crimping—*contd.*

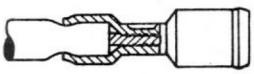
Cable group	Termination						Cable stripping dimensions (ins.)
	Ferrule	Plug pin	Socket insert	Tag or lug	Outer thimble	Inner sleeve	
C1				5X/2267	5X/2270	Double conductor	$\frac{5}{8}$
C2, C3				5X/2266	5X/2269		$\frac{5}{16}$
C4				5X/2267	5X/2270		$\frac{5}{16}$
C4		5X/3242				5X/3146	$\frac{5}{16}$
C5		5X/3242				5X/3147	$\frac{5}{16}$
C6		5X/3242					$\frac{5}{16}$
C4			5X/3241		5X/3150	5X/3146	$\frac{5}{16}$
C5			5X/3241		5X/3150	5X/3147	$\frac{5}{16}$
C6			5X/3241		5X/3150		$\frac{5}{16}$
C5				5X/2268	5X/2271	5X/3147	$\frac{5}{16}$
C6				5X/2268	5X/2271		$\frac{5}{16}$
C7	5H/27					5X/6766	$\frac{5}{16}$
C7		5X/6803				5X/6766	$\frac{5}{16}$
C7			5X/6401			5X/6766	$\frac{5}{16}$
C8, C9	5H/27						$\frac{11}{32}$
C8, C9		5X/6803					$\frac{11}{32}$
C8, C9			5X/6401				$\frac{11}{32}$
C10		5X/6805				5X/6807	$\frac{15}{32}$
C10			5X/6400			5X/6807	$\frac{15}{32}$
C10				5H/114		5X/6807	$\frac{15}{32}$
C10				5H/117		5X/6807	$\frac{15}{32}$
C10	5H/120					5X/6807	$\frac{15}{32}$
C11		5X/6805				5X/6808	$\frac{17}{32}$
C11			5X/6400			5X/6808	$\frac{17}{32}$
C11				5H/114		5X/6808	$\frac{17}{32}$
C11				5H/117		5X/6808	$\frac{17}{32}$
C11	5H/120					5X/6808	$\frac{17}{32}$
C12		5X/6805					$\frac{19}{32}$
C12			5X/6400				$\frac{19}{32}$
C12				5H/114			$\frac{19}{32}$
C12				5H/117			$\frac{19}{32}$
C12	5H/120						$\frac{19}{32}$
C15				5H/115		5X/6810	$\frac{13}{16}$
C15				5H/118		5X/6810	$\frac{13}{16}$
C16				5H/115			$\frac{15}{16}$
C16				5H/118			$\frac{15}{16}$
	Avro						
C1	5X/6621						$\frac{3}{8}$
C2, C3	5X/6621						$\frac{3}{8}$
C4	5X/6620						$\frac{3}{8}$

23. When crimping ferrules and ferrule adapters up to and including 37 amp., the cable insulation should be cut back neatly, the conductor trimmed, and the cable inserted into the ferrule so that the insulation is held firmly in the skirt when the termination is crimped (*fig.* 3). With cables in group C1, the conductor is to be doubled back before insertion. The ferrule must not be unduly distorted, and shearing of the sides must not occur during the crimping process. Cut off any excess length of conductor protruding from the end of the ferrule, and ensure by visual inspection that a firm and satisfactory crimp has been made.

24. With ferrule adapters and cable lugs over 37 amp., the insulation should not enter the skirt, but should come closely up to the end of it. The insulation should be cut back sufficiently to allow the conductor to extend to the end of the lug.

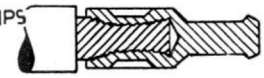


(A) 4-AMP. FERRULE

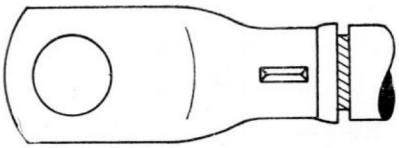


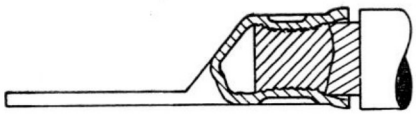
INSULATION CRIMPS FOR CONDUCTORS UP TO 37 AMP.

NO INSULATION CRIMPS FOR LARGER CONDUCTORS



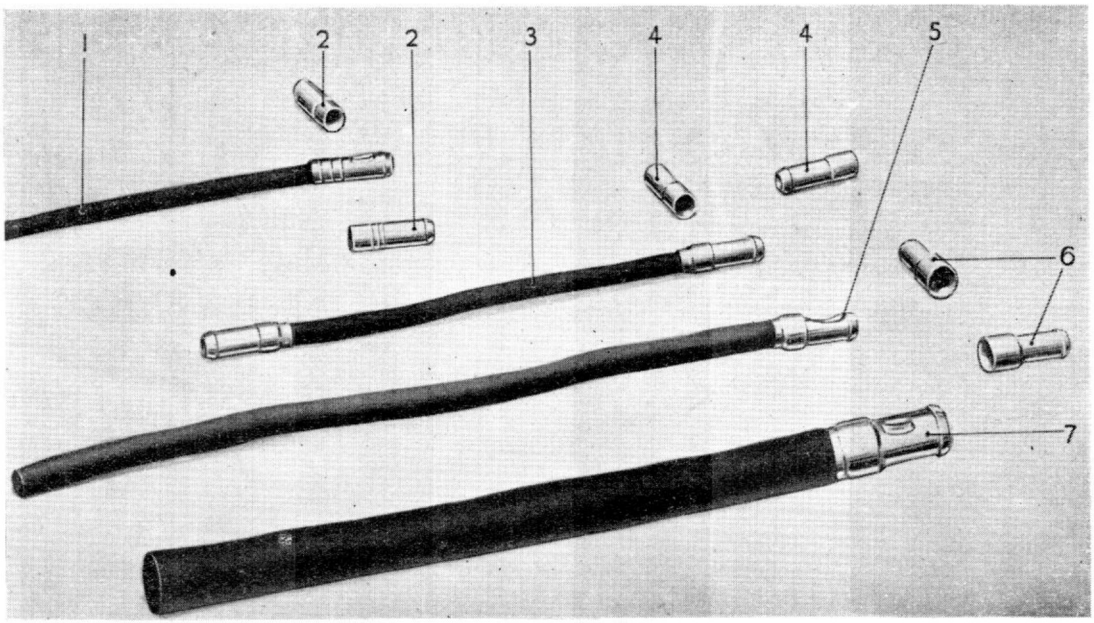
(B) FERRULE ADAPTERS





(C) CABLE LUGS

Fig. 3. Crimping of S.B.A.C. type ferrules and lugs



1 4-amp. CABLE, WITH FERRULE ATTACHED BY CRIMPING

2 4-amp. FERRULES, SHOWING IDENTIFICATION RING

3 7-amp. CABLE, WITH FERRULES ATTACHED BY CRIMPING

4 7-amp. FERRULES

5 19-amp. CABLE, WITH FERRULE ATTACHED BY CRIMPING

6 19-amp. FERRULES

7 37-amp. CABLE, WITH FERRULE ATTACHED BY CRIMPING

Fig. 4. S.B.A.C. ferrules before and after crimping to cables

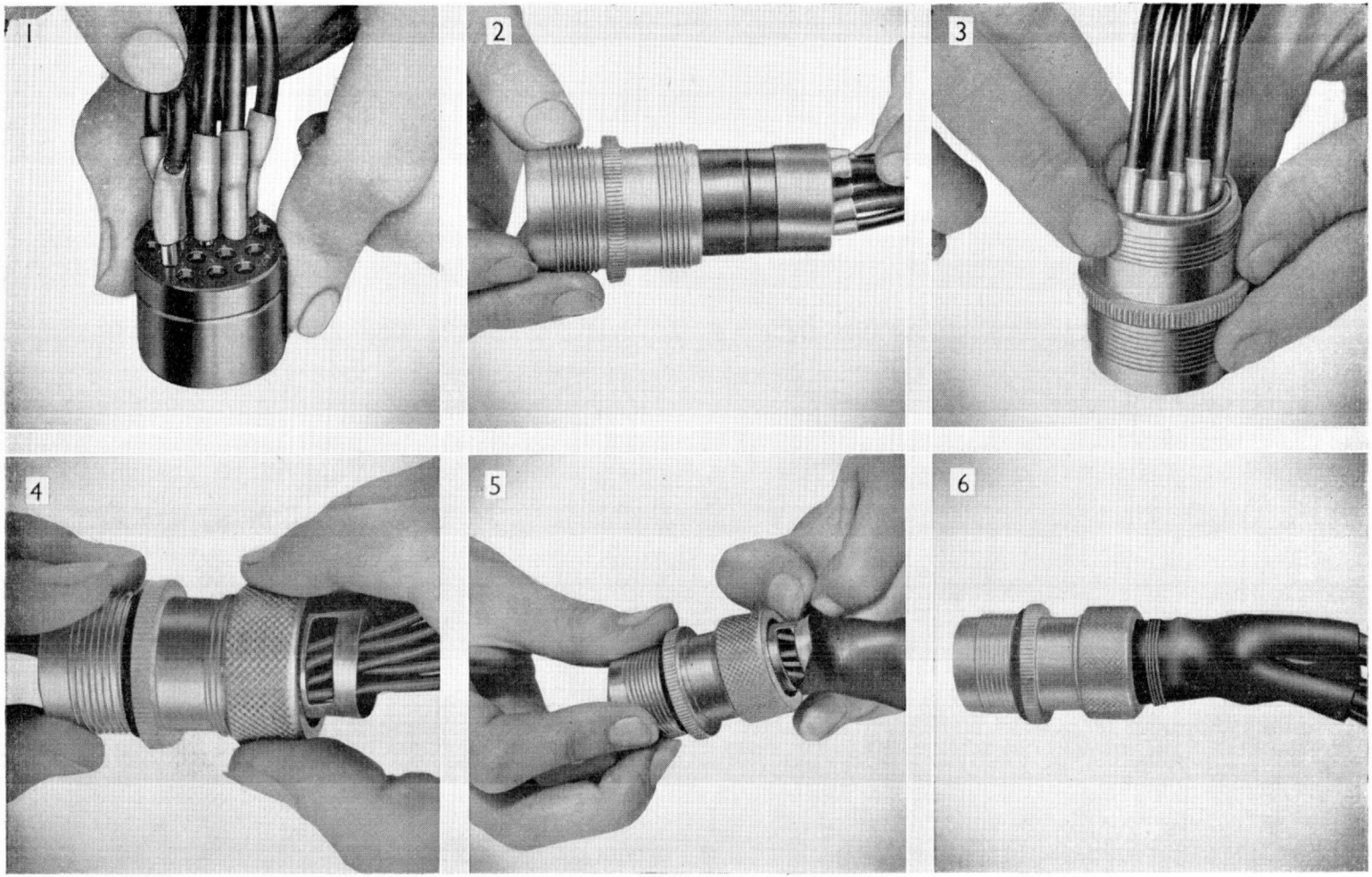


Fig. 5. Socket assembling sequence

Plessey plugs, sockets, and quick-release tags

25. The components of the Plessey wiring system are described and illustrated in A.P.4343C, Vol. 1, Sect. 5, Chap. 1. The hand crimping tool kit, No. 3 (Stores Ref. 5X/3186) has a range of indent dies suitable for crimping 4 amp., 7 amp. and 19 amp. plug pins, socket inserts and tags; the tool kit, Mk. 2 covers the same range, but crimps the insulation as well; and the heavy-duty tool kit (Stores Ref. 5X/6462) includes dies for 37 amp. and 64 amp. vibration-proof socket inserts. Table 3 lists the terminations appropriate to the various cable sizes.

26. The assembling of a climatic-proof socket, using bunched cables and a cut ferrule, is described in full as a typical example of the procedure involving crimping of socket inserts (*fig.* 5).

(1) Dismantle the socket by removing the circlip located at one end of the socket shell, and withdrawing the insulating sleeve, comb and socket mouldings complete with socket inserts, and the insulating washer.

(2) Bare the end of each cable just sufficiently for the wire to lie along the narrow section of the socket insert.

(3) Fit the split sleeve, coupling nut, cut ferrule, ferrule gasket, circlip, and insulating sleeve, over the cable assembly in the order given.

(4) Ensure that a thimble is located over each socket insert, then locate the first cable end in its relevant insert.

(5) Locate the thimble centrally in the crimping tool, and firmly squeeze the handles. Ensure that a firm and satisfactory crimp has been made, and pass a marker sleeve over the joint.

(6) Repeat sub-para. (5) for the remaining cables and inserts.

(7) Line up the comb and socket mouldings, and push each insert into the correct hole in the comb moulding until it locks in position (1, *fig.* 5). Re-assemble the insulating washer, comb and socket moulding and insulating sleeve in the socket shell (2), and fit the circlip (3).

(8) Slide up and locate the ferrule gasket and washer on the socket end, and screw the coupling nut up tight (4).

(9) Pull the end of the split sleeve over the cut ferrule (5) and bind it securely in position with waxed twine (6).

Note . . .

An approved alternative for sealing these sockets when single-core cables are used is the Hellerman sealing gland.

27. When crimping plug pins, remove the four nuts and bolts which retain the assembly, feed the cables through the correct holes in the rear moulding, and crimp the pins as

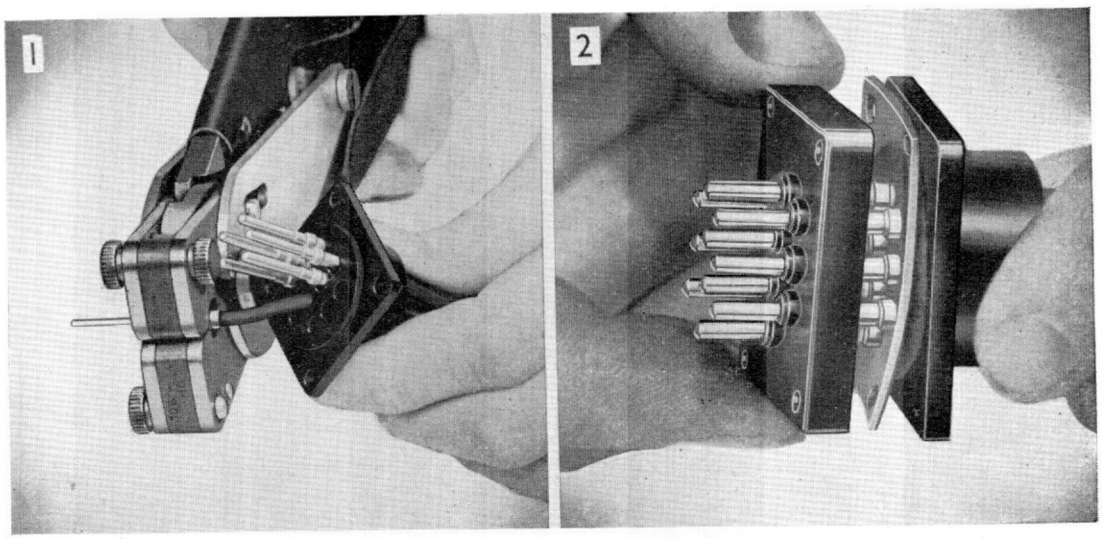


Fig. 6. Assembling a climatic-proof plug

shown in (1), fig. 6. Note that the bucket end of each pin should shroud the end of the cable insulation so that sleeving of the joint is unnecessary, although a marker will still be required. Replace the sealing gasket and feed the pins through the holes in the front moulding (2, *fig.* 6). Replace the next gasket and front shell, and retain the assembly with the four bolts and nuts.

28. When a quick-release tag is attached to the cable by crimping, a thimble must first be placed over the tag to facilitate crimping. The joint should be finished by covering with a binding sleeve.

Hexagon crimping of lugs

29. Hexagon crimping of lugs for cables up to and including Pren 50 is done by means of the heavy-duty tool kit (Stores Ref. 5X/6462), which includes the range of dies required, and also hand-operated heavy-duty pliers (Stores Ref. 5X/6463); over that size a hydraulic crimping tool (*Stores Ref.* 3A/3042 or 3304), suitable for lugs for Pren 35 and upwards, is needed. The appropriate lug sizes and cable stripping dimensions, for copper and aluminium lugs, are given in Tables 4 and 5 respectively.

TABLE 4

Data for hexagon crimping of copper cable lugs

Cable group	Cable lug Mark	Stores Ref. (5X/-)	Stud size	Cable stripping dimensions (in.)
C1, C2	1A	6667	6 B.A.	$\frac{5}{16}$
C1, C2	2A	6668	4 B.A.	$\frac{5}{16}$
C1, C2	3A	6669	2 B.A.	$\frac{5}{16}$
C4	4A	6670	4 B.A.	$\frac{5}{16}$
C4	5A	6671	2 B.A.	$\frac{5}{16}$
C5	6A	6672	4 B.A.	$\frac{5}{16}$
C5	7A	6673	2 B.A.	$\frac{5}{16}$
C6	8A	6674	4 B.A.	$\frac{5}{16}$
C6	9A	6675	2 B.A.	$\frac{5}{16}$
C6	10A	6676	$\frac{1}{4}$ in.	$\frac{5}{16}$
C6	11A	6677	$\frac{5}{16}$ in.	$\frac{5}{16}$
C7	12	6512	4 B.A.	$\frac{5}{16}$
C7	13	6513	2 B.A.	$\frac{5}{16}$
C7	14	6514	$\frac{1}{4}$ in.	$\frac{5}{16}$
C7	15	6515	$\frac{5}{16}$ in.	$\frac{5}{16}$
C7	16	6516	$\frac{3}{8}$ in.	$\frac{5}{16}$
C8	17	6517	$\frac{1}{4}$ in.	$\frac{11}{32}$
C8	18	6518	$\frac{5}{16}$ in.	$\frac{11}{32}$
C8	19	6519	$\frac{3}{8}$ in.	$\frac{11}{32}$
C10	20	6520	$\frac{1}{4}$ in.	$\frac{15}{32}$
C10	21	6521	$\frac{5}{16}$ in.	$\frac{15}{32}$
C10	22	6522	$\frac{3}{8}$ in.	$\frac{15}{32}$
C11	23	6523	$\frac{1}{4}$ in.	$\frac{17}{32}$
C11	24	6524	$\frac{5}{16}$ in.	$\frac{17}{32}$
C11	25	6525	$\frac{3}{8}$ in.	$\frac{17}{32}$
C11	26	6526	$\frac{1}{2}$ in.	$\frac{17}{32}$
C13	27	6527	$\frac{5}{16}$ in.	$\frac{11}{16}$
C13	28	6528	$\frac{3}{8}$ in.	$\frac{11}{16}$
C13	29	6529	$\frac{1}{2}$ in.	$\frac{11}{16}$
C14	30	6530	$\frac{5}{16}$ in.	$\frac{23}{32}$
C14	31	6531	$\frac{3}{8}$ in.	$\frac{23}{32}$
C14	32	6532	$\frac{1}{2}$ in.	$\frac{23}{32}$
C15	33	6533	$\frac{5}{16}$ in.	$\frac{13}{16}$
C15	34	6534	$\frac{3}{8}$ in.	$\frac{13}{16}$
C15	35	6535	$\frac{1}{2}$ in.	$\frac{13}{16}$
C16	36	6536	$\frac{5}{16}$ in.	$\frac{15}{16}$
C16	37	6537	$\frac{3}{8}$ in.	$\frac{15}{16}$
C16	38	6538	$\frac{1}{2}$ in.	$\frac{15}{16}$
C17	39	6539	$\frac{5}{16}$ in.	$1\frac{1}{32}$

Table 4—Data for hexegon crimping of copper cable lugs—*contd.*

Cable group	Cable lug Mark	Stores Ref. (5X/-)	Stud size	Cable stripping dimensions (in.)
C17	40	6540	$\frac{3}{8}$ in.	$1\frac{1}{32}$
C17	41	6541	$\frac{1}{2}$ in.	$1\frac{1}{32}$
C18	42	6542	$\frac{5}{16}$ in.	$1\frac{3}{16}$
C18	43	6543	$\frac{3}{8}$ in.	$1\frac{3}{16}$
C18	44	6544	$\frac{1}{2}$ in.	$1\frac{3}{16}$

TABLE 5

Data for hexagon crimping of aluminium cable lugs

Cable group	Cable lug Mark	Stores Ref. (5X/-)	Stud size	Cable stripping dimensions (in.)
A1	1	6545	4 B.A.	$\frac{7}{16}$
A1	2	6546	2 B.A.	$\frac{7}{16}$
A1	3	6547	$\frac{1}{4}$ in.	$\frac{7}{16}$
A1	4	6548	$\frac{5}{16}$ in.	$\frac{7}{16}$
A1	5	6549	$\frac{3}{8}$ in.	$\frac{7}{16}$
A2	6	6550	$\frac{1}{4}$ in.	$\frac{17}{32}$
A2	7	6551	$\frac{5}{16}$ in.	$\frac{17}{32}$
A2	8	6552	$\frac{3}{8}$ in.	$\frac{17}{32}$
A3	9	6553	$\frac{1}{4}$ in.	$\frac{5}{8}$
A3	10	6554	$\frac{5}{16}$ in.	$\frac{5}{8}$
A3	11	6555	$\frac{3}{8}$ in.	$\frac{5}{8}$
A4	12	6556	$\frac{1}{4}$ in.	$\frac{3}{4}$
A4	13	6557	$\frac{5}{16}$ in.	$\frac{3}{4}$
A4	14	6558	$\frac{3}{8}$ in.	$\frac{3}{4}$
A4	15	6559	$\frac{1}{2}$ in.	$\frac{3}{4}$
A5	16	6560	$\frac{5}{16}$ in.	$\frac{15}{16}$
A5	17	6561	$\frac{3}{8}$ in.	$\frac{15}{16}$
A5	18	6562	$\frac{1}{2}$ in.	$\frac{15}{16}$
A6	19	6563	$\frac{5}{16}$ in.	$1\frac{1}{32}$
A6	20	6564	$\frac{3}{8}$ in.	$1\frac{1}{32}$
A6	21	6565	$\frac{1}{2}$ in.	$1\frac{1}{32}$
A6	22	6566	$\frac{5}{8}$ in.	$1\frac{1}{32}$
A7	23	6567	$\frac{5}{16}$ in.	$1\frac{1}{8}$
A7	24	6568	$\frac{3}{8}$ in.	$1\frac{1}{8}$
A7	25	6569	$\frac{1}{2}$ in.	$1\frac{1}{8}$
A7	26	6570	$\frac{5}{8}$ in.	$1\frac{1}{8}$
A8	27	6571	$\frac{5}{16}$ in.	$1\frac{1}{4}$
A8	28	6572	$\frac{3}{8}$ in.	$1\frac{1}{4}$
A8	29	6573	$\frac{1}{2}$ in.	$1\frac{1}{4}$
A8	30	6574	$\frac{5}{8}$ in.	$1\frac{1}{4}$

30. The crimping process is illustrated in fig. 7. It is most important that copper lugs should not be used on an aluminium condutor, and vice versa, as otherwise the presence of even slight moisture would set up corrosive action between the two metals.

31. Copper conductors.—Place the bared conductor carefully in the barrel of the lug; with cables up to Pren 24 the lug will also overlap a portion of the cable insulation. Crimp the lug on to the cable. With copper lugs, Mk.1A to 11A (i.e., up to and including

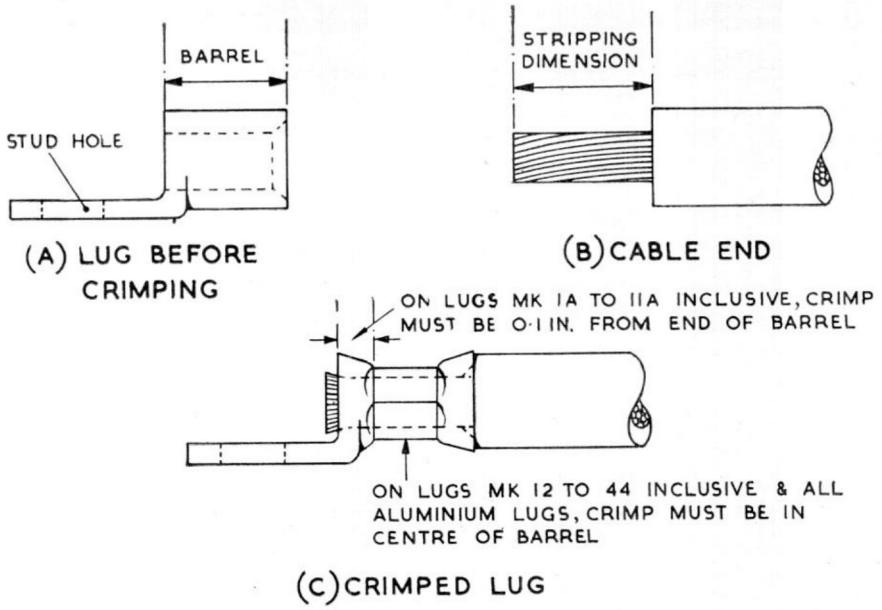


Fig. 7. Hexagon crimping of cable lugs

Pren 24), the crimp should be 0·1 in. from the end of the barrel. With copper lugs Mk.12 to 44 inclusive, the crimp should be in the centre of the barrel. Ensure by visual inspection that a firm and satisfactory crimp has been made. An efficient hexagon crimp will produce a homogenous mass of lug and conductor; a photomicrograph of a cross-section of a crimped connection is shown in fig. 8.

32. Aluminium conductors.—When crimping aluminium cables, it is essential first to clean the conductor with a wire brush to remove the oxide film, and then to apply a suitable inhibitor to prevent further oxidation. The inhibitor should be packed into the lug, and the end blocked while the cable is inserted to ensure adequate penetration. Crimping should be done immediately, and conductors must not lie about bared for any length of time. The crimp should be in the centre of the barrel.

Soldering

33. The cable must not be soldered to the terminals of any piece of apparatus if a satisfactory joint can be made in any other way, such as crimping by a tag to the cable end.

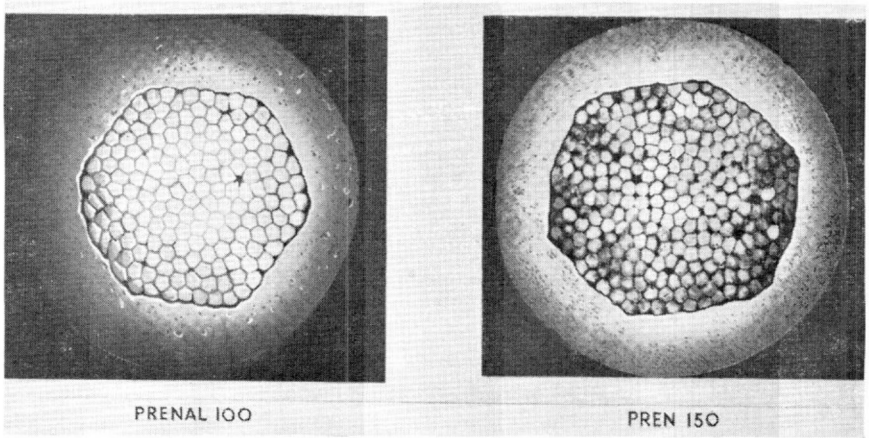


Fig. 8. Cross-section of hexagon crimped connection

Soldering is normally confined to connections inside items of equipment.

34. If it is required to wire up a solder type plug, no dismantling of the plug is necessary. A marker and a rubber sleeve must first be placed on each cable; the conductor should then be bared and soldered in position, after which the rubber sleeve should be brought forward over the connection to form a protective covering. Further instructions relevant to the soldering of Mk. 4 miniature plugs and sockets will be found in A.P.4343C, Vol. 1, Sect. 5.

35. Soldering the flexible strands of a cable requires great care, as the strands are liable to break away at the point where the core loses its flexibility through the rigidity of the solder. Great care must be taken to prevent the solder running up the core, and to avoid dry joints. The flexible cable must be well supported at the point near the soldered portion to avoid a bending movement which might cause the strands to break. Resin flux (Stores Ref. 33C/1201) should be used as a soldering flux.

Compass interference

36. Care must be taken to place cables so that their magnetic field does not interfere with the functioning of the aircraft compasses. Services must be run as far as possible with the positive and negative leads of each service adjacent to each other, to avoid loops which will create a magnetic field. Particular care must be taken with aircraft in which an earth return system of wiring is employed.

37. When new circuits are installed, tests should be carried out on various headings to ensure that compass interference is not caused. For maximum permissible deviation in compass readings when the circuit is energized, reference should be made to A.P.1275B, Vol. 1, Sect. 10.

INTERCHANGEABILITY OF EQUIPMENT

38. Information is given in the following paragraphs on certain items of equipment used by both the United Kingdom and the United States; tables are included which indicate the degree of interchangeability of the items.

Cables

39. Tables 6 and 7 list the range of general purpose cables, with copper and aluminium conductors respectively, for use at ambient temperatures up to 50 deg. C. (with a permissible temperature rise of 40 deg. C.), which have been adopted as standard.

TABLE 6
Interchangeability of cables with copper conductors

U.S. MIL-W-5086			U.K. BS. E21			U.K. EL. 1771		
Cable	Max. dia. (in.)		Cable	Max. dia. (in.)		Cable	Max. dia. (in.)	
	Conductor	Cable		Conductor	Cable		Conductor	Cable
AN.26	0·022	0·075	—	—	—	—	—	—
24	0·027	0·080	—	—	—	—	—	—
22	0·033	0·090*	Unipren 4	0·033	0·105	Uninypren 4	0·033	0·105
AN.20	0·041	0·100*	Unipren 6	0·041	0·110	Uninypren 6	0·041	0·110
18	0·052	0·115	9	0·052	0·115	9	0·052	0·115
16	0·061	0·130	12	0·061	0·130	12	0·061	0·130
AN.14	0·076*	0·150	Unipren 18	0·078	0·150	Uninypren 18	0·078	0·150
12	0·096	0·170	24	0·096	0·170	24	0·096	0·170
10	0·122	0·200	35	0·122	0·200	35	0·122	0·200
AN.8	0·167	0·255	Unipren 50	0·167	0·255	Uninypren 50	0·167	0·255
6	0·218	0·310	70	0·218	0·310	70	0·218	0·310
4	0·272	0·370	100	0·272	0·370	100	0·272	0·370
AN.2	0·345	0·445	Unipren135	0·345	0·445	Uninypren135	0·345	0·445
1	0·384	0·495	150	0·384	0·495	150	0·384	0·495
0	0·432	0·550	170	0·432	0·550	170	0·432	0·550
AN.00	0·490	0·610	Unipren200	0·490	0·610	Uninypren200	0·490	0·610
000	0·548	0·680	230	0·548	0·680	230	0·548	0·680
0000	0·615	0·750	280	0·615	0·750	280	0·615	0·750

*Denotes a difference in dimension from the U.K. equivalent

Note . . .

For sizes AN.10 and larger, caution should be exercised when replacing Nypren cable by cables to MIL-W-5086 unless the latter cables are coated with nylon, as the life of uncoated cables to MIL-W-5086 will be reduced when in contact with ester based oils or fluids.

TABLE 7

Interchangeability of cables with aluminium conductors

U.S. MIL-W-7072			U.K. BS. E21		
Cable	Max. dia. (in.)		Cable	Max. dia. (in.)	
	Conductor	Cable		Conductor	Cable
AL.8	0·160	0·260	Uniprenal 35	0·160	0·260
6	0·211	0·325	50	0·211	0·325
4	0·262	0·385	70	0·262	0·385
AL.2	0·330	0·465	Uniprenal 100	0·330	0·465
1	0·368	0·515	—	—	—
0	0·418	0·570	135	0·418	0·570
AL.00	0·478	0·630	Uniprenal 150	0·478	0·630
000	0·535	0·705	170	0·535	0·705
0000	0·587	0·775	200	0·587	0·775

Cable lugs

40. Tables 8 and 9 list the standard copper and aluminium cable lugs. These tables are based on stud and conductor diameters, not on tongue width, which may not be suitable for a particular installation.

41. U.K. cable lugs are crimped with U.K. tools, and U.S. lugs with U.S. tools; they are used with cables to U.K. Spec. BS. E21 and U.S. Spec. MIL–W–5086.

TABLE 8

Interchangeability of copper cable lugs

Stud size		6B.A. (No. 4)		4B.A. (No. 6)		2B.A. (No. 10)		¼ in.		⅝ in.		⅜ in.		½ in.		⅝ in.	
Cable		U.S. AN.659—						U.K. Stores Ref. 5X/									
AN.	Pren or Ny-pren	U.S	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.
22	4	—38	6667	—1	6668	—2	6669					—25	—				
20	6	—38	6667	—1	6668	—2	6669					—25	—				
18	9	—38		—1	6670	—2	6671					—25	—				
16	12	—39		—3 / —26	6670	—4	6671					—27	—				
14	18	—39		—3 / —26	6672	—4	6673					—27	—				
12	24				6674	—5	6675		6676	—6	6677	—28	—				
10	35				6512	—5	6513		6514	—6	6515	—28	6516				
8	50					—7			6517	—8	6518	—29	6519				
6	70					—30		—9	6520	—31	6521	—10	6522				
4	100							—11	6523	—32	6524	—12	6525		6526		
2	135							—13			6527	—14	6528	—33	6529		
1	150							—15			6530	—16	6531	—34	6532		
0	170							—17			6533	—18	6534	—35	6535		
00	200									—19	6536	—20	6537	—36	6538		
000	230										6539	—21	6540	—22	6541		
0000	280										6542	—23	6543	—24	6544	—37	

TABLE 9

Interchangeability of aluminium cable lugs

Stud size		4B.A. (No. 6)		2B.A. (No. 10)		¼ in.		5/16 in.		⅜ in.		½ in.		⅝ in.	
Cable		U.S. Part No. MS25021—						U.K. Stores Ref. 5X/							
AL.	Prenal	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.	U.S.	U.K.
8	35		6545	—1	6546	—2	6547	—3	6548	—4	6549				
6	50			—5		—6	6550	—7	6551	—8	6552				
4	70			—9		—10	6553	—11	6554	—12	6555				
2	100					—13	6556	—14	6557	—15	6558	—16	6559		
1	—					—17		—18		—19		—20			
0	135					—21		—22	6560	—23	6561	—24	6562		
00	150							—25	6563	—26	6564	—27	6565		6566
000	170								6567	—28	6568	—29	6569		6570
0000	200								6571	—30	6572	—31	6573		6574

SERVICING

42. Aircraft wiring systems should be inspected regularly with a view to locating possible sources of trouble, and in this connection the following points should be studied.

Connections

43. All connections should be visually inspected to ensure that no depreciation is evident at the points of connection. Screw terminal connections should be examined for tightness to ensure that high-resistance conditions will not develop. Standard type terminal blocks which form part of the Plessey system have the terminals coated with Bakelite varnish after final assembly, and when the wires are replaced after removal, the varnish must again be applied to prevent loose connections developing. This does not apply to the quick-release terminal block.

44. All screws holding fixtures should be checked for tightness and an examination should be made to ensure that no loose parts, ends of wires, swarf, or similar material which might cause short-circuits are left behind in the junction boxes.

45. Crimped connections should be examined for security, and soldered joints or connections should be inspected at the point where the stiff soldered portion of the cable meets the unsoldered flexible portion. If the loosened strands of the core are breaking away at their junction with the soldered portion, the soldered end must be cut off, the covering of the cable stripped back a little further, and the end re-soldered.

Cables

46. Deterioration of the insulation of cable may be caused by prolonged exposure, or by the action of heat or deleterious substances such as oil or gasoline, and damage may be caused by accidental stresses or by chafing at the fixing points, at lead-in sections to instruments, conduits, or other points of contact with adjacent parts.

47. Particular attention should be paid to cables which are unavoidably exposed to fuel, heat, or weather, at the entry to electrical components. Where the installation of these cables is found to be defective, the cables should be protected by means of suitable synthetic rubber sleeves. Referring to fig. 9, proceed as follows: —

(1) Slit back the outer cable sheath for a distance of ¼ in. (A of fig. 9). Fit a synthetic rubber sleeve (1) over each core, pushing it as far as possible under the outer sheath.

(2) If necessary, for the length of cable required, fit a second sleeve (2) which must overlap sleeve (1) by ¼ in.

(3) Fit an outer synthetic rubber sleeve (3) over the entire cable (B of fig. 9). Mark each sleeve (2) to show the colour of the core.

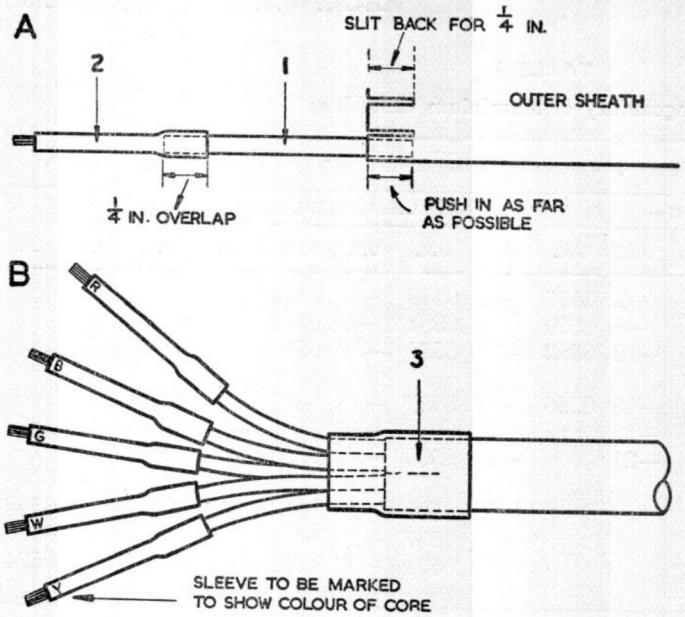


Fig. 9. Method of protecting deteriorated cables

48. Damaged or broken cables should be entirely renewed wherever possible and economical, but to obviate the removal of long lengths of cables from looms, and in particular where cables pass through bulkhead sealing bungs, the cable can be cut and rejoined by means of the in-line connector.

49. The method of fitting these connectors is shown in stages in fig. 10, at A, B and C for Pren 4–6, 9–12, 18 and 24, and at D, E and F for Pren 35, 50 and 70. By referring to Table 10 the correct size of in-line connector, crimps to be used, dielectric stripping length, and correct insulating sleeve can be determined for a particular Pren cable size.

50. To repair a damaged cable proceed as follows:—

(1) Cut out or off the damaged portion of the cable. If the damaged cable is in the centre of a cable run it may be possible to rejoin the existing cable ends, this being dependent upon the length of the damaged cable which has been removed. If this is not possible, a new length of cable of the same size may be inserted.

(2) Strip off the dielectric from the cable ends to be joined to the required distance. Care should be taken not to damage or cut the strands of wire.

(3) Fit the insulating sleeve over one end of the prepared cable using pliers (Stores Ref. IC/5862 or 5683).

(4) Fit the prepared cable ends into the in-line hexagon connector. During this operation ensure that all the strands of wire are fitted into the inner barrel of the connector, and that the cable ends butt each other in the centre. This can be verified by looking through the inspection hole in the centre of the connector.

(5) Make hexagon crimps at position A on the connector (*fig.* 10), using the heavy-duty pliers (Stores Ref. 5X/6463) for Pren cables 4–24, and the hydraulic crimping tool (Stores Ref. 3A/3042 or 3304) for Pren cables 35–70, ensuring that the correct size dies are fitted to the tool.

(6) For Pren cables 4–24 make further crimps at position B on the connector by using the next size larger crimp dies in the hand tool. It is most important when making this dielectric crimp to ensure that the edge of the die is in line with the edge of the connector. This is to ensure the maximum effectiveness of this crimp in holding in the dielectric, and also to prevent the connector end belling out.

(7) Inspect the new joint for the following:—
  (a) That the cable ends are butting at the centre of the connector.
  (b) That the crimps have been made correctly and are in the right position.
  (c) That no flashes have been produced which will pierce the insulating sleeve. Any flashes that do exist are to be removed.

(8) Reposition the insulating sleeve so that it fits over the in-line connector with an equal amount of the sleeve covering the dielectrics of the cables which have been joined together.

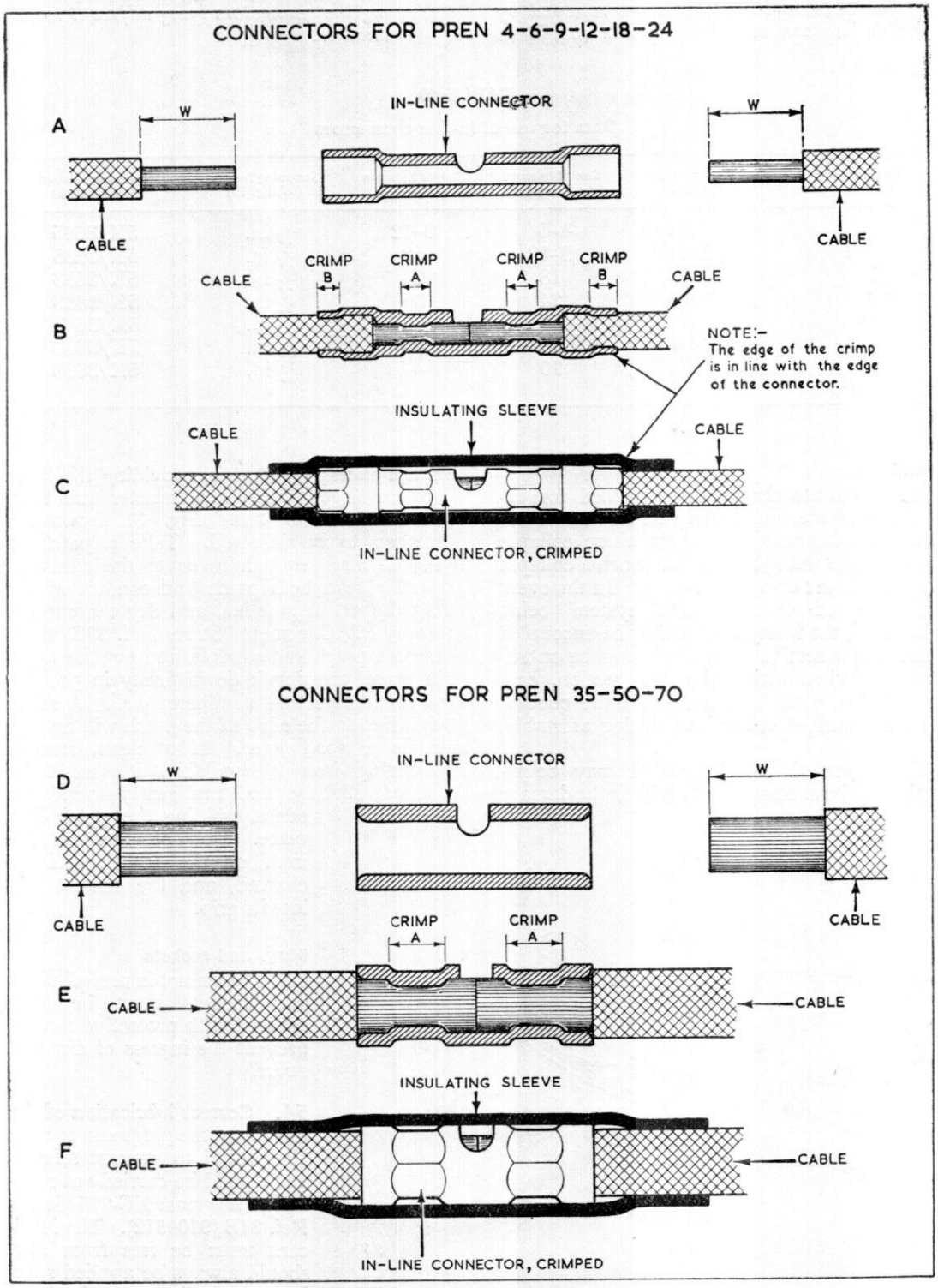


Fig. 10. Fitting of in-line connectors

Note . . .

If more than one cable is damaged in a loom, and the cables are repaired by in-line connectors, the joints should be made in a position such as to allow the connectors to be staggered, thus preventing the connectors lying adjacent to one another.

TABLE 10

Data for use of in-line connectors

Cable size (Pren)	In-line connector (Stores Ref.)	Size of hexagon crimp at A	Size of hexagon crimp at B	Stripping length (W, fig. 10)	Insulating sleeve (Stores Ref.)
4–6	5X/6943	4–6	9–12	$\frac{5}{16}$ in.	5K/3685
9–12	5X/6944	9–12	18	$\frac{5}{16}$ in.	5K/3685
18	5X/6945	18	24	$\frac{5}{16}$ in.	5K/3686
24	5X/6946	24	35	$\frac{5}{16}$ in.	5K/3686
35	5X/6976	35	—	$\frac{5}{16}$ in.	5K/3687
50	5X/6977	50	—	$\frac{11}{32}$ in.	5K/3688
70	5X/6978	70	—	$\frac{15}{32}$ in.	5K/3688

Conduits

51. Conduits should be examined for external damage, and denting on screened cable may be observed at a point where collapse of the inner lining may exist. Such a collapse is liable to set up a local failure. In the event of part of the electrical system being damaged, the faulty section may be uncoupled and a new section from the Stores be substituted. When fitting the new section, care should be taken to ensure that the conduit is not stretched or strained during assembly.

52. Damaged P.V.C. conduit may be repaired quite successfully providing the damage is not excessive—that is, providing the holes are no larger than $\frac{3}{8}$ in. diameter and tears no longer than 4 in. Fig. 11 shows the method to be followed. Take a patch of P.V.C. large enough to cover the damaged part. Clean both patch and conduit with a rag dipped in gasoline, and dry thoroughly. Apply P.V.C. cement (Stores Ref. 33C/1209) to both patch and conduit, and put the patch in place, pressing it down firmly in position to make sure that it adheres well. A slight chamfer on the edge of the patch will help to make a good joint. If a clean, smooth soldering iron is available, it should be heated, slightly, and run gently round the edges, welding the patch into place. Do not overheat the iron, or the P.V.C. will be charred, and the cement will lose its grip.

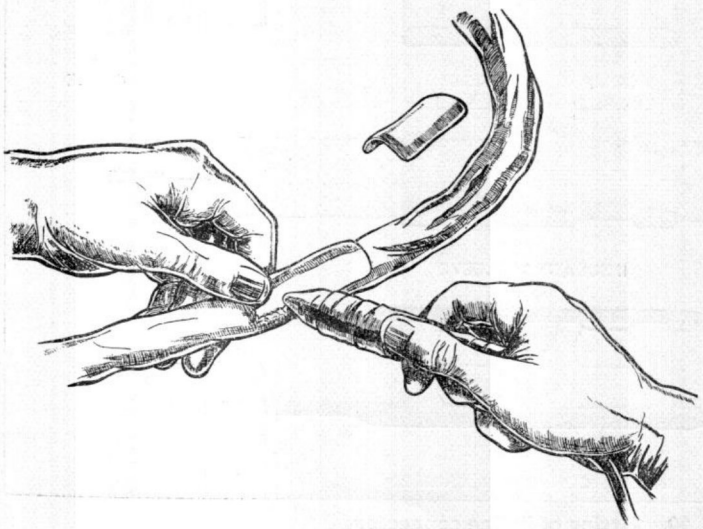


Fig. 11. Method of repairing P.V.C. conduit

Plugs and sockets

53. When not in use, all plugs and sockets must be kept covered with protective caps to prevent the ingress of dirt and swarf.

54. Correct lubrication of the threads of the plugs and sockets is essential to prevent seizure, and should be carried out regularly with grease XG-275 (Stores Ref. 34B/9100512). The lubricant must be free from dirt, should always be applied sparingly, and all excess wiped off. Only the approved lubricant

flannelette (Ref. No. 32B/84726) tied to the leading end.

(2) Attach an air line to the end of the pipe, and fit the P.V.C. tubing to the appropriate portion of the nozzle end according to its diameter.

(3) Apply compressed air, which need not be at a pressure exceeding 50 lb. per sq. in., when the cord will be passed through the tubing.

(4) Having passed the cord through the P.V.C. tubing, proceed as usual to draw the cable through▶

Conduits

51. Conduits should be examined for external damage, and denting on screened cable may be observed at a point where collapse of the inner lining may exist. Such a collapse is liable to set up a local failure. In the event of part of the electrical system being damaged, the faulty section may be uncoupled and a new section be substituted. When fitting the new section, care should be taken to ensure that the conduit is not stretched or strained during assembly.

52. Damaged P.V.C. conduit may be repaired quite successfully providing the damage is not excessive—that is, providing the holes are no larger than $\frac{3}{8}$ in. diameter and tears no longer than 4 in. Fig. 12 shows the method to be followed. Take a patch of P.V.C. large enough to cover the damaged part. Clean both patch and conduit with a rag dipped in gasoline, and dry thoroughly. Apply ◀Titebond 22 (Ref. No. 33C/1302)▶ to both patch and conduit, and put the patch in place, pressing it down firmly in position to make sure it adheres well. A slight chamfer on the edge of the patch will help to make a good joint. If a clean, smooth soldering iron is available, it should be heated, slightly, and run gently round the edges, welding the patch into place. Do not overheat the iron, or the P.V.C. will be charred, and the ◀Titebond 22▶ will lose its grip.

Plugs and sockets

53. When not in use, all plugs and sockets must be kept covered with protective caps to prevent the ingress of dirt and swarf.

◀**54.** Correct lubrication of the threads of the plugs and sockets is essential to prevent seizure, and should be carried our regularly with grease XG-275 (Ref. No. 34B/9100512), or as an alternative silicone compound MS4 (Ref. No. 33C/1172) may be used. The lubricant must be free from dirt, should always be applied sparingly, and all excess wiped off. Only an approved lubricant must be used, and on no account should a lubricant with a graphite base be employed.▶

55. Coupling nuts must never be coss-threaded or forced on to the sockets; the same precaution applies when connecting a socket to a plug. Should excessive tightness be felt when connecting a plug and socket the trouble should be investigated. Excessive pressure must not be used to force the two

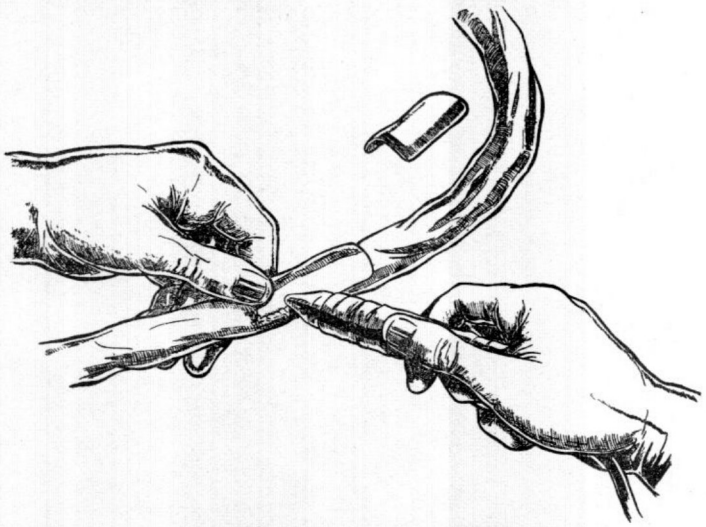


Fig. 12. Method of repairing P.V.C. conduit

parts together. The trouble may be due to the displacement of the plug shell in relation to the plug pins and re-alignment may be necessary by slackening the plug shell fixing screws, inserting the socket and rescrewing. A tight fitting may also be due to a lack of lubrication.

56. A socket with a damaged thread must not be inserted into a plug housing, because the fine metal shavings may be detached and cause short circuits between the pins. Badly damaged fittings should be renewed, but minor damage to the threads may be cleared with a thread chaser.

57. When a plug or socket repeatedly shows signs of severe corrosion due to the ingress of moisture, the pins should be *lightly* smeared with insulating silicone compound MS4 (Ref. No. 33C/1172).

STORAGE

58. Electric cables must be stored in such a manner that they will be in prime condition when needed. Cables require a clean, dry sheltered place, free from extreme changes in temperature. Careless handling, improper storage, heat, direct sunlight, and moisture are the principal causes of damages to cables in storage.

Conditions of storage

59. Wherever possible, cables should be stored indoors, in a cool, dry place. Avoid storing them near the oils, acids or other chemicals which might cause damage through corrosion.

60. When cable is stored in an open shed, or in the open, the cables and reels must be protected from moisture from the ground by being placed on a raised platform or on planks.

61. Cables wrapped or packed in cartons should be kept in the original wrapping or carton. When reels of cable are moved, they must be rolled in the direction that will tighten the layers of cable on the reel; they should be rolled on a smooth surface, to avoid breaking the lagging or the flanges of the reel.

Sealing of cable ends

62. All types of cable should have the ends sealed when in storage to prevent the entry of moisture.

63. Lead-covered cable must always be sealed. The small size cables should have their ends dipped in hot paraffin wax (Ref. No. 33C/318): in larger sizes, the end of the lead sheath should be stripped back for a short way, and a seal of plumber's metal or solder should be applied.

64. Alternatively, the lead sheath should be extended beyond the conductors by tapping with a wooden cable dresser, and the cable, should then be sealed by soldering a lead disc or ellipse on the end of the protruding sheath.

65. Braided and rubber-covered cables are best sealed by having their ends dipped in hot paraffin wax.

66. " Met"-covered cables should be sealed by having enough of the braiding removed to allow for the application of sealing tape directly on to the insulation first, and then on to the braiding.

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