

BELL SYSTEM PRACTICES
Outside Plant Construction
and Maintenance

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AERIAL CABLE SPLICING

TENSION SPLICING

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1. GENERAL

1.01 Experience with aerial cables has shown that where they are spliced in warm weather, little bowing is to be expected later. On the other hand, if the splicing is done in cold weather and preventive measures are not taken, the cable will bow later when temperatures are higher.

1.02 Tension splicing, which is done only in cold weather, consists essentially in stretching the cable by an amount which is approximately equal to the amount by which it is contracted due to the cold weather. In other words, tension splicing enables as good, if not better results, to be obtained from a bowing standpoint on cable spliced in the winter as on summer spliced cable.

1.03 These practices cover the procedure for tension splicing both cables supported in rings and lashed cables with the exception of those which are lashed directly to the suspension strand from moving reels. The methods now being used for lashing cable directly to the strand as the reel is moved along the line do not lend themselves to tension splicing.

2. EQUIPMENT REQUIRED

2.01 In addition to the tools and materials normally used in splicing aerial cable the following item is needed for tension splicing cables as covered in these instructions:

Tension Splicing Tool

Consisting of:

- 1 Tension Jack
- 2 Tension Splicing Clamps
- 1 2-1/2 ft. Tension Splicing Sling
- 1 4-1/2 ft. Tension Splicing Sling
- 2 1-1/2 in. Split Cable Grips for Cable diameters from 1-1/4" to 2-1/4" inclusive
- 2 2-1/2 in. Split Cable Grips for Cable diameters from 2-3/8" to 2-5/8" inclusive

3. SIZES OF CABLE TO BE SPLICED UNDER TENSION 7

3.01 When the temperatures are as indicated in Part 4 tension splice all cables carried on 10M or larger strand provided they weigh 2 pounds or more per foot.

3.02 Tension splicing of cables weighing less than 2 pounds per foot is not recommended for the reason that experience indicates it cannot be justified.

Note: The appearance of cables too small to warrant tension splicing can often be improved if during the cable placing operations the ends of the cable are clamped to the suspension strand while the pulling line is still taut.

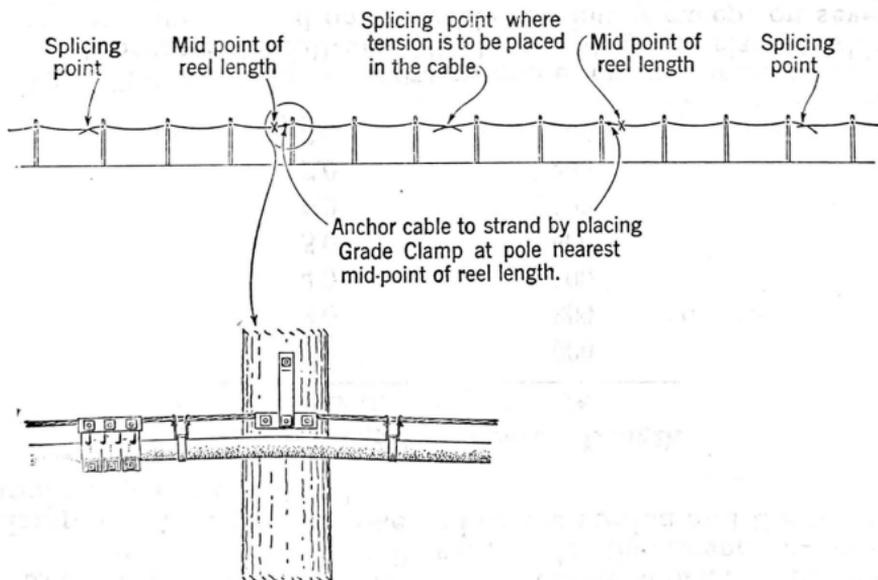
4. TEMPERATURES AT WHICH TENSION SPLICING IS REQUIRED

4.01 During the fall, winter and spring months take air temperatures in the vicinity of the cable with a reasonably accurate thermometer before lashing a cable to its suspension strand or, in the case of a ring-supported cable, before splicing. The thermometer should be given the same exposure to sun and prevailing winds as the cable itself in order to obtain proper temperatures. Do not suspend thermometers where they are sheltered by poles, trucks, fences, etc.

If the observed temperature is **50 degrees or less in the case of ring-supported cables or 30 degrees or less for lashed cables**, place tension in the cable by stretching to the amount indicated in the table of cable stretch in Part 10.

5. PREPARING RING-SUPPORTED CABLE FOR TENSION SPLICING

5.01 Where cable is installed in section lengths greater than those shown in the table in paragraph 5.02, place a temporary grade clamp at the pole nearest the midpoint of the section as shown in the illustration below. If a grade clamp has already been installed, say at a corner, somewhere near the center of the section it may be used in lieu of the temporary grade clamp.



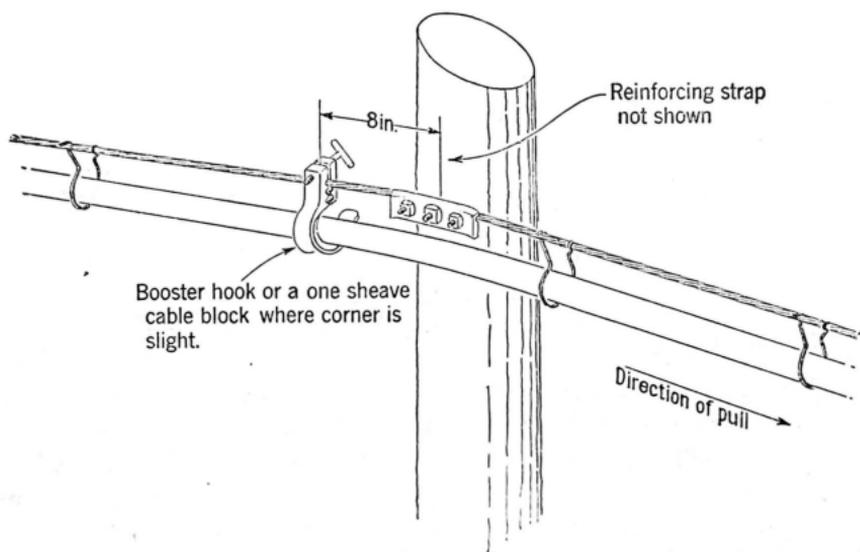
5.02 Where cable is placed in sections shorter than those indicated in the following table, the temporary grade clamp may be located at one end of the section and the tension applied at the other end.

Cable Weight lbs. per ft.	Section Length ft.
2.0	900
3.0	800
4.0	700
5.0	600
6.0	500
7.0	400
8.0	300

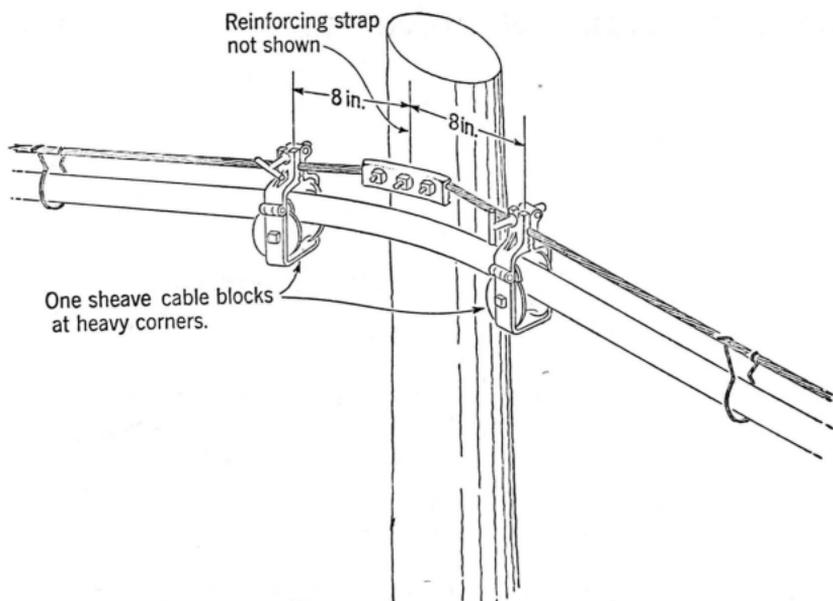
5.03 Between the temporary grade clamps mentioned in paragraphs 5.01 and 5.02, loosen all grade clamps which may have been placed on the cable previously except on severe grades where this procedure would permit the cable to slip downhill. In such cases do not loosen the grade clamps until the tension splicing tool is set up ready to place tension in the cable.

5.04 Where cable is equipped with aerial cable supports at poles, loosen the wire portions of the cable supports sufficiently to permit easy movement of the cable along the suspension strand when placed in tension. At corners it may be necessary to detach the wire portion of the cable supports from the strand and to substitute cable rings as temporary supports in order that the cable will not be hindered in its movement around the turn.

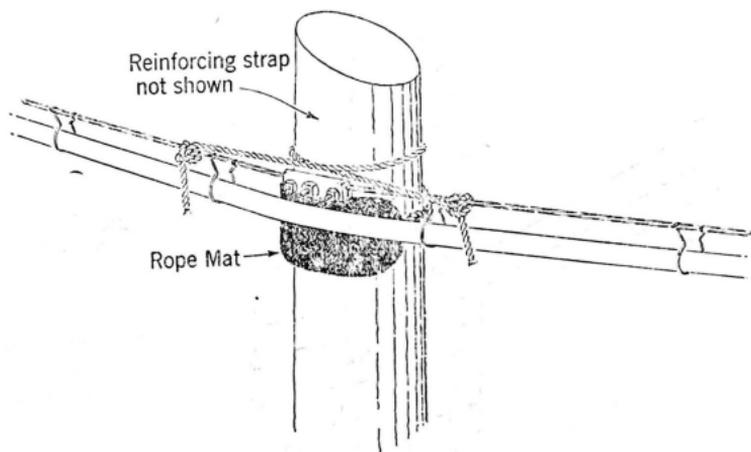
5.05 For cables weighing about 5 or more pounds per foot, at corner poles where the pull is away from the pole and where the corner is slight, place a **One Sheave Cable Block** or **Booster Hook** close to the pole and on that side of the pole away from the splice point.



At heavy corners, place a One Sheave Cable Block on each side of the corner pole.



5.06 For cables of about 5 or more pounds per foot at corner poles where the pull is against the pole place a rope mat or its equivalent on the pole as shown below.



6. PREPARING LASHED CABLE FOR TENSION SPLIC- 7 **ING**

6.01 Cable to be lashed to its suspension strand and to be tension spliced should first be pulled into temporary rings spaced 5 feet apart.

6.02 Place a temporary grade clamp in each section of cable either at midpoint or at one of the ends depending on the length as prescribed in Part 5 for ring-supported cable.

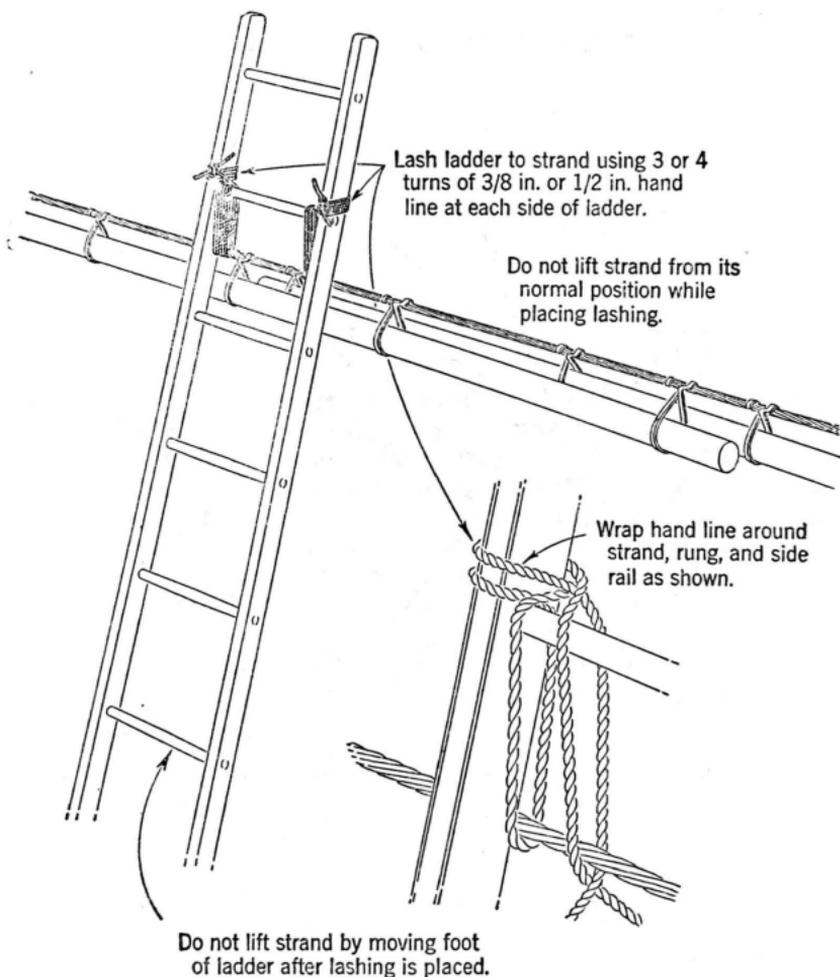
6.03 Place booster hooks or blocks on the larger sizes of cable at corner poles when the pull is away from the pole as indicated in paragraph 5.05 for ring-supported cable.

6.04 Where the pull at corners is against the pole place a rope mat or its equivalent on the pole as shown in paragraph 5.06 for ring-supported cable. 7

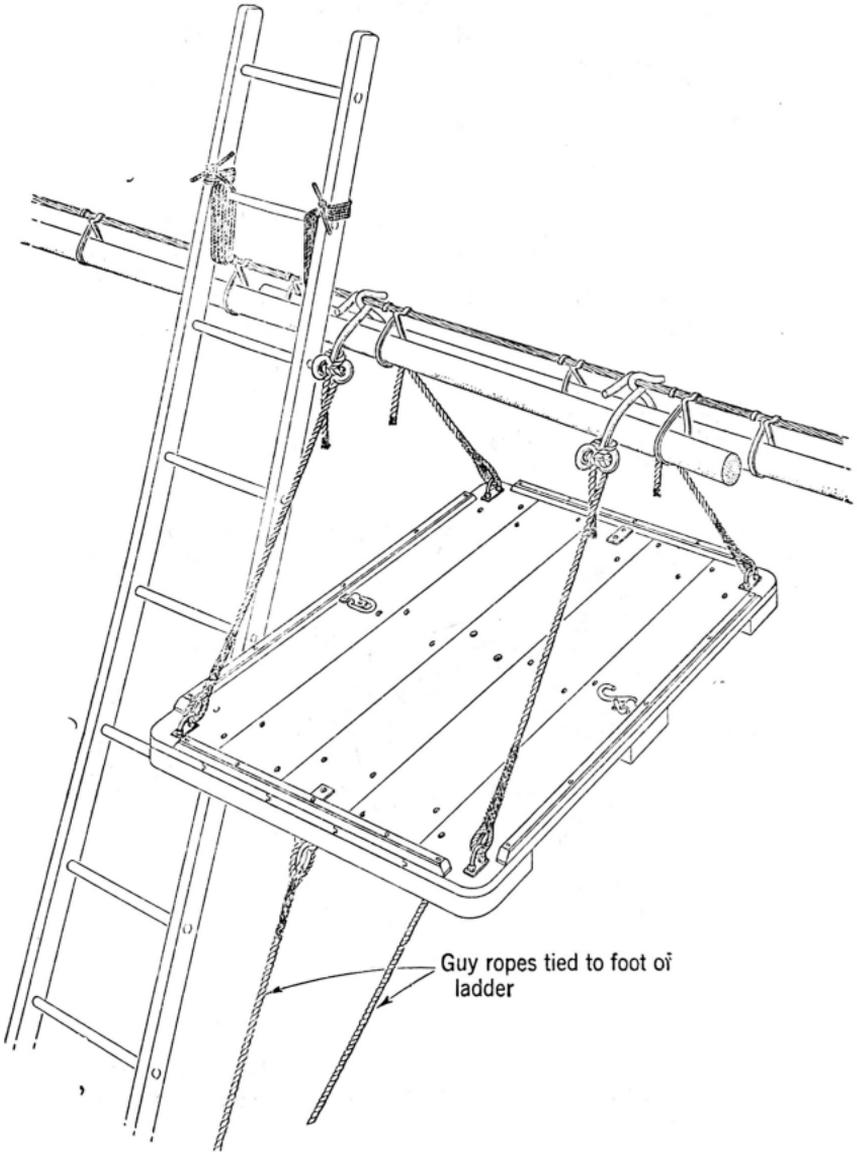
1. PLACING TENSION IN RING-SUPPORTED CABLE

Placing Ladder and Platform

7.01 Place the ladder on the strand alongside the splice point and lash it to the strand as shown below. Do not pull the lashing so tight that the ladder carries part of the weight of the strand and cable. Do not move the foot of the ladder after the lashing is placed.



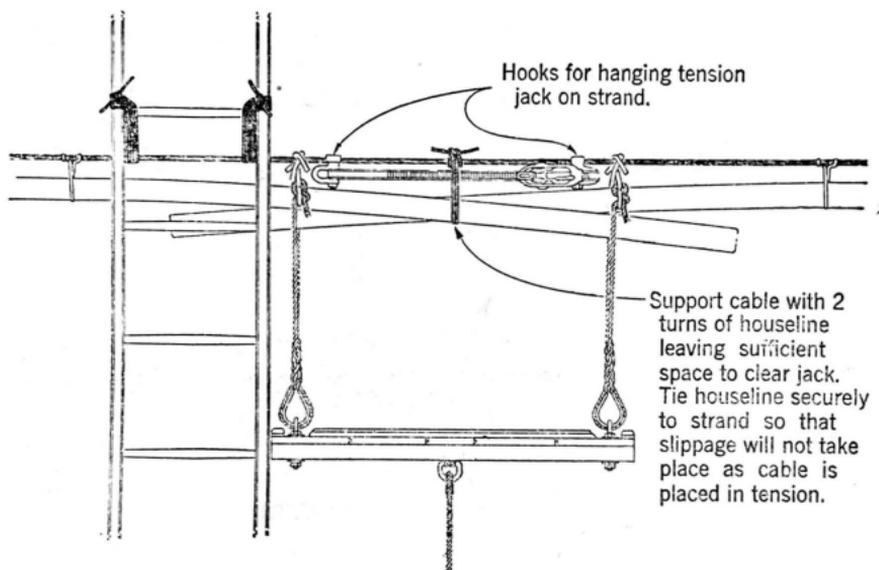
7.02 Place the splicing platform on the strand alongside the ladder as shown below and guy it to the foot of the ladder.



Placing Tension Splicing Tool

7.03 Place the traveling head of the tension jack near the end of the rack bar. Hold the jack parallel with the strand and hook it on the strand using the hooks provided on the shackles on one end of the rack bar and on the traveling head. Lower the cable ends at the splicing point slightly, if necessary, to avoid interfering with the placing of the jack. Locate the jack on the strand between the platform supports leaving about an equal amount of clearance at each end. Do not cut off the ends of the cable nor strip off the sheath until after the proper amount of tension has been placed in the cable and the cable ends have been anchored to the strand as specified hereinafter.

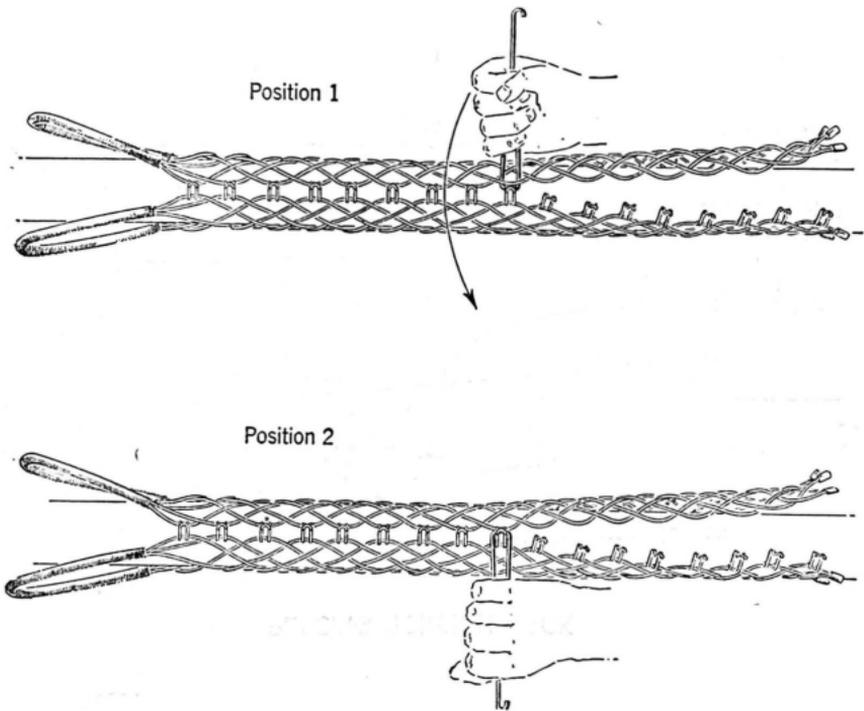
PLACING TENSION JACK



7.04 Place one tension splicing clamp on the strand at a distance of approximately 15 inches from the shackle on the traveling head, as shown in the illustration in paragraph 7.06. Do not tighten the bolts of the clamp more than finger tight at this time.

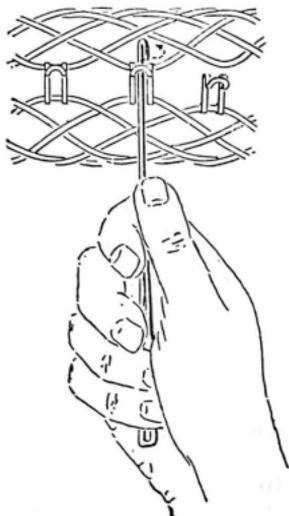
7.05 Place a split grip on the cable beyond the tension splicing clamp. The open side of the grip should be placed on the side of the cable for ease in hooking or lacing the sides of the grip together. For cables with diameters between 2-3/8" and 2-5/8" use the 2-1/2" split grip (having hooks) and for cables with diameter between 1-1/4" and 2-1/4", the 1-1/2" split grip which requires lacing. Connect the sides of the grip as shown below.

HOOKING SPLIT CABLE GRIP

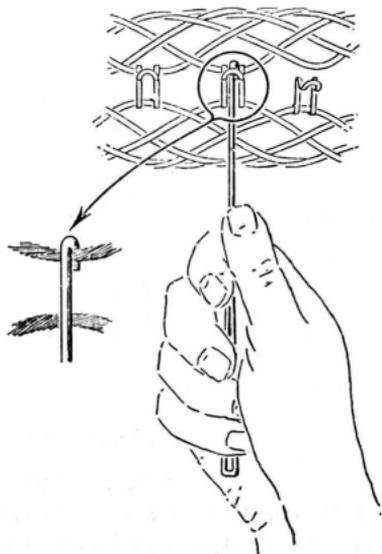


REMOVING CABLE GRIP

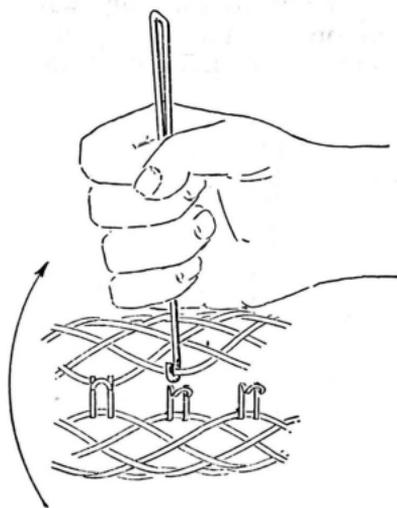
Position 1



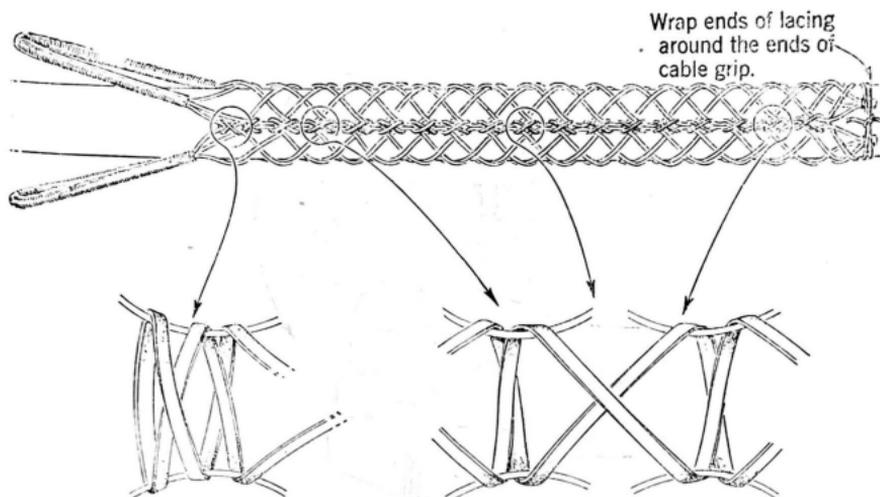
Position 2



Position 3

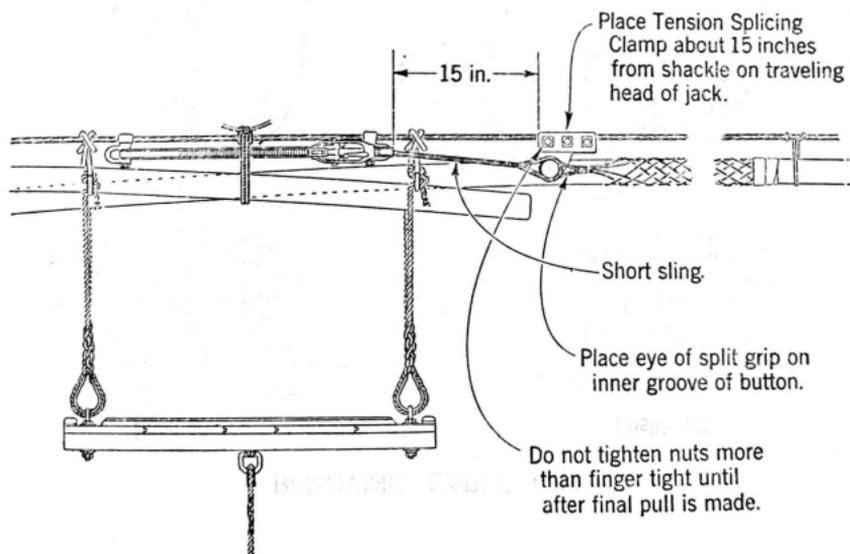


LACING SPLIT CABLE GRIP



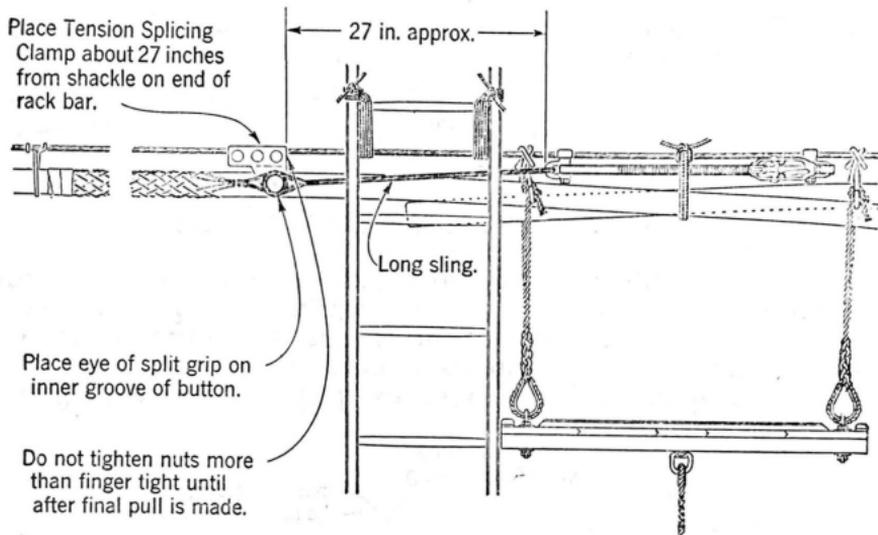
7.06 After the sides of the grip are connected together, turn it about the cable so that the hooks or lacings are on top of the cable. Place the eyes of the split grip on the inner grooves of the buttons on the sides of the tension splicing clamp. Pass the short sling through the shackle on the traveling head of the jack and hook the eyes on the outside grooves of the buttons on the tension splicing clamp.

RIGHT HAND SIDE OF SETUP



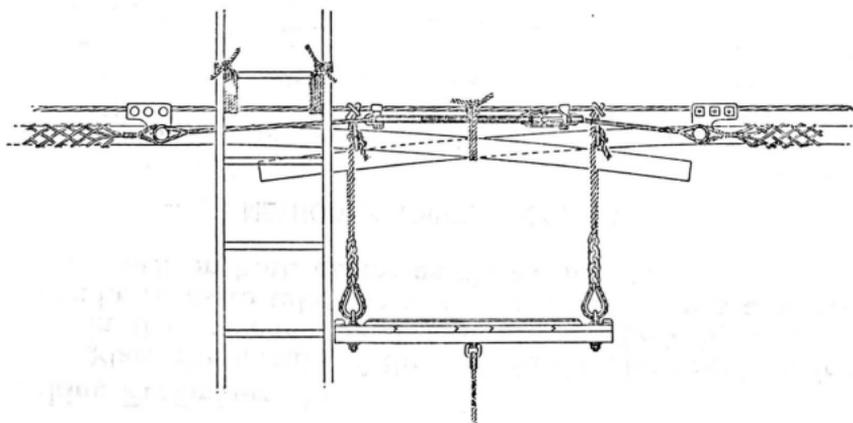
7.07 Place the other tension splicing clamp on the left-hand side of the set-up at a distance of about 27 inches from the shackle on the end of the jack and place the split grip as before. Pass the long sling through the shackle on the end of the rack bar of the jack and hook the eyes on the outside grooves of the buttons on the tension splicing clamp.

LEFT HAND SIDE OF SETUP



7.08 The complete set-up of the tension splicing tool at a splice point preparatory to placing tension in the cable is as illustrated below.

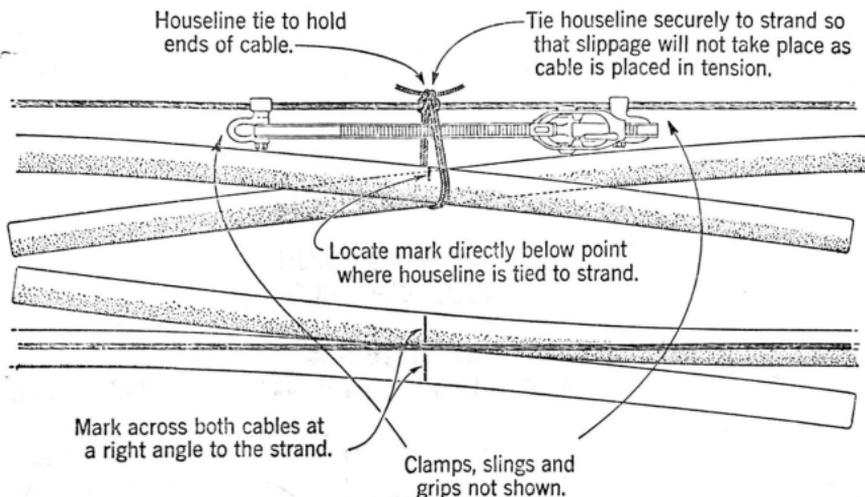
COMPLETE SET-UP FOR STRETCHING THE CABLE



Making Preliminary Pull

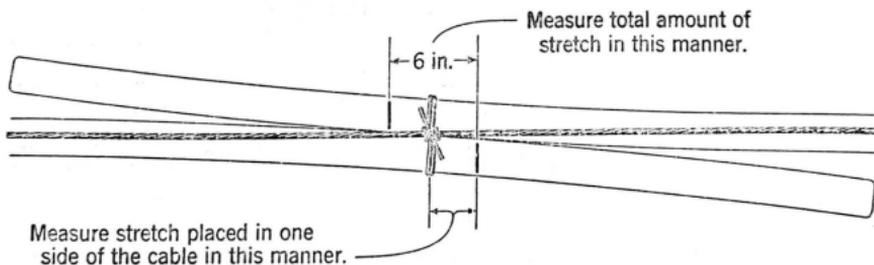
7.09 Place the handle of the jack in the slot provided for it in the traveling head. Operate the jack by means of this handle so as to take the slack out of the slings and grips. Make a mark on both cables as shown below.

METHOD OF MARKING CABLES



7.10 Operate the jack so as to pull the cable toward the splicing point from both directions. Continue pulling the cable until the marks on the cables are separated by 6 inches for 750 ft. lengths between grade clamps. (Proportionately more or less for longer or shorter lengths.)

METHOD OF MEASURING CABLE "STRETCH"



Release the tension in the cable by operating the jack in the reverse direction until the slings are slack. It will usually be found that the marks do not come quite together again since some excess slack has been pulled in toward the splicing point.

Making Final Pull

7.11 Make a new mark across both cables directly beneath the point where the houseline tie is attached to the strand. Pull up the cable with the jack until the new marks are separated by an amount equal to the "stretch" required by the temperature existing just before the work was started. The amounts of stretch corresponding to different splicing temperatures are given in paragraph 10.01.

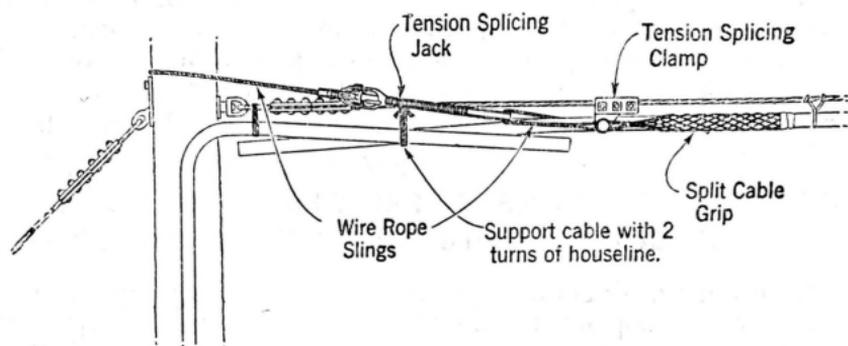
7.12 Where the lengths of cable being placed under tension to the right and left of the splicing point are approximately equal (within say 50 ft.) the cable should come in toward the splice equally from both directions as tension is applied. Make sure that the cable is doing this by observing whether or not the marks have moved an equal distance to the right and left of the point where the houseline tie is attached to the strand. If the cable is not coming equally from both sides, continue to pull the cable with the jack until one-half the total required stretch has been pulled from one side. Tighten the tension splicing clamp on the strand on that side and continue pulling up the cable with the jack until half the total required amount of stretch has been pulled from the other side.

7.13 Where the lengths of cable to the right and left of the splicing point are not approximately equal, compute the amounts of stretch to be placed on each side separately. Take up on the jack until the amount of stretch computed for the short side has been pulled on that side. Tighten the tension splicing clamp on the short side and then continue to operate the jack until the stretch computed for the long side is pulled on that side. Tighten the tension splicing clamp on the long side.

8. PLACING TENSION IN RING-SUPPORTED CABLE AT LOAD POINTS, DEAD ENDS, UNDERGROUND DIPS OR SLACK SPANS

8.01 At "H" fixture loading points there will sometimes be a half section of cable on each side of the fixture which may have to be placed under tension at that point. In this case the tension splicing tool is placed between the poles of the fixture and the required amount of tension placed in the cable from that point. Place the permanent grade clamps, required by Section G52.120, on the cable outside the poles of the loading fixture so that the tension will be retained in the cable. Remove the tension splicing tool leaving the section of cable between the poles of the loading fixture free of tension. Do this work before the cable at the loading point is set up or balloon splices are made.

8.02 At cable dead-ends or underground dips there may be a half section of cable located to one side of such points which may have to be placed under tension. In these cases place one end of the tension splicing tool on the cable as shown below and anchor the jack to the pole by passing the sling about the pole and through the shackle at the other end of the jack.



When the required amount of tension has been placed in the cable, install a permanent grade clamp on the cable outside the split grip in order to retain the tension. The tension splicing tool is then removed.

8.03 Where cable terminates in a slack span place the tension splicing tool on the cable at the pole between the slack span and the regular span in a manner similar to that shown in paragraph 8.02. After the proper amount of stretch has been given the cable, install a permanent grade clamp beyond the tension splicing tool so as to maintain the cable tension. **No cable tension is necessary in the slack span.**

9. PLACING TENSION IN LASHED CABLE

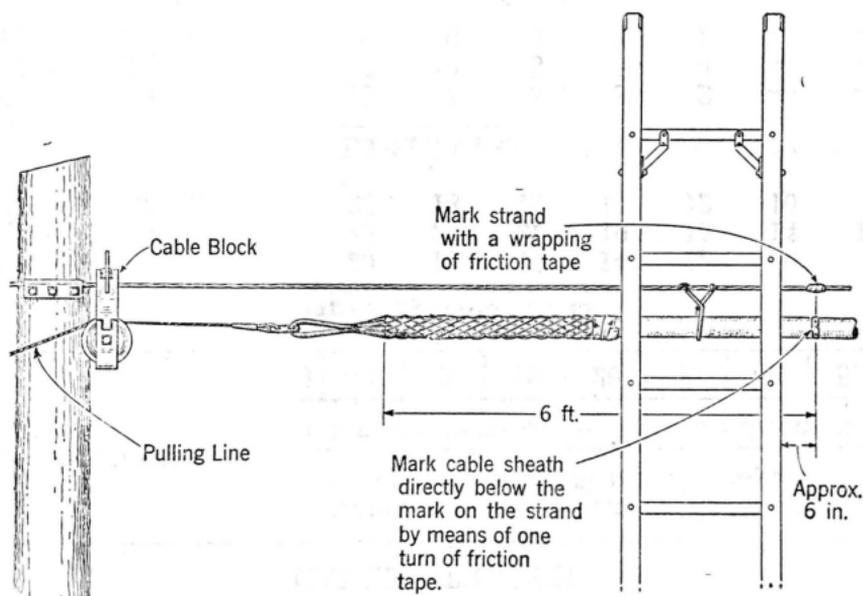
9.01 Lashed cable is placed in tension while supported in temporary rings and before the wire lashings are spun around cable and suspension strand. Consequently the required stretch in the cable can best be given by means of the pulling-in line used for placing the cable in the temporary rings.

9.02 Where a cable grip, placed over the end of the cable, is used for attaching the pulling-in line precautions must be taken to prevent slippage of the sheath over the core wires at the pulling end while placing tension in the cable. Any such slippage will result in an insufficient amount of tension being given the cable. Therefore before the cable grip is put

on, beat in two rings around the cable sheath near its end and serve with wire as described in the practices covering the pulling of underground cable into ducts. After the grip is slipped over the cable end, wrap its pigtail ends against the sheath with friction tape or wire.

9.03 After the cable has been pulled into the temporary rings keep enough tension in the cable to prevent it from sagging between the widely spaced rings. Place a ladder against the suspension strand as indicated below.

9.04 Mark both cable and strand with friction tape at a point about 6 feet from the end of the cable as indicated below. Do not mark the cable sheath with any hard object as the scoring is a potential source of sheath failure.



Take up on the pulling line until the marks on the strand and cable are separated by an amount equal to the "stretch" required for the temperature observed just before work started.

9.05 With the cable in proper tension, clamp it to the suspension strand with a grade clamp placed about 3 feet from the end of the cable. Release the tension in the pulling line and remove the cable grip. Proceed with the lashing of the cable to the strand in the regular manner.

The grade clamps at the ends of the cable are not to be removed until after the cable ends have been spliced through.

10. STRETCH REQUIRED IN CABLE TO PREVENT BOWING

10.01 The amount of stretch required to prevent bowing depends upon the temperature and the length of cable to be placed under tension from one point. The temperature to be used for determining the amount of stretch required for ring-supported cable is that observed just before starting splicing and in the case of lashed cable is that observed at the time the cable is placed. The amounts of stretch recommended for various cable sizes and span lengths are given in the following table.

CABLE STRETCH

Average Span Length	Cable Stretch in Thirty Seconds of an Inch per 100 Ft. of Length							
	For temperatures of — degrees fahrenheit							
	-20	-10	0	10	20	30	40	50

Ring-Supported Cable

200 ft. or less	22	20	18	16	14	12	10	8
201 ft. to 250 ft.	28	25	23	21	19	16	14	11
251 ft. to 300 ft.	22	20	18	16	14	12	10	8

Lashed Cable

200 ft. or less	12	10	7	5	3	2	—	—
201 ft. to 250 ft.	16	13	10	8	6	4	—	—
251 ft. to 300 ft.	11	9	8	5	3	2	—	—

Note: The proper amount of stretch to provide at a given temperature is obtained by multiplying the number of hundreds of feet in the length of cable being placed under tension by the amount of stretch per one hundred foot length indicated in the above table.

Example: Assume the length of cable being placed under tension to be 1000 ft., the cable to be supported in rings in 240 ft. spans and to be spliced at a temperature of 20°F.

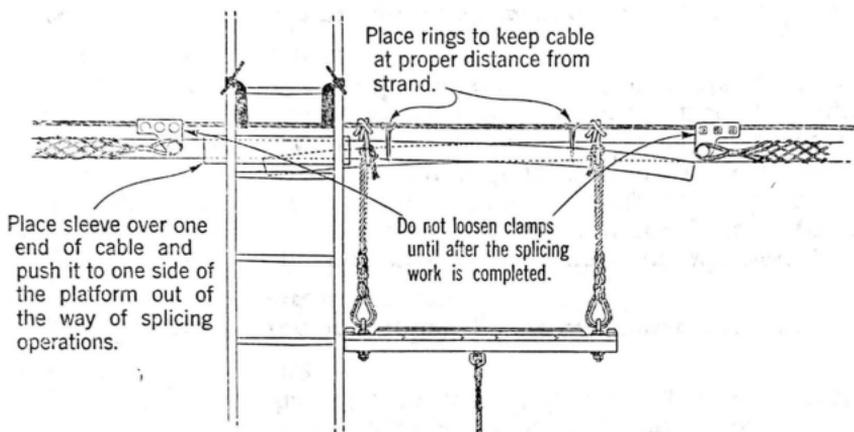
The stretch required would then be:

$$\frac{1000}{100} \times 19 = 190 \text{ thirty-seconds of an inch which is equal to } 5\frac{15}{16} \text{ inches, say 6 inches}$$

11. PREPARATIONS FOR SPLICING

11.01 **Ring-Supported Cables**—Remove the tension splicing jack and slings used in stretching the cable. Slip a sleeve over one of the cable ends and push it back far enough to be out of the way of splicing operations. Raise the cable ends into position for splicing and hold there with either rings or houseline. The set-up for splicing is shown below.

READY FOR SPLICING



11.02 **Lashed Cables**—Slip a sleeve over one of the cable ends and prepare for splicing as in the case of ring-supported cables.

12. SPLICING

12.01 Splice the cable in the usual manner. In making the splice keep the cable ends as near the strand as practicable in order to avoid introducing unnecessary slack in the cable at this point.

13. PROCEDURE AFTER SPLICING

Ring-Supported Cable

13.01 After the sleeve has been wiped and the metal has cooled, loosen the tension splicing clamps and remove them together with the cable grips. Support the splice if required and put back the missing cable rings on the cable in their proper places.

13.02 When two consecutive splices have been completed remove the temporary grade clamp placed between them unless required for construction or protection reasons as called for in other sections of these practices.

13.03 Tighten all grade clamps which may have been loosened preparatory to placing the cable under tension. Also put back any aerial cable supports at poles which were loosened to permit free movement of the cable along the line.

Lashed Cable

13.04 After the splicing operations are completed remove the grade clamps on both sides of the splice and support the splice in the usual way.

14. NECESSITY FOR FOLLOWING INSTRUCTIONS IN SPLICING CABLE UNDER TENSION

14.01 When the foregoing tension splicing methods are followed, practically no bowing should occur during subsequent hot weather.

14.02 Where bowing does occur in tension spliced cables, experience has shown that it is usually due to one or more of the following:

- (a) **Failure to tension splice when temperatures are below the prescribed minimum.**
- (b) **Omission of the preliminary pull in ring-supported cables.** The purpose of the preliminary pull is to take all slack out of the cable before actually placing it under tension. If the preliminary pull is not properly made the final pull made in placing tension in the cable, instead of stretching the cable as is intended, may not accomplish much more than to pull slack out of the cable, straighten out waves in it, etc.
- (c) **Failure to clamp the cable properly.** If the cable is not clamped to the strand, as called for in the foregoing instructions, before making the preliminary pull or applying tension, the cable will slide through the rings instead of being stretched as intended.
- (d) **Insufficient stretch placed in the cable for temperature at which it is spliced.**
- (e) **Premature removal of temporary grade clamps.** Premature removal of temporary grade clamps will undo much of otherwise good tension splicing work. Follow the instructions given in Part 13 in regard to removal of temporary clamps.

(f) **Failure to install permanent grade clamps.** Omission of permanent grade clamps at corners, dead-ends or loading fixtures in the case of ring-supported cables will allow the cable to pull away from these points in cold weather ordinarily resulting in bowing later in warm weather at poles adjacent to these points.

15. OPENING CABLES IN COLD WEATHER

15.01 Cables which are spliced, without tension, in warm weather or are tension spliced in cold weather will have the wires inside them taut when temperatures are low. If such cables are opened during low temperatures and it is desired to obtain slack in the conductors in order to facilitate such work operations as cutting terminals, clearing cable trouble, etc., proceed as indicated below.

Ring-Supported Cable

15.02 Place a tension splicing tool on the cable across the sheath opening as when making a tension splice, and operate the jack until the desired amount of slack is obtained. Where the tension jack will interfere with the work and it is desired to remove it, first tighten the tension splicing clamps on the strand on the two sides of the sheath opening and then slack off the jack until it can be removed readily.

Lashed Cable

15.03 Slack, in the case of lashed cable, can best be obtained by temporarily pulling slack out of the cable suspension strand. ↗

15.04 Secure the wire lashing to the suspension strand by means of 2 one-bolt clamps placed about 9 feet apart on both sides of the splice or sheath opening. Unfasten or cut the lashing wire at some convenient point between these clamps and push the resulting loose coils of lashing wire to one side thus permitting the cable to hang free.

15.05 As indicated in the following drawing place a second one-bolt clamp on the strand about 6 inches in from each of the clamps set previously. Suspend the splicing platform by placing the platform hooks on the suspension strand on the far sides of the inner pair of clamps. The purpose of these clamps is to prevent the hooks of the splicing platform from sliding into and possibly disengaging the strand pullers used for gripping the suspension strand in the take-up operations described below.

15.06 Where the suspension strand is 16M or 25M use the jack assembly shown in the drawing below, consisting of a light pole jack and H strand pullers. For 10M suspension ↙

strand the tension splicing jack and L strand puller may be used.

15.07 By operating the jack pull slack out of the suspension strand until the strand and cable between the strand pullers begin to show signs of slackness.

15.08 After the wire work is completed back off the jack and remove it from the strand after which the splicing work may be completed.

15.09 Restore support to the cable and splice.

