

WIRING
RUNNING AND CUTTING

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2. GENERAL

2.1 Scope

2.11 This section covers the requirements and methods to be followed when running and cutting power wire. It includes rules for separating and pairing of certain critical power runs and is to be used with other sections of the 6 series.

2.2 Planning

2.21 Job information will give a general layout for the power wiring. Where power wire and switchboard cables are to be run on the same rack it is important that supervisors confer to determine arrangements on the rack which will be most favorable for the entire cabling installation. To avoid the possibility of having to make subsequent changes the following should be considered.

2.211 Pairing

2.212 Separating of conductors for different types of current.

2.213 Allowable number of wires under each clip or stitch when securing. See section on clipping and sewing.

2.214 Wire arrangements which will give best results at points where wires leave rack.

2.215 All wires installed so as to permit the installation of the ultimate equipment.

2.216 Wires of equal size grouped together in so far as pairing permits and larger sized wires placed on the bottom layer.

2.217 Arrange power wires in such a manner that solderless type lugs and connectors are not covered so as to be inaccessible for inspection and maintenance. Where space does not permit subsequent cabling without blocking solderless type connectors, report this on a Route "C" JIM.

2.3 Protection

2.31 Protect existing cabling and equipment before pulling in new power wire.

3. INSTALLING EQUIPMENT

3.1 The required tools and suppliers are shown in Section 6A.

4. SEPARATION BETWEEN CONDUCTORS

4.1 Minimum separation requirements for conductors are covered in Table A. The separation requirements shall also be followed as far as possible at the rear of panels.

4.2 Leads enclosed and paired in metal conduit, armored cable, or lead covered cable with the sheath grounded at both ends, (except ringing and tone leads in armored cable which are covered in Table A) need not be separated from other conductors similarly enclosed or run openly except as covered in Paragraph 4.3.

4.3 Whether in conduit or open, and regardless of walls or floors, the following spacings shall be maintained between power leads and Program Transmission Equipment except for leads specifically feeding such equipment.

4.31 Charge, signal and telegraph leads - 10'-0".

4.32 Paired talk, paired filament leads and plate if run with paired filament leads - 3'-0"

4.4 Run charge conductors and discharge conductors in separate conduit when conduit is used.

5. TELEGRAPH AND TELETYPEWRITER CONDUCTORS

5.1 Telegraph and teletypewriter discharge conductors are run in armored cable from the battery control board to the fuse panel, regardless of whether these leads are telegraph or combined telegraph and plate.

6. RINGING, TONE AND RINGING SIGNAL LEADS

6.1 Ringing, tone and ringing signal leads between the 20-cycle ringing power board and the ringing machine mounting framework shall be run with armored cable or with electrically shielded with a metallic braid, or shall be run in conduit unless the board and machine table are adjacent.

6.2 Leads between the 20-cycle ringing power board and the fuse panels shall be armored cable, shielded wire or in rigid conduit and the leads shall occupy as few cables (or conduits) as possible and meet the following conditions:

6.21 Tone and nontone shall not be together.

6.22 Continuous high-tone leads except howler HT2 may be run together.

6.23 Howler leads HT2 and HLR shall be run together, and no other leads shall be run with them.

6.24 Continuous low-tone leads may be run together.

6.25 Low-tone leads and high-tone leads shall not be run together.

6.26 Interrupted low-tone leads which are not interrupted simultaneously shall not be run together.

6.27 Continuous low-tone and interrupted low-tone shall not be run together.

6.28 Machine-ringing shall not be run with audible continuous ringing.

6.29 Machine-ringing leads from one interrupter brush to the fuse board shall not be run with similar leads from any other brush to the fuse board and within the same common shield unless the make and break interruptions are simultaneous.

TABLE A SEPARATION BETWEEN CONDUCTORS (PAR. 4)

Type of Conductor	Charge-Paired	Charge-Unpaired	Ring-ing or Tone-Armored	Talk Filament-Paired (See Note 3)	Talk Filament-Unpaired (See Note 3)	Signal-Paired	Signal-Unpaired	Plate
Charge-Paired	0	0	0	3" (See Note 2)	3" (See Note 1)	0	3"	3"
Charge-Unpaired	0	0	0	3" (See Note 1)	As far as possible (5'-0" Min.)	3"	5'-0" if distance of exposure exceeds 10'-0"	5'-0" if distance of exposure exceeds 10'-0"
Ring-ing or Tone-Armored	0	0	0	3"	3"	0	0	0
Talk, Filament-Paired (See Note 3)	3" (See Note 2)	3" (See Note 1)	3"	0	0	3" (See Note 2)	3" (See Note 1)	0
Talk, Filament-Unpaired (See Note 3)	3" (See Note 1)	As far as possible (5'-0" Min.)	3"	0	0	3" (See Note 1)	As far as possible (5'-0" Min.)	0
Signal Paired	0	3"	0	3" (See Note 2)	3" (See Note 1)	0	0	0
Signal Unpaired	3"	5'-0" if distance of exposure exceeds 10'-0"	0	3" (See Note 1)	As far as possible (5'-0" Min.)	0	0	As far as possible (5'-0" Min.)
Plate	3"	5'-0" if distance of exposure exceeds 10'-0"	0	0	0	0	As far as possible (5'-0" Min.)	0

NOTE 1: 6" separation if exposure is more than 50'.

NOTE 2: 6" separation if exposure is more than 300' except that when 1200 amp. 65 volt or 1500 amp. 33 volt sets are used, the 6" separation shall apply above 100'.

NOTE 3: The discharge leads from the battery to the point of separation of quiet and signal current are considered talk, filament or plate leads in offices having no power filter. In offices having power filters, regardless of whether the filter is common or decentralized the discharge leads from the battery to the filter are considered signal leads.

7. CROSSING SIGNAL AND QUIET CONDUCTORS

7.1 When it is necessary to cross signaling and quiet leads, they may touch at the point of crossing, but the crossing should be made at right angles as nearly as the bending radii of the cables will permit.

8. PAIRING OF LEADS

8.1 Communication Circuits

8.11 In the charge circuit, pair the conductors, extending the pairing as nearly as practicable to their terminations. This is to neutralize noise so it will not spread to other conductors.

8.12 In the discharge circuit having a central filter, pair the battery conductors with their respective ground conductors, extending the pairing as nearly as practicable to their termination. When filters are in the switchroom there is no requirement for pairing discharge leads between the power board and the filter.

8.13 Run the filtered plate lead with the filament and filament ground leads when the filament is taken through a centralized filter, in order to pair the plate and filament ground. Plate leads are run separately and shielded when the filament leads use a decentralized filter only.

8.14 When arranging paired quiet conductors, the polarity should alternate with adjacent conductors throughout the layer. The polarity of these conductors should also alternate, as nearly as possible, with conductors of subsequent layers. See Figure 1.

8.15 Signal conductors need not be alternated in polarity with subsequent layers. See Figure 1.

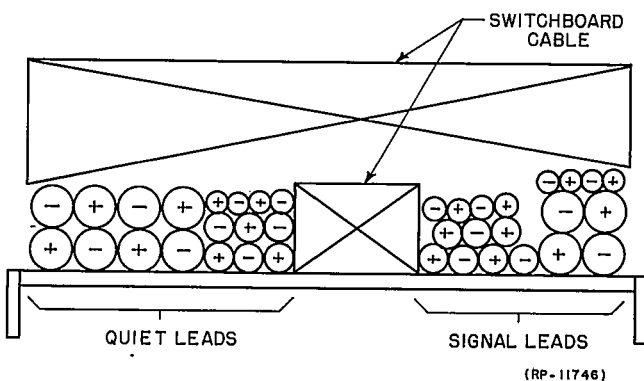


FIG. 1 QUIET LEADS, SIGNAL LEADS AND SWITCHBOARD CABLE ON CABLE RACK, TYPICAL SECTION (PARS. 8.14, 8.15, 10.051)

8.2 AC Service Circuits

8.21 Run all of the leads of the same service circuit in the same conduit or armored cable if possible to avoid overheating of the metal sheath by induction. If more than one conductor per phase is required, all will be run in the same conduit or raceway, unless additional conduits or raceways are furnished, in which case the wires shall be so arranged that

the same number of conductors from each phase is contained in each conduit or raceway. The associated neutral conductors, when provided, shall also be arranged to appear in each conduit or raceway. See Figure 2.

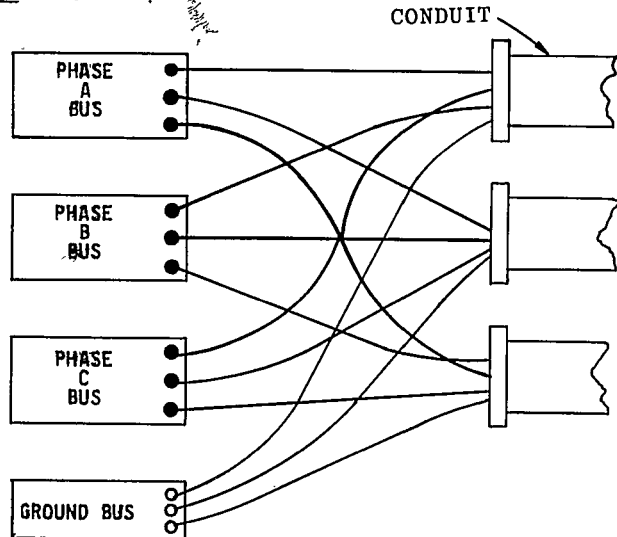


FIG. 2 TYPICAL CONDUIT ARRANGEMENT FOR MULTIPLE SERVICE CONDUCTORS (PAR. 8.21)

9. COLOR CODE AND POLARITY

9.1 The color code for power service wire is white, black, red, blue and yellow. White is reserved for circuit ground or neutral leads and these leads, if permanent, must always be white (white includes natural gray). Green is not in the color code but is used for frame or equipment grounds such as in cords for portable equipment. The other colors are used in sequence; white with black or white with red in ground return two-wire circuits; black and red in two-wire circuits without ground return; white with black and red in three-wire circuits with a ground lead; black, red and blue in three-wire circuits without a ground or neutral lead, (the blue is a white wire painted at the exposed ends - see Section 6D) and white with black, red and blue for three-phase, four-wire circuits with a ground or neutral lead. If a white wire is used as a live lead it must be painted at exposed ends either black or in accordance with the color code.

9.2 Wire No. 6 or smaller, shall be painted if necessary at exposed ends, to conform with the color code.

9.3 Wire No. 4 or larger, shall be painted if necessary at the exposed ends, so that the ground or neutral lead is natural gray or white and all remaining leads are black.

NOTE: See Section 6D for method of painting wire ends.

9.4 Information covering polarity connections for leads attached to receptacles or plug caps is covered on

standard drawings such as ED-91181-10. This drawing may be ordered if information is not available on the job drawing.

10. RUNNING POWER WIRE

10.01 General

10.011 Each reel or coil contains a length of wire for a particular run, or runs, as covered in the job specification. Use wire from the proper reel or coil. Reels may contain several cut lengths each for a specific run, in which case the cable tag affixed to the reel will list each length in the order in which they are placed on the reel, i.e. the outside length will correspond to the last one listed on the tag. Longer lengths improperly used on short runs will result in insufficient wire for the remaining runs.

10.012 When reels are of continuous length and must be cut to make two or more runs, the runs should be planned in advance to make maximum use of the wire on each reel.

10.013 It is advisable to carefully measure and cut wire to the proper length to avoid waste. Several methods, depending upon conditions may be used, such as (1) Measuring the distance between the points of termination, (2) Running in a wire, cutting it to length and removing it to be used as a cutting length for other wires, and (3) running in a piece of twine to determine the cutting length.

10.014 Due to both installation verification and the subsequent operating company maintenance procedure, consideration shall be given to the location of solderless connectors when planning and running power wiring. The area of these wires allocated for solderless connectors shall be so arranged that they are not covered on present and not likely to be covered on subsequent cabling jobs.

10.02 Setting Up the Reels

10.021 The large size reels containing power wire are supported while being unreeled on Jack Set R-1615 (Figure 3) or reel lift R-3195 (Figure 4).

10.022 Protect the floor under the jacks, reel lifts and supports in preparation for lifting and pulling.

10.023 When a large reel is being rolled, it is essential that the floor be properly protected each time the direction in which the reel is being rolled is changed as the procedure of swinging the reel around to change its direction will damage the linoleum surface. It is necessary, therefore, to run the reel on to a piece of cardboard, fiber board or similar material, manually twist the reel to change its direction and then proceed in the new direction.

10.024 Use the R-3195 reel lift for power wire reels weighing up to 2,000 pounds, measuring up to 42 inches

in diameter and not over 32 inches wide. The cable reel is placed on the lift in the following manner:

- (1) Insert axle through reel,
- (2) Slip sliding "T" fitting on axle,
- (3) Arrange the reel so the wire is unreel by pulling against the long foot on the lift and pays out from the bottom of the reel. ←
- (4) Tip the frame with the short dimension of the base on the floor and slide the handles through the axle fittings to the desired height,
- (5) Grasp the handles and set up the reels using the same motion as when tipping a wheelbarrow. To increase leverage for heavy reels, slip lengths of 1 inch conduit inside the handles.

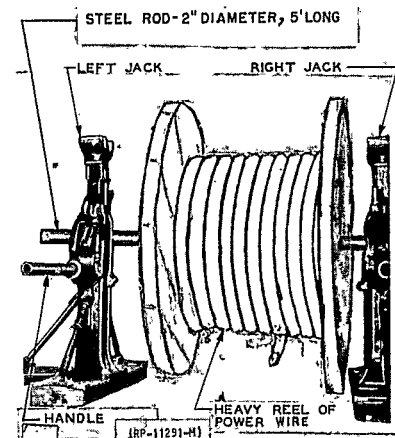


FIG. 3 CABLE REEL SUPPORTED WITH JACK SET R-1615 (PAR. 10.021)

10.025 When power wire is furnished in coils, if the size of the coil adapts itself the coil cable dispenser R-3409 (Figure 5) may be used. Anticipate the coiled tension when cutting the retaining ties to prevent damage to personnel and equipment.

10.03 Preparing to Run

10.031 When removing the protective shipping cover, cut the thin steel bands with the R-3662 Safety Steel Strapping Cutter. Hold the band on each side of the snips to prevent the ends from injuring personnel or damaging equipment.

10.032 In further preparation for running power wire, tape the end of the wire by applying a band or two of friction tape near the end. Fold the tape back and forth across the end pressing it against the band. Finish with several more turns to secure the folded ends until sufficiently protected.

10.033 Affix SD4-218 cable tags as described in Section 6A.

illustrated in Figure 6 through the brake shoes. It is essential that one installer remain at the brake lever during the running operation until the wire can be temporarily secured with trunk straps or other suitable method. This is because the wax coating on KS-5482-01 power wire will cause the wire to slip or creep through the brake if not manually checked.

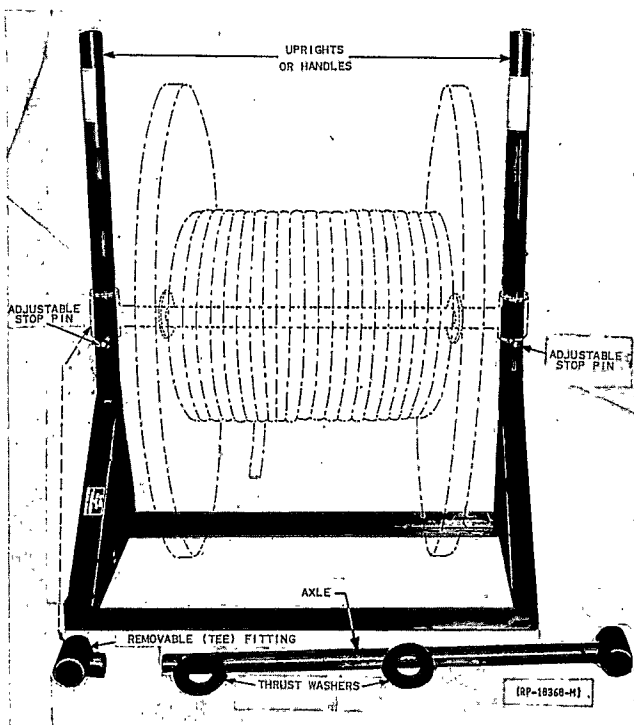


FIG. 4 R-3195 POWER WIRE REEL LIFT
(PAR. 10.021)

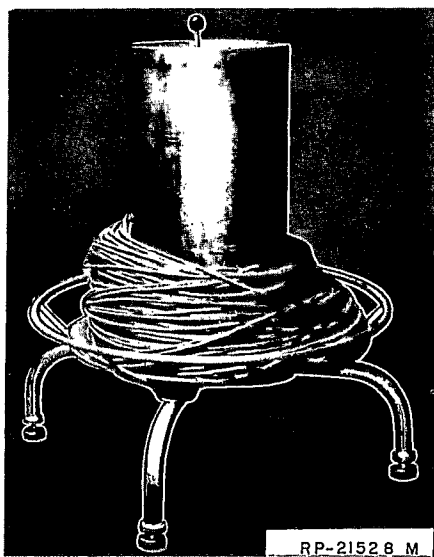


FIG. 5 R-3409 COIL CABLE DISPENSER
(PAR. 10.025)

10.04 Controlling Vertical Runs

10.041 Vertical power wire runs too heavy to handle by hand (usually in excess of two floors) should be controlled by the R-3363 Power Wire Brake. To use the brake, place the reel on the higher floor and feed the wire down as

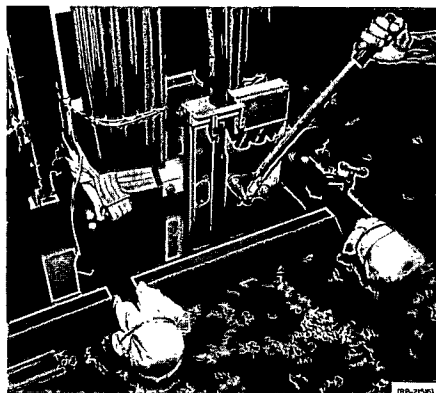


FIG. 6 R-3363 POWER WIRE BRAKE USED AT A CABLE HOLE (PAR. 10.041)

10.042 An alternate method is shown in Figure 7. Precautions must be taken to prevent the weight of a long vertical run from placing a strain on the reel and possibly losing control. This may be prevented by feeding the wire from the reel over the horizontal rack on the upper floor, if possible, and then passing the wire through two pieces of 2" x 10" planking which is long enough to fit across the shaft framework. Bolt one end of the planks together with 5/8" rods, spacing the planks slightly less than the diameter of the cable, and the other end gripped and controlled by an R-1455 C clamp. Cut a smooth depression or runway in the 10" side of the planks, and face these grooves to form a pathway for the cable. Apply a thick coat of RM-641450 or similar wax, and observe the wire after passing through the planks to note that no damage to the braid is apparent.

10.043 Temporarily support vertical runs of large wires with trunk straps until they are permanently secured in place. This will relieve the strain on the upper horizontal resting run and prevent the clipped or sewed section from moving. If leads are allowed to hang for a short time their weight will tend to straighten out any kinks.

10.05 Battery Distributing Leads

10.051 On new installations it will generally be desirable to run power leads either on a separate rack (see Figure 8), or below or on either side of the switchboard cable as shown on Figure 1. On additions to existing installations, however, it is satisfactory to run the additional power wires directly on the switchboard cable already installed.

10.052 When running in power wire, the use of R-2061 cable guides, and R-2062 brackets, shown in Figure 9 will facilitate the pulling operation. Place

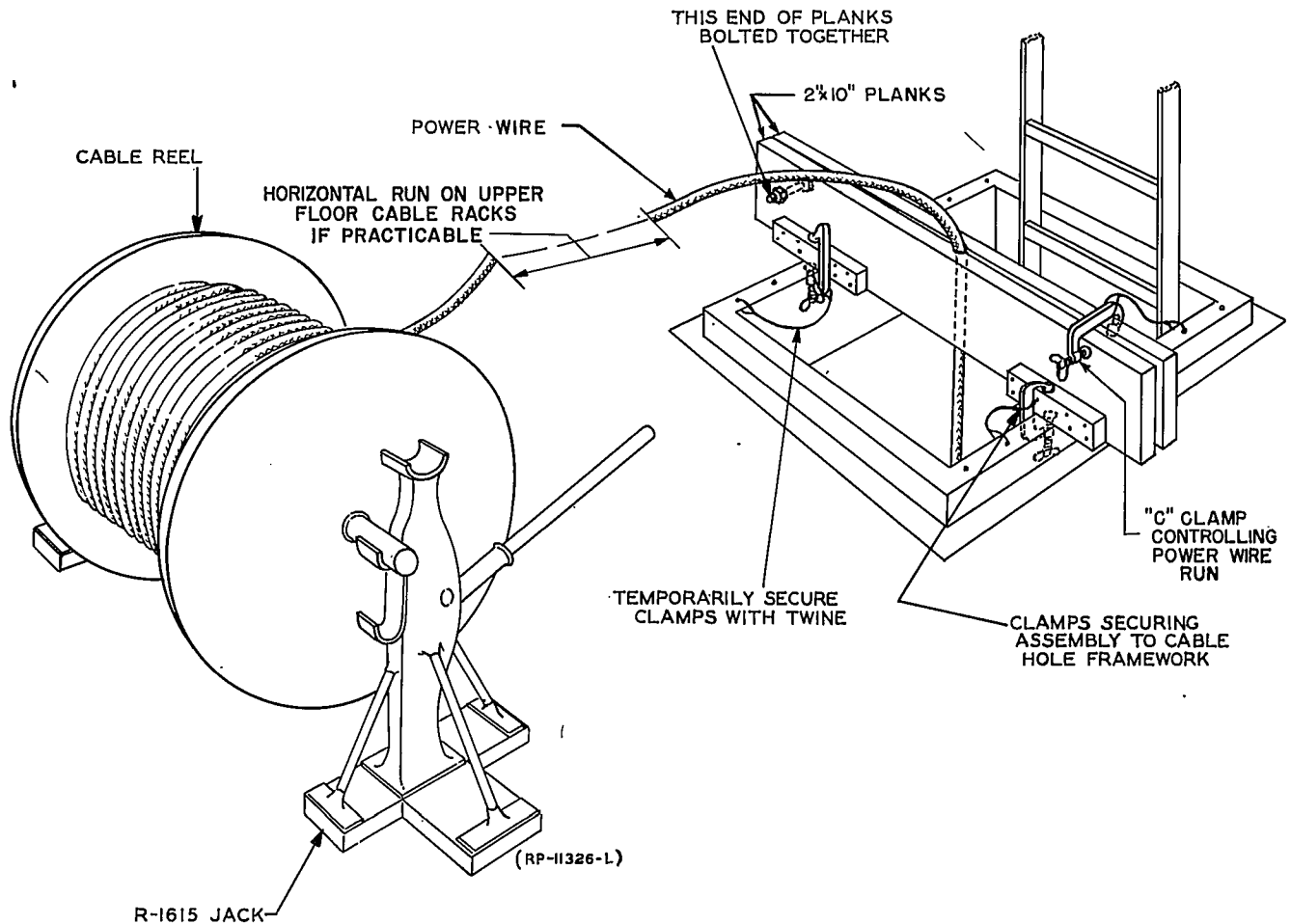


FIG. 7 AN ALTERNATE ARRANGEMENT FOR CONTROLLING WIRE AT CABLE HOLE
(PAR. 10.042)

the guides clear of all conductors and apparatus and at suitable locations and angles to prevent wires from dragging on sharp projections or wires already in position

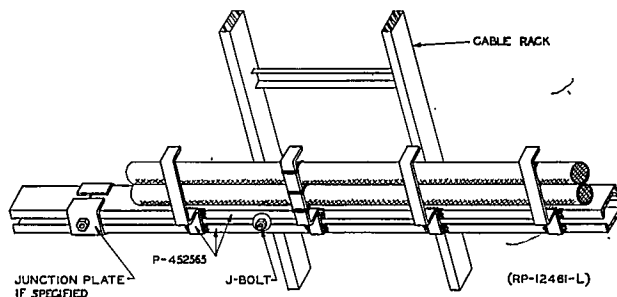


FIG. 8 POWER WIRE SUPPORTED BY P-452565
CABLE RACK (PAR. 10.051)

10.053 Run all leads in continuous lengths where practicable.

10.0531 If necessary, to utilize lengths of wires effectively on long runs, one or two splices per run may be made. These must be made only on horizontal portions of runs when the joint is not stressed by nearby vertical runs. Such splices should be made with "Split Cable Connector - Solder Type", soldered and taped with rubber and friction tape, and shellacked if exposed. They are provided for stranded power wire sizes No. 6 AWG to 800 MCM inclusive with the same size on either end. Orders are supplied by National Telephone Supply or Reliable Electric. (See Section 7 for additional splicing and taping information.)

10.054 As near as practicable arrange the wires from similar bays so as to be adjacent on cable racks, as it is preferable that these wires be connected in sequence to the fuses of one panel.

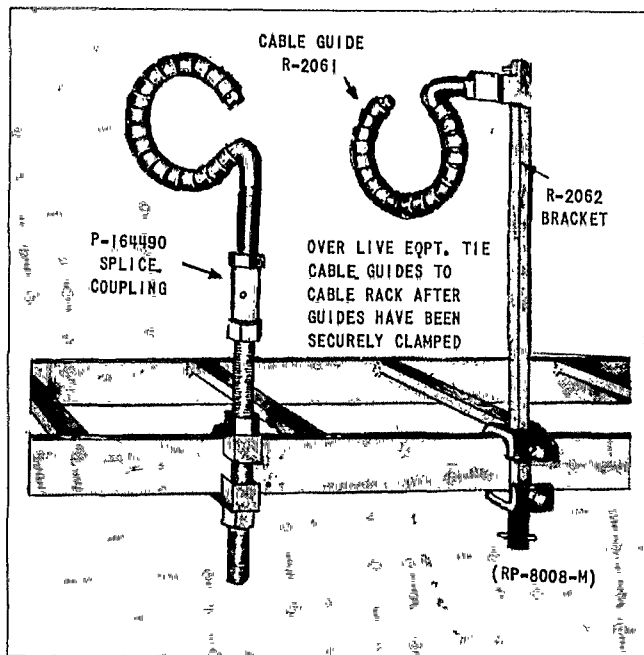


FIG. 9 METHOD OF MOUNTING CABLE GUIDES, R-2061 (PAR. 10.052)

10.06 Power Service Leads

10.061 Power service leads shall be run within a protective enclosure such as armor, conduit, loom, wireways, floor raceways, etc.

10.062 Wires shall be run continuously between fittings or pull boxes or other points of access. This means no splices can be pulled within flexible or rigid conduit sections.

10.063 See Section 7 for splicing, taping, and connecting information. Section 9 covers the installation of conduit.

10.07 Measuring Wires for Conduits

10.071 To determine the length of wire to be pulled in conduit, use either of the following methods.

10.0711 Tie a cord to the leading end of the R-2588 fish wire and fish both through the conduit at the same time. Allow enough cord for forming, then pull out the cord and use it to measure the wire which is to be pulled into the conduit.

10.0712 With a linen tape R-2122 measure outside of the conduit run and around outside corners of conduit "L" fittings and boxes. Allow for leader attachment and sufficient length for connections at each end.

10.072 The maximum number and size of leads for each conduit trade size as allowed by the National Electric Code, is shown in Table B. Special Conditions apply for mixed sizes of wires and short conduit runs used mainly for mechanical protection. Questions relating to these conditions should be referred to the Equipment Engineers (or the Telephone Company Engineers in the case of telephone company engineered jobs).

TABLE B

APPROXIMATE DIMENSIONS OF METAL CONDUIT AND ALLOWABLE NUMBER OF POWER WIRES IN EACH CONDUIT (PAR. 10.072)

CONDUIT SIZE	1" 2	3" 4	1" 1	1 1/4" 4	1 1/2" 2	2" 2	2 1/2" 2	3" 3	3 1/2" 3	4" 4
OUTSIDE DIA.	27 1/32"	1 1/16"	1 5/16"	1 21/32"	1 29/32"	2 3/8"	2 7/8"	3 1/2"	4"	4 1/2"
INSIDE DIA.	5 1/8"	53/64"	1 3/64"	1 3/8"	1 39/64"	2 1/16"	2 15/32"	3 1/16"	3 35/64"	4 1/32"
WIRE SIZE										
14	4	6	10	18	25	41	58			
12	3	5	8	15	21	34	50			
10	1	4	7	13	17	29	41			
8	1	3	4	7	10	17	25	38		
6	1	1	3	4	6	10	15	23		
4	1	1	1	3	5	8	12	18		
2		1	1	3	3	6	9	14	19	
1		1	1	1	3	4	7	10	14	
0			1	1	2	4	6	9	12	
00			1	1	1	3	5	8	11	14
000			1	1	1	3	4	7	9	12
0000				1	1	2	3	6	8	10
300 MCM				1	1	1	3	4	5	7
350 MCM				1	1	1	1	3	5	6
400 MCM					1	1	1	3	4	6
500 MCM					1	1	1	3	4	5
600 MCM						1	1	1	3	4
700 MCM						1	1	1	3	3
750 MCM						1	1	1	3	3
800 MCM						1	1	1	2	3

10.08 Pulling in Wires in Conduit

NOTE: Switchboard cable shall not be run in the same conduit with power service wires.

10.0801 Before placing additional leads in a conduit containing power wire, make provision to maintain service if necessary, pull out the existing leads, and then pull in the new and old leads together.

10.0802 Use the R-2588 Round, Nylon Insulated, Fish Wire for fishing conduit. The ball provided with the fish wire is to be used in conduit greater than one inch to prevent the eyelet from snagging inside the conduit.

10.0803 The vacuum method can be used as an alternate method for fishing conduit if a vacuum cleaner with attachment is available. Proceed as follows: Place a paper cone, or a ball of paper or cheesecloth with a cord tied to it, into one end of the conduit and place the attachment against the other end. The partial vacuum created will pull either article with attached cord through the conduit. Then tie a rope to the cord and pull through the conduit.

10.0804 To fish one or two small wires in conduit of comparatively straight runs pull in directly with the R-2588 fish wire as shown in Figures 10 and 11. The housing of the reel acts as a handle and gives a good grip. This eliminates the use of pliers or other special pullers. To fish large wires use a R-7850 rope attached to the wires as shown in Figure 12.

10.0805 Use reels, KS-8047 when running in wires for frame and aisle lighting. These reels can be arranged so that wire from several coils can be run in simultaneously. As an alternate method for running short lengths of No. 14 wire when no reel is available, the coil may be placed in a carton and the cover cut for a 4" diameter opening through which the wire is pulled from the inside of the coil. 542.4 Gummed Tape can be used to hold the cover in place.

10.0806 Feed the wires into the conduit steadily at the same time that they are being pulled, also feed them in straight preventing them from twisting as they enter the conduit. One man properly feeding the wire into the conduit, keeping the wire from twisting etc., is as helpful as several men pulling. The use of R-3327 Wire Lubricant will greatly reduce the pulling effort, especially on long runs.

10.0807 When pulling wires through horizontal runs of conduit, run them in so that the longer exposed lengths will not have to be pulled through the conduit. This practice will keep the exposed lengths cleaner and provide less chance of the insulation becoming frayed. Secure the wires to the pulling-in wire as shown in sketch "A" and "B" of Figure 13.

10.0808 When pulling wires through vertical runs of conduit, it is best to run from the upper floor to the lower floor so that the weight of the wires will aid in the pulling operation.

10.0809 When pulling wires through pull boxes, etc., in which splices are to be made, pull sufficient slack in the box for initial and future splices.

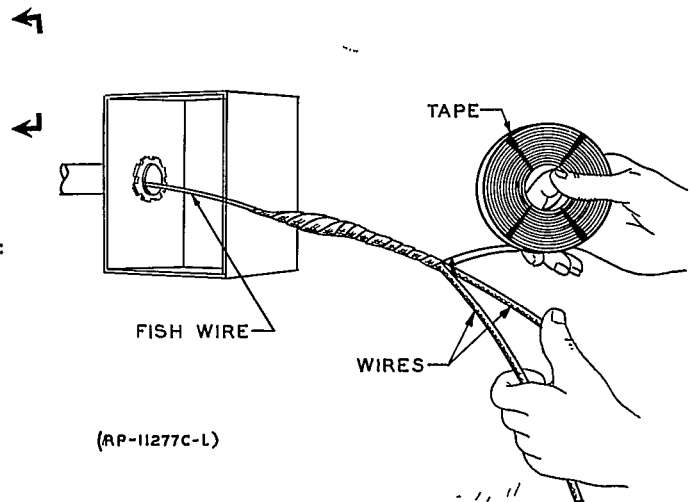


FIG. 10 TAPING THE CONNECTIONS BETWEEN THE FISH WIRE AND THE CONDUCTORS (PAR. 10.0804)

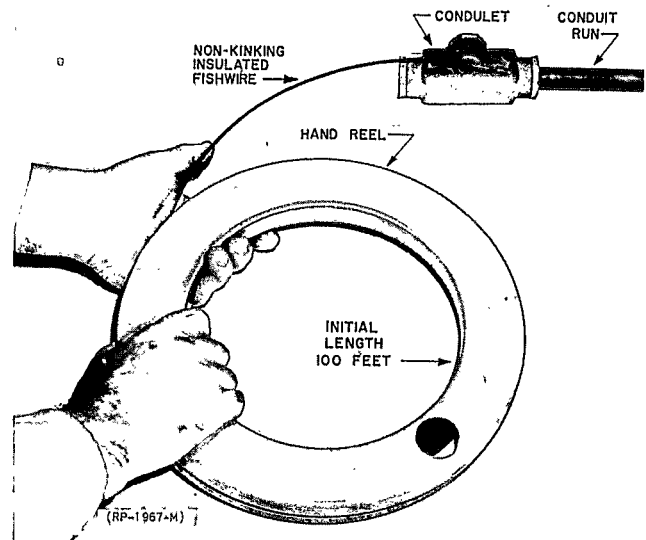


FIG. 11 R-2588 ROUND, NYLON INSULATED, FISH WIRE (PAR. 10.0804)

10.0810 When pulling long runs of small gauge power wires exercise care so as not to damage the wire insulation. When difficult pulls show signs of damaging the insulated fish wire it might be suspected that similar injury is occurring to the wire insulation. Break up long runs into successive short pulls utilizing pull boxes and fittings as intermediate access points.

10.0811 On all runs pulled in by mechanical means (chain falls, rope hoists, power winches, etc.), check the conductors for absence of ground with the ITE-4740 Insulation Test Set. Test between conductors and each conductor to ground. The minimum amount of resistance shall not be less than 1 megohm.

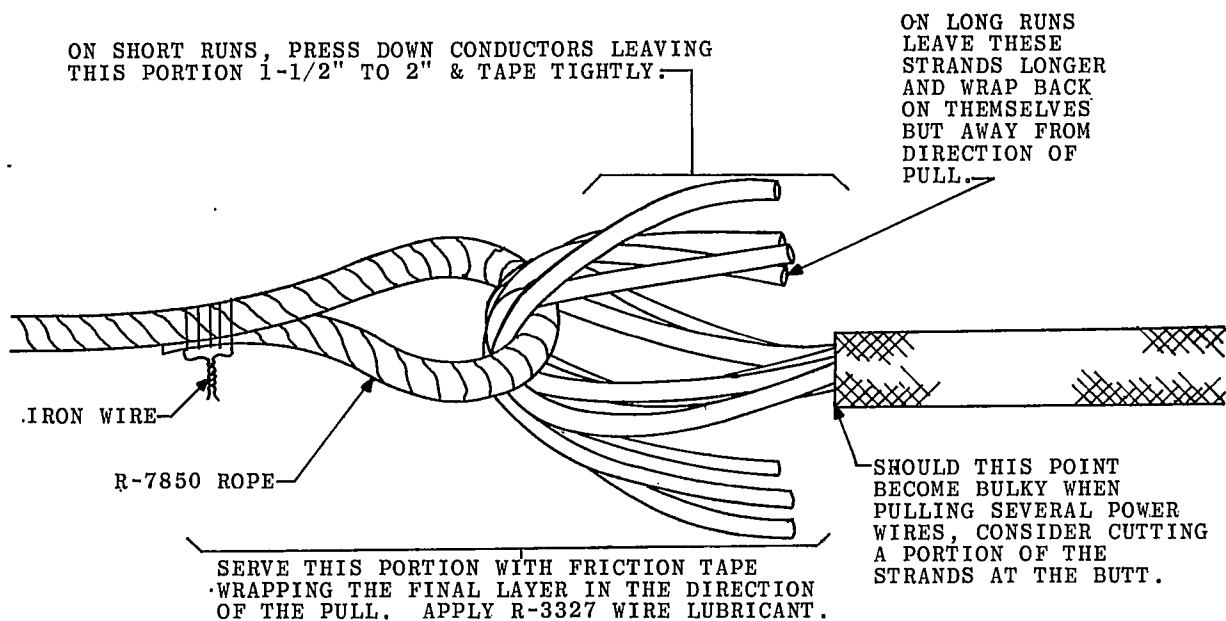
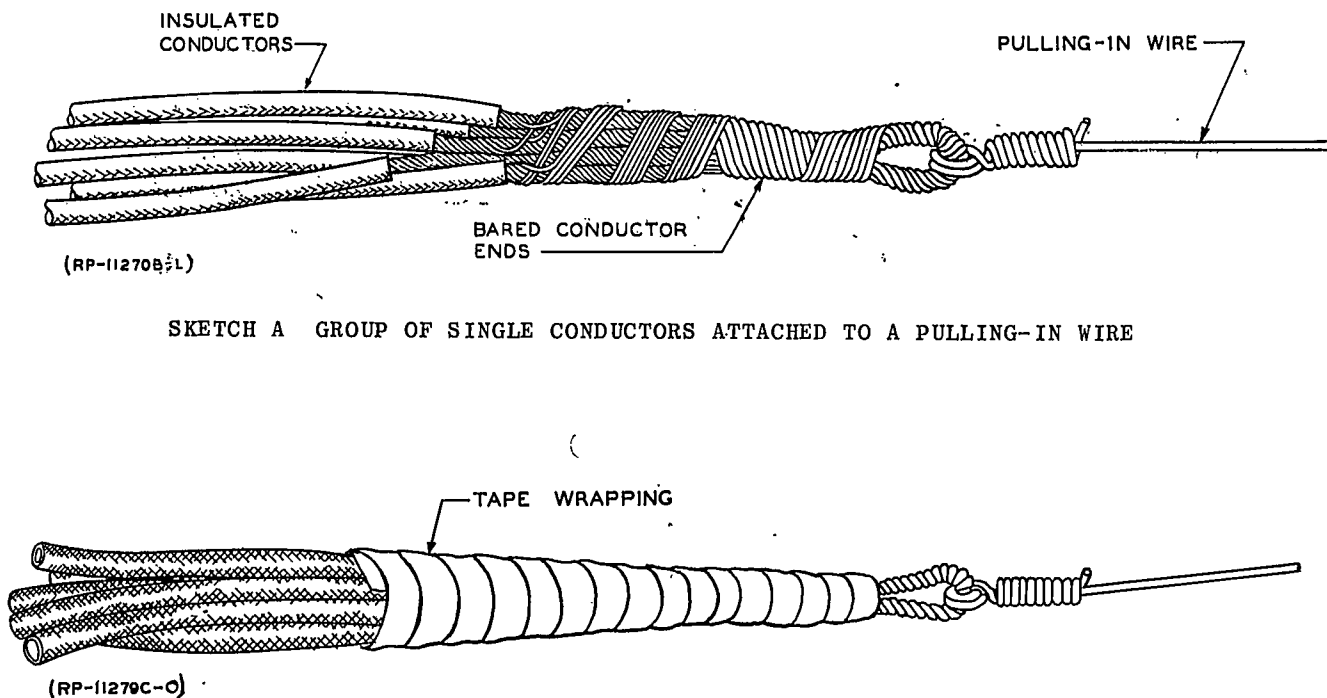


FIG. 12 PREPARATION FOR PULLING LARGE KS-5482-01 WIRE (PAR. 10.0804)



SKETCH B ATTACHMENT TAPED OVER AND READY FOR PULLING IN

FIG. 13 SECURING AND TAPING GROUP OF CONDUCTORS TO PULLING-IN WIRE (PAR. 10.0807)

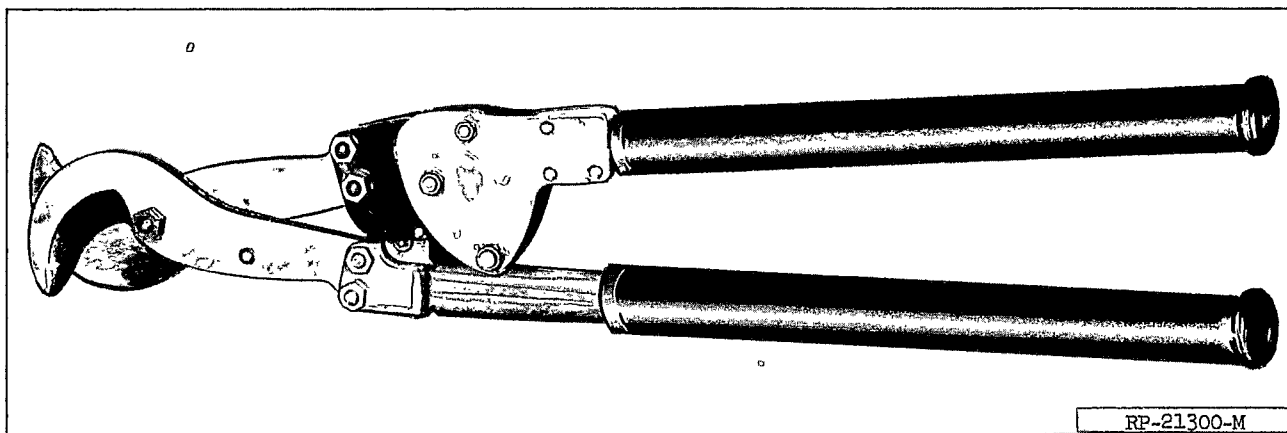


FIG. 14 P-3371 POWER WIRE SHEAR (PAR. 11.3)

10.09 Ammeter and Ammeter Relay Leads

10.091 Ammeter and ammeter relay leads are calibrated with the meter and shall not be cut.

10.092 Any excess in ammeter shunt leads after the shunt is in place shall be enclosed in a fiber tube (P-68235) or any other suitable fiber tubing, on the rear of the power board in an unexposed place, preferably near the associated ammeter. The fiber tube shall be used in all cases except where the shop has provided differently or the installer has been instructed otherwise on a drawing or specification. When it is necessary to pull ammeter leads into conduit exercise care that undue strain is not put on these leads as this may affect meter calibration.

10.10 Armored Wire and Cable on Cable Rack

10.101 Because of the danger of short-circuiting the shielding on BX armored wire and cable and flexible conduit (Greenfield) to live bus bars and equipment, provide adequate protection around live equipment. Men should be stationed in strategic locations along the length of the run to provide control of the wire movement around live equipment.

10.102 On cable racks above or near live equipment, or equipment which may be made alive before the cables are permanently secured to the racks, secure armored cables temporarily with No. 48 twine in such a manner as to prevent the coming in contact with the live equipment. Where additional armored cables are to be run to a live power board, strip the armor to the required length for the power board end. Where feasible, run the cable or wire from the distant end toward the power board and secure the butts at the proper point. Secure the cable starting at the power board end and progress to the distant end.

10.103 To splice or tap armored cable use an outlet box or a conduit fitting of a size required for the wires, with connectors and reducers as required. The fitting shall be securely mounted, large enough to allow connectors to be handled and inspected and so located to be readily accessible.

11. CUTTING

11.1 Use R-6433 Diagonal Cutters for cutting wire size #12 and smaller. R-2195 8" side cutters can be used on sizes up to and including #6.

11.2 The R-1514 cable shears were standardized for cutting switch-board cable. They may, however, be used to cut power wire in size including No. 2. These shears should not be used to cut any iron or steel wire such as might be used for packing or crating purposes.

11.3 Power wire larger than No. 2 AWG should be cut with the R-3371 Power Wire Shear (See figure 14) or the R-2281, hand hack saw. With assistance for supporting the power wire, the R-3148 reciprocating saw may be used as an alternate. Use a fine blade with either saw for ease of cutting. A small amount of petrolatum on the blade will prevent drag from the rubber covering.

11.4 Small armored wire and cable (one to three conductor No. 14, 12 and 10) should be cut by first parting the armor with the R-2912 armor cutter and then cutting the conductors with the R-2195 8" side cutting pliers. When these tools are not available apply several turns of friction tape and cut through the tape with the R-2281 hack saw.

11.5 Cut large armored wire and cable by bending the armor down forming an arc. Make a diagonal cut with the hack saw so as to sever one turn of the armor. Always tilt the back of the hack saw frame sideways toward the hand. In event the blade should slip it will then skid away