PLUMBING OF LEAD-SHEATHED CABLES

1 **GENERAL** This Instruction describes the methods to be adopted for enclosing and sealing joints in lead-sheathed cable with lead sleeves when the sleeve exceeds 25 mm in diameter. Sizes of lead sleeves for all cables are given in **D4053** . Methods of construction of multiple joints are described in **D4054** .

2 **PRECAUTIONS** When using a Lamp, Torchblowing or Torch, Propane precautions should be taken to ensure that any polythene cables nearby and the bitumen protection on loading coil cases are not accidently damaged during the plumbing of the lead-sheathed cables. All polythene cables should be protected with asbestos blankets.

3 Any cable may contain air under pressure, and precautions should be taken to prevent molten solder 'blowing' when unplumbing any cable joint. Before the plumbed joint in a lead-sheathed cable is opened, the core of the Schrader valve should be withdrawn to ensure that no air pressure remains in the joint. The sleeves of joints which are not fitted with Schrader valves should be pierced and a Valves Air No. 1 fitted using a Drill for Valves Air No. 1.

4 Earth faults on power lines sometime produce potential differences along the length of nearby telephone cables. To minimise these effects it is desirable when working on telephone cables to avoid breaking the continuity of metallic sheaths. This is also desirable to maintain the flow of protection current where cathodic protection is applied to the cables, and also near to telephone exchanges where metallic cable sheaths contribute to the effectiveness of the exchange earth electrode system. To this end wherever a metallic sleeve of a cable joint is to be removed, the lead sheaths of the cable ends entering the joint should be bridged across temporarily by soldered bonding connexions. Lead Strip 1 in - 8lb or at least three strands of 40lb copper wire twisted together should be employed. This action is however unnecessary if, by visual inspection, it is seen that electrical continuity of the sheath is already assured by contact through adjacent cables or metalwork.

5 **PROPERTIES OF LEAD** Lead consists of crystals which, in the case of cable sheaths and lead sleeves, are formed as the material cools after the extrusion process. The strength of the material and its resistance to vibration and other stresses depends to a large extent on the size of the crystals and their formation. Stressing and heating of lead adversely affect its crystal structure, and it follows that all plumbing operations should be carried out as quickly as possible, reheating being kept to a minimum.

6 **PROPERTIES OF SOLDER** The constituent parts of solder are detailed in . When molten solder cools from a sufficiently high temperature, particles of lead begin to separate and solidify at about 525°F, the remaining molten alloy becoming richer in tin as the cooling and separation of the lead proceeds. The effect of the partial solidification is to render the mass plastic and workable. The separation and solidification of lead continues until, as 358°F, the remaining molten metal consists of 63% tin and 37% lead (called the 'eutectic alloy'). The whole of the mass then solidifies.

The proportions of tin, lead and antimony in Solder No. 8B have been carefully chosen to give a solder which will remain plastic over a sufficiently wide temperature range, when cooling from the liquid state, to enable it to be shaped around the joint and also result in a solid mass which will not be porous. No attempt should be made to alter the mixture by the addition of lead, tin or

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other solders of different composition. The re-use of recovered solder from wiped joints is inadvisable unless the jointer is sure it is actually Solder No. 8B Solder which might be Solder No. 5 should be treated as scrap and returned to Section stock.

7 PROPERTIES OF FLUXES The desirable properties of a flux for soldering are:-

7.1 It should be fluid at the soldering temperature.

7.2 It should have a solvent or slagging action on the oxides of the metal to be soldered.

7.3 It should prevent reoxidization of the metal surface.

7.4 It should be capable of being displaced from the metal surface by the solder.

Tallow has, for many years, been the accepted flux for plumbing but, although quite efficient, it does not possess property 7.2 to any great extent. Flux, Plumber's was introduced to give a flux which would more nearly comply with the above. If tallow is used great care must be taken to ensure that the surfaces to be plumbed are perfectly clean.

8 TYPES OF LEAD SLEEVE Lead sleeves may be fitted in the following ways:-

8.1 As a seamless sleeve plumbed or soldered to the cable sheath at each end (see Fig 1).

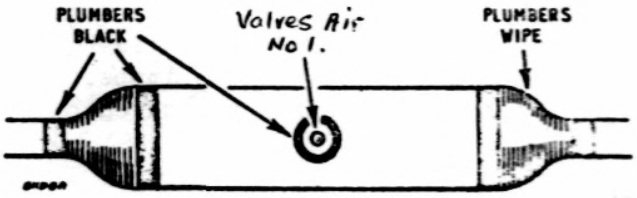

FIG. 1.—SEAMLESS SLEEVE

8.2 As a divided sleeve:-

8.2.1 in two seamless parts (see Fig 2), or

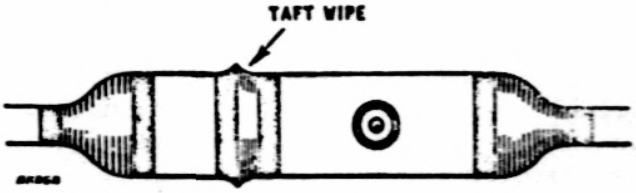

FIG. 2.—DIVIDED SLEEVE

8.2.2 as in 8.2.1 but with a plug at one end of the joint as described in (see Fig 3).

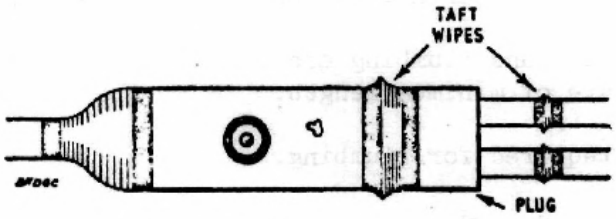

FIG. 3.—DIVIDED SLEEVE (PLUG JOINT)

8.3 As a split divided sleeve:-

8.3.1 in two parts, one or both being split longitudinally (see Fig 4), or

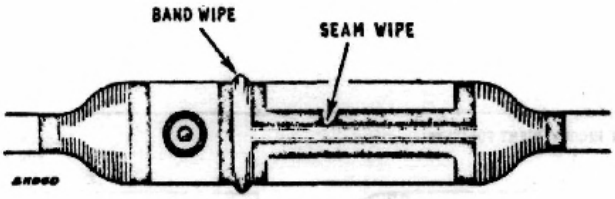

FIG. 4.—SPLIT DIVIDED SLEEVE

8.3.2 in three parts, the centre section being split longitudinally and with a plug at each end of the joint, as described in (see Fig 5).

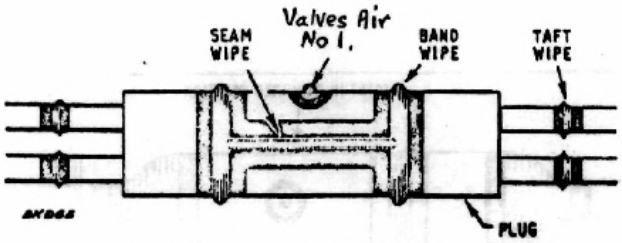

FIG. 5.—SPLIT DIVIDED SLEEVE (DOUBLE PLUG JOINT)

8.4 As a single sleeve split lingitudinally (see Fig 6).

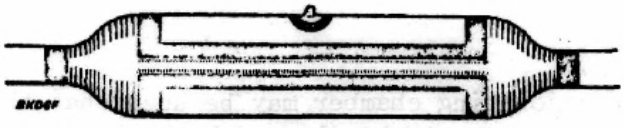

FIG. 6.—SPLIT SLEEVE

9 WHOLE SEAMLESS SLEEVES These are used for normal joints connecting two cable ends where subsequent disturbance of the plumbing is not anticipated. They have the following advantages over divided or split sleeves:-

9.1 Faults due to unsound plumbing are less likely to occur because the junctions to be sealed are of minimum length.

9.2 Less time is required for plumbing.

9.3 Less solder is required.

10 DIVIDED SLEEVES FOR NEW WORK The use of a seamless sleeve may restrict the choice of position for a joint because a corresponding length of cable is required to accommodate the sleeve while the wire joint is under construction. Where the use of a divided sleeve will permit the selection of a better position for the joint, eg where access to other plant is made easier or where plumbing conditions would be better, this type should be used in preference to a whole seamless sleeve (see Fig 7).

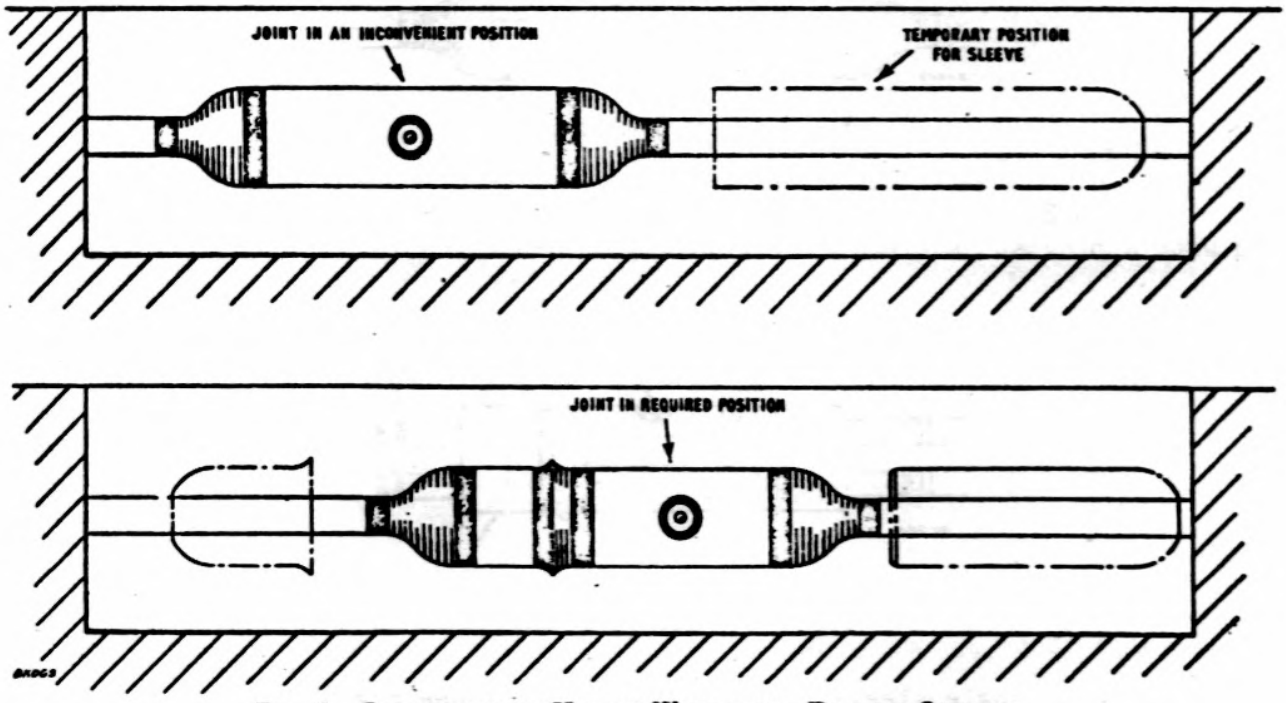

FIG. 7.—COMPARISON OF USE OF WHOLE AND DIVIDED SLEEVES

11 The conditions in a jointing chamber may be such that there is insufficient room for a whole seamless sleeve to be slipped back along the cable, hence a divided sleeve should, where practicable, be used (see Fig 8). Here each part of a divided sleeve could be slipped part-way along the curved section of the cable and would thus require a shorter straight length than would a whole seamless sleeve.

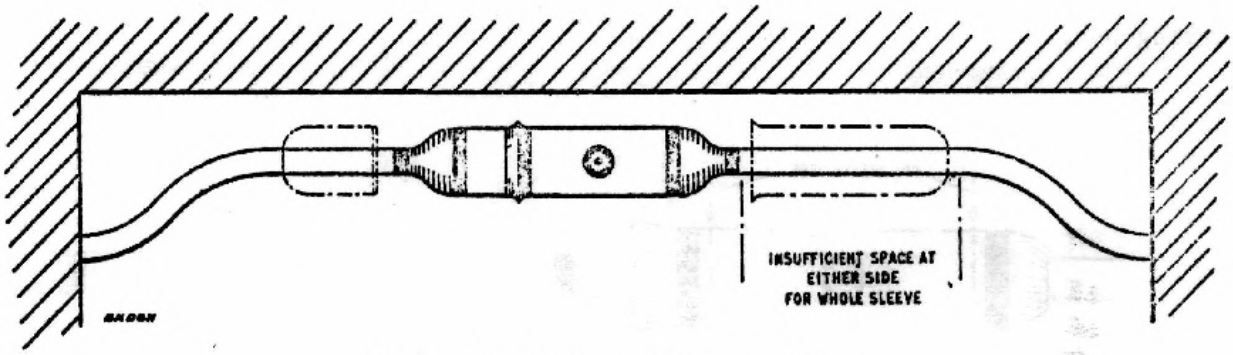

FIG. 8.—TYPICAL USE FOR DIVIDED SLEEVE

12 **SLEEVES ON EXISTING CABLES** An existing whole sleeve which has to be removed should be converted to a divided sleeve:-

12.1 By cutting around the sleeve, leaving the plumb undisturbed at one end (see Fig 9).

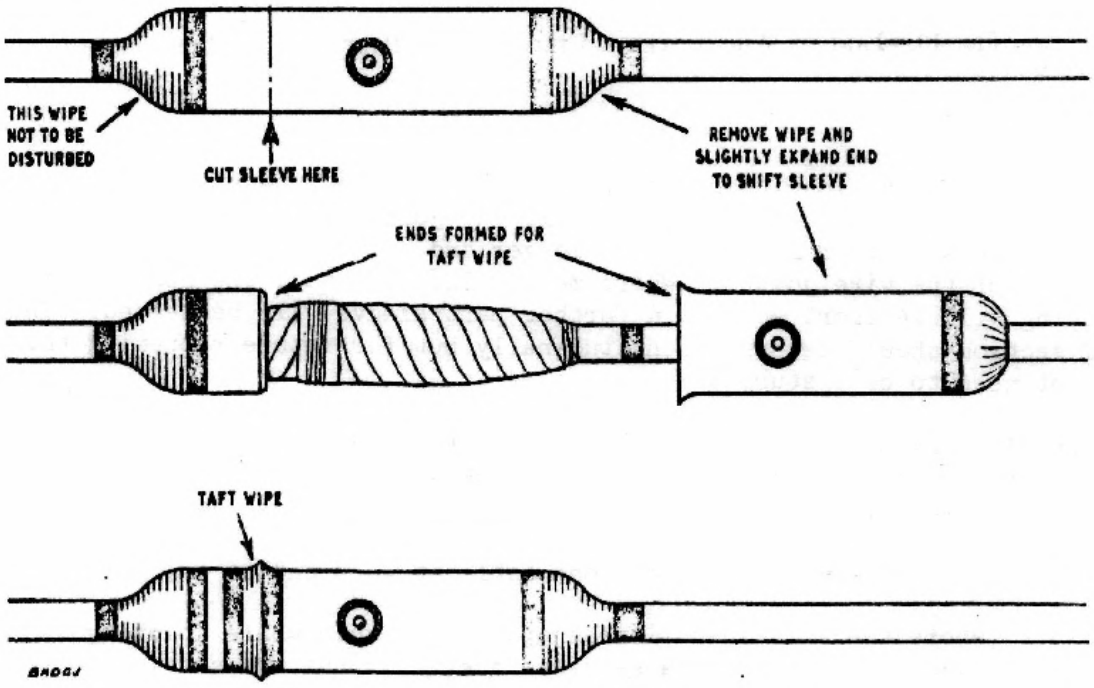

FIG. 9.—WHOLE SLEEVE RECONSTRUCTED AS A DIVIDED SLEEVE

12.2 By cutting away the sleeve ends to leave a sound section, as shown in Fig 10. This method should be used where 12.1 is not practicable, eg where the sleeve ends are mutilated or where a cable sheath has been cut back for drying-out.

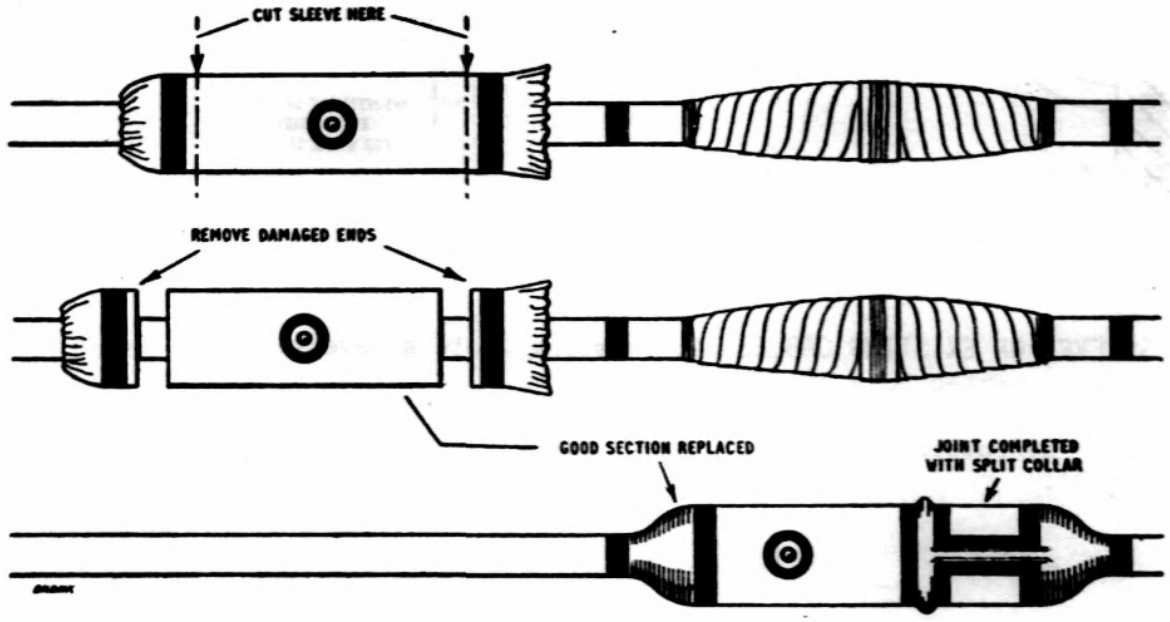

FIG. 10.—PART OF WHOLE SLEEVE USED TO FORM PART OF A DIVIDED SLEEVE

The sleeve may in either case be cut so that one long and one short section are used for closing the joint. Thus, if the joint is subsequently reopened, it will be necessary to remove only the longer end in order to gain access to nearly the whole of the wire joints. Where method 12.2 is used, the section of sleeve remaining will be short so that a further part-sleeve will be needed. This added section should be split longitudinally but for future reopening this seam will not need to be disturbed.

13 SPLIT SLEEVES These are less desirable than seamless or divided sleeves because of the long plumbed seam which increases the fault liability. They become necessary, however:-

13.1 where there is more than one cable at each end of the joint.

13.2 where there is insufficient space available while jointing is in progress to accommodate either a seamless sleeve or the two sections of a divided sleeve.

13.3 where the existing sleeve has had to be cut away to meet altered conditions (eg for cable rearrangements) or, as in par 12.2, has been partly cut away.

Where practicable, the split sleeve should be divided so that if reopening becomes necessary the longer section can be slipped back without disturbing the longitudinal seam wipe.

14 PREPARATION OF THE SLEEVE To limit the 75 mm width of the wipes Black, Plumber's mixed with water should be painted on the parts of the sleeve adjacent to those to which the solder is required to adhere (see Table 1). Before application of the black the parts of the sleeve to be painted and those to which solder is to be applied should be cleaned with a shavehook or a file brush. If a shavehook is used, great care should be exercised to avoid leaving a weak spot at the edge of the cleaned portion. The minimum amount of lead should be removed and adjacent strokes started at different points along the sleeve to give a staggered edge.

TABLE 1 - DIMENSIONS OF WIPES

Sleeve diameter mm	Length of sleeve dressed mm	Length of sleeve cleaned for plumbing mm	Length of cable cleaned for plumbing mm
38 mm	19 mm	19 mm	19 mm
51 mm	25 mm	19 mm	19 mm
64 mm	32 mm	19 mm	19 mm
76 mm	38 mm	25 mm	32 mm
89 mm	44 mm	25 mm	32 mm
102 mm	51 mm	32 mm	44 mm
114 mm	57 mm	32 mm	44 mm
127 mm	64 mm	32 mm	44 mm
152 mm	76 mm	32 mm	44 mm

To give neat edges to the bands of plumber's black a piece of insulating paper may be wrapped round the sleeve on each side of the parts to be painted. Immediately after cleaning and blacking, the surface of parts to which solder will be applied should be coated with flux and tinned.

15 DRESSING Whatever the type of sleeve employed, ie seamless, divided or split, the dressing should produce a shape having as nearly as practicable a spherical surface starting from a point equal to half the sleeve diameter away from the end of the sleeve (see Fig 11). The diameter at the end should be reduced until

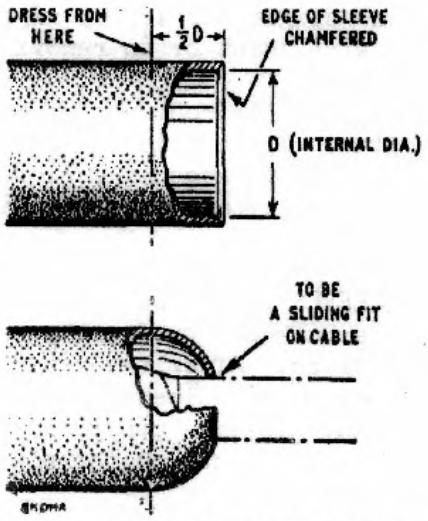

FIG. 11.—DRESSING OF A LEAD SLEEVE

it becomes a sliding fit over the cable concerned. When a seamless sleeve is to be made only one end should be dressed down. For divided or split sleeves both ends should be dressed before cutting or splitting. Before dressing, the inside edge of the sleeve should be chamfered. This will reduce the tendency of the sleeve edge to buckle during dressing and will also prevent a sharp edge of the sleeve being presented to the cable sheath.

16 PREPARATION OF DIVIDED SLEEVES FOR NEW WORK (see Fig 12). A lead sleeve of a size appropriate to the joint should be selected (see **D4053**) and should be sawn through on a line marked around the circumference. The dimensions of the two sections should be decided by the conditions under which the sleeve is to be used. Generally, they should be equal in length but in certain cases unequal sections may be advantageous as removal of the longer part will then give access to nearly the whole of the wire joints. The shorter section should be approximately 152 mm long but some latitude is permissible.

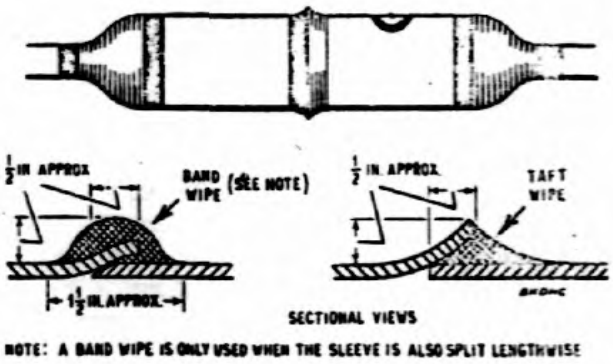

FIG. 12.—TYPES OF WIPE USED ON DIVIDED SLEEVES

17 The shorter section (or the one which is less readily removed if the two sections are equal in length) should be chamfered slightly on the outer edge where it is to meet the second section and should be well cleaned with a shavehook for about 75 mm on the outside from this edge. Plumber's black should be applied to the cleaned surface (eg as a band about 38 mm wide), leaving 19-25 mm band of cleaned lead extending from the sleeve edge, which should next be fluxed and tinned. This sleeve end should not be dressed inwards because the diameter of the sleeve would be reduced and slight difficulty might be met in pushing the sleeve into position over the wire joint or in removing the sleeve.

18 The second section should be belled-out at one end, cleaned, fluxed and tinned inside to a depth of about 19 mm. The outside should be painted with a band of plumber's black reaching to the sleeve edge if a 'Taft' wipe is to be made or to about 19-25 mm from the sleeve edge if a 'Band' wipe is to be made, the remaining 13 mm being fluxed and tinned.

19 CONVERSION OF SEAMLESS SLEEVES TO DIVIDED SLEEVES The sleeve should be cut around the circumference with a hack-saw preferably near one end and, if possible, before removal of the plumbed wipes. After the wipes have been removed the dressed ends of the two sections of the sleeve should be inspected for damage which may have been caused by any previous openings. If both sleeve sections are in good condition they should be prepared for plumbing as described in pars 16 and 17.

On completion of any conductor jointing and after the paper insulation has been replaced (see D4001), the sleeve sections should be plumbed into position as described in par 28.

Should the ends of the sleeve sections be so severely damaged that they cannot be re-used, the ends should be cut away and an additional section of sleeve, split longitudinally, provided. The preparation of split sleeves is described in par 19 and their plumbing in par 29.

20 PREPARATION OF SPLIT SLEEVES (see Fig 13). A lead sleeve of the appropriate size should be selected and the ends prepared for plumbing. The sleeve should be split longitudinally by means of a saw. The edges of the split should be chamfered slightly so that a shallow 'V' groove is formed when the sleeve is fitted on the cable. The sleeve should be opened sufficiently to allow it to be passed over the completed wire joints, and dressed to shape so that the sleeve edges meet to form the 'V' groove. The sleeve should be cleaned for about 38 mm on each side of the split and then painted with plumber's black to within 13-19 mm of the cut line so that the finished wipe will be at least 25 mm wide. The remaining cleaned portion should then be fluxed and tinned.

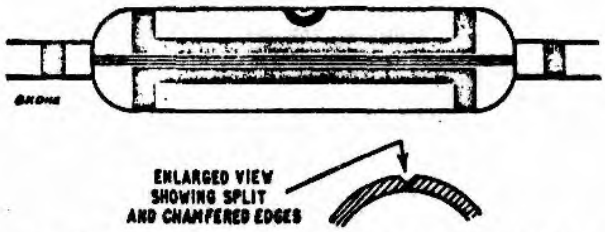

FIG. 13.—SPLIT SLEEVE PREPARED FOR PLUMBING

21 TINNING Solder of the same type as used for plumbing (ie Solder 8B) should be used for tinning, the solder being wiped around the cleaned lead with a piece of rag or moleskin.

22 PRESSURE TEST POINT Fit a Valves Air No. 1.

23 PLACING SLEEVE IN POSITION When the completed joint has been wrapped with paper the sleeve should be drawn over the joint and the ends dressed down into position. It is unnecessary to dress the sleeve tightly to the cable, and excessive dressing at this stage may cause damage to the cable sheath.

24 PREPARATION OF CABLES When the sleeve is in position the cable should be cleaned and plumber's black applied to limit the flow of solder. The length of cable to which solder should be applied will depend on the sleeve diameter (see Table 1).

To reduce the risk of cracking at the edge of the wipe, which may be accelerated by corrosion if a circumferential groove is formed by beginning each shavehook stroke from this edge. The commencement of each stroke should be staggered as described in par 13. Alternatively the shavehook strokes may be made in the reverse direction, ie starting near the sleeve, which should be moved a little so that the cleaned portion reaches right up to or even extends under the sleeve when it is in its final position. The minimum amount of lead should be removed and if, because of scores or scratches, it is necessary to remove lead to a greater depth at one spot, no attempt should be made to achieve a smooth surface by the removal of lead on each side of the depression so formed. After preparation of the cable on each side of the joint the sleeve should be placed in its final position with the pressure test hole on top and one end 'tacked' with solder to the cable to prevent movement whilst the other end is plumbed.

25 SLEEVES FOR CABLES WITH THIN-LEAD SHEATHS The end of a cable having a thin-lead sheath is normally provided with a reinforcing collar to which the sleeve is plumbed (see D3105).

26 PLUMBING CLOTHS Two moleskin cloths should be prepared in readiness for wiping the joint. The larger cloth, known as the 'catch cloth', should be prepared from half-a-yard of moleskin folded three times into a pad of eight thicknesses, the pad being approximately 230 x 230 mm. The smaller cloth, known as the 'finishing cloth', should be made up in a similar manner, but should be about 100 mm square and should consist of about four thicknesses. Before use, the cloths should be warmed to ensure that they are thoroughly dry and should then be well smeared with flux.

27 PLUMBING METHOD The joint should be plumbed by using the 'torch and stick' method. The aim should be to produce wipes having the shape shown in Fig 14. This slender shape will result in a stronger joint with less risk of fracture at the change in section. Bulbous wipes should be avoided.

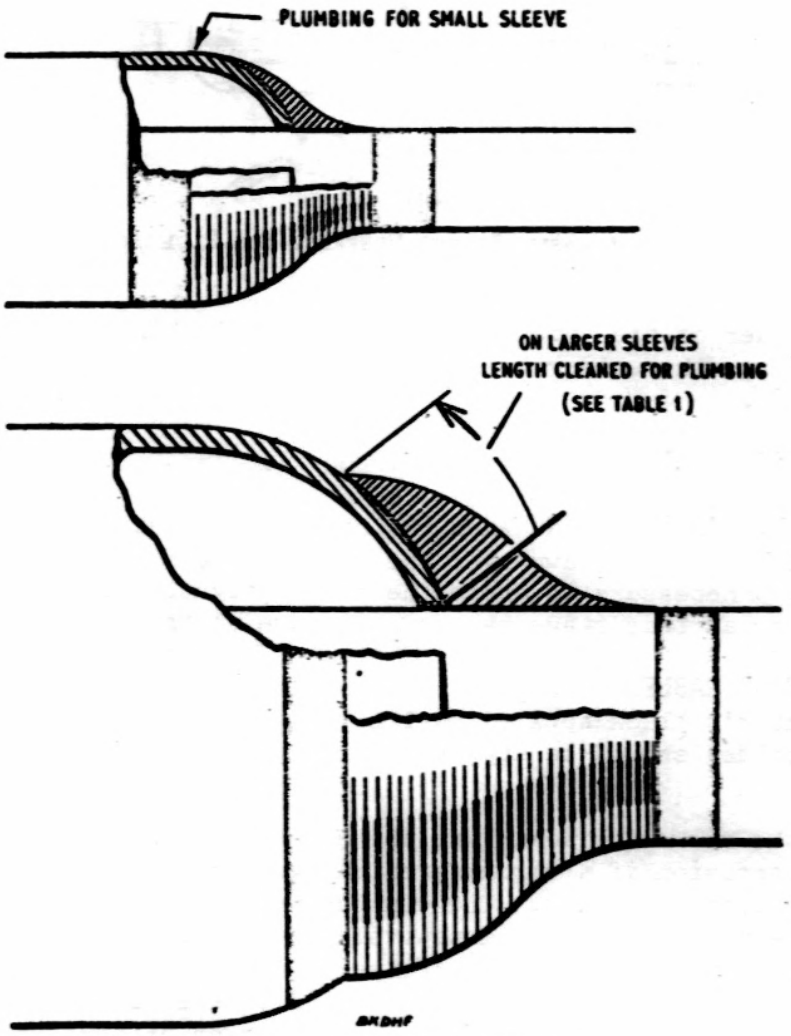

FIG. 14.—CONTOUR OF WIPES

28 **TORCH AND STICK SOLDER METHOD** Sticks of Solder No. 8B are melted on the joint by means of a torch. Pre-heating of the joint with the torch is desirable if this method is used. To ensure that the solder of the completed wipe is an even mixture throughout it should be completely melted as it is applied and efforts made to keep the whole mass of the solder at the same temperature throughout the manipulation. To achieve this the solder is applied to the top of the joint, and then remelted causing it to run down each side of the joint, where it is caught in the catch cloth held under the joint. The solder is wiped back to the top of the joint and the process repeated, by which time it should be possible to discard the torch and wipe the solder into its final shape. if necessary re-using the torch to 'clean-up' the edges.

29 **PLUMBING OF DIVIDED SLEEVES** The two sleeve sections, which will have been slipped over the cable ends before jointing commenced and will have been prepared for plumbing at one end in accordance with normal practice, whould be drawn over the wrapped joint to meet each other snugly. They should have been so positioned that the belled-out section is the more readily removed. For a divided sleeve a 'Taft' wipe about 13 mm wide should be made round the junction line (see Fig 12) but if the sleeve is also split lengthwise a 'Band' wipe about 25-38 mm wide should be made.

30 **PLUMBING OF SPLIT SLEEVES** Plumbing should commence at one end, the wipe being carried 2 in or 3 in along the seam line, after which the other end should be similarly plumbed. The seam wipe, which should be about 25-38 mm wide, should then be carried along the joint to fuse with the plumbs at the ends.

31 **COOLING** After plumbing, the joint should be allowed to cool naturally. Flux should not be applied as uneven cooling may result in a mechanically weak wipe. Until cool the solder is very weak and should not be disturbed.

32 **PRESSURE TESTING** The soundness of the joint should be checked by raising the internal air pressure and applying Solution, Leak Detecting No. 2 (see D4021) to the wipes, sleeve and all the exposed lead sheath. In using Solution, Leak Detecting No. 2 care will be needed to detect porosity of the wipe as several seconds elapse before bubbles become visible.

Dry air should be introduced into the joint from a Desiccator, with Footpump, Small, Portable fitted with an Adapter Desiccator.
Before connecting the hose to the sleeve, a little air should be passed through the hose to displace any dampness which may have collected in the hose during storage. Connexion to the sleeve should be made with a Valve, Air, No. 1 fitted directly to the joint sleeve.

The core of the Valve, Air, No. 1 and the Ring, Sealing should be removed before soldering operations commence.

The pressure should be raised to and maintained at 600-900 mbars during the test.

If a leak is discovered during the test the faulty wipe must be completely removed and remade. 'Patching' or 'touching up' a wipe which has cooled will never result in a good wipe and should not be attempted.

33 **CODING** On completion of the work, a collet (which may be made from scrap lead) bearing the type, size and code of the cable should be soldered around the cable. At spur joints, or where there are different sized cables on each side of the joints, collets should be fitted on each cable. Stamps, Letter and Stamps, Number should be used to mark the code on the collet.

34 **SUPPORTING THE JOINT** The importance of adequate support cannot be over-emphasized. An otherwise perfect joint may subsequently fail through lack of, or insufficient, support. Movement of the joint after plumbing should be kept to an absolute minimum to avoid strain on the sheath. Details of supports are given in G0251 .

35 **PROTECTING THE JOINT** Joints on Protected (see D3105) and Armoured (see D3106) Cables should be wrapped with Tape Sealing No. 3 - 2 in. The continuity of the armouring wires should be continued over the sleeve.

TD8.2.1

(From: EI LINES UNGD F3240)

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