Chapter 1

GENERAL INFORMATION ON CRIMPING

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ILLUSTRATIONS

INTRODUCTION

1. Considerable progress has been made in recent years in the design and development of crimped solderless terminations on electric cables. Improvements have been made in terminations, crimp forms, crimping techniques, and in the design of crimping tools. Some types of crimped joints, particularly those used on aircraft have been subjected to extensive testing, this led to the publication of British Standard G.178, "Crimped joints for general purpose aircraft electrical cables", (subsequently superseded by 3G.178). This British Standard details the requirements which enable the performance of crimped joints under long-term service conditions to be properly assessed.

CRIMPING TERMS AND TECHNIQUES

2. Crimping is a method of firmly attaching a terminal end, pin or socket contact or in-line connector to an electric cable conductor, by pressure forming or reshaping a metal barrel or socket together with the conductor, to establish a joint which has both good electrical and good mechanical properties. The forming of a satisfactory crimped joint depends on the correct combination of conductor, crimp barrel and crimping tool. The conductor and the crimp barrel must be of compatible material and finish, and the dimensions and hardness of the barrel must be suitable for use with the particular tool die and indentor being used.

CRIMPING TERMS

3. The following terms used in crimping are from BS.3G.178:-

Crimped joint

4. A permanant connection formed by crimping a terminal end, pin or socket contact, or cable splice onto an electrical conductor.

Terminal end

5. A connecting device with barrel(s) accommodating an electrical cable conductor with or without additional provision to accommodate and secure the insulation.

Pin or socket contact

6. A contact used in a 'free connector' or 'receptical' with a barrel at one end to accommodate an electrical cable conductor with or without the provision to secure the insulation.

Cable splice

7. A connecting device with barrel(s) each accommodating an electrical cable conductor(s) with or without additional provision to accommodate and secure the insulation.

Cable splice connection

8. A permanant connection formed by the ends of electrical cable conductors attached to a cable splice.

Crimping

9. The physical compression or deformation of a conductor barrel or ferrule around a conductor in order to make a mechanical and electrical connection.

Insulation grip

10. That part of a terminal barrel into which the insulation of the cable is placed and which by reforming, grips the insulation.

Crimping tool

11. A manually or power operated mechanical device for crimping, and where required, reforming the insulation support.

Positioner

12. A locator, turret or other device, permanently or removably attached to a crimping tool, serving correctly to locate and control the position of the crimp on the barrel.

Flash

13. Material of the barrel of a termination or cable splice(s) extruded between the edge of the dies in a crimping tool during the crimping operation. ▶

CRIMPING TOOLS

14. Crimping tools may be either hand or power operated types. The use of hand tools is generally limited to joint forming on small cables (less than 0·01 in^2 cross-sectional area of conductor, or size 12 aircraft cables and smaller). For larger sizes of cable and conductors, power operated tools are necessary.

15. Tools are generally designed to compress or deform the barrel and conductors to a fixed shape with precise dimensions limited by the closure of suitably dimensioned positioners. Positioners may be fixed in the tool or they may be removable, allowing for different sizes of dies to be used with the same tool. A particular set of dies may be designed to cater for a limited range of sizes of crimp barrel or cable conductors. Some tools have movable turret heads containing two or more different sizes of dies; others have turret heads with locators for different size pin and socket contacts, together with a range of indent settings to suit different sizes of conductors.

▶ 16. Deleted

17. Some tools incorporate a second set of positioners, independent of the conductor crimping dies, which lightly crimp the insulation support barrel. Such dies may be adjustable to cater for differing thicknesses of cable insulation. Conductor crimping dies must not be adjustable.

18. The mechanism by which the tools are operated and the method of positioner closure vary with different types of tools. Entry of the crimp barrel into the tool may be through open jaws or through side entry on the face of the tool. Some tools have provision for positioners designed to hold the appropriate size or type of termination in the correct position whilst crimping.

19. All modern types of crimping tool have a device which prevents incomplete crimping in that the jaws of the tool will not release until they have first closed sufficiently to make a satisfactory crimp.

20. For large scale production of crimp joints automatic machines are available, which in addition to making the crimped joint cut and trim the cable.

CRIMP FORMS

21. In forming a satisfactory crimped joint, the overall cross sectional area of a stranded conductor will be reduced, some or all of the individual conductor strands being deformed from a circular to some other section, filling the interstices originally between the circular strands. Lateral deformation or extrusion of some strands should occur, limited by the design and dimensions of the dies to avoid over crimping which might result in mechanical weakness in the joint.

22. In the case of a solid conductor, limited lateral extrusion should also occur with a consequent slight reduction in cross sectional area of the conductor.

23. There are several forms or shapes of crimped joints. These can be divided into two types namely confined crimps and dispersive crimps. Confined crimps are those in which the barrel and conductor are compressed into a reduced volume in which any sectional dimension does not exceed the original diameter of the barrel before crimping. Typical examples are the hexagon, square and four-indent crimps illustrated in fig.1. In this type most, if not all, of the individual strands are deformed from their original circular section. Dispersive crimps are those in which the barrel and conductor are compressed into some shape whose sectional dimensions, at one or more points, exceed the original diameter of the barrel before crimping. Typical examples are the oval, flattened hexagon and side-by-side double

indent crimps illustrated in fig.2. In this type it may be that not all of the barrel is compressed, and some strands may not be deformed from their original circular section.

NON-INSULATED AND INSULATED JOINTS

24. Crimped joints may be non-insulated or they may be post-insulated (Hellermann) or pre-insulated (A-MP). A post-insulated joint is an uninsulated joint which is insulated by a sleeve or other means, subsequent to the crimping. A pre-insulated joint is one in which the crimp barrel or bucket has an insulated covering, through which the crimping pressure is applied and the crimp formed; the insulation usually stays deformed after crimping.

INSULATION SUPPORT

25. Terminal ends and cable splices used on small cables up to 0·005 in^2 cross-sectional area (12 AWG) must, and on larger cables may, have an additional barrel which encloses and supports the exterior of the cable insulation. In some cases the barrel is deformed to grip the insulation by means of suitable positioners, which may be an extension of, or be separate from, the dies which make the conductor crimp. In the case of the post-insulated or pre-insulated joints the insulation, which usually extends beyond the insulation barrel, may give additional mechanical support to the completed joint, Because of space limitations between pins, pin and socket contacts should not have insulation barrels. Insulation support in plugs and sockets should be provided by other means.

PERFORMANCE REQUIREMENTS FOR CRIMPED JOINTS

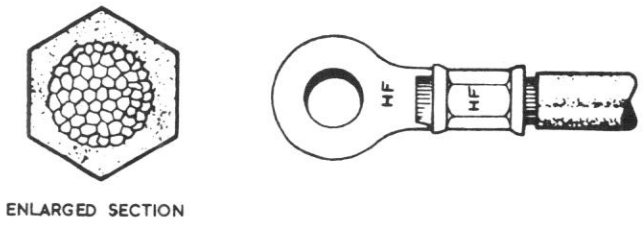
26. Unless stated to the contrary, crimped joints should meet the requirements of BS.3G.178. In certain ground support equipment applications the environmental conditions experienced may not call for all the requirements of BS.3G.178 which was prepared for aircraft applications.

SELECTION OF CABLE, TERMINATIONS AND TOOLS

27. General requirements. The type of cable, terminal end, cable splices, pin and socket contact, tool, positioner, locator, or turret shall be such that the particular combination used will produce a crimped termination which meets the requirements of a specification approved by the appropriate authority.

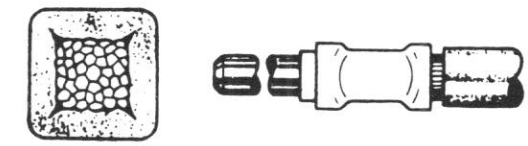
SUITABLE COMBINATION OF CABLES TERMINATIONS AND TOOLS

28. Use of a particular crimping tool with a particular die, locator or turret, with a particular cable conductor and crimp barrel does not validate the use of that tool with other dies, locators, turrets, or other sizes and types of conductors or barrels.



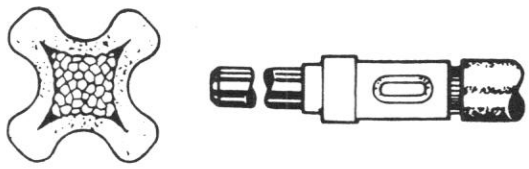
ENLARGED SECTION

HEXAGON CRIMP



ENLARGED SECTION

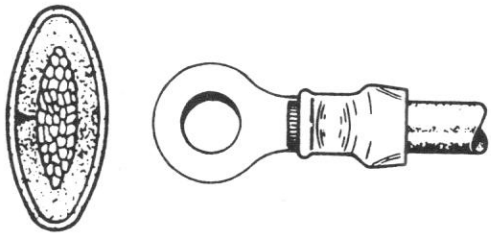
SQUARE CRIMP



ENLARGED SECTION

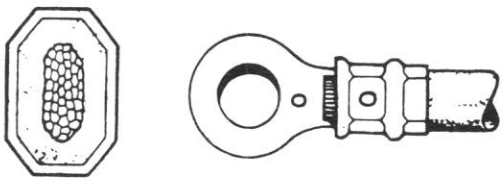
4-INDENT CRIMP

Fig.1 Confined crimps



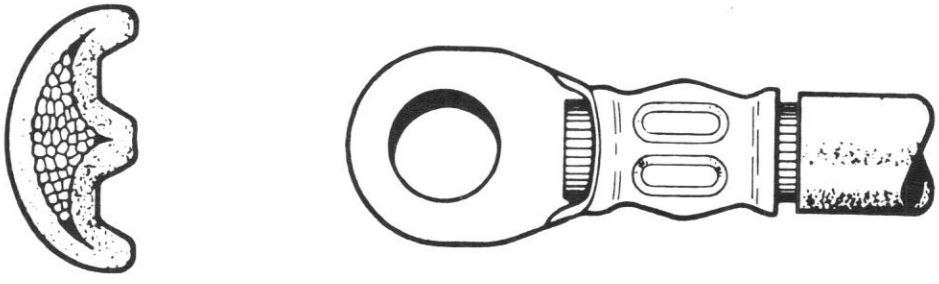
ENLARGED SECTION

OVAL CRIMP



ENLARGED SECTION

FLATTENED HEXAGON CRIMP



ENLARGED SECTION

SIDE BY SIDE DOUBLE INDENT CRIMP

Fig.2 Dispersive crimps

PREPARATION OF JOINTS

29. Cable ends should be stripped of insulation in accordance with the manufacturer's recommendation, care being taken not to sever or damage any strands. All insulation should be removed from the stripped portion of the conductor. After stripping, the end of the insulation should be left clean and square. If the lay of the strands is disturbed it should be reimposed by a light twist. The conductor should be inspected for cleanliness before assembly with the terminal end, pin or socket contact or cable splice.

Note...

When stripping cables having braid adjacent to the conductor any attempts to remove the dielectric and the braid together risks damage to the conductor.

FORM OF CRIMPED JOINT

30. The completed crimped joint should preferably take the form of a conductor crimp and insulation grip effected in one operation, using the positioner or positioners stipulated on the approved drawings. For all terminal ends or cable splices used on conductor sizes up to and including 0.0005 in^2 cross-sectional area (12 AWG) the connections should incorporate an insulation support unless equivalent insulation support is otherwise provided, e.g., as in electrical plugs and recepticals. The joints should have been formed by a tool so designed that it will:-

(1) Correctly locate and control the position of the crimp on the barrel.
(2) Not release the termination during normal operation until the crimped joint has been correctly formed.
(3) Not, during the formation of the conductor crimp, axially deform pin or socket contacts or increase the effective diameter along the length of the crimped section by more than the amounts specified in the connector specification.
(4) During the formation of the conductor crimp apply the appropriate mark, where required by para.32 to indicate the die size or tool which has been used.
(5) Not adversely affect the external protection or insulation during the crimping operation.
(6) Not fracture the terminal end or cause any rough or sharp edges, or flash.

MARKING AND GAUGING

31. Tools should be marked with the manufacturer's name and serial number. If the dies are not interchangeable they should be marked to identify the tool for which they are suitable.

32. The completed joint should in the case of terminal ends and cable splices and preferably in the case of pin and socket contacts, be marked in accordance with the code declared in the approxed drawings to identify the size of the crimping tool or die. Such marking, which should be applied during the formation of the crimp, may be embossed or indented.

33. Crimping tools must be provided with a means of checking for accuracy and damage (Chapter 4 refers).

USERS CONTROL TESTS

The crimp

34. All crimped joints shall be visually examined for:-

(1) Correct combination of cable, tool and terminal end, pin or socket contact or cable splice.
(2) Correct die mark (see para.32).
(3) Correctness of form and location of crimp.
(4) Freedom from fracture, rough or sharp edges and flash.
(5) Adequate insertion of all conductor strands in the barrel.
(6) Absence of damage to the conductor or insulation.

Crimping tools

35. Tools and dies shall be examined in association with Chapter 4 on the following occasions:-

(1) On issue from stores.
(2) At monthly intervals.

Pull-off tests

36. Should a crimped joint or tool be suspect an indication of its efficiency can be obtained by checking the "pull-off" of the joint. Table 1 gives the minimum loads expected for the range of cable sizes in common use; the joint should not move when an axial pull is applied. These figures only apply to the conductor crimp. When testing terminals having an insulation grip, the insulation grip shall be made ineffective by removing the cable insulation. Extracted from BS.3G.178.

TABLE 1

Pull-off test figures

AWG Size	Pull-off load (lb)	AWG Size	Pull-off load (lb)
28	3	16	38
24	9	14	57
22	14	12	90
20	19	10	135
18	32	8	190

CABLE DOUBLING

▶ 37. It is permissible in an emergency to double a conductor to fit a larger size crimp bucket, provided the following rules are obeyed:- ◀

(1) The doubled conductor size does not exceed that of the largest conductor the crimp bucket is designed to accommodate.

(2) The free end of the doubled conductor must protrude from the end of the conductor crimp barrel (not the insulation bucket if fitted)

(3) The doubled end of the conductor must be visible through the inspection hole of the crimp barrel.

(4) A pull test must be carried out as in para. 36 using the figures for the cable (NOT contact) size used.