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Waxed Linen Twine

Use for lacing in electrical and electronic applications as well as for wrapping and tying. This twisted twine consists of multiple-ply 100% pure linen threads treated with a wax compound to resist mildew. Meets MIL-T-713, Type N. Color is off-white.

Warning! Never exceed breaking strengths; never use to lift people or items over people.

| Twine Dia. | Trade Size | Breaking Strength, lbs. | Length, ft. | | Each |
|---------------|---------------|----------------------------|----------------|-------------------------|---------|
| 0.040" | 6 | 32 | 450 | 3858T13 | \$18.58 |
| 0.046" | 8 | 48 | 330 | 3858T12 | 18.58 |
| 0.056" | 12 | 70 | 225 | 3858T11 | 18.58 |

Waxed Linen Twine

Wiring and Cabling

From OP 2230, "Workmanship and Design Practices for Electronic Equipment", published by the direction of the chief of the *Bureau of Naval Weapons*, 1 December, 1962. pp. 7-9 --- 7-14.

Scanned by [Gary Allsebrook](#).

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How To Lace Cable Harnesses

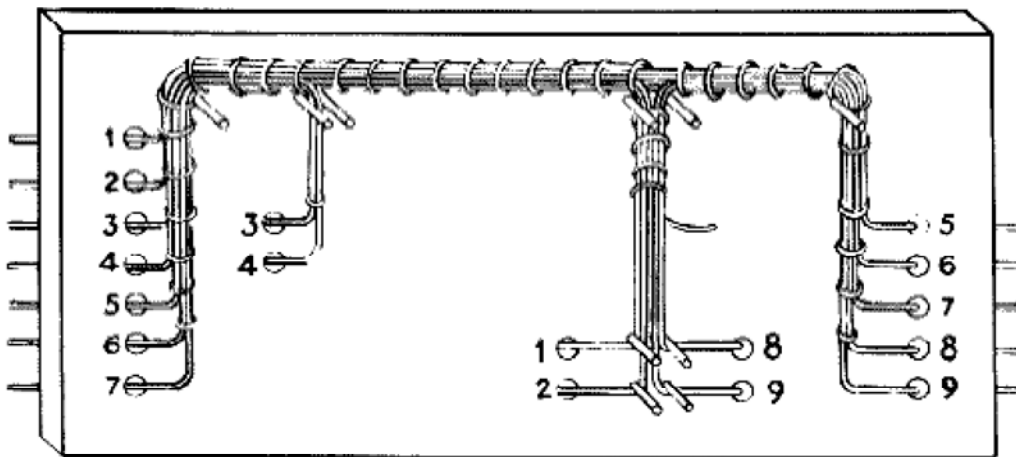
Harnesses should be located so that circuit tracing can be readily accomplished, and accessibility to parts or components which may require replacement is not limited.

Individual wires of a harness should be arranged to run parallel or at right angles to each other wherever possible. Sharp bends which may damage conductors or insulation are to be avoided.

Harnesses are usually fabricated on a *harness jig* or *forming board*. The board may be marked with numbers and symbols to indicate wire sizes, color coding, routing, terminations, and wiring sequence. Pegs or nails, placed in a pattern which follows a pictorial wiring diagram, serve to locate wire runs.

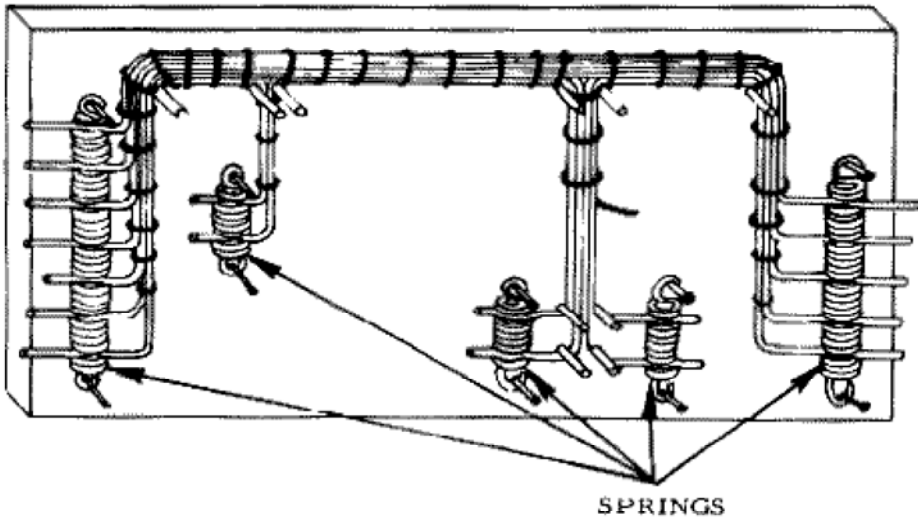
Conductor ends may be anchored to the board by wrapping them about nails or pegs, or may be fanned out for easier dressing if holes to accommodate wire ends are provided.

A typical application for a forming board is shown below.



Harness Forming Board

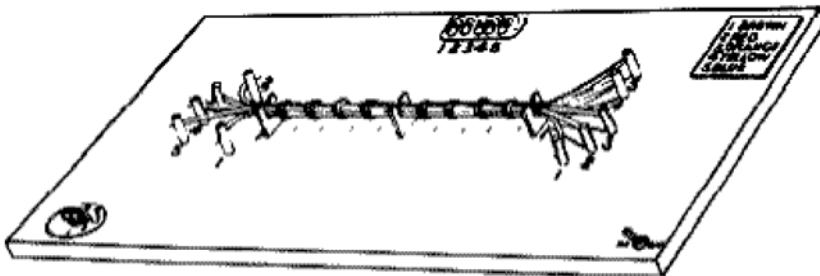
Another method of anchoring conductor ends on a harness jig is to attach springs on the board near the termination point of the wire. The pitch of the spring should be determined by the size of the wires to be held in place. The wire may be pushed into the spring, where it will be held firmly. This method is rapid and minimizes drilling of holes and placing of pegs or nails in the board. Harness jigs may thus be reused many times. A typical application of a forming board utilizing springs is shown below.



Harness Forming Board with Springs

Harnesses may be laid out on a jig bottom-side-up for ease of lacing. When this is done and the harness is installed in a given unit, the lacing knots and splices will not be visible from above and the harness will have a neat, workmanlike appearance.

Forming boards are sometimes equipped with electrical checking devices to speed harness testing, as show below.



Harness Forming Board with Electrical Checking Devices

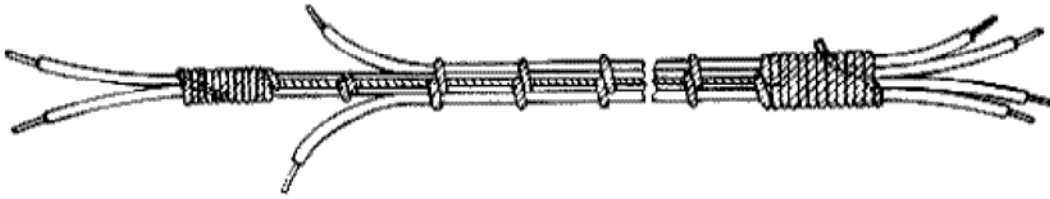
Ribbon-type lacing cord should be used in preference to round cord to reduce the possibility of cutting into wire insulation. One-eighth inch nylon or similar ribbon is best suited for this purpose.

If round cord is used, sizes should be as follows:

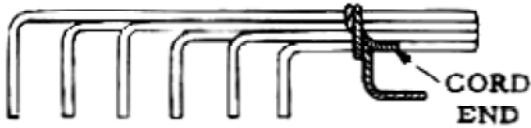
Principal Cable Diameter Cord Size

| | |
|---------------|------|
| Up do 3/8" | # 4 |
| 5/16" to 3/4" | # 6 |
| 5/8" to 1" | # 9 |
| 7/8" and over | # 12 |

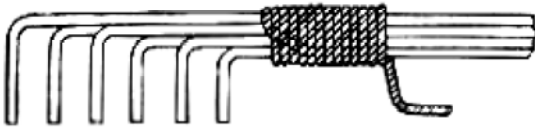
The harness is laced after all wires have been cut to length, stripped, tinned, and placed in position.



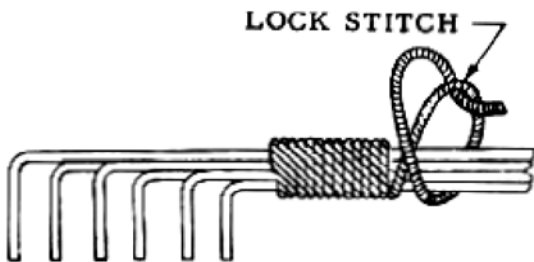
A Finished Harness



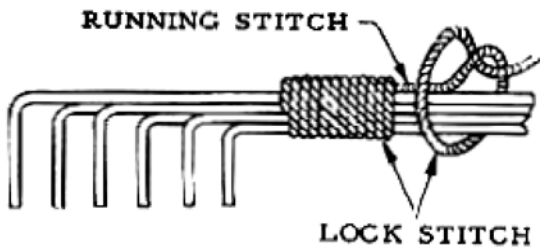
The process of lacing or binding a harness can be started at one end with a *starting tie*. Alternatively, lacing can be started at the center with a *lock stitch*, and a terminating wrap can be used at each end.



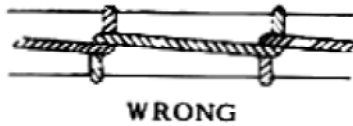
Lacing is started by cutting a length of cord two and one-half times the length of the proposed harness. One end of the cord is laid alongside the principal cable pointing into the harness. The cord end is secured as approximately four turns of cord are wound over it, and wrapping is continued until a total of twelve turns is wound about the principal cable.



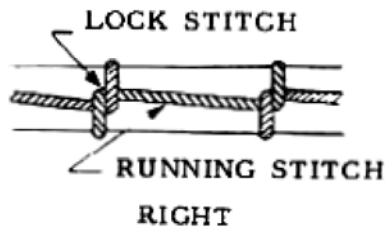
The wrap is secured by a lock stitch. This is made by forming a loop, passing the cord over the loop, then through the loop, and finally pulling the cord tight.



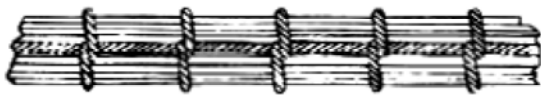
Secure stitches can be formed only by lacing the cord over the loop, never under, to form the so-called *lock stitch*. The cord is thus locked under each loop.



Lock stitches at approximately 1/2-inch intervals thereafter secure other loops in the same fashion.

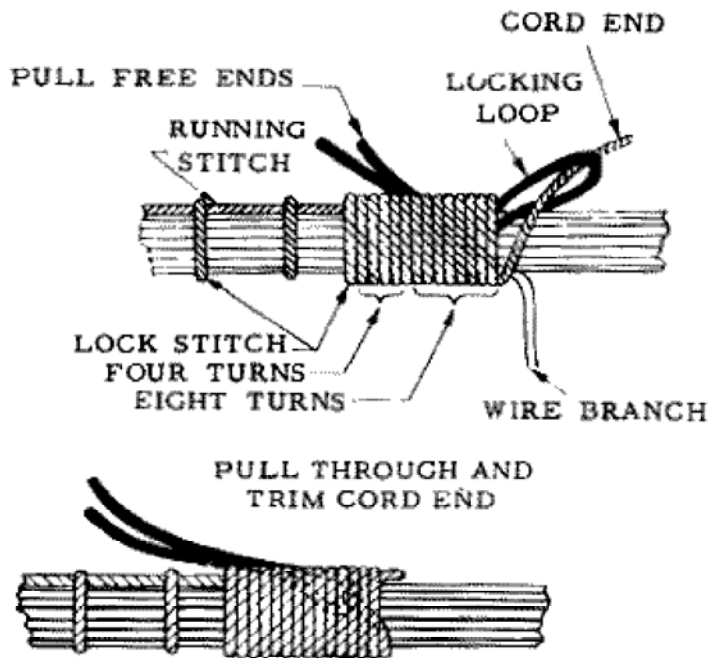


The foregoing describes the *regulation cableman's knot*, which is self locking.

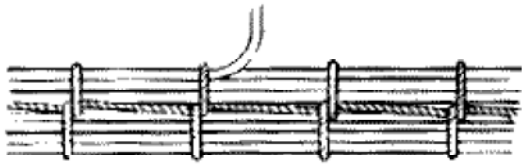


As lacing is advanced, the wires should be re-formed to insure a neat and firmly bound cable; conductors should be arranged to lie parallel without crossovers except when twisting is required.

Lacing is terminated by the following procedure. Four turns of cord are wrapped adjacent to the last lock stitch. A separate piece of cord is formed into a 2-inch loop and laid alongside the cable as show. Eight turns of lacing are wrapped about the loop and the end of the lacing cord is then drawn through the loop.

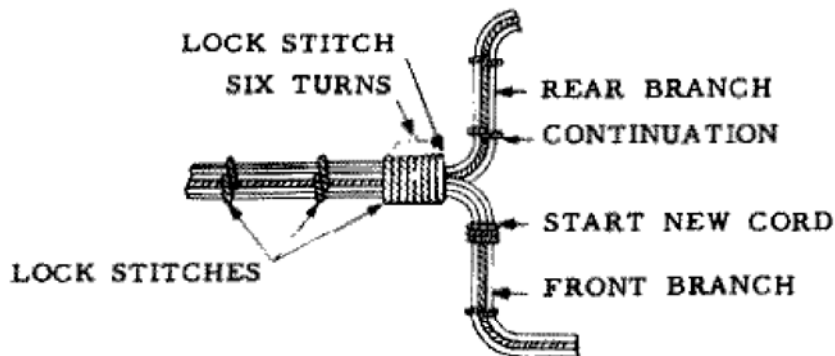


Both ends of the loop are then pulled to carefully draw the cord end underneath and out of the wrap. The cord end is then pulled tight, locking the wrap, and finally the end is cut to approximately 1/8 or 1/4 inch.



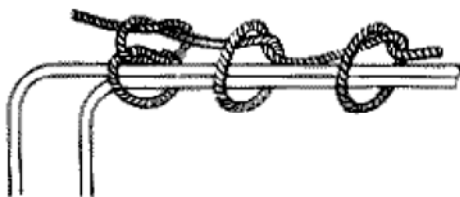
Branches and sub-branches, including single leads, are usually referred to as *breakouts*. Single-lead breakouts should be preceded by a lock stitch without variation in the distance between stitches.

Any breakout of two or more wires should be laced. When a group of wires is branched from a cable, a lock stitch is made; six turns are wrapped firmly about the principle cable adjacent to the new stitch, and finally, another lock stitch is made adjacent to the new turns. After a branch is thus secured, the running stitches are continued along the main cable.



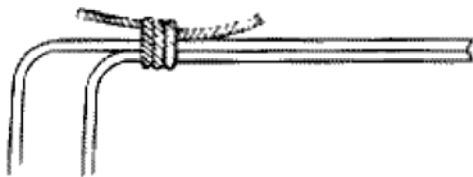
All lacing should follow the top of the harness. All knots, splices, or other irregularities should be hidden from view when the cable is installed in the equipment.

When laced, the cord should be sufficiently tight to minimize slippage but should not cut into the insulation.

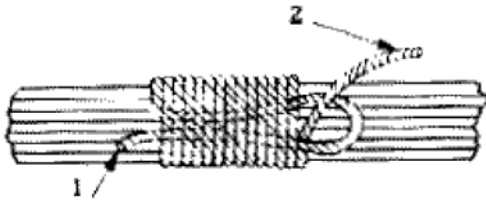


Lacing may also be started with a square knot, followed by two lock stitches.

Lacing is performed as previously described, and terminated by a lock stitch and a square knot.



Another procedure for lacing consists of making a series of individually bound wraps at equidistant points along the cable, as required.



Lacing cord, 2 inches longer than the length required to make twelve turns about the harness, is cut. One end of the cord is formed into a 1-inch loop which is placed flat on the harness, parallel to the wiring.

Twelve turns are wound tightly over this loop and, at the last turn, the cord end is pushed through the loop which extends from under the wrap.



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DESIGN OF CABLE FORMS WIRING AND CABLING GENERAL EQUIPMENT REQUIREMENTS

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1. GENERAL

1.01 This practice covers the general equipment requirements for the design of cable forms where formed wiring is specified. This type of wiring is generally used for entire bays of equipment for units over five mounting plates in size, or for units having 206-type selectors, and for cases where surface wiring is not applicable.

1.02 Detailed reasons for reissue are listed under **Reasons for Reissue** at the end of this practice.

1.03 Surface wiring is generally used on bench-wired units consisting of five mounting plates or less, depending on the width of mounting plates and the type of apparatus mounted on the unit. Surface wiring of certain units, such as those consisting of a large number of terminal strips and relays, or those with a large number of printed wiring board connectors on one mounting plate, may result in a pileup of wiring so great that the wires extend beyond the outside edges of the mounting plate.

This condition may cause crushing, pinching, and/or displacement of wires by adjacent units during mounting, and/or displacement of terminals, which may cause shorts, or abraiding of the wires during shipment. In order to avoid this condition, the following should be considered in the choice between surface wiring and local cable:

(a) *Single mounting plate units consisting predominantly of terminal strips and wire spring relays* should generally be local cable wired if the design is such that the unit terminal strips provide more than 48 terminals.

(b) *Single mounting plate units consisting predominantly of printed wiring board connectors* that are not provided with horizontal wiring paths between terminals (such as the 906-through 914- and similar types), should be local cable wired except where the design of the unit is such that the number of surface wires running along the outside edges of the unit will not extend beyond the edges.

(c) *Units of two or more mounting plates consisting predominantly of terminal strips and/or wire spring relays* can generally be designed so that it will be possible to limit the number of surface wired leads at the top and bottom edges of the units to approximately 24 leads, with the balance of the leads run in the center of the units. However, on units with two mounting plates, if the unit terminal strips provide a total of 120 or more terminals, the unit should be carefully reviewed for the possibility of using local cable wiring.

(d) *Units consisting of two or more mounting plates consisting predominantly of printed wiring board connectors* can generally be surface wired, except where the design is such that the number of surface wires running along the outside edge of the units is so great as to result in a pileup of wiring that would extend beyond the outside edges of the unit.

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1.04 The practices listed below contain wiring and cabling requirements that supplement the requirements of this practice, and where applicable, are referred to in other parts of this practice.

- 005-150-101—Wiring Symbols, Wiring Abbreviations, and Definitions
- 800-610-152—Gauge and Insulation of Wire
- 800-612-150—Specific Requirements for Electronic-Type Equipment
- 800-612-153—Stripping and Butting Cables
- 800-612-154—Connecting and Soldering Individual Conductors
- 800-612-156—Placing, Securing, and Supporting Cable Forms
- 800-612-157—Protection of Cable Forms and Skinners
- 800-612-158—Splicing Switchboard and Lead-Covered Cables, Local Cables, and Individual Conductors
- 800-612-160—Dressing of Skinners
- 800-612-161—Color Combinations and Uses
- 800-612-162—Selection of Standard Copper and Lightguide Central Office Cables
- 800-612-163—Specific Requirements for Crossbar-Type Equipment
- 800-612-164—Forming, Grounding, Splicing, and Terminating Shielded Wiring
- 800-612-165—Dressing of Skinners—Power Plant Apparatus
- 800-614-152—Switchboard, Power, and Local Power Cables
- 802-005-180—Assembly and Installation of Power Plant Bus Bar and Wiring

1.05 Where lightguide cables are provided, they shall not be sewn into cable forms. Where it is necessary to secure the cables in order to hold them in place or in formation they may be taped to adjacent cabling, or they may be tied with twine to framework details. However, where the cables are to be tied, they shall be protected from contact with the twine and the metalwork by wrapping the cables with RM-583101, 1/64-inch thick sheet fiber. Although protected, the cables shall not be tied so tightly as to cause the fiber protection to deform the cables since deformation of the cables could adversely affect the transmission characteristics of the glass fibers. If a lightguide cable is kinked or otherwise damaged during handling or installation, the damaged cable shall be discarded and replaced by a new cable.

1.06 The requirements covered in this practice should be followed except as modified by applicable specifications and drawings.

2. DESIGN OF CABLE FORMS

A. General Shape of Forms

2.01 Forms should, in general, follow the contour of the equipment framework and conform to the arrangement of the associated apparatus. Where possible, forms should be designed that all required bends in arms can be made while forming the cable. The design of forms should also be such that skinners located at the same point on an arm will break out of the arm in only one direction. Bends in directions other than in the plane of forms should be avoided. Where unavoidable, sufficient distance between the breaking-out points of the arms and skinners should be allowed to permit making such bends when the form is installed. Ladder-type forms should be avoided where possible. To facilitate the automated manufacture of cable forms, consideration should also be given in the design of the form to locating skinner break-outs, where practicable, at least 1/2 inch apart.

B. Location of Forms

2.02 *Locate arms of cable forms* that serve relays, resistors, capacitors, and similar apparatus mounted on mounting plates or panels on channel-type framework, or on unframes where mounting plates or panels are mounted on the front of the uprights, so that the inside edges of the forms are approximately 3-1/2 inches (not more than 3-3/4 inches, maximum) from the mounting plates or panels. On unframes where the mounting plates or panels are mounted on the rear of the uprights, and on ESS-type frameworks, locate arms so that the inside edges of the forms are approximately 2-1/8 inches from the mounting plates or panels. On bulb-angle or box-type frameworks, locate the arms so that the inside edges of the forms are approximately 2-3/8 inches (not more than 2-5/8 inches, maximum) from the mounting plates or panels. When local cable forms are used on duct-type frameworks, locate the arms in accordance with the equipment information.

(a) In general, shop-wired units should be designed with local cable arms located 2-3/8 inches from the mounting plates in order to permit their use universally on channel, bulb-angle, and box-type frameworks. Shop-wired units mounted exclusively on channel-type frameworks may be designed with local cable arms located 3-1/2 inches from the mounting plates or panels.

2.03 *Locate arms of cable forms serving terminal strips* approximately 1/2 inch from the rear edge of the fanning strip. Locate the arms of forms serving terminal strips not equipped with fanning strips approximately 1/2 inch from the rear edge of the terminal strip mounting bars.

C. Interference

2.04 Forms should interfere as little as possible with access to apparatus for adjustment, repair, replacement, and cleaning. Forms should be located on the framework so they are within the limits of the guardrail or base of the frame.

2.05 *There should be no interference of forms* with movable or removable equipment parts such as keyshelf braces, commutator brushes, and multiple banks.

2.06 Where a cover is provided for the protection of wires or wire connections to backplane terminals, local, switchboard, and/or flat ribbon cable forms dressed to the backplane shall be designed and arranged so that sufficient clearance will be maintained between cover and cable forms, and between the cable forms and terminal field when the cover is in place. This may require the use of several small diameter forms instead of one large diameter form or several smaller pileups of flat ribbon cables instead of one large pileup which might displace the terminals when the cover is in place. Where a flexible cover is provided, clearances between the cover and cable forms shall be sufficient to assure that flexing of the cover will not disturb the wires or connections.

2.07 *All forms should be located*, where possible, at least 2 inches from any wiring carrying outside service current that is not enclosed in armor or conduit.

D. Forms With Horizontal and Vertical Arms

General

2.08 On relay-rack units of older designs, the use of horizontal arms was restricted to cases where the apparatus of a circuit was located on one horizontal mounting plate or on two adjacent horizontal mounting plates. When the apparatus of a circuit group was located on three or more adjoining horizontal mounting plates, the apparatus in each circuit was arranged in an approximately vertical alignment and vertical cable arms were used. On the more recent relay rack units, particularly those which are equipped with D-type terminal strips and wire-spring relays, the practice of arranging the apparatus in each circuit in vertical alignment is not recommended due to wiring difficulties. In general, the present practice is to use surface wiring for relay-rack units of five mounting plates or less. (See 1.03.) On relay rack units of more than five mounting plates, the unit is local cable wired using horizontal cable arms.

Forms With Horizontal Arms

2.09 Use horizontal cable arms for single circuit or for multicircuit units where the apparatus is mounted on more than five mounting plates. Horizontal cable arms are also used for cable-wired units of less than five mounting plates when surface wiring is not applicable. (See 1.01 and 1.03.)

2.10 One cable arm for each two adjacent mounting plates may be used wherever it is advantageous to do so and the number of loop wires or "F" stitches is not excessive. The cable arm should be centered between the two mounting plates. An exception to this practice is when the two adjacent mounting plates consist predominantly of wire-spring relays. In this case, one cable arm for each mounting plate is recommended. Cable arms should be rigid enough to support their own weight without sagging or exerting tension on wire connections. In cases where the strength or rigidity of the arm is questionable, one of the following treatments should be provided:

- (a) Use one cable arm for two adjacent mounting plates. The cable arm should be located approximately in the center of the top mounting

plate of the two served. This will result in longer skimmers to the lower mounting plate, which may be an advantage for identification purposes.

(b) Where the tip of the cable arm contains only a few wires, the arm may end at the point where the arm becomes flimsy, and the wires to the apparatus on the far end of the mounting plate (away from the cable butt) may break out of the cable arm serving the plate above, or they may be run as surface wiring from the point where the arm ends, provided the type of wire insulation permits dressing against metalwork.

(c) Except for ESS*-type equipment, use a stiffening wire such as a No. 16 gauge AM wire (COMCODE 803682533) or No. 12 gauge AT-7088 aluminum wire (COMCODE 400292215) sewn into the cable arm and formed and fastened to the framework as shown in Fig 1. In cases where it might be more practicable to use a single brace for two or more adjacent arms, reference should be made to Practice 800-612-156 covering placing, securing, and supporting cable forms, that includes procedures for cable form reinforcement and bracing.

(d) Except for ESS-type equipment, include two or three No. 16 gauge-type AM wires (dummies) or one or two No. 12 gauge aluminum wires in the form to provide the necessary stiffness.

(e) Reinforcement and bracing of cable forms on ESS-type equipment shall be in accordance with Practice 800-612-150.

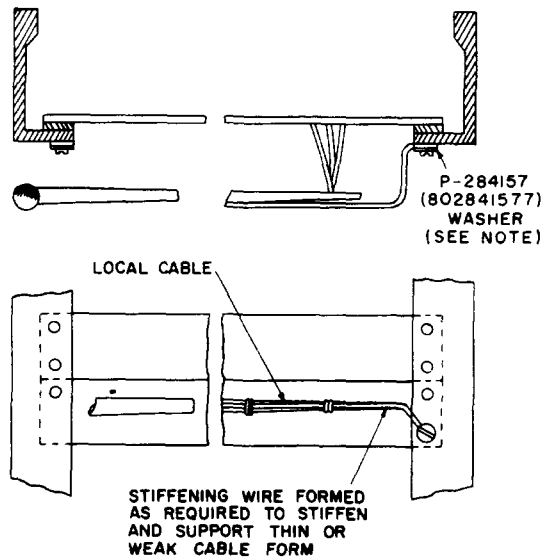
Forms With Vertical Arms

2.11 Vertical cable arms for relay-rack units should be limited to existing designs and to cases where the use of horizontal arms are not applicable. (See 2.08.)

2.12 Vertical arms may be provided where the apparatus in each circuit of a group is located on horizontal mounting plates and is approximately in vertical alignment.

2.13 *One vertical arm should be provided for each circuit* as follows:

(a) Where the apparatus is arranged with two apparatus positions (see *Note*) per circuit on all mounting plates.



NOTE - USE P-284157 (802841577) WASHER BETWEEN HEAD OF SCREW AND BRACE WIRE EYELET. WHEN MOUNTING PLATE SCREW IS INSERTED FROM FRONT, REPLACE WITH LONGER SCREW AND SECURE SUPPORT WITH P-125953 (801259532) HEXAGONAL NUT AND P-284157 (802841577) WASHER.

Fig 1—Support of Form Stiffener to Frame Upright

(b) Where the apparatus is arranged with two apparatus positions (see *Note*) per circuit on some of the plates and one position per circuit on others.

Note: More than two apparatus positions per circuit may be used for narrow apparatus such as 18- and 19-type resistors and 441- and similar-type capacitors.

2.14 One vertical arm for two adjacent circuits should be provided where the apparatus on all the plates is arranged with one position per circuit. More than one apparatus per circuit may be used for narrow apparatus such as 18- and 19-type resistors and 441- and similar-type capacitors.

Forms With Both Vertical and Horizontal Arms

2.15 Both vertical and horizontal arms may be used on the same unit, particularly on units having irregular arrangements of apparatus, such as on power boards; on units having 206-type selectors at one end and short horizontal mounting plates at the other end of the unit; and on units having multicontact relays or crossbar switches.

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E. Forms for Hinged Parts

2.16 Forms that serve hinged parts, such as the keyshelves of switchboards, the swinging gate-type rear equipments of PBXs, and similar constructions, should be designed to provide the necessary movement with minimum strain on the cable wires. The design of such forms should permit the necessary movement of the form by a twisting motion in preference to a bending motion. The part of the form subjected to twisting should be as long as practicable.

F. Size of Forms

2.17 Fig 2 through 4 show the approximate diameters of cables obtained when forming specific quantities of wire into sewn forms having circular cross sections. The wire codes shown in the figures are those most commonly used in wiring AT&T Technologies equipment. For codes not shown, the following formula may be used for calculating approximate diameters:

$$D = 2d \sqrt{T/3}$$

D = Diameter of cable

d = Diameter of wire

T = Total number of wires

G. Switchboard and Desk Local Cables

2.18 The keyshelf arms of local cables are generally designed so they will enter the keyshelf at the right of each position, looking from the front. An exception to this is made where the framework construction or interference with apparatus makes it impracticable, in which case the cable is brought in at the left.

2.19 *The keyshelf local cables should be brought through the keyshelf apron so*

that the bottom the cable is not less than 1/4 inch above the key pan at the point where the cable enters. The first bend should be located at a sufficient distance inside the keyshelf to prevent a strain on the cable when the keyshelf is raised.

2.20 *When the keyshelf cable is of such size* that it will not clear the end plug drilling where the cable passes under the plug shelf, the cable should be flattened to clear, if possible, but in no case should the cable overlap more than three fourths of the plug drilling. In general, the cable should not be flattened to a dimension of less than one inch.

2.21 *Where keys are arranged to lift out* from their mountings, the wiring to the keys should be arranged in individually formed arms for each key.

Reasons for Reissue

1. To add **1.04** listing associated Practices.
2. To add **1.05** covering requirements for lightguide cables.
3. To add **2.06** covering interference to wire connections to backplane terminals.
4. To revise **2.10(c)** to delete reference to TW or THW "and No. 12 gauge AP (iron)" wires; and to specify AT-7088 and COMCODES 803682533 and 400292215.
5. To revise **2.10(d)** to delete reference to TW or THW "and No. 12 gauge AP (iron)" wires.
6. To delete former Fig 2 covering approximate number of No. 22 and 24 gauge wires in forms having circular cross sections.
7. To add new Fig 2 to show new curves for AM- and BH-type wires.
8. To revise Fig 3 to add curve for 24BU wire and to specify 22BU in place of 26BW.
9. To revise Fig 4 to show new curves for DP-type wire.

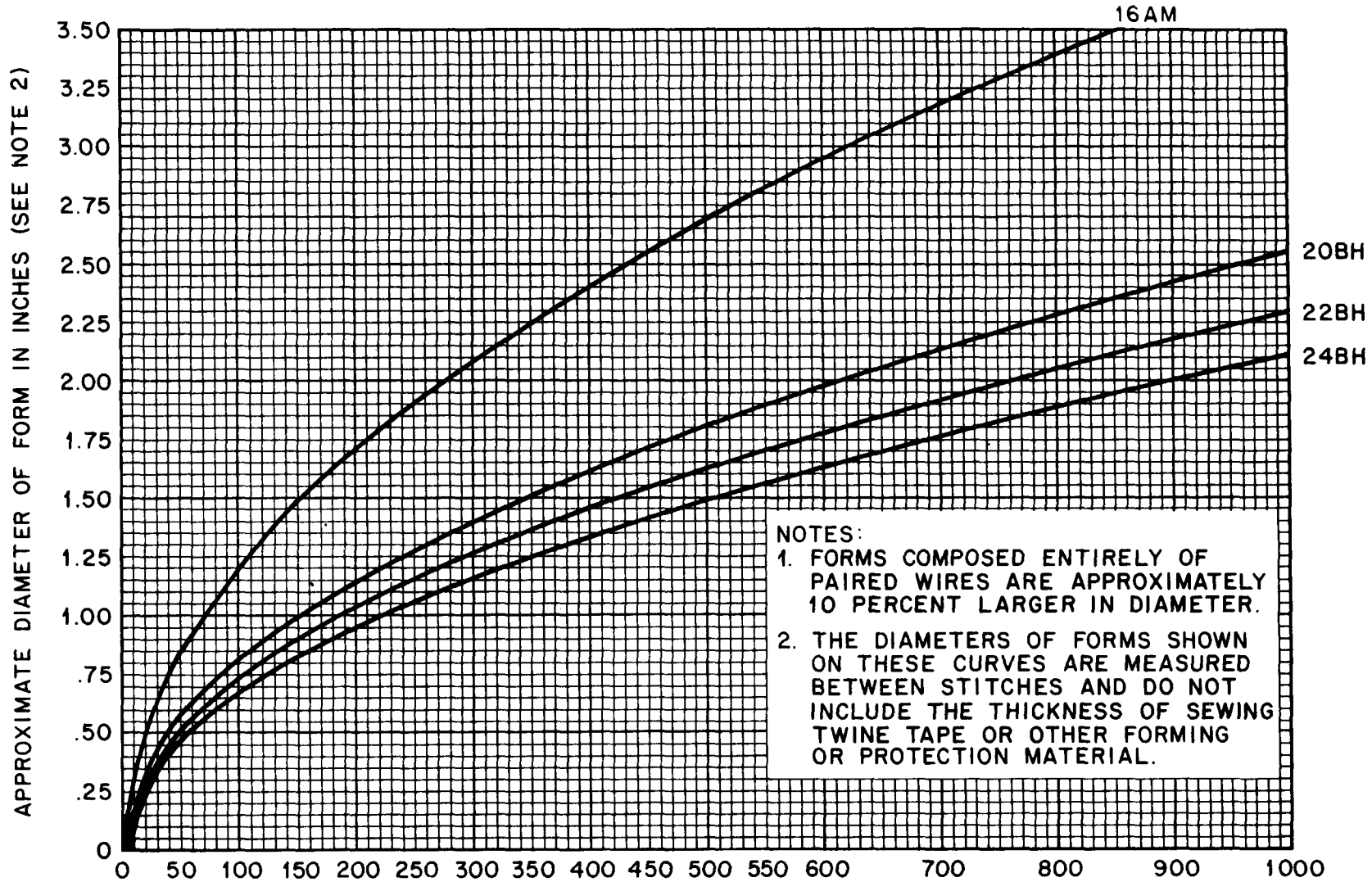


Fig 2—Approximate Number of AM- or BH-Type Wires in Forms Having Circular Cross Sections

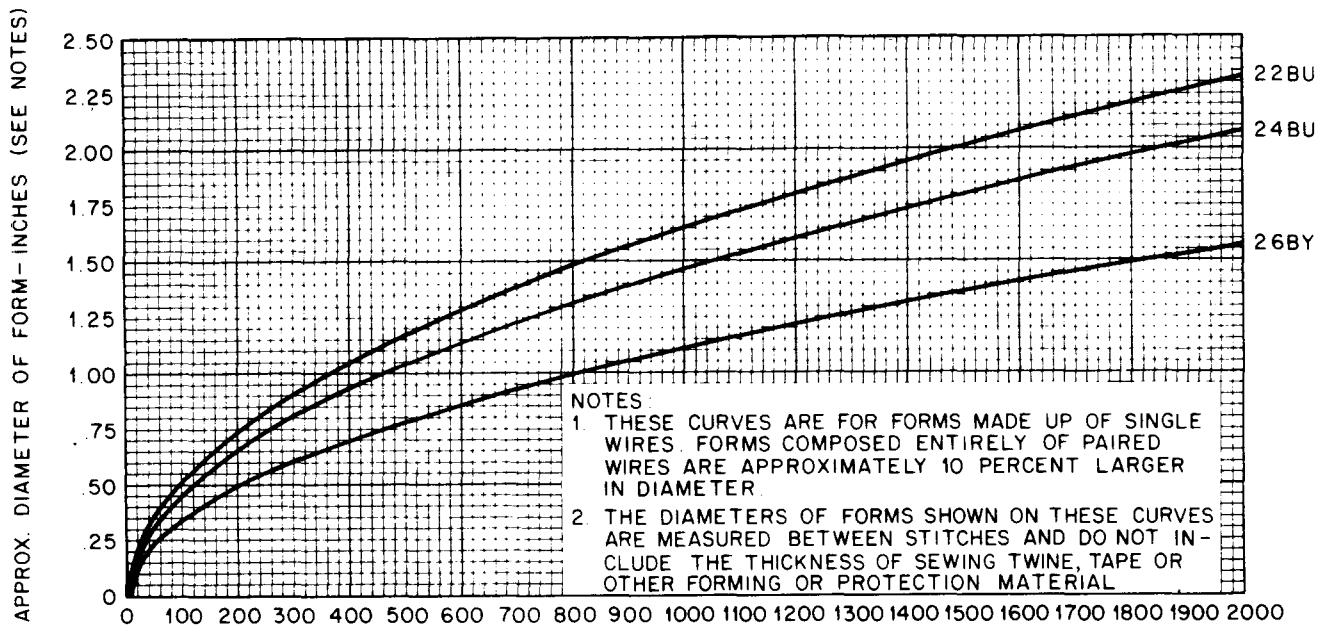


Fig 3—Approximate Number of BU- or BY-Type Wires in Forms Having Circular Cross Sections

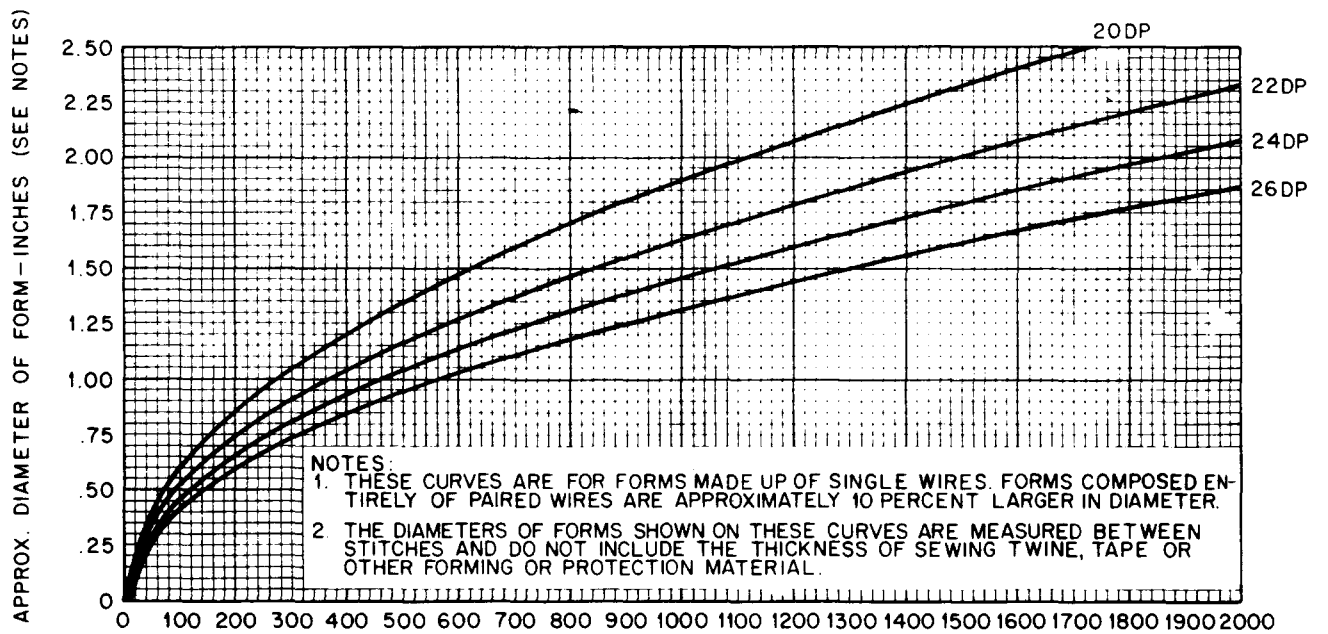


Fig 4—Approximate Number of DP-Wires in Forms Having Circular Cross Sections

STRIPPING AND BUTTING CABLES

WIRING AND CABLING

GENERAL EQUIPMENT REQUIREMENTS

1. GENERAL

SCOPE

1.01 This section contains the general equipment requirements for the stripping and butting of polyvinyl chloride (PVC) jacketed switchboard cables. Butting of coaxial and twin-conductor shielded office cable is covered in Section 800-612-164.

1.02 Butting and stripping of cable is required where the enclosed wires are to be formed out of the cable.

1.03 This section is reissued to make changes which are listed under reasons for reissue at the end of this section.

1.04 The requirements covered in this section shall be followed except as modified by applicable specifications and drawings.

1.05 Cutting devices other than approved stripping and butting tools shall not be used for the removal of cable jackets.

2. STRIPPING

2.01 Remove the outer covering or jacket of the cable to expose the stripper as shown in Fig. 1. In removing the outer covering or jacket from the cable, exercise care not to damage the wires or their insulation. The double stripper shown in Fig. 1 is used when making large quantities of switchboard short multiple cables.

3. BUTTING

3.01 On switchboard short multiple cables, a variation of plus or minus 1/4 inch from the specified dimension between butts is allowable.

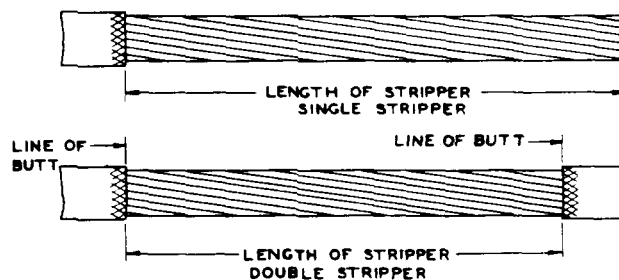


Fig. 1—Single and Double Strippers

3.02 The pressboard in cables having pressboard centers shall be terminated approximately at the line of butt, and shall not project more than 1/4 inch beyond the butt.

3.03 Two or more cables butted at the same point and made into one form should be securely tied together using a Chicago stitch as shown in Fig. 2. Where cables are butted at a point of support, the Chicago stitch is used both for holding the cables together and for tying to the support.

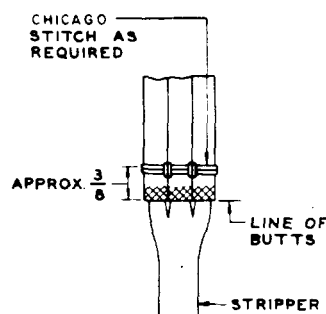


Fig. 2—Fastening and Aligning Switchboard Cable Butts

SECTION 800-612-152

REASONS FOR REISSUE

1. To omit information for fabric- and lead-covered switchboard cables.
2. To omit Fig. 2 covering butting of fabric-covered cable.
3. In 3.03, Kansas City stitch has been changed to Chicago stitch.
4. In Fig. 2, reference to Kansas City stitch has been omitted.

**FORMING, FANNING, SEWING, AND SKINNING
WIRING AND CABLING
GENERAL EQUIPMENT REQUIREMENTS**

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NOTICE

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Bell System except under written agreement

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| | | A. General |
| | | 2.01 The vertical portion of what would normally be thought of as the bay cable form (either |

switchboard or local cable form) may be either a sewed form or a loose wire form.

2.02 The sewed form shall be used for local or switchboard cable wires formed out of the vertical portion of the cable form to jacks, lamps, relays, coils, message registers, and similar apparatus not equipped with a fanning strip or other wire-retaining device, except where surface wiring or some other form of loose wiring is specified.

Sewed Forms

2.03 The general equipment requirements applying to the design of cable forms covered in Section 800-612-151 shall be followed.

2.04 The skimmers to apparatus shall break out of the cable arm at locations that will provide for the proper dress of the skimmers. The general equipment requirements for dressing of skimmers are covered in the following Sections.

800-612-150—Specific Requirements for Electronic-Type Equipment

800-612-160—General Dressing Requirements.

800-612-163—Apparatus Used Exclusively in Crossbar Equipment.

800-612-165—Power Plant Apparatus.

2.05 *Where the skimmers for two or more pieces of apparatus break out of a sewed form at the same location* the sets of skimmers to the various pieces of apparatus shall be separated approximately 1/4 inch by means of an extra stitch, except as follows.

(a) The extra stitch may be omitted where the total number of skimmers (from the regular stitch to apparatus) is fourteen or less.

(b) The extra stitch should be omitted where wiring congestion makes it impracticable, as in the case of jacks and lamps in jack fields or in switchboard front equipment.

(1) In the case of jack field where one stitch of a horizontal arm serves two jacks of a single jack mounting or four jacks of a double jack mounting, the skimmers shall be located midway between the jack mounting centers. An extra stitch with approximately 1/8-inch separation shall be provided only when color confliction exists. When separation is required, the left jack

of a single jack mounting, or the two left or two top jacks of a double jack mounting, should be the first set of skimmers at the left, looking at the wiring side.

(c) the stem of the lock stitch may be used for separating sets of skimmers in cable forms wherever it is practicable to do so.

(d) Omission of the extra stitch referred to above does not permit omission of F stitches when required to distinguish between wires of the same color.

2.06 *Where the skimmers for two units or pieces of apparatus mounted directly one above the other* break out of a horizontal form at the same location, the skimmers for the top unit or piece of apparatus shall, where the color code identification is not governing, be the first set of skimmers at the left of each group, looking at the wiring side, as shown in Fig 1.

2.07 *Where the skimmers for two units or pieces of apparatus mounted side by side* break out of a vertical form at the same location, the skimmers for the first unit or piece of apparatus at the left, looking at the wiring side, shall, where the color code identification is not governing, be the top set of skimmers of each group, as shown in Fig 1.

2.08 Wires to the same piece of apparatus approaching a stitch from opposite directions shall be brought out on opposite sides of the same stitch.

2.09 *Crossing of Wires in Forms:* The positions of the various wires in a form shall be such as to reduce to a minimum the crossing of leads. Where crossing is necessary, the cross is made in the greatest distance possible.

2.10 *Cable forms not specifically referred to in this section shall* in general, be formed in a manner similar to the forms they most closely resemble.

C. Fanned Forms

2.11 The fanned form shall be used for switchboard cable leads terminating at terminal strips, protectors, or other apparatus provided with fanning strips or other fanning devices. Local cable forms terminating at the above type of apparatus may be

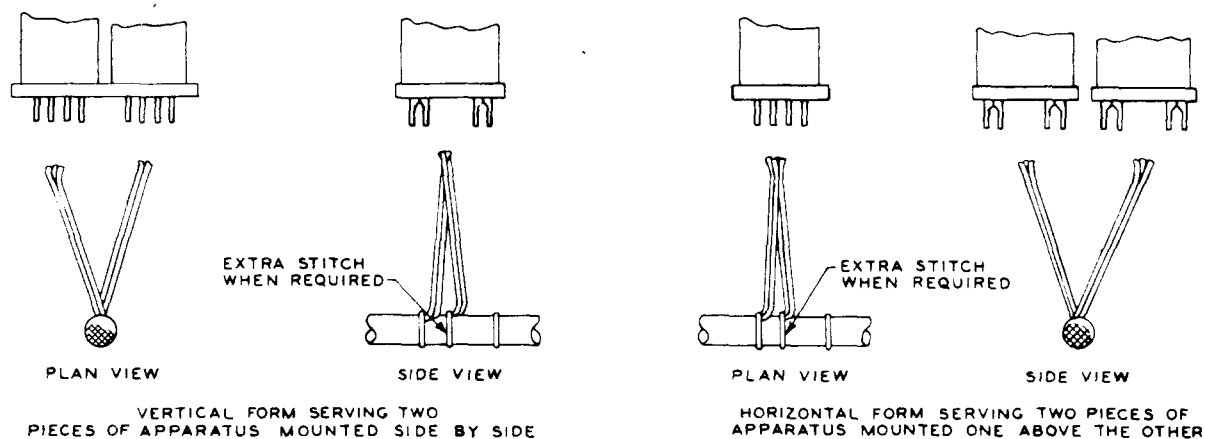


Fig 1—Single Form Serving Two Units of Apparatus

fanned out without sewing where this method of forming is practicable.

2.12 In the fanned form the wires shall be run directly from the cable butt, or from the break-out point of sewed or loose wire cable forms to the fanning strip. The wires shall be run without slack, but not so taut as to cause insulation breakdown.

2.13 Twisted, bunched, or loose fans shall be avoided. The regular twist in pairs, triples, and quads shall be maintained in the area between the cable butt and fanning strip. Where the wires in a pair, triple, or quad enter different holes in the fanning strip, the wires should be untwisted only to the extent necessary to permit fanning as required.

2.14 Where switchboard cables (one or more) serve a single piece of apparatus having a fanning strip and the cables are butted at the associated apparatus location, the conductors shall, in general, be run directly from the butt to the fanning strip, as shown in Fig 2.

- (a) On the switchboard cable side of distributing frame terminal strips, where all of the wires serving the same row of terminals are skinned to equal lengths (ie, all of the wires are skinned to reach the farthest terminal from the fanning strip hole or slot serving that particular row), the slack

in the wires shall be neatly dressed in the area between the cable butt and fanning strip. Where necessary, occasional ties shall be used to keep the wires in reasonable good formation.

2.15 Where switchboard cables (one or more) serve two or more pieces of apparatus having fanning strips, each group of conductors serving single pieces of apparatus shall constitute a fanned form starting at the butt location or the point on a sewed or loose wire cable form that will permit the conductors to fan directly into the fanning strip.

- (a) When fanning rings, enclosed cable brackets, or other wire retaining devices are provided at the second and succeeding apparatus locations (away from the cable butt), the conductors shall be run loose through these devices as loose wire forms. Generally, banding is not required unless necessary to avoid contact between conductors and uninsulated metalwork. See Fig 3 and 4. When cable supports or unenclosed brackets are provided, the conductors shall be run loose from the butt to the break-out points and secured to the cable supports or brackets.
- (b) At distributing frames where distributing rings or other wire retaining devices are not provided, protection shall be provided between the cable butt and transverse arm as specified in Sec-

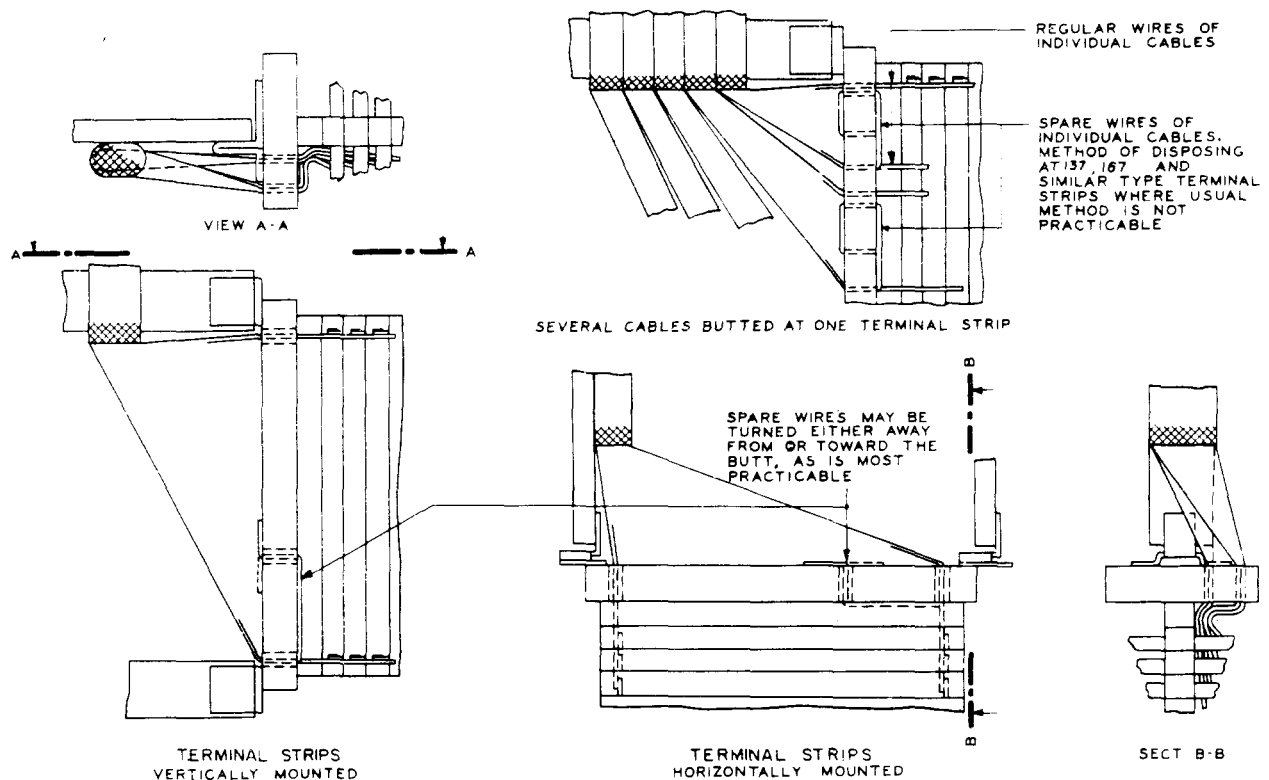


Fig 2—Fanned Form for a Single Terminal Strip

tion 800-612-157 covering protection of cable forms.

2.16 Where several terminal strips are mounted in a horizontal row, as used on various crossbar frames, and no cable supports are provided for the support of the horizontal portion of the wiring, the wires shall be run as a single fan across all the terminal strips in the same horizontal row, as shown in Fig 5. Loose bands should be applied to confine the wires. In general, it will be satisfactory to use one loose band for each terminal strip 8 inches or longer, or one loose band for each two terminal strips less than 8 inches in length.

D. Loose Wiring

2.17 Loose wiring may consist of bulk wire run from outside the bay, intrabay wiring, or switchboard cable leads run loose from the cable butt.

2.18 All loose wiring run in the vertical portion of what would normally be thought of as the bay local cable form shall be run through cable brackets, adjustable wiring supports, etc, as provided. The wires shall be run without slack, but not taut. Ties, retaining rings, clips, etc, may be used where the wires break out of the vertical run. After breaking out of the vertical run, the wires may be run in a horizontal sewed form, as a loose wire form, or as surface wiring (when the type of wire used is such that dressing back against the mounting plate would be permissible).

2.19 Ties are used at cable brackets or other places to keep the wires in a reasonably good formation. Wires held in place by rings or similar wire-retaining devices do not require tying except where there is a possibility of the wire pulling out of the rings.

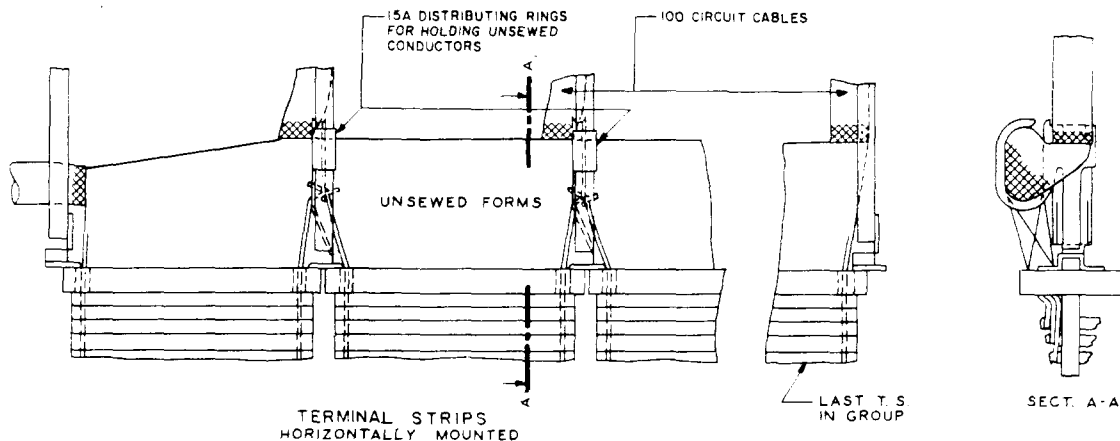


Fig 3—Horizontal Form for More Than One Terminal Strip at Distribution—With Distributing Rings

2.20 Wires held in cable formation by rings or similar wire-retaining devices (such as the loose wire forms on the rear of step-by-step shelves) shall be run throughout the rings without slack, but shall not be so tightly drawn as to interfere with the skinner dress. Usually no ties will be required because of the relatively close spacing of the rings. A ring is provided at each break-out point for the wires, and the leads to the apparatus terminals (skinners) are dressed in the normal manner for skinners from sewed forms.

2.21 All wires shall be dressed away from vitreous enamel-type resistors and heat-dissipating potentiometers (rheostats) or other heat-producing devices to avoid a possible fire hazard.

- (a) *Where vitreous enamel type resistors (such as the KS-14603-types) rated at greater than 2 watts are provided*, the clearance between the wires and the body of the resistor shall be minimum 1/8 inch.
- (b) *Where film style resistors (such as the KS-20289-types rated at greater than 2 watts are provided*, the clearance between the wires and the body of the resistor shall be minimum 1/16 inch.
- (c) *Where heat-dissipating resistors of 2 watts or less are provided*, the clearance between

the wires and the body of the resistors shall be minimum 1/32 inch.

2.22 *At angle-type relay racks*, loose wiring shall be run through adjustable wiring supports wherever they appear in the bay. On existing equipments where other cable brackets are used, the loose wires shall be secured to the cable brackets with twine. For installer-run wires, the wires may be secured to the cable brackets with KS-20986 cable ties in accordance with Section 800-612-156.

2.23 *At channel-type relay racks* where the U-type cable bracket is used, the stripped portion of all cables and wiring not in cables shall be run loose inside the U-type bracket (unless otherwise specified). The wires shall be secured to each cable bracket with twine to retain the wires within the brackets. At break-out points where no cable brackets are located, the stripped portion of cables and the loose wire should be banded together. For installer-run wires, the wires may be secured or banded with KS-20986 cable ties in accordance with Sections 800-612-156 and 800-612-153, respectively.

2.24 *At sheet-metal box-type frameworks*, such as the ESS- and Uniframe-type frameworks, loose wiring shall be run through the wire guides (rosettes), fanning rings, or other wire retaining devices, where provided. Ties are not necessary except where there is a possibility of the wires pulling out of

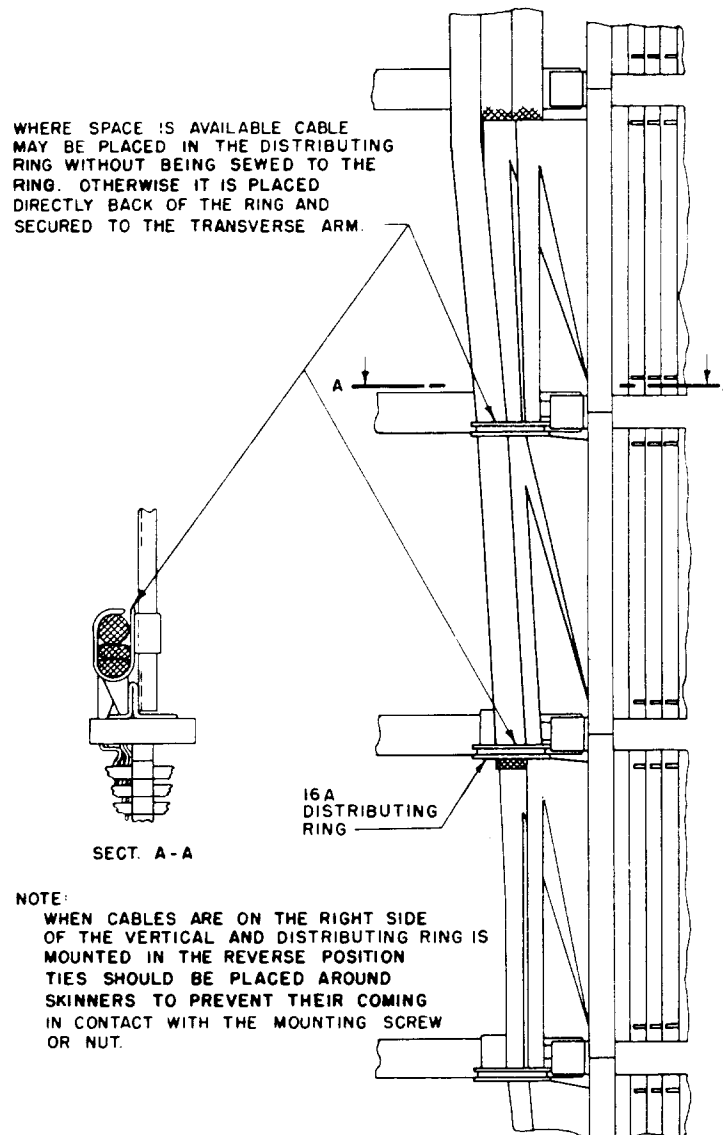


Fig 4—Vertical Fanned Form for More Than One Terminal Strip—With Distributing Rings

the rings. Specific requirements for running loose wiring on electronic-type equipment are covered in Section 800-612-150.

2.25 *Intrabay loose wiring to D-type terminal strips at the rear (wiring side) of the bay* is run vertically up and down the bay. After breaking out of the vertical run, the wires are run horizontally above the top rows or below the bottom rows of the terminals, and then vertically between terminals to the desired terminals, as shown in Fig 6.

2.26 *Switchboard cable leads to D-, BT-, and BU-type terminal strips* are usually run down the rear (wiring side) of the bay. At the break-out locations they are run through the wiring guide furnished with the terminal strip. They are then run through the wire throat of the terminal strip to the front (apparatus side) of the bay, as shown in Fig 6.

2.27 *Intrabay loose wiring to D-type terminal strips at the front (apparatus side) of the bay* is run horizontally above the top rows or below

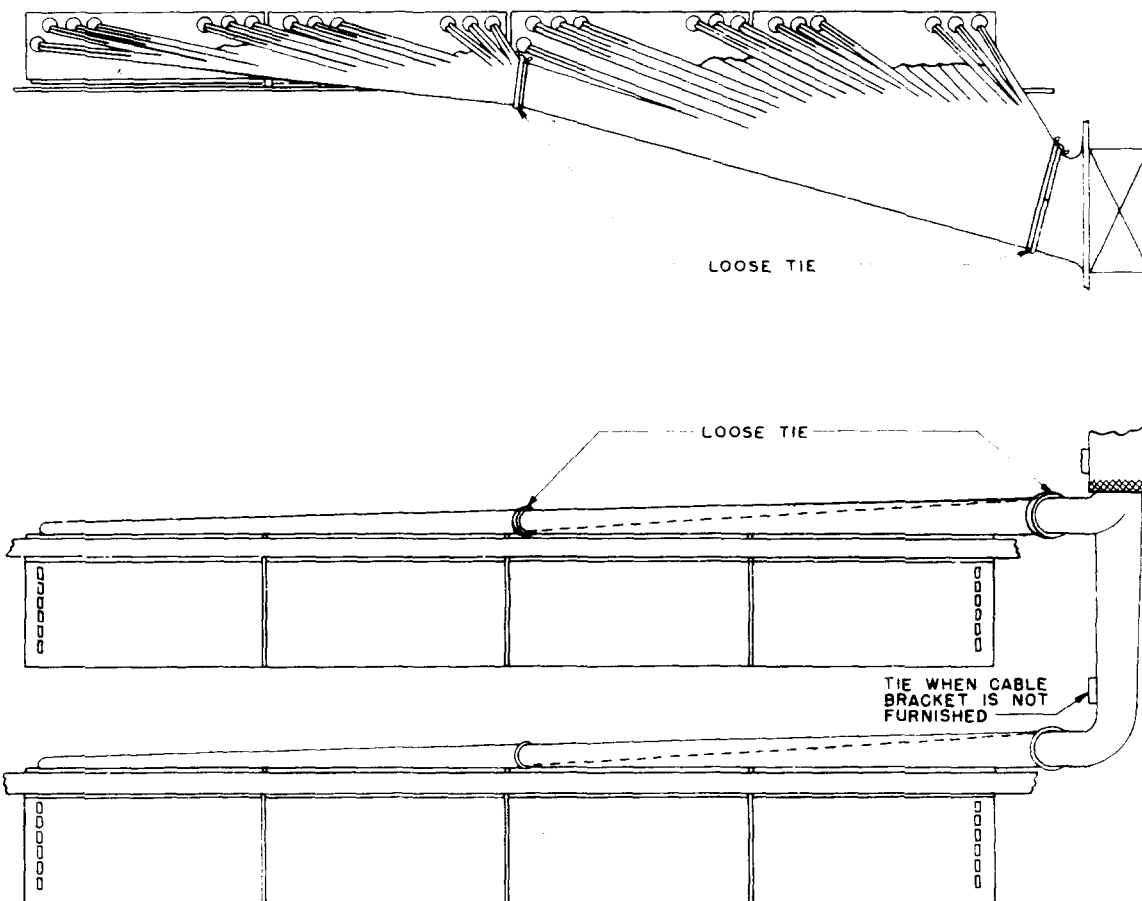


Fig 5—Fanned Forms for More Than One BB6A- and Similar-Type Terminal Strip

the bottom rows of terminals to the terminal strip nearest the frame upright. At this point the wires are run around the wiring guide and then vertically to the mounting plate on which the other terminal strip is located. The wires are then run around the wiring guide on the terminal strip nearest the frame upright, and horizontally above the top rows or below the bottom rows of terminals to the terminal strip on which the wires terminate. Weave the wires only through the wire guide slots of the terminal strips located near the frame upright at the top and bottom of the vertical run, as illustrated in Fig 7.

E. Surface Wiring

General

2.28 Electronic-type equipment used in systems other than electronic switching systems (ESS)

shall meet the requirements of this section except where the requirements of Section 800-612-150 covering electronic-type equipment are otherwise specified by the BTL design engineer responsible for the equipment. Surface wiring for ESS shall be in accordance with the requirements of Section 800-612-150.

2.29 For the definition of surface wiring, see Section 005-150-101.

2.30 Section 800-612-151 covers conditions under which the use of local cable should be considered in place of surface wiring.

2.31 There are two main types of surface wiring, SW1 and D3, (see 3.44 and 3.47) which are run loose and dressed back from the ends of the apparatus terminals near or against the mounting plate or panel, or adjacent to the plane of the mounting

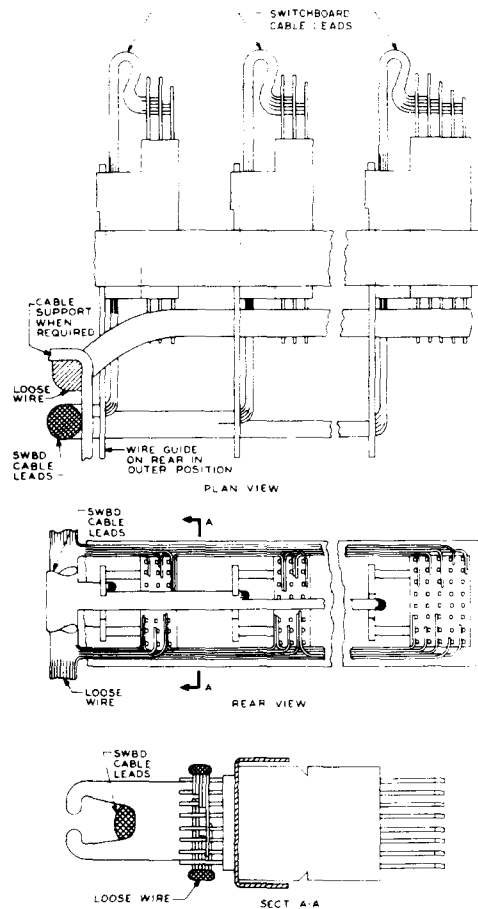


Fig 6—Terminal Strips—D Type—Loose Wiring and Switchboard Cable Leads

surface, unless wiring devices or other means are provided for controlling the dress. The wiring is run in definite paths parallel and perpendicular to the edges of the mounting plate or panel, as shown in Fig 8, 8A, or 8B, whichever is applicable. It is not necessary to make right-angle bends, but the appearance of the wiring should be neat, and sufficient slack should be provided so that the wires will not be taut. The

slack, however, shall not exceed 1-1/2 inches, except where otherwise specified.

2.32 Surface wiring (BW-, DP-, or similar-type wires) may rest against metalwork or apparatus terminals, but in no case shall the wires be drawn taut around the terminals in such a manner as to cause insulation breakdown. As far as practicable,

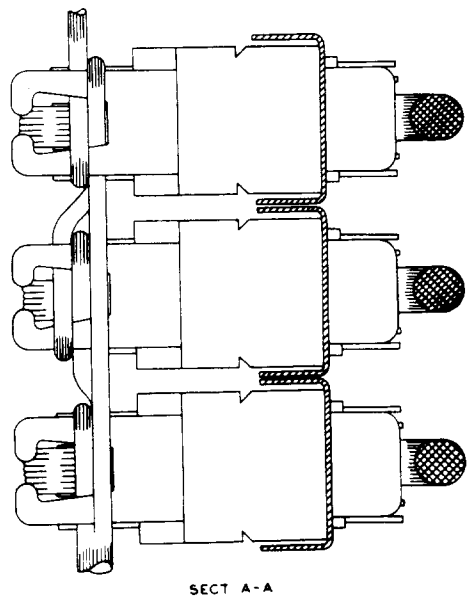
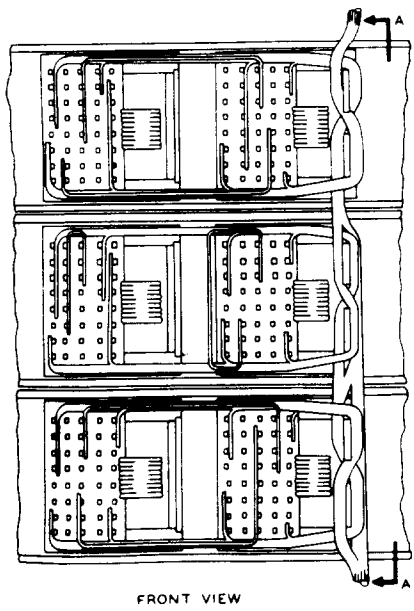
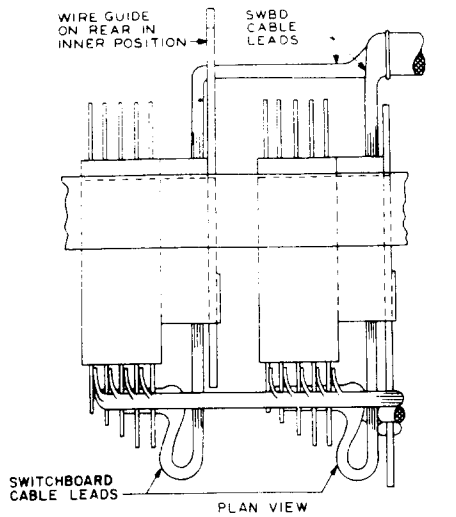
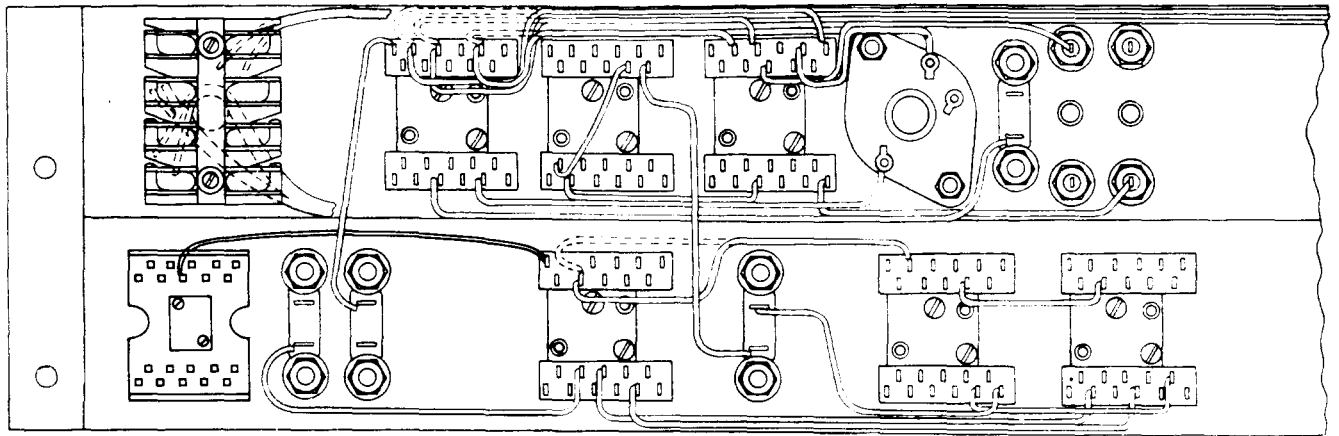
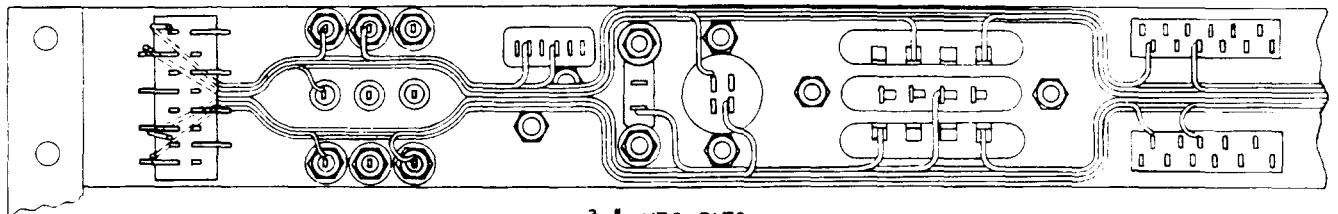


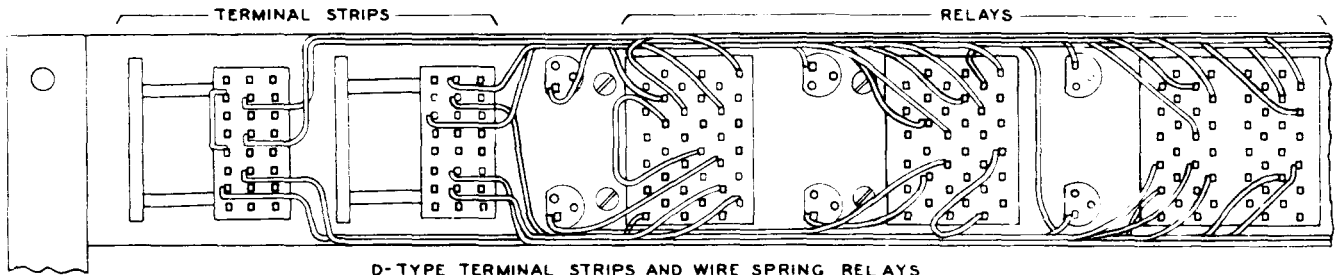
Fig 7—Loose Wiring on Front (Apparatus Side) D-Type Terminal Strips



2" MTG PLTS



1 3/4" MTG PLTS
FLAT TYPE TERMINALS



D-TYPE TERMINAL STRIPS AND WIRE SPRING RELAYS

Fig 8—Surface Wiring—Arrangement of Wiring in Paths—1-3/4 and 2 Inch Mounting Plates

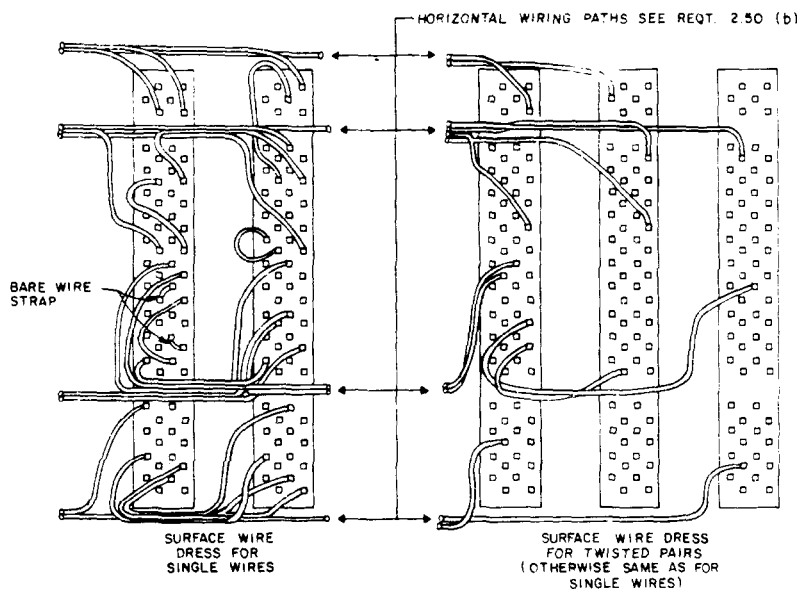


Fig 8A—Surface Wire Dress for Connectors With Staggered Terminal Arrangements Such as the 903, 905 Through 914, 916, 927, 928, 940, and Similar Types (927-type Connector Shown)

diagonally, horizontally, or vertically run wiring should be located in paths directly adjacent to the terminals being served. Leads should be distributed throughout the available paths so as to prevent unsightly bunching or excessive pileups. The distribution of wires over the available paths of a unit need not be identical for all like units, even though the units may bear the same equipment code. As far as practicable, leads should be run so as not to cover functional or equipment designations.

2.33 Where optional wiring or apparatus is specified, only such wiring should be furnished as can be connected at both ends unless notes on the wiring drawings specify that such leads be provided. In the latter case, the unconnected ends shall be protected and disposed of by tying them near their ends to other wires or to the mounting plate in such a manner that they can be identified easily. Surface wiring conductors that would connect within or to partially equipped or unequipped circuits may be omitted; however, current supply leads in this category shall be omitted.

2.34 *Tone and ringing leads to the first normally open contact* should be kept as short as practicable. the length of exposure of these leads to unpaired talking leads shall in no case exceed 18 inches.

2.35 *Battery and ground leads* shall not be buried, but shall be run at the outside of the pileup of leads as far as practicable. Leads added by the installer, as in the case of circuit modifications, shall not bury the battery and ground leads to such an extent as to make them inaccessible for maintenance.

2.36 *Where solderless-wrapped connections are used for connecting surface wiring and four or more terminals are interconnected*, it is desirable that the wire ends be connected so that a minimum number of wires need be disconnected when future changes are made in the grouping of the terminals or when a piece of apparatus has to be replaced. This can be accomplished as follows: connect the first terminal to the second terminal, the third to the fourth, the fifth to the sixth, etc, placing the turns of wire near the base of the terminal. Then, as a second connection on the terminal, connect the second terminal to the third, the fourth to the fifth, etc.

2.37 All surface wires shall be dressed away from vitreous enamel-type resistors and heat-dissipating potentiometers (rheostats) or other heat-producing devices (in accordance with 2.21) to avoid a possible fire hazard.

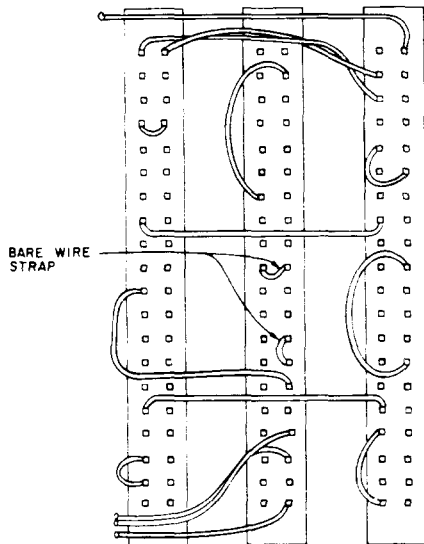


Fig. 8B—Surface Wire Dress for Connectors Having Vertically and Horizontally Aligned Terminal Arrangements such as the 924-, 925-, 926-, 947-, and Similar-Type Connectors (925-Type Connector Shown)

2.38 In general, surface wiring is run without sewing or tying. Occasional ties should be used, where necessary, to keep the leads in place and in reasonably good formation. Wires shall be dressed back from the apparatus terminals so that they rest near or against the mounting plate or panel, or adjacent to the plane of the mounting surface. If necessary, the wires shall be tied together so that they are maintained within the boundaries of the unit to prevent pinching or hooking of wires by adjacent units during mounting or installation. The wires shall also be kept clear of unit mounting bars or corresponding mounting surfaces.

2.39 For treatment of pairing and shielded wiring on surface-wired units (SW1 wiring), see 3.29 and 3.30 for paired wires and 3.54 for shielded wiring.

2.40 Strapping on surface-wired units shall be limited to connections that can be and are normally made with bare wire or extended skinner connections. All other connections shall be made as surface wiring in accordance with Fig 8, 8A, or 8B, whichever is applicable. Bare wire straps are permitted only between immediately adjacent terminals on the same piece of apparatus, provided that they do not obstruct wiring or wiring paths and that clearance requirements are met.

Specific

2.41 For E-, U-, and Y-type relays and 224-type terminal strips and similar apparatus having two terminal levels, wiring connected to terminals in the top level may be run either above or below the top level of terminals, and wiring to terminals in the bottom level may be run either above or below the bottom level of terminals as shown in Fig 8. However, wiring run in the center of 224- or similar-type terminal strips shall be dressed so as not to obstruct holes in the mounting plate through which switchboard cable leads will be carried.

2.42 For E-, U-, Y-, and similar-type relays mounted on 1-3/4 inch mounting plates it is permissible, where necessary to avoid congestion along the top or bottom edges of the unit, to run the leads in the center of the apparatus as shown in Fig 8. where a series of No. 26 or similar-type terminal punchings are mounted in the center of the mounting plate, the leads may be run in the center of the relays adjacent to the terminals.

2.43 Where 224-type or D-type terminal strips are provided, surface wiring paths shall not obstruct the hole in the mounting plate through which switchboard cable leads will be carried. Where wires are to be connected to apparatus mounted in a recess on a panel, the wires shall be run around the recess opening to permit access to the apparatus for maintenance purposes.

2.44 Wiring to 227-type terminal strips shall be run along the mounting plate to a point approximately under the corner of the fanning strip, as shown in Fig 8. From this point the leads shall dress along the terminal strip support directly into the notch of the fanning strip. Wiring terminating on the bottom four rows of terminals shall dress over the top of the terminal strip support, and wiring to the top four rows of terminals shall dress under the terminal strip support.

2.45 *Wires to wire-spring relays, such as the AF-type relays*, shall, in general, follow the wiring pattern shown in Fig 8. The relay is theoretically divided in half. In the upper half of the relay the wires shall be placed between the springs in slots that are diagonally upward to the left. In the lower half of the relay the wires shall be placed between springs in slots that are diagonally downward to the left.

2.46 *On apparatus or groups of apparatus such as keys, jacks, Minaplas assemblies, or resistor mounting boards* where the points of termination are a considerable distance from the mounting plate or panel, it is sometimes impracticable to dress the wiring between terminals back against the mounting plate. In such cases it will be satisfactory to run the wiring in the same manner as would be used for standard strapping.

2.47 *Where relays such as A-, EA-, and similar-types* which are equipped with strapping terminals are provided, the surface wiring may be run in the center of the relay and adjacent to the mounting plate to avoid interference with the strapping.

2.48 The slack requirement for skimmers in local cable wired equipments specified in Section 800-612-160 for *apparatus such as 239-type jacks in 213A jack mountings or 92-type keys in 374A key mounting* that requires removal from the front for maintenance may be disregarded in surface-wired equipments.

2.49 In the case of surface wiring to *204-type selectors on relay rack units*, sufficient slack shall be provided in the wiring to the bank terminals to permit the removal of the selector. The slack shall be disposed of as shown in Fig 9. The wiring to the coil terminals requires only the normal slack as these wires are unsoldered when the selector is dismantled.

2.50 *Surface wiring for printed wiring board and similar-type connectors* shall be in accordance with Fig 8A or 8B, whichever is applicable, and in accordance with the following:

(a) Vertical wiring shall be confined to the vertical paths between connectors except at 947-type connectors mounted directly adjacent to each

other, in which case the wiring may be dressed vertically between the connector terminals.

NOTE: IN GENERAL SURFACE WIRING IS NOT APPLICABLE TO 204 TYPE SELECTORS MOUNTED ON RELAY RACK UNITS.

(b) On connectors with staggered terminal arrangements (Fig 8A), wiring shall not be dressed horizontally between terminals except where horizontal paths $\frac{3}{16}$ inch or greater in width are provided. Horizontal wiring on connectors such as the 906- through 914-, 928-, and similar-types which are not provided with horizontal wiring paths between terminals shall be dressed along the top or bottom of the connector. Dressing of wiring between terminals where insufficient clearance is provided, especially on connectors having punched embossed-type terminals, may result in damage to wire insulation and possible misalignment of terminals.

(c) Wiring to connectors having staggered terminal arrangements shall in general follow the wiring pattern shown in Fig 8A. The connector is theoretically divided in half. In the upper half of the connector the wires shall be placed between the terminals in paths that are diagonally upward to the left. In the lower half of the connector the wires shall be placed between the terminals in paths diagonally downward to the left. If all of the wiring to a connector is to be dressed along the horizontal paths below the connector terminals, the diagonal paths between all of the terminals on the connector shall be diagonally downward to the left. If all of the wiring is to be dressed along horizontal paths above the connector terminals, the diagonal paths between all of the terminals shall be diagonally upward to the left.

3. SPECIFIC REQUIREMENTS FOR FORMING AND FANNING

A. Unequipped Wires

3.01 General: Skinner ends of unequipped wires which are not connected to terminals shall be protected in accordance with Section 800-612-157 covering protection of skimmers.

3.02 Sewed Forms: The unequipped wires shall be doubled back on the forms or enclosed in paper or fiber tubes, as outlined in the requirements for the

NOTE
 IN GENERAL SURFACE WIRING IS NOT APPLICABLE TO 204 TYPE SELECTORS MOUNTED ON RELAY RACK UNITS. WHERE SELECTORS AND RELAYS ARE MOUNTED ON THE SAME SURFACE WIRED UNIT IT IS DESIRABLE TO USE FORMED WIRING FOR THE SELECTORS. HOWEVER, WHERE SURFACE WIRING TO THE SELECTORS IS ENCOUNTERED THE SURFACE WIRING SHALL BE TREATED AS SHOWN.

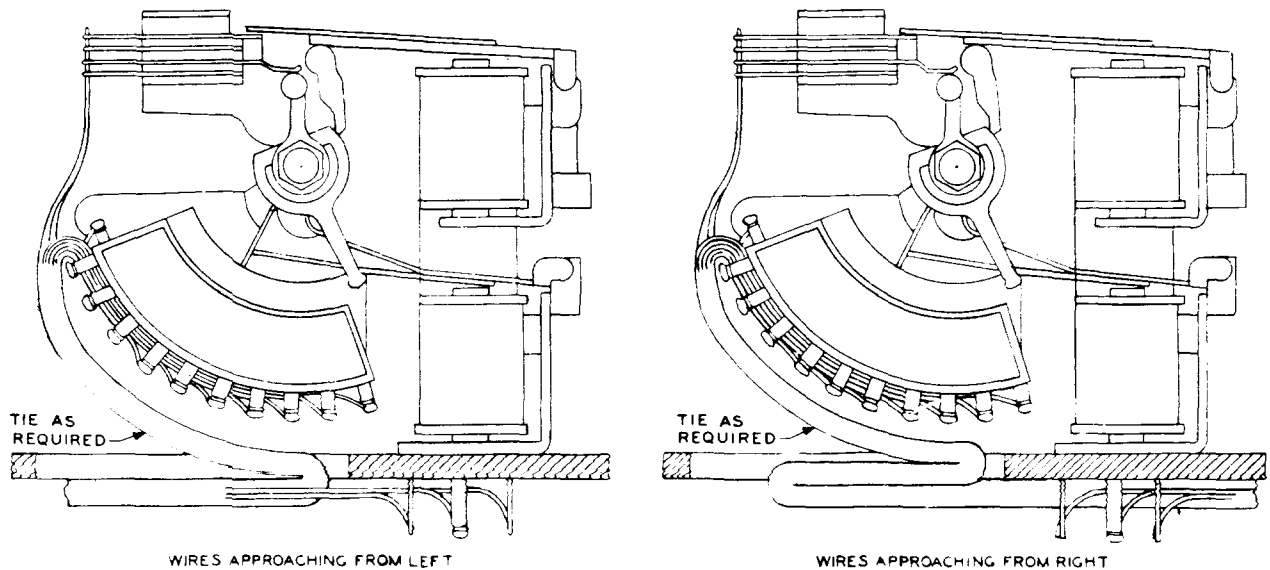


Fig. 9—Surface-Wired 204- and Similar-Type Selectors—Mounted Horizontally on Relay Rack Units

placing and supporting of cable forms, Section 800-612-156.

3.03 Fanned Forms: The unequipped leads shall be connected to terminals where terminals are provided for them.

(a) At D-, 203-, 224-, and similar-type small terminal strips where optional feature leads may not be connected initially, the unequipped leads should be sewed back on the form.

(b) At fuse panels equipped with fanning strips, the wires for unequipped circuits should be pulled through the proper holes in the fanning strip and then through adjacent holes, allowing ends to rest under other wires. The wire ends shall be located so that they will not come in contact with the rivets mounting the fanning strip assembly. Where fuse blocks are provided and dummy fuses are installed, the wires for the unequipped circuits shall

be connected at the fuse panel end and the wires at the unequipped ends shall be individually sleeved.

3.04 In the case of cable forms at 41, 42, and similar-type banks, the unequipped wires shall be left long enough to reach any terminal and doubled back on the forms or enclosed in paper or fiber tubes.

3.05 Loose Wire Forms: The unequipped leads shall be run to the apparatus location to which they would normally connect, and shall be of sufficient length to be connected to future apparatus.

(a) When fanning rings or other wire-retaining devices are provided at the apparatus or circuit position, the unequipped leads shall be bent back at the break-out for each apparatus or circuit position and tied near their ends to the other wires in the form.

(b) When cable leads are run loose from the cable butts and no fanning rings or other wire-retaining devices are provided at the unequipped apparatus or circuit positions, the unequipped leads

shall break out of the main form at each associated unequipped position, using ties or bands around the form to maintain the break-outs.

- (1) When there are only a few leads at each break-out and tagging of leads for future identification is not necessary, the leads may be doubled back and tied to the main leg.
- (2) When the leads are tagged for future identification or the number of leads is too bulky when tied back on the main leg, they shall be stored in paper or fiber tubes tied to the framework or the main leg in the most convenient manner.

B. Spare Wires

In Single-Leg Sewed Forms (Except Switchboard Multiple)

3.06 Where one or more switchboard cables are sewed into a form, the spare wires, where provided, shall not be shorter than the longest wires in the form and shall be brought out to a point approximately 1/2 inch beyond the tip of the form, doubled back along the rear of the form, and then sewed onto the form, as shown in Fig 10, 18, and 19. The free ends of the spare wires shall be cut off approximately 1/8 inch beyond the regular stitch, which includes and comes nearest the ends of the spare wires.

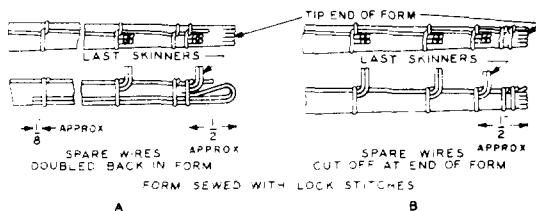


Fig. 10—Spare Wires in Sewed Forms

In Multileg Sewed Forms

3.07 where one or more cables are butted and formed into a horizontal arm serving several

vertical arms, the spares, where provided, shall be doubled back on the horizontal arm, as shown in Fig 20, except where all the leads of any cable are confined to one vertical arm, in which case the spare wires for that cable shall be doubled back on the associated vertical arm.

3.08 Where one or more cables are butted and sewed into a vertical form having several horizontal arms (with or without vertical arms), the spare wires, where provided, shall be disposed of as follows.

- (a) Where the form serves half a bay (or more) of equipment, the spare wires shall be doubled back on the main vertical section of the form at the point where the farthest horizontal arm is broken out, except where all the leads of any cable are confined to one horizontal arm, in which case the spare wires for that cable shall be doubled back on the associated horizontal arm.
- (b) Where such forms serve less than half a bay of equipment, the spare wires shall be brought out at the tip of the tip arm of the form and doubled back on the rear of the form, as shown in Fig 17, except where all of the leads of any cable are confined to one horizontal arm, in which case the spare wires for that cable shall be doubled back from the tip of the associated horizontal arm.

In Switchboard Multiple Forms

3.09 Spare wires, where provided, in short multiple, frame-to-multiple, splice-to-multiple, and multiple-to-multiple forms, except future short multiple cables for No. 10 switchboards, shall be cut off approximately 1/2 inch (gauged by eye) beyond the tip end of the forms, as shown in Fig 10.

- (a) In the case of short multiple forms for future jacks in No. 10 switchboard sections, the spare wires shall be formed out with lead No. 1 at the tip of one form and at the butt of the other connecting form. At the time that the regular leads are cut for the purpose of soldering to the jacks, the spare wires, if not required, should be cut off at the tip of one of the forms and at the first skinner stitch from the butt of the other form.

In Fanned Forms

3.10 Terminal Strips—One or More Cables per Terminal Strip: Spare wires, where provided, shall be pulled through the farthest fanning strip hole

from the cable butt of a particular cable. A hole in the outside row of holes should be used for this purpose, except for 65-type terminal strips where a hole in the middle row of holes should be used. The wires shall be cut off approximately 1-1/2 inches beyond the front of the terminal strip, bent back along the front of the fanning strip towards the cable butt, and passed through a hole which will allow the wires to project approximately 1/2 inch back of the fanning strip. The wires shall then be dressed close to the back of the strip, either toward or away from the cable butt, whichever is more practicable, as shown in Fig 2.

- (a) *In cases of large terminal strips*, such as the 137, 167B, and similar types, where several cables are butted at a single terminal strip, as shown in Fig 2, the length of the spare wires from the cable nearest the terminal strip, when cut off approximately 1-1/2 inches beyond the front of the terminal strip and disposed of as previously specified herein, may be such that they will extend more than 1/2 inch beyond the back of the fanning strip. In such cases, the spare wires shall be dressed against the back of the strip in a direction away from the butt of the cable and then turned again into a hole, through which they will not project beyond the front of the fanning strip. In order to avoid congestion, the spare wires should be confined, where possible, to the area occupied by the other wires from that particular cable.

3.11 Terminal Strips—One Cable Fanned Over More Than One Terminal Strip: The spare wires, where provided, shall be run in the form to the terminal strip farthest from the butt of the cable, where they are disposed of in the manner described above for cables formed over only one terminal strip.

- (a) Where a cable terminates so near the end of a terminal strip (end toward the cable butt) that there is insufficient room to turn the spares toward the cable butt, they should be turned away from the butt and pulled through a fanning hole, which will allow the ends to be disposed of in the usual manner.

3.12 Terminal Strips—Several Cables Formed Over More Than One Terminal Strip: Where several cables are formed to a group of terminal strips and leads from each of the cables are fanned out to all of the terminal strips, the resulting number of spares, where provided, may be such that they cannot be disposed of in the fanning holes at the

farthest terminal strip. In such cases, the spares, although left long enough to reach the farthest terminal served by the cable, should be disposed of by distributing them along the fanning strips of several of the terminal strips involved.

3.13 D- and 224-Type Terminal Strips: The spare wires, where provided, of cable terminating at D- and 224-type terminal strips located on relay rack units shall be left long enough to reach the terminals of the farthest terminal strip served. They should be pulled back to the cable or cable form and then disposed of by looping them up and down on the cable or cable form on the side of the form toward the frame upright. Ties, as required, should be used to hold them in place on the cable form.

- (a) The spare wires terminating at 224-type terminal strips located in the rear of switchboards shall be left long enough to reach the terminals of the terminal strip farthest from the cable butt. They should be disposed of by doubling them up and storing them in a paper or fiber tube. The tube should be sewed to the bottom of the terminal strips nearest the cable butt.

3.14 Protector fanning Strips: Where cables are terminated on protectors on protector frames or distributing frames, the spare wires, where provided, shall be passed through the last fully-wired outer hole in the fanning strip farthest from the butt of each cable and cut off approximately 1-1/2 inches beyond the terminal farthest from the fanning strip. The ends should be bent back, passed through the hole toward the butt that will allow the spare wires to project approximately 1/2 inch beyond the back of the fanning strip, and dressed closely to the back of the strip, either toward or away from the cable butt, whichever is more practicable.

3.15 Fuse Panel Fanning Strips: The spare wires, where provided, shall be pulled through holes, as found convenient, at the end of the fanning strip opposite that from which the cable enters and then back through adjacent holes, allowing the ends to rest under other wires. The wire ends shall be placed so that they will not come in contact with the rivets that pass through the fanning strip assembly.

3.16 Interrupter Fanning Strips: Spare leads of interrupter wiring passing through fanning strip holes shall be turned back through the fanning strip hole farthest from the cable butt.

In Loose Wire Forms

3.17 *Where the strippers of switchboard cables are held in cable formation by rings* or other wire-retaining devices such as loose wire forms on the rear of step-by-step shelves and the leads dress into apparatus not having fanning strips so that the spare wires, where provided, cannot be disposed of in the regular manner at fanning strips, the spare wires shall be left long enough to connect to the farthest terminals on the equipment. They should be bent back around the last fanning ring and laid in the form, being tied near the ends to other wires in the form.

- (a) At 227- and similar-type terminal strips where the fanning strip consists of a slotted opening, the spare wires should be treated in the same manner as apparatus without fanning strips.

3.18 *Where cables are stripped and run loose vertically from the cable butt* and the wires terminate at D-, 224-, 227-, and similar-type terminal strips or at apparatus without a fanning strip, the spare wires, where provided, cannot be disposed of in the regular manner employed at fanning strips. They shall be left long enough to reach the farthest terminal on the ultimate equipment to be served, pulled back in the loose wiring path, and disposed of as follows:

- (a) *Where cable brackets or cable supports are provided*, spare wires shall be run to the next lower cable bracket or support and looped upward (not around the bracket) behind the loose wires and tied near their ends to the loose wire form. Intermediate ties should be used, as required, to keep the wires in a reasonably good formation.
- (b) *Where the KS-15660 plastic wiring supports are provided* spare wires shall be looped under the next lower adjustable wiring support below the lowest mounting plate which the cable serves, run back up the form under any wiring supports passed, and tied near their ends to the loose wire form.
- (c) *Where the lowest mounting plate served by a cable is below the cable bracket, adjustable wiring support, etc.*, the loop in the spare wires shall be made approximately 1 inch below the break-out point of the horizontal arm and tied to the loose wire form at the break-out point.

(d) *Where no cable brackets, adjustable wiring supports, etc. are provided*, the spare wires shall be looped approximately 1 inch below the lowest break-out served by the cable and tied to the loose wiring form at the break-out point. The spare wires shall be tied near their ends to the loose wire form.

(e) Where the lowest mounting plate served by the cable is located close to the top of the bay so that the spare wires after being doubled back would project above the butt, they shall be doubled back again at the butt with the loop tied to the loose wire form approximately 1 inch below the butt.

(f) *In duct-type bays*, the spare wires should extend down in the duct, through the next fastener, and cut off at that point.

C. Use of Spare Conductors

3.19 Spare conductors shall not be used as regular conductors, except to replace defective regular conductors. A conductor is considered defective when the break (or other defect) occurs under the sheath of the cable or in a position where it cannot be repaired or spliced.

3.20 *In quadded cables*, the extra quad shall be furnished to provide a choice in case it is necessary to secure a proper capacity balance; it should not be used for other purposes unless specifically authorized. An exception may be made, however, where quadded cable is used for nonquadded circuits and the number of conductors required makes it desirable to use part of the extra quad for regular conductors.

D. Unused Wires

3.21 *Sewed Forms*: Unused wires shall be treated in the same manner as spare wires in sewed forms, (see 3.06 through 3.08) except as outlined below for oversize short multiple cables.

(a) *Oversize cables* are sometimes used in multiple runs. The large number of unused wires in such oversize cables when cut off at the tip makes a bulky form; the thickness at the tip is such that the forms cannot be kept within the standard skinner increments. In such a case about

one-half of the unused wires shall be cut off at a point one-third the distance from the butt to the tip of the form and the remaining half of unused wires about two-thirds the distance from the butt to the tip. The ends of each group of unused wires shall be taped together and sewed in the form with the regular wires in the usual manner. Where the number of conductors in the cable is very large in proportion to the number actually used as in the case of the 277-type cable used for group-busy lamp in the No. 3 toll switchboard in which as few as four leads may be used in a form, enough wires should be carried to the tip of the form to give it ample body.

3.22 Connectorized Cables: Oversize cables are sometimes terminated to multicontact connectors, such as in connectorized cable applications, and the cable is butted at the connector. In these cases, the unused wire may be cut off at the butt.

3.23 In Fanned Forms: As many of the unused wires as is practicable should be pulled through the holes or slots of the fanning strip with the spare wires and disposed of in the same manner as the spare wires in fanned forms (see 3.10 through 3.16). Such remaining unused wires as cannot be drawn through the holes or slots should be cut off at the butt of the cable or, if practicable, disposed of as spare wires per 3.18. Care should be taken to treat both ends of the same wires alike.

(a) Where it appears desirable from a future installation standpoint to store a larger number of unused wires than can readily be pulled through holes or slots in the fanning strip, they should be disposed of as covered in supplementary job information.

(b) The unused wires of cables terminating at D-, 224-, and 227-type terminal strips shall be disposed of in the same manner as spare wires.

3.24 Loose Wire Forms: Unused wires in loose wire form shall be disposed of in the same manner as spare wires (see 3.17 and 3.18).

3.25 Sectional Cables: Where cables are sectional in construction, having two or more sets of duplicate colored leads, each section should be considered as an individual cable when disposing of unused wires. Unused wires from each section shall, unless otherwise specified, be disposed of in the same manner as described for nonsectional cable.

E. Pairs, Triples, and Quads

3.26 Paired, tripled, or quadded wires shall not be untwisted within a sewed cable form.

3.27 Forms composed of a few wires twisted together in a regular and neat manner (such as a twisted pair, triple, or quadruple set of wires) need not be sewed unless other wires, pairs, triples, or quadruples are to be formed in with them.

3.28 Separation of a Pair, Triple, or Quad: When one or more but not all wires of a pair, triple, or quad are to be looped and connected to a piece of apparatus, the wires to be looped shall be cut, untwisted, and withdrawn from the other wire or wires of the pair, triple, or quad and formed out to the apparatus. The remaining slack in the wire or wires that is not looped at the apparatus is then doubled back and sewed in the form.

3.29 Disregarding Pairing: Pairing of leads may be disregarded under the following conditions.

(a) Where one wire of a pair is to loop at one break-out point and the other wire of the same pair is to loop at one or more break-out points at the same apparatus position, pairing shall be disregarded between such break-out points, but maintained in other parts of the form.

(1) The omission of pairing described above may also be employed where one wire of a pair breaks out to one apparatus position and the other breaks out at an adjacent apparatus position, provided that the two apparatus positions are not more than 2-1/2 inches apart.

(b) On SW1 wired equipments, pairing is not observed within the unit unless specifically noted on the circuit schematic. Pairing should be maintained, however, in leads up to the unit terminal strip.

3.30 Where pairing is specified on surface-wired equipments between closely spaced points of termination, it will be satisfactory to twist the wires approximately one twist per inch.

3.31 In general, the normal twist furnished in pairs, triples, and quads run in sewed cable forms is sufficient to keep the wires adjacent to each other in the form where the connections are between more than two pieces of apparatus. However, in those

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cases where break-out points are closely spaced and the connection is limited between two pieces of apparatus resulting in short wires with no twist, they shall be run as follows, in order to keep the wires adjacent to each other in the form.

| SPACE BETWEEN BREAK-OUTS | NUMBER OF TWISTS REQUIRED |
|------------------------------|--|
| Up to 1 Inch | No Twist |
| Over 1 Inch to 2 Inches | At Least One Crossover or One-Half Twist |
| Over 2 Inches to 4 Inches | At Least One Twist |

F. C, C1, C2, C4, and C5 Wiring

3.32 The symbols C, C1, C2, C4, and C5 are used to designate wiring which must be segregated to minimize its inductive effects on other wiring. These symbols are shown at the affected leads on both the circuit schematic and the wiring diagrams, except C1, which is shown on the wiring diagram only. The information in the following paragraphs indicates the degree of segregation required and also the permissible grouping of certain noise-inducing wiring with other wiring.

Note 1: For definitions see Section 005-150-101.

Note 2: Although no segregation of wire run on cable rack is required (physical segregation from other wiring), the same rules governing permissible combination of C wiring shall apply to the grouping of C leads in pairs, triples, or quads.

Note 3: Segregation in loose wire forms shall be observed only when specifically noted on the circuit schematic.

3.33 C Wiring: Wiring carrying noise-inducing currents of low intensity which requires limited segregation.

(a) No segregation required on wiring run as:

Local cable

Formed ends of switchboard cable

Loose wire forms (see Note 3 in 3.32)

Loose wire in fanning rings or other wire-retaining devices (see Note 3 in 3.32)

Wire on cable racks (see Note 2 in 3.32)

Surface wiring within a unit

(b) Wiring must be segregated from C2 wiring and all wiring not marked on the circuit schematic when run as:

Switchboard cable (see exceptions in Section 800-612-162)

Sewed local power cable

(c) Wiring may be combined in the same switchboard cable or sewed local power cable with other leads marked C or C5 in accordance with information covered in Section 800-612-162, Selection of Switchboard Cables.

(d) Prior to March 1, 1938, C leads were required to be separated from leads not marked on the circuit schematic throughout their entire length, whether in switchboard or local cable. The separation rules outlined above, however, shall be followed for C leads in all circuits except those containing operator telephone leads which were issued prior to March 1, 1938. These latter conditions, if encountered, should be referred to the Laboratories before the segregation of C leads in local cable forms is disregarded.

3.34 C1 Wiring: As indicated in Section 005-150-101, C1 wiring (a symbol used on wiring diagrams only) indicates that the physical separation of noisy leads (C2, C4, and C5) is to be accomplished in a particular manner. The same rules followed for the segregation and grouping of C2, C4, and C5 wiring apply to C1 wiring.

3.35 C2 Wiring: Wiring carrying noise-inducing currents of high intensity which requires complete segregation throughout the entire length.

(a) No segregation required on wiring run as:

Wire on cable racks (see Note 2 in 3.32)

Loose wire forms (see Note 3 in 3.32)

Loose wiring in fanning rings or other wire-retaining devices (see Note 3 in 3.32)

Surface wiring within a unit

(b) Wiring must be segregated from all leads marked C, other C2 leads (except C2 leads in other identical circuits), C4, and C5 leads as well as from all other leads not marked on the circuit schematic when run as:

Local cable

Switchboard cable

Formed ends of switchboard cable

Sewed local power cable

(c) The only C2 leads that may be grouped together are identical C2 leads from other identical circuits.

3.36 C4 Wiring: Wiring carrying commercial power within a unit which must be kept separate from all other wiring.

(a) No segregation is required within the unit on surface-wired equipment.

(b) All C4 leads may be grouped together.

3.37 C5 Wiring: Wiring carrying noise-inducing currents of medium intensity which requires segregation throughout the entire length, but is not critical enough to require complete isolation from other noise-inducing wiring.

(a) No segregation required on wiring run as:

Wire on cable racks (see Note 2 in 3.32)

Loose wire forms (see Note 3 in 3.32)

Loose wiring in fanning rings or other wire-retaining devices (see Note 3 in 3.32)

Surface wiring within a unit

(b) Wiring shall be segregated from all leads marked C2 and C4 as well as from all other leads not marked on the circuit drawing when run as:

Local cable

Switchboard cable

Formed ends of switchboard cable

Sewed local power cable

(c) All C5 leads may be grouped together in the same cable with other C5 leads, but throughout their switchboard or sewed local power cable portion they may be combined with C leads in accordance with information covered in Section 800-612-162, Selection of Switchboard Cables.

3.38 When separation of wiring in sewed cable or local cable forms is specified by the symbol C2, C4, or C5 on the circuit schematic, the leads to be segregated shall be sewed into a separate form or forms, depending on the condition, and placed on the outside of the regular form near the side on which they will turn off to the branch arms of the regular form.

(a) In keyshelves, the placing of added forms on or near the top of the original form (the part of the form nearest the apparatus) will tend to prevent damage to the wires from the movement of the form when the keyshelf is raised or lowered.

3.39 Where separation of wiring in loose wire form is specified on the circuit schematic, the leads involved shall be segregated from the other wiring by tying at intervals to ensure separation.

3.40 Where leads in the formed ends of switchboard cables terminating at cable well terminal strips require segregation, they shall be tied together where they enter the first terminal strip but need not be further segregated.

G. D, D1, D2, D3, D4, and D5 Wiring

3.41 Wiring should be run in the open from terminal to terminal **D Wiring** should be run in the open from terminal to terminal and shall not be sewed in cable forms for electrical reasons. These wires, which are always singles, should be run out perpendicular to the plane of the mounting plate or panel from the terminals on the shortest piece of apparatus to the plane of the apparatus terminals farthest from the panel, and then parallel or perpendicular to the edges of the mounting plate or panel in the shortest possible manner. A minimum clearance of 1/2 inch between any D wiring and adjacent grounded metal surfaces is desirable. The paths followed for D leads need not be identical for all like units, even though the units may bear the same equipment code designation.

3.42 D1 Wiring: In some cases the arrangement of the wiring is so critical that certain leads must be kept as short as possible. Such leads are marked D1 on the circuit schematic. These leads, which are always singles, shall be run directly from terminal to terminal instead of parallel and perpendicular to the edges of the panel as for D wiring. The amount of slack in D1 leads shall be kept to a minimum, consistent with the type of terminals and the apparatus arrangements encountered.

(a) In no case shall leads between terminals be drawn so taut as to bend the terminals; slack up to 1/4 inch maximum, measured between the points of the connection, shall be permitted.

(b) Leads to apparatus having terminals of the floating or movable type such as those encountered on electron tube sockets and certain connectors and leads between apparatus on main panels and that on subpanels (whether fixed or shock mounted) shall be run with sufficient slack so as not to hamper the movement for which the apparatus design provides.

(c) Where an intervening terminal or other apparatus part makes it necessary for D1 leads to deviate slightly from the theoretical direct path, the use of different, but otherwise equal paths to clear such interferences is satisfactory. It is not necessary that the same path be used on all panels of the same type even though the unit may bear the same equipment coded designation. Wiring that is so critical electrically that this deviation is unsatisfactory shall be specified as D2 wiring.

3.43 D2 Wiring: It is sometimes necessary for electrical reasons to keep certain leads separated from each other or to keep them in a certain location with respect to other leads. In such cases, the leads will be marked D2 on the circuit schematic drawing, and the wiring arrangement will be covered on a strapping diagram or other equipment information. This information should cover whether the D2 leads are to be kept out in the open or, if the insulation permits, dressed back against the mounting plate.

3.44 D3 Wiring: D3 wiring is similar to SW1 surface wiring (see 3.47 and 3.48) in that it is run loose and dressed near or against the mounting plate

or panel, or adjacent to the plane of the mounting surface. The difference between D3 and SW1 surface wiring is as follows.

(a) The type and gauge of wire is not restricted to 24-gauge, BW- or DP-type (as it is for SW1 wiring). For D3 wiring, the gauge and type of wire shall be specified.

Note: Polyvinyl chloride (PVC) insulated wire such as BU- and BY- type is not recommended for surface wiring because of the cold flow damage to insulation which might occur when such wires are dressed against the sharp edges or corners of apparatus terminals.

(b) Pairing is not disregarded. (Color of pairs, triples, and quads shall be specified.)

(c) General paths for groups of wires may be specified.

(d) Due to larger gauge wire which may be used, it may not be practicable to dress the leads to apparatus terminals in the same manner as for SW1 wiring. Wiring to the 227-type terminal strip is an example where following the same rules may result in congestion. In such cases, it will be satisfactory to run the wiring in a manner which will result in a neat and orderly appearance. Sufficient slack shall be available so that the wires will not be taut.

3.45 D4 Wiring: D4 wiring is similar to SW1 surface wiring in that it is run loose and dressed near or against the mounting plate or panel, or adjacent to the plane of the mounting surface. However D4 wiring differs from SW1 surface wiring in that the color, gauge, type of wire, and wire paths are specified by the BTL design engineer on the SD- or ED-drawings or other applicable drawings or specifications, and the wiring paths are controlled by a computer program.

3.46 D5 Wiring: D5 wiring is surface wiring that is specifically designed for a particular unit of equipment, that is, wiring that does not conform to the requirements covered by any of the other surface wiring symbols. Complete information for this type of wiring is specified by the BTL design engineer on the SD or ED drawings or other applicable drawings or specifications.

H. SW1 Wiring

3.47 SW1 surface wiring is restricted to the use of 24-gauge BW- or DP-type wire. SW1 is considered to be the general use type of wiring for surface-wired units. When it is necessary to use other gauges or types of wire for surface wiring, D3, D4, or D5 wiring, as covered in 3.44 through 3.46, may be used.

- (a) SW surface wiring, which was restricted to type G wire, was formerly used on step-by-step switches and, to a limited extent, on equipment units of the conventional relay mounting plate type. This type of surface wiring was replaced by SW1 surface wiring.

3.48 In SW1 wiring, distinctive colors are used for battery and ground leads, all other wiring being green. Other colors may be used occasionally for certain specific leads to facilitate manufacture, as for example where leads run from apparatus on the front of a mounting plate to apparatus on the rear. See Section 800-612-161 for the assignment of colors to surface wiring.

I. F Stitch Leads

3.49 An *F* stitch shall be used on cable forms to identify one lead of two or more leads of the same color that are brought out at a regular stitch position but which are not connected to the same terminal on the piece of apparatus. The wiring diagram indicates which of the leads should be brought out at the *F* stitch.

- (a) *F* stitches are not required on switchboard cable forms because no color designation is shown for these leads on the wiring diagram, and the use of an *F* stitch would serve no purpose for maintenance identification. Extra stitches, not identified by the symbol *F*, are sometimes used on switchboard cable forms as a convenient method of separating leads, where so desired, for manufacturing reasons. Such stitches are not specified on the wiring diagrams.

3.50 *F* stitches shall be located on the side of the regular stitch toward the tip of the form on both vertical and horizontal forms, as shown in Fig 11. If more than one *F* stitch lead is used, the *F* stitch leads shall be designated *F*, *F*1, *F*2, etc, start-

ing with the one nearest the regular stitch and using a separate stitch for each like-numbered *F* designation. Where these wires are to be identified on tabular wiring diagrams, symbols *F*, *R*, *S*, *T*, etc, may be substituted for *F*, *F*1, *F*2, *F*3, etc, respectively.

- (a) *When an extra stitch is specified on the multiple and short multiple cable drawings* to separate leads of the same color, the extra stitch shall be located toward the tip for the straight forms and toward the butt for slanting forms.
- (b) *On ladder-type forms where a cable arm has neither tip nor butt*, the *F* stitches shall be located on the right side of the regular stitch facing the wiring side of the apparatus.

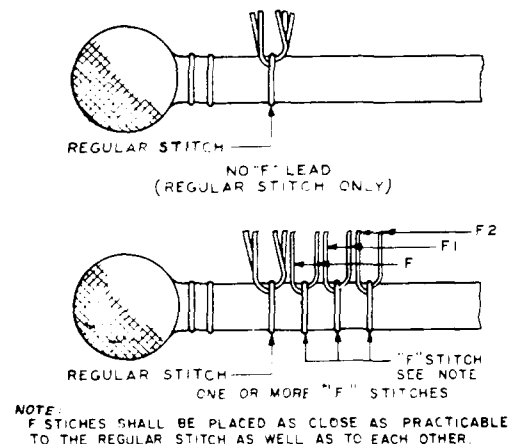


Fig 11—*F* Leads and *F* Stitches

3.51 *Number of F Stitches:* It should be possible to limit the number of *F* stitches at a given point to one by a proper selection of different colored wires. More than one *F* stitch, however, is permissible where it would be impractical to select wires with different colors to avoid duplication.

3.52 *When two or more leads of the same color* approach a stitch and are to be connected to different terminals of the same piece of apparatus, or when one wire of a pair is to be cut and the ends connected to different terminals of the same piece of apparatus, one of the wires shall be brought out at the regular stitch and each of the other wires at an extra

or F stitch. The extra stitch or stitches shall be located as close as possible to the regular stitch for the wires brought out at this point.

J. Shielded Wire and Coaxial and Twin-Conductor Shielded Office Cable

3.53 Except where otherwise specified, forming of shielded wire and coaxial and twin-conductor shielded office cable shall be in accordance with the requirements for forming specified in Part 2 of this section and the requirements of Section 800-612-164 covering forming, grounding, splicing, and terminating shielded wire and cable. In forming shielded wire and cable, the bending radii shown in Section 800-612-164 shall be maintained. Cables not listed in Section 800-612-164 shall be bent on a radius of at least five times the diameter of the cable.

Note: Care should be exercised in forming miniature coaxial cable and small diameter shielded wiring to avoid drawing the cable or wire tightly on forming boards or other wiring devices since this may cause stretching and possible breakage of the conductors of the cable or wire.

3.54 *On SW1 wired equipments*, shielded wiring is not observed within the unit unless specifically called for by means of a note on the circuit schematic. Shielding shall be maintained, however, in leads up to the unit terminal strip.

3.55 *Forming of 750- and Similar-Type Cables:*

Shielded pairs in these cables should not be stripped and formed out with other cables or wire, unless all such wire and cable conductors are insulated wires having braided, PVC, or PE insulation. This applies to either sewed forms or loose wire forms. When it is necessary to form out these shielded pairs with insulated wires having other than braided, PVC, or PE insulation, the exposed shields shall be insulated as outlined in the requirements for protecting cable forms and skimmers in Section 800-612-157.

K. Common Wiring

3.56 *The use of one set of common leads*, such as battery and ground leads, to supply several small groups of adjacently mounted unlike circuits, instead of separate sets of leads for each group, is permissible, providing the number of circuits supplied by such common leads is not greater than the smallest number specified for any of the circuits served by the particular leads.

3.57 Where it is necessary to connect battery, ground, or other common wires to strip-mounted apparatus such as relays, lamps, or jacks, the common wires shall be run in the cable form to the nearest strip of apparatus, and the loop wires shall be run in the form to the other strips of apparatus. The common or loop wires at each strip or mounting plate shall be brought out of the form at the same point as the regular skimmers to the nearest equipped piece of apparatus on each strip, except as otherwise specified herein. The loop wires should be included in the cable form only when all the wires are to be placed in the form.

(a) An exception shall be made to the preceding requirements in the case of equipment mounted on panel system single- and double-sided frames where the common lead should be brought in to the first apparatus position, either equipped or unequipped. Where such terminations unavoidably occur at unequipped apparatus positions, the leads shall be protected in accordance with the requirements for protecting such leads in Section 800-612-157.

(b) Another exception is made in the case of universal local cables where, due to variable features, common leads may be run to other than the nearest piece of apparatus to avoid splices that would be required in order to extend a lead along the form. An example of such an exception is the case of No. 3 toll switchboard keyshelf cables for outward positions where the common wire is brought out of the form at a point opposite the nearest apparatus position, which is equipped on all types of No. 3 toll positions. In 550-, 551-, and similar-type PBX switchboards, the common wire in the keyshelf form shall be run to the tip of the form where the lowest numbered key is always equipped, and the loop wire shall then be run back towards the nearest piece of apparatus.

3.58 *When all the wires are not to be included in the same cable form*, as in cases where switchboard cable is used in connection with local cable, the common wires shall be run to the strip or mounting plate having the nearest associated piece of apparatus or to punchings located on the equipment. When punchings are not furnished, the common wires shall be brought out of the cable at a point opposite the nearest strip or mounting plate of apparatus and left long enough to reach the apparatus on the strip.

3.59 *Where the nearest piece of apparatus is adjacent to a large cable form* or the common wires would otherwise cause congestion if brought out at this point, the common wires shall be brought out of the form with the regular skimmers to the next associated piece of apparatus suitable for the connection where congestion would not occur. If more than one set of common wires is required, they should be brought out at two points, one opposite each of the two nearest associated pieces of apparatus.

3.60 *Ringling loop wires between similar pieces of equipment*, such as relays on relay racks and keys in keyshelves, should not, in general, be superimposed, but should be run in the regular local cable form, except in the case of sources of ringling supply having an irregular waveform when the loop wires are segregated as C5 wiring.

3.61 *Common wires looped between adjacent terminal strips* on relay rack units or bay-wired equipments shall be formed as follows.

- (a) Where there are six or more common wires, they shall be sewed into a form and connected to the local cable side of the terminal strip.
- (b) Where there are five or less common wires, they shall be superimposed on the switchboard cable form serving the terminal strips and shall be connected to the switchboard cable side of the terminal strip.

3.62 Where one set of common leads serves more than one group of multicircuit relay rack units, the common wires shall be multiplied from the first circuit of the first group at which the common wires terminate to the corresponding circuits of the other groups served by the common leads, unless otherwise specified. The common wires within a group, that is, circuits served by one set of common leads, shall be run from the last circuit of the first unit to the first circuit of the other units in the same group (for example, 10 to 11, 20 to 21, etc).

L. Adding Wires to Existing Forms

3.63 When wires (other than the various types of C wiring) are to be added to existing sewed cable forms, the additional wires may be distributed around the existing form or they may be served into a separate form and superimposed on or banded to the existing form. Where the added wires are required to pass through metalwork (such as toll repeater panels

and sender casings) the added wires shall be distributed around the existing form in the area where they pass through the metalwork hole or slot. This will minimize interference with future placement of added wiring. Protection should be added as specified in Section 800-612-157 for stationary cable forms passing through metalwork.

- (a) Where the wires are to be added to keyshelf forms, see 3.68 through 3.71.

3.64 Supplementary local cables, which are formed by the shop and installed in the field, should, in general, be superimposed on or banded to the existing forms except for those portions of the cable passing through metalwork casings of keyshelf aprons. Where the form passes through metalwork casings or within the area of the keyshelf, the added wires shall be distributed around the existing form. Where portions of the existing form are inaccessible, making it difficult to superimpose or band the supplementary form to it, the corresponding portions of the supplementary cable may be treated as a separate cable and secured to cable brackets or supports as required.

3.65 Wiring superimposed on existing sewed cable forms shall not cover up any of the various types of C wiring already superimposed on these forms.

3.66 When superimposing wiring to existing forms, it is desirable that the added wiring be placed so as not to cover or otherwise make inaccessible any wiring associated with unused circuit options or features, such as wiring that is sewed back on the forms for storage.

3.67 Where cable forms are provided with fire detection wire, care should be taken to see that no wiring added to or superimposed on such cable forms is fastened in such a way as to cover either the 1A fire detection wire or the red-type AM or BH wire of the fire detection loop.

- (a) The fire detection loop return wire (type AM or BH) on the main vertical stem of a bay local cable may be crossed at right angles if only a few wires or the horizontal arms of a supplementary local cable are involved.

M. Adding Wires to Keyshelf Forms

3.68 When wires (other than the various types of C wiring) are to be added to existing sewed ca-

ble forms in keyshelves, the additional wires from the keyshelf apron to their termination at keyshelf apparatus shall be distributed around the form and may be placed over the existing protection material. The added wires should be secured to the existing form as specified in this section for superimposed wiring and protection should be added as specified for keyshelf local cables in Section 800-612-157.

3.69 When the added wiring consists entirely of wire types not normally requiring protection from contact with metalwork, such as types AM and BH, additional protection is not required for the added wiring if it is placed on the existing form so as not to be subject to damage by raising or lowering the keyshelf. However, the added wiring shall be protected in the area where it passes through the keyshelf apron. In this case, protection consisting of sheet fiber (995918620) covered by friction tape (995911278) should be applied around the form where it passes through the keyshelf apron as specified for keyshelf local cables in Section 800-612-157.

3.70 Where the added wires require protection, the addition of protection materials to an existing cable form which is already provided with protective materials might result in an excessively bulky cable form. This might cause rubbing of the cable against the key-pan, apron, or other metal work, and might result in damaged wires and/or improper closing of the key shelf (due to the main form extending into the space of and coming in contact with the individual key forms.) Under such conditions, the protection material on the original cable form shall be removed and all of the wires shall be sewed into one form, adding the necessary protection as required.

3.71 Wires added to keyshelf local cable forms shall be placed within the metal strap or clamp or secured with nylon cable ties at the position of the keyshelf bracket per Section 800-612-156. The added wires shall also be placed within all other form supporting details.

N. Arrangement of Wires in Switchboard Cable Forms

3.72 Wires of cables should be formed out for connecting as nearly as possible in accordance with the standard color sequence for switchboard cables, as covered in Section 800-612-161, Color Combinations and Uses.

3.73 In splitting pairs (for use as singles) over two circuits, the mate leads (fixed color or novelty

color leads) for the first, third, etc, circuits and the color lead for the second, fourth, etc, circuits should be used. In splitting pairs at a terminal strip for use as singles in an individual circuit, the mate lead shall be assigned to the terminal nearest the clamping strip and the basic color lead to the second terminal from the clamping strip, etc, where the circuit terminals are arranged in the rows perpendicular to the clamping strip. Where arranged in rows parallel to the clamping strip, the mate lead shall be assigned to the terminal nearest the top or left end of the terminal strip and the basic color lead to the next adjacent terminal, etc.

(a) Where the individual leads of a pair must be separated over widely spaced locations at one end or the other, it is preferable to separate them at the terminal strip end rather than between switches or apparatus other than terminal strips.

3.74 In 754- and 760-type cables, the white conductor shall be considered as the tip of the pair and blue conductor as the ring of the pair.

3.75 Sectional Cables: Cables that are sectional in construction shall be formed with the section having a blue binder assigned to the lowest numbered circuits followed by the section with the orange binder, etc, in the normal color sequence.

(a) An exception to the above is made in the case of sectional cables used for 4-, 5-, and 6-wire circuits where the leads from two or more binders are used for each circuit. In such cases the leads shall be formed out, using a color "slip", as covered in Section 800-612-161, Color Combinations and Uses. In rare cases it may be found that even with the color "slip" arrangement there may be an occasional color duplication at break-out points requiring an extra stitch or other suitable means of identification.

3.76 The stripper of a cable or each individual section of a sectional cable need not be untwisted between the cable butt and the first skinner break-out of that particular section.

4. SPECIFIC TYPES OF CABLE FORMS

4.01 Where two or more cables are to be made into a single round form, either straight or at right angles from the cable butt, the wires shall be formed as shown in Fig 12.

A. Multiple Forms in Switchboards

4.02 Multiple and short multiple cables in switchboards, desks, and similar equipment where cables are run parallel with and are located directly in the rear of the associated jacks, lamps, or strip-mounted apparatus shall be made as a single-arm sewed form extending from the butt, as shown in Fig 13, 14, and 15. Two types of these forms are used, the short skinner or straight form in which the blue or first set of skimmers is at the butt of the form, and the long skinner or slanting form in which the blue or first set of leads is at the tip of the form. Care should be taken to keep the skinner edge of the straight form and the outer edge of the slanting form as nearly parallel to the edges of the cable as practicable.

4.03 In order to prevent objectionable accumulation of discrepancies on the overall runs of the multiple cables, particular care should be taken to

maintain the correct dimension from the first break-out to the first break-out of each cable, as well as butt-to-butt dimensions. The maintenance of the butt-to-butt dimensions is also essential in order to ensure proper alignment of butts in the switchboard so that webbing can be suitably installed and, in the case of pin multiple, that the cable can be properly mounted on pins. A variation of $\pm 1/4$ inch from the specified dimension between butts is allowed. When there is a variation from the normal butt-to-butt dimension, either over or under, the specified dimension between the butt and first skinner at each end of the cable shall be adjusted upward or downward by the amount equal to one-half of the variation on the between-butts dimension. In this case, the tolerance of $\pm 1/8$ inch on the butt to first skinner dimensions described in 5.45 shall apply to the adjusted butt to the first skinner dimension. However, the total variation in the dimension between the first break-out to the first break-out shall not exceed $\pm 1/4$ inch.

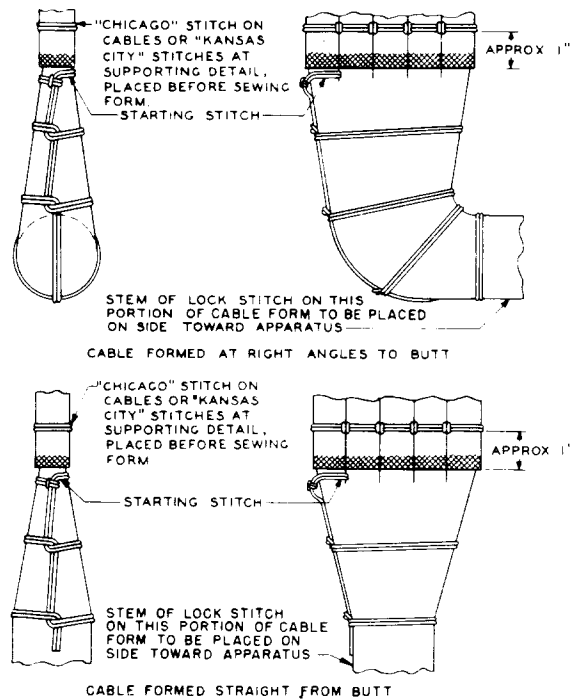


Fig 12—Two or More Cables Formed Out as a Single Round Arm

4.04 In order to avoid pronounced irregularity in the piling of cables on multiple shelves in switchboards, the thickness of the cable forms shall not exceed the maximum thickness permitted for the particular cable when used in multiple by more than 0.015 inch. The form thickness is controlled by sewing through the form as shown in Fig 13 and 14. Multiple cable forms that are to be installed on pins (instead of on a multiple shelf) need not be held to the above requirements.

(a) The 24R-, 256R- and similar-type cables shall be sewed at the butt as covered in Fig 14 for oval cables.

(b) Cables formed with 74R cable shall be sewed as shown in Fig 13, except that the winding stitch shall start at the fourth break-out from the butt of the form.

4.05 Where two short multiple cables serve the same strip of apparatus (such as in the case of two 100-circuit cables serving the 200-point checking multiple test strip used in DSA switchboards), they shall be formed out as one form and tied together at the butts in such a way as to eliminate any slack in either cable so that the cables will lie flat in the cable run. Where the use of a broom stitch performs no definite function (as in the case of checking multiple), the two forms may be sewed into one form in the same manner as shown in Fig 14 for round cables.

4.06 Short multiple cables at end sections (commonly known as special end cables) having skinners soldered singly to the jacks shall have skinners furnished 5/8 inch longer than those furnished on preceding sections so that the skinners will be long enough to be cut off at the jacks and reskinned and soldered when the multiple is extended. The slack due to the 5/8-inch extra-length skinners should be taken up preferably by pulling cables toward the rear edge of the multiple shelf. Where it is not practicable to pull back the cables, the slack may be taken up by putting a dip in the skinner dress.

(a) The 5/8-inch added skinner length does not apply to multiple with cutoff jacks, such as No. 12 subscribers multiple where the multiple leads are not, in general, doubled up on the terminal.

4.07 At the last appearance of short multiple cables where the rear cables extend beyond the front cables due to the partial appearance of the multiple in

the end section, the rear cables should be brought forward so that they are in line with the cables nearest the jack equipment. The resulting extra length of skinners is then taken up by storing the extra length of wire on a fiber detail and sewing it with temporary stitches, as shown in Fig 16.

B. Answering Jack Forms

4.08 A cable serving 20 answering jacks mounted ten-per-strip in the switchboard with an intervening strip shall be made as a double-arm form extending at right angles to the cable, as shown in Fig 17.

4.09 A cable serving two strips of ten jacks per strip with no intervening strip shall have the form made as one arm, as shown in Fig 18. The odd numbered sets of wires, 1, 3, 5, etc, serve the lower numbered strip of jacks, and the even numbered sets of wires, 2, 4, 6, etc, serve the higher numbered strip of jacks. Color combinations one to ten of the standard color scheme shall be used for the odd numbered sets of wires, and color combinations 11 to 20 shall be used for the even numbered sets of wires.

4.10 When a cable serves one strip of 20 answering jacks, the form shall be made as one arm, as shown in Fig 19.

C. Fuse and Circuit Breaker Bay Forms

4.11 In general, fuse panels on the fuse bays are equipped with fanning strips. On fuse or circuit breaker bays, where fanning details are not provided because of the size and number of wires or other reasons, single-, double-, or multi-arm sewed forms shall be used as required with one horizontal arm for each single- or double-row fuse or circuit breaker panel (see Fig 17 and 19).

D. Relay Rack Forms

4.12 In general, the requirements covered in Section 800-612-151 shall be followed.

(a) Single-, double-, or multi-arm forms as shown in Fig 17 and 19 may be used.

(b) Except for mounting plates equipped with wire-spring relays, one horizontal arm may be used for each two adjacent mounting plates whenever this is found advantageous and the number of loop wires or F stitches is not excessive.

NOTE
THE SPACING AND NUMBER OF STITCHES THROUGH THE FORM SHALL BE AS NECESSARY
TO MEET THE OVERALL REQUIREMENTS AS TO SIZE AND THICKNESS OF FORMS.

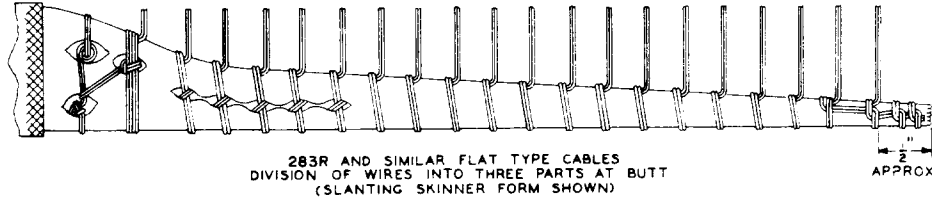
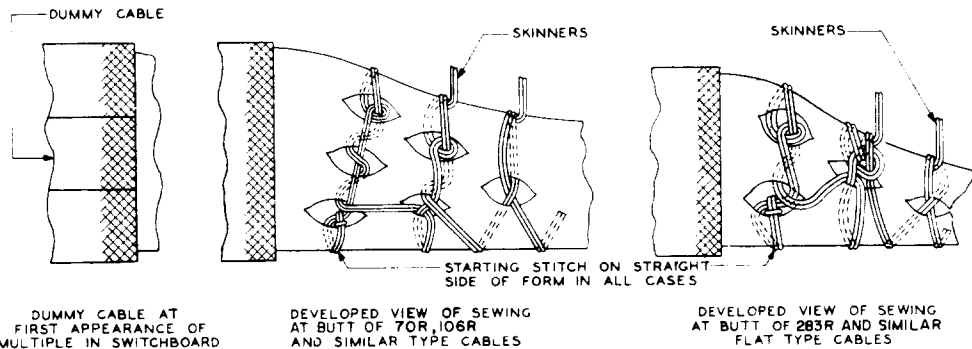
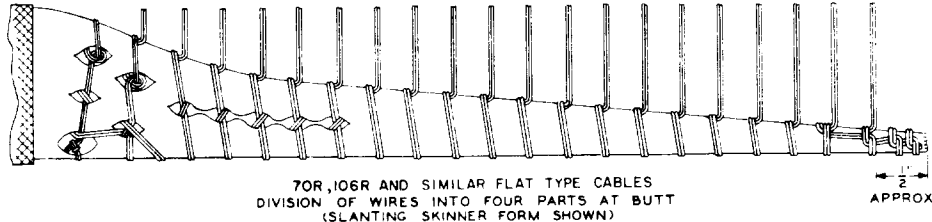


Fig 13—Single-Arm Forms of 70R, 106R, 283R and Similar Type Cables Formed Straight From the Butt

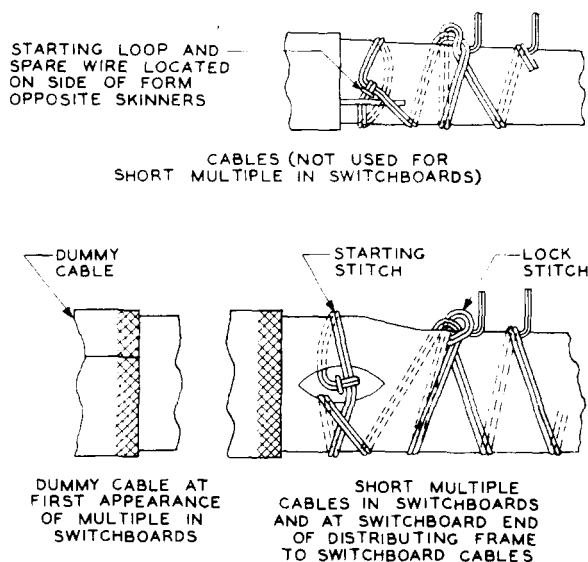


Fig 14—Single-Arm Forms of 282R- and Similar-Type Cables Formed Straight From the Butt

(c) Where the apparatus is adapted to mounting on a plate so as to be in a vertical file per circuit, the multiarm form with vertical branch arms, as shown in Fig 20, may be used.

4.13 On relay racks where switchboard cables are butted at the top of the bay and the conductors are run loose through cable brackets, adjustable wiring supports, etc, to relay rack units, the conductors shall be treated as covered in the requirements for loose wire forms. Where the conductors are sewed after breaking out of the loose wire form, they shall be treated as follows.

- (a) Where 224- or D-type terminal strips are used, they shall be sewed or banded to a point just in back of the mounting plate where the wires pass through the opening in the mounting plate.
- (b) When horizontal forms are placed above terminal strips on cable form brackets and the leads serve terminal strips with fanning strips such as the S6A, F6A, and similar type terminal strips, the skimmers shall be sewed breaking out to each terminal strip from where they break out of the horizontal form to a point at the rear of the terminal strip. This point shall be in the same relative

position as a cable butt would be if the skimmers were fanned directly from a cable to the terminal strips.

(1) Where smaller terminal strips such as F4A, J4A, and similar types are used, the skimmers may be run directly from the horizontal form to the terminal strip without sewing.

(c) To facilitate dressing at terminal strips without fanning strips such as the 181 type, the branch arms from the horizontal form should be sewed to within 1/2 inch of the rear of the terminal strip.

(1) The ending stitch for the branch arms should include only about half of the wires in the form so that the stitch will not loosen due to the spreading of the wires to the top and bottom rows of the terminal strip.

(d) Where 227- and similar-type terminal strips are used, the horizontal arm shall be run about 1/2 inch in back of the fanning strip, either over or under the terminal strip support, depending upon local wiring conditions. The skimmers shall be run directly from the horizontal form to the terminal strip without sewing.

E. Jack Box Forms

4.14 Cable forms in jack boxes of 201A-type jack mountings shall have sufficient slack in the form to permit removal of the jacks for wiring and maintenance, as shown in Fig 23.

F. Terminal Strip Forms

4.15 Unless there are factors which make it desirable to do otherwise, in designing equipment of the present general types, the switchboard cable shall be formed to the left-hand side of a terminal strip mounted vertically, or the lower side of a terminal strip mounted horizontally, and the local cable to the right-hand or upper side facing the front of the terminal strip. In general, present test fixtures are designed for this arrangement. New equipment fundamentally different in design from existing types of equipment or which uses terminal strips so radically different from conventional design as to require new test fixtures shall, unless there are controlling reasons of doing otherwise, have the switchboard cable connected to the right-hand side or upper side of the terminal strips.

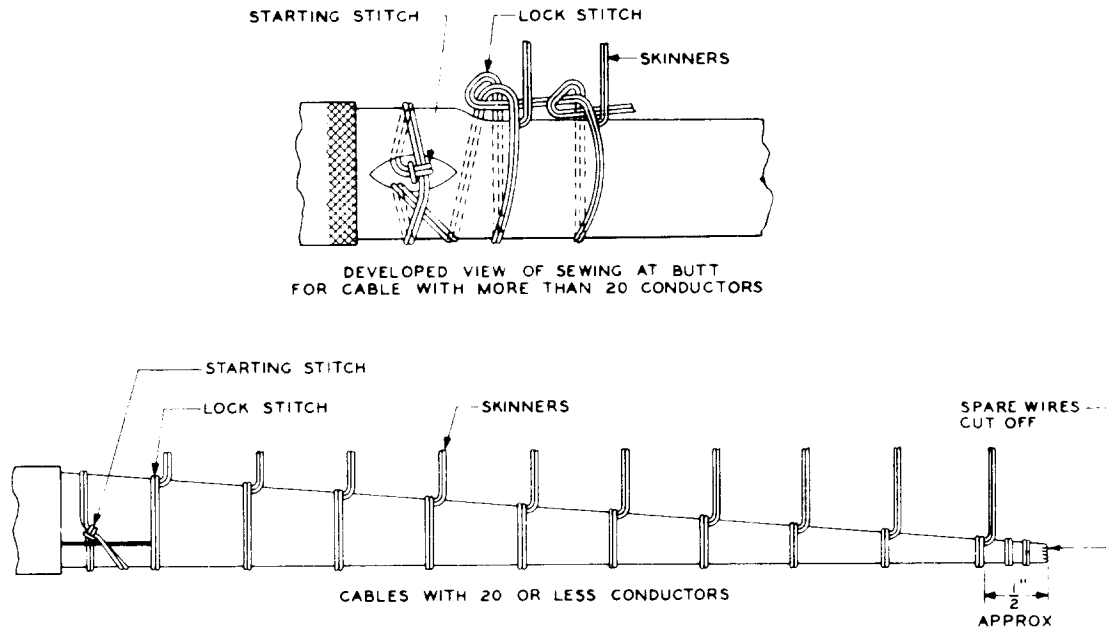


Fig 15—Multiple Forms for Ten-per-Strip Mountings of Round or Oval Cables

(a) Exceptions to this requirement are relay rack units using vertically mounted 203-, 227-, and C4A-type terminal strips, 224- (well type), and D-type terminal strips, and relay rack mounted panels designed for use on relay racks having the switchboard cable brought down the right-hand side of the bay (facing the rear).

(1) **Vertically Mounted 203 Terminal Strips:** Switchboard cable is usually terminated on right-hand side (facing the rear).

(2) **D-Type and 224 (Well Type) Terminal Strips:** Terminate switchboard cable on front (apparatus side) and local cable on rear (wiring side) of the mounting plate.

(3) **Vertically Mounted 227 and C4A Terminal Strips:** Terminate switchboard cable on right-hand side (facing rear). An exception is where the center line of the end terminal strip is located within 6 inches from the right end (facing the rear) of the mounting plate or panel. In this case, terminate the switchboard cable on the left side of the strip and the local cable on the

right (facing the rear) in order to provide access for installer connecting.

(b) Equipment other than relay rack units shall be treated in the same manner with respect to the termination of the switchboard cable as the equipment with which it is most closely associated.

5. REQUIREMENTS FOR SEWING

A. General

5.01 In determining the number of strands of twine required for sewing original forms, the maximum diameter of the main or branch forms (straight or tapered) is the controlling dimension.

5.02 Requirements for cable forms made by the installer (which require less handling than those made by the shop) are more lenient than those applied to shop-made cables. Therefore the requirements in this part of the section applicable to installer-made cable forms shall apply only to cables made by the installer.

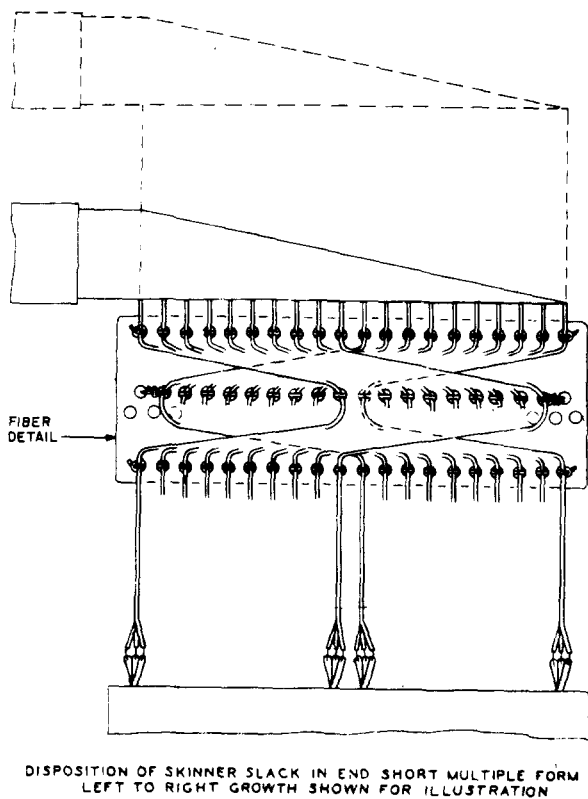


Fig 16—Switchboard Short Multiple Cable Forms—Disposition of Skinner Slack

5.03 Gray friction tape per comcode 995911278 or plastic tape per KS-14090, 995937810, or 995937820 shall be used in accordance with Section 800-612-157 for protection of cable forms where specified in this part of the section. The plastic tapes shall not be used for protection of wiring where the wiring is pressed against metalwork or resting against sharp edges. Protection of power wiring shall also be in accordance with Section 802-005-180 covering Power Plant Wiring.

B. Sewing Twine

5.04 Waxed polyester twine per Material Specification 59092 shall be used for sewing wire and cable forms. Except where otherwise specified, shop wiring shall be sewed with 8-ply polyester twine (900308998) and installation wiring shall be sewed with 9-ply polyester twine (996292686). 4-ply polyester twine (900308974) may

also be used where specifically indicated for shop wiring applications in this part of the section.

5.05 When sewing cable forms, the twine shall be wound around the form in a clockwise direction, where practicable, facing along the form toward the butt end of the form.

(a) On switchboard multiple forms sewed with the winding stitch, the twine shall be wound around the cable form in a counterclockwise direction. On answering jack forms sewed with the winding stitch, the twine may be wound around the cable form in either a clockwise or counterclockwise direction.

Shop-Made Cable Forms

5.06 Cable forms 1-1/4 inch or less in diameter shall be sewed with one strand of 8-ply twine except as follows.

(a) Short multiple or answering jack forms in switchboards or desks shall be sewed with two strands of 4-ply polyester twine.

(b) The reversal forms between the bank terminal strips of the distributing terminal assembly bays of step-by-step selector frames should be sewed with one strand of 4-ply polyester twine.

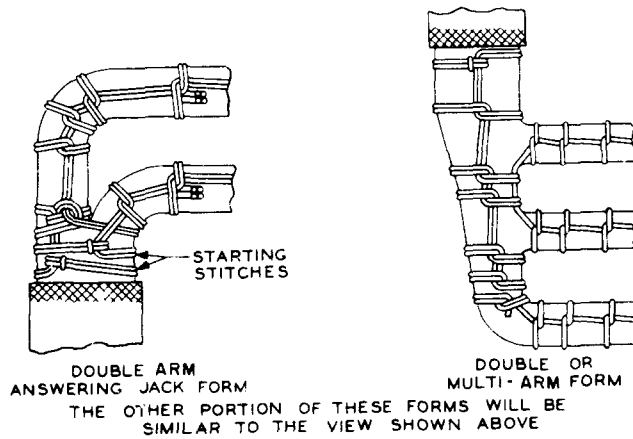
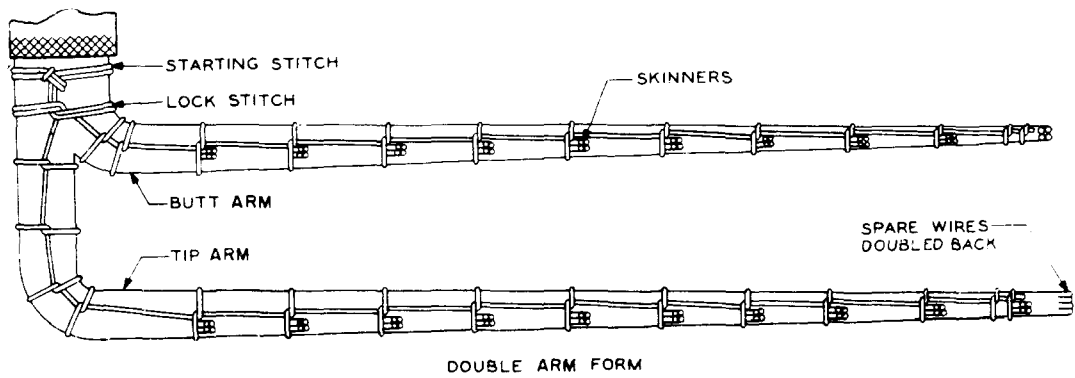
(c) Cable made up entirely of power wire, No. 14 gauge or larger, shall be sewed with a minimum of two strands of 8-ply twine regardless of the diameter of the cable.

5.07 Cable forms exceeding 1-1/4 inch in diameter shall be sewed with two or more strands of 8-ply twine.

5.08 Tapered forms having extra stitches at each break-out, where sewing with two strands of twine would result in a bulky form, may be sewed with one strand of 8-ply twine, regardless of the diameter of the form.

Installer-Made Cable Forms

5.09 Cable forms not greater than 1-1/2 inches in diameter shall be sewed with one strand of 9-ply twine.



NOTE:
NUMBER OF STRANDS, SIZE
OF TWINE AND SPACING OF
STITCHES SHOULD BE AS
REQUIRED

Fig 17—Double- and Multiarm Horizontal Forms Sewed With Lock Stitch

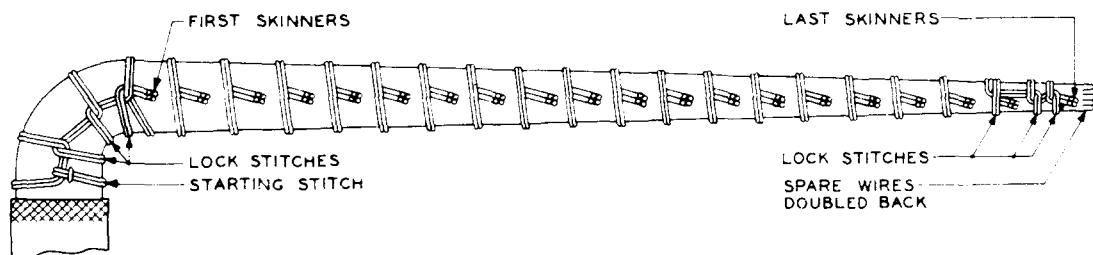


Fig 18—Single-Arm Cable Forms at Right Angles to Butt Sewed With Winding Stitch

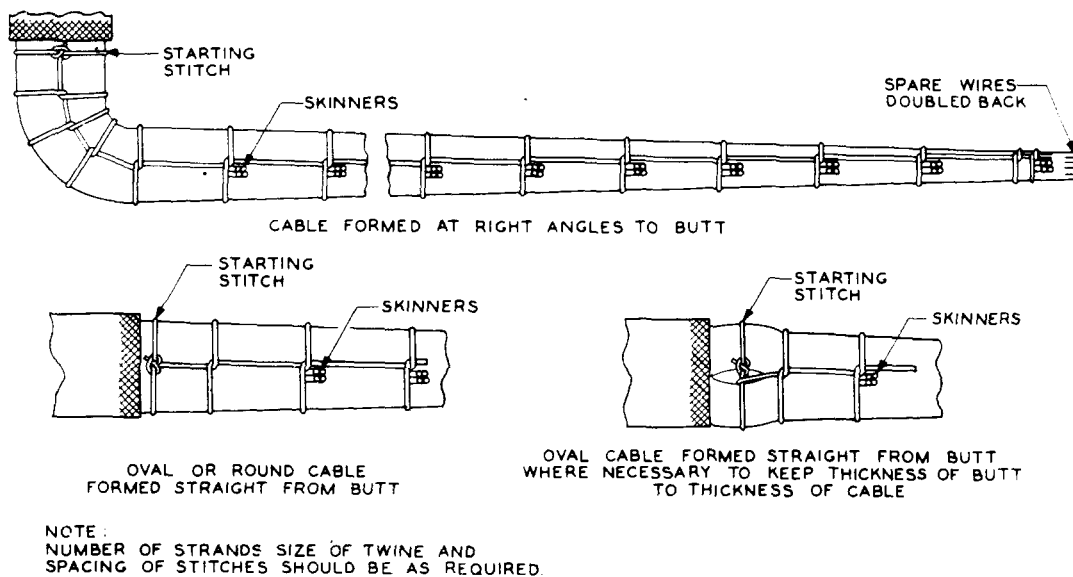


Fig 19—Single-Arm Forms Sewed With Lock Stitch

5.10 **Cable forms greater than 1-1/2 inches in diameter** shall be sewed with two strands of 9-ply twine. One strand of twine shall be used for arms (straight or tapered) not greater than 1-1/2 inches in diameter.

C. Types of Stitches

5.11 **Starting Stitch:** The starting stitches for cable forms shall be made as shown in Fig 24 and 25.

5.12 **Regular Lock Stitch:** The lock stitch shall be made as shown in Fig 25. A **double lock stitch** consists of two regular lock stitches positioned immediately adjacent to each other as shown in Fig 26.

5.13 **Winding Stitch:** The twine shall be wound around the cable form either in a clockwise or counterclockwise direction as specified herein.

5.14 **Ending Stitches:** The ending stitches consist of two lock stitches taken close together in place of the regular single lock stitch located at the point where the last skimmers break out of the form, as shown in Fig 10 and 26.

5.15 **Cross-Stitch:** The cross-stitch shown in Fig 26 and 27A shall be used to secure the break-out of each branch arm. On large diameter cable forms where additional rigidity is required, the **cross-stitch—lock stitch combination** shown in Fig 27B shall be used at the break-out of each arm.

5.16 **Chain Stitch:** The chain stitch shown in Fig 28 may be used as a shop convenience to segregate groups of wires, as in the case of 227-type terminal strips.

5.17 **F Stitch:** The F stitch (Fig 11) is a supplementary regular lock stitch (Fig 25) that is used for separating wires of the same color which are connected to different terminals of the same component. See 3.50 through 3.53.

5.18 **Broom Stitch:** Where several cables are formed into a single arm and it is necessary to keep a portion of the form near the cable butt to a given thickness or where necessary to keep a portion of a local cable in a flat formation, it may be necessary to use the "broom" stitch (see Fig 13), which is made by sewing between the groups of wires of adjacent cables or between the wires of a local cable. In cases where this type of stitching is necessary, care should be exercised to avoid damaging the insulation of wires.

5.19 "Chicago" and "Kansas City" Stitches:

Where cables are to be fastened to crossbars or brackets, the "Chicago" or "Kansas City" stitch shown in Fig 29 and 30 should be used. The "Chicago" stitch shall be used wherever secure fastening is of primary importance, particularly for fastening cables together in the absence of a support.

D. Spacing of Stitches

General

5.20 A single stitch shall be placed at each point where wires are brought out of the form. Where a large number of wires or large gauge wires are brought out, two or more stitches or a cross-stitch shall be used. An extra stitch may also be used,

where necessary, to facilitate manufacture, as on small forms where there may be a tendency for stitches to slip during the skinning operation.

5.21 Fig 17, 20, and 26 show typical sewing arrangements for cable forms having branch arms.

Shop-Made Cable Forms

5.22 The spacing between stitches on cable forms shall not exceed 1-1/2 inches.

Note: It is permissible to space occasional stitches up to 1-3/4 inches apart provided that the total number of stitches which would normally be provided at the 1-1/2-inch maximum increments are

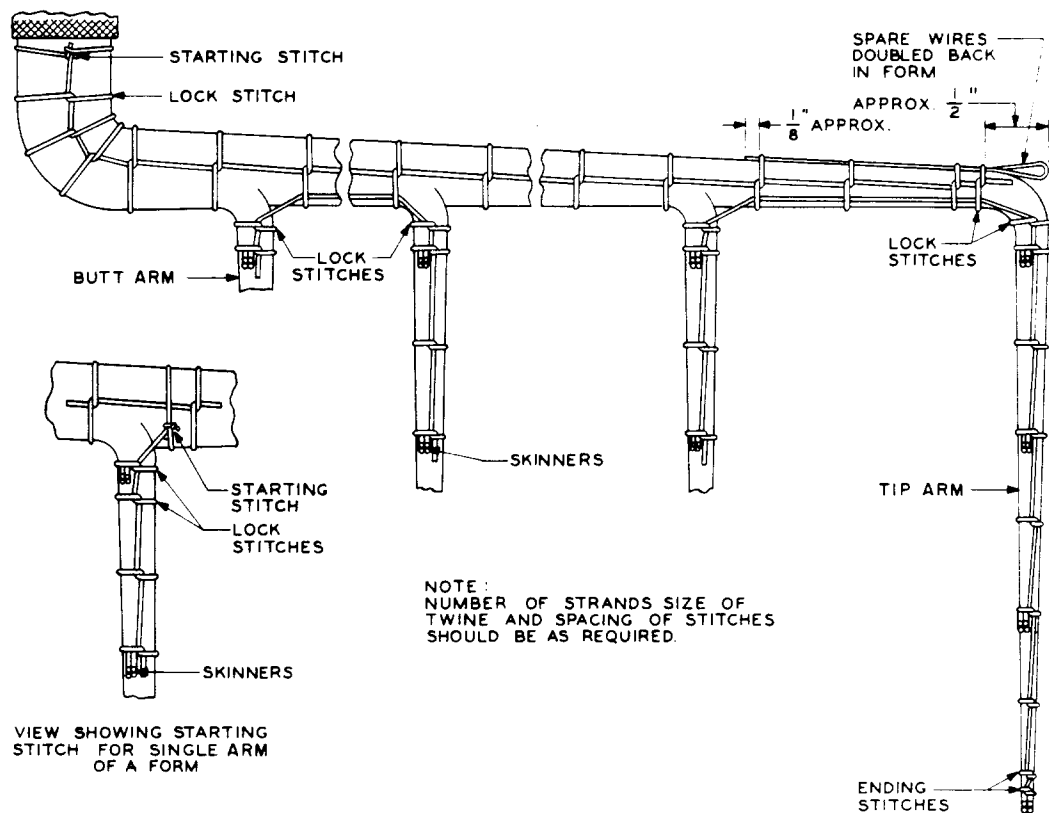


Fig 20—Multiarm Vertical Forms Sewed With Lock Stitch

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provided on the cable form (ie, spacing between 6 adjacent stitches such as 1-1/2, 1-3/4, 1-5/8, 1-3/8, and 1-1/4 inches would be considered permissible).

5.23 The spacing between a lock stitch and the approximate center of an adjacent cross-stitch shall not exceed 1-1/2 inches. Where branch arms exceed 3 inches in diameter, the lock stitch shall be located as close as practicable to the cross-stitch.

(a) Where the center to center distance between cross-stitches on closely adjacent arms exceeds 1-1/2 inches, a lock stitch shall be provided and located approximately centrally between the cross-stitches.

5.24 *At bends in cable forms* one stitch shall be placed at the beginning and at the end of each turn except on small diameter forms (1/2 inch or less) in which case a double lock stitch approximately centrally located on the bend may be used instead. The following additional stitches should be taken on each turn.

| DIAMETER OF FORM | NUMBER OF STITCHES AND SPACING ON OUTSIDE OF BEND |
|-------------------------|---|
| 1/2 Inch or Less | None |
| Over 1/2 Inch to 1 Inch | 1 Stitch (See Note) |
| Over 1 Inch | 1-1/4 Inch Maximum Spacing (See Note) |

Note: Where practicable, one stitch should be approximately centrally located on bend.

5.25 *Double Spacing:* On cable forms that are protected with tape, it is permissible to space the stitches under the taped portion approximately twice as far apart as required for untaped forms, provided that the maximum distance between stitches does not exceed 3 inches. Double spacing of stitches on cable forms also may be used as outlined herein under sewing of superimposed forms.

(a) On small local cable forms which measure approximately 1/2 inch or less in diameter and which are ultimately taped for protection purposes, it is permissible to omit the sewing entirely under those portions requiring taping.

Installer-Made Cable Forms

5.26 The stitches of the sewing on the main section of cable form may be spaced approximately 1-3/4 inches apart but shall not exceed 2 inches apart. The sewing of the branch arms shall be spaced at each break-off point not to exceed 2 inches. Intermediate stitches shall be placed at bends so that stitch spacing does not exceed 2 inches on outside radius.

(a) An exception is the wiring to 286-, 287-, and similar-type relays where 2-1/8 inch spacing (one stitch per relay) is permissible.

5.27 *Double spacing* of stitches on cable forms which are protected with tape is permissible and shall be in accordance with requirement 5.25.

E. Sewing Cable Forms

5.28 Cable forms shall be sewn tightly enough to prevent stitches from sliding out of place by the pull of the wires (perpendicular to the form), but not so tightly as to injure the insulation of the wires or to break the twine, or to cause curling and/or a reduction in the intended length of the form.

Sewing Polyvinyl Chloride (PVC), Polyethylene (PE), and Teflon (TFE) Insulated Wires

5.29 Polyvinyl chloride (PVC) insulated wires (such as types BW, BU, and BH or the PVC-insulated conductors of KS-13385 wire), irradiated polyvinyl chloride (IPVC) insulated wires (such as type DP), polyethylene (PE) insulated wires (such as type BF and shielded pairs in 750- and 760-type cables), and Teflon (TFE) insulated wires (such as those in KS-19195 and KS-19224 type cables) and KS-22247-type wires do not require protection when sewn into cable forms in accordance with 5.28.

5.30 Where a cable form of polyethylene (PE) insulated wire or the PVC-insulated conductors (braid removed) of KS-13385 wire used in power applications are to be secured to cable brackets or other supports, the form shall be protected from contact with the bracket and the twine or nylon tie used to secure the form to the bracket. Gray fiber strips, 1/64-inch thick per (995831011) or two layers of gray friction tape (995911278) wrapped completely around the form shall be used before tying the form to the bracket.

- (a) Protection as specified above shall also be provided where PVC-insulated wire such as type BU is to be secured to cable brackets that are not provided with the 483- or similar-type insulating finish.

Sewing Coaxial and Twin-Conductor Shielded Office Cable Except KS-21112, KS-19689, and Similar-Types

5.31 Except for coaxial cables such as the KS-21112 and KS-19689 types, sewed forms of coaxial and twin-conductor shielded office cable shall meet the following requirements. In forming coaxial cables, the minimum bending radius specified in Section 800-612-164 shall be maintained.

Note: Shielded cables such as the KS-21112, which are provided with a foam-type dielectric, and KS-19689 cables which are provided with a semi-solid type dielectric, are easily deformed when sewed with twine and therefore should be treated as specified in 5.32 through 5.35.

- (a) Forms consisting entirely of coaxial cable shall not be sewed or tied so tightly as to disturb the circular cross section of the coaxial cables.
- (b) Where only a few coaxial cables are to be sewed into a form with other wiring, the coaxial cables shall be, where practicable, imbedded in the form so that the sewing twine will not come in contact with the cables.
- (c) Where forms consisting of KS-19224 or similar-type miniature coaxial cables are to be secured to cable brackets or other wiring supports, the forms shall be protected from contact with the bracket and the twine used to secure the form to the bracket. This protection shall be provided in accordance with Section 800-612-157.

Sewing Rubber- or Neoprene-Covered Wires, or Coaxial Cables Having Foam-Type or Semi-Solid Type Dielectric

Note: This includes flexible rubber or neoprene insulated cordage such as KS-15141-, KS-15143-, and KS-20195 (formerly known as Tirez wire), and similar type flexible wire. This also includes KS-21112-, KS-19689-, and similar-type coaxial cables.

5.32 Where only a few rubber- or neoprene-covered wires or KS-21112- or KS-19689- type coaxial cables are to be sewed into a form made up principal-

ly of textile or PVC-insulated wires, the rubber- or neoprene-covered wire or coaxial cables shall be imbedded in the form so that the sewing twine will not be in contact with the insulation. Where this is impracticable, as at points where the wire or cable leaves the main form, two layers of tape shall be applied around the main form and the arm to protect the wiring from the twine.

5.33 Where cable forms that would normally be sewed are made up principally or entirely of rubber- or neoprene-covered wire or KS-21112- or KS-19689- type coaxial cables, the form shall be taped completely instead of sewed with twine.

- (a) For taping cable assemblies made up principally or entirely of rubber or neoprene cordage or of coaxial cables, apply 2 wraps of tape before and after each breakout and at 3-inch maximum intervals along arms and between breakouts.
- (b) For cable assemblies containing rubber or neoprene cordage or coaxial cable as well as other wiring, omit the sewing where the cordage or coaxial cables break out and apply 2 wraps of tape before and after each breakout. Where the coaxial cables break out with other wiring, sewing or taping shall be in accordance with paragraph 5.32. At locations where both the coaxial cables and other wiring are to be formed out of the formed cable, care should be exercised to provide the minimum bending radii for the coaxial cables (see BSP Section 800-612-164). In such cases, it may be necessary to form out the coaxial cables before the designated breakout location to meet the minimum bending requirement.

5.34 Superimposed cables of rubber- or neoprene-cordage or coaxial cables shall be secured to either sewed cables or the switchboard cables with bands of tape (at least 2 turns), spaced not farther apart than five times the diameter of the larger cable. At bends, the tape shall extend completely around the bend.

5.35 Where a cable form of rubber- or neoprene-cordage or coaxial cables is to be secured to cable brackets or other supports, the cable shall be protected from contact with the twine and the bracket or support by wrapping the cable with 1/64-inch sheet fiber per 995831011.

Sewing Varnished Cotton Cloth to Cable Forms

5.36 Where varnished cotton cloth per P-122229 is to be applied to regular cable forms or to superimposed forms and main forms, separate and additional stitches spaced at about twice the standard distance between stitches shall be used for securing the cotton cloth to the forms.

Sewing Local Cable Forms

5.37 *The Starting stitch* shall, when possible, consist of a lock stitch, as shown in Fig 25 and 26, located approximately at the point of greatest diameter. The sewing should proceed in both directions from the starting stitch toward the tips of the forms or arms. Where this is impracticable, the starting stitches shown in Fig 24 shall be used.

5.38 *Regular Stitches:* All sewed cable forms shall be sewed throughout with the lock stitch. Where practicable, the stems of the stitches should be located on the side of the form where the skimmers or arms break out, as shown in Fig 26.

5.39 *Cross-Stitches:* The cross-stitch as shown in Fig 26 and 27A shall be used for sewing cable forms at arm and subarm break-outs. On large diameter local cable forms where additional rigidity is required, the cross-stitch, lock stitch combination shown in Fig 27B shall be used.

Note: A subarm shall be defined as a branch of an arm.

5.40 Where the cross-stitch, lock stitch combination (Fig 27B) is to be used, a single lock stitch instead of the double lock stitch shown in Fig 26 may be used as the first stitch when sewing an arm or subarm. In this case, the single stitch may be located within 1 inch of the lock stitch portion of the combination stitch.

(a) On arms and subarms that are 3/8 inch or less in diameter, a single stitch may be used as the starting stitch when sewing the arm or subarm. In this case, it will also be permissible to locate the starting stitch within 1 inch of the stitch used to secure the arm or subarm break-out.

NOTE:
1. CABLE FORMS SHOULD BE PROTECTED FROM METALWORK AS REQUIRED.

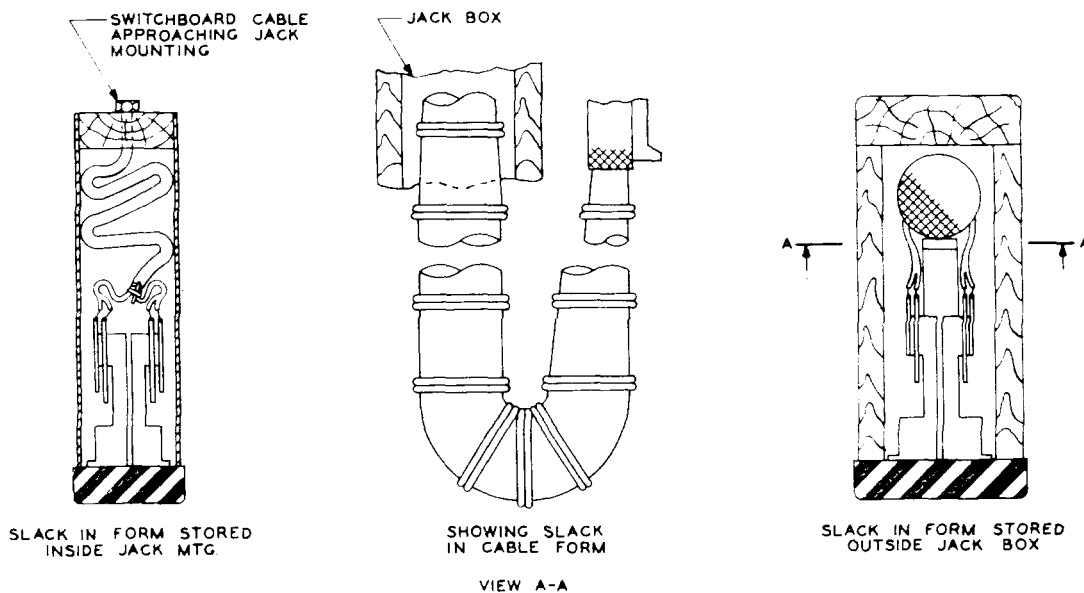


Fig 23—Jack Box Cable Forms

5.41 *Ending stitches* for terminating the sewing at the tip of a form shall be located at the point where the last skimmers at the tip of the form break out, as shown at A in Fig 10 and in Fig 17 through 22.

(a) The ending stitches shall be located at the next to the last break-out point on forms where only one skimmer breaks out at the tip of the form, except where such forms contain stiffening wires carried to the end of the form or spare wires doubled back at the tip of the form.

Sewing Switchboard Cable Forms

A. Starting Stitch

5.42 For forms sewed entirely with the lock stitch and for cable forms sewed with both the lock and winding stitches where the lock stitches precede the winding stitches, the starting stitch shall be made as shown in Fig 24. The "double twine" starting stitch shown in Fig 24 may be used instead of the single twine starting stitch where a single strand of twine is to be used for the sewing. In this case, cut one strand of the twine to within approximately 1/4 inch of the starting stitch.

5.43 Where two or more cables are formed out as a single round form, the starting stitch shall be placed around the wires at one of the outside cables, as shown in Fig 12.

5.44 Round or oval cable forms sewed with the winding stitch shall have the starting stitches made as shown in Fig 14. On the round cable forms, except where several lock stitches precede the winding stitches, the starting stitch shall be locked with one of the spare wires, as shown, in order that the twine will not slide around the form and loosen the sewing.

B. Regular Stitches

5.45 In sewing switchboard cable forms, a variation of 1/8 inch from the dimension specified for the distance between the butt of the switchboard cable and the first skimmer or set of skimmers in the sewed form is allowable.

5.46 The lock stitch shown in Fig 15, 17, 19, and 20 shall be used on all forms where the spacing of

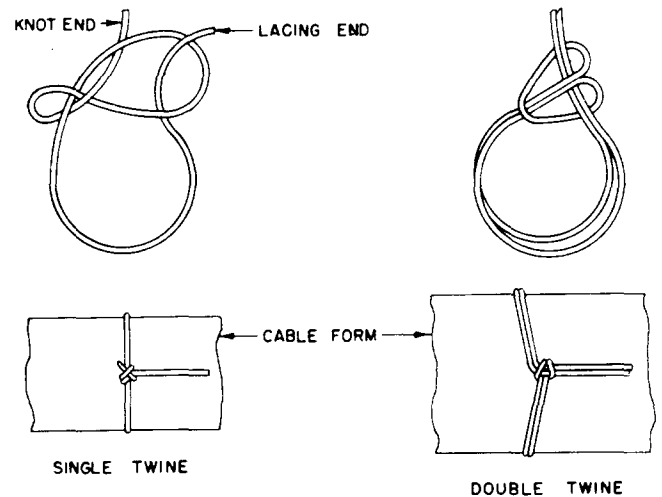


Fig 24—Starting Stitches for Cable Forms Sewing in One Direction Only

skimmers is more than 1/2 inch; for resistor forms where the resistors are mounted on 7/16-inch centers; for forms at 41-, 42- and similar-type banks; and for all sewed fuse panel forms, regardless of the spacing of the fuse posts. Wherever practicable, locate the stems of the lock stitches on the side of the form where the skimmers or arms break out.

5.47 The winding stitch, as shown in Fig 13, 14, and 18, should be used on all forms where the spacing of leads is 1/2 inch or less, such as forms to strip jacks or strip lamp sockets in the face of switchboards or on rack-mounted equipments, except as otherwise specified herein.

5.48 On forms sewed with the winding stitch, the distance between the stitches shall be equal to the spacing of the groups of skimmers, as shown in Fig 13, 14, and 18. Portions of the form where no skimmers break out shall have the same spacing of stitches as that portion from which the skimmers break out.

5.49 Loop leads shall be sewed with the type of stitch that would normally be used for other skimmers breaking out of the form at that point.

5.50 Where it is necessary to keep down the thickness of a cable form as in the case of flat-type short multiple forms, the sewing of those portions of

the form that would otherwise be too thick shall be as shown in Fig 13, 14, and 15.

5.51 Stitches between the starting stitch and the first set of skimmers shall be of the same type as those used for sewing the form where the skimmers are brought out, except that, where the winding stitch is used and the distance from the butt to the first set of skimmers is 1-1/2 inches or greater, the lock stitch shall be used between the starting stitch and first set of skimmers. The short multiple cable form in switchboards is an exception to this requirement and shall be sewed as specified herein. (See requirements 4.02 through 4.07.)

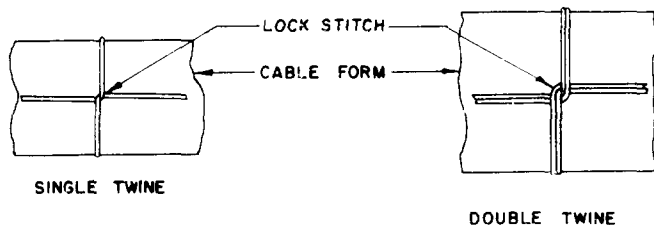


Fig 25—Starting Stitches for Cable Forms Sewing in Both Directions

C. Ending Stitches

5.52 On forms sewed with the lock stitch, the sewing shall be ended as shown in Fig 17 and 20. Where the winding stitch is used, the ending stitches shall be made as shown in Fig 13 and 18.

- (a) The ending stitches shall be located beyond the last skinner break-out point as shown at B in Fig 10, 13, and 15 for switchboard multiple forms where the spare wires are cut off at the tip of the form.

Sewing Superimposed Wiring

5.53 General: Superimposed wiring may be either a separate form or loose wires distributed around and sewed to the main form, as outlined in 3.64 to 3.72.

A. Forms Superimposed by the Shop

5.54 Where loose wires are superimposed on an existing sewed form, the stitches used to sew them to the main form shall be on the normal spacings for a form of the diameter of the combined form. If the maximum diameter of the original form and the superimposed wires is 3/8 inch or less, one strand of 4-ply or 8-ply twine shall be used; if it exceeds 3/8 inch and is not greater than 3 inches, one strand of 8-ply twine shall be used; if it is greater than 3 inches, two strands of 8-ply twine shall be used.

5.55 The number of strands of twine used to superimpose one form on another shall be determined by the size of the two forms together. If the maximum diameter of the two forms is not greater than 3 inches, one strand of 8-ply twine shall be used; if greater than 3 inches, two strands of 8-ply twine shall be used.

5.56 Superimposed forms shall be sewed to the main form as follows.

- (a) *Forms superimposed at the time of forming the main form*, if 3/8 inch or less in diameter, shall be sewed with the same twine used in tying the two forms together, as shown in the lower view of Fig 31. In this case, the spacing of the stitches on the main form may be twice the normal spacing for a form of that diameter. If over 3/8 inch in diameter, the superimposed form shall be sewed separately and then sewed to the main form, as shown in the top view of Fig 31.
- (b) *Forms superimposed subsequent to the time of forming the main form* may be sewed in accordance with the top view of Fig 31, regardless of the diameter of the superimposed form or, if 3/8 inch or less in diameter, forms may be sewed per the middle view of Fig 31.

5.57 *C wiring forms* should be attached to the main form in accordance with the requirements in 5.56 for superimposed forms, except that forms 3/8 inch or less in diameter superimposed subsequent to the forming of the main form shall always be sewed in accordance with the middle view of Fig 31.

5.58 Where leads break out of a superimposed form on approximately 1-3/4 inch centers and these leads are sewed to branch arms of the regular form, the main portions of the two forms, regular and superimposed, need only be fastened together at ap-

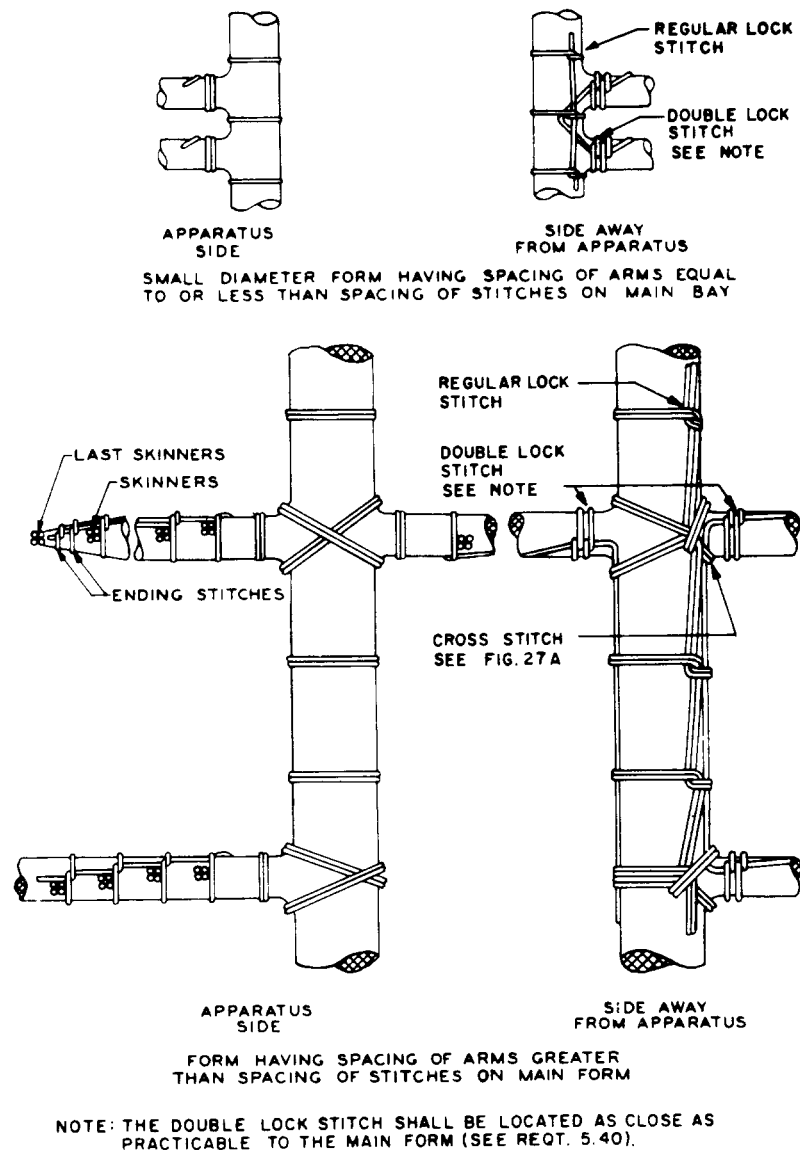


Fig 26—Sewing Local Cable Forms

proximately 8-inch intervals. In such cases, “Chicago” stitches shall be used.

B. Forms Superimposed by Installer

5.59 The requirements of 5.56 through 5.58 for superimposing loose wiring or sewed forms on other forms, as well as the following requirements, are applicable for wiring superimposed by the installer.

5.60 In superimposing loose wires or one form on another form, one strand of 9-ply twine shall be used where the combined form totals 3 inches or less across its largest diameter. Two strands of 9-ply twine shall be used where the total diameter of the combined form is greater than 3 inches.

5.61 Spacing of stitches on that portion of a form which is to be superimposed and which is not controlled by branch arms or skinner break-outs shall be every 4 inches.

5.62 Stitches used for superimposing one form on another shall be placed midway between each stitch of the superimposed form, except as follows.

- (a) Where shop cables are to be superimposed, superimposing stitches shall be placed every 4 inches. Additional stitches shall be placed at break-outs of branch arms or skimmers, as required, to prevent the superimposed form from pulling away from the main form at these locations.

6. REQUIREMENTS FOR TYING AND BANDING

A. General

6.01 Waxed polyester twine per Material Specification 59092 (see 5.04) shall be used in accordance with requirement 6.02 wherever tying or banding of wire or cable is specified in Bell System Practices sections of the wiring series. KS-20986 nylon cable ties may be used, where practicable, instead of twine for those applications of tying or banding specified in 6.03. Wiring or cabling requiring protection when tied with twine shall be similarly protected when banded with the nylon cable ties. Spacing of the nylon ties shall be the same as that specified for twine, except where otherwise specified. The comcodes for the KS-20986 cable ties are as follows:

| KS-20986 LIST | GRAY COLOR COMCODE | BLACK COLOR COMCODE |
|---------------|--------------------|---------------------|
| 1 | 401682265 | 401674270 |
| 2 | 401682281 | 401674437 |
| 3 | 400891719 | 401674593 |
| 4 | 401682323 | 401674759 |
| 5 | 401684287 | 401674924 |
| 6 | 401682349 | 401673355 |
| 7 | — | 401675087 |
| 8 | 400737929 | 401884887 |

B. Tying or Banding With Twine

6.02 Polyester twine, 4-, 8-, or 9-ply, may be used for tying or banding. Where two or more closely adjacent parallel forms or wires are to be tied together, a simple tie may be made with two strands of the twine ended in a square knot. Where the strain on the tie is such as to make the holding ability of the square knot questionable, the tie shall consist of a starting stitch followed by a square knot. Ties

on surface wired units (SW1 or D3) may be made with a single strand of 4-ply twine ended in a square knot. Closely adjacent forms or wires at right angles to each other shall be tied together *with twine* as necessary to provide for mutual support.

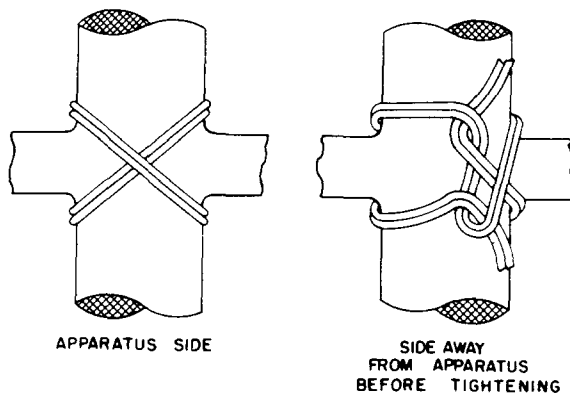


Fig 27A—Cross-Stitch

NOTE: OMIT STEP 4 WHERE ARM IS NOT PROVIDED

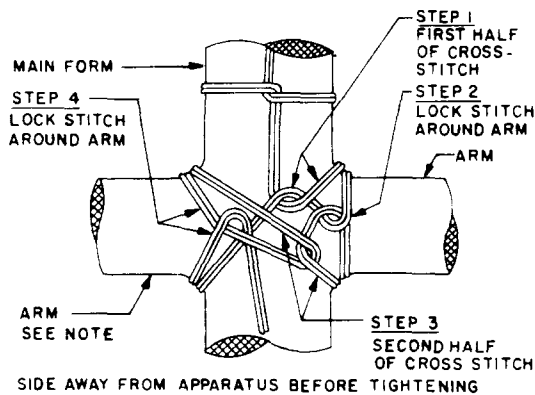


Fig 27B—Cross-Stitch and Lock Stitch Combination for Providing Additional Rigidity at Break-Out of Large Diameter Cable Arms

C. Banding With Nylon Ties

6.03 KS-20986 nylon cable ties, gray or black, when used in accordance with requirements 6.05 through 6.11, may be used for:

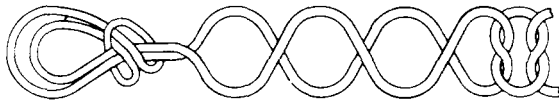


Fig 28—Chain Stitch

- (a) Banding together loose wiring or surface wiring where a simple tie of twine would normally be used for this purpose. [See 6.04(a).]
- (b) Banding installer-run vertical wiring to existing vertical wiring.
- (c) Banding of horizontally-run loose wiring to existing horizontal wiring, including local cable forms, or to towel bars and similar-type horizontal wiring supports. [See 6.04(a).]
- (d) Securing installer-run loose or sewed wiring totaling 1/2 inch or more in diameter, which is dressed vertically from the butt of switchboard cable, to cable brackets except as specified in 6.04(f) and (g). See Section 800-612-156 covering placing, securing, and supporting cable forms.
- (e) Securing installer-run vertical switchboard cable, shielded wiring, or twin-conductor shielded office cable totaling 1/2 inch or more in diameter to cable brackets or other wiring supports except as specified in 6.04 (f) and (g). See Section 800-612-156.
- (f) Securing installer-run switchboard cable to the transverse arms of distributing frames. See Section 800-614-152. Nylon cable ties may also be used as a replacement for N-type clips for securing the horizontally-run portion of switchboard cable to the transverse arms.
- (g) Securing installer-run power wire or cable totaling from 1/2- to 1-inch in diameter to cable brackets on equipment frameworks except as specified in 6.04 (f) and (g). See Section 800-612-156 covering placing, securing and supporting cable forms.

Note: Rubber- or neoprene-insulated wires such as the KS-15141-, KS-15143-, and KS-20195-types shall be protected against contact with

both the cable bracket and the cable tie (or sewing twine) by wrapping the wires with 1/64-inch gray vulcanized sheet fiber per 995831011. Textile jacketed power cables such as the KS-5482- and KS-20189-types, hypalon-insulated cables such as the KS-20921 and KS-21155-types and armored cables such as the KS-5497- and KS-20785-types do not require protection when secured with the cable ties or sewing twine.

- (h) Banding horizontal arms of sewed cable forms to towel bars and similar-type horizontal wiring supports. [See 6.04(a).]
 - (i) Superimposing horizontal arms of sewed cable forms to horizontal arms of main local cables that are secured to equipment framework. In this case, banding with nylon ties, instead of sewing with twine per top view of Fig 31, is permissible provided the required spacing between stitches is maintained. [See 6.04(a).]
 - (j) Banding cable arm break-out locations on main forms in accordance with Fig 32. [See 6.04(a).]
 - (k) Banding, instead of sewing, installer-made cable forms that are 1 inch or less in diameter. In banding such forms, 3-inch maximum spacing between ties is permissible.
 - (l) Banding together of coaxial and twin-conductor shielded office cables (including ABAM- and 606B- through 612B-type cables) except KS-21112, KS-19689, and similar-type coaxial cable which shall be treated as specified in 5.32 through 5.35. [See 6.04(a).]
- Note:** Where only a few coaxial cables are to be banded together with other wiring, the coaxial cables shall be, where practicable, imbedded in the form so that the nylon ties will not come in contact with the coaxial cables.
- (m) Banding power cable in the Shield 4 compartment of ESS cable rack.
 - (n) Banding together of power cables, including flexible cordage such as the KS-15141-, KS-15143-, and KS-20195-types. However, the flexible cordage which normally requires protection when tied or sewed with twine shall be similarly protected when banded with nylon ties.
 - (o) Securing wire or cable forms to 951A-type connectors.

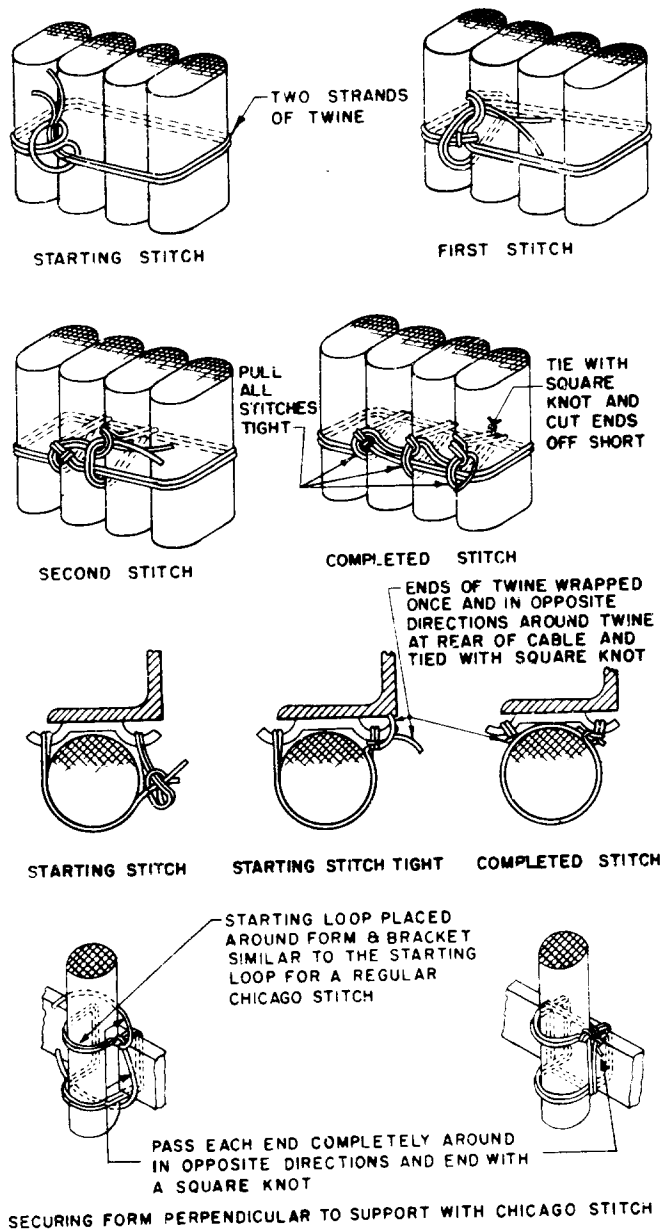


Fig 29—"Chicago" Stitches

6.04 Nylon cable ties *shall not* be used for:

(a) Shop applications where the total diameter of the wiring to be banded together exceeds 3/4 inch. Where such wiring is to be secured to towel bars or similar wiring supports, the total diameter of the wiring and towel bar or other support shall not exceed 3/4 inch.

(b) Sewing of forms which would normally be classified as sewed forms except as otherwise indicated in 6.03(k).

(c) Securing of coaxial cable to cable brackets or similar-type wiring supports except where cables are run within the ducts of duct-type framework, in which case the banding shall be in accor-

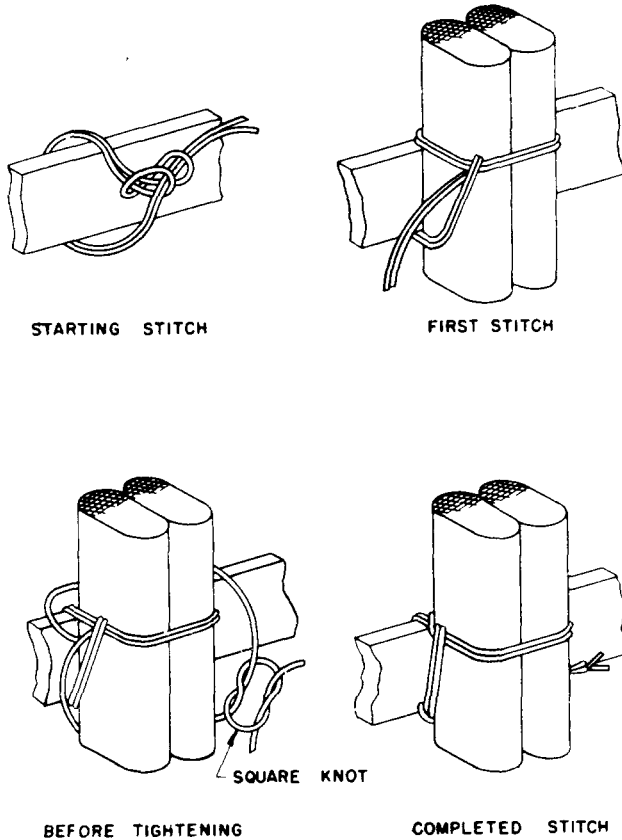


Fig 30—"Kansas City" Stitches

dance with Section 800-612-156 covering placing, securing, and supporting of cable forms.

- (d) Securing cable or wire to cable racks.
- (e) Banding together of wire or cable on cable racks except as specified in 6.03(m).
- (f) Securing switchboard cable, power wire or cable, or other wiring to the top bracket (generally the cable butt location) on the equipment framework.
- (g) Securing the butt of switchboard cable or power wire or cable to cable brackets regardless of the location of the bracket on the framework.
- (h) Securing vertically-run sewed or loose wiring, (including power wiring), shielded wiring or twin-conductor shielded office cable, or switchboard

cable totaling less than 1/2 inch in diameter to cable brackets or other wiring supports.

- (i) Securing the vertical portion of local cable forms or shop-run loose wiring or shop-run switchboard cable to cable brackets or other wiring supports, or to other wire or cable forms.
- (j) Securing vertical wiring to horizontal wiring or to towel bars or similar-type horizontal wiring devices, or at any location where wiring and/or cable intersect.

6.05 When using the KS-20986 nylon cable ties for banding wire or cable, place the tie around the wires or cables with the leading end of the tie threaded through the locking head and manually tensioned so that the tie will temporarily remain in place. Final tensioning of the cable ties and cutting off of the loose end shall be done using the R-4827 variable tension tool set to tension the ties around the wiring, as follows:

| NYLON CABLE TIE | TOOL TENSION POUNDS-MAXIMUM |
|---------------------|-----------------------------|
| KS-20986 L1, L2, L3 | 18 |
| KS-20986 L4, L5 | 13 |
| KS-20986 L7 | 23 |

Note: The tension indicators on the R-4827 tools (ie, "1" to "8") do not indicate the tension in pounds. However, the tools are generally designed to provide lower tensions at the lower indicator settings, "1", "2", etc., and higher tensions at the higher indicator settings.

Caution: Sidecutters or cutting devices other than approved tools shall not be used for cutting off the loose ends of the nylon ties since this may result in exposing hazardously sharp cut ends.

- (a) The nonadjustable R-4266 tools may also be used for applying the KS-20986 L1, L2, or L3 ties. However, the nonadjustable R-4266 tools shall not be used for applying the KS-20986 L4 or L5 ties since this may cause excessive damage to wire insulation.

6.06 For banding together wiring or cables totaling 5/8 inch or less in diameter, KS-20986 L1 through L5 nylon cable ties may be used.

6.07 For banding together wiring or cables totaling more than 5/8 inch in diameter, KS-20986 L1, L2, L3, or L5 nylon cable ties may be used.

6.08 For securing horizontal wiring or cables totaling $3/8$ inch or less in diameter to towel bars or similar-type wiring supports, KS-20986 L1 through L5 nylon cable ties may be used.

6.09 For securing horizontal wiring or cables totaling more than $3/8$ inch in diameter to towel bars or similar-type wiring supports, KS-20986 L1, L2, L3, or L5 nylon cable ties may be used.

6.10 For securing installer-run vertical wiring or cables $1/2$ inch or greater in diameter to cable brackets or similar-type brackets, KS-20986 L1, L2, or L3 nylon cable ties shall be used. Application of the ties shall be in accordance with Fig 16A of BSP Section 800-612-156 covering the General Equipment Requirements for Placing, Securing, and Supporting Cable Forms.

6.11 The following requirements shall be met wherever nylon cable ties are used:

- (a) The nylon ties shall not be placed over starting stitches or other knots of twine, or over other nylon ties.
- (b) The nylon ties shall be tensioned around wire or cable forms tightly enough to hold the wires or cables securely together and/or properly positioned on equipment framework, but not so tightly or at such angles as to cause possible damage to the insulation of the wire or cable.
- (c) Cable ties banded around wire and cable shall be capable of being rotated with slight to moderate pressure applied with the thumb to the head of the tie. Twisting of the wires or cables under and/or adjacent to the tie when rotating the tie is an indication that the tie is applied too tightly.
- (d) The locking head of the nylon tie shall be positioned so as not to interfere with the installation or removal of apparatus or equipment, or with the superimposing of additional wires or cable forms, such as at the side of the form where the skinners or arms break out. Where wires or forms are secured to cable brackets, the head shall be positioned on the side of the bracket opposite to the side on which the wires or cables are run.
- (e) The nylon ties shall not have sharp or jagged cut ends protruding out of the locking head.

7. GENERAL REQUIREMENTS FOR SKINNING

7.01 The length of individual skinners shall be such that the wire, after connection, may be dressed to conform to the requirements of Section 800-612-160 covering dressing. Where the length is specified, it may vary $+3/8$ inch $-1/8$ inch after the skinning operation has been completed (prior to connecting). For switchboard multiple cables, the specified length shall not vary by more than $\pm 1/8$ inch. The length of the skinners is measured from the front of the cable arm (side nearest mounting plate or apparatus).

(a) *In switchboard multiple*, leads from the same form connecting to apparatus with different length terminals may be skinned to reach the shorter terminals and slack left in the leads to the longer terminals where the difference in length of the terminals does not exceed $5/32$ inch. Such slack will be in addition to the $\pm 1/8$ inch permissible variation mentioned above.

(b) *On the switchboard cable side of distributing frame terminal strips*, all of the wires serving the same row of terminals may be skinned to equal lengths (ie, all of the wires may be skinned to reach the farthest terminal from the fanning strip hole or slot serving that particular row). Under this condition, the slack in the wires shall be neatly dressed in the area between the cable butt and fanning strip. Where necessary, occasional ties shall be used to keep the wires in reasonably good formation.

7.02 All skinning shall be done, as far as practicable, so as not to leave the insulation frayed.

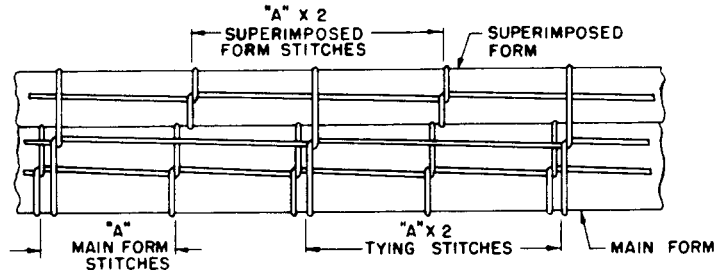
7.03 Skinned wires shall be free of nicks which expose copper.

7.04 Skinned wires shall be free from kinks and dents.

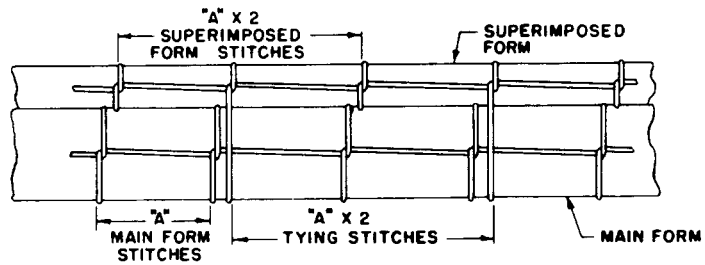
7.05 The wires to unequipped positions in all cable forms shall be skinned except the loop leads carried through the sewed forms for unequipped circuits.

(a) Where the skinner length of local cable wires is not known and they are left long enough to reach apparatus which is not furnished initially, the skinners need not be skinned.

NOTE: NUMBER OF STRANDS, SIZE OF TWINE AND SPACING OF STITCHES SHALL BE AS REQUIRED.

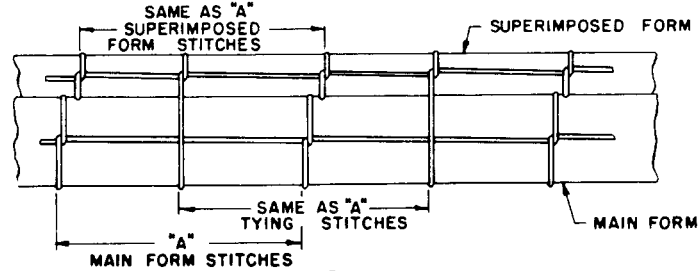


SUPERIMPOSED FORMS GREATER THAN $\frac{3}{8}$ IN DIAMETER



SUPERIMPOSED FORMS $\frac{3}{8}$ OR LESS IN DIAMETER

SUPERIMPOSED FORM ON MAIN FORM
SUBSEQUENT TO TIME OF FORMING OF MAIN FORM



SUPERIMPOSED FORMS $\frac{3}{8}$ OR LESS IN DIAMETER

SUPERIMPOSED FORM ON MAIN FORM
AT THE TIME OF FORMING OF MAIN FORM

Fig 31—Sewing of Superimposed Forms

NOTES:

1. FOR MAIN FORMS UNDER 1/2-INCH IN DIAMETER, USE KS-20986 L4 OR L5 TIES. FOR CABLE FORMS OVER 1/2-INCH IN DIAMETER, USE KS-20986 L1, L2, OR L3 TIES.
2. THE USE OF NYLON CABLE TIES SHALL BE IN ACCORDANCE WITH THE REQUIREMENTS OF PART 6 OF THIS BSP.

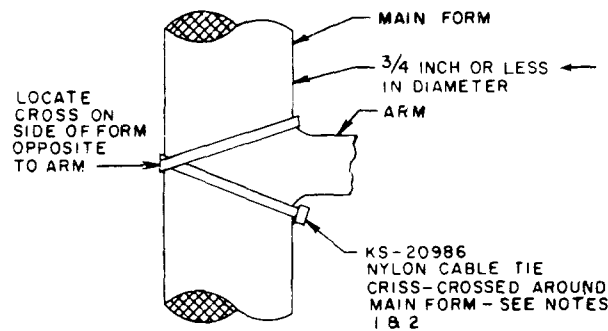


Fig 32—Banding Cable Arm Break-Outs Using Nylon Cable Ties

8. CHECKING LIST FOR FIGURES

8.01 The figure numbers in this section are frequently referred to in associated instructions and drawings. In order that these references may remain correct, the figure numbers as assigned per Issue 9-D of this section have not been changed.

8.02 The figures discontinued with this or previous issues of the section are: fig 21 and 22. References to these figures which appeared subsequently in the text have been deleted.

8.03 The complete list of figures used in this issue is as follows:

- Fig 1—Single Form Serving Two Units of Apparatus
- Fig 2—Fanned Form for a Single Terminal Strip
- Fig 3—Horizontal Form for More Than One Terminal Strip at Distribution Frame—With Distributing Rings
- Fig 4—Vertical Fanned form for More Than One Terminal Strip—With Distributing rings
- Fig 5—Fanned Forms for More Than One BB6A- and Similar-Type Terminal Strip
- Fig 6—Terminal Strips—D-Type—Loose Wiring and Switch board Cable Leads

Fig 7—Loose Wiring on Front (Apparatus Side) D-Type Terminal Strips

Fig 8,8A,—Surface Wiring, and Surface Wiring Dress

8B

Fig 9—Surface-Wired 204- and Similar-Type Selectors—Mounted Horizontally on Relay Rack Units

Fig 10—Spare Wires in Sewed Forms

Fig 11—F Leads and F Stitches

Fig 12—Two or More Cables Formed Out as a Single Round Arm

Fig 13,14,—Single-Arm Forms of Cables 18,19

Fig 15—Multiple Forms for Ten-per-Strip Mountings of Round or Oval Cables

Fig 16—Switchboard Short Multiple Cable Forms

Fig 17—Double- and Multi-Arm Horizontal Forms Sewed with Lock Stitch

Fig 18—Single Arm Cable Form, At Right angle to Butt Served With Winding Stitch

Fig 19—Single Arm Frame Sewed With Lock Stitch

Fig 20—Multi-Arm Vertical Forms

Fig 23—Jack Box Cable Forms

Fig 24,25—Starting Stitches

Fig 26—Sewing Local Cable Forms

Fig 27A,B—Cross-Stitch

Fig 28—Chain Stitch

Fig 29—"Chicago" Stitches
 Fig 30—"Kansas City" Stitches
 Fig 31—Sewing of Superimposed Forms
 Fig 32—Banding Cable Arm Break-Outs

REASONS FOR REISSUE

1. To revise 1.04 to include reference to: BSP Section 800-612-161 covering color combinations and uses; BSP Section 800-614-152 covering switchboard, power, and local power cable installation; and BSP Section 802-005-180 covering assembly and installation of power plant bus bar and wiring.
2. To add 1.05 for reference to ED-5A005-10 for forming and terminating flat-type flexible cables.
3. To revise 2.04 to include reference to BSP Section 800-612-150 covering the specific requirements for electronic type equipment.
4. To add 2.14 (a) to include information for dressing skinned wires of equal lengths through fanning strips to distributing frame terminal strips.
5. To revise 2.21 to add clearances between wires and specific types of heat-dissipating resistors.
6. To revise 2.22 and 2.23 to include information on securing loose wire to cable brackets with KS-20986 cable ties.
7. To revise Figures 6 and 7 to designate the switchboard cable leads in the plan view for front side of terminal strips.
8. To include 2.32, reference to BW-, DP-, or similar-type wires.
9. To revise 2.37 to refer to clearances in 2.21 between wire and specific types of heat-dissipating resistors.
10. To omit 3.10 information on treatment of spare wires in multiple cable forms to 1-, 2-, and similar-type banks since the banks are rated MD and the spare wires are no longer furnished in the switchboard cables.
11. To include in 3.21 (formerly 3.22) reference to paragraphs 3.06 through 3.08.
12. To include in 3.23 (formerly 3.24) reference to paragraphs 3.10 through 3.16.
13. To include in 3.24 (formerly 3.25), reference to paragraphs 3.17 and 3.18.
14. to revise 3.44 (formerly 3.45) to clarify the difference between D3 and SW1 surface wiring, to omit reference to BG-type wire, and to include reference to DP-type wire.
15. To revise 3.47 (formerly 3.48) for clarification.
16. To revise 3.69, 3.70, and 3.71 (formerly 3.70, 3.71, and 3.72) for clarification.
17. To add to 3.69 (formerly 3.70) comcodes for sheet fiber and tape.
18. To revise 4.02, 4.08, 4.09, 4.10, 4.11, 4.12 (c), and titles of Figures 14, 17, 18, 19, and 20, to change reference for sewed cables from "leg" to "arm".
19. To revise Figure 13 and 14 to change references in title from "single-leg" to "single arm" and to change cable code designations from 232-, 239-, 84-, and 16-types to 70R-, 106R-, 283R-, and 282R-types, respectively.
20. To revise 4.04(a) and (b) to change cable code designations from 236-, 241-, and 277M-types to 24R-, 256R-, and 74R-types, respectively.
21. To omit information formerly in 4.14 on cable forms for 1-, and 2-type banks which are rated MD.
22. To revise 5.03 to include comcodes 995937810 and 995937820 for plastic tape instead of R-3359 and R-3428, respectively, and to include reference to BSP Section 802-005-180.
23. To revise 5.04 to specify 9-ply polyester twine instead of 8- and 10-ply polyester twine for WE installation sewing applications and to include comcodes for 4-, 8-, and 9-ply polyester twine.
24. To omit figures 21 and 22 showing cable forms for panel-type banks (1- and 2-type) which are rated MD. Subsequent references to these in the text have been deleted.
25. To revise 5.09 and 5.10 to specify 9-ply instead of 8-ply twine for WE installation sewing applications.

SECTION 800-612-153

26. In 5.14, to omit note on location of double lock stitch which is covered in note of Figure 26.
27. To add note to 5.22 to permit occasional stitches to exceed the maximum 1-1/2 spacing as long as the required number of stitches are provided on the cable form.
28. To revise 5.29 to include information for KS-13385, KS-22247, and DP-type wires.
29. To revise 5.30 to include information for KS-13385 wire and comcodes for the gray fiber and friction tape.
30. To revise 5.31 to include information on KS-19689 coaxial cables.
31. To revise 5.32 and 5.33 to include reference to KS-19689 coaxial cables and to add procedures 5.33 (a) and (b) for taping cable forms containing rubber or neoprene cordage or coaxial cables.
32. To revise 5.34 to specify taping with two turns instead of 1-1/4 turns of tape for securing rubber or neoprene cordage or coaxial cables to adjacent cable forms.
33. To revise 5.35 to specify 1/64 inch sheet fiber for protecting cable forms secured to cable brackets.
34. To revise 5.42 to include the use of the double twine starting stitch as an alternative in the sewing of cable forms with a single strand of twine.
35. To revise 5.60 to specify the use of 9-ply twine instead of 8-ply twine for superimposing WE installer-run loose wires.
36. To revise 6.01 to include comcodes for KS-20986 cable ties.
37. To revise 6.02 to include the use of 9-ply twine for tying wiring.
38. To revise 6.03 to specify the use of "gray or black" KS-20986 cable ties.
39. To add 6.03 (g) to include information for securing WE installer-run power wire or cable with KS-20986 cable ties; and to include comcode for sheet fiber.
40. To revise 6.03 ((l) [formerly 6.03 (k)] to include reference to ABAM-type cables, KS-19689 coaxial cable, and 606B- through 612B-type cables.
41. To include 6.03 (o) for securing wire or cable to 951A-type connectors with KS-20986 cable ties.
42. To revise 6.04 (f) and (g) to reference power wire and cable.
43. To omit 6.04 (k) which indicated that power wire or cable was not to be secured to cable brackets or other wiring supports with KS-20986 cable ties.
44. To revise 6.05: to change the cable tie fastening tool designation from "R-4266" to "R-4827"; to specify tool tensions in pounds instead of tool indicator settings; to include the note regarding tool indicator settings; and to add paragraph (a) regarding the optional use of the R-4266 tool for applying KS-20986 L1, L2, L3 cable ties.
45. To revise 6.06 to permit the use of KS-20986 L1 to L5 cable ties instead of L1 or L4 for banding together cable forms up to "5/8" inch in diameter instead of "1/2" inch.
46. To revise 6.07 to specify the use of KS-20986 L1, L2, L3, or L5 cable ties instead of L1, L2, or L5 for banding together cable forms more than "5/8" inch in diameter instead of "1/2" inch.
47. To revise 6.08 to specify the use of KS-20986 L1 through L5 cable ties instead of L1 or L4.
48. To revise 6.09 to specify the use of KS-20986 L1, L2, L3, or L5 cable ties instead of L1, L2, or L5.
49. To revise 6.10 to include reference to BSP Section 800-612-156 covering placing, securing, and supporting cable forms.
50. To add 6.11 (c) to indicate procedure for checking the tightness of KS-20986 cable ties.
51. to revise 6.11 (d) [formerly 6.11 (c)] to indicate that the nylon tie head should not interfere with the installation or removal of apparatus or equipment.
52. To revise 7.01 and 7.01 (a) for clarification.
53. To add 7.01 (b) to indicate that wires serving the same row of terminals on distributing frame terminal strips may be skinned to equal lengths.

FORMING, FANNING, SEWING, AND SKINNING WIRING AND CABLING GENERAL EQUIPMENT REQUIREMENTS

1. GENERAL

1.001 This addendum supplements AT&T Practice 800-612-153, Issue 10D.

1.002 This addendum is issued:

- (a) To add Part 2 F. Lightguide Cables information which includes paragraphs 2.51 and 2.52.
- (b) To revise paragraphs 6.03(a), 6.03(b), 6.03(c), 6.03(d), 6.03(f), 6.03(m), and 6.03(n).
- (c) To delete paragraphs 6.03(e) and 6.03(g).
- (d) To delete paragraphs 6.04(c), 6.04(e), 6.04(g), and 6.04(h).
- (e) To add new paragraph 6.04(c).
- (f) To revise paragraphs 6.04(d) and 6.04(f).

2. CHANGES TO PRACTICE

2.001 On page 14:

Add:

F. Lightguide Cabling

2.51 In general, lightguide cables should be run loose without sewing or tying. Where it is necessary to secure the cables in order to hold them in place or in formation on equipment frameworks, they may be taped together or to adjacent cabling or they may be tied with twine to cable brackets or other framework details. However, where the cables are to be tied, they shall be protected from

contact with the twine and the metalwork by wrapping the cables with 995831013, 1/64-inch thick sheet fiber. Although protected, the cables shall not be tied so tightly as to cause the fiber protection to deform the cables since deformation of the cables could adversely affect their transmission characteristics.

2.52 Lightguide cables shall not be pulled, twisted, or kinked. Minimum bending radii shall be adhered to throughout the entire dressing operation. (See AT&T Practice 800-612-162 for minimum bending radii.) Lightguide cables that are kinked or otherwise damaged during handling or installation shall be replaced. Damaged cables should be discarded promptly to avoid accidental use.

2.002 On page 43:

Revise: Paragraphs 6.03(a), 6.03(b), 6.03(c), 6.03(d), 6.03(f), 6.03(m), and 6.03(n)

To read:

6.03(a) Banding together loose wiring or surface wiring where a simple tie of twine would normally be used for this purpose. [See 6.04(a) and (c).]

6.03(b) Banding installer-run vertical wiring to existing vertical wiring. [See 6.04(c).]

6.03(c) Banding of horizontally-run loose wiring to existing horizontal wiring, including local cable forms, or to towel bars and similar-type horizontal wiring supports. [See 6.04(a) and (c).]

6.03(d) Securing installer-run loose or sewed wiring to cable brackets or other wiring supports on equipment framework except as specified in 6.04(c) and (f). See AT&T Practice 800-612-156 for method.

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Note: Flexible cordage, such as the KS-15141, KS-15143, and KS-20195 types and coaxial cables having soft inner dielectrics such as the KS-21112 and KS-19689 types shall be protected from contact with the cable bracket and cable tie (or sewing twine) by wrapping the wires with 1/64-inch sheet fiber per 995831013. Although protected, the cables shall not be tied so tightly as to cause the fiber protection to deform the cables.

6.03(f) Securing installer-run switchboard cable to the transverse arms of distributing frames. See AT&T Practice 800-614-152 for method.

6.03(m) Banding cables in the 1, 2, and 4 compartments of ESS* cable rack. [See 6.04(c).]

6.03(n) Banding together of power cables, including flexible cordage such as the KS-15141, KS-15143, and KS-20195 types.

2.003 *On page 43:*

Delete: Paragraphs 6.03(e) and 6.03(g).

2.004 *On page 44:*

Change: Paragraph 6.04(c)

To read:

6.04(c) Banding or securing of lightguide cables.

2.005 *On page 45:*

Revise: Paragraphs 6.04(d) and 6.04(f)

To read:

6.04(d) Banding or securing cable or wire in cable racks except as noted in 6.03(m).

6.04(f) Securing wire or cable to the top cable bracket on equipment framework.

2.006 *On page 45:*

Delete: Paragraphs 6.04(e), 6.04(g), and 6.04(h).

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**PLACING, SECURING, AND SUPPORTING CABLE FORMS
INCLUDING UNEQUIPPED FORMS
WIRING AND CABLING
GENERAL EQUIPMENT REQUIREMENTS**

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1. GENERAL

1.01 This practice covers the general equipment requirements for placing, securing, and supporting cable forms (including unequipped forms) and loose wire forms.

1.02 This practice is reissued to make changes that are listed under reasons for reissue at the end of this practice. Since this reissue covers a general revision, the arrows ordinarily used to indicate changes have been omitted.

1.03 The requirements covered in this practice shall be followed except as modified by applicable specifications and drawings.

1.04 The AT&T practices listed below contain wiring and cabling requirements that supplement the requirements of this practice and, where applicable, are referred to in other parts of this practice.

800-612-150—Specific Requirements for Electronic-Type Equipment

800-612-151—Design of Cable Forms

800-612-153—Forming, Fanning, Sewing, and Skinning

800-612-157—Protection of Cable Forms and Skinners

800-612-163—Specific Requirements for Crossbar-Type Equipment

800-614-152—Switchboard, Power and Local Power Cables—Installation

2. PLACING, SECURING, AND SUPPORTING SEWED FORMS

PLACING SEWED FORMS

2.01 *Locate sewed forms* in accordance with the information given on the cable plan drawings.

2.02 *Locate and place forms* so that they interfere as little as possible with access to apparatus requiring adjustment, repair, replacement, or cleaning.

2.03 *There should be no interference of forms* with movable or removable equipment parts such as keyshelf braces, commutator brushes, multiple banks, etc.

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2.04 All forms should be located, where possible, at least 2 inches from any wiring carrying outside service current that is not enclosed in armor or conduit.

2.05 Where the physical layout is not controlling, switchboard cable forms will be located on top of the local cable forms in the case of horizontal forms, and to the right of them (facing the rear) in the case of vertical forms.

2.06 Locate sewed arms of cable forms that serve relays, resistors, capacitors, and similar apparatus mounted on mounting plates or panels as follows:

(a) **On channel-type framework, or on uniframe where the mounting plates or panels are mounted on the front of the uprights**, locate the arms so that the inside edge of the form is approximately 3-1/2 inches, not more than 3-3/4 inches maximum, from the mounting plate or panel.

(b) **On uniframe where the mounting plates or panels are mounted on the rear of the uprights, and on ESS-type frameworks**, locate the arms so that the inside edges of the forms are approximately 2-1/8 inches from the mounting plate or panel.

(c) **On bulb-angle or box-type frameworks**, locate the arms so that the inside edge of the form is approximately 2-3/8 inches, not more than 2-5/8 inches maximum, from the mounting plate or panel.

(d) **On duct-type frameworks**, locate the arms in accordance with the equipment information. The arms should be located within the limits of the guardrail.

(e) In general, shop-wired units should be designed with local cable arms located 2-3/8 inches from the mounting plate in order to permit their use universally on channel, bulb-angle, and box-type frameworks. Shop-wired units mounted exclusively on channel-type frameworks may be designed with local cable arms located 3-1/2 inches from the mounting plate or panel.

2.07 Locate sewed arms of forms serving terminal strips approximately 1/2 inch from the rear edge of the fanning strip. Locate the

sewed arms of forms serving terminal strips not equipped with fanning strips approximately 1/2 inch from the rear edge of the terminal strip mounting bars.

SECURING SEWED FORMS

2.08 Secure sewed forms to cable brackets or other framework details by tying with twine in accordance with this practice, unless otherwise specified. Provide protection, if required, in accordance with AT&T Practice 800-612-157.

2.09 Use the Chicago stitch or the Kansas City stitch specified in AT&T Practice 800-612-153 to secure the form in place. The Chicago stitch should always be used when additional rigidity is required.

2.10 Cable forms on power panels should be secured by means of metal clamps per specification AT-6933 or approved equivalents. (See paragraph 2.11.) Protect the cable form from direct contact with the metal cleat or clamp by wrapping 3/4-inch wide friction tape per 995911278 around the cable. Where necessary, several layers of tape may be used to build up the diameter of the cable for a more secure fastening of the cable within the clamp. Sheet fiber 1/64-inch thick per 995831011 may also be used instead of tape to protect or build up the cable.

(a) The drawing number and sizes of the AT-6933 clamps available for securing cable forms on power panels are as follows:

| Clamp Size | Cable Diameter (inches) | Size Of Screw Hole (inches) | Part Number |
|------------|-------------------------|-----------------------------|-------------|
| 1 | 0.19 or less | 0.203 | A-155215 |
| 3 | 0.19 to 0.24 incl | 0.203 | 400120895 |
| 4 | 0.25 to 0.33 incl | 0.203 | 400120903 |
| 6 | 0.34 to 0.43 incl | 0.265 | 400120911 |
| 8 | 0.44 to 0.60 incl | 0.280 | 400120937 |
| 10 | 0.60 to 0.72 incl | 0.280 | 400120952 |
| 13 | 0.73 to 0.93 incl | 0.280 | 400120978 |
| 17 | 0.94 to 1.20 incl | 0.280 | 400120986 |
| 21 | 1.21 to 1.70 incl | 0.280 | 400120994 |
| 30 | 1.71 to 2.00 incl | 0.280 | 400121018 |
| 35 | 2.01 to 2.75 incl | 0.280 | 400121026 |

(b) The screws, nuts, and washers that should be used to fasten the clamps specified in (a) are as follows:

See proprietary notice on cover page.

| Type of Panel | Screw | Nut | Washer |
|--|--|--------------|---------------|
| Fiberglass, Insul-Roc, or impregnated asbestos composition, 1 inch thick | RH type B self-tapping (8 by 3/4) P-422007 | — | Flat P-284148 |
| Fiberglass, Insul-Roc, or impregnated asbestos composition, 5/8 inch thick | PHST type B (6 by 1/2) P-424816 | — | Flat P-284145 |
| Metal 1/8 inch thick | PHM (0.164-32 by 1/2) 840059083 | Hex P-206518 | Flat P-284148 |
| Metal, 7/32 inch thick | PHM (0.164-32 by 5/8) 840059109 | Hex P-206518 | Flat P-284148 |

2.11 As a substitute for the AT-6933 metal clamps specified in paragraph 2.10, the R-4065 nylon clamps, the KS-20986 L8 cable ties, the plastic loop supports specified below, or equivalent plastic supports may be used to secure cable forms as shown in Fig 1. The clamps or plastic loop supports should be secured to power panels with the screws, nuts, and washers specified in paragraph 2.10(b) for metal clamps. The R-4065 clamps or KS-20986 L8 cable ties shall not be used in shop applications for securing cable forms greater than 3/4 inch in diameter.

(a) **R-4065 nylon clamps and KS-20986 L8 cable ties** are strap-type clamps that wrap and permanently lock around the cable form. To secure the cable form, position the clamp or tie around the cable form, thread the end of the clamp or tie through its locking device, and manually tension the clamp or tie to temporarily hold the cable in place. Final tensioning of the clamp or tie and cutting off of the unused end shall be done using the R-4827 cable tie fastening tool set to tension the tie around the cable at approximately 23 pounds. See AT&T Practice 800-612-153.

(b) **Plastic loop supports** (cable clamps) are snap-on type clamps and therefore should be one size smaller than the diameter of the cable to be secured. The following sizes are available:

| Size ID | COMCODE |
|---------|-----------|
| 1/8 | 996248720 |
| 3/16 | 997126321 |
| 1/4 | 996609160 |
| 5/16 | 996609178 |
| 3/8 | 997656582 |
| 7/16 | 400932026 |
| 1/2 | 400932034 |
| 9/16 | 997842257 |
| 5/8 | 900010969 |
| 11/16 | 997842323 |
| 3/4 | 997842265 |
| 7/8 | 997888698 |
| 1 | 996233011 |
| 1-1/8 | 900005927 |
| 1-3/16 | 996233037 |
| 1-1/4 | 996233045 |
| 1-3/8 | 996233052 |
| 1-1/2 | 996233060 |

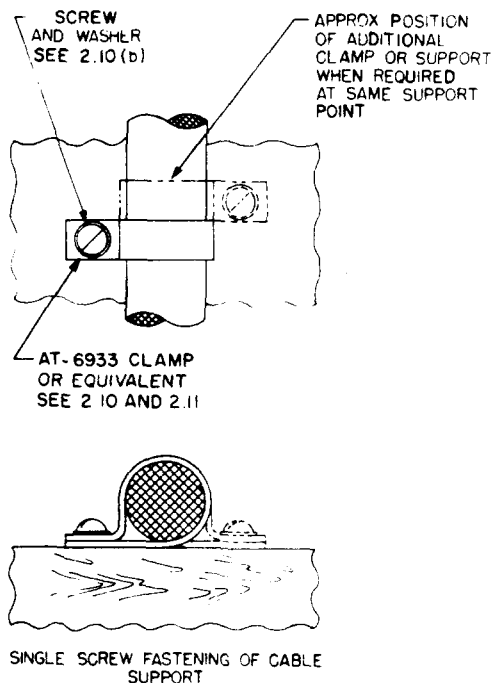


Fig 1—Securing Sewed Cable Forms on Power Panels

See proprietary notice on cover page.

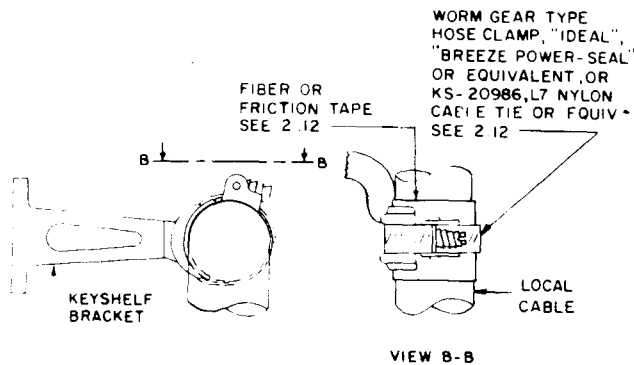


Fig 2—Fastening Keyshelf Local Cables to Keyshelf Cable Brackets

2.12 Keyshelf Local Cable Forms: Where brackets such as those shown in Fig 2 are furnished for securing keyshelf local cable forms, the forms shall be securely fastened to the brackets in accordance with Fig 2.

- (a) Where the metal strap or clamp is used for securing the cable, friction tape per 995911278 or 995831011 1/64-inch sheet fiber shall be placed under the metal strap or clamp to protect the cable from damage.
- (b) Where the nylon cable tie is used for securing the cable, several wrappings of 995911278 friction tape instead of the fiber shall be used under the nylon tie. Application and tensioning of the tie around the keyshelf bracket and local cable shall be in accordance with paragraph 2.11(a). The nylon cable tie shall not be used in shop applications for securing cable forms greater than 3/4 inch in diameter.
- (c) Cables shall be built up sufficiently with wrappings of 995911278 friction tape to ensure that they will be securely fastened to the bracket by the clamp, strap, or tie.
- (d) Where the keyshelf bracket is located on the same side of the keyshelf as the keyshelf brace, the end of the metal strap or clamp or the locking head of the nylon tie shall not protrude so as to result in a hazard when closing the keyshelf.

SUPPORTING SEWED FORMS

2.13 Cable supports, cable brackets, or other supporting details are generally provided for securing and supporting cable forms on equipment framework. Cable forms shall be secured to cable supports, cable brackets, etc. in accordance with the applicable requirements of Fig 3, 4, or 5. Where cable supports, etc. are not provided or where it is impracticable to secure the cable forms to the cable supports, tie the forms directly to the metal framework as shown in Fig 5. When securing cable forms to the cable supports, cable brackets, etc. or to the metal framework, provide protection, where required, in accordance with AT&T Practice 800-612-157.

2.14 Where it is impracticable to secure the cable forms to cable supports, brackets, etc. or to the framework, they may be tied to adjacent forms or other cables that are fastened to the cable supports or framework.

2.15 Installer-run wiring may be secured to L-, U-, or similar-type brackets or to other cable forms, using KS-20986 nylon cable ties instead of twine. The use of the nylon cable ties for this purpose shall be in accordance with Part 6 of AT&T Practice 800-612-153 covering the requirements for tying and banding wire and cable. Securing of the cable forms to the L-, U-, or similar-type brackets with the nylon ties shall be in accordance with paragraph 2.31.

2.16 Where two or more closely adjacent parallel forms or arms of forms serve the same or adjacent apparatus, the forms should be tied or sewed together with twine as necessary to make a compact bundle of forms. This is especially important where the several forms are small, in order to keep them in place. Where applicable, KS-20986 nylon cable ties may be used instead of twine, as specified in Part 6 of AT&T Practice 800-612-153.

2.17 Closely adjacent forms at right angles to each other should be tied together with twine as necessary for mutual support and to present a professional appearance. Nylon cable ties shall not be used for securing together cable forms that are at right angles to each other or for securing forms at right angles to towel bars or similar-type supports.

See proprietary notice on cover page.

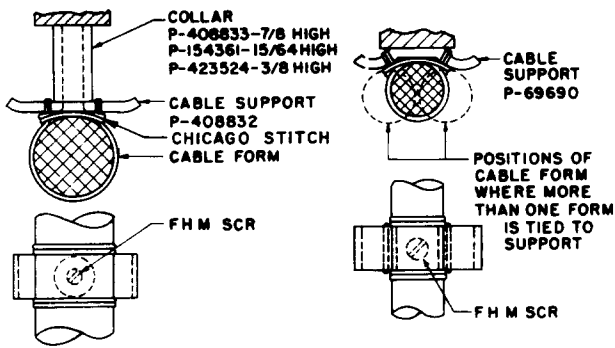
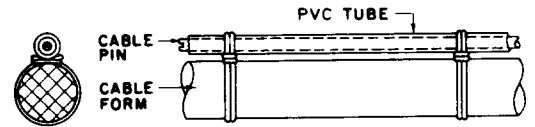
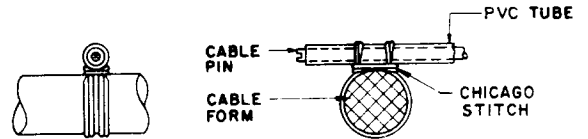


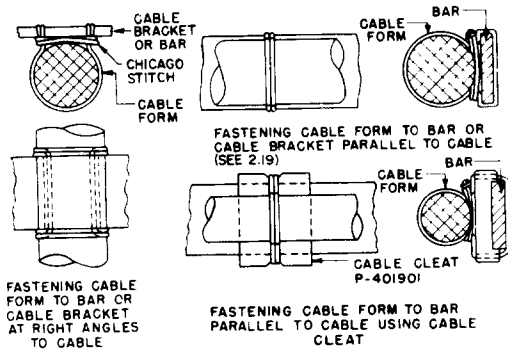
Fig 3—Fastening Cable Forms to Cable Supports



FASTENING CABLE FORM TO
CABLE PINS PARALLEL TO CABLE

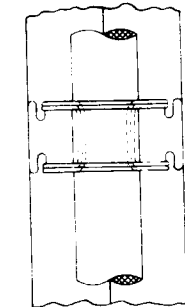
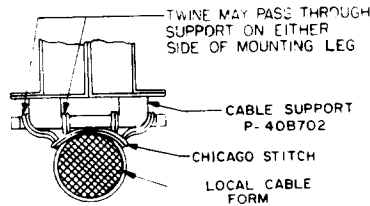


FASTENING CABLE FORM TO CABLE
PINS AT RIGHT ANGLES TO CABLE



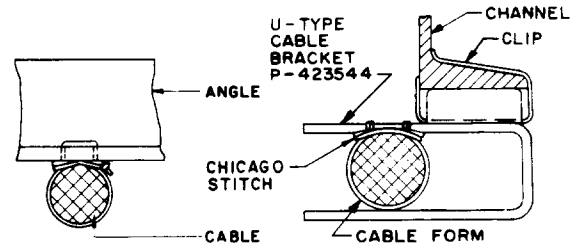
FASTENING CABLE
FORM TO BAR OR
CABLE BRACKET
AT RIGHT ANGLES
TO CABLE

FASTENING CABLE FORM TO BAR
PARALLEL TO CABLE
USING CABLE
CLEAT



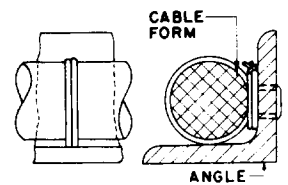
METHOD OF
SUPPORTING MAIN CABLE ARM
ON DOUBLE BAY FRAMES

Fig 4—Fastening Cable Forms to Cable Brackets or Bars

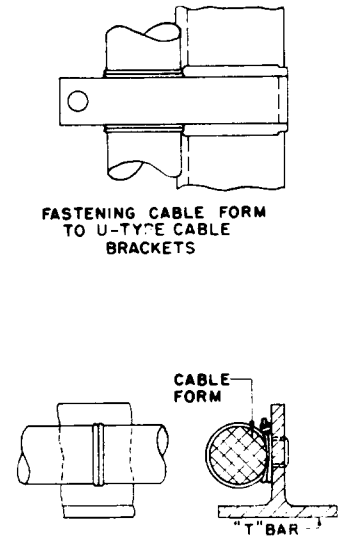


FASTENING CABLE FORM TO
ANGLE AT RIGHT ANGLES TO
CABLE

FASTENING CABLE FORM
TO U-TYPE CABLE
BRACKETS



FASTENING CABLE FORM TO
ANGLE PARALLEL TO CABLE



FASTENING CABLE FORM TO
"T" BARS

Fig 5—Fastening Cable Forms to Cable Pins, Angles, Channel Uprights, T Bars, and L-, or U-Type Brackets and Similar Type of Framework Details

See proprietary notice on cover page.

2.18 Where a vertical cable is to be secured to a vertical bar and the weight of the cable is such that the twine may slip and cause the cable to sag, wrap five or six turns of R-3428, R-3359, or KS-14090 gray plastic tape tightly around the bar immediately below the uppermost tie. Tape should not be used if the bar is notched to engage the twine.

2.19 Cable Forms (Local or Switchboard):

The standard spacing of points of support for cable forms is approximately 1 foot 8 inches. This is not a fixed dimension, however, and will vary as the design of the framework structure and the shape and size of the cable forms dictate.

SUPPORTING UNEQUIPPED FORMS

A. General

2.20 Entire Arm Unequipped: Enclose the unequipped arm in a rigid PVC tube (see paragraph 2.29) and secure the tube in place with twine. For installer-run wiring, the tube may be secured, where practicable, with KS-20986 nylon cable ties instead of twine.

(a) **Horizontal Form:** Fasten the horizontal form to the framework or dummy mounting plate as shown in Fig 6 and 7.

(b) **Vertical Form:** Fasten the vertical form to the mounting plate as shown in Fig 8 except where space limitations or other factors make this procedure difficult, in which case the method shown in Fig 10 for supporting unequipped skimmers may be used.

2.21 Arm Partially Unequipped: Unequipped skimmers may be sewed back against the form as specified below, or enclosed in rigid PVC tubes (see paragraph 2.29) that are tied to the mounting plate or to a dummy plate furnished for this purpose as shown in Fig 9 and 10 and specified below.

(a) **Where the last breakout at the tip of the form is unequipped** (last two breakouts where the skimmers break out at closely spaced points, 1/2 inch or less apart) and there are six or fewer skimmers in the breakout (in both breakouts where two are included), the unequipped leads may be doubled back at the last

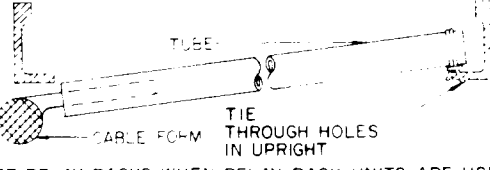
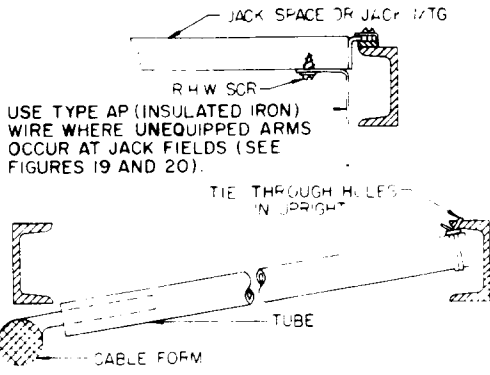
breakout point and sewed to the form with twine. A single strand of twine shall be used for such sewing. The stitches should coincide with the regular sewing on the form wherever practicable, but should be located so as to hold the ends of the skimmers in place. Where the number of skimmers exceeds six, the entire tip of the form shall be enclosed by a tube. This tube is supported by tying to the mounting plate or framework or by means of a tube support as shown in Fig 9 and 10. Where the last two or more breakouts are unequipped, enclose the entire tip of the form in a tube regardless of the number of skimmers involved, except as indicated above.

(b) **Where there is a small number of unequipped skimmers** at each breakout point [six or fewer, except as covered in (a)], as in the case of 18- or 19-type resistors, or where only a portion of the skimmers at any breakout point is left unconnected, as in the case of universal local cables, the unequipped leads may be doubled back and sewed to the form with twine. The skimmers should be as evenly distributed as practicable on the side of the form facing the mounting plate. A single strand of twine may be used for such sewing. The stitches should coincide with the regular sewing on the form, wherever practicable, but should be located so as to hold the ends of the skimmers in place.

(c) If the total number at breakout points is seven or more and the unequipped skimmers break out at closely spaced points (1/2 inch or less apart), enclose skimmers in a single short tube and tie it to the mounting plate. For example, sew three and three skimmers, but enclose three and four skimmers in a tube.

(d) **Where the number of sets of unequipped skimmers is so large** as to make the use of individual tubes for each set of skimmers uneconomical, and the circuits, when equipped, will be added in regular consecutive order, a split rigid PVC tube (see paragraph 2.29) may be used over the unequipped portion of the form as shown in Fig 9. Tie the tube at approximately 12-inch maximum intervals with twine or KS-20986 cable ties to prevent the split in the tube from opening. Where the length of the unequipped portion is considerable, overlap the tubes end to end before applying the ties.

See proprietary notice on cover page.



AT RELAY RACKS WHEN RELAY RACK UNITS ARE USED

NOTE: CUT AP WIRE TO APPROX LENGTH BEFORE FORMING. FORM ONE END OF WIRE TO FIT SNUGLY AROUND TUBE. FORM OTHER END TO FIT UNDER HEAD OF MOUNTING SCREW.

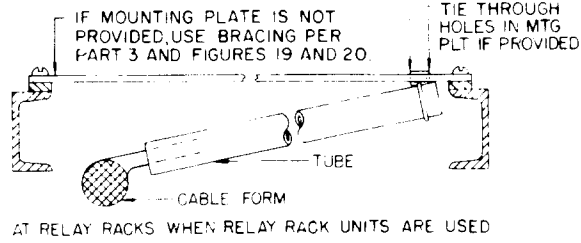


Fig 6—Supporting Completely Unequipped Horizontal Cable Forms (Channel and Bulb-Angle Uprights Shown)

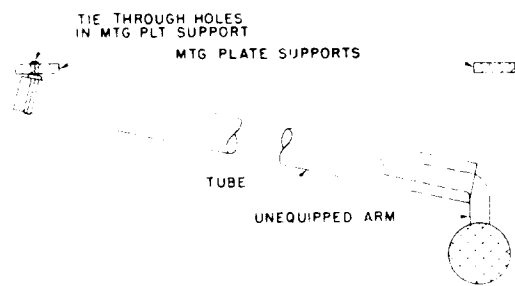


Fig 7—Supporting Unequipped Horizontal Cable Arms in Switchboards and Desks When Mounting Plates Are Omitted

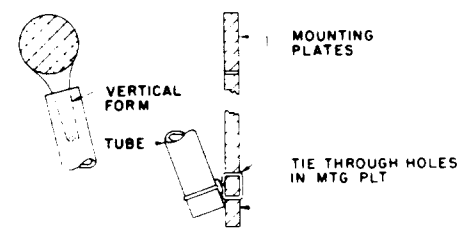
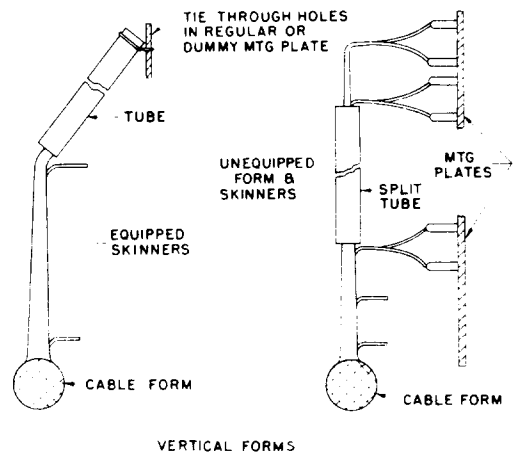
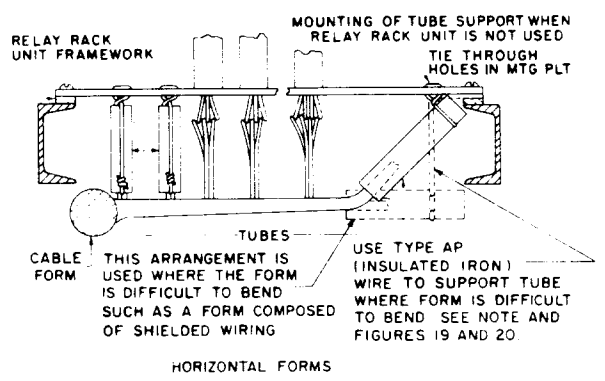


Fig 8—Supporting Completely Unequipped Vertical Forms



NOTE: CUT AP WIRE TO APPROX LENGTH BEFORE FORMING. FORM ONE END OF WIRE TO FIT SNUGLY AROUND TUBE. FORM OTHER END TO FIT UNDER HEAD OF MOUNTING SCREW.

Fig 9—Supporting Partially Unequipped Cable Forms

See proprietary notice on cover page.

2.22 Unequipped arms of ladder-type forms should be enclosed in split rigid PVC tubes (see paragraph 2.29). Where the diameter of the arm is so large that the use of a split tube is impracticable, use 1/64-inch gray sheet fiber per 995831011 wrapped around the arm in the form of a tube and securely tied with twine. Tie split tubes as specified in paragraph 2.21(d).

2.23 Where it is impracticable to support unequipped forms enclosed in rigid PVC tubes in the regular way, as shown in Fig 6 through 10, the forms shall be held in proper position by tying the tubes to adjacent equipped forms.

B. Specific Requirements

2.24 Bank Cable Forms: Unequipped vertical cable arms attached to 26-, 27-, and similar-type banks should be enclosed in rigid PVC tubes (see paragraph 2.29) and supported as shown in Fig 11.

2.25 Fuse Bay and Fuse Panel Forms: At partially equipped fuse and lamp panels, forms that are so small that they are not self-supporting should be supported as shown in Fig 12. In general, one support placed midway between the butt and tip of the form will be sufficient. An additional support should be furnished where the tip of the form is not equipped.

- (a) For circuit breaker panels or fuse panels equipped with 18-, 19-, 20-, 21-, or similar-type fuse blocks or with 22-, 23-, 24-, or similar-type modular fuse blocks, cable form bracing CBF2, as covered in Part 3 and Fig 19, may be provided to support vertical or horizontal forms.

2.26 Keyshelf Local Cable Forms: Enclose unequipped key arms of keyshelf local cables in rigid PVC tubes (see paragraph 2.29) as shown in Fig 6 through 10 (whichever is most applicable) whether the keyshelf is partially or entirely unequipped.

- (a) Where the main arm of the keyshelf also requires support either at unequipped key positions or when fully equipped, provide bracing such as that shown in Fig 19 or 20.
- (b) Where key positions are equipped with 12-, 14-, or similar-type ticket boxes instead of keys, the skimmers normally sewed into key arms for these positions should be sewed back on the main form.

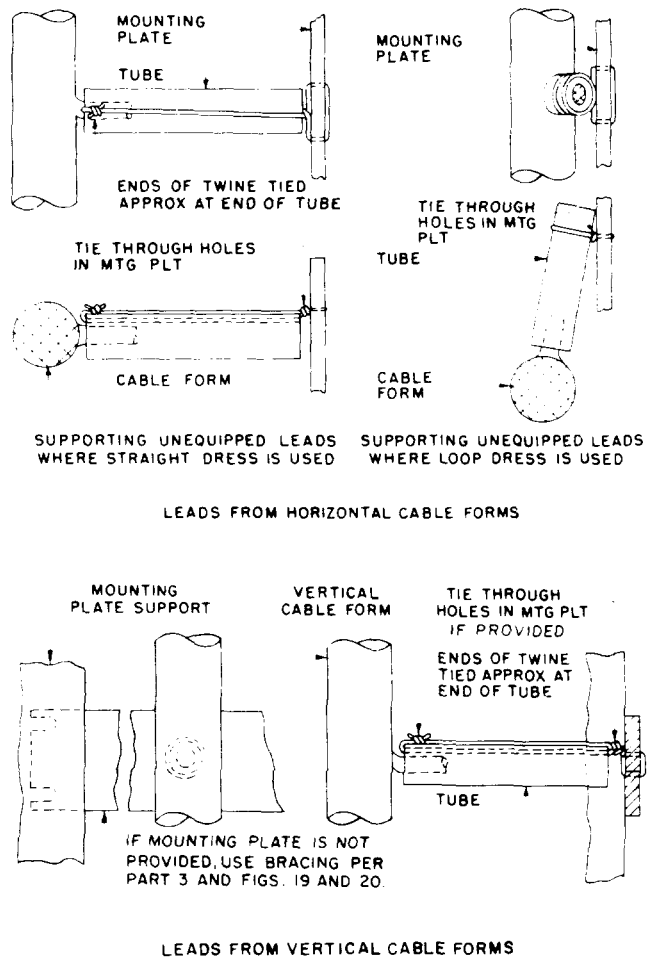


Fig 10—Supporting Unequipped Skimmers of Cable Forms

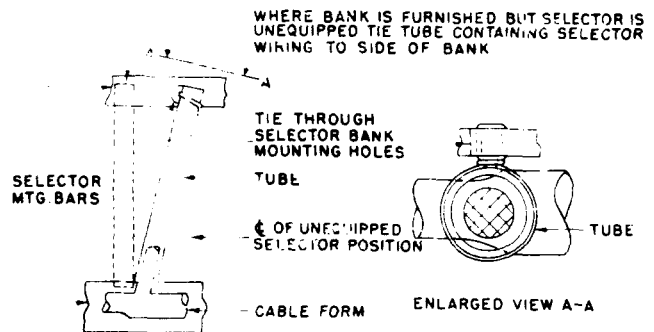


Fig 11—Supporting Unequipped Cable Arms to 26-, 27-, and Similar-Type Banks

See proprietary notice on cover page.

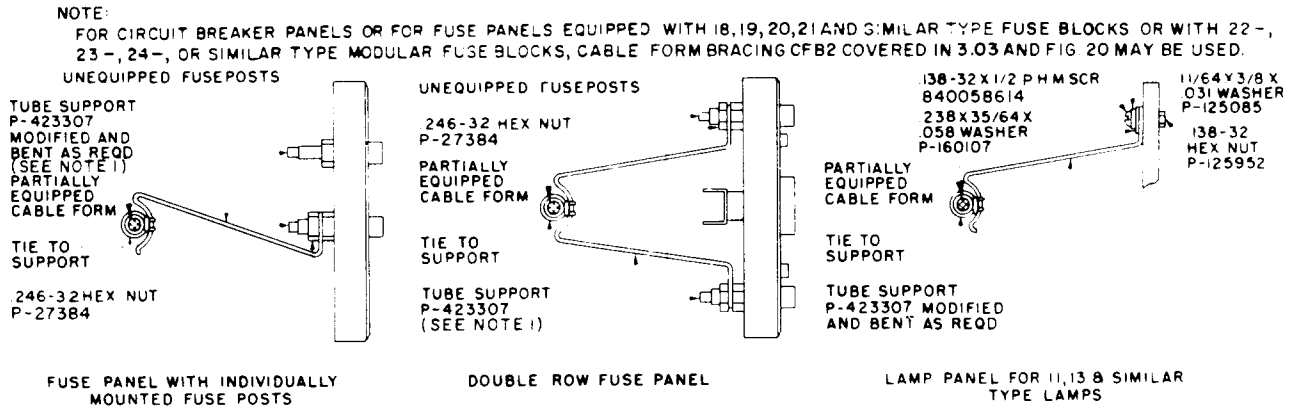


Fig 12—Supporting Cable Forms at Partially Equipped Fuse, Circuit Breaker, and Lamp Panels

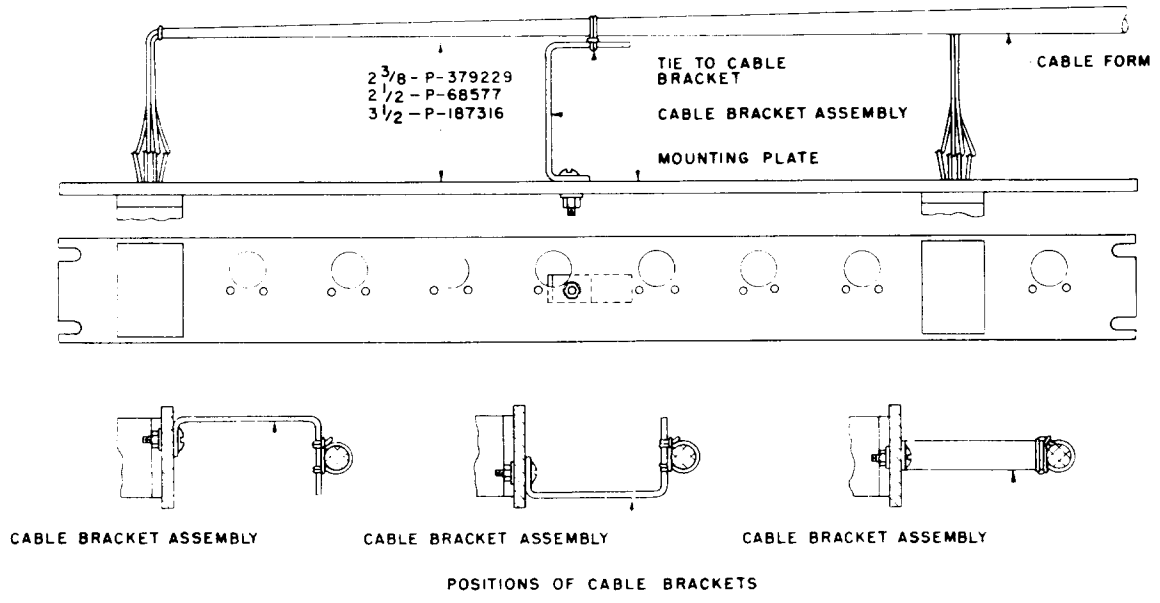


Fig 13—Supporting Cable Forms at Unequipped Apparatus Positions

See proprietary notice on cover page.

2.27 Relay Resistance and Similar Forms:

Cable forms for apparatus on strip-type mounting plates should be supported by brackets where the distance between equipped apparatus positions or between the equipped apparatus and the butt of the form exceeds 1 foot 3 inches. The brackets are fastened to the mounting plate approximately at the middle of the unequipped part of the forms as shown in Fig 13.

2.28 Universal Local Cable Forms: The unequipped wire should be doubled back and sewed to the form unless otherwise specified.

TYPES OF TUBES

2.29 Unless otherwise specified, the following tubes (length as required) shall be used to enclose unequipped wiring. They are also used where moistureproofing is required. Tubing may be cut to the required length with scissors.

RIGID POLYVINYL CHLORIDE TUBES

| Inside Diameter (inches) | Length (inches) | COMCODE |
|--------------------------|-----------------|-----------|
| 1/2 | 32 | 995524584 |
| 5/8 | 20 | 995524360 |
| 3/4 | 33 | 995524170 |
| 1 | 36 | 995524485 |
| 1-1/8 | 32 | 995524501 |
| 1-1/4 | 30 | 995524550 |
| 1-1/2 | 29 | 995524527 |
| 1-3/4 | 37 | 995524543 |

SPLIT RIGID POLYVINYL CHLORIDE TUBES

| | | |
|-------|----|-----------|
| 3/4 | 16 | 801600065 |
| 1 | 29 | 801600099 |
| 1-1/4 | 30 | 814023131 |
| 1-1/2 | 30 | 814034054 |
| 1-3/4 | 23 | 995841749 |

LOOSE WIRES IN RINGS, WIRE RETAINING DEVICES, OR CABLE BRACKETS

2.30 At locations where cable brackets are provided, such as L- and U-type and the cable brackets provided on No. 5 crossbar frames, the loose wiring shall be secured to the cable brackets with twine in the same manner as for sewed forms. See Fig 14. Provide protection, when required, in accordance with AT&T Practices 800-612-153 and 800-612-157.

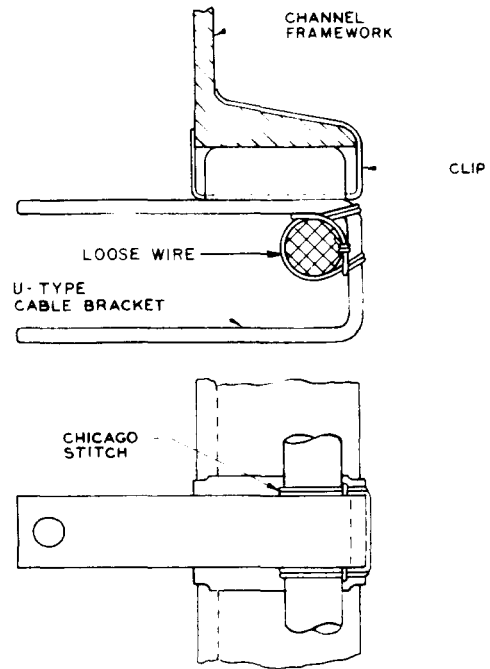


Fig 14—Fastening Loose Wire in U-Type Cable Brackets on Relay Racks

2.31 Installer wiring and cabling run within equipment bays or frames may be secured to L-, U-, or similar-type brackets or wire retaining devices using KS-20986 L1, L2, or L3 cable ties instead of twine. See (b)(4) below. The use of cable ties for this purpose shall be in accordance with the requirements of AT&T Practice 800-612-153 and as indicated below.

- (a) Securing of wires and cables to cable brackets or similar-type wire retaining devices with cable ties shall be in accordance with Fig 15 or 16 whichever is applicable.
- (b) Securing of power wiring to the brackets or wire retaining devices with the cable ties shall be in accordance with Fig 15 and the following requirements:

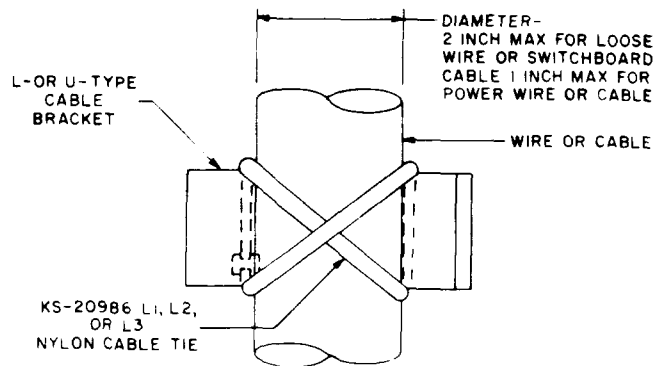


Fig 15—Securing Installer-Run Loose Wire, Switchboard Cable, or Power Wire or Cable to L- or U-Type Cable Brackets With Nylon Cables Ties

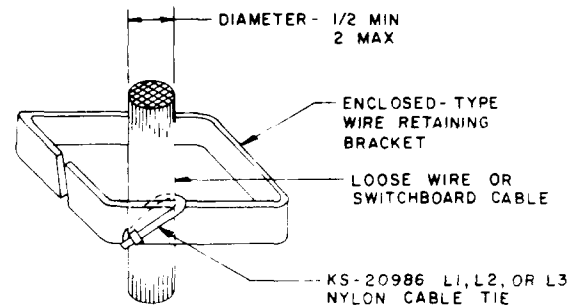


Fig 16—Securing Installer-Run Loose Wire to Enclosed-Type Retaining Brackets With Nylon Cable Ties

- (1) Except as indicated in paragraph 2.35, wires and cables shall be secured with twine at the top cable bracket or other wiring support on the equipment bay where they enter the bay from the cable rack.
- (2) KS-20986 L1, L2, and L3 cable ties shall be tensioned, and the loose ends shall be cut off using the R-4266 (fixed tension) or R-4827 (adjustable tension) cable tie fastening tool in accordance with AT&T Practice 800-612-153.
- (3) Flexible cordage (such as the KS-15141, KS-15143, and KS-20195 types), coaxial cables having soft inner dielectrics (such as the KS-21112 and KS-19689 types), and conductors having foamed polyethylene insulation (such as those in 1244-, 1245-, 1247-, and 1249-type cables) shall be protected from contact with the cable bracket and cable tie (or sewing twine) by wrapping the wires with 1/64-inch sheet fiber per 995831011.
- (4) Lightguide cables shall not, generally, be tied to cable brackets or other framework details. Where it is necessary to secure the cables in order to hold them in place or in formation, they may be taped to adjacent cabling or they may be tied with twine to framework details. However, where the cables

are to be tied, they shall be protected from contact with the twine and the metalwork by wrapping the cables with 995831011, 1/64-inch thick sheet fiber. Although protected, the cable shall not be tied so tightly as to cause the fiber protection to deform the cables since deformation may cause damage to the glass fibers. Lightguide cables that are kinked or otherwise damaged shall be replaced.

2.32 Where enclosed-type cable brackets, fanning rings, adjustable wiring supports, or other wire retaining devices are provided, tying is not required except when there is a possibility of the wires pulling out of the ring or wire retaining devices.

2.33 Additional ties should be placed on the forms between the cable brackets or wire retaining devices where necessary to keep the wiring in a reasonably good formation and to prevent the wiring from contacting adjacent framework or apparatus.

2.34 At points where wiring breaks out of the form, such as from the main vertical form, additional ties are not required where a cable bracket or wire retaining device is provided at the breakout point. However, ties should be provided at breakout points when no wire retaining devices are provided on the main vertical form.

(a) As an exception to the above, no ties are required on the main vertical form at breakouts to D-type terminal strips when they are located close to the frame uprights or to units equipped with wire retaining clips mounted adjacent to the frame upright. In these cases, the terminal strip wiring guides and the unit wire retaining clips provide sufficient support for the main vertical form and provide turning point support at the breakouts.

2.35 Switchboard cables or loose wires (such as P-wire) entering the duct of duct-type bays do not require additional support within the duct if they are secured by sewing at the cable rack strap or stringer where they turn off the rack to enter the duct. However, the loose wiring should, where practicable, be secured within the duct with the nylon cable ties and clamps furnished with the bay framework as shown in Fig 17. At breakout points, band the wires with twine or nylon cable ties in accordance with AT&T Practice 800-612-153. At unequipped positions, when the wiring within the duct has a tendency to extend outside the duct, use straight details made with No. 14 gauge bare copper wire and place as shown in Fig 18.

3. CABLE FORM REINFORCEMENT AND BRACING

3.01 In general, the equipment arrangement and design of cable forms make unnecessary the bracing or reinforcement of such forms. In some cases, where forms contain only a few wires or where the skimmers are too few or too long to provide good support for the forms, some supplementary support is required. Also, the location of equipment may be such as to make reinforcement of the forms desirable where the rear of the equipment is on an aisle having heavy maintenance activity. Except on electronic-type switching equipment, reinforcement or bracing of the forms to provide mechanical strength and to resist movement of the forms should be provided only when specified in the design specifications or drawings, or by the telephone company. The requirements and methods for reinforcement or bracing of forms on electronic-type switching equipment are covered in AT&T Practice 800-612-150.

- NOTES:
- 1 THE CABLE FASTENERS SHALL BE INSTALLED IN THE VERTICAL ROW OF HOLES IN THE BAY UPRIGHTS NEAREST THE TERMINAL STRIPS OF THE PANELS AND UNITS IN THE BAY.
 - 2 SHIELDED WIRE OR CABLE SHALL NOT BE SECURED SO TIGHTLY AS TO CAUSE DEFORMATION OF THE WIRE OR CABLE.

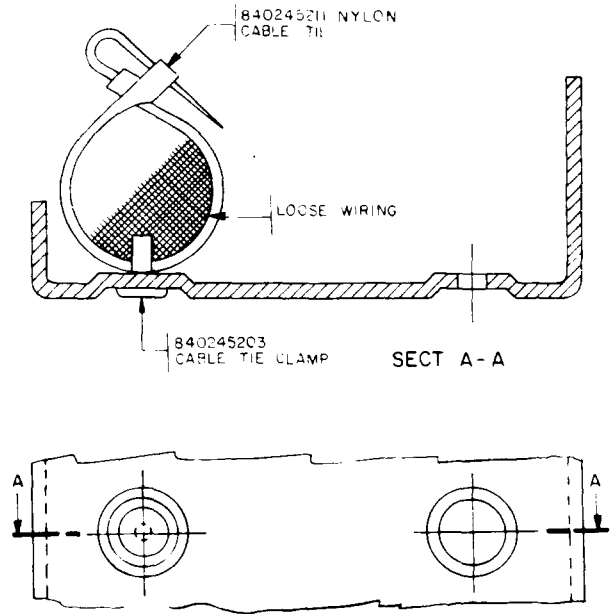


Fig 17—Method of Holding Loose Wiring in Cable Duct

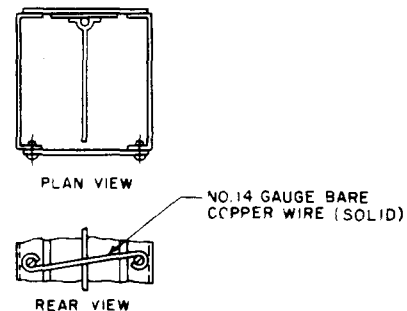


Fig 18—Method of Retaining Cables Within Ducts

See proprietary notice on cover page.

3.02 When supplementary supports are specified for cable forms, use type AP (insulated iron) wire for reinforcing and bracing as indicated in Fig 19, 20, and 21. Locate the reinforcing wire on the side of the forms away from the equipment. Tie the wire to the forms with sewing twine, spacing the ties approximately 3 inches apart. Cut ends of twine close to the knot. Where the cable forms are run parallel to the AP reinforcing wire, KS-20986 nylon cable ties may be used, instead of the twine, in accordance with AT&T Practice 800-612-153.

(a) For convenience in specifying cable form braces in the design specifications or drawings or in job specifications, reference numbers CFB1, CFB2, and CFB3 are assigned to the three types of cable form braces shown in Fig 19, 20, and 21, respectively.

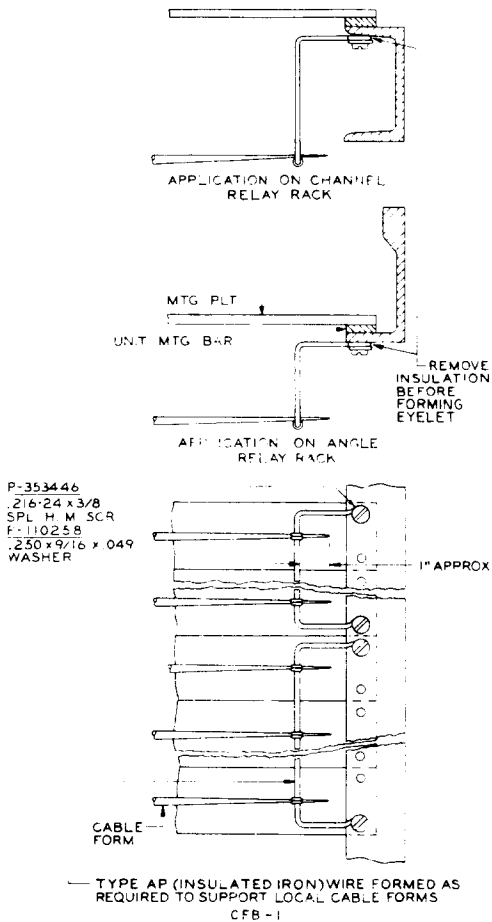


Fig 19—Bracing Horizontal Cable Forms to Frame Uprights (Relay Rack Unit Shown)

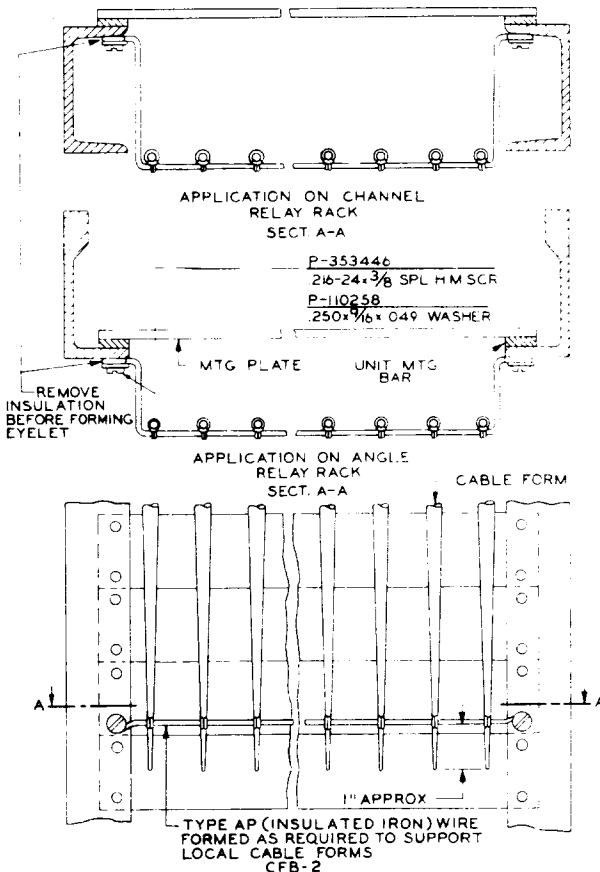


Fig 20—Bracing Vertical Cable Forms to Frame Uprights (Relay Rack Unit Shown)

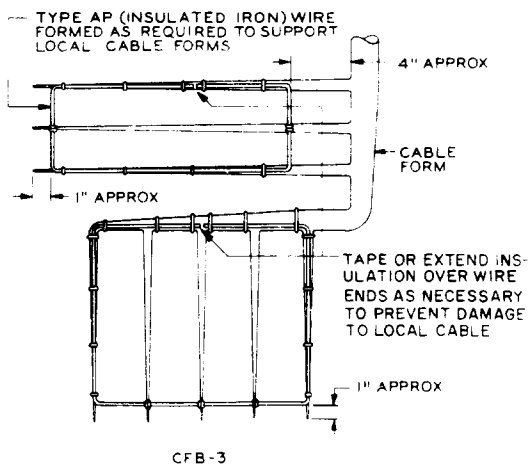


Fig 21—Reinforcement of Cable Forms

See proprietary notice on cover page.

3.03 Brace forms to the framework where the arrangements are such that the end of the brace wires can be conveniently fastened (as in the case of forms at relay rack units), as shown in Fig 19 and 20. Attach the brace wires to the rear of the relay rack uprights with P-353446, 0.216-24 by 3/8-inch special head machine screws in the tapped holes regularly provided in the uprights. By properly locating the brace wire, it should be possible to avoid interference with the screws used to attach the relay rack units to the frame uprights.

- (a) Where the mounting plates are fastened directly to the relay rack uprights (without the use of unit mounting bars), the regular mounting plate screws at the points of fastening of the cable form brace wires should be replaced by screws long enough to permit attaching the brace wire to the end of the screw by means of a nut and washer at the rear of the upright.

3.04 **Where conditions are not suitable for attaching the form braces to the framework**, reinforcement should be provided in a manner similar to the example shown in Fig 21. While a "closed loop" arrangement of reinforcement is shown, the shape of the reinforcement may be varied to suit conditions. The U- and L-shaped reinforcement will also be commonly used for supporting small or weak forms from adjacent rugged forms. In general, this type of cable form brace would be used only for the support of occasional individual weak forms from adjacent rigid forms, although it may sometimes be found more convenient to use this type of reinforcement for reconditioning wiring, instead of the braces described in paragraph 3.03.

- (a) Where the form is located so that the closed loop arrangement cannot be used to support the form, heavier gauge dummy wires may be included as part of the cable form to provide the necessary stiffness. The stiffener (dummy) wires shall consist of two or three 803682533 16-gauge type AM wires, one or two 803682947 14-gauge type AM wires, or one or two 400292215 12-gauge (type AT-7088) wires.

3.05 **Cable-Duct Framework:** When forms extend outside of the frame uprights, attach the form brace wires in a manner similar to that shown in Fig 19 and 20 for the application on angle

relay racks. The brace wire should be mounted under the heads of the mounting plate screws with a P-110258 washer on each side of the brace wire eyelet. Replace the regular mounting screws with longer screws of the same type. Forms between the uprights requiring reinforcement shall be treated per Fig 21.

3.06 **Box-Type Framework:** When forms extend outside of the frame uprights, attach the form brace wires in a manner similar to that shown in Fig 19 and 20 for the application on angle relay racks. Forms between the uprights requiring reinforcement shall be treated per Fig 21.

- (a) Where the self-tapping mounting plate screws are inserted from the front (apparatus side), the screw at the points of fastening of the cable form brace wire should be replaced by a screw of sufficient length to permit the brace wire to be attached to the end of the screw by a nut and washer at the rear of the upright. The screw should be long enough to permit the nut to be fully engaged beyond the tapered portion of the self-tapping screw.

- (b) Where the mounting plate screws are inserted from the rear (wiring side), the cable form brace wire should be mounted under the heads of the screws in the same manner as specified for cable-duct framework in paragraph 3.05.

REASONS FOR REISSUE

1. To change "BSP Section" to "AT&T Practice" throughout the practice.
2. To include in 1.04 reference to AT&T Practice 800-612-151.
3. To delete former 2.10 information for securing cable forms run on woodwork with waxed webbing.
4. To delete from 2.10 (formerly 2.11) reference to varnished cotton cloth per P-122229 for protecting cable forms on power panels.
5. To delete from 2.10(a) [formerly 2.11(a)] references to clamp sizes 7, 9, 11, 25, and 42, which are no longer required.

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6. To change Fig 1, to remove information on 2-hole cable clamps, to change wood panel to plastic panel sectioning, and to replace 996294561 wax-impregnated webbing (strap) reference with AT-6933 clamp or equivalent designation.
7. To delete from 2.11 (formerly 2.12) reference to 996291561 strap.
8. To revise 2.12 (formerly 2.13) and Fig 2 to remove obsolete bracket and clamping information and to provide general information for securing cables to keyshelf brackets.
9. To revise 2.12(a) [formerly 2.13(a)] to indicate that friction tape may also be placed under the metal strap or clamp to protect the cable.
10. To delete from Fig 5 reference to U-type cable bracket part number.
11. To revise Fig 6 to remove reference to wire supports listed in Fig 14 (deleted) and dummy mounting plates, which are no longer available, and to specify bracing per Fig 19 and 20.
12. To revise Fig 9 to remove references to tube supports in Fig 14 (deleted), which are obsolete, and to specify use of type AP wire per Fig 19 and 20.
13. To revise Fig 10 to delete obsolete information on dummy mounting plates and to include reference to bracing information in Part 3 and Fig 19 and 20.
14. To delete 2.32(a), which contained obsolete information on supporting PVC tubes with wooden dowels.
15. To delete 2.26, which contained obsolete information on clutch cable forms.
16. To delete 2.27 and Fig 12, which presented obsolete information on commutator cable forms.
17. To revise 2.26(a) (formerly 2.29) containing reference to Fig 19 and 20, instead of Fig 14 (deleted), for bracing keyshelf local cable forms at unequipped or equipped key positions.
18. To delete 2.32 covering the support of wiring for service observing jacks on line link frames in No. 1 Crossbar Systems.
19. To revise 2.29 (formerly 2.33) to delete all but the longest lengths of PVC tubes for each diameter listed and to indicate that the tubing may be cut to length as required.
20. To change Fig 13 to Fig 12.
21. To delete Fig 14, which contained obsolete information.
22. To change Fig 15 to Fig 13.
23. To revise 2.30 (formerly 2.34) to include references to AT&T Practices where protection is required.
24. To change Fig 16 to Fig 14, Fig 16A to Fig 15, and Fig 16B to Fig 16.
25. To include revised information in Fig 15 (formerly Fig 16A) and 2.30 and 2.31 (formerly 2.34 and 2.35) from Addendum Issue 1 of 800-612-156 covering new and revised cable tie requirements.