CONSTRUCTION OF BARE OPEN WIRE PLANT

Contents

1. GENERAL

1.01 This section is intended to provide REA borrowers, consulting engineers, contractors and other interested parties with technical information for use in the design and construction of REA borrowers' telephone systems. It discusses in particular considerations in the construction of bare open wire plant.

1.02 This section replaces REA TE & CM-616, Issue No. 3, dated June 1956 and its addenda. The reissue is to bring the section into conformity with the applicable specifications in the November 1960 issue of the "Telephone System Construction Contract," REA Form 511, and to suggest precautions in construction work to prevent electric shock.

2. POLE TOP ASSEMBLY UNIT APPLICATIONS

2.01 Pole top assembly units for a particular application are specified on the staking sheets by the engineer. The applications and limitations of the various units for use with bare open wire are given in REA TE & CM-625, "Pole Top Assembly Units."

2.02 REA Form 511 provides specifications for outside plant construction including various matters relating to bare open wire plant. Certain matters concerning this type of plant that are not given in REA Form 511 are given here.

2.03 Crossarms can be purchased bored for either wood or steel pins. The average project uses steel pins so infrequently that generally all crossarms purchased are ordered bored for wood pins. Long shank steel pins can be used with these arms but locust bushings must be inserted in each pin hole where they are used. REA TE & CM-625 specifies the conditions where steel pins are required.

2.04 There are two types of pins and three types of insulators acceptable for open wire plant use in telephone systems of REA borrowers. The selection of a particular combination of pin and insulator is dependent upon the transverse load to be applied by the wires. REA TE & CM-625 gives the transverse load limits for pins and insulators. The types of pins and insulators approved by REA are described and illustrated in Figure 1.

2.05 Care must be exercised to make certain that no foreign matter such as sand or small stones are in the insulator's pin cavity. If foreign matter is left in this cavity, the inside of the insulator may be scratched as the insulator is screwed onto the pin. If the insulator has an internal scratch, it may fracture under load. All insulators shall be screwed down snugly on the pins.

3. HANDLING AND STORAGE OF TELEPHONE LINE WIRE AND GUY STRAND

3.01 Improper handling and storage of telephone line wire and guy strand will result in accelerated corrosion or other damage to this material. This damage will have the effect of decreasing the service life normally expected from the completed plant and may also create problems in both the construction and operation of the plant. It is important, therefore, that the precautions and storage methods suggested herein be observed.

3.02 All shipments of telephone line wire and guy strand should be inspected closely upon delivery and promptly reported and claim made for any damage. Coils of wire, also coils and reels of strand, should be inspected for nicks, cuts, severe abrasion, rust, and corrosion. Corrosion may be a white or rust-colored dust on galvanized wire or greenish-black spots or coating on copper or copper-covered steel wire.

3.03 Coils of wire and strand should be handled with care at all times. They should not be dropped from a railroad car or truck when unloading and should not be dragged over a rough surface.

3.04 Wire in coils and strand in coils or on reels should be protected from the weather when possible and, during sudden changes of temperature, from contact with warm, moist air which can cause water to condense on the surface of the conductors. When water from rain, condensation, or any other source, collects on the coils it penetrates the hundreds of crevices between the turns. If the turns are separated immediately so that the water can dry out promptly, no damage will result. When the metal surfaces are left in contact with a slow-drying stagnant film of water, however, an accelerated corrosion will occur. This may damage the wire or strand and also give them a harsh, rough surface which will increase the risk of entanglement of wire during construction.

3.05 Coils of wire or strand should never be stacked directly on dirt, cinders, treated timber or concrete floors. These materials will generally contain either acids or alkali. The acids or alkali, in the presence of moisture, will react with metallic surfaces and cause severe corrosion on the surface of the metal.

3.06 It is recommended that the best of the following storage methods possible with existing facilities be used when wire and strand are to be stored:

3.061 Best Storage - Store coils and reels in a dry, heated room or shed with a wood floor. If the coils must be piled on a concrete or dirt floor, lay clean untreated boards or timbers under them. Allow as much circulation of air through the coils as possible.

3.062 Acceptable Storage - Store in a tightly closed,dry unheated wooden floored room or shed. Pile coils as mentioned above. After a sustained cold spell doors and windows should not be opened unnecessarily. Moist, warm outside air will cause the cool wire to "sweat" and corrosion will result even though the material is stored indoors. In order to avoid sweating it is much better to allow several days for the room to warm up so that the inside temperature will be approximately equal to the outdoor temperature.

3.063 Outdoor Storage - In some locations, outdoor storage cannot be avoided. Coils should be stacked on clean untreated boards or timbers well above the ground. Some sort of roof should be built over the coils employing tar paper, roofing paper, or a tarpaulin. The sides should be protected by tarpaulins. Sudden rise in temperature and humidity can cause moisture to condense on the metal with this type of storage even though it may be protected from rain. For this reason outdoor storage should be used only when indoor space is unavailable.

3.064 Minimum Protection for a Very Short Storage Time - For brief periods (not over 30 days) wire and strand may be stored in the open, exposed to the elements, provided the coils do not come in contact with the ground.

4. LINE WIRE STRINGING

4.01 Wire stringing reels should be inspected for sharp objects such as nails, screws, et cetera, which may damage the wire during unreeling. The wire must not be dragged over fences, stones, or any other abrasive objects. A kink or a nick on a wire will not only promote corrosion but also forms a point of concentrated stresses which may cause fatigue failures. The wire should not be permitted to be run over by vehicles. If the wire is paid out from a non-rotating reel or coil, each turn removed will give the wire a complete twist which may cause kinks or other damage. The preferred method of wire pay out is from moving rotating reels. In this method, the rotating reels are carried on a vehicle and the wires are laid out on the ground. This method will lessen the possibility of the wires being damaged by being dragged over abrasive objects.

4.02 Another method is by the use of stationary, rotating reels. In this method, the stringing usually is started at the deadend pole and the wires are pulled out as far as practicable. The reels are then transported to the point where the pull stopped and the above operation is repeated. The wires may be pulled by means of a truck, or by hand. If the wires are pulled over the crossarms, a transposition running board shown in Figure 2 can be used and should be eased over the crossarm and the wires placed in the proper pin positions with wires reversed at transposition points so that it will not be necessary to cut the wires to make transpositions. REA Form 511 specifies how the wires shall be rotated depending on the transposition system used.

4.03 If wires are being strung where there is a possibility of the wires interfering with vehicles or pedestrians as at a street, sidewalk and highway crossings, a man should be stationed to warn traffic and temporary warning signs should be set out. At railroad crossings the method of stringing recommended for use at the crossing is the same as given in paragraph 4.06 for crossings above power wires.

4.04 If the wires are paid out on the ground, they may be placed on the crossarms by a man climbing each pole or by using a wire raising tool.

4.05 When wires are being strung on joint-use poles or near power wires, the power wires should always be treated as being energized. The wire being strung also should be treated as being energized. In this work all pay-out reels should be grounded and rubber gloves which meet ASTM Specification D 120-59T (which have been tested to be free of pin holes) with suitable leather over-gloves should be worn by all personnel until the wire is tensioned and deadended. Tying in of wire does not require that the rubber gloves be worn. All body contacts with conducting surfaces should be avoided as the rubber gloves protect only the hands and forearms. In such situations the bare wires should be grounded on the crossarms at about one-half mile intervals during the wire stringing operations. This is done by stapling a bare wire along the top of the crossarm and connected to a ground wire, anchor guy or a ground rod. These grounds should be maintained until the circuits are connected at the cable terminal.

4.06 In the rare cases where telephone wires must be strung over electric light or secondary power wires, the major precaution is to prevent the telephone wires from making contact with the supply wires. This situation requires special construction procedure similar to the one shown in Figure 3 in addition to the precautions stated in paragraph 4.05. Telephone wires should not be strung across or above primary power wires.

4.07 In the stringing of wires below power wires there are two dangers from electric shock:

a. Induction - This is adequately protected against by grounding as specified above and the use of rubber gloves.

b. Direct Contact - This is very dangerous and preventive measures must be used. The telephone wire may contact the overhead power wires due to telephone wire flip-up during the stringing operations. Extreme caution must be exercised to prevent any direct contacts with power wires.

4.08 Flip-up of a telephone wire into a power wire can occur during stringing if it snags under something on the ground and suddenly is released when tension is applied in the sagging operation. It also can occur when a pin, insulator or tie failure allows the wire at a low pole to rise above normal. Guard crossarms or guard wires recommended in REA TE & CM-615, "Design of Open Wire Plant," should be placed at low poles where the possibility of flip-up contact may occur. At evidently dangerous low pole situations if guard crossarms or guard wires are not in place it is advisable to place a handline across the wires that are being strung in both spans adjacent to the low pole where there are power wires above and keep it held taut by a man at each handline until the sagging is completed.

5. LINE WIRE SAGGING

5.01 Where more than one kind of wire is strung on the same crossarm, all wires on the arm shall be sagged evenly with the wire requiring the greatest sag. The engineer will supply the necessary sag data to the contractor. (See paragraph 6.01.)

5.02 Conductors of different weights will have different tensions for the same amount of sag. Therefore, uniform sag will not be obtained for different weights of wire by simply making the tensions the same when pulling in. This may better be seen from the following equation:

$$\text{Tension in lbs.} = \frac{1.5 \times \text{Weight of Wire (lb/ft)} \times (\text{Span in Feet})^2}{\text{Sag in Inches}}$$

5.03 To insure that the wires in all spans come up to the proper sag, especially in spans distant from where the pull is being made, the wires should be pulled up to double the required normal tension then slacked off to obtain the correct sag value. This will remove some of the inelastic stretch in the wires. In tangent construction sag measurements should be made in the span adjacent to the deadend span and every fifth span thereafter. Due to the increased friction at corners sag measurements should be made more often in sections containing corners. On pulls of five spans or less, a sag measurement for a span at the midpoint of the section being pulled usually will be adequate.

5.04 The maximum length of wire that can be handled in one pull will depend on:

a. Number of wires pulled. A pair of wires can be pulled over a greater distance than several pairs.

b. Number and angle of corners in the section to be pulled. Corners reduce the distance a pull can be made.

c. Situations such as highway, railroad, and power line crossings. Guarding such situations can be done more safely if the pull is short.

In general, the pull should be as near the length of wire in a standard coil as practicable.

5.05 The correct sag for the line wires can be determined by the sighting method, but the return wave method is recommended by REA. Both methods can be used by a man on a pole, but the return wave method also can be done from the ground. The sighting method is not recommended because in long spans with their large sag values it is difficult to see the dip at the low point of the sag. In addition, sight gauges long enough to measure the long span sags are not commercially available.

5.06 The return wave method is based on the principle that the time required for a wave to travel along the wire from one rigid support to another and return is a definite function of the sag present in the wire. This principle is true regardless of span length, type or gauge of conductor, temperature or stringing tension which is shown by the equation:

$$S = 12.075 \left(\frac{T}{N}\right)^2$$

Where S = Sag in inches
T = Time in seconds
N = Number of return waves counted

5.07 The return wave method may be used by a man on a pole as follows:

5.071 The wire is struck a sharp blow close to the crossarm at the same instant that a stop watch is started or the second hand of an ordinary watch crosses the 60 second mark. Striking the wire will cause a wave to travel along the wire to the crossarm on the adjacent pole. The wave will be reflected back and forth between the two crossarms until it dies out. Immediately after striking the wire, a finger should be placed near the wire so that the reflected waves will strike it. The number of times that the wire strikes the finger should be counted. Care must be taken not to count "one" when the impulse is given to the line, but to count "one" on the first return of the wave, that is, "start, one, two, et cetera." When the tenth return wave in the wire is felt, the elapsed number of seconds should be noted. For convenience, the Time-Sag relations for the tenth return wave have been prepared and are given in Table 1. If difficulty is encountered in discerning the tenth wave return, the sag indicated by the time of the fifth wave return may be determined by dividing the time indicated in Table 1 by 2.

5.072 The return wave equation given above involves the square of the time; therefore, an error in the measuring of the time is magnified in the calculated sag value. It is advisable to repeat the time-wave count operation once or twice for accuracy.

5.073 One method for checking sag from the ground is by the use of a light weight cord thrown over the wire about three feet from the crossarm. The cord can be used to initiate the wave and to count the number of return waves.

5.074 The preferred method for checking sag from the ground is by means of a lightweight telescoping pole which has a hook on the end for engaging the wire. This device permits giving the wire a jerk near the crossarm after which it is held lightly and the count of return waves can be made more accurately than with the cord method as the cord will have a tendency to stretch. A fiberglas pole, with length markings, of this collapsible type is commercially available. The pole also can be used for measuring ground clearance of wires and cables.

5.075 Satisfactory results cannot be obtained with the return wave method if the line wire is subjected to noticeable movement by the wind, linemen working on the poles during the test or by any other influence that will affect the natural period of the waves in the wire.

6. SPECIAL SAG TABLES FOR WINDY AREAS

6.01 Special Sag Tables 2, 3, and 4 have been developed to be used in special cases where decreased sags are desirable to minimize midspan hits in windy areas. The sag data provided by the wire manufacturers shall be used except in the windy areas.* These recommendations specify that .080 inch 30% EHS copper-covered steel wire shall not be strung with increased tensions in any case. The sag of all line wires after tying shall be in accordance with the data furnished by the engineer except that a maximum deviation of two inches from the specified sag is acceptable provided that all line wires are sagged evenly.

7. LINE WIRE TIES

7.01 Line wire ties are to be made using the type of tie selected by the engineer. There are three types of ties specified in REA Form 511 for use by REA borrowers: 1) The prelashed tie, 2) the "V" notch, and 3) the modified horseshoe tie. The modified horseshoe tie is for use at railroad crossings. The advantages accruing

* The following areas are considered to be windy; Iowa, Kansas, Minnesota, Nebraska, North Dakota, Oklahoma, South Dakota, and the heavy loading districts of Texas, Colorado and Wyoming.

from the use of the prelashed tie make it the preferred tie for use elsewhere. It comprises a splint that is intended to be prelashed to the insulator either in the storeroom or out on the job. It will be necessary to tighten the pigtail of the tie wire after the insulator is in place and the spiralled ends of the splint are wrapped onto the line wire. A tool is available to spiral the splint ends onto the wire. This tie has the advantage that the spiralled ends of the splint can be unwound from the line wire to release it to permit resagging. These spiralled ends may then be wound on the line wire again with holding power greater than they had before removal. Furthermore, these ties are more uniform than is practicable in older types of ties. They can be inspected before use for uniformity and quality of workmanship.

7.02 All ties shall be made tightly to insure the proper support of the line wire at the insulator. Line wires shall be tied at the locations specified in REA Form 511.

7.03 Where the "V" notch or prelashed tie is used at non-transposition points in double arm construction, the splint ends between the two insulators must be cut off to leave approximately one-half inch separation. This procedure is necessary since the opposing ends of the splints will not intertwine.

7.04 REA Form 511 specifies that wires shall be tied in at the earliest practicable time and no later than seven days after stringing.

8. LINE WIRE POSITIONING ON INSULATORS

8.01 Wires shall be positioned on insulators as specified in REA Form 511. REA TE & CM-463, "REA-1 Transposition System," shows the wire positioning for this transposition system.

9. LINE WIRE SPLICING AND DEADENDING

9.01 The appropriate compression type sleeve for type and size of conductor shall be employed for splicing all line wires. This sleeve must be compressed in such a manner as to prevent it from bowing.

9.02 The compression splice, when properly installed is as strong as the line wire itself. The sleeve employed for the compression splice is compressed tightly around the line wire and does not permit the entrance of or hold water in the splice. This materially reduces the possibility of corrosive action occurring at the splice.

9.03 Some difficulty has been experienced with fatigue failures (breaks) of the line wire at its point of entrance into the splicing sleeve as a result of vibration because the sleeve is rigid while the wire is flexible. The difficulty can be reduced by placing the splice some distance from the point of support and by compressing the sleeve without bowing. Splices in new line wire preferably should be located ten feet or more from the point of support in order to minimize wire fatigue at the splice. It may not be practicable to obtain this distance in stringing or repair operations, but in no case should a splice be less than two feet from its support.

9.04 When line wires of different gauges must be spliced reducing type adapter sleeves shall be used which provide a smaller bore at one end than at the other end. When wires of two different gauges and metals must be spliced together, special adapter sleeves shall be used which are suitable to prevent corrosion due to the galvanic action between the two dissimilar metals.

9.05 No more than one splice per conductor is permitted in any span in new work. Splices are not permitted in a railroad crossing span or in either span adjacent to a railroad crossing span. Splices shall be kept to the minimum necessitated by coil lengths and deadends.

9.06 Clevises at deadends must be mounted so that the pin through the porcelain insulator is in a horizontal plane. This permits vertical oscillation of the line wire with minimum wear at the clevis.

9.07 There are at present three types of line wire deadends acceptable for use in telephone systems of REA borrowers. These are: 1) the preformed type and 2) the compression bail type. (See Figure 4.) The bails of the compression type are stainless steel which are compressed into the sleeves at the factory. The line wire is inserted into the sleeve end and attached thereto using a compression tool.

9.08 Bridle wire shall be attached to line wire with approved bridging connectors of the compression type suitable for attaching the bridle wire to the particular gauge and type of line wire being used. Bridle wires should be arranged as shown in REA Form 511.

10. VIBRATION DAMPENERS

10.01 REA Form 511 specifies that a vibration dampener shall be placed on each conductor in every span and that if a splice occurs in a span more than 25 feet from a pole, one dampener shall be installed on the wire on each side of the splice; also that <u>all of the dampeners shall be installed at the time the conductor is placed on the pole top assembly</u>. Dampeners are necessary to protect against fatigue failure before the line wire is tied in as well as afterwards.

Table 1

TIME-SAG RELATIONS - Based on 10th return of wave

Sag Inches	Time Seconds	Sag Inches	Time Seconds	Sag Inches	Time Seconds
5	6.4	45	19.3	85	26.5
6	7.0	46	19.5	86	26.7
7	7.6	47	19.7	87	26.8
8	8.1	48	19.9	88	27.0
9	8.6	49	20.1	89	27.2
10	9.1	50	20.4	90	27.3
11	9.5	51	20.6	91	27.5
12	10.0	52	20.8	92	27.6
13	10.4	53	21.0	93	27.8
14	10.8	54	21.1	94	27.9
15	11.1	55	21.3	95	28.1
16	11.5	56	21.5	96	28.2
17	11.9	57	21.7	97	28.3
18	12.2	58	21.9	98	28.5
19	12.5	59	22.1	99	28.6
20	12.9	60	22.3	100	28.8
21	13.2	61	22.5	101	28.9
22	13.5	62	22.7	102	29.1
23	13.8	63	22.8	103	29.2
24	14.1	64	23.0	104	29.3
25	14.4	65	23.2	105	29.5
26	14.7	66	23.4	106	29.6
27	15.0	67	23.6	107	29.8
28	15.2	68	23.7	108	29.9
29	15.5	69	23.9	109	30.0
30	15.8	70	24.1	110	30.2
31	16.0	71	24.3	111	30.3
32	16.3	72	24.4	112	30.5
33	16.5	73	24.6	113	30.6
34	16.8	74	24.8	114	30.7
35	17.0	75	24.9	115	30.9
36	17.3	76	25.1	116	31.0
37	17.5	77	25.3	117	31.1
38	17.7	78	25.4	118	31.3
39	18.0	79	25.6	119	31.4
40	18.2	80	25.7	120	31.5
41	18.4	81	25.9		
42	18.7	82	26.1		
43	18.9	83	26.2		
44	19.1	84	26.4		

TABLE 2

Special Stringing Sags and Tensions for .109 Grade 135 (No. 12 B.W.G.) High Tensile Telephone Line Wire

HEAVY LOADING DISTRICT

To be used in special cases where decreased sags are desirable to minimize mid span hits and where maximum average span length does not exceed 300 feet and maximum individual span length does not exceed 350 feet.

Temperatures in Degrees Fahrenheit

Span Length (Feet)	100°	90°	80°	70°	60°	50°	40°	30°	20°	10°	0°
	---- Sags in Inches ----										
180	9.5	8.5	8	7.5	7	6.5	6.5	6	5.5	5.5	5
190	10.5	9.5	9	8.5	8	7.5	7	6.5	6	6	5.5
200	11.5	11	10	9.5	9	8	7.5	7.5	7	6.5	6.5
210	13	12	11	10.5	9.5	9	8.5	8	7.5	7.5	7
220	14	13	12	11.5	10.5	10	9.5	9	8.5	8	7.5
230	15.5	14	13	12.5	11.5	11	10	9.5	9	8.5	8.5
240	16.5	15.5	14.5	13.5	12.5	12	11	10.5	10	9.5	9
250	18	17	15.5	14.5	13.5	13	12	11.5	11	10.5	10
260	19.5	18	17	16	14.5	14	13	12.5	11.5	11	10.5
270	21	19.5	18	17	16	15	14	13.5	12.5	12	11.5
280	22.5	21	19.5	18.5	17	16	15	14.5	13.5	13	12.5
290	24.5	22.5	21	19.5	18.5	17	16	15.5	14.5	14	13
300	26	24	22.5	21	19.5	18.5	17.5	16.5	15.5	15	14
310	28	26	24	22.5	21	19.5	18.5	17.5	16.5	16	15
320	30	27.5	25.5	24	22.5	21	20	18.5	17.5	17	16
330	31.5	29.5	27.5	25.5	24	22.5	21	20	19	18	17
340	34	31	29	27	25.5	24	22.5	21	20	19	18
350	36	33	31	28.5	27	25	24	22.5	21	20.5	19.5
	-- Approximate Tension in Pounds for All Above Span Lengths --										
	164	177	190	204	218	232	246	260	275	289	303

TABLE 3

Special Stringing Sags and Tensions for .102" EHS 30% Conductivity Copper Steel Communication Wire

HEAVY LOADING DISTRICT

To be used in special cases where decreased sags are desirable to minimize mid span hits.

Span Length (Feet)	Temperatures in Degrees Fahrenheit 120°	90°	60°	30°	0°
	---- Sags in Inches ----				
180	7	6	5	4.5	3.5
190	7.5	6.5	5.5	5	4
200	8.5	7	6	5.5	4.5
210	9.5	8	6.5	6	5
220	10.5	8.5	7.5	6.5	5.5
230	11.5	9.5	8	7	6
240	12.5	10.5	9	8	7
250	13.5	11	9.5	8.5	7.5
260	14.5	12	10.5	9	8
270	15.5	13	11	10	8.5
280	16.5	14	12	10.5	9.5
290	18	15	13	11.5	10
300	19	16	14	12	10.5
310	20.5	17	14.5	13	11.5
320	21.5	18.5	15.5	13.5	12
330	23	19.5	16.5	14.5	13
340	24	20.5	17.5	15.5	13.5
350	25.5	21.5	18.5	16.5	14.5
360	27	23	20	17	15.5
370	28.5	24	21	18	16
380	30	25.5	22	19	17
390	31	27	23	20	18
400	33	28	24.5	21.5	19
410	34.5	29.5	25.5	22	20
420	36	31	26.5	23.5	21
430	37.5	32.5	28	24.5	22
440	39	33.5	29	29	23
450	41	35	30.5	27	24
460	42.5	37	32	28	25
470	44.5	38.5	33	29	26
480	46	40	35	30.5	27
490	48	41.5	36	31.5	28.5
	--- Approximate Tension in Pounds for All Above Span Lengths ---				
	206	240	283	325	365

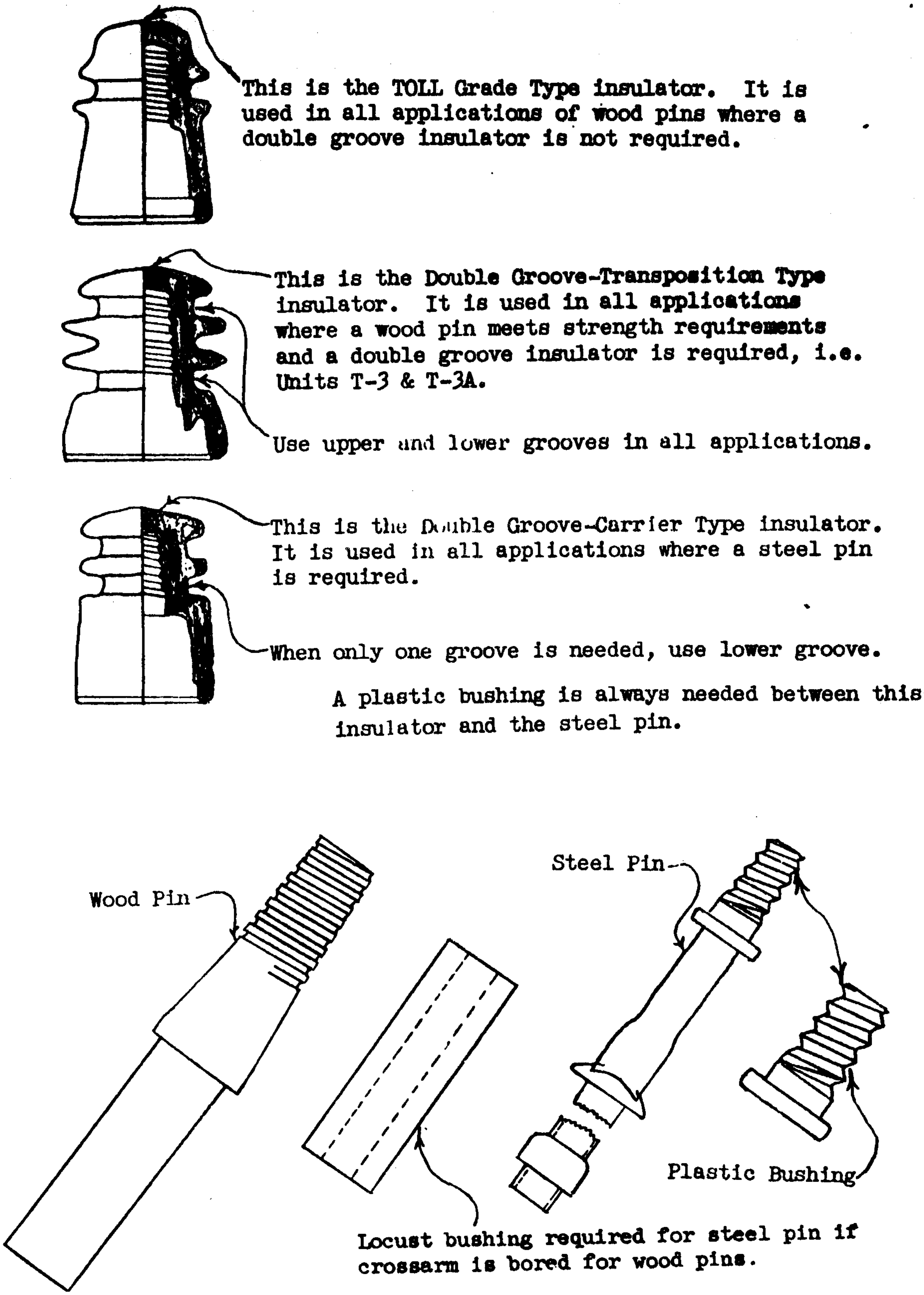
TABLE 4

Special Stringing Sags and Tensions for .104" HS 40% Conductivity Copper Steel Communication Wire

HEAVY LOADING DISTRICT

To be used in special cases where decreased sags are desirable to minimize mid span hits.

Span Length (Feet)	Temperatures in Degrees Fahrenheit 120°	90°	60°	30°	0°
	---- Sags in Inches ----				
180	11	8.5	7	5.5	5
190	12.5	9.5	8	6.5	5.5
200	13.5	10.5	8.5	7	6.5
210	15	11.5	9.5	8	7
220	16.5	13	10.5	8.5	7.5
230	17.5	14	11.5	9.5	8
240	19	15	12.5	10.5	9
250	20.5	16.5	13.5	11.5	9.5
260	22	18	14.5	12	10.5
270	23.5	19	15.5	13	11.5
280	25	20.5	16.5	14	12
290	27	21.5	18	15	13
300	28.5	23	19	16	13.5
310	30	24.5	20.5	17.5	14.5
320	32	26	21.5	18.5	15.5
330	33.5	27.5	23	19.5	16.5
340	35.5	29	24.5	20.5	17.5
350	37	30.5	26	22	18.5
-- Approximate Tension in Pounds for All Above Span Lengths --	141	174	212	252	294



PINS AND INSULATORS

Figure 1

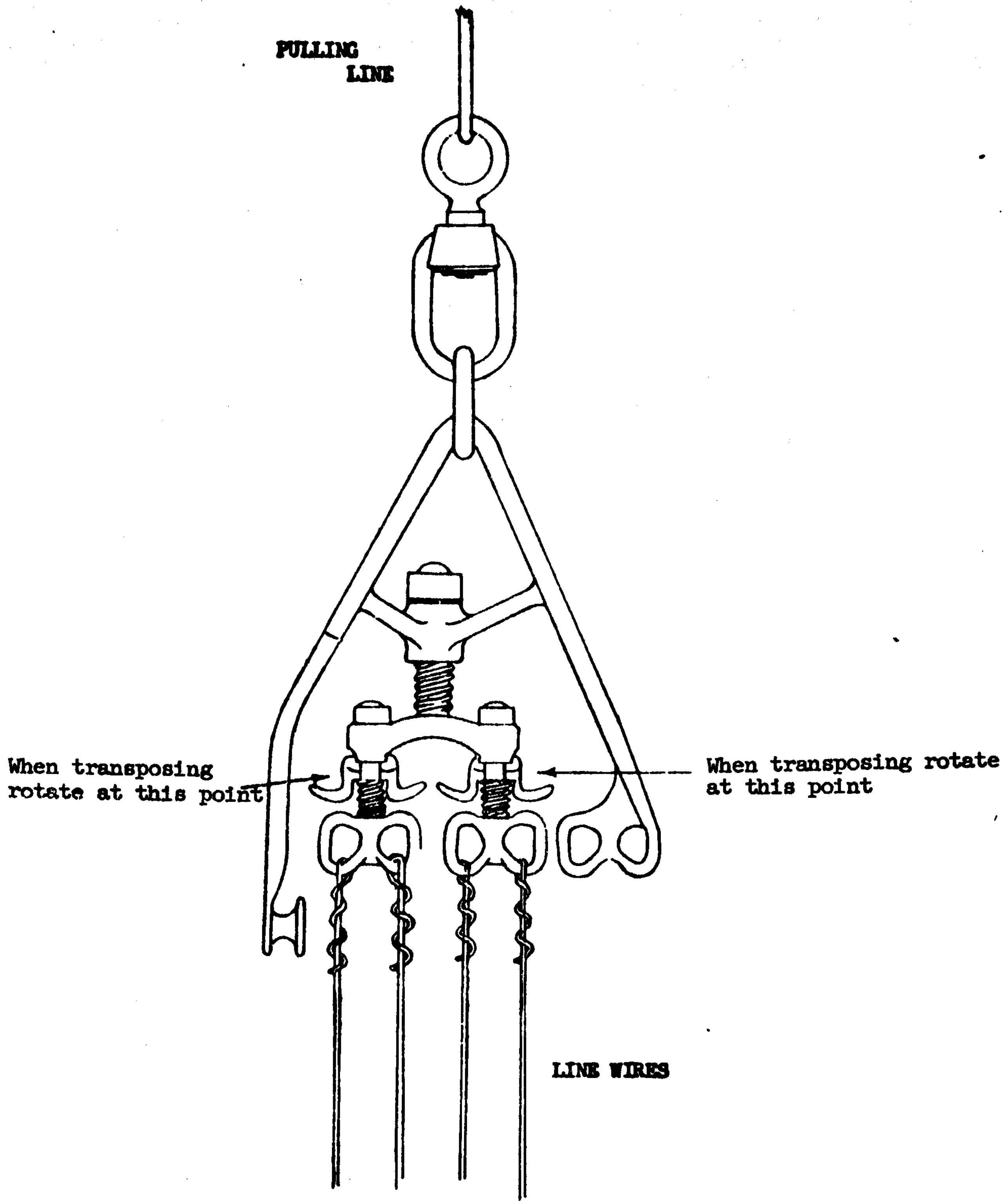
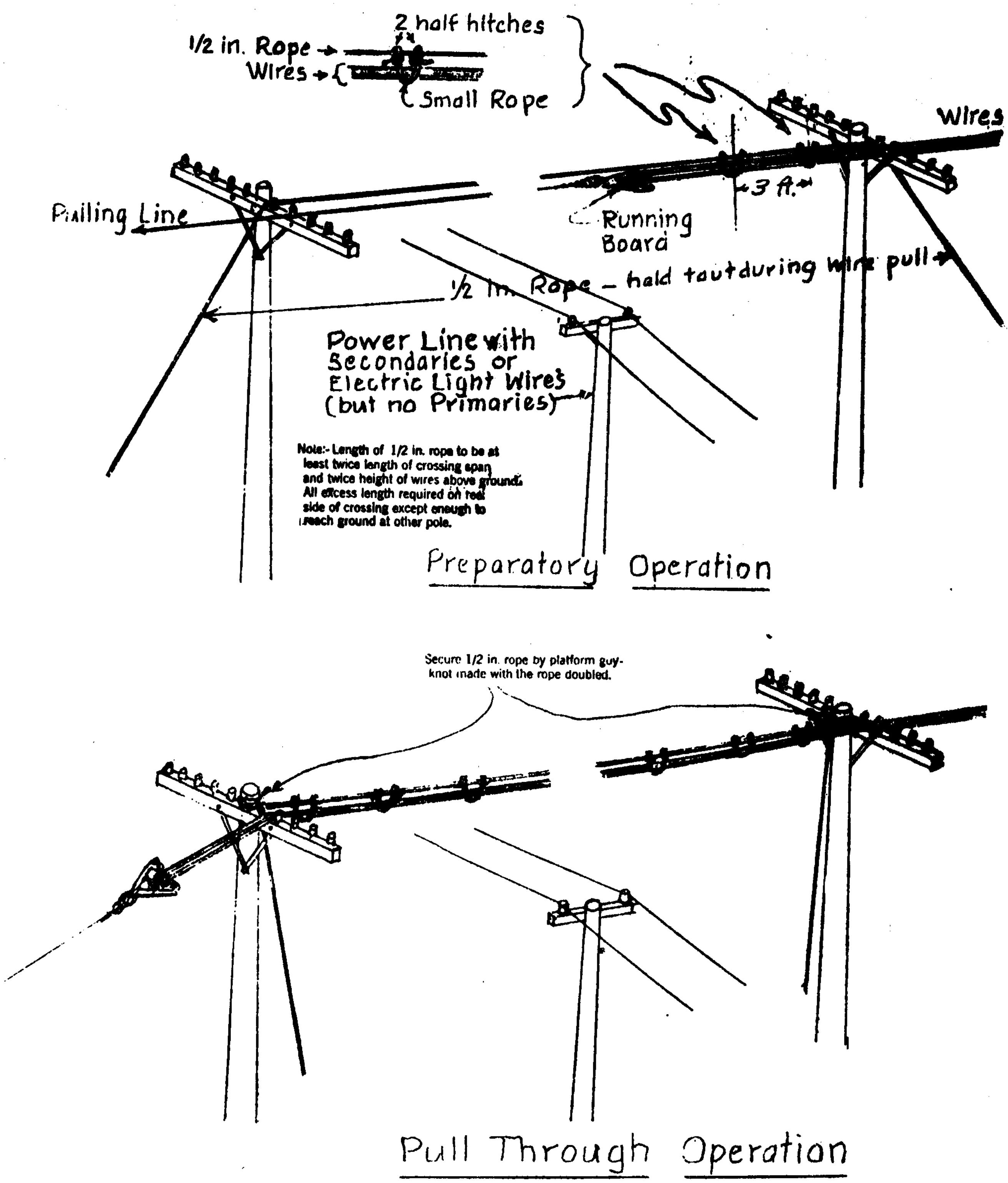
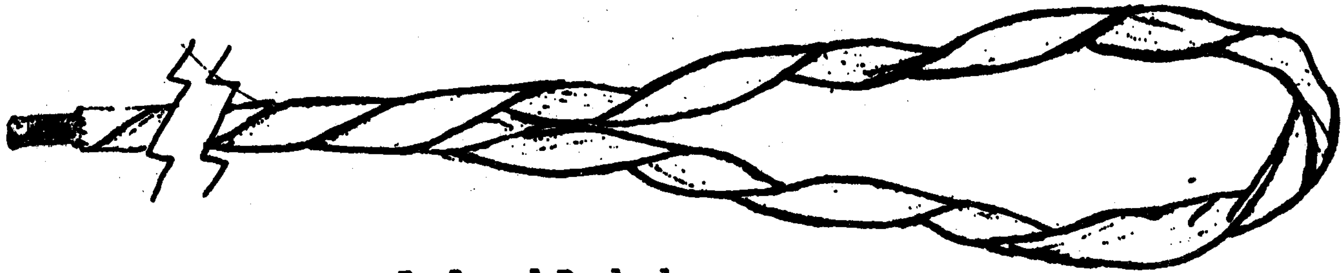


Figure 2
Transposition Running Board

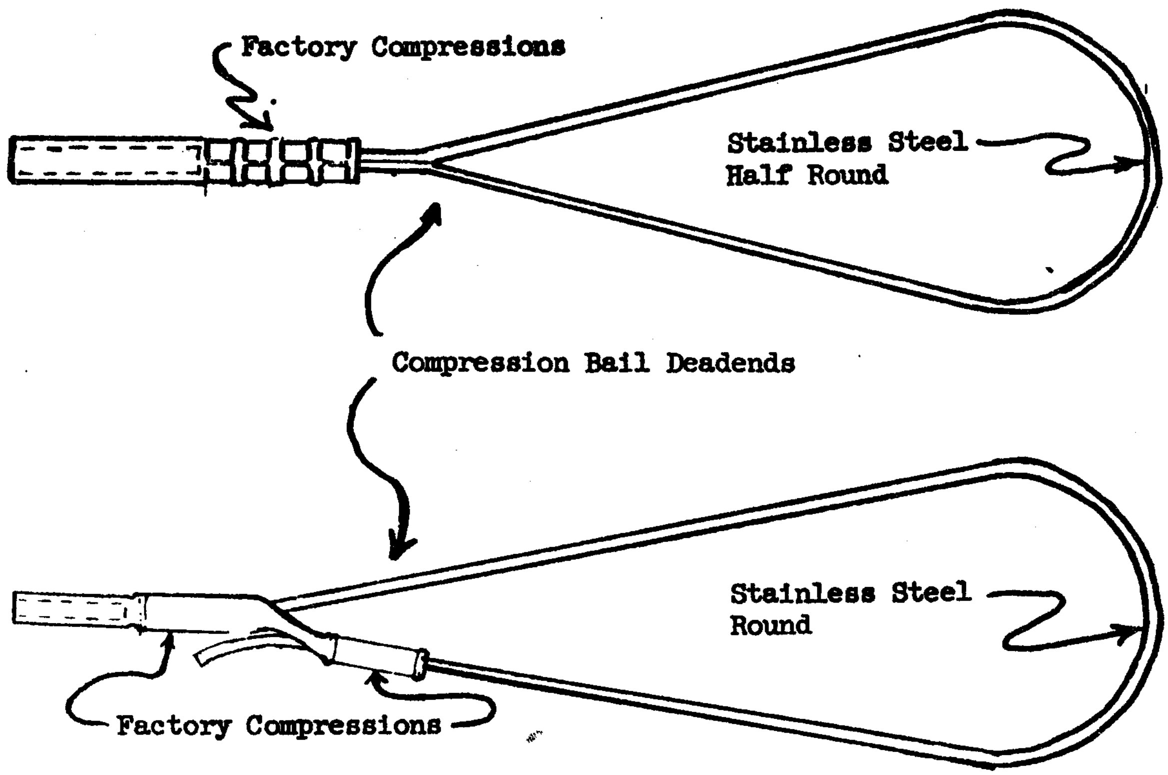


STRINGING WIRES OVER POWER LINE

Figure 3



Preformed Deadend



LINE WIRE DEADENDS
Figure 4