

BELL SYSTEM PRACTICES
Outside Plant Construction
and Maintenance

SECTION G41.120
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AT&T Co Standard

MAIN CONDUIT
LAYING CLAY CONDUIT

Part	Page
1. Cleaning and Testing Conduit.....	1
2. Use of Damaged Conduit.....	2
3. Base for Conduit Structure.....	3
4. General Instructions for Laying Clay Conduit.....	5
5. Standard Methods of Laying Clay Conduit.....	6
6. Laying Straight Clay Conduit.....	6
7. Laying Transposition Clay Conduit.....	9
8. Laying Expanded Web Clay Conduit.....	11
9. Laying Mitered Clay Conduit.....	14
10. Changes in Duct Structure.....	20
11. Foreign Structures	20
12. Plugging and Terminating Ducts.....	21
13. Placing Top Protection.....	22
14. Concrete Encasement	22

1. CLEANING AND TESTING CONDUIT

1.01 All types of conduit should be inspected before laying to see that the bores are clean and free from mud, sand, etc. Only conduit having ducts with a relatively smooth bore free from burrs, rough projections caused by blisters or salt drip, etc., shall be used.

1.02 Where burrs or other rough areas likely to damage cable are found in the ducts of a piece of conduit, they should be smoothed off by rasping or scraping.

(2) Before making the joint, cover the broken portion of the conduit with a piece of terne plate or several thicknesses of heavy paper **not over 1-1/2 inches in width**. It is important not to exceed this width, as otherwise the bond between the mortar bandage and the conduit will be impaired. This covering is intended to reinforce the broken portion and prevent the bandage from being forced into the duct in backfilling.

(3) Make the joint, centering the bandage evenly over the reinforcing material.

2.02 Units of conduit which have been broken to such an extent that it is not practicable to use them in the manner described in 2.01 can be repaired in accordance with G40.057, "Repairing Broken Ends of Clay Conduit."

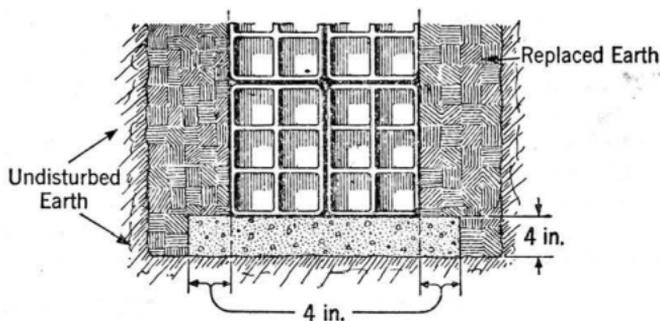
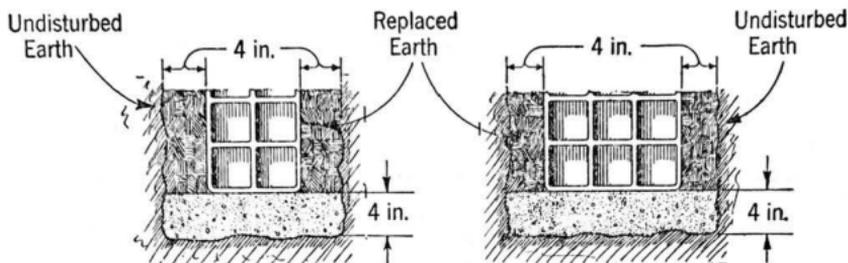
2.03 Use care in moving conduit which has been damaged or has been subject to rough handling. Such conduit may have developed cracks in the walls without actually breaking and sections so weakened may break away when the conduit is lifted. Grasp multiple conduit near the webs rather than at the corners.

3. BASE FOR CONDUIT STRUCTURE

3.01 A concrete base ordinarily is required only when the conduit is being laid with troweled joints or when the bed of the trench is unstable to the extent that it will not afford firm support for the conduit. The need for a base and the details of its construction will usually be indicated on the detail plans. If a base is not specified and excavation discloses that it may be desirable, refer the question to the supervisor or inspector.

3.02 Where a concrete base is required, follow the instructions of G45.150 in mixing and placing the concrete. Use the Class 2A concrete described in G45.140 for conduit base.

3.03 The concrete base should fill the entire width of the trench, or, if the trench is wider than is necessary for the conduit, should extend 4 inches each side of the conduit, using forms if necessary. The thickness of the base should normally be 4 inches, and the concrete should be well tamped to provide a level bed for the conduit. Where additional strength is required, the thickness of the base and the type of reinforcing will be indicated on the detail plans or will be furnished by the supervisor or inspector.

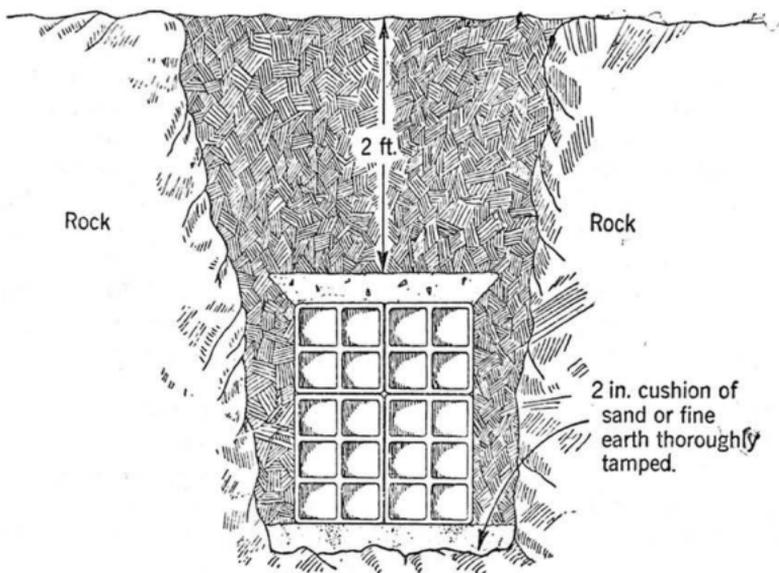


Trench is wider than is necessary to accommodate conduit formation. Base extends 4 inches each side of conduit.

3.04 Conduit should be laid immediately following the placing and leveling of the base concrete so that the conduit will find even bearing while the concrete is still yielding. For the same reason, no more base should be placed than is required for the conduit being laid at any one time.

3.05 If the conduit structure is to be encased in concrete, refer to Part 14 for instructions on placing a reinforced concrete base in preparation for encasement.

3.06 When laying conduit through rock, place a cushion of sand or fine earth as a base for the conduit structure. The thickness of material to be used will depend on the irregularity of the trench bed. Sufficient material should be placed to provide a minimum cushion of 2 inches between the conduit and the rock.



3.07 Where steep grades are encountered in trenches excavated in rock, there is a possibility that water draining through the trench may wash out an earth or sand cushion. In these circumstances, it will be advisable to place a shallow bed of base concrete in order to obtain a reasonably even bottom in the trench.

4. GENERAL INSTRUCTIONS FOR LAYING CLAY CONDUIT

4.01 Where practicable, lay the conduit in formations as shown in the detail plans. The following rules will apply to laying all types of Clay Conduit.

- (a) Align all sections reasonably straight initially to avoid excessive shifting of the conduit structure after the joints have been made. Any deviations from a true line should be corrected.
- (b) Stagger all vertical joints in order to increase the rigidity of the structure.
- (c) Exercise care to avoid disturbing base material.

4.02 In urban and suburban areas, if obstructions or other considerations necessitate the construction of a dip in the grade of the conduit in excess of five feet below the normal level of the balance of the section between manholes, consult the supervisor or inspector to determine whether steel pipe for electrolysis protection should be used in the portion below the normal grade of the trench.

5. STANDARD METHODS OF LAYING CLAY CONDUIT

5.01 The standard methods of laying clay conduit are as described below. Reference to the method number to be employed will appear on the detail plans. The method number does not indicate the order of preference.

Method No. 1 —Concrete top protection and concrete base.

Method No. 1A—Creosoted Plank top protection and concrete base.

Method No. 1B—Concrete base only.

Method No. 2 —Concrete top protection only.

Method No. 2A—Creosoted Plank top protection only.

Method No. 3 —Complete encasement of concrete.

Method No. 4 —No top protection nor concrete base.

6. LAYING STRAIGHT CLAY CONDUIT

6.01 In laying Clay Conduit without encasement one of two types of joints may be employed, the mortar bandage joint or the troweled joint. Because of its strength and resistance to the passage of silt, the bandage joint is preferred to the troweled joint. However, since there may be occasions, particularly in repair work or for minor extensions, when the amount of work might not justify assembling the materials needed for the bandage joint, both types of joints have been included in the instructions.

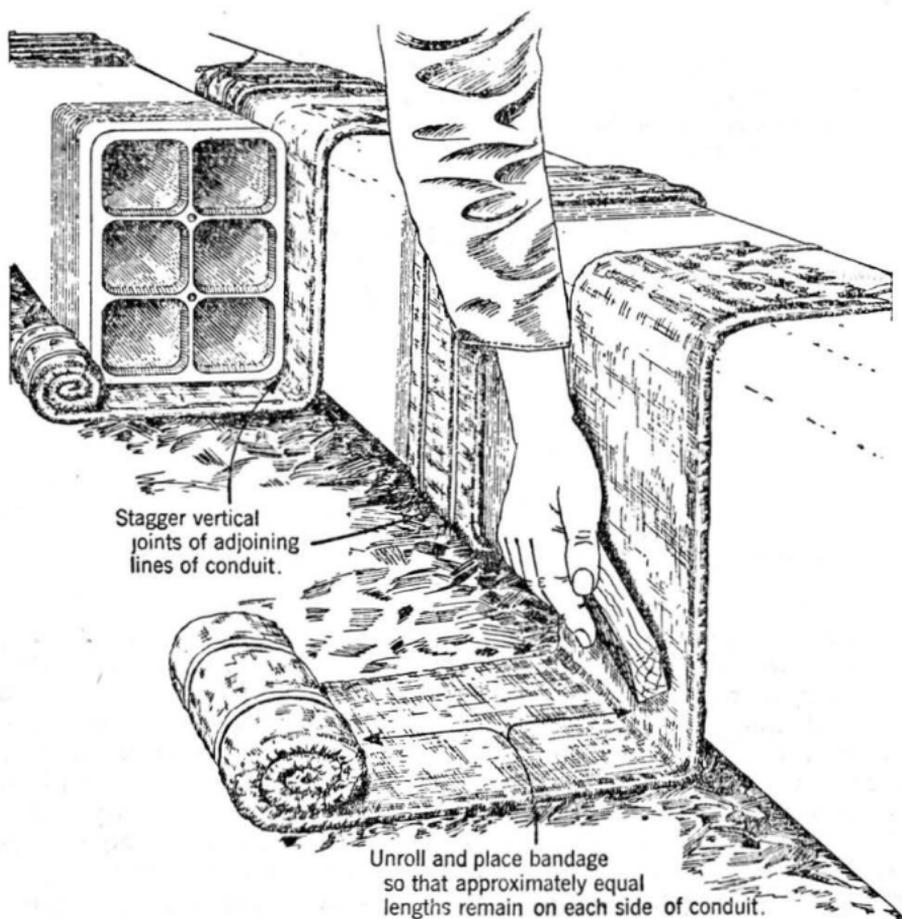
6.02 When ready to lay conduit, place the mortar bandage or layer of mortar for the troweled joint on the bed of the trench as instructed in G41.130.

6.03 Insert two dowel pins in the piece of conduit last placed. The purpose of the dowel pins is to assist in aligning the ducts and to hold the conduit in position until the joints have set. When there is a choice of dowel pin holes, select the two which are most convenient for assembling the units.

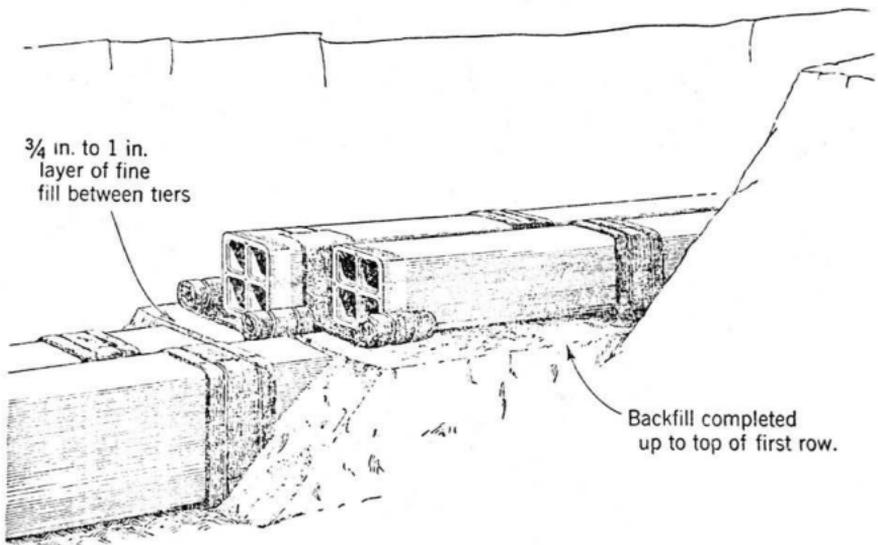
6.04 Pass a length of 1 inch rope through one duct of the unit and with one man at each end of the rope lift and lower the section into the trench. As an alternative to the use of rope for lowering, the conduit can be handled by means of hooks engaging only the ends of the ducts or in shallow trenches can even be lowered by hand. These methods do not afford the same security in handling the conduit however, as is afforded by a piece of rope passed entirely through the unit. The unit will be guided into approximate position in the trench by one of the men in the trench.

6.05 In adjusting each new unit of conduit into place, be careful to lift it and the adjacent unit clear of the bandage or mortar while butting the ends. Roll the bandage back snugly against the sides of the tile to prevent any falling dirt from getting on the bonding surface. The joint itself is to be completed as described in G41.130.

6.06 When laying conduit in a formation consisting of two or more units placed side by side, the joints in the first line are handled in the usual way. But as the second row is placed beside the first it is necessary for the conduit layers to unroll one side of the bandage and lay it over the conduit already in place. The bandage is then stroked against the side of the conduit to flood mortar to the surface before the unit is laid in position. The joints of the second line of conduit should, of course, be staggered with those of the first, as shown.



6.07 As the lower row of a formation consisting of several units is partially completed, the backfill at the sides should be carried up even with the top of the row and tamped firmly in place. Before laying the next row above the conduit in place, it is generally advisable to sprinkle over the lower conduit a layer of $\frac{3}{4}$ to 1 inch of earth free from rock or hard lumps to form a bedding for the upper run. Then proceed with the laying of successive rows as outlined above. If troweled joints are employed, care should be taken not to disturb the joints of the lower bank when laying the upper units of conduit.



6.08 In a formation of several multiple units, endeavor to carry the entire formation forward instead of completing the lowest run for an entire section and then returning to the next row. This will facilitate backfilling and also will keep the conduit laying operation near the bandage making crew, thereby saving time in carrying the bandages to the point where they are to be used. After the conduit laying has progressed some distance along the trench, the bandage making equipment is moved to a new location.

6.09 When a line of conduit is to be left uncompleted for over an hour, a block of wood about the thickness of a bandage should be placed under the end of the last unit. The block should be placed about 5 inches from the end so that when placing is resumed in this line of conduit, a bandage can

be slipped under the end without disturbing the joint last made, which may in the meantime have started to set.

Prejoined Sections

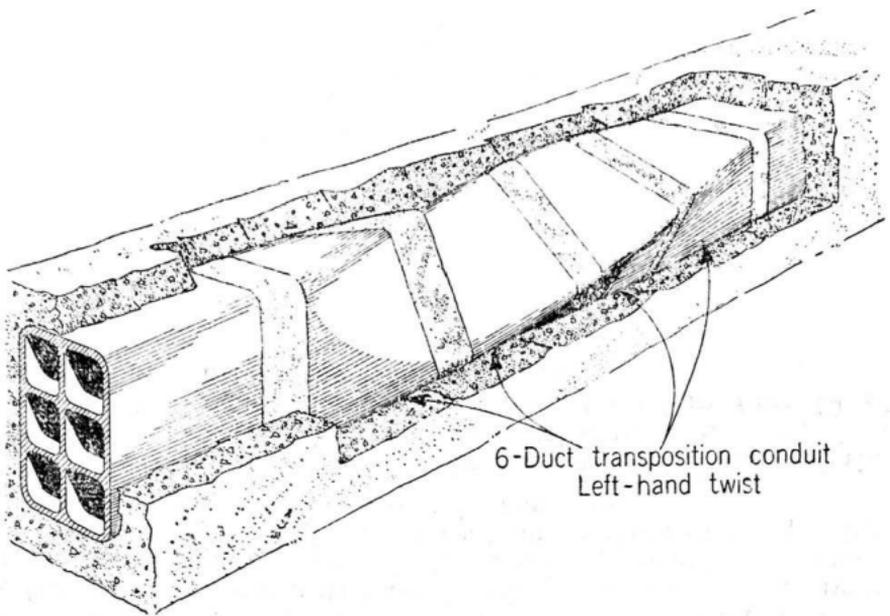
6.10 On some jobs, where the run is generally straight and few obstructions are encountered in the trench, it may be economical to join two or three pieces of full-length conduit in the storeyard and place these sections in the trench direct from the storeyard. In this case the jointed conduit may be handled mechanically by a small derrick mounted on a truck. This method can also be employed in the construction of curves consisting of a number of short mitered pieces. The method to be followed in constructing prejoined sections is outlined in G41.130.

7. LAYING TRANSPOSITION CLAY CONDUIT

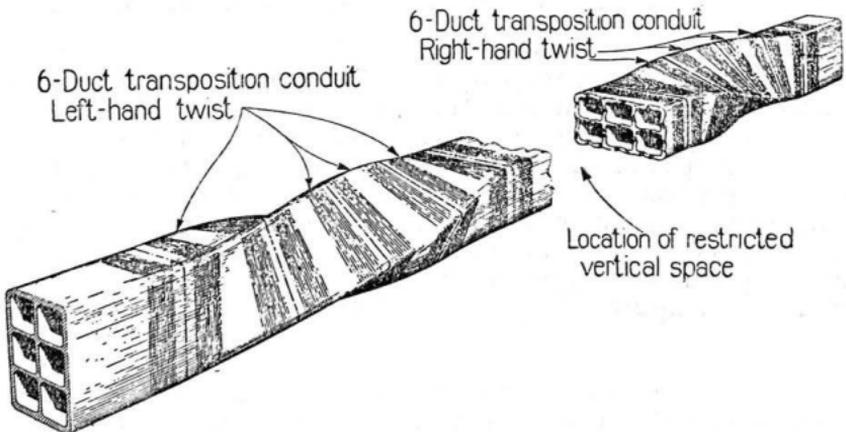
7.01 Transposition conduit is intended for use in changing the formation of a conduit run, as outlined in G40.060 describing the various types and uses of Clay Conduit. Four pieces of transposition conduit are required to make a 90 degree transposition.

7.02 The section of the conduit run containing the transposition and two or three feet of the conduit adjacent to each end of the transposition should be completely encased in concrete in order to prevent any of the conduit sections being forced out of position when cable is installed in the ducts. If the ordinary straight sections of the multiple conduit are to be laid without a concrete base, it will be necessary to excavate the trench 4 inches deeper in the section in which the transposition is to be made in order that this portion of the conduit run may be completely encased in concrete.

7.03 Two dowel pins should be used at each joint and the joints made as outlined for conduit to be encased, Section G41.130. Encase the conduit as instructed in Part 14 of this section, omitting the reinforcement.



7.04 When a transposition is made in a conduit run between manholes to avoid an obstruction, the conduit should be retransposed in the reverse direction on the other side of the obstruction in order that the duct formation will be the same in the adjacent manholes. This can be accomplished by using transposition conduit made with a right-hand twist on one side of the obstruction and transposition conduit made with a left-hand twist on the other side of the obstruction. The following figure illustrates the manner in which the conduit run may be transposed and then retransposed so that the duct formation in the adjacent manholes will be the same.

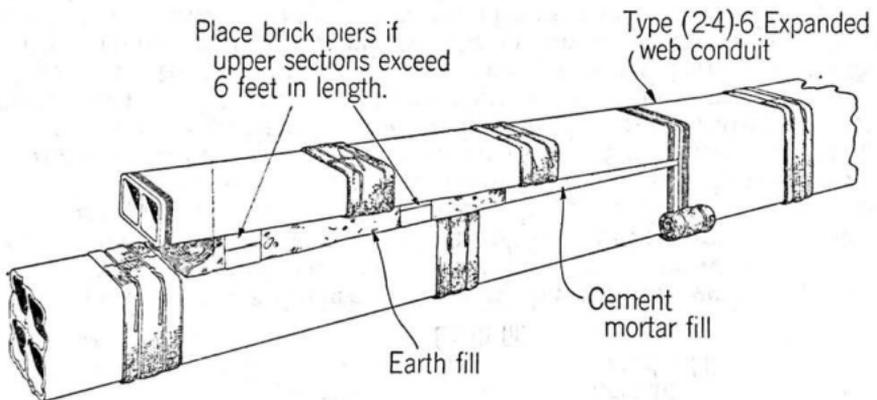


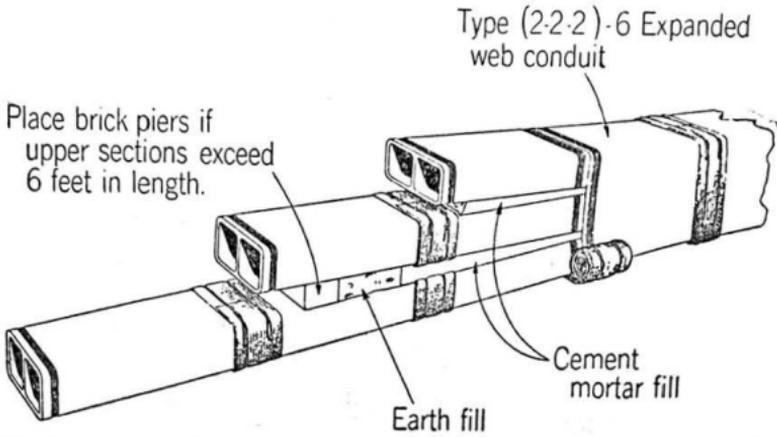
8. LAYING EXPANDED WEB CLAY CONDUIT

8.01 The uses of Expanded Web Clay Conduit and the types available are described in G40.060 on types and uses of Clay Conduit. This conduit should be placed in the same manner relative to the provision of a base or top protection or complete encasement as the conduit to which it is to be joined.

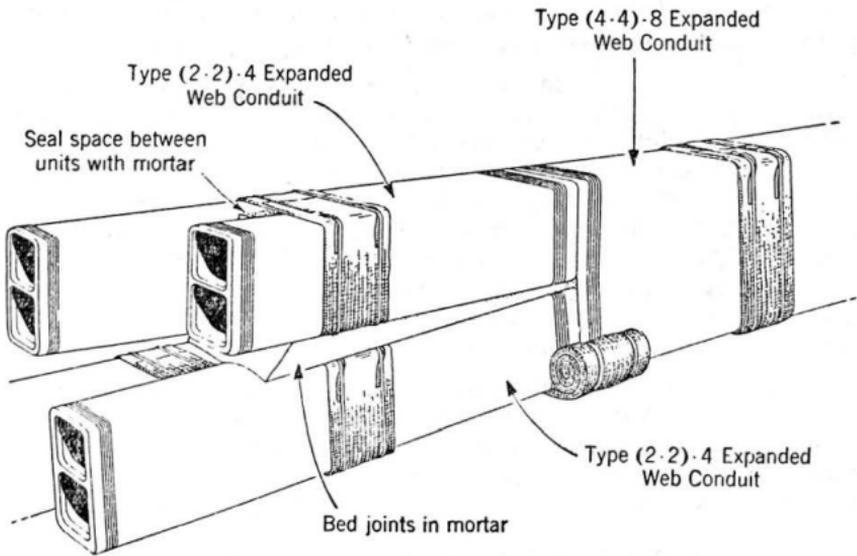
8.02 The small end of the expanded web conduit should be joined with two dowel pins to the section of conduit to be divided. The smaller sections are then joined to the expanded end, as illustrated. Cement mortar of the quality used for joints should be placed between the sections joined to the enlarged end of the expanded web conduit. As succeeding pieces are placed, they should be supported on a well compacted earth fill. If the length of the upper-section so separated exceeds 6 feet, it should be supported on brick piers spaced one to each unit, as shown, to avoid settlement.

8.03 Encase the joint between the expanded web conduit and the adjoining smaller sections with a mortar bandage of suitable length.



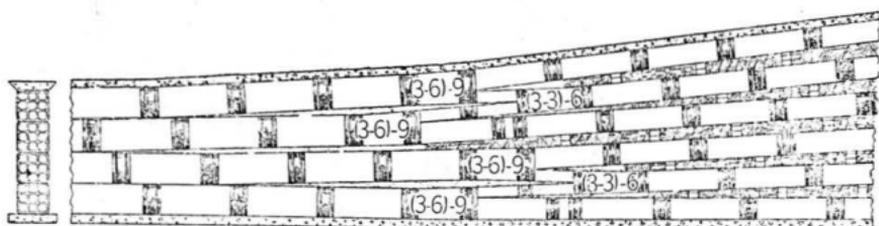


8.04 Using units designed to split the conduit vertically into two smaller sections, expanded web conduit can be employed to produce a "partial splay" of conduit entering man-holes. By this method the ducts can be brought into the man-holes near the side walls and reduce the space required for setting up cables and the amount of bending necessary to bring the cables in a position to be racked. This construction is generally restricted to conduit formations of 18 ducts or less. When splaying is to be employed, the size of units into which the conduit is to be divided will be shown on the detail plans. The illustration immediately following shows the general construction features entailed in such splaying arrangements. See G40.060 for information as to the spacing of the expanded web units necessary to obtain the desired separation at the manhole.



8.05 The following figure illustrates the manner in which expanded web conduit may be employed to splay the ducts of the main conduit run vertically to enter the cable vault of a central office building. The main conduit run is composed of sections of 9-duct conduit while the run entering the cable vault is composed of 6-duct conduit with the necessary separation between the sections to bring the ducts approximately in line with the cable hooks.

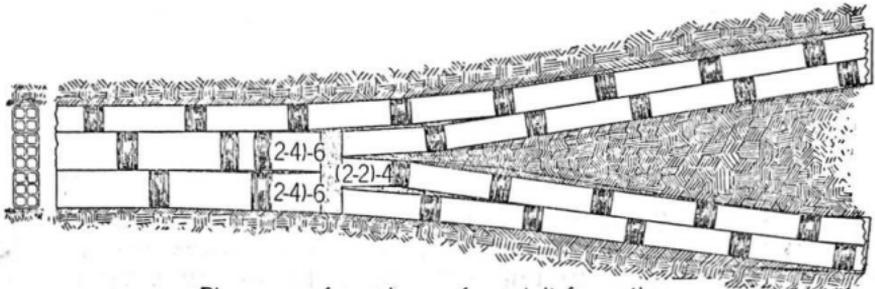
-  Cement mortar
-  Earth fill
-  Concrete
-  Brick piers



Elevation

8.06 The same general method may be used to divide the main conduit run horizontally between the alleys of the cable vault or to divide the ducts entering the alleys so that one-half of them will terminate on each side of an alley in line with the cable racks. In the following example, each layer of the main conduit run is composed of one 4-duct and two 6-duct units, while each layer of the conduit runs entering the two alleys of the cable vault is composed of two 4-duct units. If these ducts were to be brought into the vault in line with the racks, they would again be subdivided so that one 4-duct unit would appear in the vault opposite each line of racks. In no case should conduit terminated in line with the racks exceed 3 ducts in width.

 Cement mortar
 Earth fill



Plan view of one layer of conduit formation

9. LAYING MITERED CLAY CONDUIT

9.01 The use of Mitered Clay Conduit for making vertical and horizontal curves in conduit runs is outlined in G40.060 relating to the types and uses of Clay Conduit.

9.02 The following table indicates the number of mitered and 6 inch straight sections of conduit required to construct 90 degree curves of various radii. See G41.110 for instructions for finding the radius of curvature of the trench.

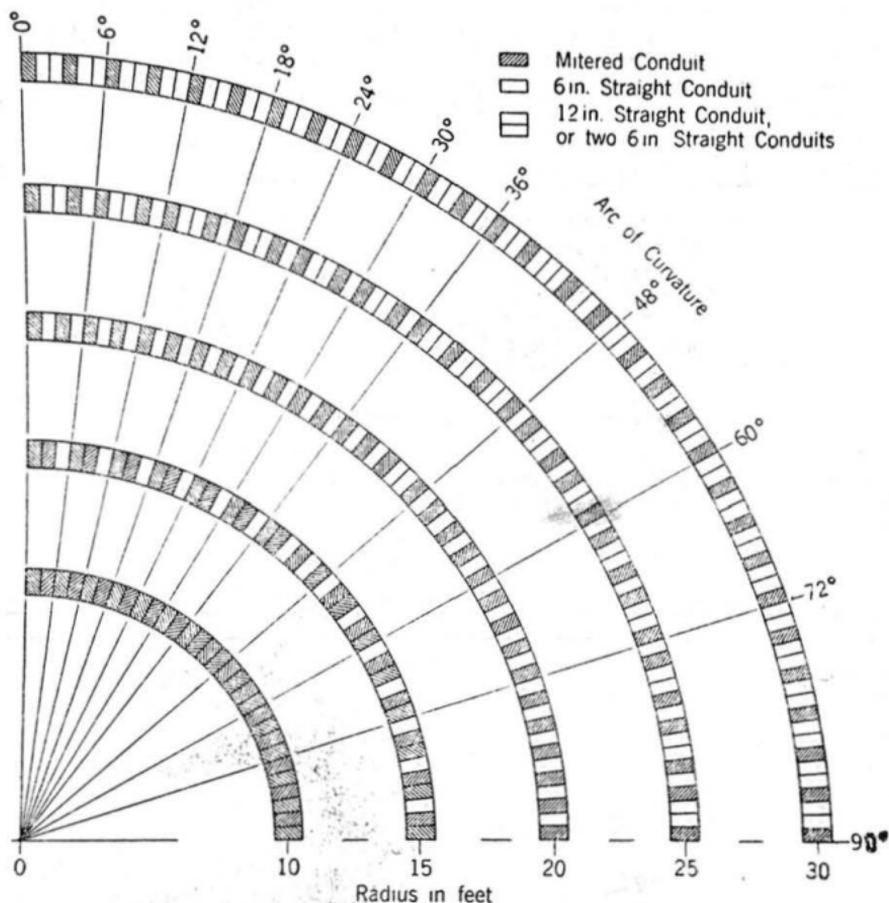
TABLE SHOWING NUMBER OF MITERED AND 6-INCH STRAIGHT SECTIONS REQUIRED TO CONSTRUCT 90° CURVES OF VARIOUS RADII

Nominal Radius (Feet)	Number of 3° Mitered Sections	*Number of 6-inch Straight Sections	Ratio of Mitered to Straight Sections
10	30	None	All Mitered
15	30	15	2:1
20	30	30	1:1
25	30	45	2:3
30	30	60	1:2

*A 12-inch Straight Section may be substituted for two adjacent 6-inch Straight Sections.

9.03 The method of assembling mitered and straight sections of conduit to construct curves with the radii indicated in the above table is shown in the following figure. Mitered conduit should be placed with the marked side (XX) toward the center of the curve.

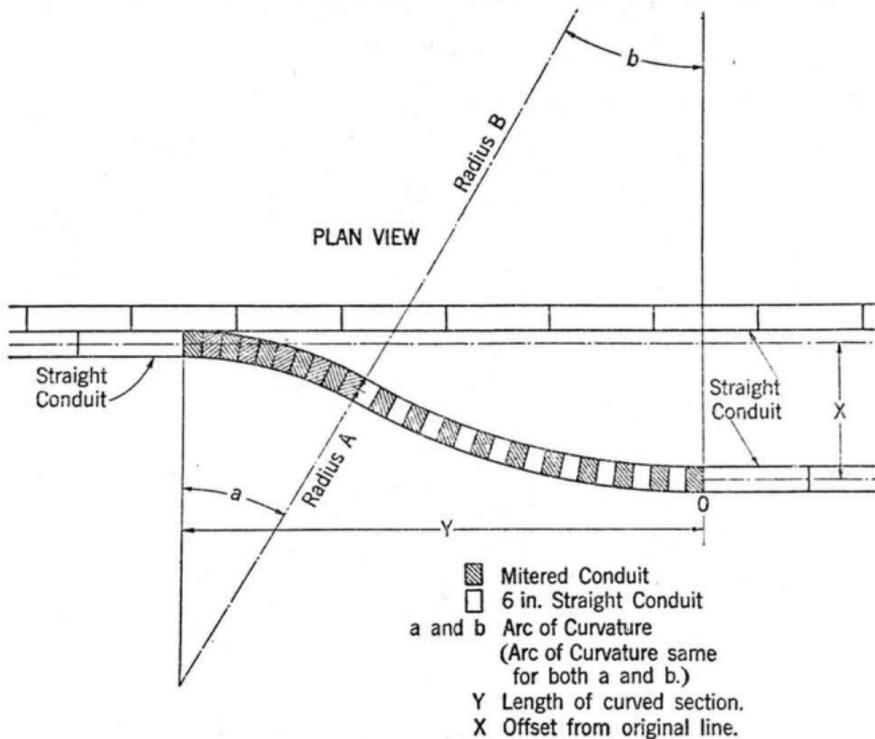
PLAN OF CURVE ASSEMBLIES USING MITERED CONDUIT



9.04 Curves with radii other than those shown in 9.03 can, of course, be constructed with mitered conduit by varying the ratio of the mitered sections to the straight sections and by using straight sections of lengths other than those shown.

9.05 Offsets and reverse curves in a conduit line increase cable pulling tensions and consequently should be avoided wherever practicable. When such construction is unavoidable, however, as in by-passing obstructions or in arrang-

ing for the entrance of reinforcing ducts into an auxiliary or enlarged existing manhole, the following illustration and table, in conjunction with the chart under 9.03, can be used as a guide in constructing the curves so as to produce the minimum resistance to cable placing. In general it is desirable to use curves of equal radii and of the largest radius that sub-surface conditions will permit.



	Radius A = 10 ft. Radius B = 10 ft.	Radius A = 10 ft. Radius B = 15 ft.	Radius A = 10 ft. Radius B = 20 ft.	Radius A = 15 ft. Radius B = 15 ft.	Radius A = 15 ft. Radius B = 20 ft.	Radius A = 20 ft. Radius B = 20 ft.						
Distance X feet	Arc degrees	Distance Y feet	Arc degrees	Distance Y feet	Arc degrees	Distance Y feet	Arc degrees	Distance Y feet	Arc degrees	Distance Y feet	Arc degrees	Distance Y feet
1	18	7	16	7	15	8	15	8	14	9	13	9
1½	22	8	20	9	18	10	18	10	17	11	16	11
2	26	9	23	10	21	11	21	11	19	12	18	13
2½	29	10	26	11	24	12	23	12	22	14	21	14
3	32	11	28	12	26	13	26	13	24	15	22	16
3½	34	12	31	13	28	14	28	14	26	16	24	17
4	37	12	33	14	30	15	30	15	28	16	26	18
4½	39	13	35	15	32	16	32	16	29	17	27	19
5	41	13	37	15	34	17	33	17	31	18	29	20
5½	43	14	39	16	35	18	35	18	32	19	30	21
6	45	15	41	17	37	18	37	18	34	20	32	21

9.06 The following example will illustrate the method of using the chart: Assume that the reverse curve in the plan above is to be constructed with curve A of 10 foot radius and curve B of 20 foot radius to produce an offset of 4 feet, as indicated by the distance "X" between center lines. In order that the conduit at point "O" will lie parallel to its position before offsetting, the insertion of mitered pieces will have to start at a point approximately the distance "Y" ahead of the point "O". Under the column headed by the above radii and in the horizontal row corresponding to distance "X" = 4 feet, the arc will be found to be 30° and the distance "Y" to be 15 feet. Referring to the chart of curve assemblies under 9.03, the combination of conduit units required for 30° arc at 10 foot radius is found to be 10 mitered units and, for 20 foot radius, 10 mitered units alternated with 10 six-inch straight units. Starting at a point approximately 15 feet ahead of "O", therefore, the first part of the curve would be made with the units indicated for 10 foot radius and then, with the position of the mitered units reversed, the pieces required for the 20 foot radius would be placed. When all of the units required for the curve are in place the construction should have reached the point "O." Minor adjustments in the alignment of the units can be made to compensate for any slight differences.

9.07 If the position of the curves used in the example in 9.06 is reversed, i.e., the larger radius is required for curve A and the smaller for curve B, the same procedure is followed in determining the makeup of the curves, except that in laying the combinations of units their relative positions are reversed.

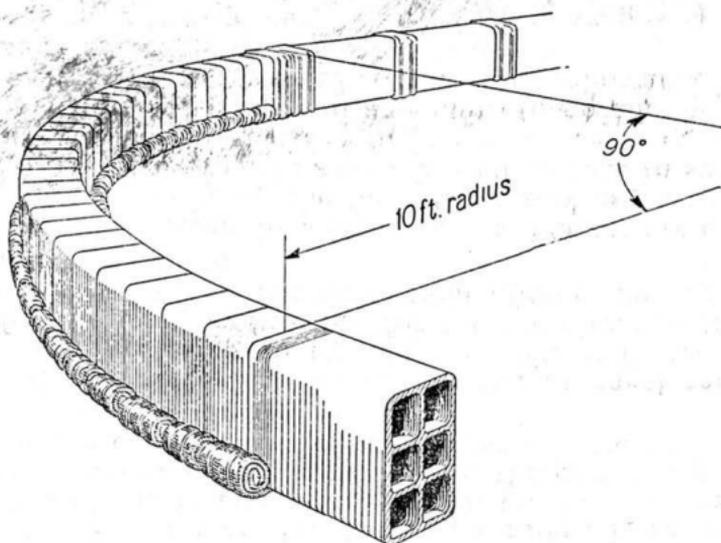
9.08 If the curves can be constructed of equal radii it is only necessary to lay out the units indicated by the chart for the given radius and for the arc obtained from the table and then place an identical combination of units, reversed, to complete the curve.

9.09 It will be found in some instances that the arc of curvature indicated by the table has no exactly corresponding arc in the plan of curve assemblies under 9.03. In such cases take the combination of pieces indicated by the next lower arc of curvature in the chart and add units to obtain the nearest approximation of the desired arc, making allowance for the extra units as follows:

<u>Radius</u>	<u>Each 6 Inch Unit Adds</u>
10 feet	3 degrees
15 feet	2 degrees
20 feet	1-1/2 degrees

If the exact arc cannot be obtained in this way, adjustments, if necessary, can be made by shifting the units slightly.

9.10 Using mortar bandages, lay the conduit as described for straight clay conduit. Concrete encasement is not required unless called for in the detail plans.

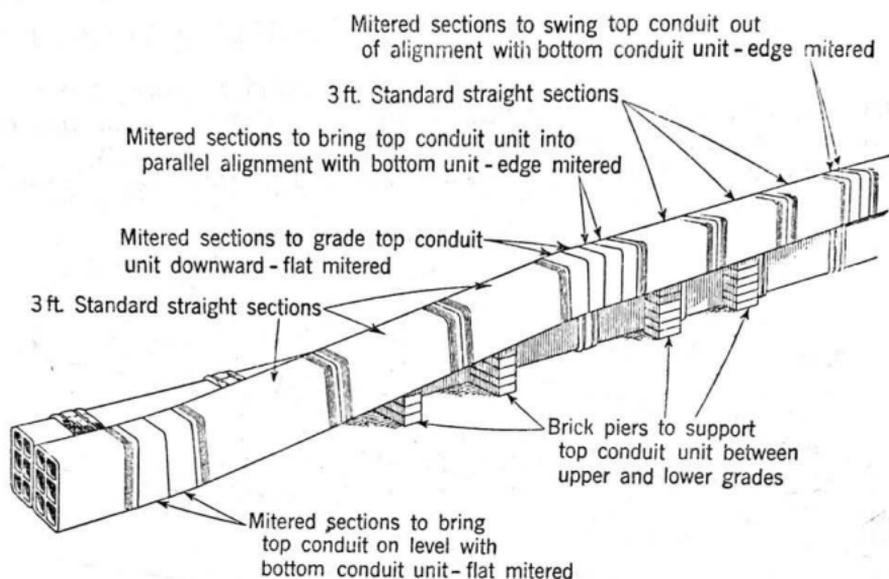


9.11 If mortar bandage joints are not used, the section of the conduit run containing the mitered conduit and two or three feet of the straight sections adjacent to each end of the curve should be completely encased in concrete in order to prevent any of the conduit sections from being forced out of position when cable is installed in the ducts. If the ordinary straight sections of the multiple conduit are to be laid without a concrete base, it will be necessary to provide a 4 inch concrete base in the section in which the curve is to be constructed in order that this portion of the conduit run may be completely encased in concrete.

9.12 Two dowel pins should be used at each joint, and the joints should be covered as described in G41.130 for conduit to be encased. Encase the conduit, as instructed in Part 14 of this section. Reinforcement may be omitted, except where it is required to conform to the base construction of the remainder of the section.

9.13 The following figure illustrates the manner in which mitered conduit may be employed to construct horizontal and vertical curves to change the duct formation so as to avoid obstructions in the trench. A conduit formation of 12

ducts composed of two 6-duct conduits laid with one conduit unit on top of the other has been changed by means of horizontal and vertical curves made with edge mitered and flat mitered conduit so that the two 6-duct conduits are brought into position alongside each other.



9.14 The same general method of constructing horizontal and vertical curves with mitered conduit may be used to divide the main conduit run between the alleys of a central office cable vault or to divide the ducts so that one-half of them will terminate on each side of an alley in line with the cable racks. The same method of providing curves in a conduit run may also be used to bring the ducts into the cable vault or a manhole at a particular level.

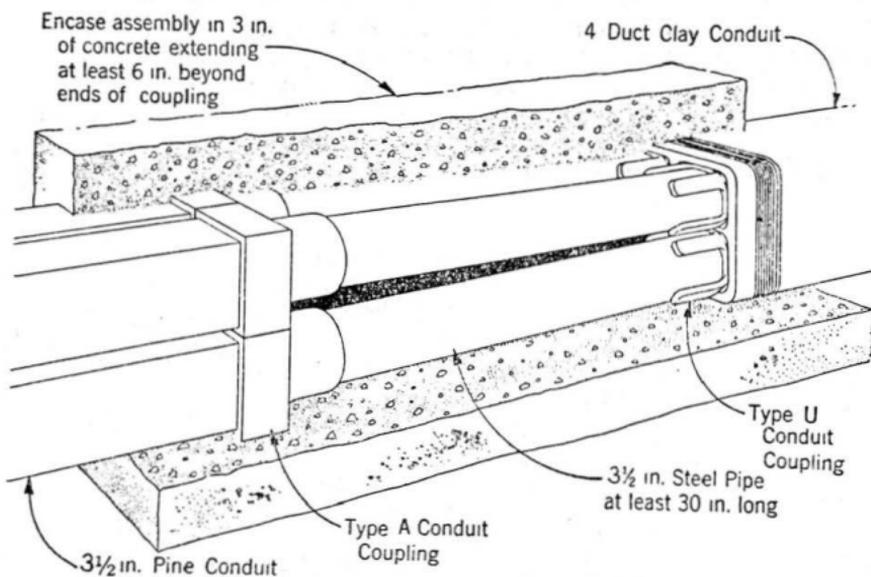
9.15 In some instances, it may be desirable to lay out the curves above ground and make the joints in several adjacent pieces of mitered or mitered and 6 inch straight conduit before placing the conduit in the trench. See 6.10.

9.16 Mitered conduit can be used in the construction of splayed entrances to manholes by using mitered pieces to produce either vertical or horizontal separation between units. In this construction, in contrast with that described in 8.04, employing expanded web conduit, the units are not broken down into smaller sections but the conduit formation is subdivided into its component parts to provide a "unit splay." Its use should

be considered in situations where the number of ducts in the formation exceeds that in which it is practicable to employ "partial splay."

10. CHANGES IN DUCT STRUCTURE

10.01 Where required, conduit couplings can be used to change from Clay Conduit to steel pipe or Pine Conduit. If the change is to be made to Pine Conduit, the connection between the Clay Conduit and the Pine Conduit is made with the aid of short sections of steel pipe, as shown below. Suitable couplings for use in main conduit construction are described in G42.120, "Conduit Fittings."



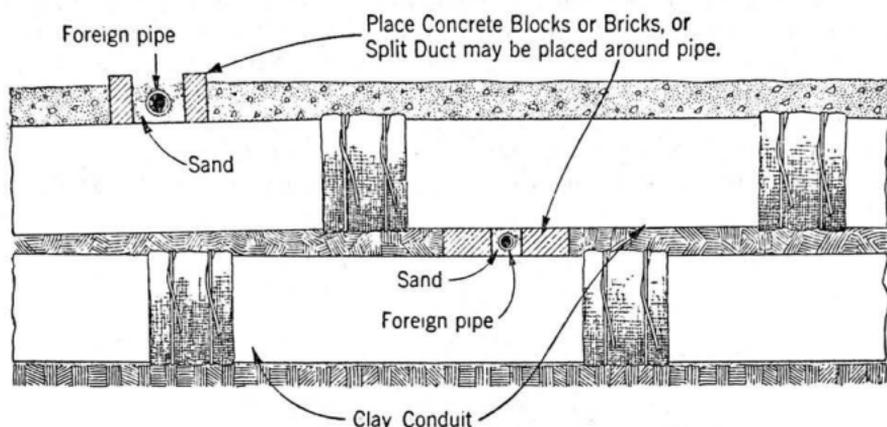
10.02 This method can also be used to change from multiple Clay Conduit to 1-Duct Clay Conduit in lieu of expanded web conduit by substituting 1-Duct Clay Conduit for the Pine Conduit shown.

11. FOREIGN STRUCTURES

11.01 Foreign structures, such as service pipes for gas, water or sewer, which it is not practicable to avoid by deepening the trench as described in the section on trench work, or by changing the duct formation as described in Part 10 of this section, may be cared for as outlined below. Such construction, however, is undesirable because of the possibility of future com-

plications and every effort should be made to clear the service during the initial construction.

11.02 Where it is necessary, foreign pipes crossing the trench may be included in the conduit structure by surrounding the foreign pipes with broken stone or sand or split duct, so as to allow them to be withdrawn without disturbing the conduit structure. In this construction sufficient space must be provided, of course, to clear the largest diameter of the pipe, such as the bell of sewer pipe.



12. PLUGGING AND TERMINATING DUCTS

12.01 Ducts should be plugged tightly with wooden conduit plugs or approved equivalent at the close of each day's work or whenever work is to be discontinued for any length of time, so as to prevent the entrance of mud and silt into the ducts. If untreated plugs are used, they should be soaked in water and covered with cheese-cloth so as to avoid damage to the conduit due to subsequent swelling.

12.02 Conduit which is dead-ended short of a terminating point with the intention of later extension should be plugged with treated wooden Conduit Plugs faced with cement mortar. The end units should be 6 inch sections so as to minimize material loss if the conduit is broken in removing the plugs.

12.03 In ending ducts at manholes and buildings, use only full length sections of conduit to minimize the possibility of disturbance due to subsequent settlement of the fill adjacent to the structure. Insert the short lengths necessary for adjustment further out in the section. Select for the terminating

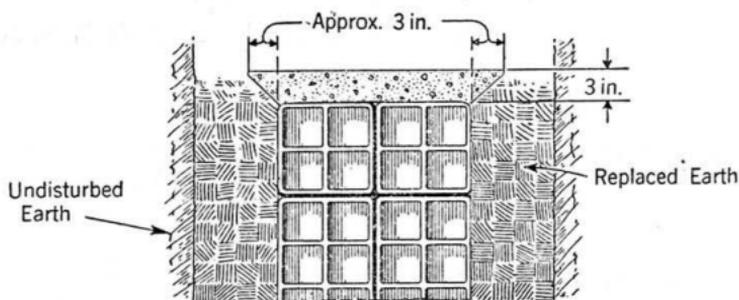
pieces units which are free from deep cracks in the ends of the walls or webs. This is to facilitate sealing in the event it is later desired to plug the ducts.

12.04 Ducts terminated in buildings should be sealed in accordance with the instructions of G55.150, "Underground Cable—Sealing Ducts."

13. PLACING TOP PROTECTION

13.01 When concrete top protection is required, follow the instructions of G45.150 in mixing and placing the concrete. Use the Class 2A concrete recommended in G45.140 for top protection unless other proportions are specified by the supervisor.

13.02 Concrete top protection should be placed to a depth of 3 inches and should overhang the sides of the conduit by about 3 inches. The top of the conduit should be cleaned to provide a bonding surface for the concrete.



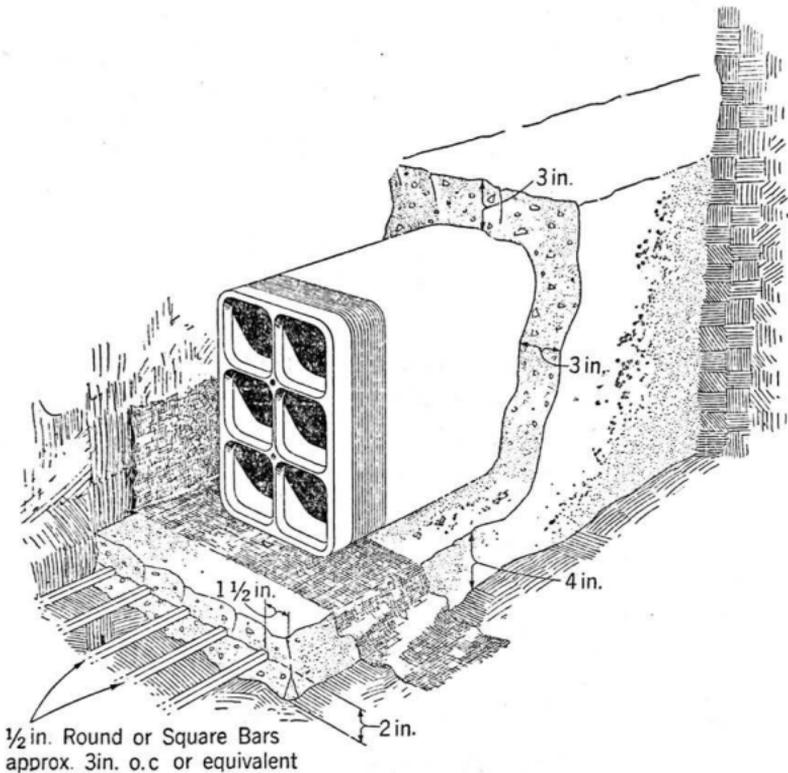
13.03 If creosoted Plank is used for the top protection use the proper combination of 4-1/2, 9 or 13 inch width planks necessary to cover the top of the conduit. Before placing the plank over Clay Conduit, spread a thin layer of earth over the duct for the plank to rest on. This is to distribute the load evenly over the conduit rather than have it concentrated on the joints. Butt the ends of successive lengths of plank together closely to obtain maximum protection.

13.04 When subsidiary ducts are to be placed in the trench with the main conduit, lay the subsidiary ducts above the main conduit and place top protection, if required, as instructed in G42.110, "Subsidiary Conduit-Laying."

14. CONCRETE ENCASEMENT

14.01 The need for conduit encasement other than that called for in these instructions will be indicated on the detail plans. The dimensions of the base, sides and top and the size

and spacing of the reinforcement for any formation are the same as for the 6-duct installation illustrated. Additional reinforcing bars on the same spacing should, of course, be placed as the width of the conduit formation increases. Follow the instructions of G45.150 in mixing and placing the concrete. Use the Class 2A concrete described in G45.140 for the entire encasement.



14.02 In preparing to encase conduit lay the base concrete and reinforcement in accordance with 14.01. Lay the conduit and join it in the manner described in G41.130 for conduit to be encased. Exercise care to avoid brushing soil from the sides of the trench onto the concrete base as soil falling on the base will increase the difficulty of obtaining a good joint with the sides of the encasement.

14.03 Placing the side and top concrete should follow as soon as the conduit formation has been brought up to level. Brush all loosely adhering material from the base and paint the concrete with a grout of cement and water mixed to the consistency of thick paint. Complete the placing of the sides and top in one operation.