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BELL SYSTEM PRACTICES
Outside Plant Construction and Maintenance

SECTION G71.135
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AT&T Co Standard

CABLE TERMINATING
CONSTRUCTION OF CABLE FORMS

Contents **Page**

1. GENERAL

1.01 This section describes methods of fanning, forming and sewing cable forms used to terminate quadded and non-quadded strip paper and pulp insulated lead-covered cables. It also covers the requirements for non-quadded cable forms; the requirements for quadded cable forms are described in Section G71.138.

1.02 Cable forms made of textile-insulated lead-covered cable with or without enameled conductors should generally be employed to terminate paper and pulp-insulated lead-covered cables in central offices and in subscriber buildings where the form method of termination is to be employed.

1.03 A cable form usually consists of a length of textile-insulated lead-covered cable, one end of which has a portion of the sheath removed and the exposed conductors sewn together with wires brought out at regular intervals along all or part of the unsheathed portion. The wires brought out of the form between stitches are called skinners.

1.04 The cable forms for terminating exchange cables are generally made of 22-gauge textile-insulated cable. However, 24-gauge textile may be used to terminate strip paper-insulated or pulp-insulated cables which are entirely underground; also, exposed cables which are adequately protected by fuses. The cable forms for terminating quadded paper-insulated cable should be made of 19-gauge quadded textile-insulated cable.

2. MATERIALS

2.01 The names of the materials required in constructing cable forms are given below:

Cable, (Code), (No. of Pairs) Order should indicate the number of feet of cable desired.

Cable, (CA-602 or CA-603), (No. of Quads) Order should indicate the number of feet of cable desired.

Solvent, Shellac (Available in 1-quart bottles) For thinning orange shellac.

Thread, Cotton, Waxed (6-ply or 12-ply) (Available in 1/4-pound and 1/2-pound tubes) For lashing forms to main frame.

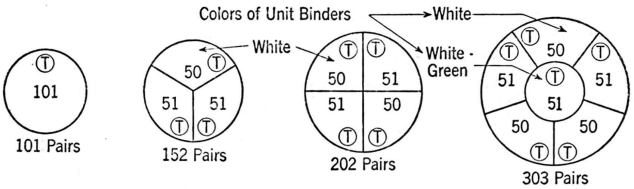
Varnish, Shellac, Orange (Available in 1-pint and 1-quart bottles) For painting forms and skinners.

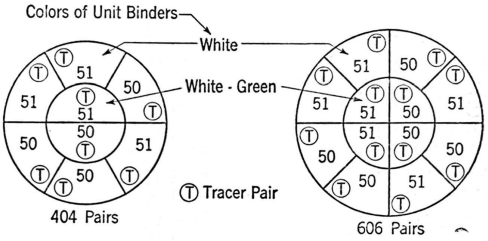
Wax, Impregnating, KS-8104 (Available in 1-pound cakes) For impregnating forms.

3. CABLE FOR FORMS

3.01 **Non-Color-Code Cable (Types AFA and NFA):** The conductors in these cables are 22-gauge annealed copper. The wires in AFA cable are tinned and those in NFA cable are tinned and enameled. All pairs, except tracer pairs, have white textile insulation on one wire and red-white textile insulation on the other. The insulation on some of the wires may contain a black thread which is provided for manufacturing reasons only. Cables of these types are made containing 101, 152, 202, 303, 404 and 606 pairs. The tracer pair in 101-pair cable and in 51-pair units has white insulation on one wire and blue insulation on the other. The tracer pair in 50-pair units has white insulation on one wire and brown on the other. The arrangement of the units, number of pairs in each unit, number of tracer pairs, and the colors of the binding strings around each unit are shown in the following sketch. Type AFA cable is generally used for terminating cables containing 101 pairs or more in central offices and other buildings. Type NFA cable is intended for use where a higher degree of insulation resistance is required than can be obtained with non-enameled conductors.

ARRANGEMENT OF UNITS, COLORS OF INSULATION
AND BINDING STRINGS
TYPE AFA AND NFA CABLES





Note: Each unit in the outer layer has a white binder
Each unit in the center has a white - green binder.
All pairs, except tracer pairs, have white insulation on one wire and red - white on the other.

3.02 **Color-Code-Cable (Types AGA and NGA):** The conductors of these cables are 22-gauge annealed copper. The conductors in AGA cable are tinned and those in NGA cable are tinned and enameled. The conductors are textile insulated and are so colored that each pair may be distinguished from all other pairs in the cable. The color code is given in Paragraph 3.04. With this arrangement, testing to identify pairs in the form is unnecessary. Cables of these types are made in various sizes from 6 to 202 pairs, inclusive. Type AGA cable is intended for general use in terminating lead-covered paper-insulated cable in buildings. It should also be used in central offices where cables smaller than 101 pairs are required. NGA cable is intended for use where a higher degree of insulation resistance is required than can be obtained with non-enameled conductors. Forms made of these cables should be formed and terminated in accordance with the color code unless otherwise specified.

3.03 **Color-Code-Cable (Types BUA and OUA):** These cables are similar in construction to types AGA and NGA cables except that the insulation is treated with cellu-

lose acetate lacquer. BUA cable is available in various sizes from 6 to 101 pairs, inclusive, and OUA cable in various sizes from 6 to 51 pairs, inclusive. The use of these types of cables is advantageous in that they may be installed by workmen who are not equipped with facilities necessary for boiling out. They may also be used by splicers where fumes that would be liberated by boiling-out compounds might be objectionable to owners or tenants of buildings or where local ordinances do not permit the use of open flames in buildings. Forms made of cables of these types should be formed in accordance with the color code unless otherwise specified.

3.04 **Color-Codes of Types AGA, NGA, BUA and OUA Cables:** The color codes of these cables are indicated in the following tables.

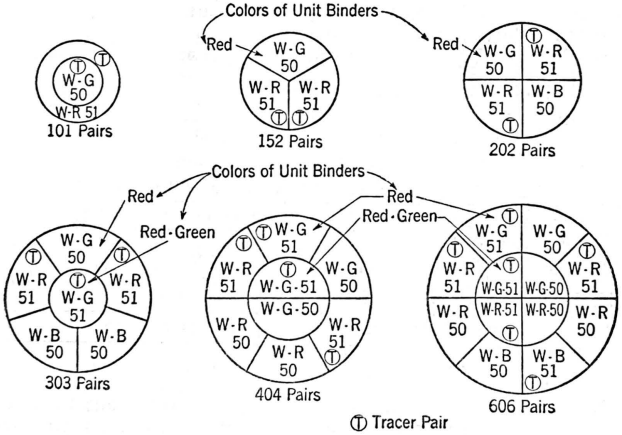
Pair Number	Tip Wire	Ring Wire
1	White	Blue
2	White	Orange
3	White	Green
4	White	Brown
5	White	Slate
6	White	Blue-White
7	White	Blue-Orange
8	White	Blue-Green
9	White	Blue-Brown
10	White	Blue-Slate
11	White	Orange-White
12	White	Orange-Green
13	White	Orange-Brown
14	White	Orange-Slate
15	White	Green-White
16	White	Green-Brown
17	White	Green-Slate
18	White	Brown-White
19	White	Brown-Slate
20	White	Slate-White
21-40	Red	First 20 colors repeated
41-60	Black	First 20 colors repeated
61-80	Red-White	First 20 colors repeated
81-100	Black-White	First 20 colors repeated
101-120	Red-Black	First 20 colors repeated
121-140	Black-Orange	First 20 colors repeated
141-160	Black-Green	First 20 colors repeated
161-180	Black-Brown	First 20 colors repeated
181-200	Black-Slate	First 20 colors repeated

201*	White	Red
202*	White	Black

*Note: In cables from 6 to 101 pairs, the highest numbered pair has the same colors of insulation as that shown for pair designated as 201. In the 152 pair cable, pairs 151 and 152 have colors of insulation corresponding to pairs 201 and 202, respectively.

3.05 **Non-Color-Code Cable (24-gauge—CA-744):** The conductors of Drawing CA-744 cable are 24-gauge tinned annealed copper. The size of the cables, arrangement of the unit, the number of pairs in the units, the colors of insulation, the number and location of tracer pairs and the colors of the binding strings around the individual units are shown in the following sketch. The letters in the units indicate the predominant colors of the insulation as follows: W-G for White-Green, W-R for White-Red and W-B for White-Blue.

ARRANGEMENT OF UNITS. COLORS OF INSULATION AND BINDING STRINGS
24-gauge Cable per Drawing CA-744



Note: Each unit in the outer layer has a red binder.
Each unit in the center has a red - green binder.
W - G = White - Green
W - R = White - Red
W - B = White - Blue

4. CABLE FOR TERMINATING QUADDED CONDUCTORS

4.01 Quadded textile cable should be used to terminate quadded paper insulated cable. The conductors of these cables are made of 19-gauge wire. Adjacent quads in each layer of the cable are distinctively colored, the four wires of each quad having one of the color combinations shown in the following table.

Color code of quadded lead-covered textile-insulated cable				
Type of quad	First pair		Second pair	
	Wire	Mate	Wire	Mate
1	Blue	Blue - White	Orange	Orange - White
2	Green	Green - Red	Brown	Brown - Red
3	Blue - Green	Blue - Green - White	Blue - Brown	Blue - Brown - White
4	Blue - Slate	Blue - Slate - Red	Orange - Green	Orange - Green - Red
5	Slate	Slate - Black	Blue - Orange	Blue - Orange - Black

4.02 Quadded textile cables contain 7, 12, 19, 27, 37, 52, 75, 108 or 154 quads and the conductors are either tinned or tinned and enameled. Cables with tinned conductors should be ordered under Drawing CA-602 and those with tinned and enameled conductors under Drawing CA-603.

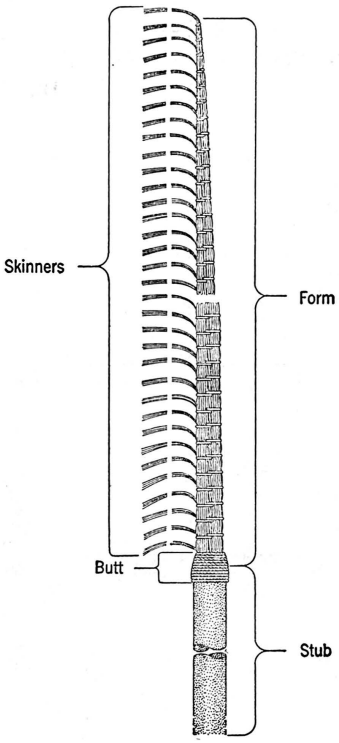
5. FORMS FOR QUADDED COMPOSITE CABLE

5.01 Quadded and non-quadded conductors should generally be terminated in separate forms. In those cases where the cable contains only a small number of non-quadded conductors, it may be advisable to use textile cable of the quadded type to terminate all the conductors.

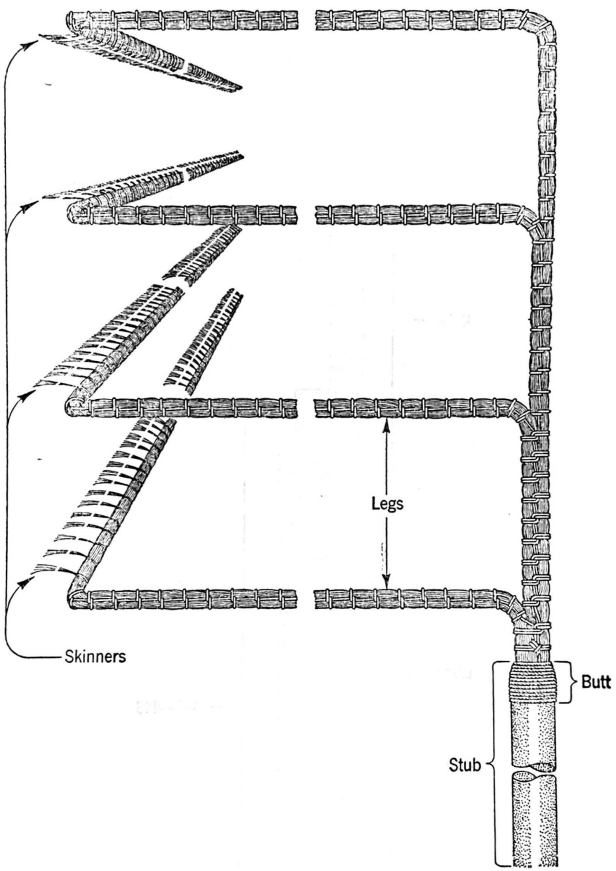
6. TYPES OF CABLE FORMS

6.01 Cable forms for terminating paper insulated cables on frames are of either the single-leg or multi-leg type. Single-leg cable forms are generally used on "B" type and double-sided protector frames and multi-leg forms on "A" type frames. A single-leg cable form is illustrated on Page 7 and a multi-leg cable form on Page 8.

SINGLE LEG CABLE FORM



MULT-LEG CABLE FORM



7. PREPARATION

7.01 Because of the better facilities afforded, it is generally preferable to have cable forms made in an established shop rather than to make them at the location where they are to be installed. The room in which cable forms are to be made should be reasonably dry and should have a fairly

uniform temperature; otherwise the cable forms may accumulate excessive moisture. Facilities for heating the impregnating wax should be available and also arrangements for boiling out and draining the forms. A board or table should be provided for fanning and sewing the form. A megger should be available for testing the insulation of the completed cable form.

7.02 A forming board may be prepared by driving a straight row of No. 6 two-inch or No. 8 two and one-half inch finishing nails in a board on centers the same distance apart as the lugs on the terminating strip or block to which the form is to be connected. The nails should be driven about 3/4-inch into the board.

8. SINGLE-LEG CABLE FORMS

8.01 Where only a single-leg cable form is to be made, or where a number of forms are to be made of color-code cable, the total length of cable used will include the length needed for the stub plus that required for the form. The length of cable required for the formed end where the verticals are equipped with protector blocks on 3/8-inch or 1/2-inch centers and also for verticals equipped with No. 444 type jacks is given in the following table.

Size of Cable (Pairs)	Length of Cable Required for Formed End		
	Vertical Equipped with Protector Blocks		Vertical Equipped with No. 444 Type Jacks
	3/8 in Spacing of Terminal Lugs	1/2 in Spacing of Terminal Lugs	
51	2 ft. 4 in.	2 ft. 10 in.	
101	3 ft. 10 in.	5 ft. 0 in.	2 ft. 4 in.
152	5 ft. 6 in.	7 ft. 0 in.	
202	7 ft. 0 in.	9 ft. 0 in.	3 ft. 10 in.
303	10 ft. 2 in.	13 ft. 2 in.	5 ft. 6 in.
404	13 ft. 4 in.	17 ft. 4 in.	7 ft. 0 in.
606			10 ft. 2 in.

8.02 Where a number of similar cable forms are to be made of non-color-code cable, it is possible to effect an appreciable saving in the cable by making two forms from one piece of cable. In this case, the length of cable required will be the sum of the length of cable needed for the combined formed ends, shown in the table below, plus the length of cable required for the two stubs.

Size of Cable (Pairs)	Length of Cable Required for Formed End		
	Vertical Equipped with Protector Blocks		Vertical Equipped with No. 444 Type Jacks
	3/8 in Spacing of Terminal Lugs	1/2 in Spacing of Terminal Lugs	
101	6 ft. 1 in.	7 ft. 7 in.	3 ft. 7 in.
152	7 ft. 8 in.	9 ft. 5 in.	
202	9 ft. 3 in.	11 ft. 9 in.	5 ft. 2 in.
303	12 ft. 5 in.	15 ft. 11 in.	7 ft. 0 in.
404	15 ft. 7 in.	20 ft. 0 in.	8 ft. 8 in.
606			12 ft. 9 in.

8.03 The order in which the conductors should be cut in making two forms from one length of cable, the method of measuring and the number of pairs to be cut at each point can be determined from the following table. In cutting the conductors select those pairs which will give a neat lay-up in each cable form.

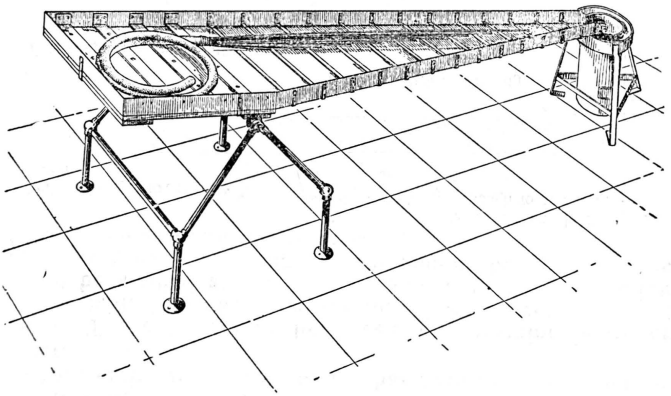
Cut Number	Distance from sheath and number of Pairs for each cut														
	Vertical with 3/8 in. term. lug spacing					Vertical with 1/2 in. term. lug spacing					Vertical with No. 444 type jacks				
	Size of Cable					Size of Cable					Size of Cable				
	101 pr.	152 pr.	202 pr.	303 pr.	404 pr.	101 pr.	152 pr.	202 pr.	303 pr.	404 pr.	101 pr.	202 pr.	303 pr.	404 pr.	606 pr.
1	27 in. 50 prs.	27 in. 50 prs.	27 in. 50 prs.	27 in. 50 prs.	27 in. 50 prs.	33 in. 50 prs.	33 in. 50 prs.	33 in. 50 prs.	33 in. 50 prs.	33 in. 50 prs.	17 in. 50 prs.	17 in. 50 prs.	17 in. 50 prs.	17 in. 50 prs.	17 in. 50 prs.
2	46 in. 51 prs.	46 in. 51 prs.	46 in. 51 prs.	46 in. 51 prs.	46 in. 51 prs.	58 in. 51 prs.	58 in. 51 prs.	58 in. 51 prs.	58 in. 51 prs.	58 in. 51 prs.	26 in. 51 prs.	27 in. 51 prs.	27 in. 51 prs.	27 in. 51 prs.	27 in. 51 prs.
3		65 in. 51 prs.	65 in. 50 prs.	65 in. 50 prs.	65 in. 50 prs.		83 in. 51 prs.	83 in. 50 prs.	83 in. 50 prs.	83 in. 50 prs.		37 in. 50 prs.	37 in. 50 prs.	37 in. 50 prs.	37 in. 50 prs.
4			84 in. 51 prs.	84 in. 51 prs.	84 in. 51 prs.			108 in. 51 prs.	108 in. 51 prs.	108 in. 51 prs.		47 in. 51 prs.	47 in. 51 prs.	47 in. 51 prs.	47 in. 51 prs.
5				102 in. 50 prs.	102 in. 50 prs.				133 in. 50 prs.	133 in. 50 prs.			57 in. 50 prs.	57 in. 50 prs.	57 in. 50 prs.
6				123 in. 51 prs.	123 in. 51 prs.				158 in. 51 prs.	158 in. 51 prs.			67 in. 51 prs.	67 in. 51 prs.	67 in. 51 prs.
7					142 in. 50 prs.					183 in. 50 prs.				77 in. 50 prs.	77 in. 50 prs.
8					163 in. 51 prs.					208 in. 51 prs.				87 in. 51 prs.	87 in. 51 prs.
9															97 in. 50 prs.
10															107 in. 51 prs.
11															117 in. 50 prs.
12															127 in. 51 prs.

8.04 To remove the sheath, cut a nick around the surface of the cable at the point designated (care should be exercised so as not to cut through the sheath); then bend the cable back and forth until the sheath parts. In removing long lengths of sheath or where the sheath cannot be pulled as in making two forms from one length of cable, split the sheath throughout the length that is to be removed. Avoid damaging the insulation of the conductors in cutting or splitting the sheath.

8.05 After the sheath is removed, make a temporary tie at the end of the sheath to hold about 1/2-inch of the core wrapping paper in place until the conductors are boiled and the butt is served. Dress the cut end of the sheath and remove the core wrapping paper to the temporary tie. Place temporary ties around the conductors at intervals of about 3 feet to hold them together.

8.06 It is unnecessary to boil out cable having insulation treated with cellulose acetate lacquer, unless it is to be used in place of AFA cable on main frames. The boiling should be done with impregnating wax heated to a temperature of approximately 375° F., except where it is necessary to do the work in rooms containing central office equipment or other terminal apparatus. When boiling out in apparatus rooms cannot be avoided, heat the wax to a temperature not greater than 285° F. This temperature should be used regardless of whether the forms are boiled out by pouring the wax over the wires or by immersing the wires in a pot.

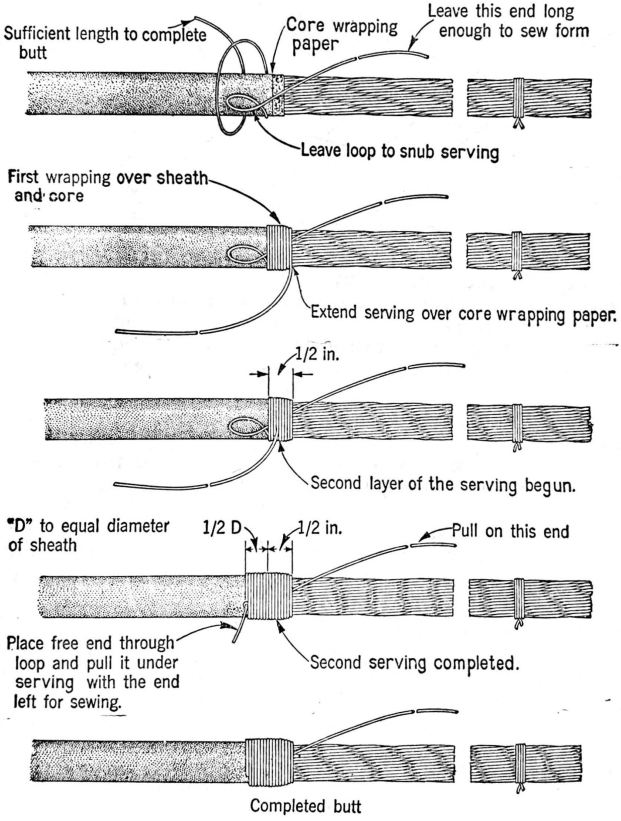
8.07 The cable should preferably be spread in a trough for boiling, when one is available. A dipper should be used to pour the hot wax over the wires. The trough should be arranged to permit surplus wax to drain. When such facilities are not available, the boiling out may be done by immersing the wires in a pot of hot wax.



8.08 In pouring wax, start at a point about 6 inches back on the sheath and continue along to the end of the wires until the insulation on all wires is thoroughly saturated with wax and any moisture which may have been absorbed by

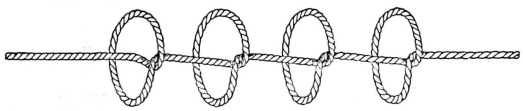
the insulation is thoroughly removed. This is indicated by the stopping of the bubbling or frying sound as the wax is applied. After boiling out, allow the surplus wax to drain. Shake the wires to aid in draining. When an open flame is used to heat the wax, never boil out the wires until the flame has been extinguished and the pot has been removed from the heater.

8.09 The cable should be placed on a forming board or table for sewing. A serving of waxed cotton thread should be applied at the butt, as shown in the illustration below. Any core wrapping paper extending beyond the edge of the serving should be removed.

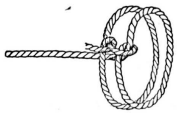


8.10 In preparation for forming, the stub should be clamped securely to the forming board or table so that the desired distance is obtained between the butt of the cable and the point where the first pair is to be brought out of the form. The conductors should be fanned in such a manner that each pair of wires lies straight and taut from the butt to the point where it leaves the form. Avoid untwisting the wires of pairs.

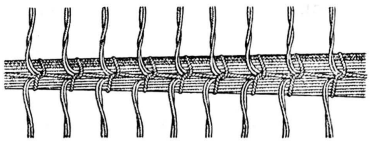
8.11 Sew forms containing 51 pairs or less with 6 or 12-ply waxed cotton thread, those with 51 to 303 pairs with 12-ply waxed cotton thread and all forms containing more than 303 pairs with two strands of 12-ply thread. A cable dresser may be used to shape the form as it is being sewed. Any dressing required should be done carefully to avoid damaging the insulation of the conductors. Where exchange cable forms are to be installed on frames equipped with 3/8-inch protector blocks, the stitches, beginning at the butt, should be spaced 1-1/8 inches apart (three pairs will thus be brought out between stitches). Where exchange cable forms are to be installed on frames equipped with 1/2-inch protector blocks the stitches should be spaced 1 inch apart (this will result in two pairs being brought out between stitches). On forms for quadded cables, the stitches should be made 3/4 inch apart for 3/8-inch protector blocks and for 1/2-inch protector blocks the stitches should be spaced 1 inch apart. (This will result in one quad being brought out at each stitch.) When the form is to be connected to No. 444 type jacks, two pairs should be brought out at each stitch and the stitches should be placed 3/8 inch apart. The method of sewing forms is illustrated below. In sewing, all twists and crossings in the wires should be straightened and each stitch pulled tightly enough to obtain a compact form. Avoid jerking when drawing the thread tight, as this is likely to break it. (T)



8.12 The end of the thread should be secured by a double stitch (two half hitches). The second half hitch should be made over the first half hitch, as shown below.



8.13 The figure below illustrates the construction of a form for a building terminal where skinners are brought out on both sides of the form.



8.14 When additional thread is required to complete the sewing operation, lay the new thread in the form when approximately 2 feet of the first thread remains. Make approximately four stitches with the first thread and then lay the remainder in that part of the form which has not been sewed and proceed to use the second thread.

8.15 After forms have been sewed, boil those which are to be installed on main frames, as well as any that have untreated insulation regardless of where they are installed, so as to remove any moisture that may have been absorbed by the insulation in handling the wires during forming and sewing.

8.16 The form should be tested for insulation resistance after it has cooled. The megger should be used to make the test, as described in the splicing practices. An infinity reading should be obtained between each wire and the sheath with all other wires in the form grounded to the sheath. Forms on which the insulation resistance is low should be reboiled and retested.

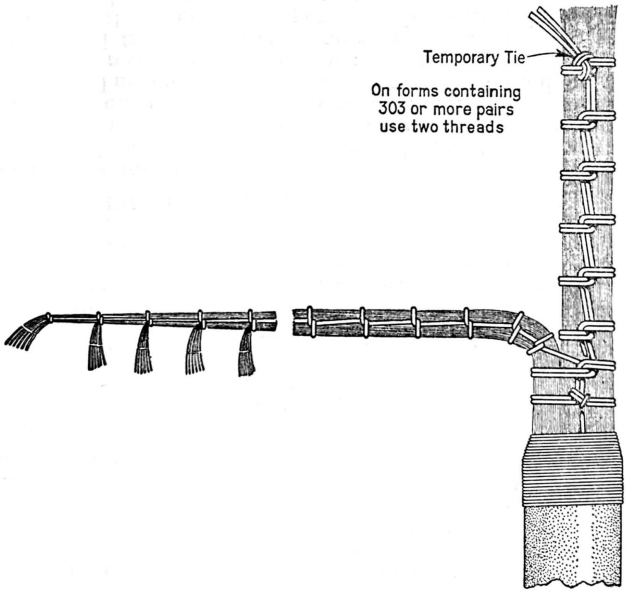
9. MULTI-LEG CABLE FORMS

9.01 The amount of cable required for a multi-leg cable form will be the sum of the length of sheath needed for the stub, the length of wire necessary to reach the farthest termination plus eight inches for testing and terminating. Where a number of similar forms are to be made, two forms may be made from one piece of cable to effect a saving in cable required.

9.02 The method of removing the sheath, boiling the conductors and sewing the butt should be in accordance with that outlined for single leg cable forms.

9.03 In preparation for forming, the stub should be clamped securely to the forming board or table with the butt the required distance from the first leg. The conductors comprising the first leg of the form should be fanned in such a manner that each pair of wires lies straight and taut from the bend. The conductors may be brought out of the form as outlined for single-leg forms, i. e., the pairs brought out the same distance apart as the lugs on the terminating strip. Where forms are made on the job the work can be facilitated by taking out 10 or 20 pairs at suitable intervals.

9.04 Parts of the form containing more than 303 pairs should be sewed with 2 strands of 12-ply waxed cotton thread and those containing 303 or less pairs with a single strand of 12-ply thread. A cable dresser may be used to shape the conductors as the form is being sewed. The stitches should be made approximately 1 inch apart. The method of sewing is illustrated below.



9.05 When an additional thread is required for sewing a branch, its end should be laid in with the wires of the main form before the latter is sewed. In this way the second thread will be held securely without tying it to the first thread, thus eliminating knots and improving the appearance of the form. A completed multi-leg cable form is illustrated on Page 8.

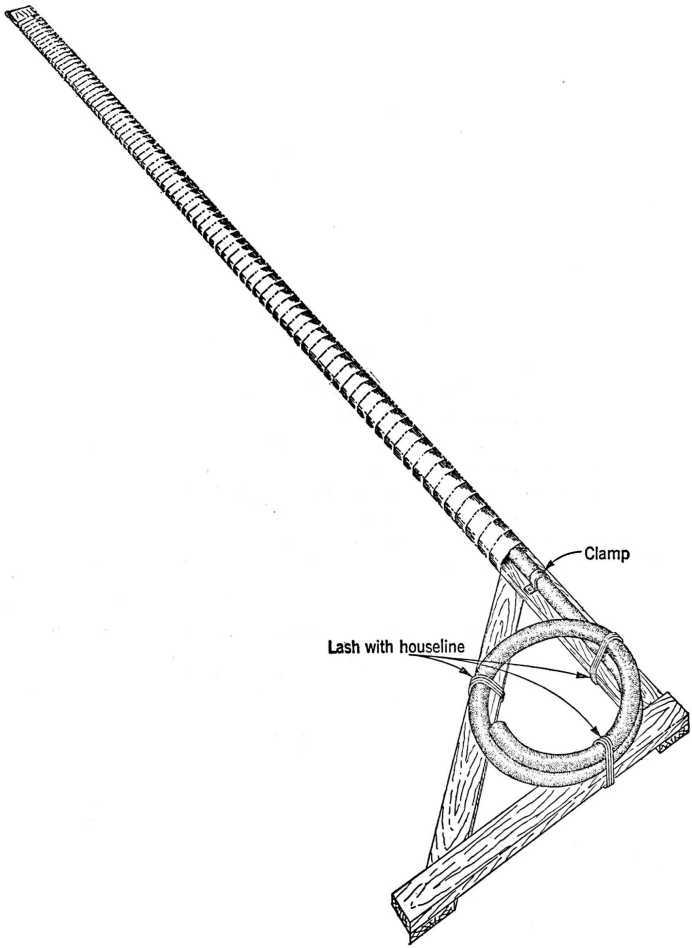
9.06 The method of boiling and testing the completed form is similar to that given under the method of making single-leg cable forms.

10. SHELLACKING FORMS

10.01 Forms which are not lacquer treated should be coated with orange shellac, as shellac improves the insulation characteristics of the form. Avoid soaking the form in applying the shellac.

11. SHIPMENT OF FORMS

11.01 The forms should be securely fastened by means of a clamp and houseline to boards about 7/8-inch thick and from 3 to 6 inches wide. The length of the main board should be sufficient to afford proper support for the end of the form. The end of the sheathed portion should be protected from moisture by sealing with solder or by wrapping it with several layers of friction tape. It is desirable to wrap the form with waterproof paper or boiled muslin in order to keep it dry during shipment. The figure below shows a form ready for shipment.



CABLE TERMINATING
CONSTRUCTION OF
CABLE FORMS