PRESSURE TESTING

COLD RESIN PRESSURE PLUG

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1. GENERAL

1.01 This section describes the methods of constructing pressure plugs in various sizes and sheath types of cable by impregnating the core with a mixture of C Plug Resin and C Resin Activator. When mixed in the proportions provided by the unit packages, the two materials form a rubber-like solid.

1.02 The plugging operation consists of injecting the resin mixture into the core of the cable by means of a Pressure Gun. In every instance, the resin must be injected into the cable slowly

and the required waiting periods between injections observed in order to prevent failure of the cold resin plug.

1.03 The use of cold resin plugs should be confined to cables which can be relieved of gas pressure for a period of not less than 48 hours. Failure of the plugs may result if they are placed under pressure before a lapse of 48 hours after the plugs are constructed.

1.04 Resin material lowers insulation resistance to a degree that is not service effecting, but will definitely be noted on insulation resistance completion tests for a period of several months. Whenever possible, cold resin plugs should be constructed on new cables requiring insulation resistance tests after these tests have been completed.

2. PRECAUTIONS

2.01 The C Plug Resin and C Resin Activator contain chemicals which may on some individuals cause a skin reaction similar to that of creosote, but to a lesser degree. Therefore, these materials should be handled carefully to avoid contact with the skin.

2.02 "Kerodex" Protective Creams have been provided for protection of exposed skin areas while working with Resin materials and tools. To obtain effective protection, the following procedure should be observed:

(a) Prior to working with resin materials and tools, wash all exposed skin areas that may be contacted, and dry thoroughly.

(b) Apply No. 71 cream lightly and evenly over the exposed skin areas until the cream disappears into the skin. Pay particular attention to the hands, between the fingers, into the cuticle and under the nails.

(c) Apply a second coat of No. 71 cream and set with an application of cold water, then dry thoroughly.

(d) Apply No. 55 cream over the same areas, spreading lightly and evenly until the cream is dry, then apply a second coat.

(e) After the creams have been on for four hours, wash the exposed skin areas clean, dry thoroughly and reapply the creams as indicated above. If water or a solution containing water is

contacted before the end of the four hour period, the area contacted should be washed clean, dried thoroughly and the No. 55 cream reapplied.

(f) When work is finished and tools have been cleaned, wash the exposed skin areas with soap and water.

2.03 Keep all tools clean and free from spilled liquid resin. Avoid direct inhalation of the vapors and provide ventilation while the resin is being used in confined spaces.

2.04 Empty tubes and unused material expelled from the gun should be placed in a container for subsequent disposal.

3. LOCATION OF PLUG

3.01 Pressure plugs may be located in accordance with detail plans or located at the discretion of field forces. The specific location may best be determined by the requirements and circumstances of each installation. Cold resin plugs may be made either vertically or horizontally which will be determined by the position of the cable to be plugged and the selected plug location.

3.02 Where the plugs are made in terminal stubs, they should be located as close to the terminal as practicable to permit placing the greatest amount of cable under pressure.

3.03 In aerial cable the plug can be located at any convenient point in the span. If near a pole, the plug should be located at least 30 inches beyond the point where a splice may later be made. If a splice is present, the plug should be made at least 30 inches from the nearest wiped joint or end of a splice case, in order to avoid the possibility of resin compound flowing into the splice.

3.04 In main underground cable the plug should be made as far as practicable from the lead sleeve or splice case. Care should be taken in locating the plug so that resin compound will not flow in the cable past the duct entrance, as it would eliminate the possibility of future by-pass requirements. In plugging branches from the manhole, the plug may be made in the stub cable if it can be located at least 30 inches from the main and stub splices. Otherwise the individual branch cables can be plugged in the manhole, in the riser on the pole, or at a building entrance.

3.05 Due to the extremely loose core of Polyethylene Insulated Conductor cable, the measurements given in Paragraphs 3.03 and 3.04 should be increased to 48 inches when cold resin plugs are constructed in this type of cable.

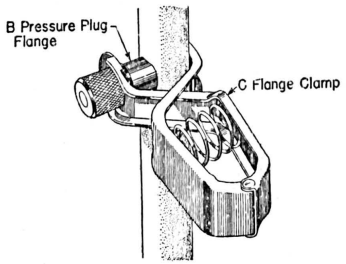
3.06 Due to possible future requirements for insulating joints in many central office vaults, plugs should not be located in the first two splicing bays from the duct entrances to these vaults.

4. SHEATH PREPARATION - LEAD CABLES LESS THAN 1 INCH IN DIAMETER

4.01 For lead cables less than 1 inch in outside diameter, only one injection point should be used.

4.02 At the point where the resin is to be admitted, clean the sheath with the Carding Brush and coat the cleaned area with stearine. Drill a hole in the sheath using the C Cable Drill. Depress the core and slightly raise the sheath at the opening with the B Cable Core Depressor. Remove any burr from the inner surface of the sheath. Remove the core wrapping paper at the hole by making a series of closely spaced holes in the paper around the opening and then, with a pair of tweezers, remove the paper disc. Gently penetrate the core of the cable with the orangewood stick. In these operations, avoid damaging the insulation on the conductors.

4.03 Clean and stearine a B Pressure Plug Flange, center it over the hole in the sheath and hold it in place with the C Flange Clamp. Solder the flange to the sheath. Then remove the clamp.



5. SHEATH PREPARATION - LEAD CABLES 1 INCH IN DIAMETER UP TO AND INCLUDING FULL SIZE

5.01 For construction of horizontal cold resin plugs in lead cables of 1 inch outside diameter up to and including full size, a sheath opening should be used, covered by a lead sleeve 1/2 inch larger than the outside diameter of the cable. The following table provides the length of sheath opening and length of lead sleeve for horizontal plugs:

Outside Diameter of Cable	Length of Sheath Opening	Length of Lead Sleeve
1 in. up to 2 in.	7 in.	10 in.
2 in. to full size	9 in.	12 in.

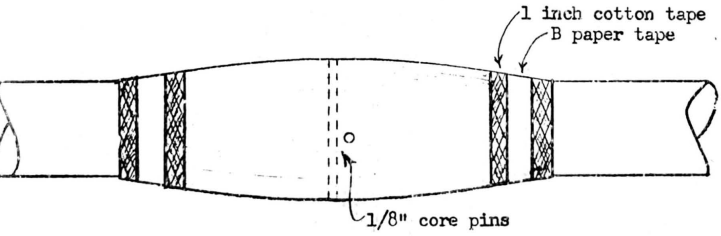
5.02 After making the correct sheath opening at the selected plug location, prepare the core and sheath for plugging as follows:

(a) Place cotton tape at the sheath ends in the normal manner and remove the core wrapping paper.

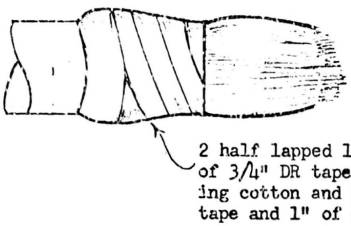
(b) If unit type cable, cut the binder strings to free the conductors, but do not tie them around the groups of conductors at the sheath ends.

(c) Place two 1/8 inch diameter core pins through the center of the conductors at 90° to each other at the mid-point of the sheath opening. Exercise care in placing the core pins to prevent conductor insulation damage. These pins should be previously dried in a suitable container of dessicant, and cut to lengths equal to the core diameter of the cable to be plugged as needed.

(d) Place two tight wraps of 1 inch cotton tape around the core adjacent to each sheath end and hold in place with a wrap of B paper tape as shown in the following illustration.

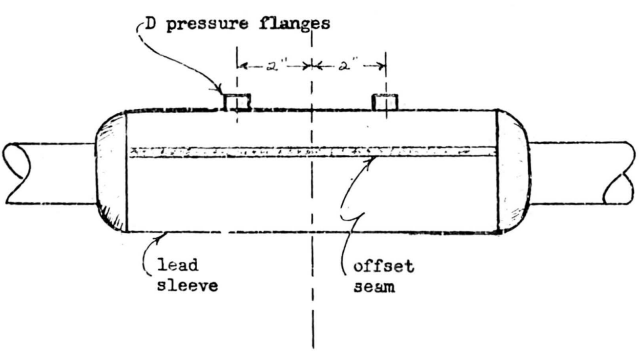


(e) Place two half-lapped layers of 3/4 inch DR tape, under tension, over 1 inch of the sheath and the cotton tape at each sheath end as shown in the following illustration. Do not allow overlapping of the DR tape onto the conductor insulation.



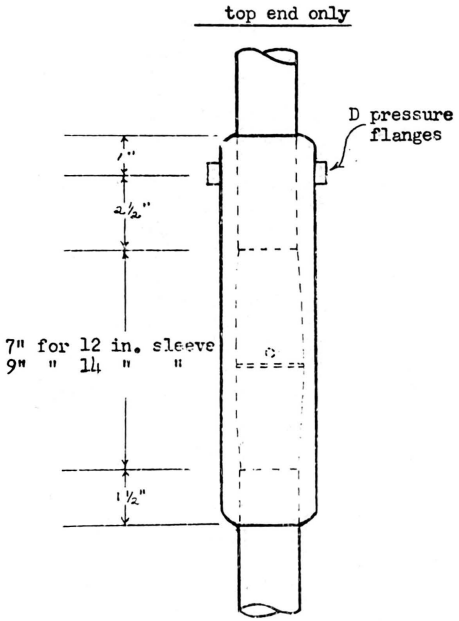
(f) Prepare the correct size and length lead sleeve. To prevent waste, it will be found advantageous to cut required lengths from standard 72 inch length lead sleeving. Mark the mid-point of the sleeve and drill a 1/2 inch hole with the D Cable Drill at a point centered 2 inches each way from the mid-point. Install D Pressure Flanges in the two openings. When a split sleeve is used, allow enough space between the seam and the flanges for soldering operations on the seam.

(g) Place the lead sleeve over the sheath opening. When a split sleeve is used, complete the soldering operations on the seam, turn the sleeve so that the flanges will be vertical on top of the sleeve, and then solder the end joints. The completed sheath preparation is shown in the following illustration.



5.03 For vertical plugs in lead sheath cables of 1 inch outside diameter up to full size, the sheath and core preparation is identical with that given in Paragraphs 5.02(a) through 5.02(e). However, the vertical plug differs in the length of the lead sleeve, placement of the flanges, and the position of the sleeve over the sheath opening as indicated by the following table and illustration.

Outside Diameter of Cable	Length of Sheath Opening	Length of Lead Sleeve
1 in. up to 2 in.	7 in.	12 in.
2 in. up to full size	9 in.	14 in.



5.04 Where it is desired to restrict the flow of resin to a very short space or extremely loose core lead sheath cable is encountered, constricting rings may be placed in a manner similar to their use for duct splices. Use of constricting rings should be held to a minimum, but when used for either vertical or horizontal plugs in lead sheath cables of 1 inch outside diameter or larger, they should be placed in accordance with the following:

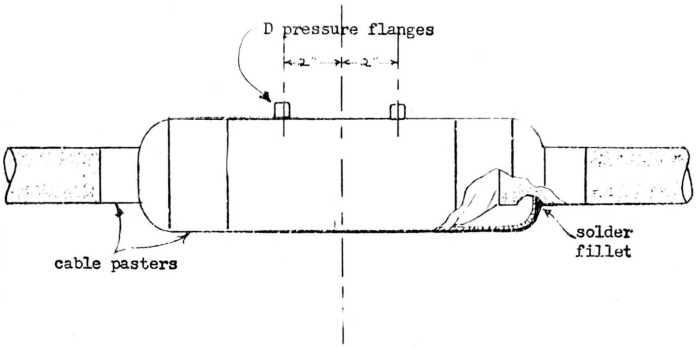
(a) Mark the sheath opening, clean the sheath, and apply stearine to the cleaned areas.

(b) Mark the sheath on the cleaned areas where the ends of the lead sleeve will contact the sheath when the sleeve is properly positioned for soldering. Use these marks as the center line of the constriction ring and place cable pasters 1/4 inch on each side of them to act as guides for the constricting operation. The rings can be formed using the cable sheath constrictor or by striking with a hammer a smooth 1/2 inch steel rod which is held against the sheath between the paster guides. The position of the rod should be changed frequently and moved around the sheath between hammer blows to ensure the formation of a smooth ring of uniform depth. The depth of the ring should be checked frequently with outside calipers until the exact depth is achieved around the sheath.

(c) The following table shows the depth of ring for the various diameter cables:

Outside Diameter of Cable	Depth of Ring
1 in. to 1 1/4 in.	3/32 in.
Over 1 1/4 in. to 1 1/2 in.	1/8 in.
Over 1 1/2 in. to 1 3/4 in.	5/32 in.
Over 1 3/4 in. to 2 in.	3/16 in.
Over 2 in. to 2 1/2 in.	7/32 in.
Over 2 1/2 in. to 3 in.	1/4 in.

(d) After the rings have been formed, remove the sheath at the previously marked sheath opening and prepare the sheath and core as described in other Paragraphs of this section. Place and solder the lead sleeve as shown in the following illustration.



6. SHEATH PREPARATION - ALPETH AND STALPETH CABLES

6.01 For construction of cold resin plugs in all sizes of Alpeth or Stalpeth cable, a sheath opening must be used, covered by a lead sleeve 1/2 inch larger than the outside diameter of the cable. The following table provides the length of sheath opening and length of lead sleeve for horizontal plugs.

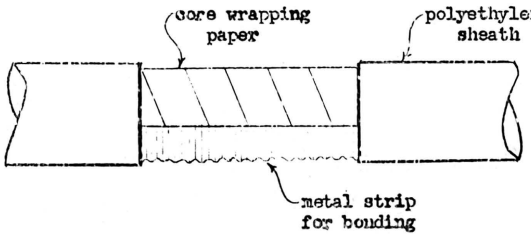
Outside Diameter of Cable	Length of Sheath Opening	Length of Lead Sleeve
0 in. up to 2 in.	7 in.	10 in.
2 in. to full size	9 in.	12 in.

6.02 For Alpeth or Stalpeth sheath cables, prepare the core and sheath in the following manner:

(a) Mark the required sheath opening at the selected plug location, score the polyethylene completely around the sheath at the marks and remove the sheath.

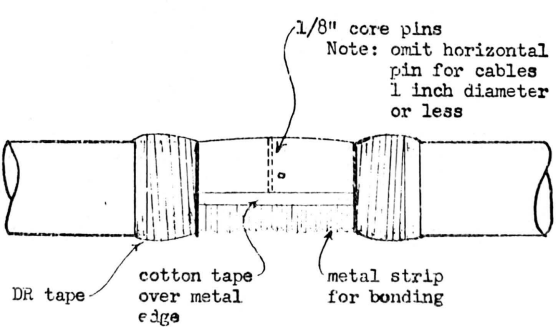
(b) For cables 1 inch in outside diameter or less, clean the aluminum or terne-plate and remove a longitudinal strip of the metal on the top equal to one half the circumference of the metal for the length of the sheath opening. Use caution to prevent burrs or slivers on the edges of the remaining metal and flare the ends slightly at the sheath openings. For cables over 1 inch in outside diameter, the width of the longitudinal strip

removed should be 2/3 the circumference of the metal in orde to provide space for the horizontal core pin. The remainin metal provides the bond for the sheath opening as indicated i the following illustration.



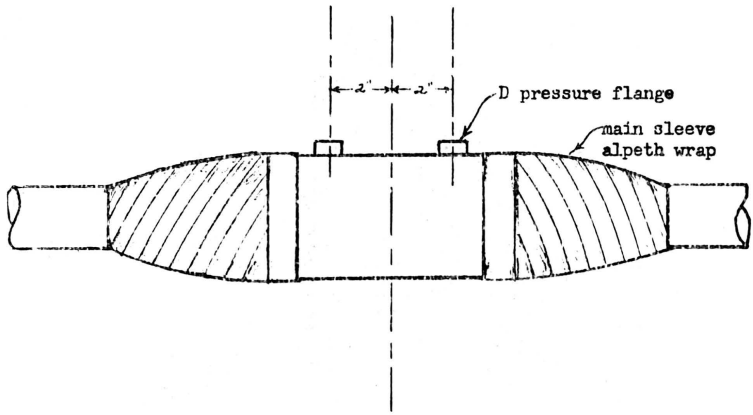
(c) Protect the exposed edges of the metal by tucking 1 inch cot ton tape under the metal edges at the sheath ends and betwee the horizontal edges of the bonding strip and the core wrappin paper. Remove the exposed core wrapping paper by trimming a close to the horizontal edges of the bonding strip as possible Do not remove the wrapping paper between the core and the bond ing strip.

(d) Complete the preparation of the sheath ends and core a specified in Paragraphs 5.02(b), 5.02(c), 5.02(d), and 5.02(e for lead cables except that for Alpeth or Stalpeth cables of 1 inc or less in outside diameter, the horizontal core pin should b omitted. The completed sheath preparation is shown in th following illustration.



(e) Prepare the lead sleeve as specified in Paragraph 5.02(f) of this section.

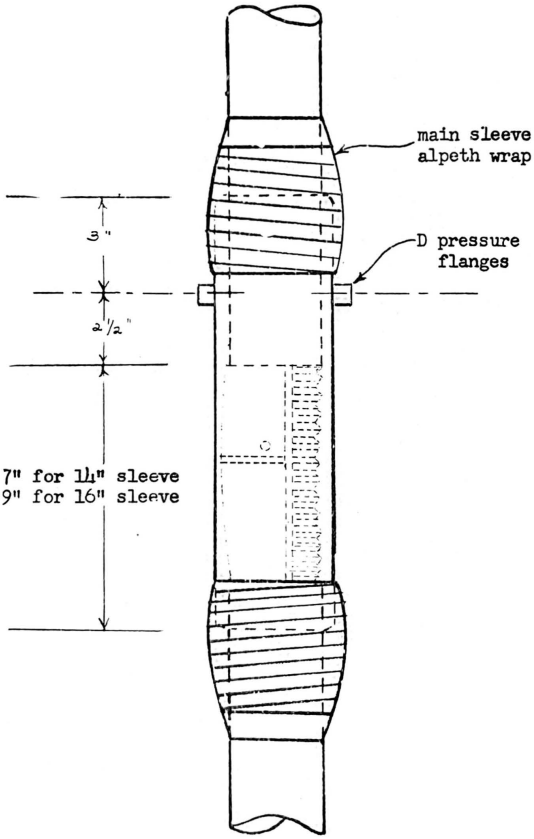
(f) Place the lead sleeve over the sheath opening. When a split sleeve is used, complete the soldering operations on the seam, turn the sleeve so that the flanges will be vertical on top of the sleeve, and then complete the end joints in accordance with other sections of the practices covering Cable Splicing, General, Main Sleeve Wrapped Joint for Alpeth Cables. The completed sleeve installation is shown in the following illustration.



6.03 For vertical plugs in Alpeth or Stalpeth sheath cables, the sheath and core preparation is identical with that given in Paragraphs 6.02(a) through 6.02(d). However, the vertical plug differs in the length of lead sleeve, placement of the flanges, and

the position of the sleeve over the sheath opening as indicated by the following table and illustration.

Outside Diameter of Cable	Length of Sheath Opening	Length of Lead Sleeve
0 in. up to 2 in.	7 in.	14 in.
2 in. to full size	9 in.	16 in.



7. SHEATH PREPARATION - LEPETH CABLE

7.01 Cold resin plugs may be constructed in Lepeth Sheath Cable in the same manner as specified for lead sheath cables in other Paragraphs of this section. Use caution in soldering operations to prevent damage to the very thin outer lead sheath and the underlying polyethylene layer.

7.02 Do not use constricting rings on Lepeth sheath cable.

8. SHEATH PREPARATION - POLYETHYLENE INSULATED CONDUCTOR CABLES

8.01 Cold resin plugs may be constructed in Polyethylene insulated Conductor cables in the same manner as specified for Alpeth and Stalpeth cables in other Paragraphs of this section except that the two half-lapped layers of DR Tape placed at the sheath ends in the core preparation should be omitted. Such constriction of the conductors would tend to cause physical contact when the polyethylene insulation becomes softened due to the heat generated by the resin process.

9. INJECTING RESIN - LEAD CABLE LESS THAN 1 INCH IN DIAMETER

9.01 The quantities of mixed resin compound required for each plug constructed by direct injection into the sheath of lead cables less than 1 inch in diameter are as follows:

OUTSIDE DIAM. OF CABLE INCHES	TOTAL QUANT. MIXED RESIN PER PLUG	NO. OF COMBINED UNITS PER PLUG*
Up to .65	69 Grams	1 Tube Unit
.65" .73 inc.	138 "	2 " "
.74" .83 "	208 "	3 " "
.84" .90 "	276 "	4 " "
.91" .99 "	346 "	5 " "

*Tube unit = One 50 gram tube resin and one 19 gram tube of activator

Can unit = One 168 gram can resin and one 64 gram tube of activator

9.02 B and C Pressure Guns are available for use to inject resin compounds into cables for plugging purposes. The B gun has a capacity of 1 tube unit while the C gun will hold 3 tube units or 1 can unit. Both guns are of the screw actuated piston type.

It will be found advantageous to use the C gun when plugging cables requiring 3 tube units or more of the resin compound. The C gun must be equipped with a No. 51942 Alemite Adaptor to fit the B Pressure Plug Flange.

9.03 Place the required number of tube units of C Plug Resin and C Activator in a clean container and stir the contents vigorously for at least one minute with the flat end of the B Cleaning Rod. Remove the rod and clean it with a cloth. When more than three tube units are required, mix no more than three tube units at a time, as the time interval required to mix the additional compound and reload the gun is very necessary in order to allow the resin to penetrate the insulation and core. When the B Pressure Gun is used, mix and inject only one tube unit at a time.

9.04 When the B Pressure Gun is used, remove the front cap from the gun, turn the piston screw until the piston is at the bottom of the barrel and then pour the mixed tube unit of resin into the gun. Replace the cap on the gun and expel the air in the gun by turning the piston screw clockwise until resin appears at the nozzle. Back off the piston screw to stop the flow and screw the nozzle into the flange on the cable.

9.05 When the C Pressure Gun is used, remove the screw cap and piston, turn the piston screw until the piston is at the bottom of the screw cap and plug the adapter on the gun with a suitable plug. Pour the mixed resin into the gun. Replace the screw cap and piston, remove the plug on the adapter and expel the air in the gun by turning the piston screw clockwise until resin appears at the adapter. Back off the piston screw to stop the flow and screw the adapter into the flange on the cable.

9.06 Inject the mixture into the cable by slowly turning the screw clockwise in quarter or half turns. In some terminal stubs, particularly pole mounted terminals, high back pressure in the cable will be encountered. When high back pressure is encountered, wait a few seconds after each turning operation for the pressure to diminish. As the cable becomes filled and the back pressure increases, the length of turn should be decreased. When the handle remains tight, or practically so after two or three consecutive waiting periods, stop turning the screw but leave the gun attached to the flange for about two minutes to prevent back flow of the compound. Then disengage the gun and install the screw plug in the flange. The piston should not be withdrawn before detaching the gun as this would suck compound out of the cable.

9.07 If additional resin is required, the gun may be left in place and the piston withdrawn after about 2 minutes. A second charge of the plugging compound is then prepared and injected into the cable as before. In all cases of multiple injections, at least 5 minutes should be consumed in injecting one charge and at least 2 minutes should elapse before injecting the next charge. After the final waiting interval the gun is removed and the screw plug is installed in the flange.

10. INJECTING RESIN - ALL CABLES REQUIRING A LEAD SLEEVE

10.01 The method of injecting resin into all cables requiring the use of a lead sleeve differs from direct injection into the sheath in that pressure is used only in the final charge to ensure that the sleeve is full. The quantity of mixed resin required will be determined by the size and type of cable and the size of the lead sleeve, but in general, will be appreciably less than required for direct injection. In most cases, it will be found advantageous to use can units of mixed resin or a combination of can units and tube units. A can unit consists of one 168 gram can of resin and one 64 gram tube of activator. Mix and inject only one can unit or three tube units at a time as the time interval between charges is essential for proper core and insulation penetration.

10.02 Prepare the resin compound and load the C Pressure Gun as specified in Paragraphs 9.03 and 9.05 of this section.

10.03 Remove the plugs from the D Pressure Flanges on the sleeve and inject the charge or repeated charges into one of the flanges until resin appears in the other open flange.

10.04 Leave the gun in place and wait 15 minutes for penetration of the resin into the core and insulation. Refill the sleeve with a small charge of resin and wait a second 15 minute period. To prevent waste, one or two tube units of resin should be used for the refilling operations and mixed as needed.

10.05 Place a plug securely in the flange that has been used for venting purposes and inject a final charge of resin to ensure the complete filling of the lead sleeve. After back pressure is encountered, turn the piston screw slowly in 1/4 or 1/2 turns for two full turns and stop. Allow the gun to remain in position for two minutes, then remove the gun and install the plug in the flange.

11. INJECTING RESIN - TEMPERATURE BELOW 45°F.

11.01 When the temperature is 45°F. or less, the cable should be filled as covered in the following paragraphs.

11.02 After the C Plug Resin and C Resin Activator have been placed in the container to mix, play a moderately low acetylene torch flame on the container, working the flame around the outside to avoid concentration of heat. At the same time stir the mixture thoroughly and continuously with a thermometer until the temperature of the resin reaches 75° to 80°F. Remove the flame but continue stirring the mixture with the thermometer. The temperature should rise to about 100°F. Should the temperature, through inadvertent overheating, reach a temperature of 110°F. or more, allow the resin mixture to cool to 100°F. before it is poured into the gun. Remove and clean the thermometer.

11.03 When the resin mixture has reached the desired temperature, play the acetylene torch flame around the shell of the gun to remove the chill until it is warm but not hot to the touch. Pour in the warmed resin compound.

11.04 On lead sheath cables or terminal stubs, gently heat approximately 18 inches of the cable where the plug will be located. If the terminal stub is less than 18 inches, heat the entire stub, starting at the terminal. Heat the cable until it is warm but not too hot to the touch, avoiding concentration of the flame on any one point. Attach the gun to the flange and inject the resin in the usual manner.

11.05 On polyethylene sheath or polyethylene insulated conductor cables, heat the resin mixture and the gun only. Due to the low melting point of polyethylene, the torch flame should not be applied to the lead sleeve required for plugging these cables.

12. PROCEDURE FOR FAULTY PLUGS

12.01 When it is necessary to repair a faulty plug, the existing flanges may be used for injecting additional resin or a new plug can be constructed about 30 inches from the first plug.

12.02 Remove the screw plug from both of the flanges and look for a void between the bottom of the flange opening and the core. A void may be found in one or both of the flanges. When a void is found, two tube units or one can unit of the plugging mixture are prepared and injected into the cable through each flange having a void.

12.03 In replugging cables it will be found that the plugging mixture already in the cable offers considerable resistance to the enterance of the new material. The resin is injected until the resistance encountered makes it impracticable to force in more. After waiting a minute or two, the injection is continued until high back pressure is again encountered. During the initial stages of the injection it may not be possible to inject any resin at all after high resistance is first experienced. However, it is necessary to maintain a high injection pressure in order that a channel can be formed in the core. When this occurs it will be possible to operate the handle of the gun at more frequent intervals until the charge has been injected into the cable.

12.04 If after several attempts it is found that the resistance of the original plugging compound makes repair of the plug impossible, a new plug should be constructed at another suitable location.

13. CLEANING TOOLS

13.01 The pressure gun and associated tools must be cleaned before the resin has set. Disassemble the gun and remove the excess resin from the gun parts and other tools by wiping with rags or paper towels. Immerse the gun parts and tools in Perm-a-Clor Cleaner and allow to stand for 2 or 3 minutes. Then clean and dry all parts with rags. Repeat the immersion if necessary and then lubricate the piston screw, the cap threads and the gaskets on the gun with light oil or petroleum jelly.

13.02 Perm-a-Clor is stabilized Trichlorethylene and may be re-used repeatedly with good results. It is non-flammable but should be stored in a suitable metal container.