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DEPARTMENT OF NATURAL RESOURCES

DIVISION OF FORESTRY

TELEPHONE HANDBOOK

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F. A. SILCOX, CHIEF

TELEPHONE HANDBOOK

1937

PREPARED BY

DIVISION OF ENGINEERING

T. W. NORCROSS, CHIEF

PREFACE

Purpose

The purpose of this Handbook is to establish principles, standards and methods to be observed in the construction and maintenance of telephone systems on the National Forests. The use of this Handbook by men doing construction and maintenance work on Forest Service telephone lines should result in a more uniformly high standard of work and should also aid in the training of inexperienced men engaged on such work.

Acknowledgements:

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TABLE OF CONTENTS

CHAPTER I - GENERAL INSTRUCTIONS

CHAPTER II - PLANS

CHAPTER III - WIRE STANDARDS

CHAPTER IV - TREE LINE CONSTRUCTION

CHAPTER V - POLE LINE CONSTRUCTION

CHAPTER VII - CIRCUITS AND EQUIPMENT INSIDE THE TELEPHONE

CHAPTER VIII - TELEPHONE TROUBLES

CHAPTER IX - MAINTENANCE

CHAPTER I - GENERAL INSTRUCTIONS

1. Purpose

The purposes of the handbook are:

A. To describe certain approved types of telephone construction and maintenance, including installation of instruments, and to establish standard specifications for the more important types. See National Forest Manual for policy matters.

B. To explain briefly the fundamental principles involved in the operation of telephone lines and instruments.

C. To furnish instructions for locating and clearing trouble.

D. To describe special methods used, and practices followed, in different regions, which are adaptable to the varying field conditions.

2. Types of Lines

Grounded circuit lines have only one wire and use the ground for the return circuit. Metallic circuit lines consist of two wires and do not use the ground for a return. Except for line interference caused by electric power wires, and in localities where it is not possible to make a satisfactory telephone ground, it is possible to talk and ring as far over a grounded circuit as over a metallic circuit. All tree lines are grounded circuits, while pole lines may be either grounded circuits or metallic circuits.

3. Private Connections

Permits granting to parties outside of the Service the privilege of attaching instruments will be issued in accordance with the special-use regulations or cooperative agreements, which, in all cases, should stipulate, in addition to the printed requirements, the following:

A. Type of construction and maintenance consistent with Forest Service standards, and work done in a manner satisfactory to the Forest Service.

B. Type of instrument to be attached and methods of installation.

4. Use of the Handbook

The specifications and instructions given herein are confined to the more obvious details and the major principles of telephone line construction, equipment installation and maintenance. They are based upon methods and principles of which the worth and general applicability have been proven by experience.

Field officers are not expected to memorize the contents of this handbook, but they are expected to remember:

A. That the handbook is available.

B. That it is to be consulted and studied before starting a job.

C. That every man placed in charge of telephone work must have a copy of it, supplemented, where necessary, by specific written instructions to indicate the parts of the handbook that are applicable to his job.

D. That the instructions it contains will govern on all jobs unless physical conditions clearly prevent.

It is expected that the instructions will be followed. The burden of proof of inapplicability will always be upon the officer who is responsible for getting work done in accordance with the handbook specifications and instructions.

CHAPTER II - PLANS

5. General Plans

A standard form of plan, complete in all details, will not be prescribed. As a suggested procedure, however, a map called "The Plan and Progress Map" should be prepared for each forest. It should show the location of each telephone line, with separate symbols for "proposed" and "completed". Forest Service lines should be shown by one color and private lines by another color. In carrying out the plan, the proposed lines should be constructed only at such times as the need for them has been demonstrated.

Some of the important points to be considered in the development of telephone system plans are:

A. The relation of the proposed line to existing systems, private and Forest Service, local and inter-forest lines considered.

B. Load factors, or the effect that additional mileage and instrument load will have upon the existing systems.

C. Switching arrangements needed at different points to break up the "load" and to give clear right-of-way over trunk lines.

D. Development required to centralize, so far as practicable, switching arrangements at points for central fire dispatchers.

E. Avoidance of high-voltage electric transmission and telegraph lines as far as practicable.

F. All other factors given due weight, the routes which will render the greatest advantage:

   (a) as bases from which to extend emergency lines in case of fire,

   (b) for lines paralleling possible or existing patrol routes,

   (c) as trunk lines from which to extend permanent branches.

G. General accessibility of the route.

6. Line Length

The principal factors to be considered in determining the maximum length of single units of Forest Service telephone lines which may be operated satisfactorily are:

A. Normal line leakage.

B. Interference.

C. Number of telephones and other equipment connected to the circuit.

Ordinarily, lines extending through dense forests may be operated in lengths ranging from 40 to 50 miles provided they are not too heavily loaded. Through more open country, where the probability of line leakage due to brush is less, lines up to 75 miles in length may be operated satisfactorily. If lines are heavily loaded or if points farther apart are to be reached, the installation of a repeater at an intermediate point may be advisable. A 50 mile grounded circuit line is about the limit for the line that can be operated satisfactorily over high divides or in any other localities where a considerable volume of static interference may be encountered.

7. Line Capacity

Each telephone or extension bell connected to a line adds a load to the line since it consumes a certain amount of electric energy. Too many instruments connected to a line load it so heavily electrically that ringing and talking over the line may be seriously hampered. Each connected telephone usually means added load and traffic. A heavy traffic load is a most objectionable form of interference. In view of these facts, every line has its limit as to the number of telephones, extension bells, and repeating coils that can be carried. Accordingly, "line capacity" is a material factor to be dealt with in the development of the forest communication plans. Lines which are free from all forms of physical interference have the greatest capacity. Interference may be caused by brush, poor insulation, static, induction from high voltage power lines, and telegraph lines, or cross-talk from adjacent telephone lines. These elements, in addition to the traffic load, must be considered in estimating the capacity of a given line. On principal trunk lines, the traffic or use load is a factor calling for regulation by careful planning and supervision.

The most recent development for calculating telephone line capacity uses the decibel unit (db) as a measuring device. This is simply a unit of load. Each item of load is considered and the sum of the items is the total line load.

The following decibel ratings are considered close enough for practical purposes:

Parts of system		Average db load
Wire, #9 BWG, Iron - EBB grounded - per mile of line		0.15
Wire, #9 BWG, Iron - EBB metallic - per mile of line		0.25
Wire, #12 AWG, Copper-covered-grounded - per mile of line		0.15
Wire, #12 AWG, Copper-covered-metallic - per mile of line		0.25
Wire, #10 AWG, Copper metallic - per mile of line		0.07
Ringer, 2500 ohm	each	1.00
Spur lines	each	1.00
Repeating coil	each	0.50

A line load of 31 db is standard, and the speech level is very satisfactory. In cases of emergency, the line can be loaded to 35 db and still maintain communication. In planning a new line it is better to design it for a load of less than 31 db to allow for the installation of several extra emergency telephones, or some extension of the line without exceeding the db limit.

Except when needed, all instruments at unoccupied camps or other points will be cut off the line by means of a switch. Such instruments, depending upon circumstances, may or may not be counted as a part of the ordinary load, in calculating a line's carrying capacity.

CHAPTER III - WIRE STANDARDS

8. Line Wire

Copper or copper-covered wire should always be used where there is a possibility of corrosion from salt water or acid fumes.

No. 12 AW gauge, diameter 0.081 inches, copper-covered wire will ordinarily be used in the construction of new circuits. This wire has a high strength steel core with a covering of copper. It has a rated breaking load of 785 pounds and weighs 96 pounds per mile.

No. 10 AW gauge, diameter 0.102 inches, copper-covered wire may be used for spans of from 250 to 500 feet. It has a rated breaking load of 1,130 pounds and weighs 153 pounds per mile.

No. 8 AW gauge, diameter 0.128 inches, copper-covered wire may be used for spans of from 500 to 1,000 feet. It has a rated breaking load of 1,650 pounds and weighs 240 pounds per mile.

No. 6 AW gauge, diameter 0.162 inches, copper-covered wire may be used for spans of over 1,000 feet and in heavy loading areas. It has a rated breaking load of 2,430 pounds and weighs 384 pounds per mile.

No. 10 AW gauge, diameter 0.102 inches, solid copper wire may be used on exceedingly long metallic circuits where it is necessary to obtain proper conductivity, or where it is required in contacting commercial company lines. The rated breaking load of this wire is 528 pounds and the weight is 166 pounds per mile.

No. 9 BW gauge, diameter 0.148 inches, galvanized EBB iron wire may be used for the same span lengths and types of circuits as No. 12 AWG copper-covered steel wire. The rated breaking load is 785 pounds and the weight is 314 pounds per mile.

When other than No. 12 copper-covered wire or No. 9 iron wire is used, prior approval must be obtained from the Regional Forester.

9. Line Connections

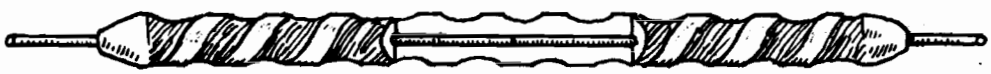
Experience indicates that unless splices are carefully made by experienced men, 25% to 50% of the efficiency of the line may be lost after a few years. This difficulty is not altogether overcome by soldering due to the fact that a poor soldering job, such as would be done by inexperienced labor, usually results in a higher resistant splice than before.

For the above reasons the sleeve type splice is recommended as a standard for splicing all line wires of the same kind and size. The single tube, compressed type or the double tube twisted joint type

may be used. Sleeves afford the best assurance of proper line wire splicing even when used by inexperienced men. Instructions for making the compressed type of sleeve connection come with the tools used for this work. Instructions for making twisted sleeve connections are given in detail in the next Article.

Although the use of sleeves is recommended as a standard in all cases, the Western Union splice may be used when No. 9 iron is used as line wire. This splice consists of five long wraps with five close wraps on each end. Soldering splices in line wire is unnecessary, but care should be taken that the wires are clean before each splice is made and that each turn is tight.

At points where galvanized iron wire and copper-covered wire are to be joined together, both line wires should be dead-ended and the ends joined by soldering or by means of a bridging connector. This is necessary so that no corrosive action is set up due to dissimilar metals.



Cut-away section of sleeve before rolling

SINGLE TUBE SLEEVE

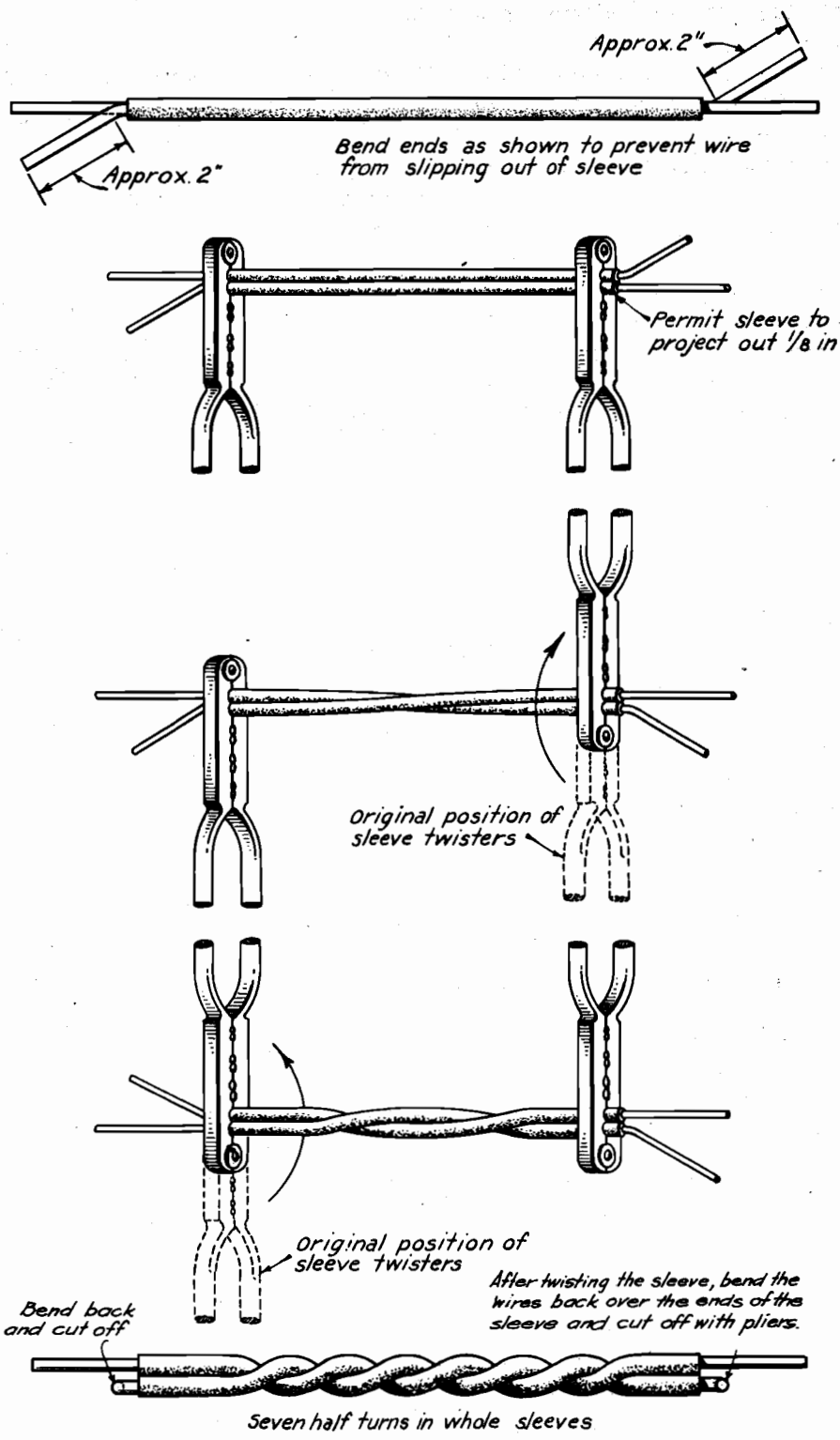
WESTERN UNION SPLICE

10. Making Twisted Sleeve Connections

The following successive steps should be used in making twisted sleeve connections:

(1) Make certain that the ends of the line wire to be joined are sufficiently straight and cleanly cut to permit of inserting the sleeve.

(2) Clean the ends of the wire with abrasive cloth. In the case of galvanized wire exercise care to avoid injury to the galvanizing, particularly at the ends of the sleeve and for a distance of about one inch inside the sleeve. In order to assure that the joint will have good electric conductivity, it is essential that new as well as old wire be thoroughly cleaned. Although the new wire may appear bright and clean, there is a possibility that it is covered with an oil film.



MAKING SLEEVE CONNECTION

(3) After cleaning the wire with the abrasive surface of the cloth, remove the dust, etc., from the wire by wiping it with the smooth surface of the abrasive cloth.

(4) Select a clean, straight sleeve and insert the ends of the wire and proceed as shown on Page 11.

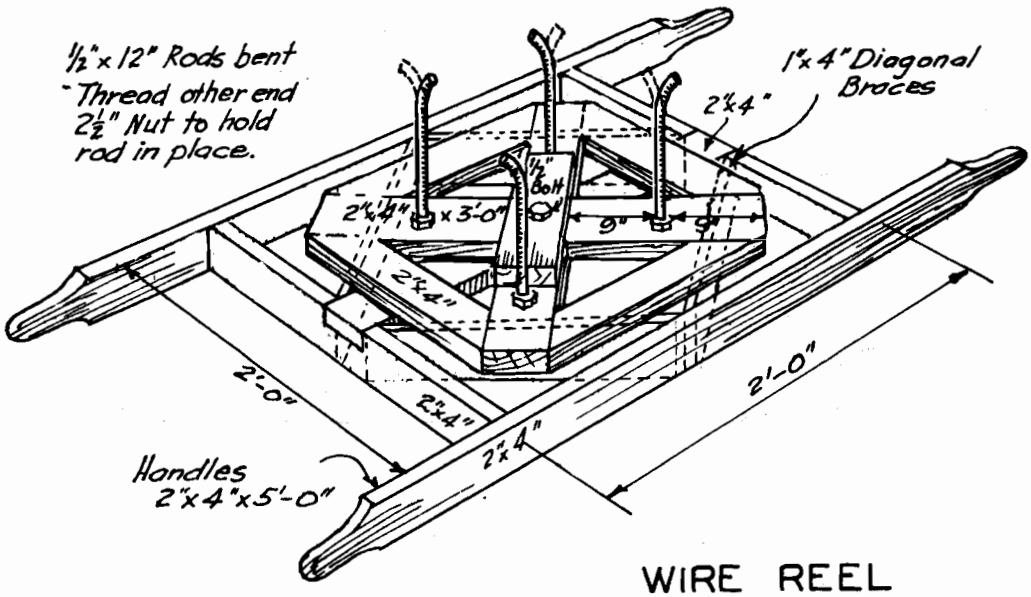
(5) If the wires are spliced together as they are being run out, tie a piece of twine, tape or burlap in front of the joint so that the sleeve will slide over the crossarms.

11. Handling Wire

Care should be taken in handling and paying out any wire. This is especially true for copper and copper-covered wire which are much softer than iron wire. When stringing the wire, it should be paid out from a reel as it is carried along. The most convenient method is to place the reel on the truck, but where it has to be carried by hand, shoulder straps should be attached to the reel to facilitate carrying it. If it is necessary to have the reel set stationary, care must be taken to avoid dragging the wire over rocks or around sharp turns. Kinks in the wire must be avoided.

Wire may be paid out by hand in places where it is too difficult to take the reel. When this method is used, the coil of wire should be reversed once in every ten loops to take out the twists and to avoid kinks.

Pliers must not be used to make ties or to pull the wire. Grips or come-alongs with smooth jaws should be used when pulling slack. Wire must be protected against nicking and kinking at all times. If these occur, the wire must be cut and a splice made at that point.



WIRE REEL

CHAPTER IV - TREE LINE CONSTRUCTION

12. Essential Features

The essential features of this type of construction are:

A. A slack line, supported by trees instead of poles.

B. Insulators hung so as to swing freely from the supporting tree and through which the line wire may easily slide in either direction, as contrasted with the fixed tie of a tight line to the standard type of insulators common in pole line construction.

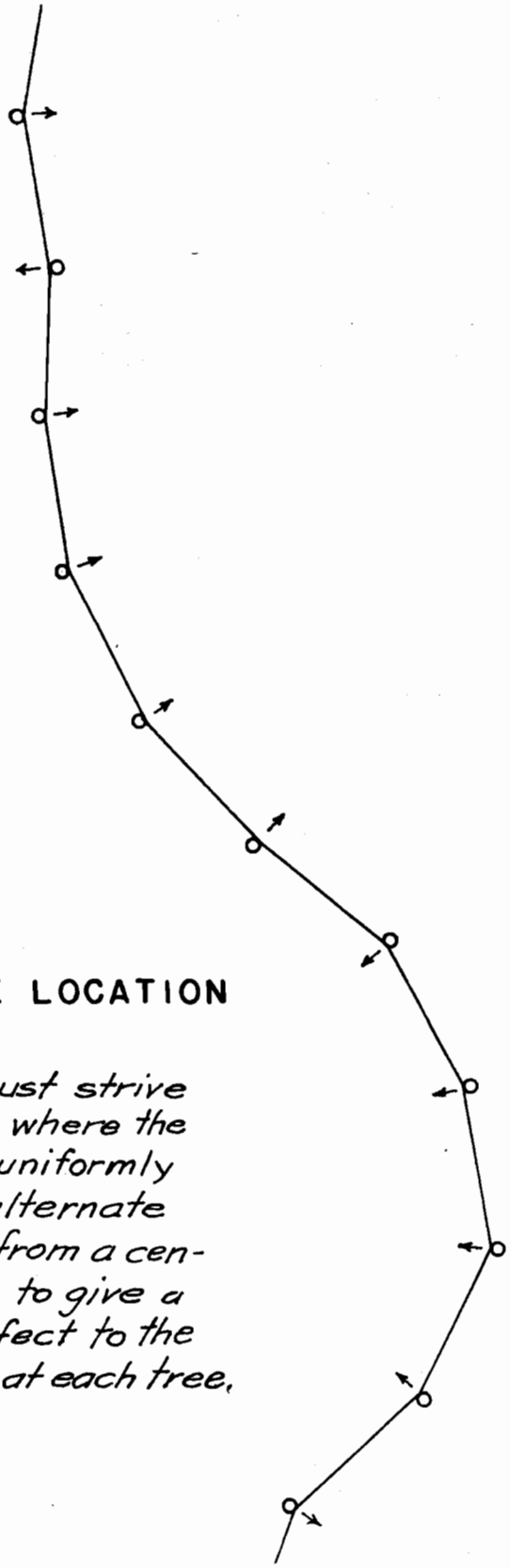
C. Approximately uniform span lengths.

13. Historical Background of Tree Line Construction

In its early development of the National Forests the Forest Service was faced with the problem of providing a reliable, low cost means of communication into the vast wildernesses which it was attempting to protect. It was apparent that the construction cost of pole lines was prohibitive and that maintenance was almost impossible with the limited funds available. Someone conceived the idea that if a line could be built which would come down to the ground without breaking when a tree fell on it, the problem might be possible of solution. Such a line must be attached to the trees through which it passes in such a manner that it would come down under severe loading. It must be free running through whatever supports were used for it, and the means of attaching it to the trees must be simple and readily available.

From this idea the present type of construction was developed. At first, porcelain knobs were used for insulators and the wire was run through the hole. This was difficult to attach because enough of them to hang from ¼ to ½ mile of wire had to be threaded on the wire and pushed along to where needed at the tie trees. Then somebody thought of having the insulators come in two parts so that they could be readily attached anywhere on the line. At first they were round, but it was found that the tendency was for the wire to hang in the joint and cause mechanical failures where the two pieces met. The oval type was the natural outcome of this problem. The brown color was finally adopted because the white porcelain insulators were too conspicuous a target for riflemen.

The means of attaching the insulator to the tree was the subject of much study. There were almost as many methods developed as there were men doing the work in the field. It was soon learned that



IDEAL TREE LINE LOCATION

The locator must strive for a location where the tie trees are uniformly spaced and alternate trees offset from a center line so as to give a pull-a-way effect to the insulator tie at each tree.

while the line wire could be strung through the woods in a rather haphazard manner, it was essential that its freedom of movement in all directions be restricted as much as possible.

Good construction holds the wire as closely to the tree as possible and still does not allow either the line wire or the insulator to touch the tree. It is necessary that the amount of slack in the line be sufficient to allow it to come to the ground in any span when subjected to excessive loads such as fallen trees. The insulator tie should be made so that it will pull out of the staple when all of the slack in a given section of line has been taken up and the line wire will remain unbroken and continue to furnish some service though lying on the ground. This eliminates additional splices along the line on account of breakage. The material used for making ties should be such that it can readily be replaced in the staple or other holder after being pulled loose.

14. Location of Tree Lines

Lines will be located:

A. To minimize trouble from high winds, falling timber, deep snow and land slides, proximity of other grounded telephone and telegraph lines and electric transmission lines. Telegraph and electric transmission lines should be avoided, even at considerable additional expense.

B. Adjacent to and in plain view from protection roads and trails. Short cuts along which the line will be totally obscured from view from a protection road or trail should be avoided as a rule. Savings in construction costs can sometimes be made by short-cutting across canyons, switchbacks, etc., but such savings must be very material indeed to justify placing the line out of sight of the road or trail.

C. Along roads and trails so that the wire will not fall across the traveled way if hangers should break or if the line is borne down by the weight of snow or fallen timber.

When the telephone line is at the outer bend of a stream, road or trail, a shield tree should be arranged for, where practicable, to prevent the line from swinging into the stream, road or trail, if it pulls off the tie tree.

D. To avoid crossing main highways, roads, railroad tracks and power lines, if possible.

E. Along the lower side of the railroad tracks, to keep wires from falling on tracks in case of breakage.

F. To avoid the use of poles for tree circuits. It is a better plan to skirt a meadow or park by hanging the wire on bordering trees than to seek straight alignment and higher standards of visibility of the proposed line by building on poles across such openings. Likewise, rather than cross rock stretches which necessitate blasting for poles, or the construction of tripods, detour to trees if they are available along reasonably accessible routes.

Two men should do the locating. They should provide themselves with a piece of light wire, 140 feet long, with a hand hold on each end. The boss locator should be on the head end of the line to make the selection of the tie tree. After the selection is made, he sights back along the line and informs the rear man on which side of the tree to place the "leaner", red cloth or other marker to inform the construction crew on which side of the tree to place the line.

Pacing does not result in sufficiently accurate span lengths to give satisfactory construction.

15. Construction Along Highways

Telephone lines must not be constructed within 200 feet of the center of Class 1 or Class 2 highways or within 100 feet of the center of Class 3 highways without the prior approval of the Regional Forester. Necessity for the construction must be proven, and proper precautions must be taken to preserve roadside scenic values. The instructions in Article 32 should be carefully observed.

16. Span Lengths

Too much emphasis cannot be placed upon the need for uniform span lengths in a tree telephone line since it governs the uniform distribution of slack which is the secret of the success of this type of construction. The most satisfactory span length is 140 feet with a variation from 130 to 150 feet. One or two short spans between longer or average spans will do no harm. A little more slack should be provided in the adjacent longer spans to make up for the short spans. Where it is necessary, in order to avoid setting a pole or tripod, to put in a span up to 200 feet in length, the three or four adjacent spans on each side should be spaced proportionally down to the average span length so that slack will not run into the long span. If the span is 200 feet or more, it is better to set a pole or tripod with uniform spacing.

17. Right-of-Way

Right-of-way must be purchased or easements obtained before any telephone line is constructed over private land.

18. Clearing

Do not swamp out a separate right-of-way for a telephone line along roads or trails in whole or in part unless to do so is necessary in order to carry out the instructions of "Location of Lines". Utilize the clearing of the road or trails as much as these instructions and those under Article 14-c permit.

So far as practicable, do all necessary clearing for the line prior to the unreeling of the wire. To do so facilitates the stringing and the raising of the wire into place. When the wire is in place, cut any remaining obstruction to a distance of not less than four feet from the wire. Be sure to cut away all branches which might possibly interfere with the line when snow laden. Rapid growth trees under the wire will also be removed. Thorough line clearing is essential to prevent line leakage (loss of the ringing and talking current) which will result if the wire is allowed to come in contact with branches and tree trunks.

Trimming is necessary only on the line side of the tie trees and on obstructing intermediate trees. Tie trees on main traveled roads, however, should be neatly trimmed. Where aesthetic considerations are not involved, it is permissible to leave sufficient stubs or branches to facilitate climbing.

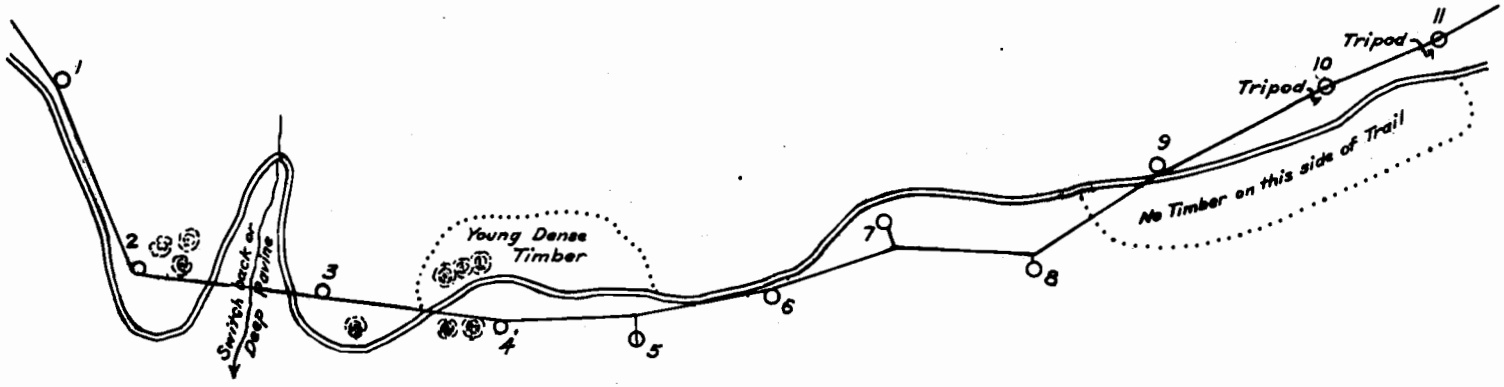
The limbing of standing trees will be greatly facilitated by the use of one of several different tree trimming tools which are available from standard manufacturers or may be made up specially. For some types of young growth, a tree trimmer operated by a lever or rope on a pole will expedite clearing. For larger limbs, a trimming saw with a long handle made up of sections will do faster and better work than an axe, which necessitates climbing the tree.

Where practicable, it is desirable to fell all snags, particularly rotten ones, which may later fall on the line wire. The felling of snags is usually practicable except in the old Douglas fir burns in Oregon and Washington and in the vast deadenings of Idaho and Montana. Many snags may be cheaply disposed of along telephone lines by burning them down if the job is undertaken during a period of no fire danger.

19. Selection of Tie Trees

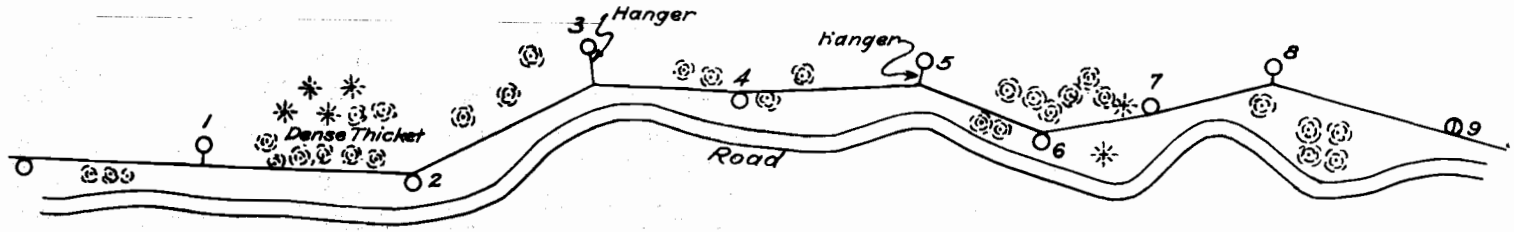
Suggestions for the selection of tie trees along a trail or road will be found on Pages 16 and 17.

Tie trees which throw a sharp turn in the line should be avoided unless the diameter of the tree permits the proper separation of two insulators. If practicable, avoid large trees which are difficult to



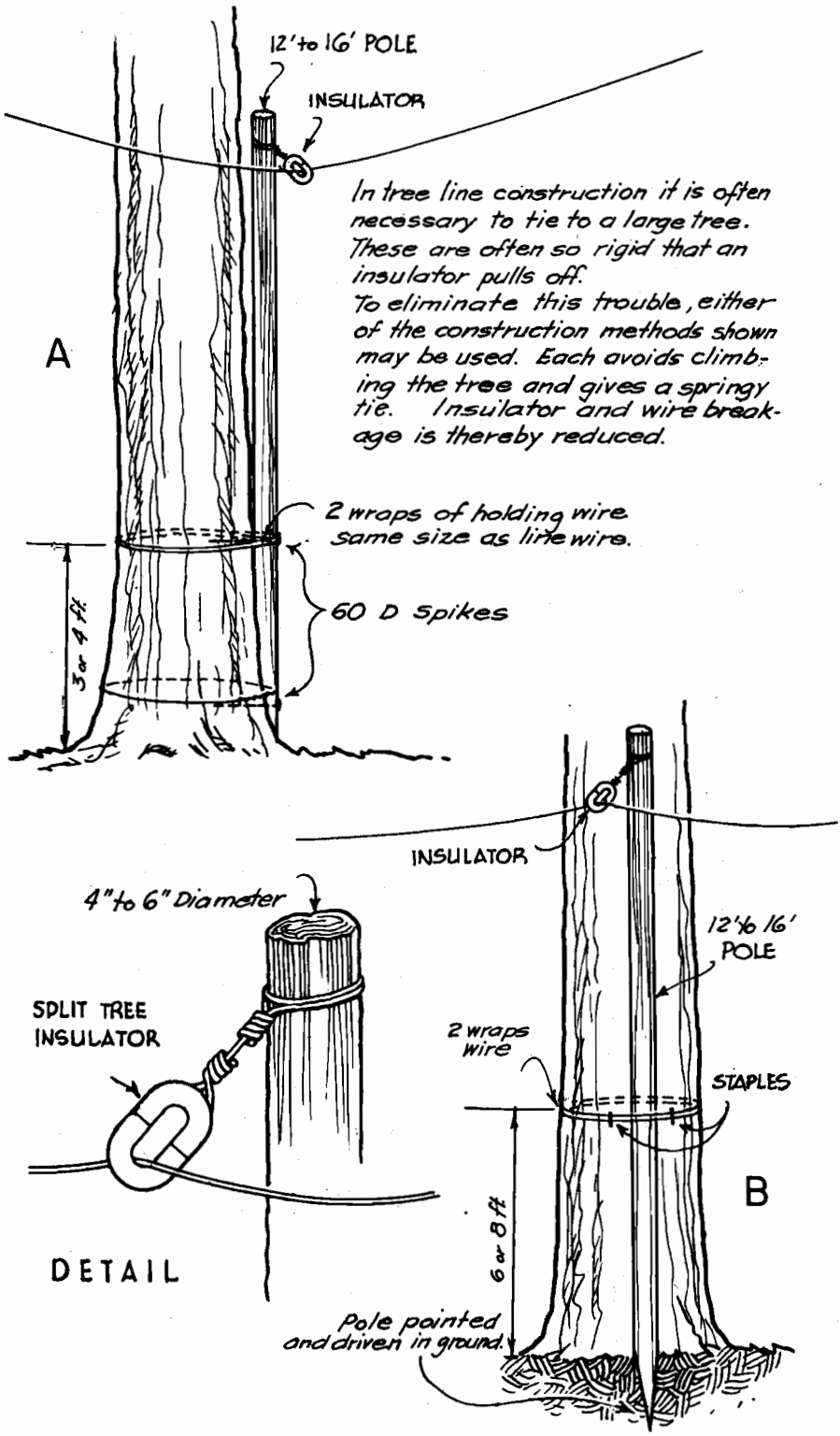
NO. OF TIE TREES	TYPE TIE USED SHOWN ON PAGE	REASON FOR SELECTION OF TYPE OF TIE
1	22, 28A	Pull is away from tree.
2	18A, 18B, 30B	Tree too large to climb; necessary to use to keep line in sight of trail.
3	25, 26	Pin necessary to keep line away from tree.
4	22, 28A, 28B	Tree OK. Tie high enough to clear trail.
5	24A, 24B	Set pole; impracticable to set pole near trail account of rock; use longer hanger.
6	25, 26	Tree pin necessary to keep line away from tree.
7	24A, 24B	Long hanger to prevent too sharp angle in line.
8	24A, 24B, 29A, 29B	No other trees available nearer trail.
9	22, 28A, 28B	Necessary to cross trail. Tie high to give clearance.
10	19	No trees available - rocky ground.
11	19	No trees available - rocky ground.

SUGGESTIONS FOR SELECTION OF TREE TIES FOR LINE ALONG A TRAIL

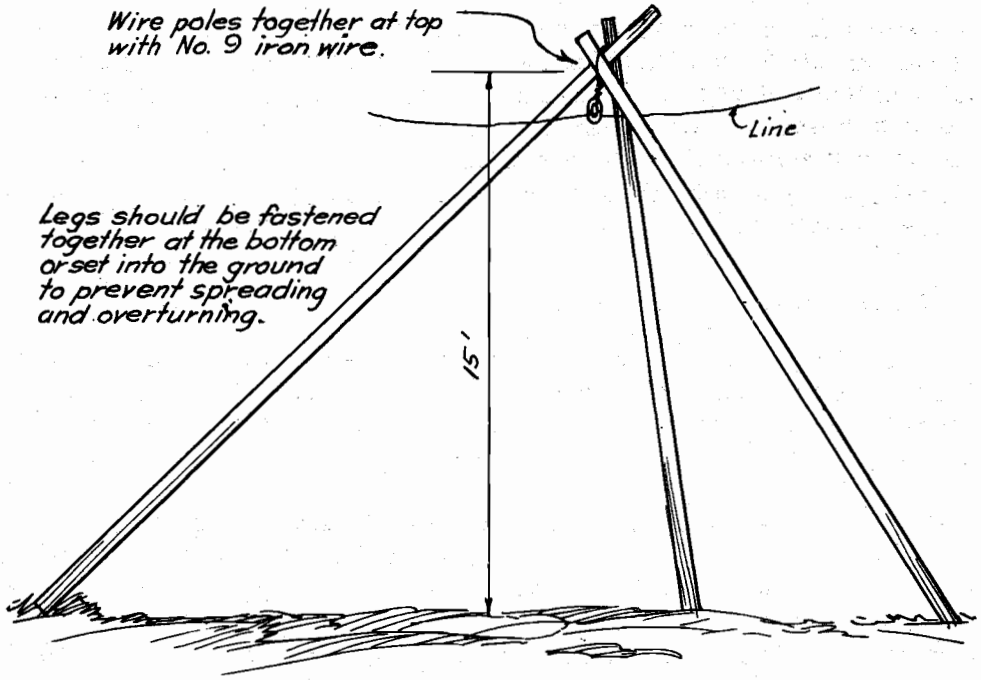


NO. OF TIE TREES	TYPE TIE USED SHOWN ON PAGE	REASON FOR SELECTION OF TYPE OF TIE
1	24A, 24B	Long hanger necessary account undergrowth near rod.
2	22, 28A, 28B, 30B	Standard tie.
3	24A, 24B	Long hanger necessary account young timber prevents line close to tree. No other suitable tree available.
4	22, 28A, 28B	Standard tie.
5	24A, 24B	Long hanger necessary account dense timber near tree.
6	22, 28A, 28B, 30B	Standard tie.
7	25, 26	Tree pin.
8	22, 24A, 24B, 28A, 28B	Long tie or standard tie.
9	22	Set pole, necessary account no suitable tie trees.

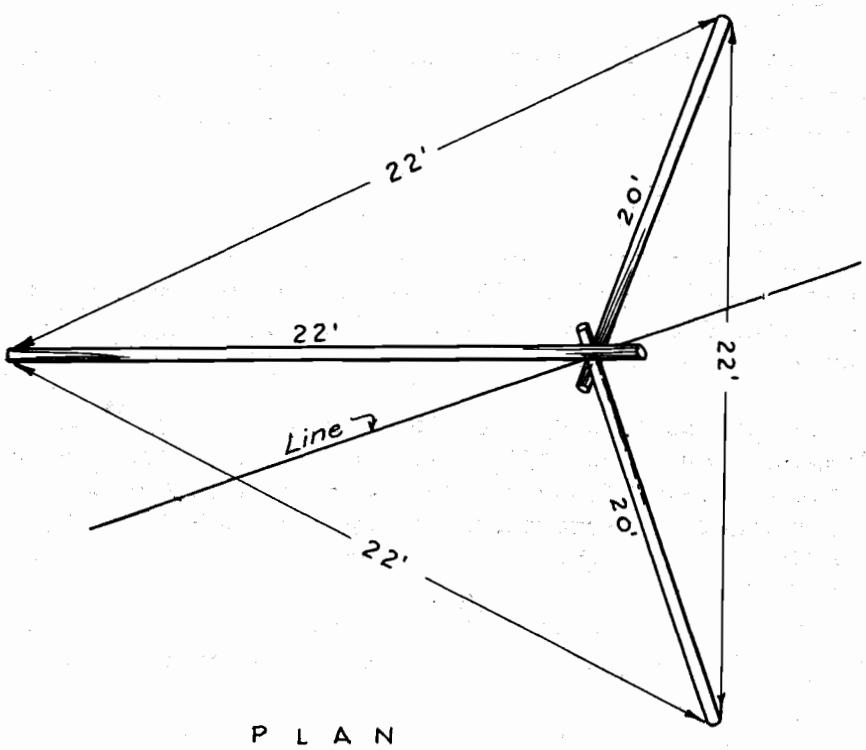
SUGGESTIONS FOR SELECTION OF TREE TIES FOR LINE ALONG A ROAD



TYING TO LARGE TREES



E L E V A T I O N



P L A N

TRIPOD CONSTRUCTION

climb. If it is necessary to use large trees, one method of tying shown on Page 18 is applicable. On account of the rapid growth of sprouts on oaks, alder, vine maple, etc., these trees should not be used if other species are available. If suitable material is at hand, it is better practice to build tripods as shown on Page 19 or to set occasional poles rather than to use unusually long spans. This is especially applicable in snow country or in places where long detours will place the line out of sight in inaccessible locations.

20. Use of Poles in Tree Lines

It is frequently necessary to use poles in the construction of tree lines. Where not over 15 poles are needed, the split tree insulator should be used and the same construction methods followed as in a regular tree line.

When this is done, alternate poles should be set off the line about two feet so that the insulators will function properly and the line will hang free from the poles.

When 16 or more poles are needed, the tree line should be dead-ended on the first pole and the bracket type of pole line construction used. This, in turn, should be dead-ended on the last pole and the tree line construction resumed. The method of dead-ending tree lines is shown on Page 30.

21. Stringing Wire

Care should be taken in handling and paying out any wire. This is especially true of copper-covered wire, and the instructions contained in Article 11 should be carefully followed.

22. Height of Wire

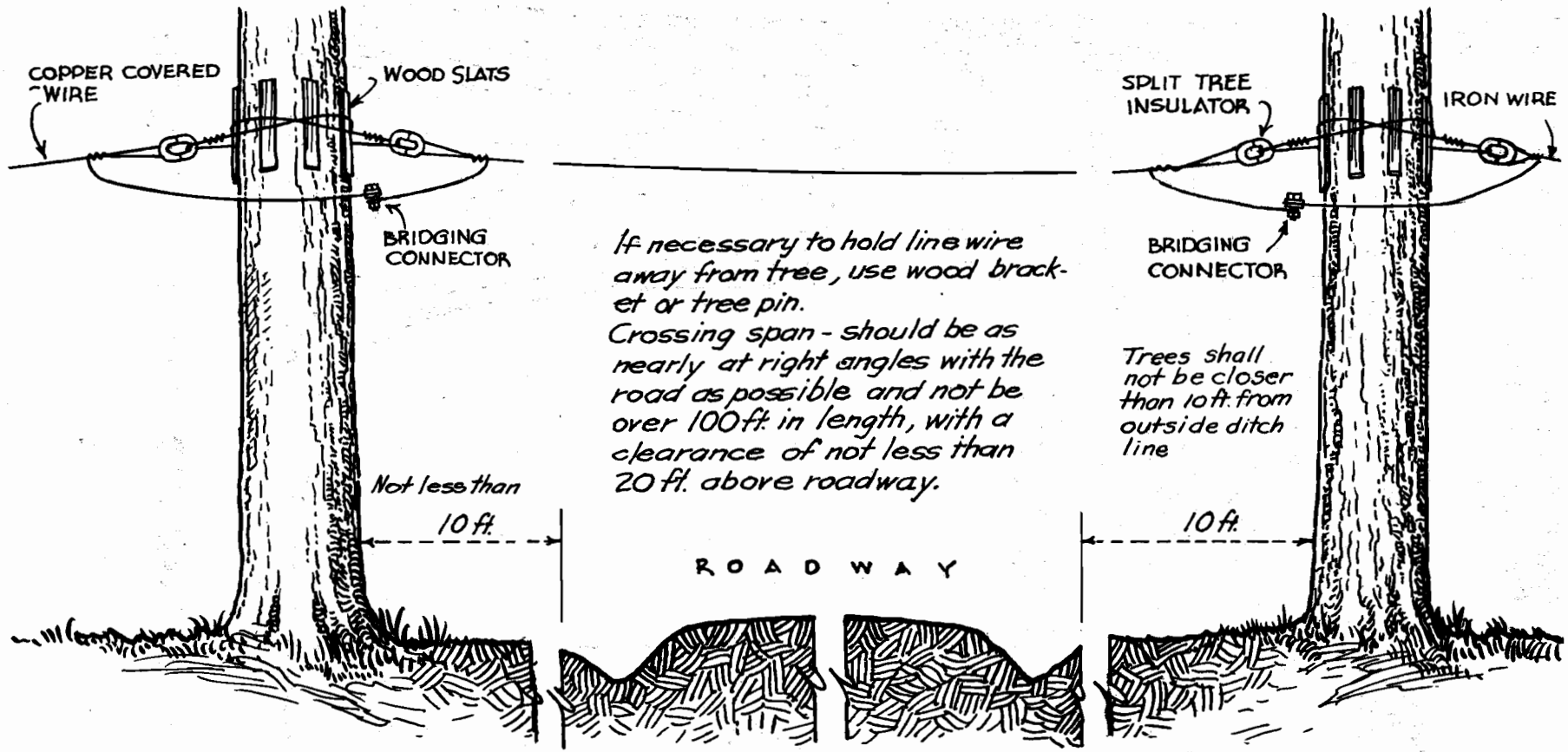
The hanger should ordinarily be attached to the tree so that the insulator will be from 15 to 18 feet above the ground. This will secure a ground clearance at the lowest point of the line of at least 12 feet.

In regions of deep snow the wire should hang above the level of the deepest snow. The object is to keep all of the line high enough to prevent it being "snowed under" and badly broken when the snow begins to settle. In some cases it may be necessary to hang the wire from 25 to 35 feet high.

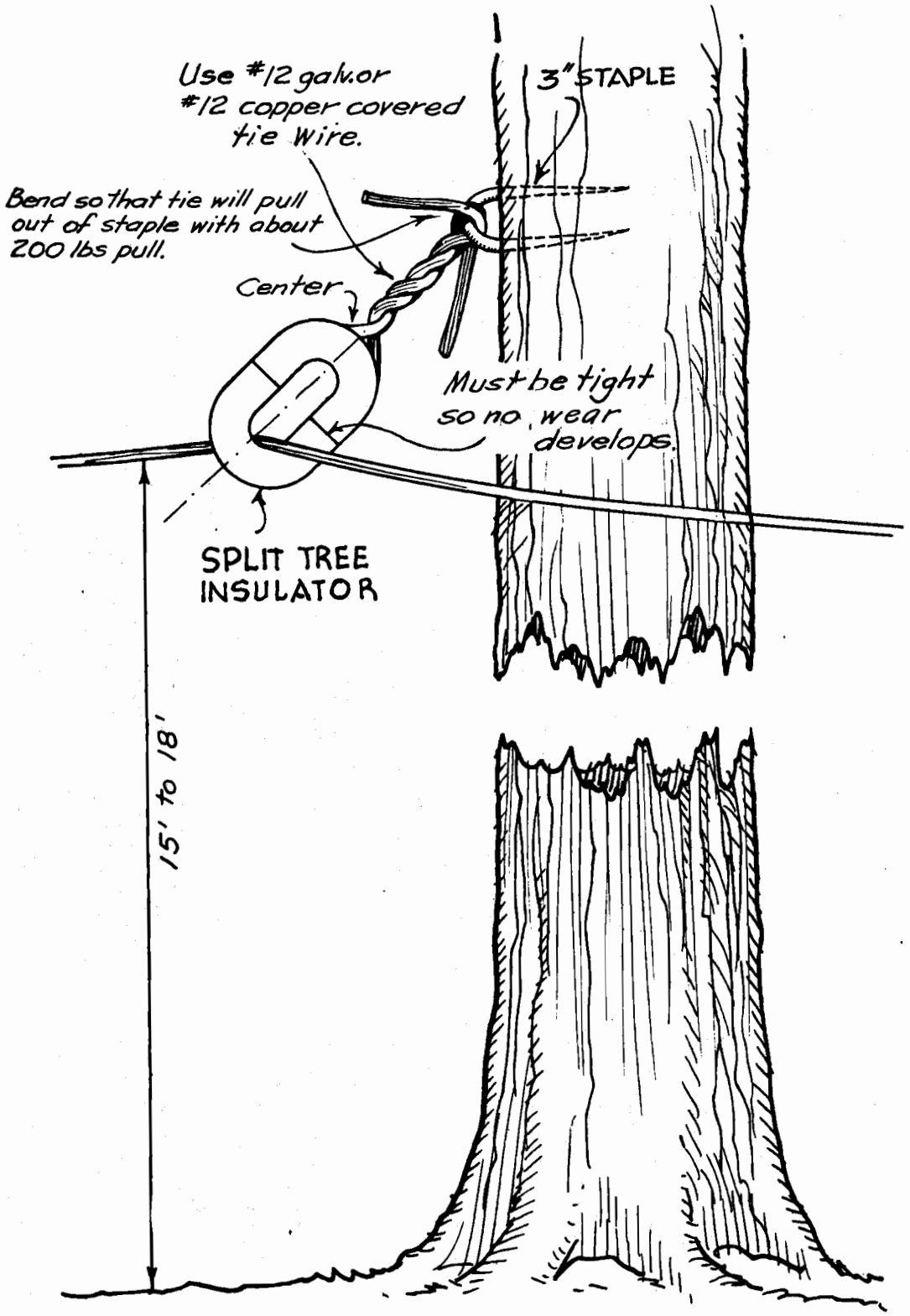
Over rolling country the ties must be so placed as to get the proper elevation of the wire over each knoll or rise of the ground.

23. Ties and Fasteners

Approved types of ties and fasteners are shown on Pages 21 to 28 inclusive. Although all of the types are not used by each Region, they are shown so that the regions will have the specifications of the type most suitable to them.

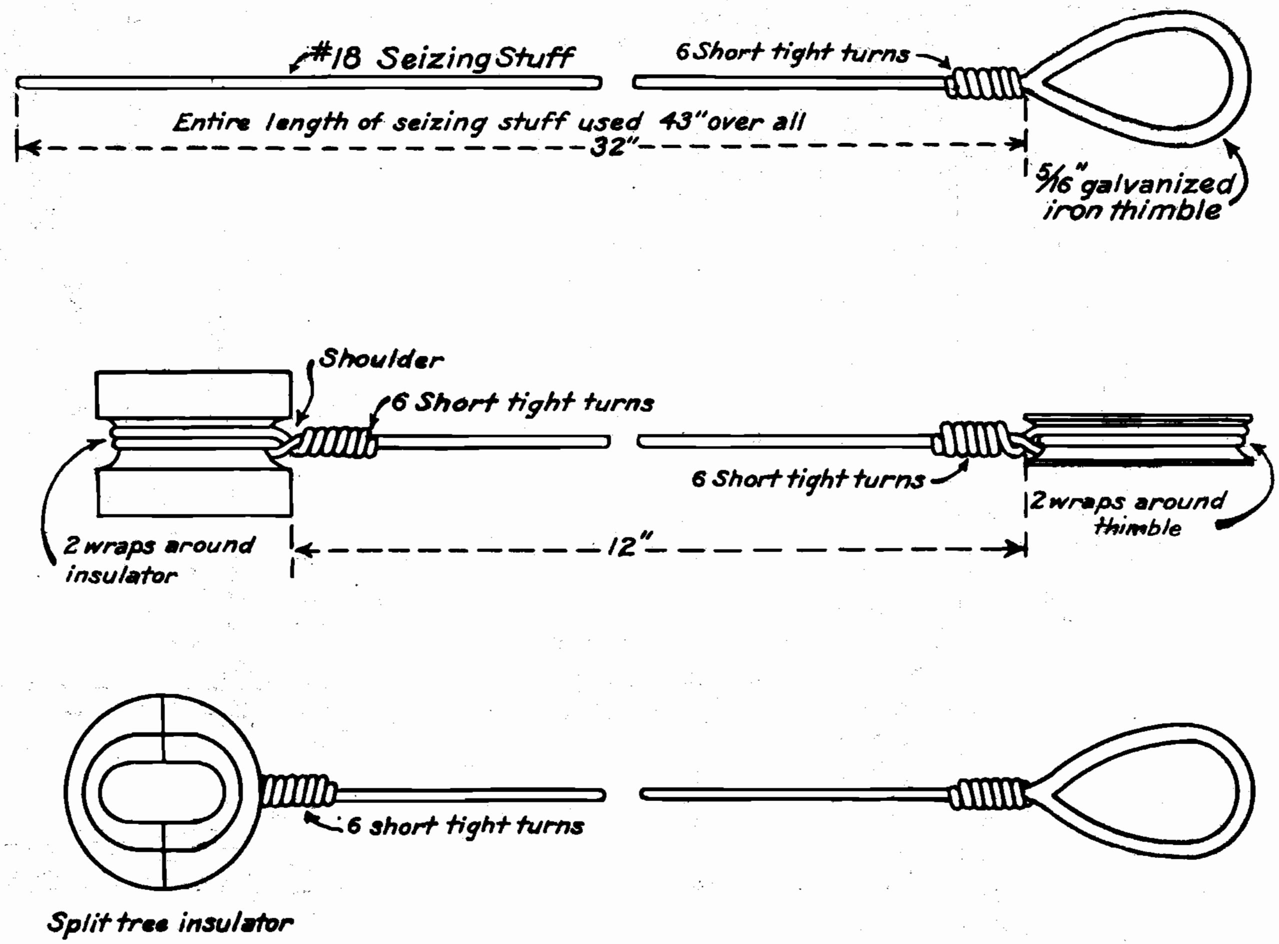


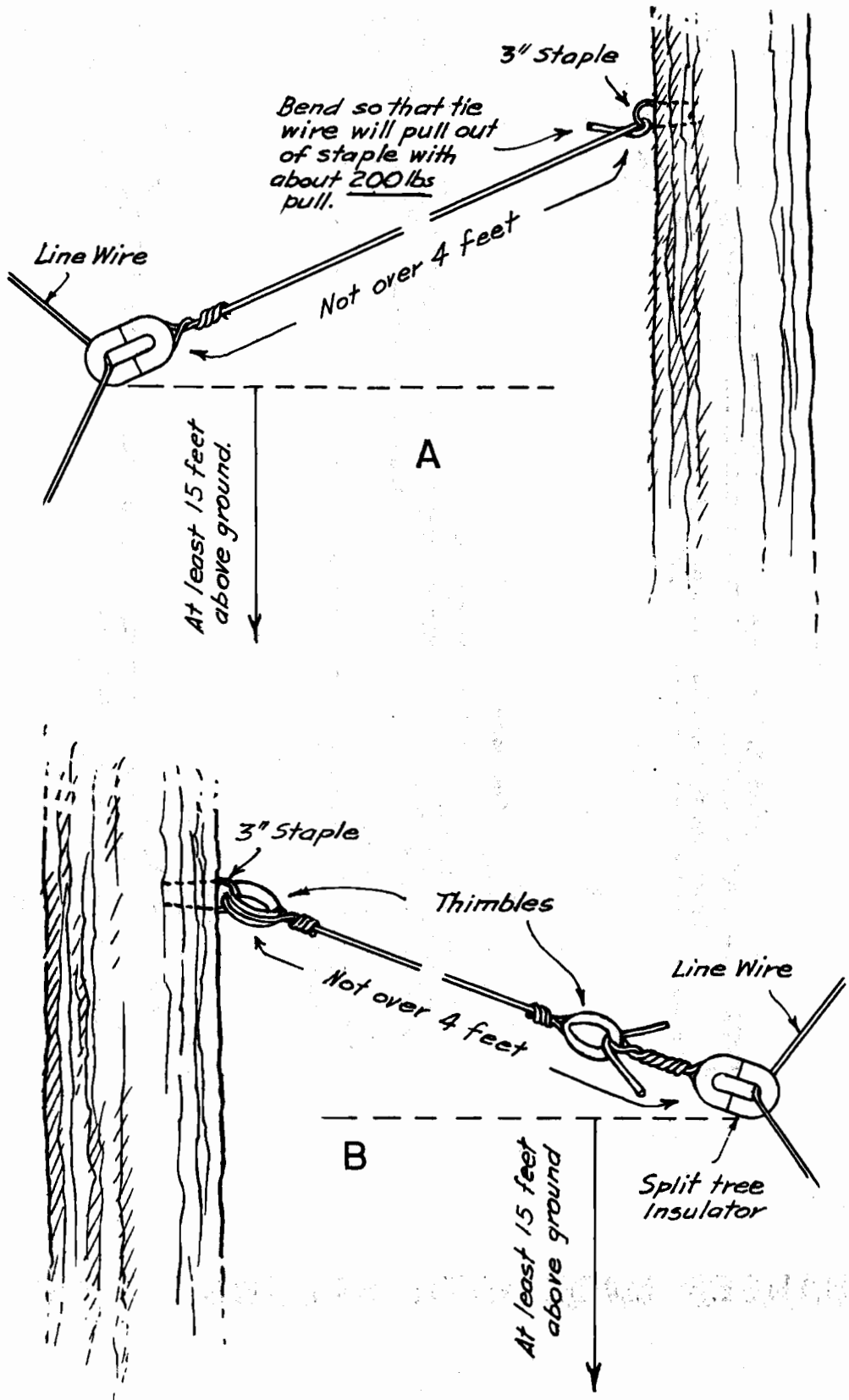
CROSSING OVER FOREST SERVICE ROAD



STANDARD SHORT HANGER

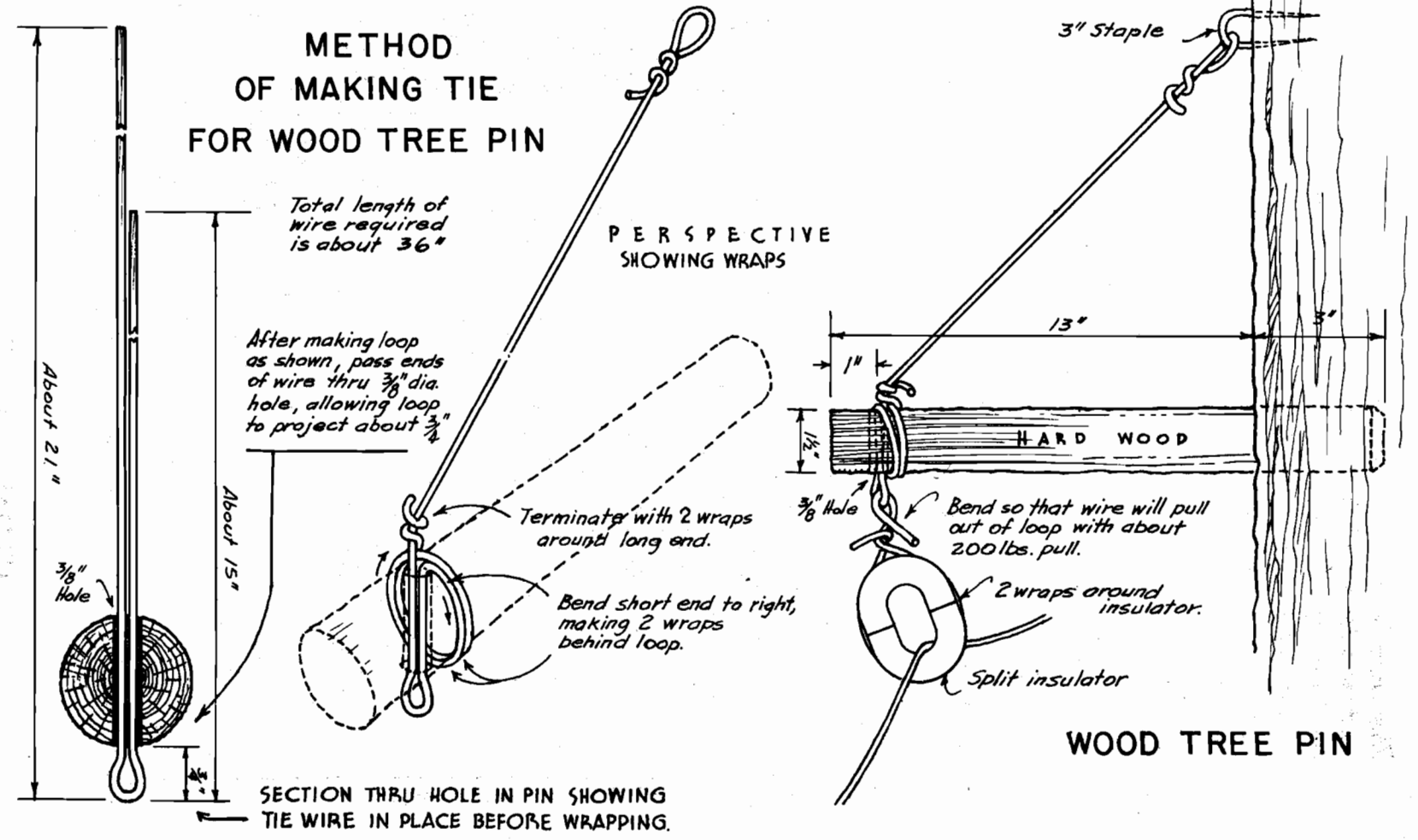
HANGER MADE WITH SEIZING STUFF

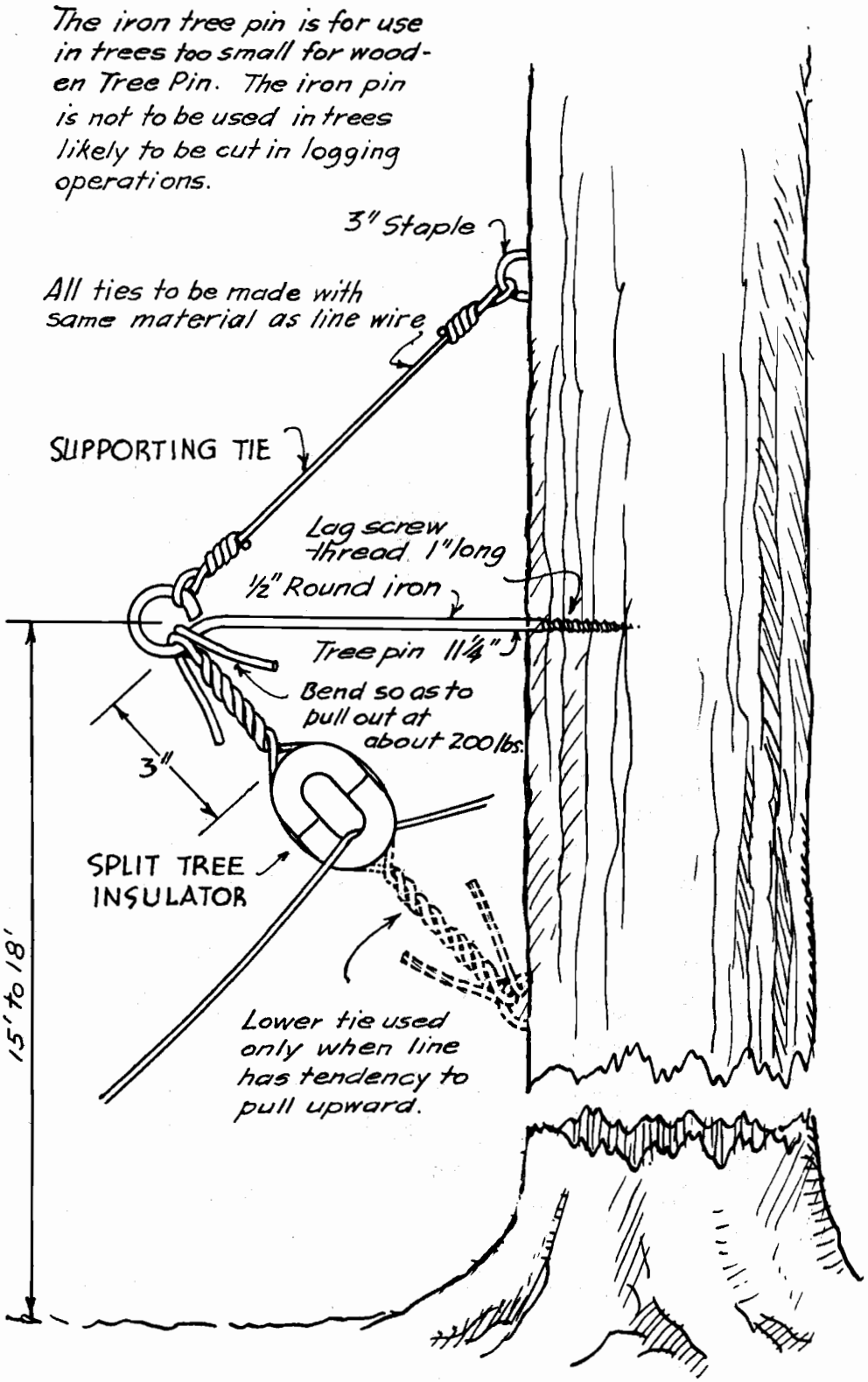




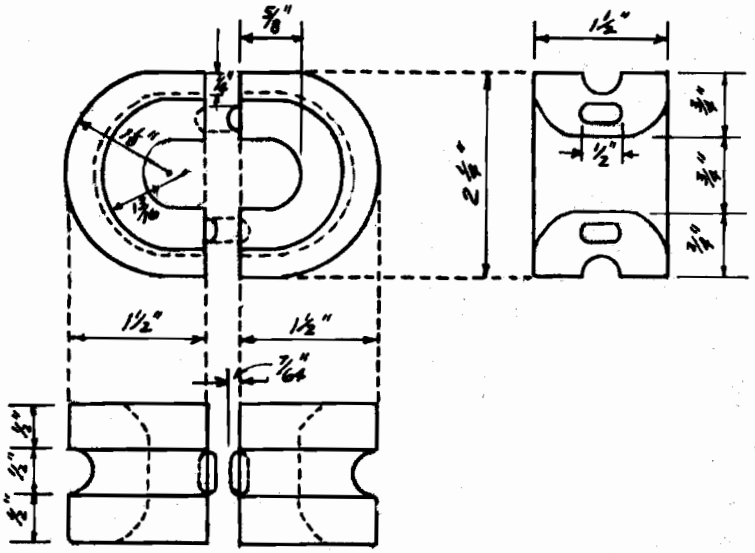
LONG HANGER METHODS

METHOD OF MAKING TIE FOR WOOD TREE PIN

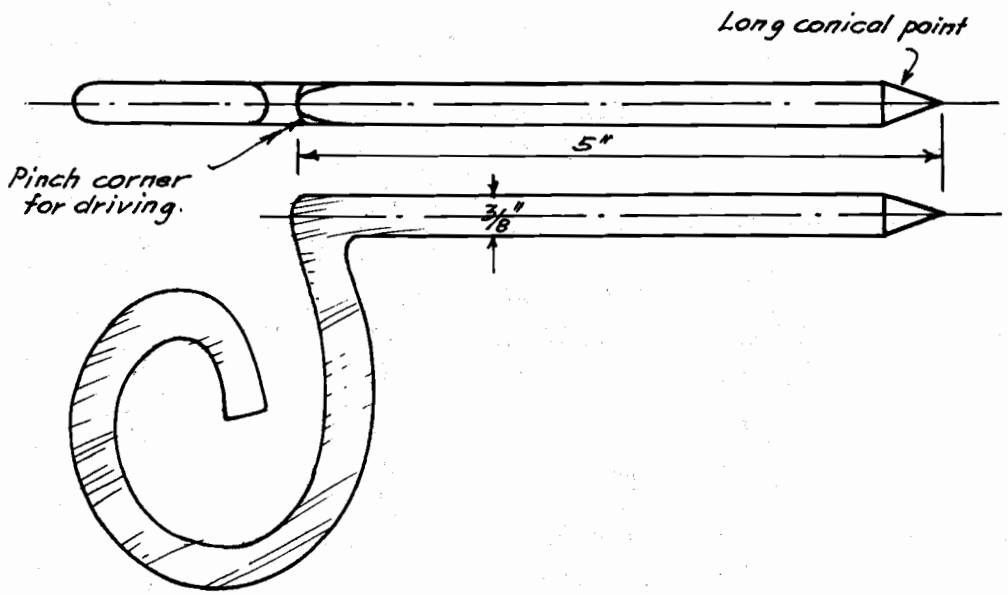




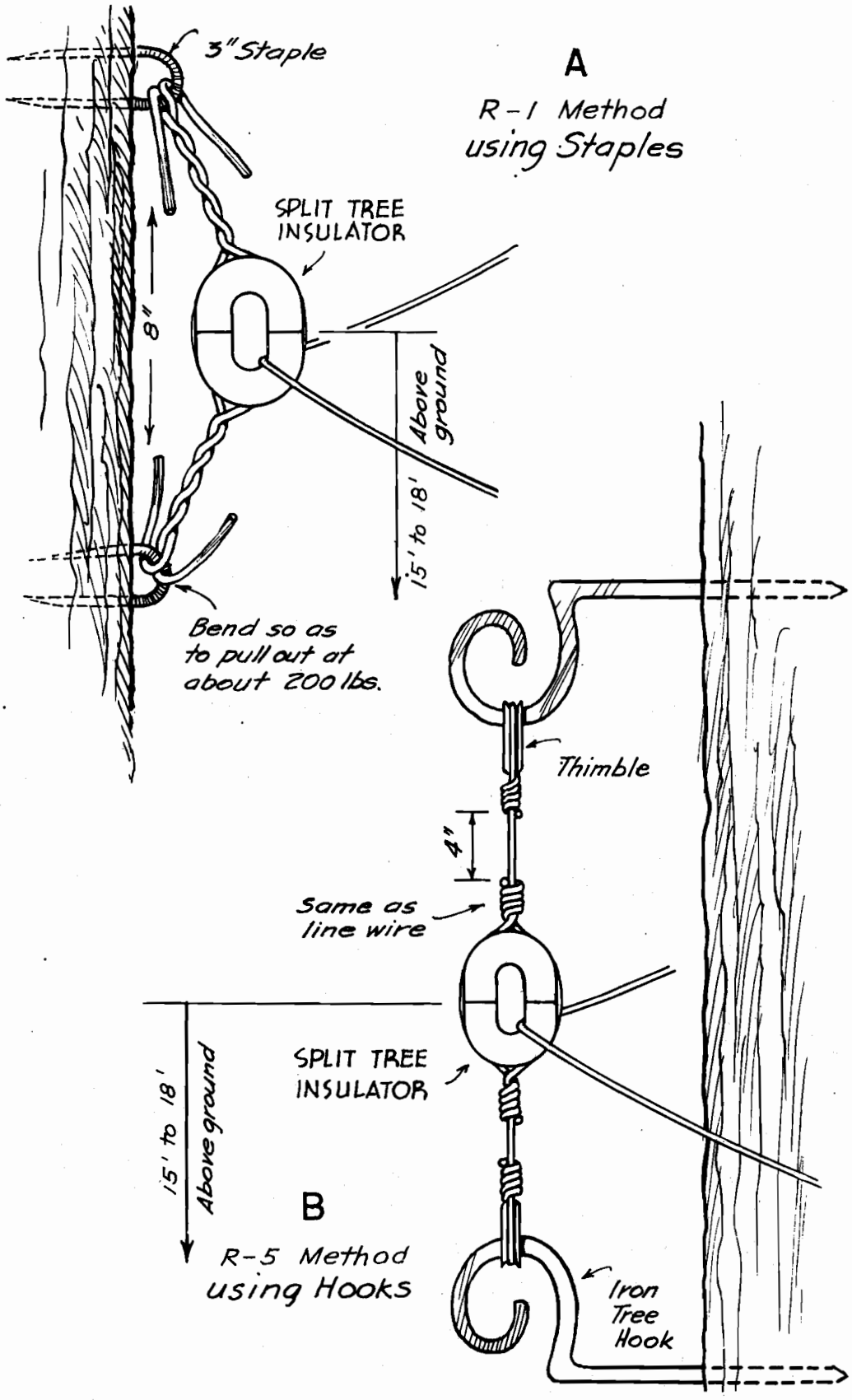
IRON TREE PIN



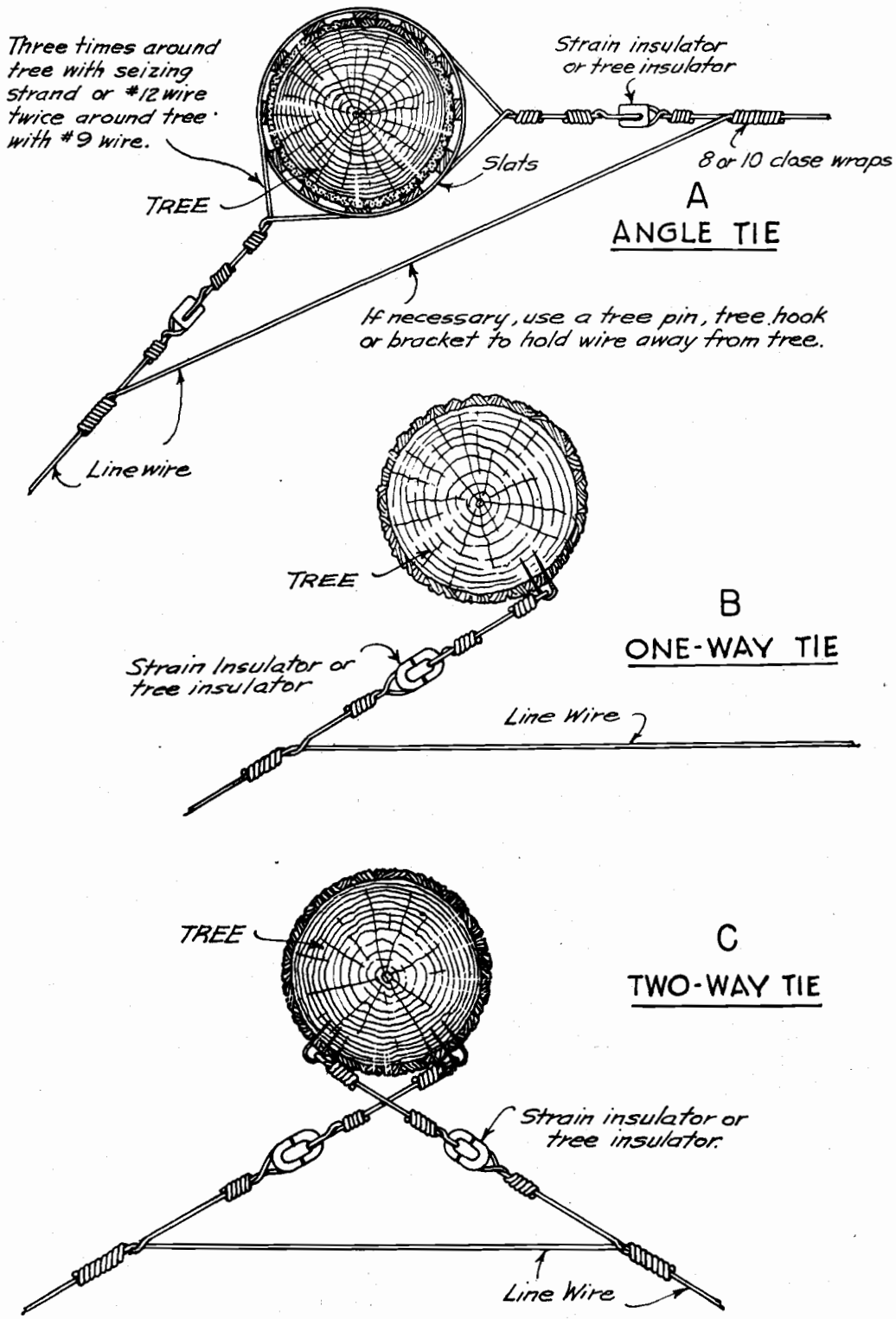
SPLIT TREE INSULATOR



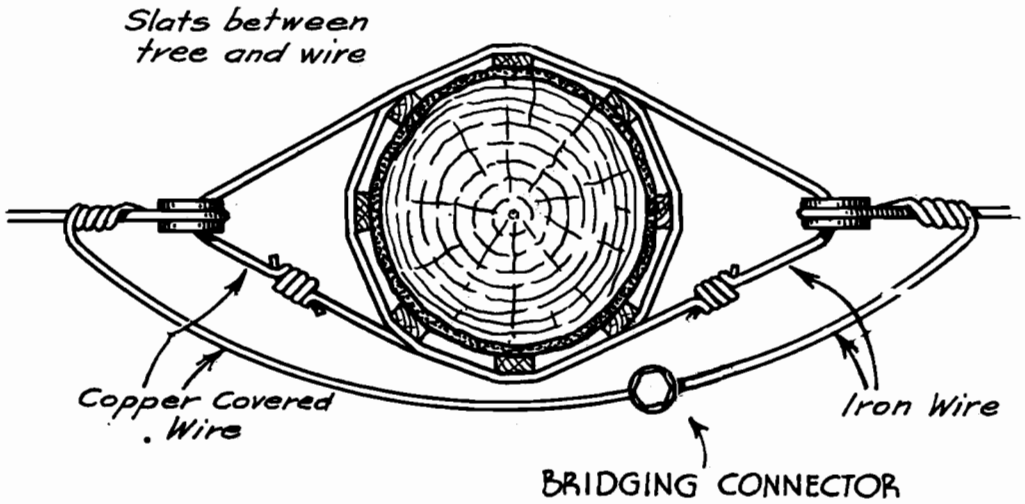
TELEPHONE TREE HOOK



DOUBLE HANGER METHODS

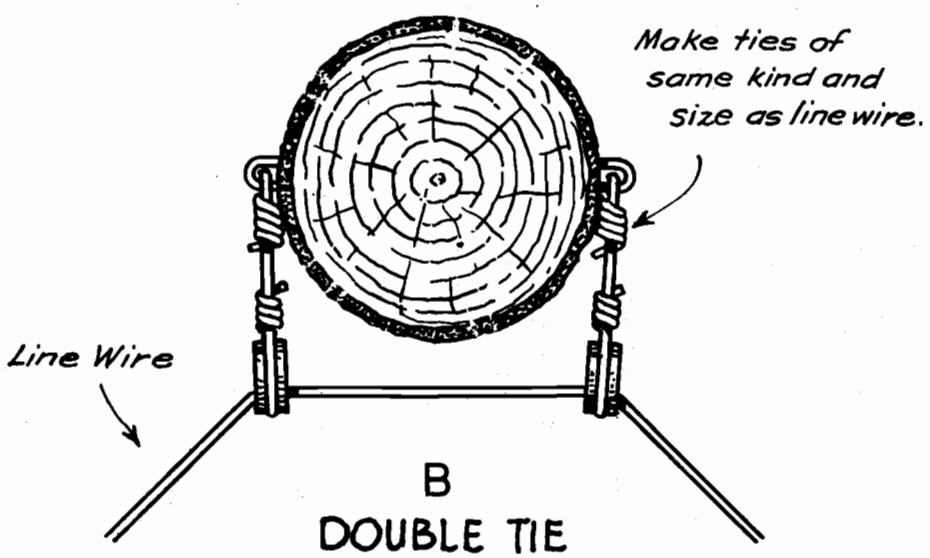


ANCHOR TIES



A

DEAD END TIE



B

DOUBLE TIE

TREE LINE TIES

In addition to those mentioned above there are occasions when solid and stay or anchor ties should be used in tree line construction. Solid ties should be used where the line is run at an abrupt angle, on a steep slope, or distances in excess of 1/4 mile, or where there is danger of the slack running to the bottom of the grade. Stay or anchor ties should be used: (a) at railroad, highway and transportation line crossings; (b) on each side of exceptionally long spans; (c) at terminals of line, and (d) at the top of abrupt slopes where the strain might be too great for an ordinary solid tie.

24. Hanging Wire

Where practicable it is better practice to use ladders rather than lineman's climbers. Ladders make for faster, more uniform and altogether better work. They are also better for clearing. One pair of the tree climbers, however, should be on every job. They come in handy for miscellaneous climbing.

Tree climbers with 5" gaffs should be used on thick-bark trees such as ponderosa pine, but 3" gaffs are preferable for thin-bark trees such as lodgepole pine.

Smooth off the rough bark with a light hand axe before driving staples, but do not cut into the sap wood. Ordinarily, tree hooks can be driven into the tree without removing the bark. Long hooks should be driven about 2½" in solid wood leaving room for many years of tree growth.

Staples should be driven in a vertical plane to cause the tie to pull away from the tree. They should be driven in only sufficiently to hold, leaving room for many years of tree growth before the staple is overgrown. Ordinarily, 3" staples will be used, but on thick-bark trees the 4" staple is preferred.

25. Slack

Adequate slack is almost as indispensable to a successful tree line as the line wire itself since without slack frequent breaks in the line are inevitable. Men inexperienced in this work invariably pull the line too tight. It is better to have too much slack than too little, but the proper ground clearance must be observed.

Leave sufficient slack in each span so that the line may be easily pulled to the ground between the hangers. "Easily pulled" means that the wire will come down under an applied weight of from 75 to 90 pounds. For span lengths of from 100 to 140 feet, the proper amount of slack should be from 3 to 4 feet. In order to maintain even distribution of slack, all spans must be of approximately equal length.

Longer spans will be hung higher and will be given more slack. Spans of 400 feet should not have less than 10 feet of slack and a span of 1,000 feet should not have less than 20 feet. Spans of intermediate lengths should have slack in proportion.

Do not use blocks and tackle to pull slack. They are unnecessary except possibly in pulling up long spans across inaccessible places. "Tight lines" can be charged to the use of blocks and tackle oftener than to any other cause. Slack should be adjusted to correct proportions in each span as the hanger is placed in position.

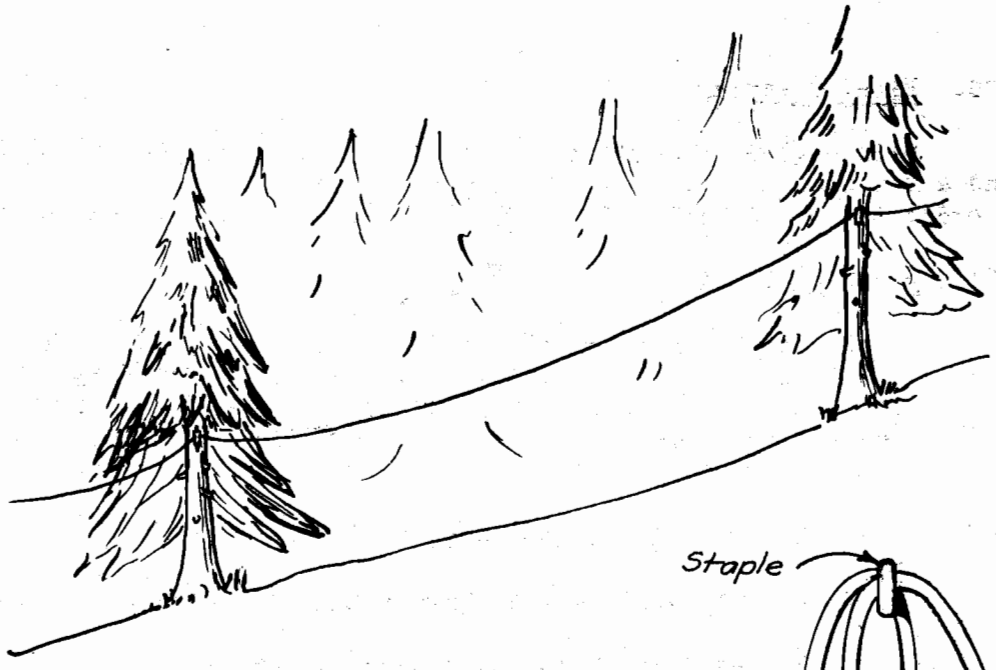
Two or three men working together can do the job to the best advantage. A puts up the first hanger; B climbs the next tree, and while A holds the wire at Station 1, B adjusts the slack toward A. In the meantime, C has climbed Station 3 and placed the hanger. While B holds the slack at Station 2, C adjusts the slack back to B. A has now advanced to Station 4 and repeats the operation on the span between 3 and 4. Two men may work in the same way, and one man can do a fairly good job working alone. Slack can be held at the insulator if a slight bend is placed intthe wire on each side of the insulator and about 4 or 5 inches from it.

The above example is not set up as a standard, and the Regions may use any method which they have developed. When hanging operations are suspended for any length of time, slack should be held by putting a solid tie around the last insulator. This tie should be removed when work is resumed.

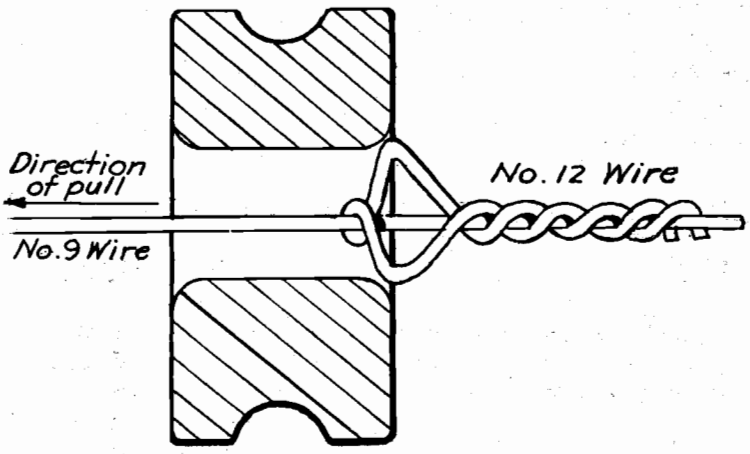
Special conditions call for special methods in handling slack. When it is necessary to construct a tree line up or down a slope in excess of 30% or 40%, it is almost impossible to hold the slack in the several spans without the use of some special measure. A satisfactory method of doing this is shown on Page 33. This is sometimes called the St. Joe tie method. As each insulator is hung up, the slack holding loop is put on the uphill side of the insulator. When any unusual strain comes on the line, this loop will slip through the insulator before the hanger will pull loose from the staple. When the line is rehung during maintenance, all that is necessary to replace the loop is to pull it back through the insulator and straighten it out.

If possible, the location on extremely steep slopes should be avoided by routing the line in a zig-zag course across the slope. Each leg of the zig-zag should be not less than one-quarter mile in length or there will not be enough slack in the leg to take care of falling trees, etc. If an abrupt turn is necessary at the end of each leg, a solid tie should be made, using one of the methods shown on Page 30.

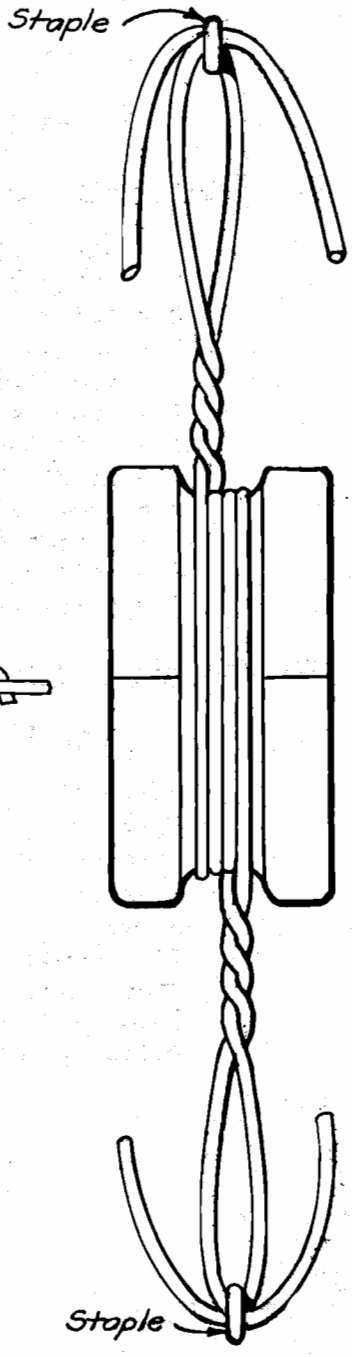
When it is necessary to construct lines across steep slopes where snow slides are prevalent, special construction methods are necessary. The slopes may be almost barren due to the slides, or there may be occasional trees that are so located as to be out of the path of the slides. Usually there are narrow ridges or outcrops of rock which are not disturbed by slides. It is preferable to locate the line so that hanger trees, poles or tripods are located on these ridges. This type of location makes spans of uneven lengths. In some cases it may be necessary to put in spans up to 500 or 600 feet in length. For such spans the line wire should be hung high enough to be above the slides. The line should be dead-ended at the end of each span. In some cases a special strain insulator may be used, but in most cases the split tree insulator can be used as a strain insulator.



Hitch to keep slack from running down hill. Excessive pull on downhill side will cause hitch to bend and pull through insulator without breaking wire.



SECTION



TREE LINE TIE
STEEP SLOPE METHOD

26. Final Clearing

With a given section of the line in final and proper position, send a man back over it for the purpose of removing all branches, etc. in order to insure that the clearing specifications are completely met.

27. Brush Disposal

The Regional Forester will establish brush disposal practice appropriate to different conditions or regions. The methods used should not be more costly than is required on account of the fire danger, and aesthetic or scenic values. Ordinarily, one of the three following methods will be used:

1. No disposal where brush is very light.

2. Lop and scatter where brush is moderate.

3. Pile and burn where brush is heavy.

28. Tools needed for Tree Line Construction - Five-man Crew

1 - wire reel
2 - ladders
2 - pliers, 8"
2 - connectors, 11"
1 - tree trimmer, with saw
2 - axes, double blade
1 - hand axe
1 - cross cut saw, 6', 2-man
2 - tree climbers
2 - lineman's belts
2 - safety straps
1 - abrasive cloth

29. Material Needed to Construct One Mile of Tree Line

Material	Amount
Wire, line, #12 copper-covered	1 mi.
Wire, tie, #12 copper-covered	100 ft.
Insulators, split tree	40
Sleeves	2
Staples	40
Tree hooks	10
Tree pins, iron	3
Tree pins, wood	3
Bridging connectors	5

CHAPTER V - POLE LINE CONSTRUCTION

30. Location

Location is one of the most important factors in pole line construction, and time spent on this work is well worth while. The location survey should be made by a competent engineer, and he should be accompanied by the construction foreman.

The survey data should consist of three parts:

1. Traverse and Classification Notes

Traverse Notes

(a) Pole number
(b) Span length
(c) Stations
(d) Bearings
(e) Ties to G.L.O. survey

Classification Notes

(a) Timber types and age classes
(b) Soil type (rocky, marshy, etc.)
(c) Right-of-way needed
(d) Location of adjacent power, telegraph and telephone lines
(e) Location of guys, rock anchors, etc.

2. Profile and Cross Section Notes

The profile should be taken with an Abney level using percent readings from station to station. No profile notes need be kept across level country where only standard height poles will be used.

Cross section notes are not necessary except where an alternate route may appear to be desirable. The profile of the proposed alternate line may be obtained from the cross sections in such cases.

3. Map

The map consists of two parts; the plan and the profile. The plan section should be at the top of the map and should show the following data:

1. Main topographic and cultural features
2. Ties to General Land Office surveys
3. Road and trail traverses

4. Final line location
5. Alternate routes, if any
6. Pole number
7. Station numbers and bearings
8. Location of guys, rock anchors, etc.

The profile section should be located at the bottom of the map sheet. This should show the pole number and height of each pole as well as the ground profile.

31. Construction Along Highways

Telephone lines must not be constructed within 200 feet of the center of Class 1 or Class 2 highways or within 100 feet of the center of Class 3 highways without the prior approval of the Regional Forester. Necessity for the construction must be proven, and proper precautions must be taken to preserve roadside scenic values. The instructions in Article 32 should be carefully observed.

32. Scenic Highways

Pole lines should not be constructed on National Park highways unless approved by the Regional Forester.

If approved by the Regional Forester, a pole line may be constructed on or along scenic sections or a road or highway provided there is no alternate feasible route and if consistent with local or state policy. When it is necessary to use the highway right-of-way, the poles should be set on the side away from scenic points of interest; such as a stream or lake, a view from the road through a clearing in the timber or along the side of a mountain, etc.

Only poles which are symmetrical, reasonably straight and peeled should be used - without crossarms unless there are more than four wires. There should be no overhead guys crossing the roadway unless absolutely necessary. Very often, if oversized poles set with a rake are used on curves, no guys will be required. If there are trees along the highway, it may be desirable to set the poles back in, or close to the edge of the timber; or to make them more inconspicuous by spraying the poles and crossarms with a suitable color, which should be selected by a qualified person and may vary in accordance with cover and surroundings. In general, the pole line should be made as inconspicuous as possible.

Care should be taken not to leave any brush scattered on the ground where it will be conspicuous or where it will increase the fire hazard.

33. Location of Poles on County or State Road or Highway

Ordinarily, poles should be set from 3 to 5 feet inside the road or highway right-of-way, unless otherwise specified by the county court or State Highway Commission. In the event it is necessary to set poles closer to the traveled part of the right-of-way, care must

be taken to see that poles are not in the way of road maintenance equipment, etc. Poles should be set so that on curves the line will not hang over the traveled part of the right-of-way. Poles should not be set across a private right-of-way without first securing an easement or written permission.

34. Pole Line Classifications

Primary pole lines include those carrying a trunk or branch circuit, or circuits, necessary for fire control or administrative purposes over which a high standard of communication, with a minimum of interference and trouble, is required.

Secondary pole lines include those carrying ordinarily not more than two circuits which are of secondary importance and used principally for administrative or recreational purposes over which reasonably dependable communication is required.

35. Pole Line Grading

The length of poles is determined by the class of construction. Longer or shorter poles may be used where, on account of the profile of the country, it is necessary to avoid abrupt changes in the grade line of the wires. The changes in grade at any pole should be such that there will be a difference in elevation of not more than 8 feet between the wire at that pole and a straight line between the poles on either side of it.

It will seldom be necessary to use poles more than 5 feet longer or shorter than the standard length. All poles must be of such a length that the minimum clearance above the ground will be obtained. Poles may be shortened on abrupt rises or lengthened in depressions, but if the change in grade at each pole is too great, the spans may be shortened or lengthened as the case will require.

36 Pole Sizes

	Class 4				Class 5			
Minimum diameter top - inches	$6\frac{3}{4}$				6			
Minimum circumference top - inches	21				19			
Length of Pole feet	Minimum circumference six feet from the butt - inches							
	Fir and Pine	Chest-nut	West. Red Ced.	North. White Cedar	Fir and Pine	Chest-nut	West. Red Ced.	North White Cedar
18	24.5	26.0	26.5	30.0	22.5	24.0	24.5	28.0
20	25.5	27.0	28.0	31.5	23.5	25.0	25.5	29.0
25	28.0	30.0	30.5	35.5	26.0	28.0	28.5	32.5
30	30.0	32.5	33.0	38.5	38.0	30.0	30.5	35.5
35	32.0	34.5	35.5	41.0	30.0	32.0	32.5	38.0
40	34.0	36.5	37.5	43.5	31.5	34.0	34.5	40.0

	Class 6				Class 7			
Minimum diameter top - inches	5½				4¾			
Minimum circumference top - inches	17				15			
Length of Pole feet	Minimum circumference six feet from the butt - inches							
	Fir and Pine	Chest nut	West. Red Ced.	North White Cedar	Fir and Pine	Chest nut	West. Red Ced.	North White Cedar
18	21.0	22.0	22.5	25.5	19.0	20.5	21.0	23.5
20	22.0	23.0	23.5	27.0	20.0	21.5	22.0	25.0
25	24.0	25.5	26.0	30.0	22.0	24.0	24.5	28.0
30	26.0	28.0	28.5	33.0	24.0	26.0	26.5	30.5
35	27.5	30.0	30.5	35.0	25.5	27.5	28.0	32.5
40	29.0	31.5	32.0	37.0	27.0	29.5	-	-

37. Classes of Construction

There will be three classes of pole line construction.

Class A construction will be used either for pole lines built along important arterial highways, through municipalities, those carrying important circuits or where approved by the Regional Forester for other conditions. The species and preservative treatment of the pole used will follow the best commercial practice necessary to insure a minimum pole life of 20 years.

Class B construction will be used for the average Forest Service pole line unless otherwise specified by the Regional Forester. Poles and preservative treatment, if any, will be selected to insure a minimum life of 10 years.

Class C construction will include either round or split poles, stubbed poles, tripods, other special construction, etc. This class of construction may be used on forest ways, trails, "across country", through municipalities or settlements. Stubbed poles, if the stubbing is properly done, cost as much, and often more, than full length poles and their maintenance cost is usually considerably higher. Therefore, this method of construction should be used only in isolated regions where the transportation costs of full length poles would be excessive.

38. Pole Line Specifications

Covering Poles and Pole Treatment

The following specifications and instructions will be used for the construction of pole lines, except where, on account of peculiarity of conditions, it is impractical to secure poles of appropriate species and dimensions. In this event, poles of other species and dimensions may be substituted upon approval of the Regional Forester.

Class A Construction

1. Pole Species and Treatment: Western red cedar, Northern White cedar or Chestnut complying with A.S.A. specification 05c1 and 05c2 to be butt treated with creosote according to A.W.P.A. specification #43-B, if incised or #44-B if not incised.

   Lodgepole pine complying with A.S.A. specification 05f1 and 05f2 and having a full length 8 pound empty cell treatment of creosote according to A.W.P.A. specification #41-A.

   Western larch or Douglas fir complying with A.S.A. specification 05g1 and 05g2 and having a full length 8 pound empty cell treatment of creosote according to A.W.P.A. specification #41-A.

   Southern yellow pine, Norway pine or Ponderosa pine complying with A.S.A. specification 05e1 and 05e2 and having a full length 8 pound empty cell treatment of creosote according to A.W.P.A. specification #36-C.

2. Pole Sizes: All poles should ordinarily be class 6 with a minimum circumference 6 feet from the butt equal to that shown in the table of pole sizes for the species selected, and a minimum top circumference of 17 inches. This size of pole will withstand a pull of 1,500 pounds applied 2 feet from the top. This is the commercial standard size for poles carrying 8 wires or less.

3. Pole Lengths: Ordinarily to be 25 feet, but longer if necessary to secure a minimum clearance between the lowest wire and the ground of 20 feet at intersections or driveway crossings unless more clearance is required by State laws. Twenty foot poles may be used along less important roads and through sparsely settled areas. The lowest wire along a road must have a minimum clearance above the ground of at least 18 feet.

Class B Construction

1. Pole Species and Treatment: Poles which comply with the specifications for Class A construction may be used if obtainable at a reasonable cost. Any other species may be used with or without treatment, if local experience has demonstrated that it will have the average life required. Poles must be of sound timber and reasonably straight, cut locally as near the job as possible. Thoroughly seasoned lodgepole pine poles conforming to A.S.A. specification 05f1 and 05f2 - 1933 with a full length 8 pound empty cell creosote treatment at a commercial plant or butt treated with creosote at a Forest Service treating plant may be used. See Pages 42, 43 and 44.

2. Pole Sizes: All poles should ordinarily be Class 7 with a minimum circumference 6 feet from the butt equal to that shown in the table of pole sizes for the species selected, and a minimum top circumference of 15 inches.

3. Pole Lengths: Ordinarily to be 25 feet, but longer if necessary to secure a minimum clearance between the lowest wire and the ground of 20 feet at intersections or driveway crossings unless more clearance is required along less important roads and through sparsely settled areas. The lowest wire along a road must have a minimum clearance above the ground of at least 15 feet.

Class C Construction

A. Full length Poles, Round or Split
   1. Pole Species and Treatment: To be the same as for Class B construction.
   2. Pole Sizes: To be the same as for Class B CON* struction.
   3. Pole Lengths: 18 to 20 feet permitted provided they will give a minimum clearance of 12 feet above the ground.

B. Stubbed Poles
   1. Stubs Species and Treatment: Western red cedar, Northern white cedar, yew or juniper, and the Heartwood of redwood, Southern cypress, and Chestnut may be set untreated. Lodgepole pine, Douglas fir and Western larch must be treated with creosote as specified for Class B Construction.

2. Stub Lengths and Sizes:

Kind	Length feet	Min. circum. 5' from butt - in.	Area sq. in.
Western red Cedar	8	30	71.62
No. white Cedar	8	30	71.62
Redwood	8	30	71.62
Chestnut	8	30	71.62
So. cypress	8	30	71.62
Yew	8	28	62.39
Juniper	8	28	62.39
Douglas Fir	8	28	62.39
Lodgepole pine	8	31	76.47
Western Larch	8	31	76.47

C. Poles Attached to Stubs

1. Species: Lodgepole pine, fir, larch or equal
2. Sizes: Round, square or split equivalent to a 6" top diameter round pole.
3. Lengths: Fourteen to sixteen feet or long enough to secure a clearance as specified under A-3 for full length poles.

Suggestions for methods of attaching poles to stubs will be found on Page 79. Poles to be attached to stubs on the roadside on straight lines and on the inside at corners.

Suggestions covering use and construction of tripods will be found on Page 19.

39. Creosote Treatment of Poles at Forest Service plants

A. General

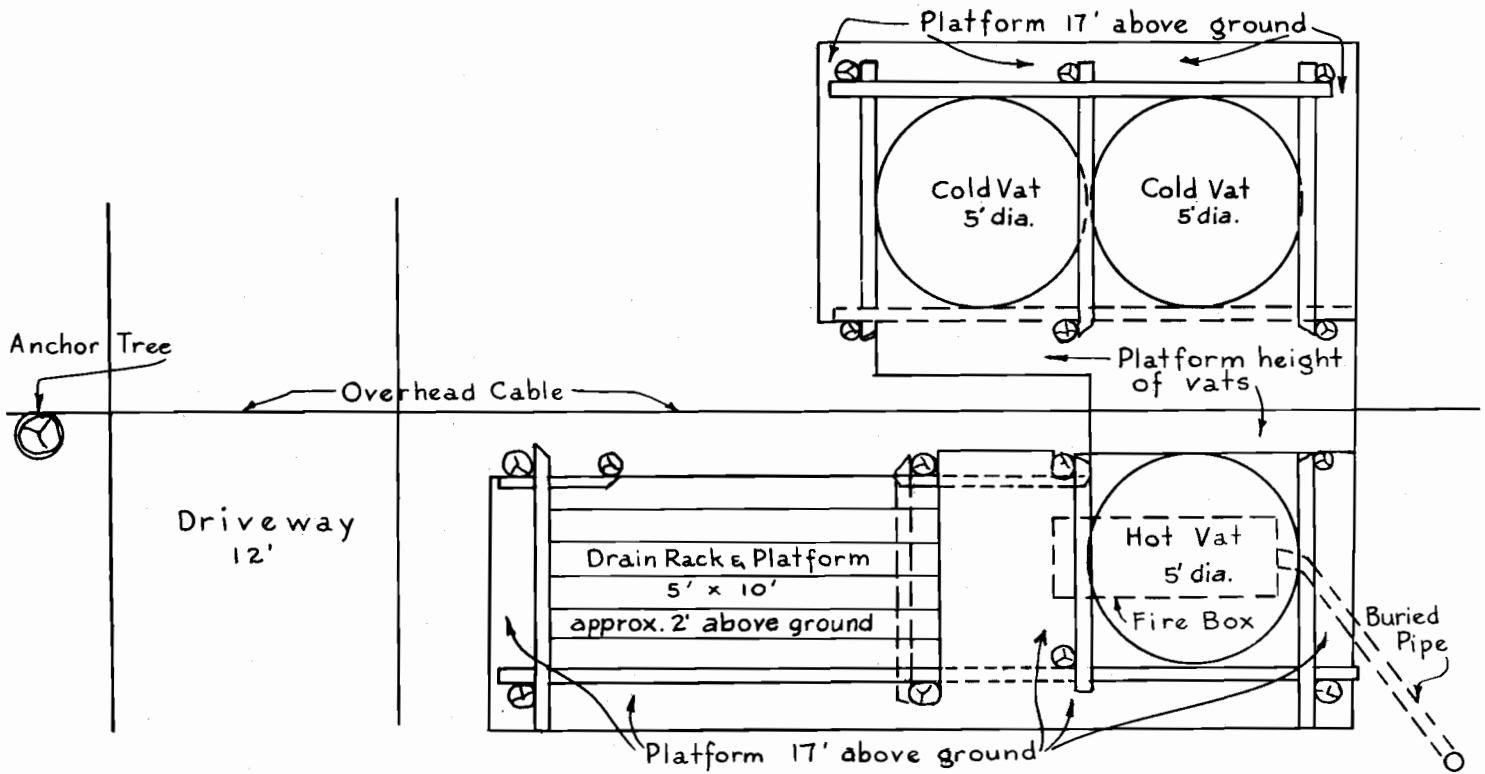
The timber should be sound, entirely free from decay except as permitted in the A.S.A. specification for poles, carefully peeled, and thoroughly seasoned. In good seasoning weather open-piled poles will take from 5 months to a year; Douglas fir, 5 to 8 months; lodgepole pine and ponderosa pine, 5 to 7 months; western red cedar, northern white cedar and western larch, 8 to 12 months.

B. Preservative to be Used

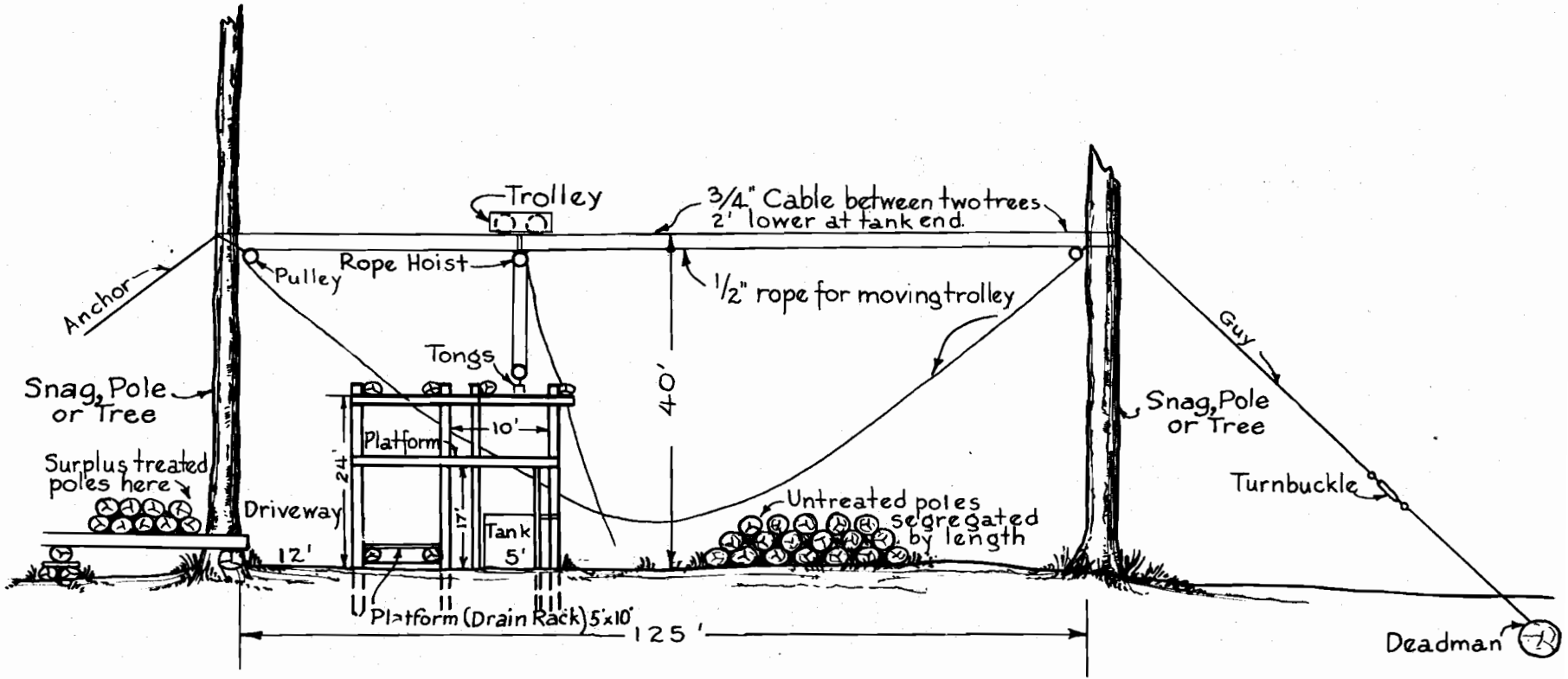
The preservative should conform tc A.W.P.A. specification 4-f or subsequent revision.

C. Single Tank Method

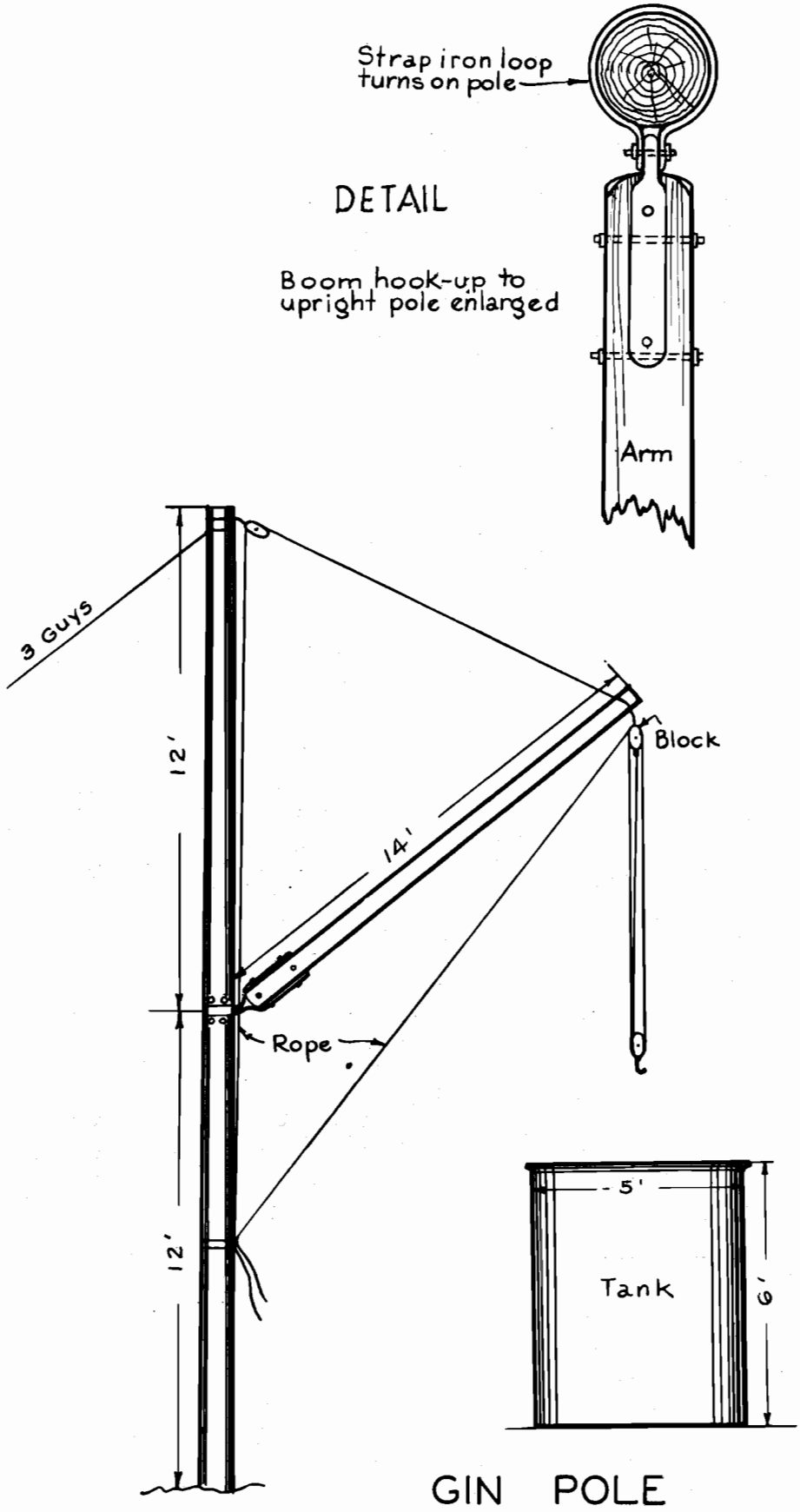
With this method only one tank is used. The creosote should be heated to about 200 degrees F. Add additional creosote to the tank to compensate for that absorbed by the wood and lost by volatilization. The material may be placed in the creosote after it



PLAN FOR CREOSOTE TREATING PLANT



SIDE VIEW OF CREOSOTE TREATMENT PLANT



GIN POLE

is brought to the desired temperature, or at the time heating is begun. At the end of the heating period (from 3 to 7 hours), the fire is allowed to die down or is drawn. The timber is then allowed to remain in the cooling creosote from 3 to 14 hours, depending on the species to be treated. See table below.

Care should be exercised that the creosote in the tank remains at about the same level, so that a penetration will always be secured for the required length. Treatment should extend at least 1 foot above ground line. The poles should then be removed from the tank and allowed to drain. The surface creosote will drain off the poles better if the oil in the cooling tank is slightly heated prior to the removal of the poles.

D. Two Tank Method

This method uses two or more vats instead of one. The poles are allowed to remain in the hot creosote for the required number of hours and are then transferred directly to the cold vats. After the required length of time in these vats, they are moved to the drain rack. The requirements are the same as for the single tank method. The plant layout is shown on Pages 42, 43 and 44.

E. Results to be Secured

Penetration ranging from about $\frac{3}{4}$ to 1 inch for lodgepole pine and ponderosa pine, and from $\frac{1}{2}$ to $\frac{3}{4}$ inch for Douglas fir and cedar should give good results. The time necessary to secure any desired penetration will vary with the species, the moisture content of the material, and many other factors, and must be determined by actual tests in each case.

At least one piece of timber from each of the first six runs should be selected for tests.

Penetration tests are best made by boring with an increment borer and then splitting open the boring. In freshly treated poles, a borer sometimes carries oil over the surface of the boring and often indicates a deeper penetration than is actually the case. By splitting the boring, the true penetration can be observed. The hole must be plugged tightly with a creosoted wooden plug.

The following table gives the length of time the poles should usually be left in the hot and cold creosote. The times may be changed, however, as local observations indicate desirable.

Species	Number of hours in hot creosote	Number of hours in cooling creosote
Lodgepole pine (cut green and seasoned)	7	14
Lodgepole pine (fire killed)	3	7
Ponderosa pine	4	3
Douglas fir	7	14
Western red cedar	7	14
Spruce	7	14

The best treatment is the one which gives the greatest penetration with the least absorption of oil. The hot oil bath controls the penetration. If the penetration is not sufficient, the hot bath should be lengthened. If the penetration is satisfactory but too much oil is abosrbed, the cold or cooling bath should be shortened. The schedule given should produce an absorption of from 4 to 8 pounds of oil per cubic foot of wood impregnated. In the experimental work which has been conducted on lodgepole pine in Region One, with similar time schedules the 6 inch by 25 foot poles absorbed about 1.5 gallons of oil for each pole. In using these figures in estimating the amount of oil required for a given job, allow from 10 to 20 percent additional for evaporation during treatment.

Low residue oil is extremely volatile, and to reduce volatilization of oil, the hot bath should be given at as low a temperature as possible, without impairing the treatment. In specifying 200 degrees F., for the hot bath, it is assumed that the timber is thoroughly air-dry. The maximum temperature should not be allowed to go above 220 degrees, as excessive heating is likely to unduly increase the loss of the oil through volatilization. There is also danger that the oil will boil over the sides of the tank and take fire when an open flame is used. The oil is not dangerously inflammable, but treating plants should not be constructed near to buildings or other valuable property.

40. Framing

Framing of telephone poles includes roofing, gaining and boring of holes for crossarms. All framing should be completed before the poles are treated. Recommended framing methods are shown on Page 47.

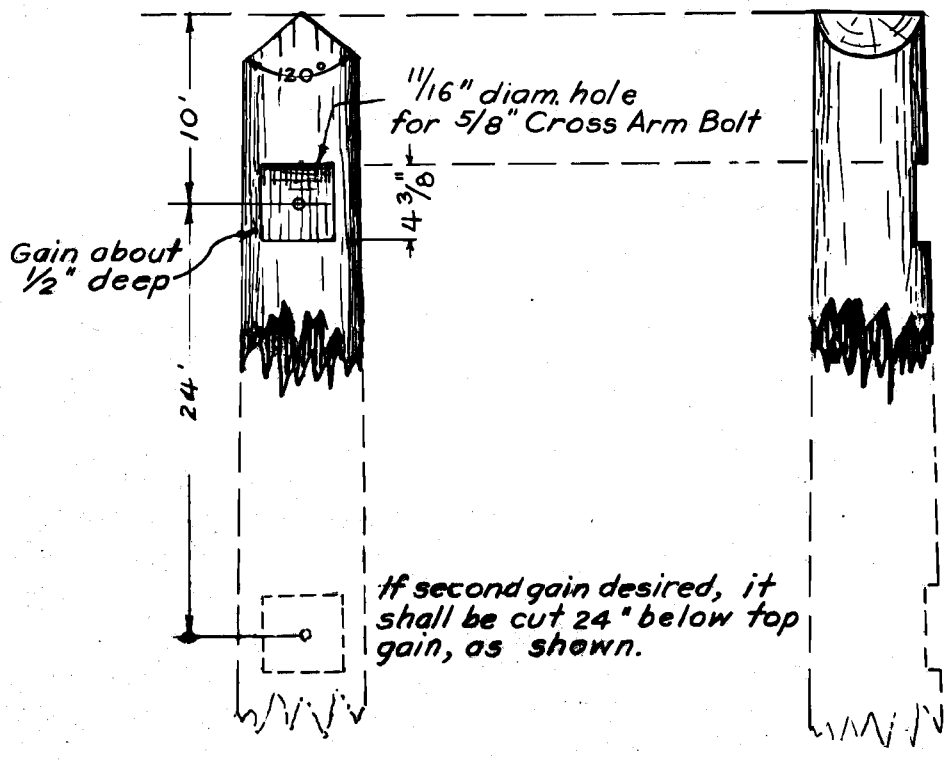
41. Roofing

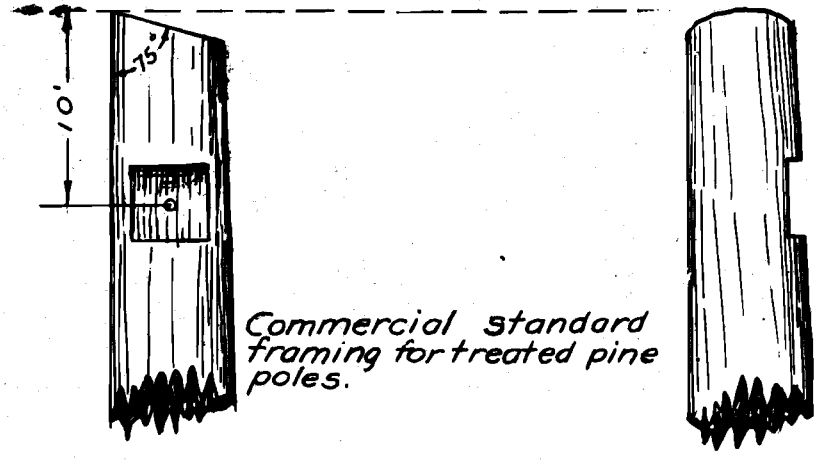
The top of each pole must be roofed. Two methods are used, and either one is acceptable. The one-way roof is widely used commercially especially for treated pine poles. Both methods are shown on Page 47.

Where crossarms are used, or are contemplated, the ridge of the roof shall run parallel to the line wires. If only brackets are to be used, the ridge of the roof shall run at right angles to the line wires to prevent water, snow and sleet from draining directly against the brackets.

42. Gains

Gains on poles showing sweep or curvature must be located on the concave side in the plane of the greatest curvature and are to be cut as shown on Page 47. Gains should be cut 4-3/8" wide and not more than $\frac{1}{2}$" deep. They should be flat so that the crossarm will not rock on the pole. The center of the gain should be 10 inches below the ridge of the roof. If additional gains are cut, they should be spaced 24 inches, center to center.





STANDARD FRAMING

On steep grades of 20% or more, where local experience indicates it to be desirable, gains may be cut on a slant. This will permit the line wire to fit in the wire grooves of the insulators. The gain should be only large enough to provide a flat bearing surface for the crossarm.

An 11/16" hole must be bored in the center of the gain for the crossarm bolt. The hole should be at right angles to the gain.

43. Crossarms

Crossarms should be used on poles on which there will be more than four wires. Crossarms should be attached to the poles with 5/8" x 12" crossarm bolts using two 3/16" x 2¼" crossarm washers. Two braces are to be used with each crossarm. Braces are to be attached to the crossarms with 3/8" x 4" carriage bolts, and to the pole with 1/2" x 4½" lag screws. Two sets of crossarm dimensions are shown below for the convenience of the regions. In some parts of the country the "electric light arms" may be purchased, while in other parts of the country the "pacific arms" may be purchased. Each kind will be considered standard for Forest Service telephone line construction.

ELECTRIC LIGHT ARMS

Number of Pins	Length of Crossarm (feet)	Size of Crossarm (inches)	Diameter of holes for 1½" x 9" wood pins (inches)	Diameter of holes for ½" x 9¼" steel pins. (inches)	PIN SPACING			Size of bolt in center of crossarm	Number of crossarm braces	Length of crossarm braces	Number of holes	HOLES FOR BRACE BOLTS		
					Between Center Pin Holes (inches)	Between Side pin Holes (inches)	Between end pin hole and end of crossarm (inches)					Diameter of holes for 3/8" Bolts (inches)	Distance of holes from Center of crossarms (inches)	Distance between brace bolt holes.
6	6	3¼×4¼	1 17/32	9/16	16	12	4	5/8	2	20	2	7/16	12½	25
10	10	3¼×4¼	1 17/32	9/16	16	12	4	5/8	2	30	2	7/16	21	42

PACIFIC ARMS

6	7	3¼×4¼	1 17/32	9/16	28	12	4	5/8	2	26	2	7/16	16	32
8	9	3¼×4¼	1 17/32	9/16	28	12	4	5/8	2	30	2	7/16	21	42
10	11	3¼×4¼	1 17/32	9/16	28	12	4	5/8	2	30	2	7/16	21	42

44. Attaching Crossarms to Poles

1. Select a crossarm bolt long enough to extend about 5" beyond the face of the gain without cutting into the back of the pole.

2. Place a 2¼" square washer on the bolt and drive the bolt into the hole from the back of the pole.

3. Place the crossarm over the bolt with the braces away from the pole.

4. Place a 2¼" square washer on the bolt and turn the nut firmly into place. If the bolt extends more than 2" beyond the nut, cut it off about ½" from the outside of the nut.

5. Line up the crossarm at right angles to the axis of the pole as follows:

(a) If the pole is on the ground, place the short leg of a steel square on the bottom side of the crossarm in such a position that the outer edge of the long leg points along the center line of the pole toward the butt. Place a nail or mark the pole at a point 6 feet from the butt and move the crossarm until the long leg of the square points toward the mark.

(b) If the pole has been erected, line up the crossarm by sighting from the ground a short distance away or from an adjacent pole

6. Bring the lower ends of the crossarm braces together so that the holes register and attach the braces to the pole with a ½" x 4½" lag screw.

45. Double Crossarms

Double crossarms should be used at the following locations:

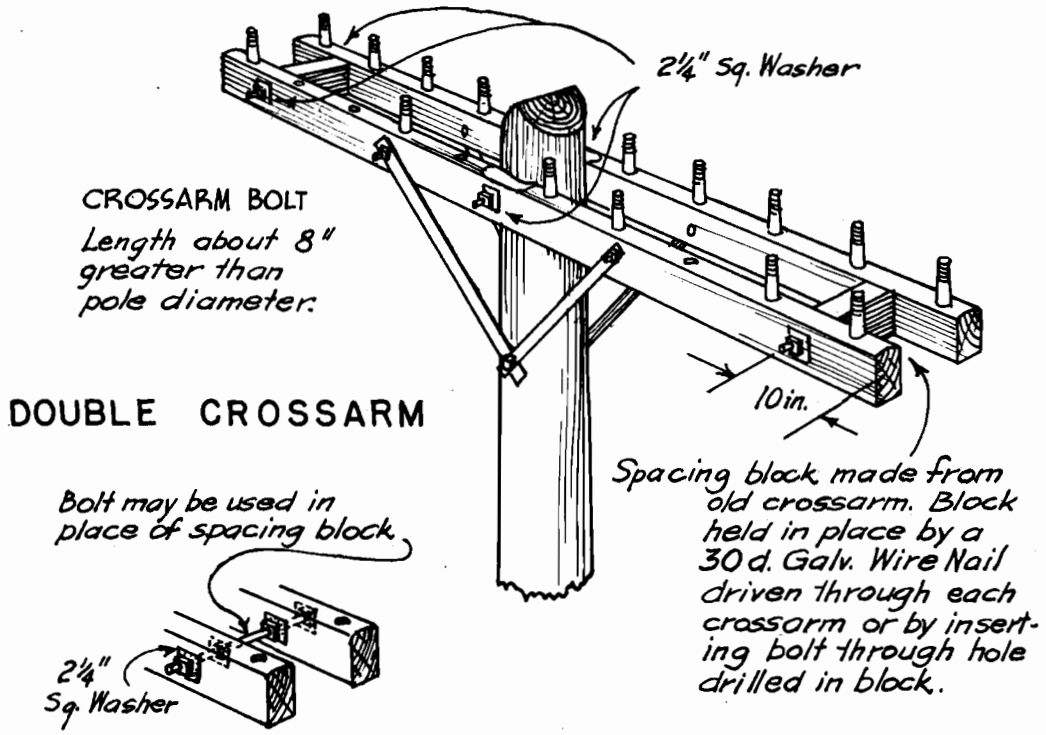
(1) On poles supporting spans, the length of which exceeds the normal span by 50% or more.

(2) On corner poles where the pull is 20 feet or more.

(3) On poles where circuits are dead-ended or buckarm construction is used.

(4) On poles at changes in grade where heavy construction is required.

Correct double crossarm construction is shown in the following illustration.

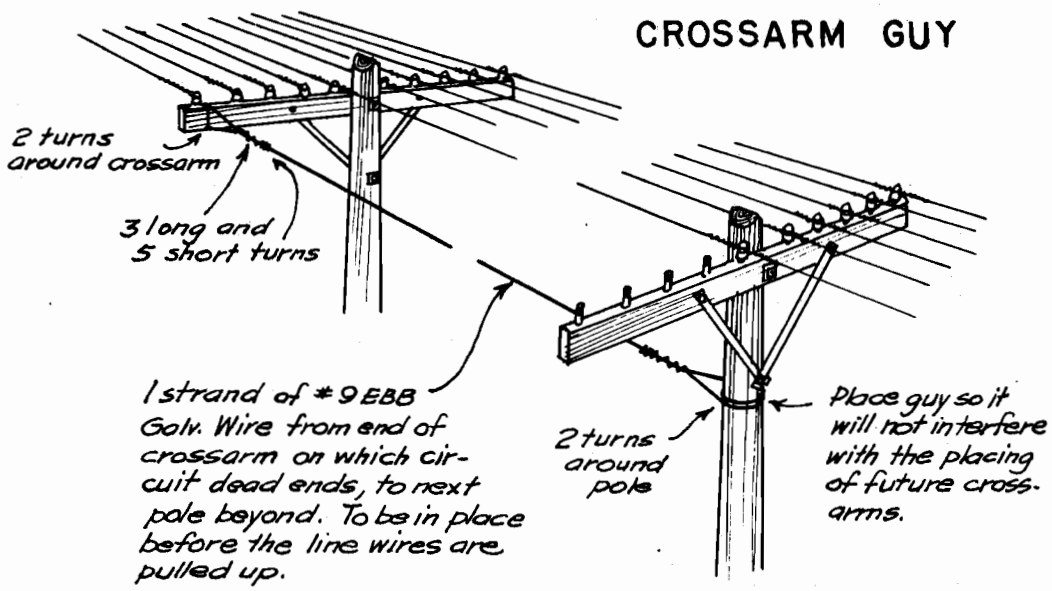


DOUBLE CROSSARM

ALTERNATIVE CONSTRUCTION

46. Crossarm Guys

Crossarm guys are used where two or more wires terminate on the pins of only one side of a crossarm.



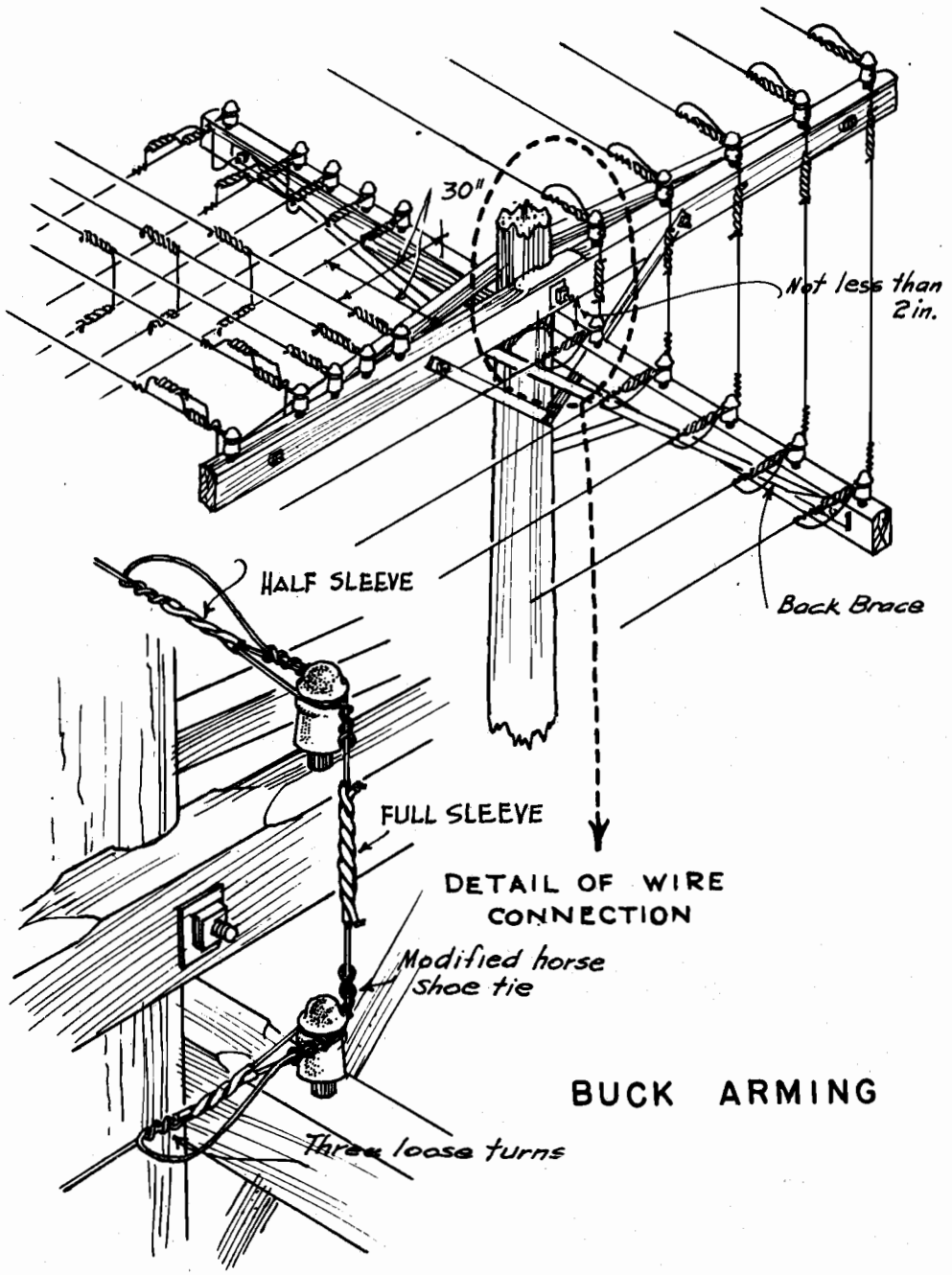
47. Reverse (Buck) Arms

Reverse arm construction is used:

(1) At side leads where it is not practicable to branch off on a two-pole corner.

(2) At right angle corners where it is impracticable to make the turn on two or more poles.

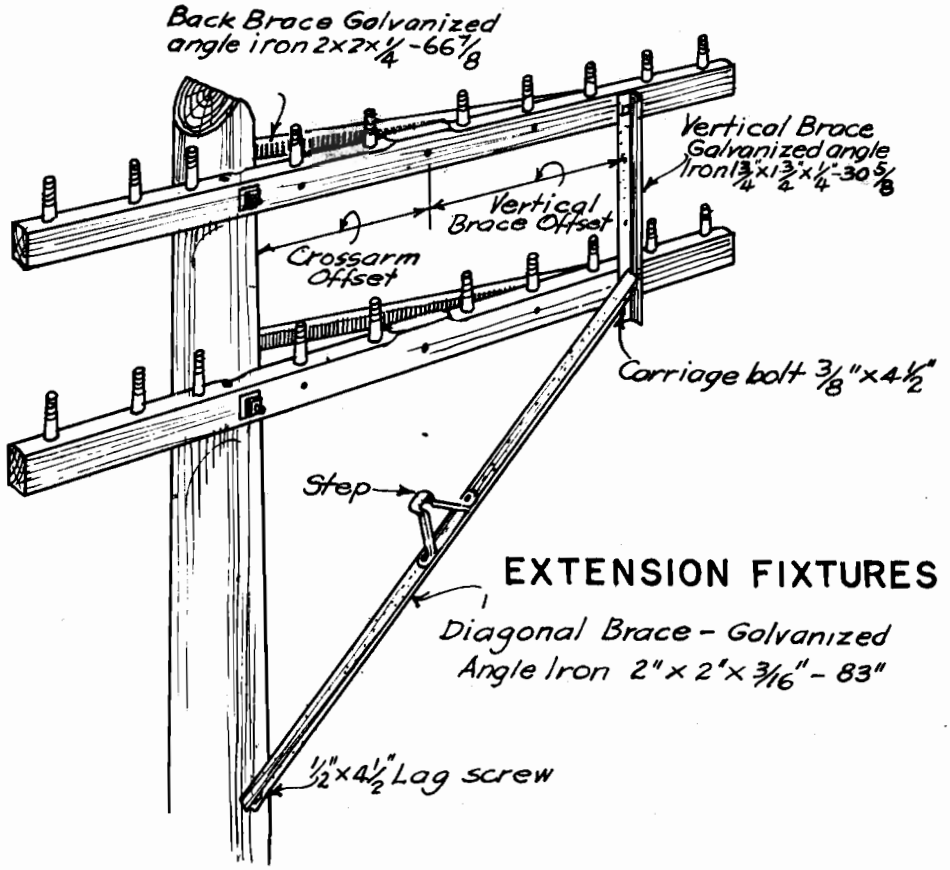
Pins on buck armed poles must be spaced so as to provide climbing space. Where buck arm construction is employed, line wires extending between crossarms must be secured by a modified horse shoe tie to the insulators on which the wires are dead-ended.



BUCK ARMING

48. Extension Fixtures

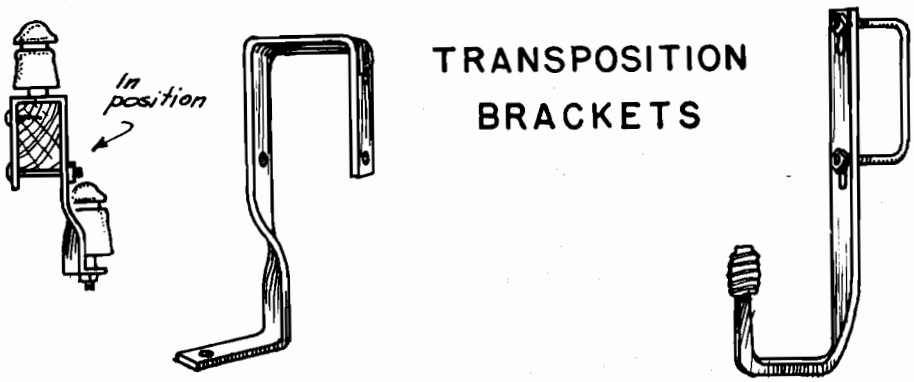
Where it is necessary to clear buildings or trees without the use of high poles, extension fixtures may be constructed as shown below:



49. Transposition Brackets

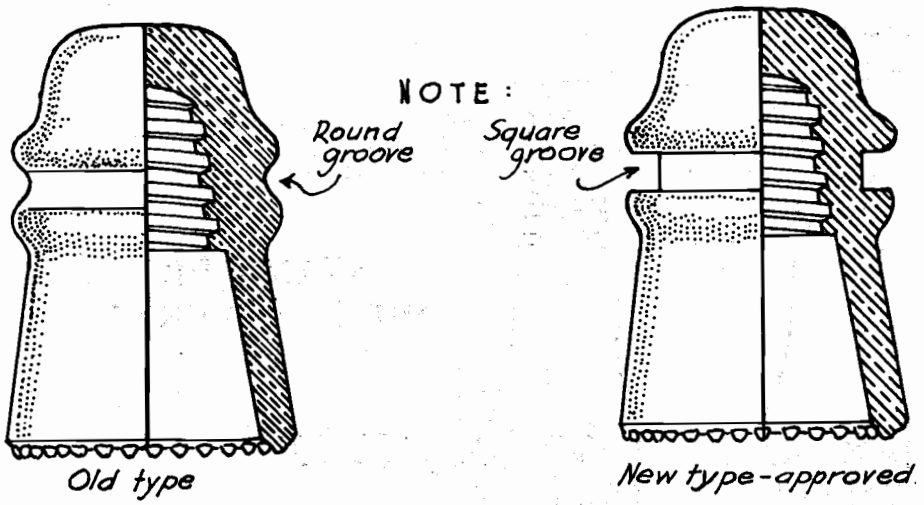
The single point transposition bracket will be standard for non-phantom circuit transpositions. Two types are illustrated below. The bracket on the left requires a wood top steel pin and is fastened to the crossarm by a 2" wood screw and a 3/8" x 4½" carriage bolt. The bracket on the right requires no pin and is fastened to the crossarm by a U bolt.

Braces for transposition brackets are required on corner poles where the pull exceeds 10 feet.

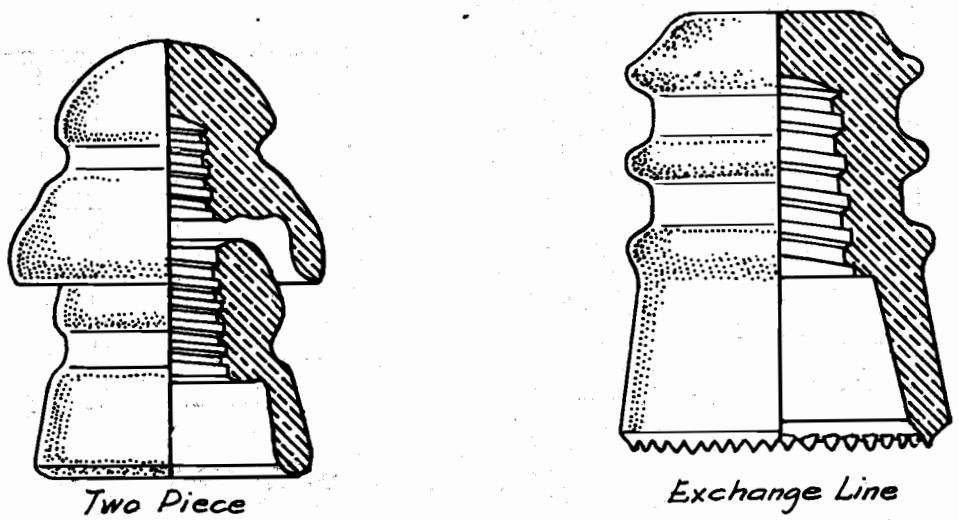


50. Insulators

The standard insulator to be used for Forest Service telephone lines is the No. 16 glass with square grooves. For transpositions, the No. 50 two-piece glass insulator or the No. 10 double groove insulator is standard.



STANDARD INSULATORS



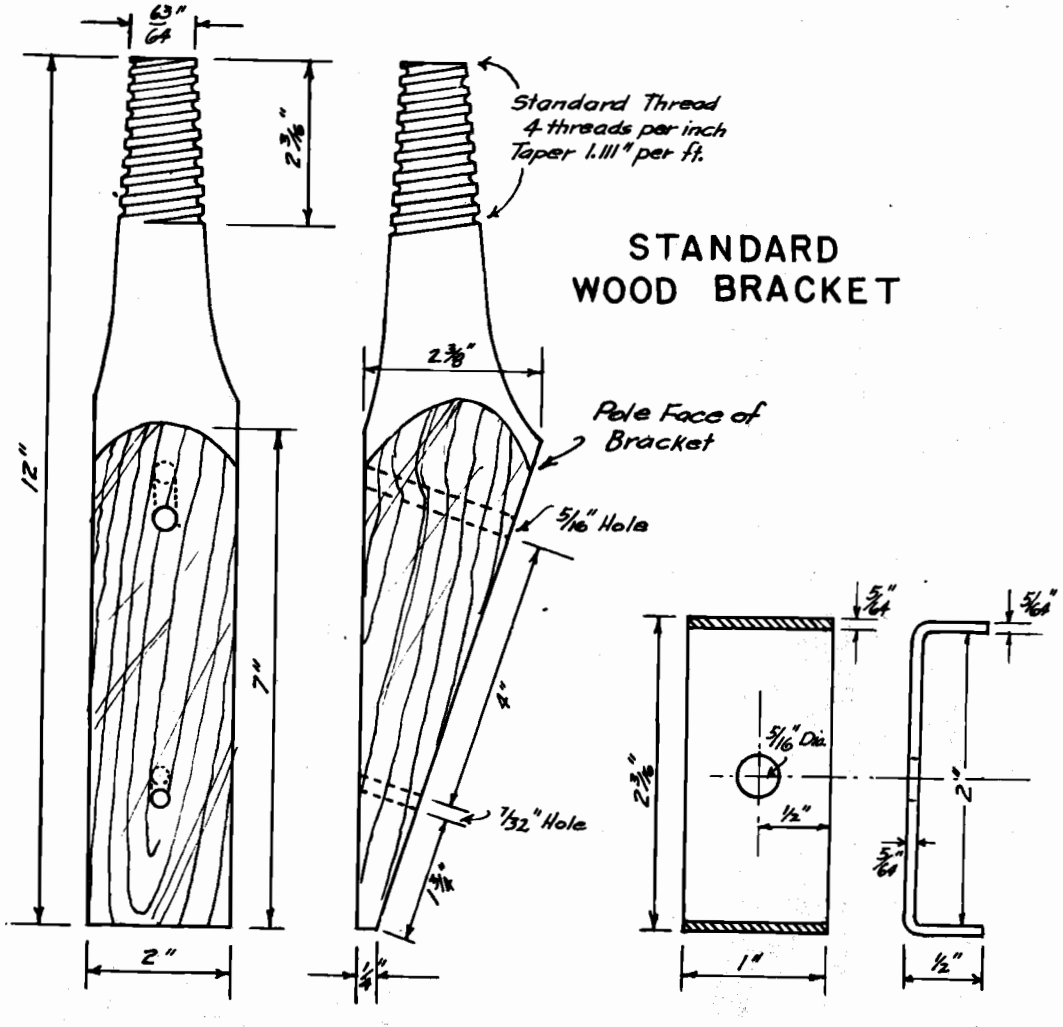
TRANSPOSITION INSULATORS

51. Crossarm Pins

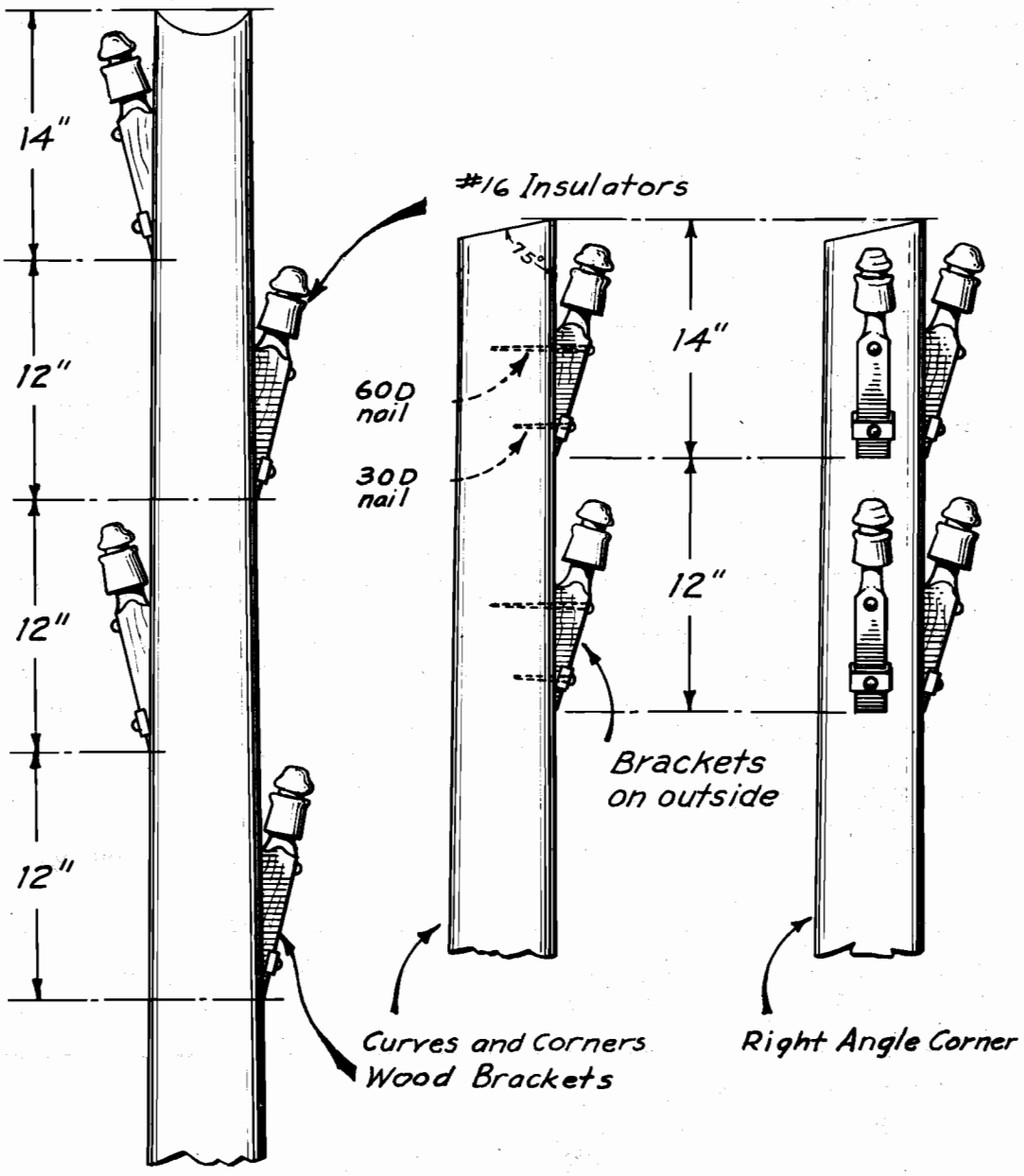
Two types of pins are used for crossarms. The $1\frac{1}{2}$" x 9" locust wood pin is standard. If steel pins are used, they should be the Western Union type galvanized steel pins with wood top, size $\frac{1}{2}$" x $9\frac{1}{4}$".

52. Wood Brackets

Brackets should be used for poles on which there will not be more than four wires, provided there will be a sufficient clearance between the lowest wire and the ground. The standard size bracket is 2" x 2-3/8" x 12". Brackets should be attached to the poles as shown on Page 55.



When necessary in order to secure proper clearance above the ground either at intersections or along the side of the road, the brackets for both wires of a metallic circuit may be attached to the pole at the same height from the ground as shown on Page 101. Transpositions of lines on brackets will be more effective in securing a balanced circuit with the wires in this position, than if placed one above the other.



METHOD OF ATTACHING BRACKETS

53. Lightning Conductors

The present trend in commercial practice is to discontinue the use of lightning conductors except in localities of extremely high lightning hazards. Even in these localities the conductors are placed only on every fifth to tenth pole. However, where local experience indicates the need for more frequent use, conductors should be placed as deemed necessary. The best conductor is No. 2 solid copper wire, but the regular line wire may be used.

The practice now is to have the lower end of the conductor stop about 18 inches above the ground line. This keeps the line from being normally grounded and is recommended as a safety measure by preventing the men from being accidentally connected to the ground when working on the line. Stopping the conductor above the ground line will not keep lightning from jumping to the ground. Page 57 shows the proper method of installation for bracket lines. For crossarm lines, the conductor may be installed over the roof and down the pole behind the crossarm.

54. Pole Holes

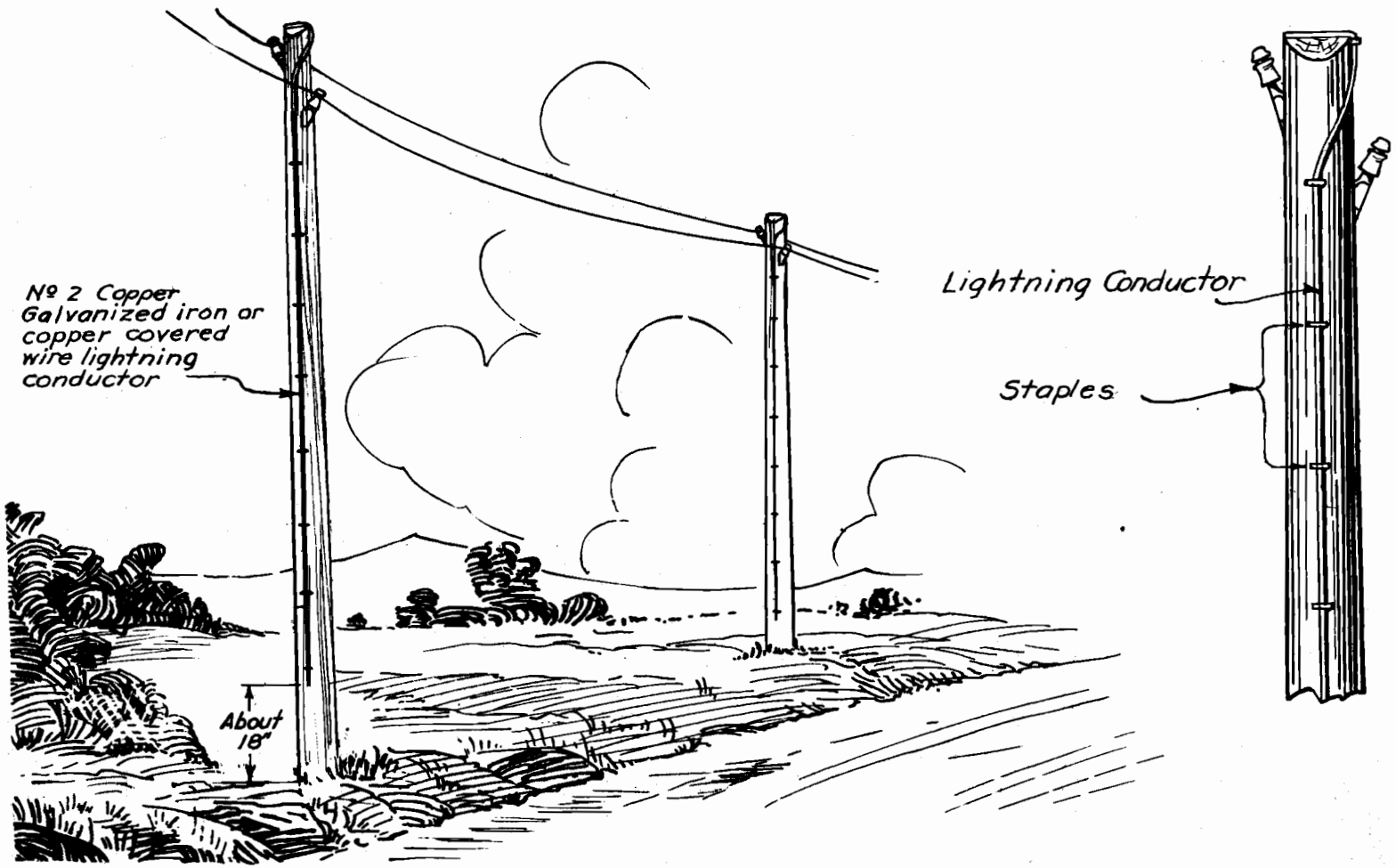
All pole holes must be large enough to permit the free setting of the pole without cutting. They must be of sufficient size to permit tamping of the back-fill throughout the depth of the hole. They should be of uniform diameter from top to bottom. Where large poles are to be set with pike poles, the side of the hole should be trenches to facilitate the entrance of the pole.

55. Depth of Holes

The following table for depths of pole holes is recommended:

Length of Pole (feet)	Depth in Soil (feet)	Depth in Solid Rock (feet)
20	4	3
25	5	3
30	5½	3½
35	6	4
40	6	4
45	6½	4½

These are the average depths but conditions may cause slight changes. In no case should the pole be set so that the top of the creosoted portion is below the ground level.



BRACKET LINE LIGHTNING CONDUCTOR

Where a pole hole is blasted in rock and the diameter of the hole at the surface is more than two feet, set the pole to the full depth recommended for poles set in earth.

Where there is any probability of the road grade or ground under the line being changed within a short time, set poles, whenever practicable, so that they will be in the ground not less than the specified depths after the new grade is established.

In loose earth or swampy ground, set poles one foot deeper than is specified or set them to the depths recommended in the table and in addition use an anchor plank ground brace.

In wet or loose soil that cannot be tamped to a firm foundation, the hole should be made large enough to permit placing an anchor plank under the pole.

Poles set in sloping banks or within four feet of the edge of a bank, particularly the edge of a drainage ditch, should be set a foot deeper than specified in the table.

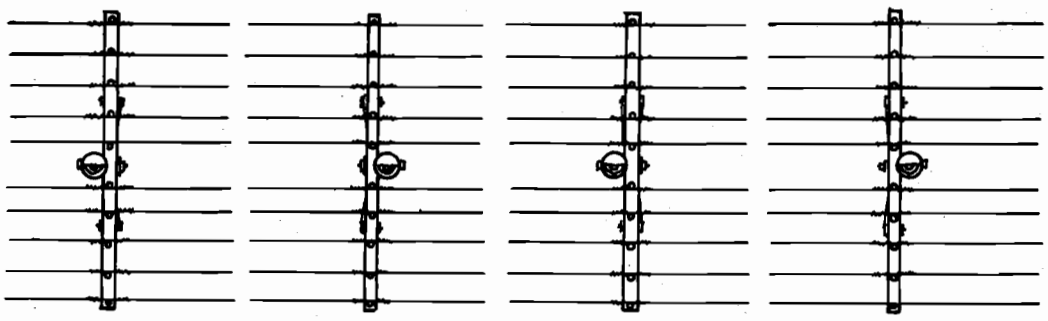
Unguyed corner poles should be set 6 inches deeper than normal depending on the nature of the soil.

56. Face of Poles

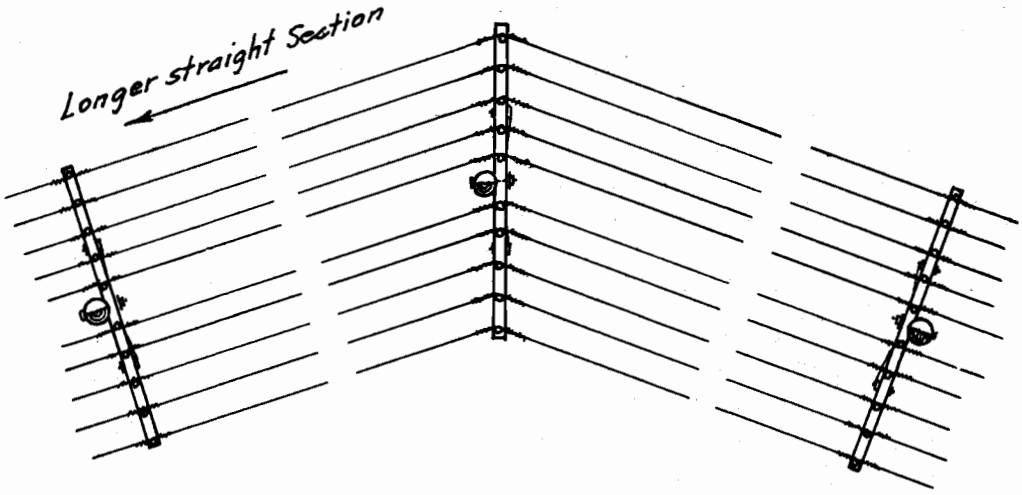
The face of a pole is the side of the pole on which the crossarms are attached. If the pole does not carry crossarms, the face is the concave side of the pole. If the pole is practically straight and does not carry crossarms, the face may arbitrarily be designated as either side of the pole in line with the lead.

The following diagrams illustrate proper methods of pole facing for crossarm lines:

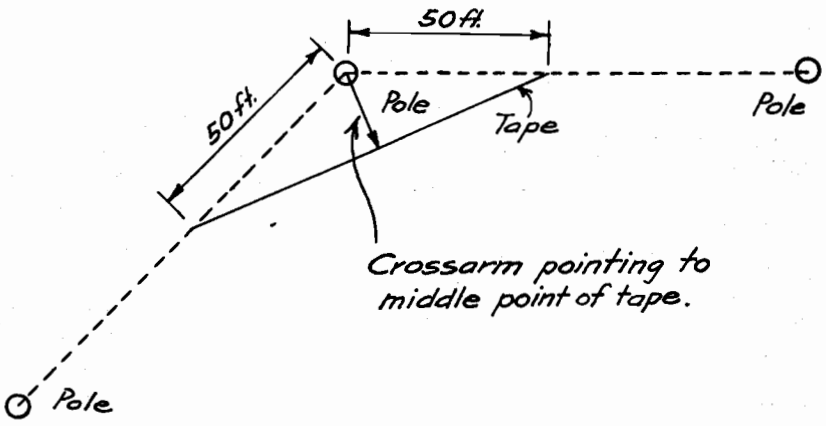
In straight sections of line, set intermediate poles so that adjacent poles will face in opposite directions. In connection with pole replacement work, it is unnecessary to observe this general rule.



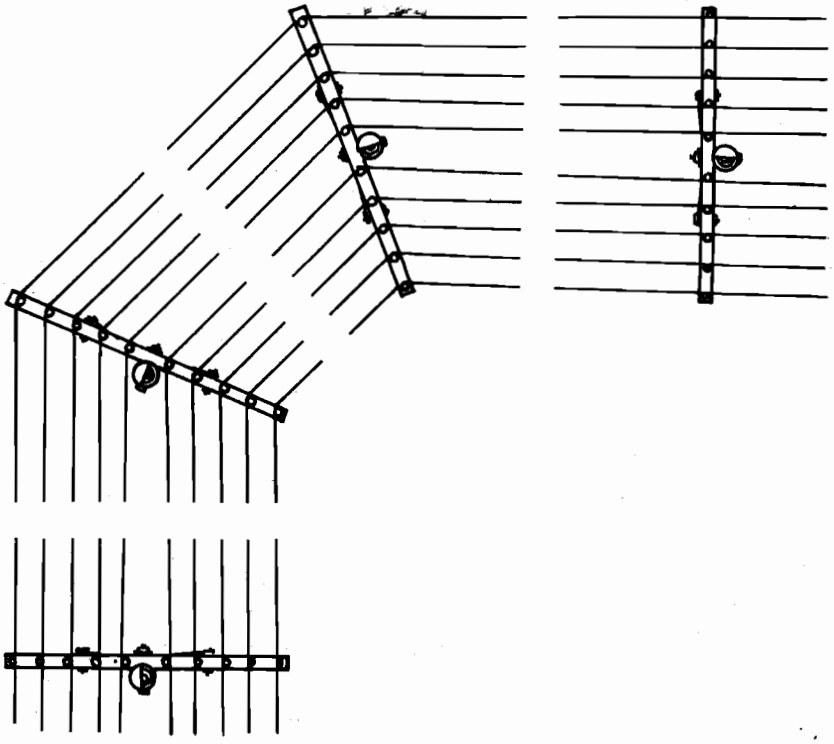
At single pole corners, face the poles so that the crossarms will bisect the angle and will be on the face of the pole away from the longer straight section of the line. Crossarms on the poles adjacent to the corner shall face toward the corner pole.



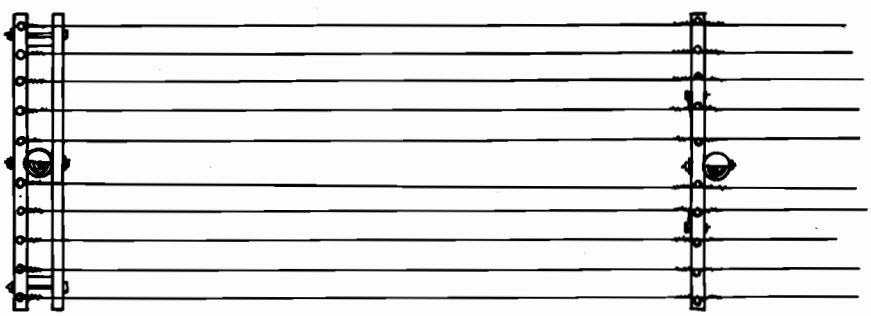
Note: A crossarm bisects the angle in the line when it points to the mid-point of a tape line stretched between two points laid off a convenient distance (50 feet, for example) along the lead from the corner pole.



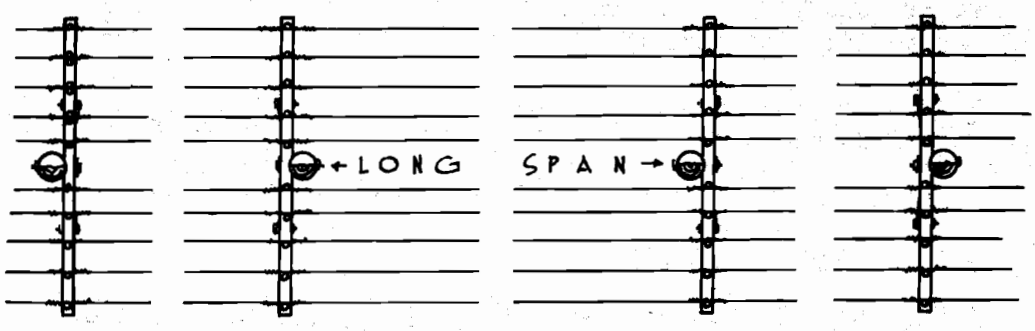
At two-pole corners, face the poles so that the crossarms will bisect the angle at each pole and so that the crossarms will be on the pole away from the adjacent straight section of line. Crossarms on the poles adjacent to the corner shall face toward the corner pole.



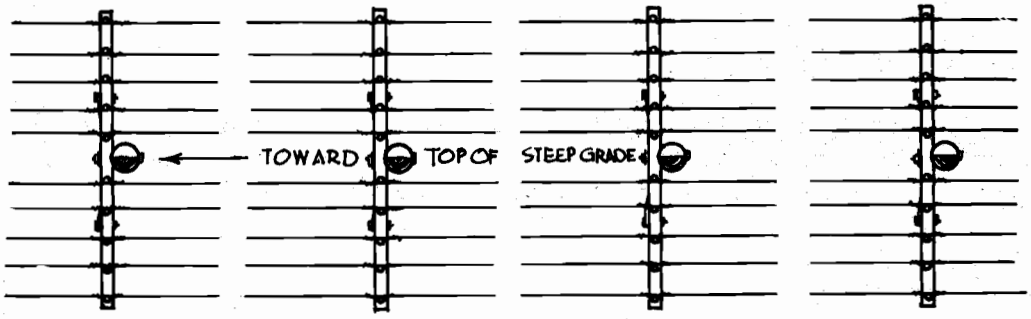
At open wire dead-ends, set poles with the face away from the last span. Set the pole next to the dead-end pole with the face toward the last span.



At long spans, face the poles supporting the long span away from the long span.



At steep grades (20 per cent or over) face the poles toward the top of the grade.



57. Erecting Poles

The method to be employed in erecting poles depends upon the size and weight of the pole and upon conditions encountered at the pole location. Pole attachments such as crossarms and brackets should be placed before the pole is erected.

58. Rake of Corner Poles

It is desirable that guyed or unguyed corner poles shall be raked. Rake is provided by "setting in" the butts approximately one foot. This may be exceeded, however, by 50% where the poles carry a heavy load.

When placing guys, pull the top of the pole such an amount that when the load comes on the pole and the anchor and pole have settled, the pole top will come back into line. Under average conditions, poles should be pulled out of line an amount approximately equal to the diameter of the pole top. Where conditions are such that more or less yield is expected from the pole and guy, this amount may be modified accordingly.

Poles supported by push braces should be set with the butt of the pole in line and with a rake of such an amount that when the structure has settled, the top of the pole will be in line.

59. Backfilling and Tamping

After the pole has been set, the hole should be filled with earth. It is important that the earth be tamped thoroughly for the full depth of the hole. Two tampers and one man shoveling is a good rule to follow. If practicable, avoid backfilling with frozen ground. When snow is on the ground, precautions should be taken to keep snow from mixing with the earth that is tamped back into the hole. Where conditions permit, coarse soil or gravel should be used at the top of the hole. Rock should be wedged firmly around poles that are set in solid rock. Bank the earth around the pole above the ground level and pack firmly. Be careful, however, not to bank it above the creosote line on treated poles.

60. Soft Soil Fixtures

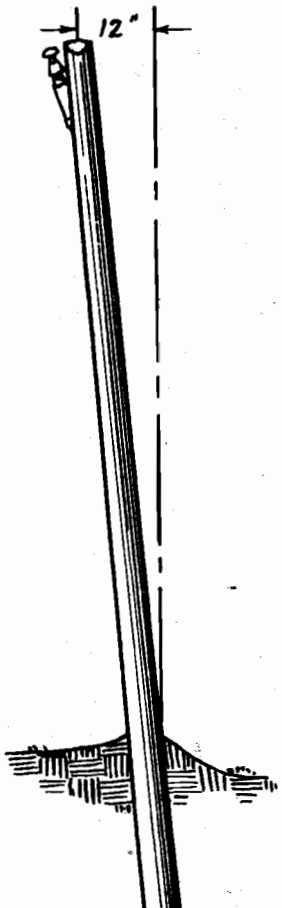
In swampy locations or in unstable ground where the usual type of construction will not afford the required stability, one of the methods shown on Pages 64, 65 and 66 may be used.

61. Pole Braces

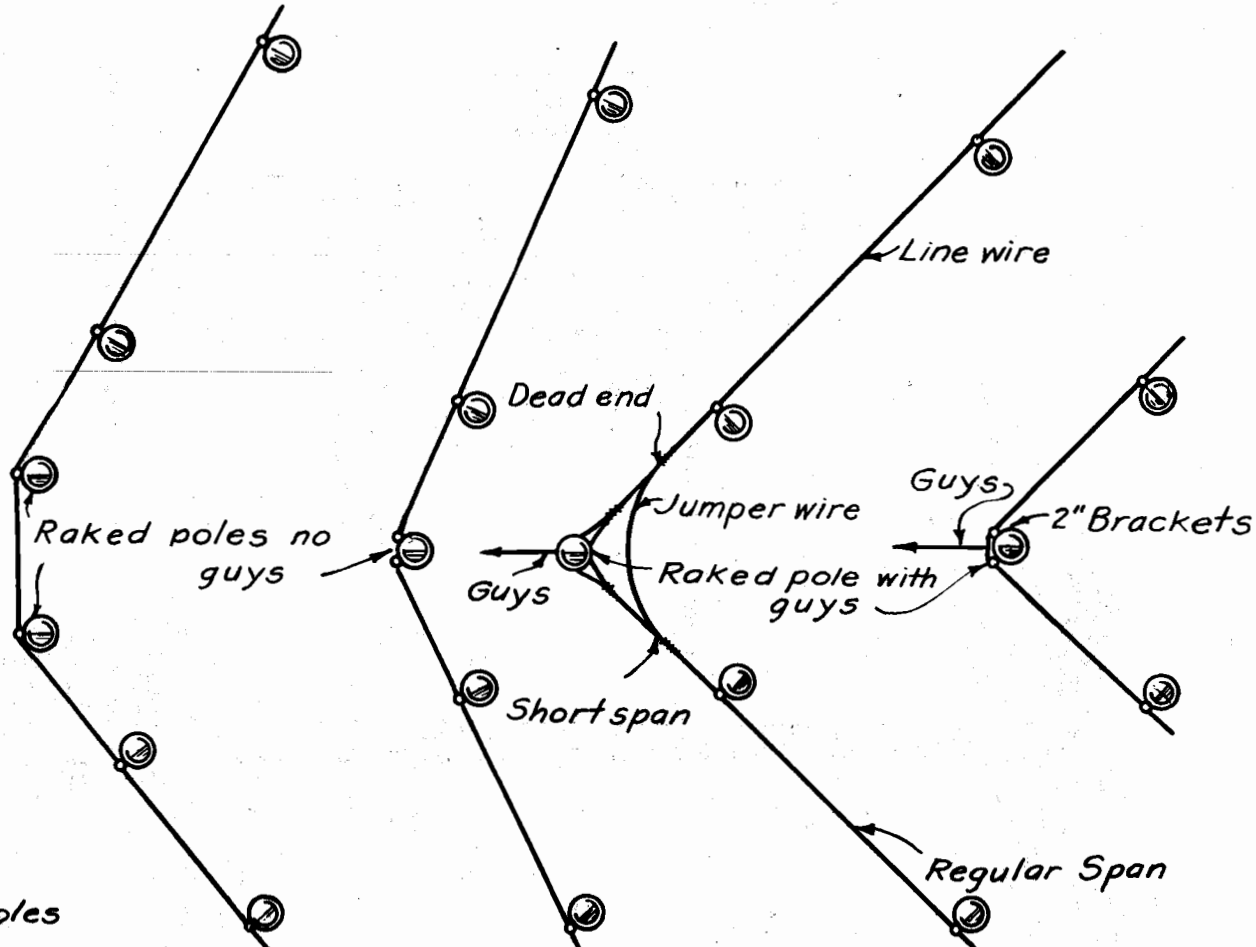
The use of pole braces as substitutes for anchor guys is not recommended. Under certain conditions, however, particularly where anchor guys cannot be placed, the use of pole braces may offer advantages. Pole braces should be placed as shown on Page 67.

62. Guys

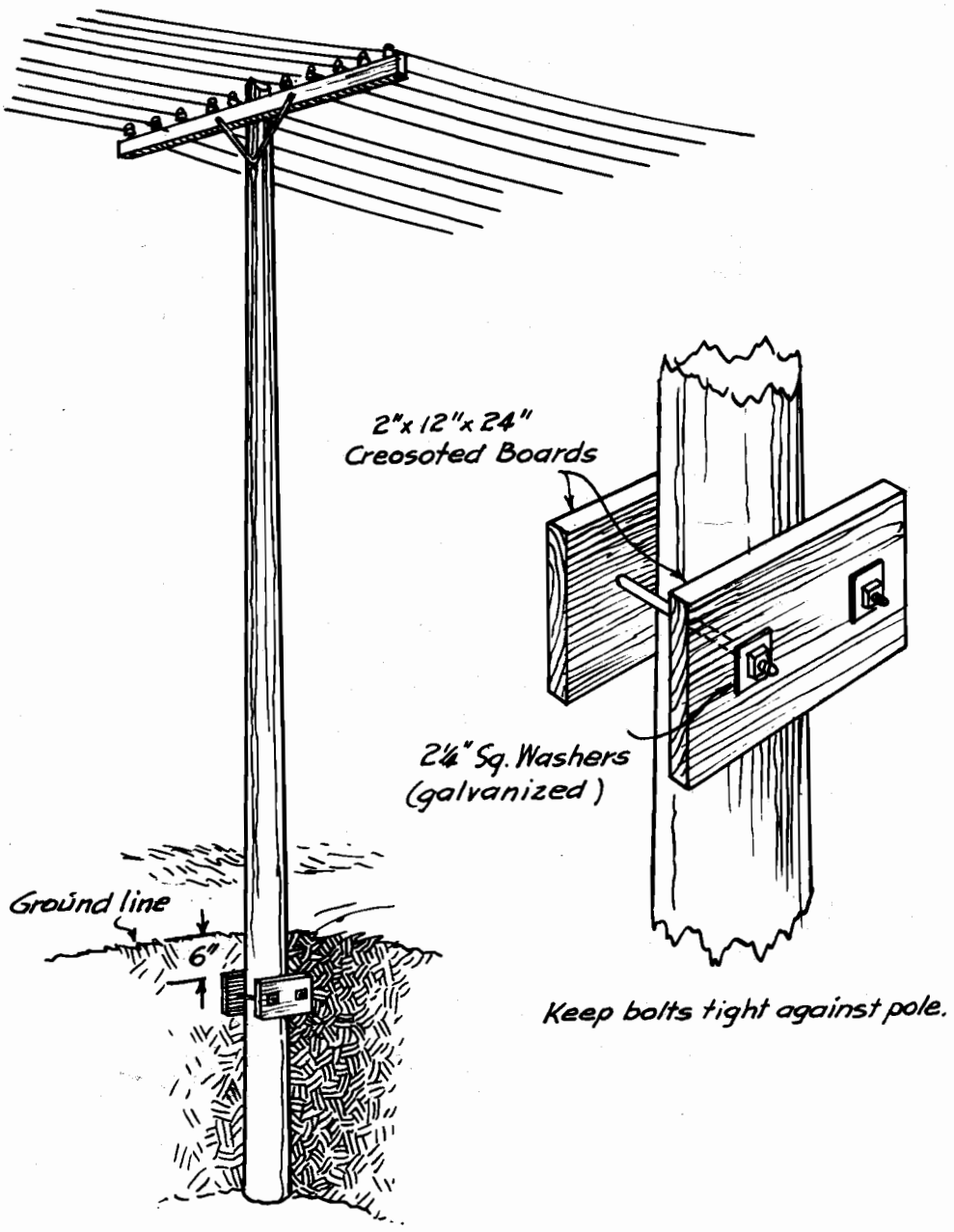
In many cases the use of guys is obviated by a proper amount of rake and a sufficient support of the pole below the ground line. Under ordinary conditions no guy will be required for bracket line construction unless the pull is 10 feet or over. Poles supporting crossarms should be guyed if the pull exceeds 4 feet.



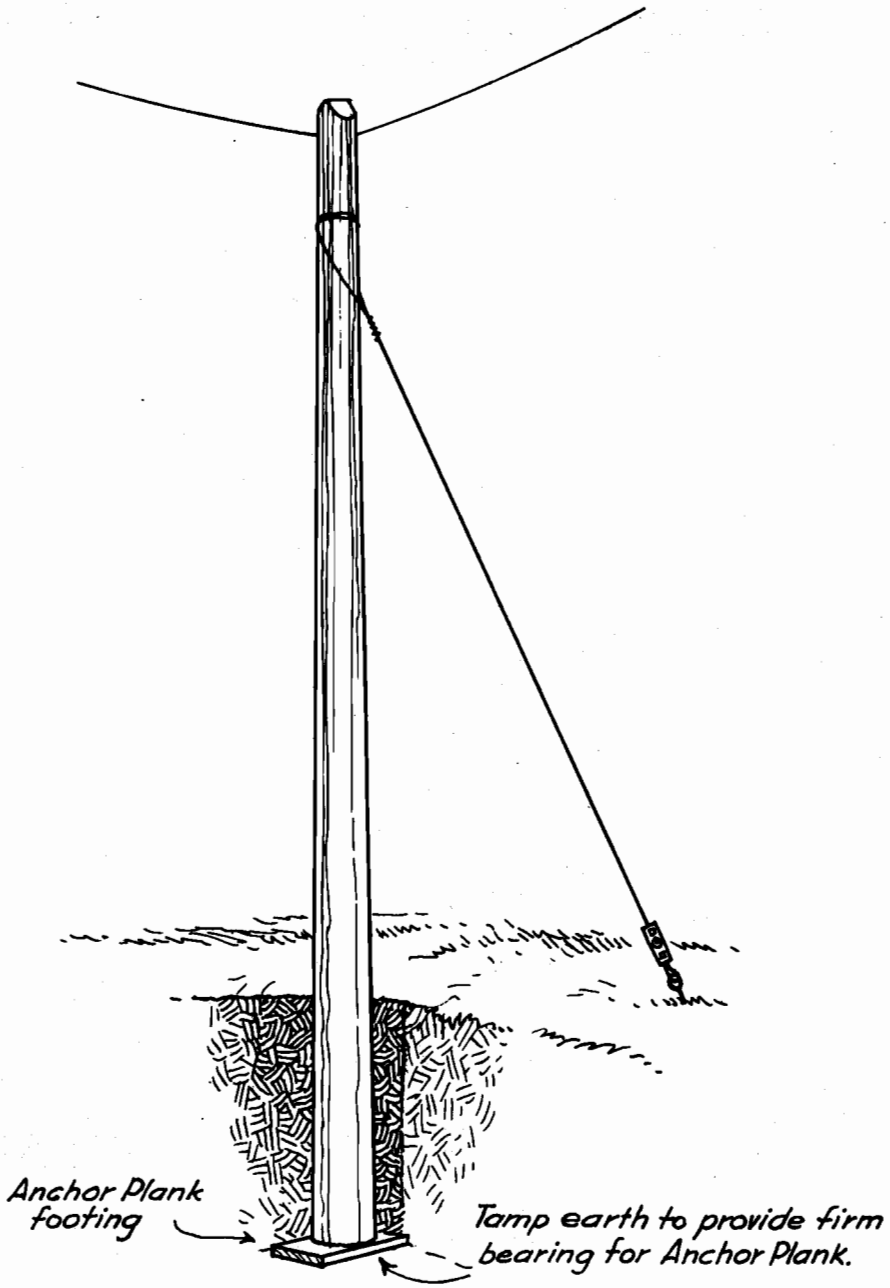
Rake to be 12" for poles



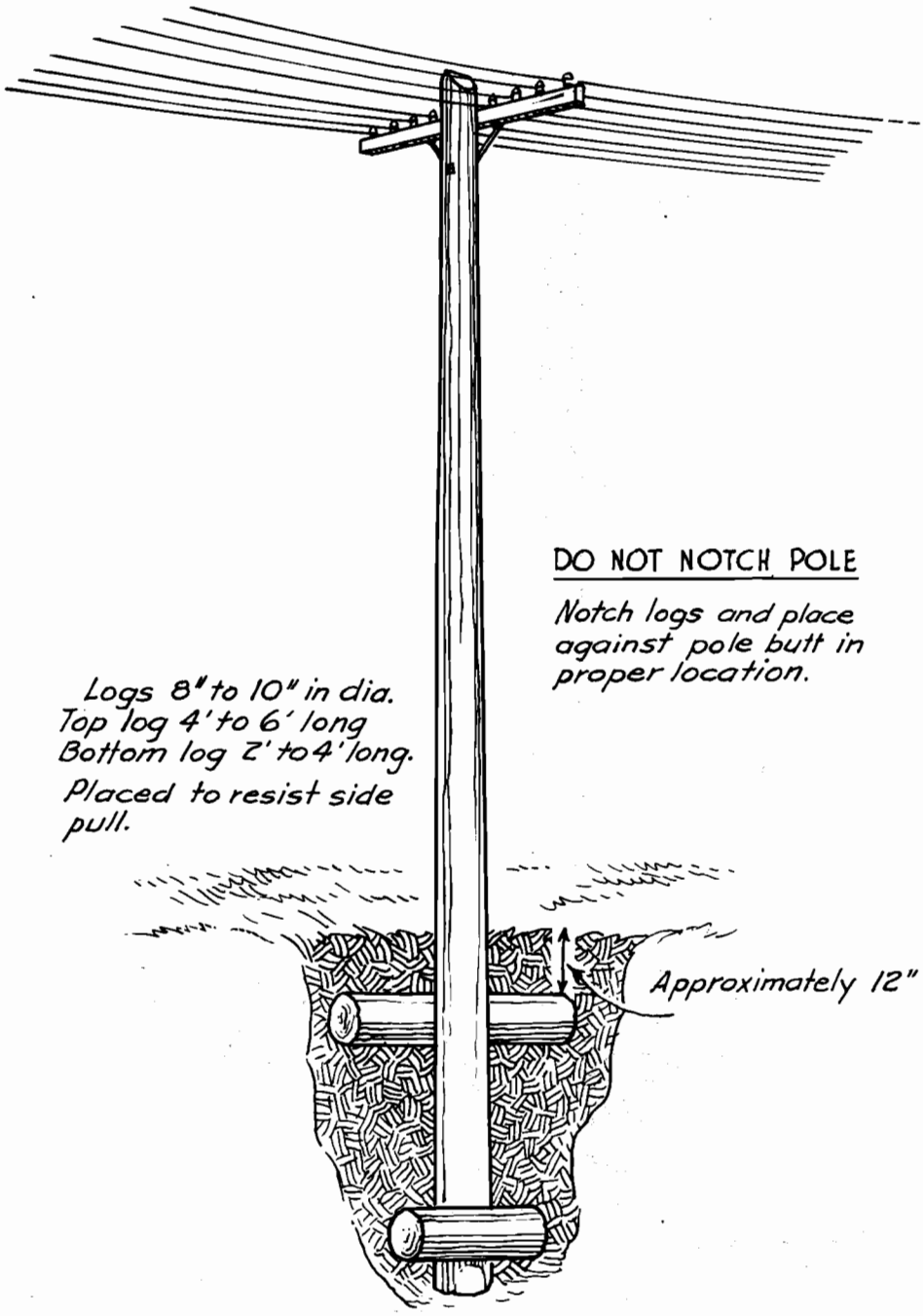
RAKING AND GUYING



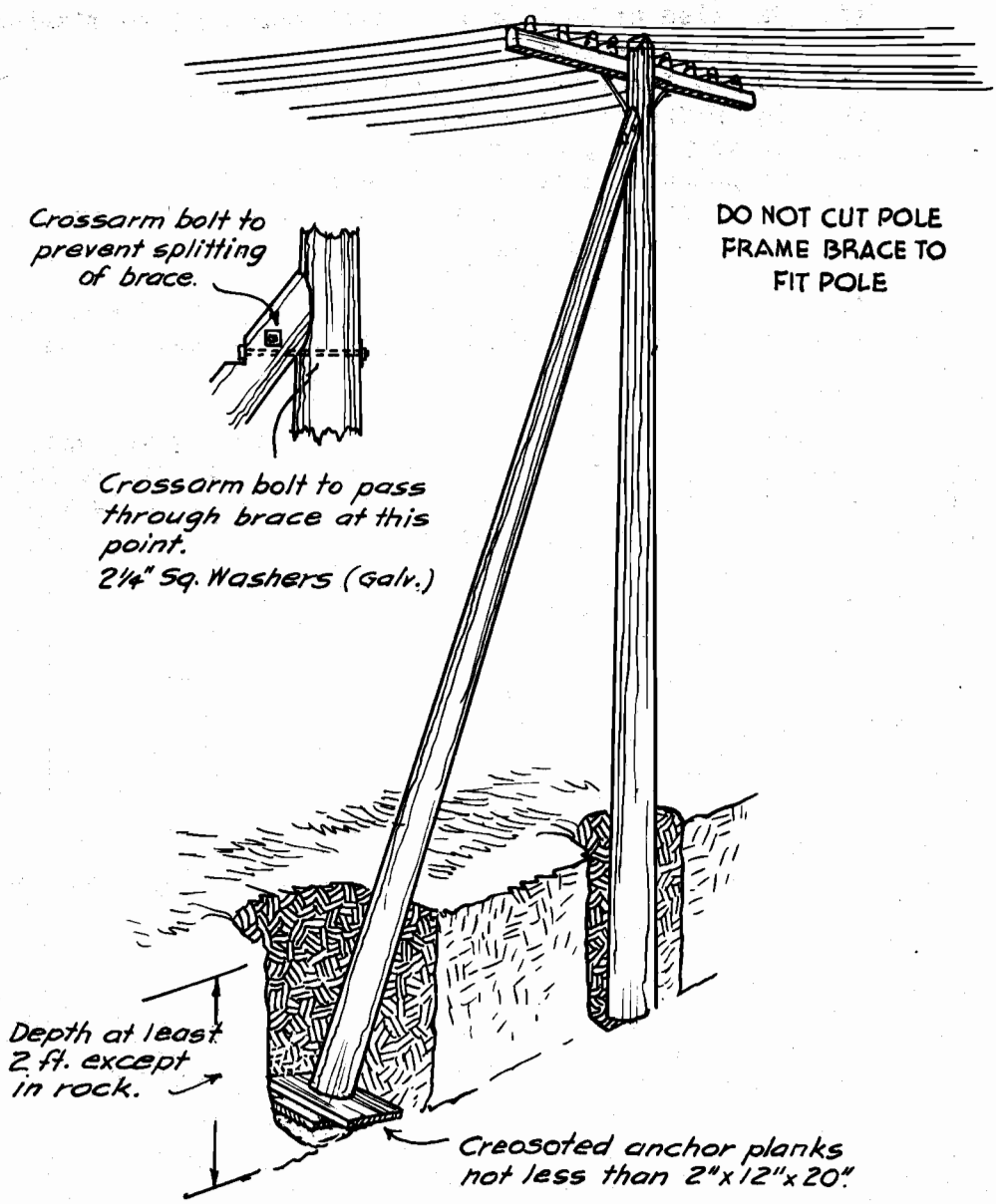
ANCHOR PLANK BRACING



ANCHOR PLANK UNDER POLE



ANCHOR LOG BRACING



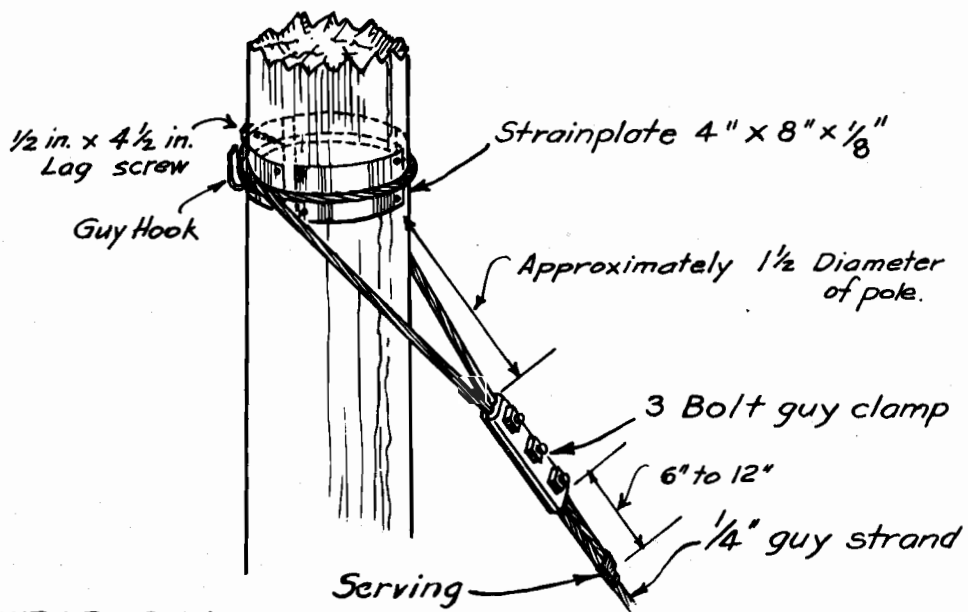
POLE PUSH BRACE

The following specific conditions call for the use of guys:

(a) On curves where the pull exceeds that shown above.
(b) On the two end poles of spans longer than 300 feet.
(c) On poles at each side of a crossing over highways and railroads.
(d) On poles at both ends of high-tension transmission line crossings.
(e) On the first and last pole of a line.
(f) On "H-frame" fixtures.
(g) On very steep slopes.
(h) On poles in swamps or loose ground.
(i) On alternate poles in places exposed to severe mud or snow conditions.

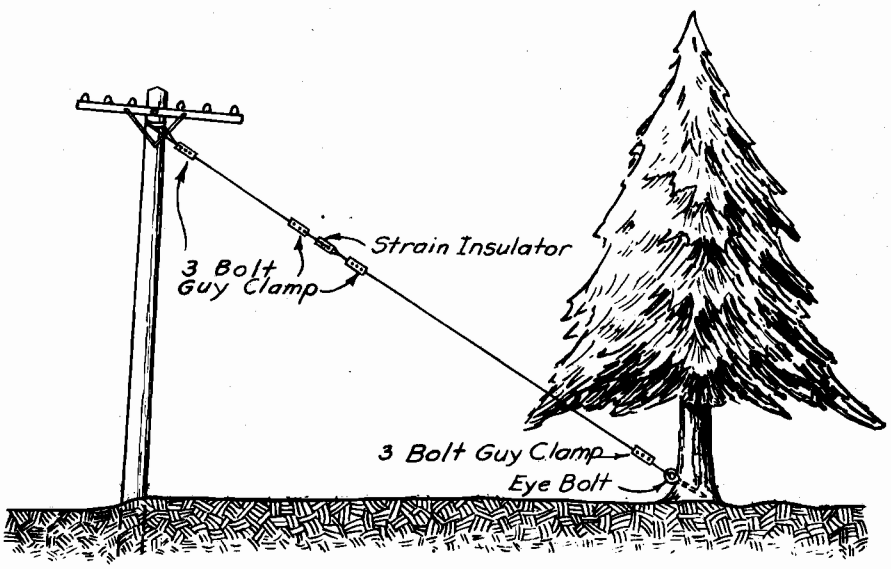
Two methods of guying may be used, and either is acceptable. The wrap method is the more common, but the eye-bolt method is widely used.

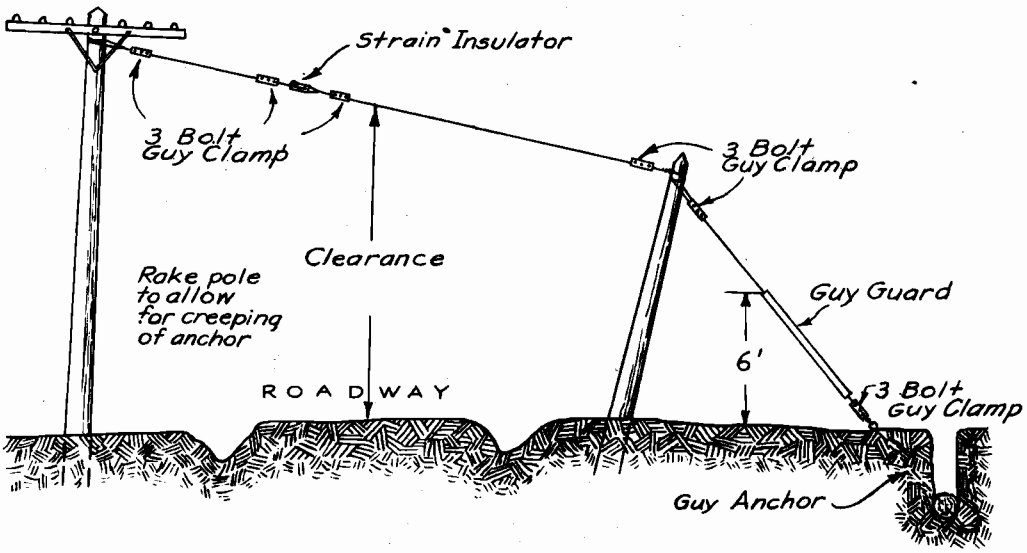
Standard construction of bracket line wrap guys calls for $\frac{1}{4}$" guy strand, light three-bolt guy clamps, guy hook, strain insulator and anchor. For crossarm line wrap guys the standard is the same except that 5/16" guy strand should be used.

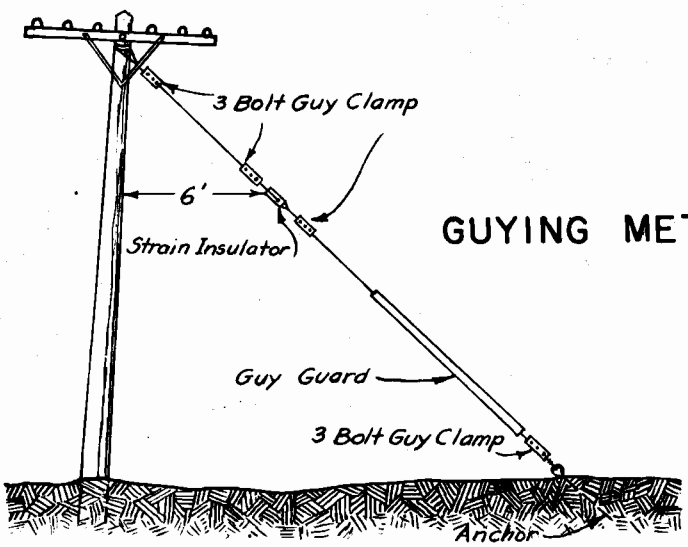


WRAP GUY

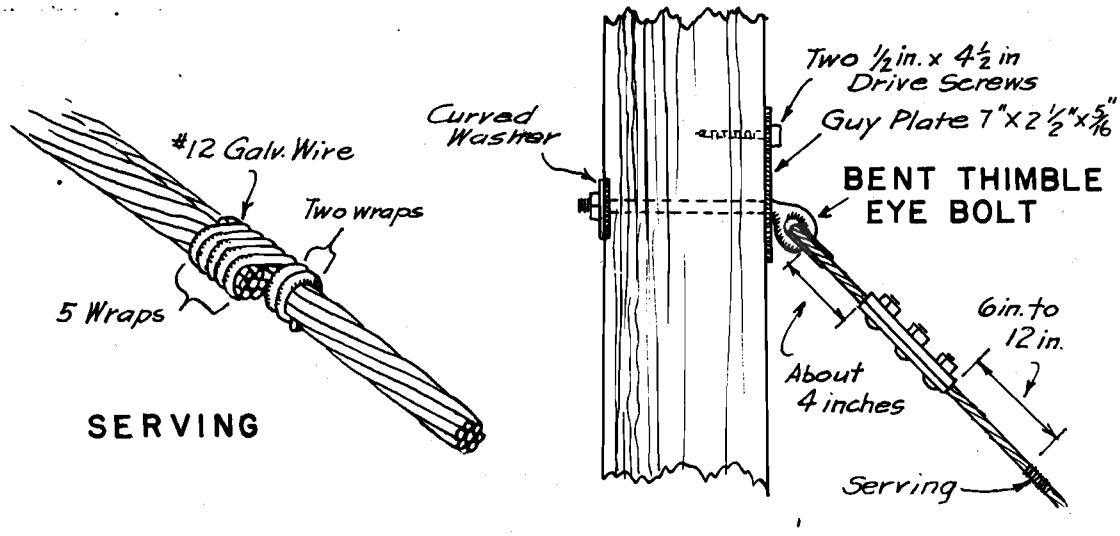
If the eye-bolt method of guying is used, the pole should be bored before setting. The guy can be made up on the ground and then attached by inserting the eye-bolt in the hole and drawing tight. Standard construction by this method eliminates the use of the guy hook, but substitutes an eye-bolt.



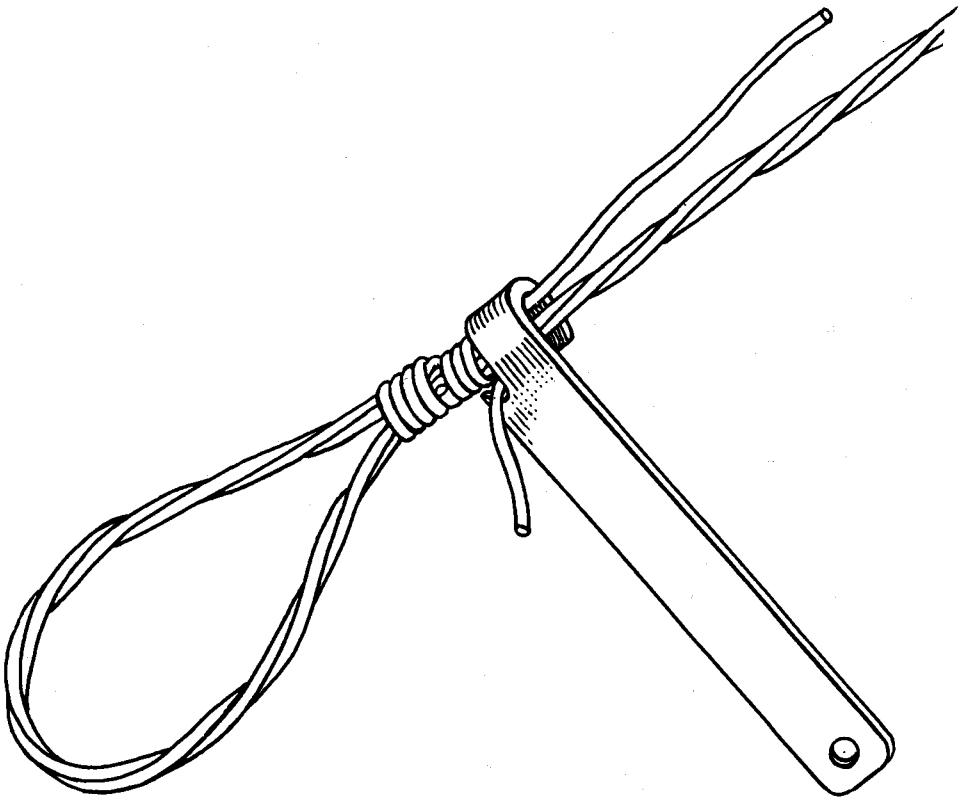




GUYING METHODS

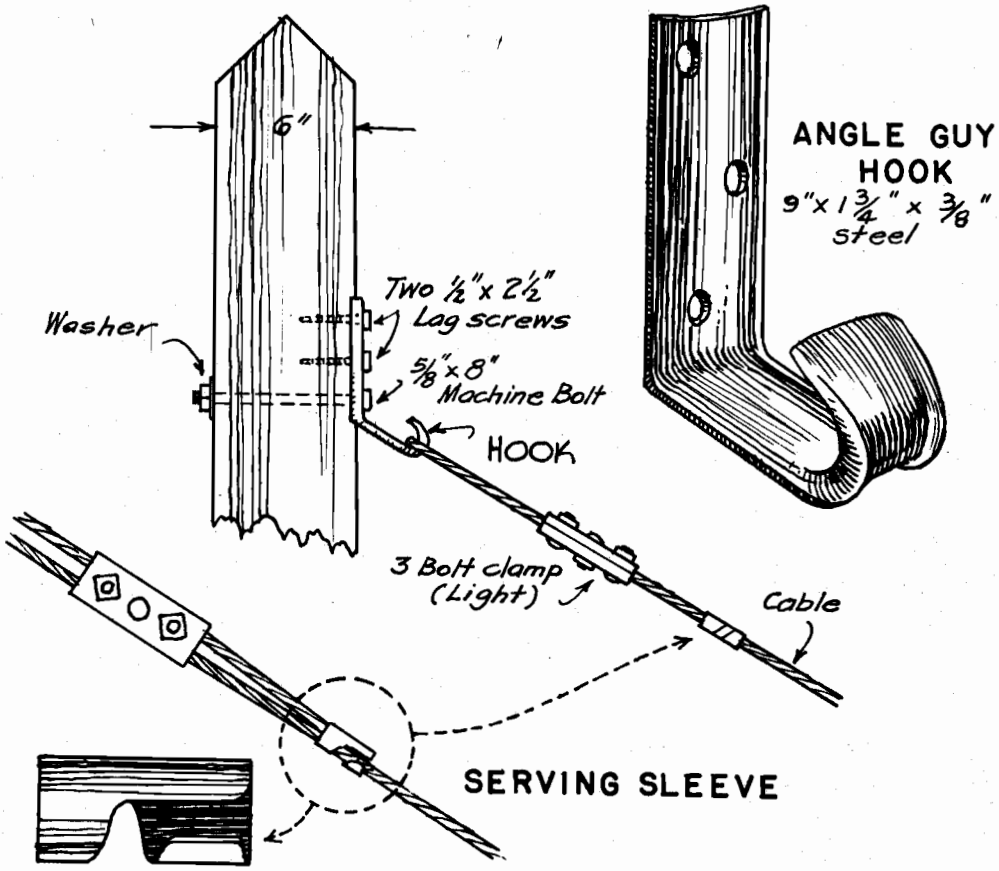


A handy serving tool is shown below. Its use is recommended in preference to pliers, because it does not score or nick the wires, and gives a tight, smooth, neat-appearing serve. If the wire is partly cut before serving, it will break off when the serving tool reaches the cut mark.



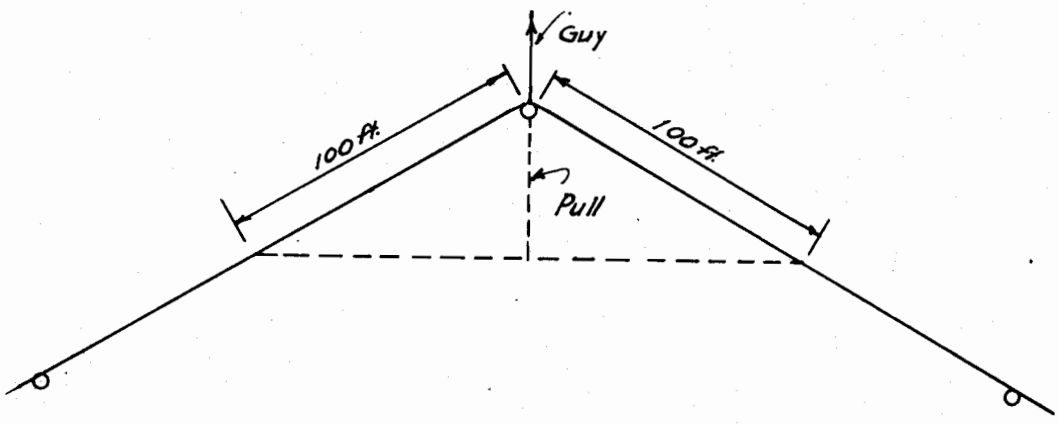
SERVING TOOL

Angle guy hooks are sometimes substituted for the eye-bolt method. These may be attached to the pole before setting. After the guy is made up on the ground, it may be looped over the hook.



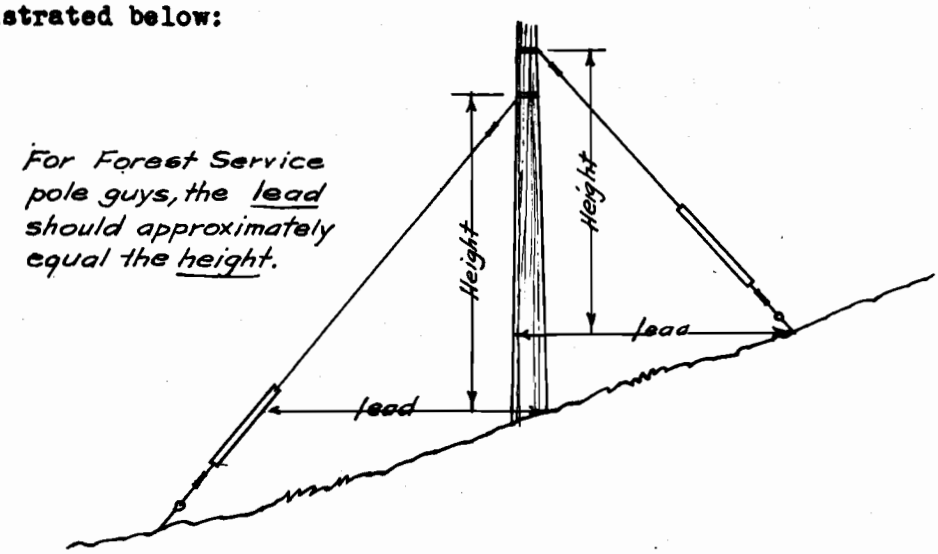
63. Determining Pull

Pull at a corner pole is defined as the distance in feet measured as illustrated below:



64. Determining Lead & Height

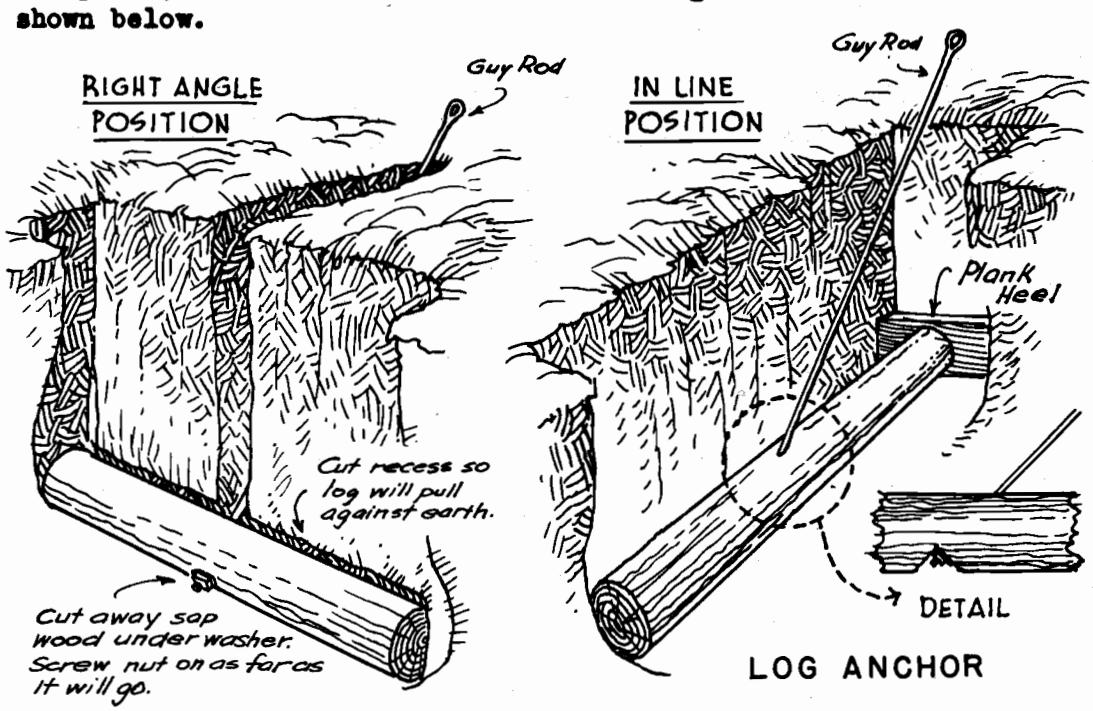
Lead and height of a guy are defined as distance measured as illustrated below:



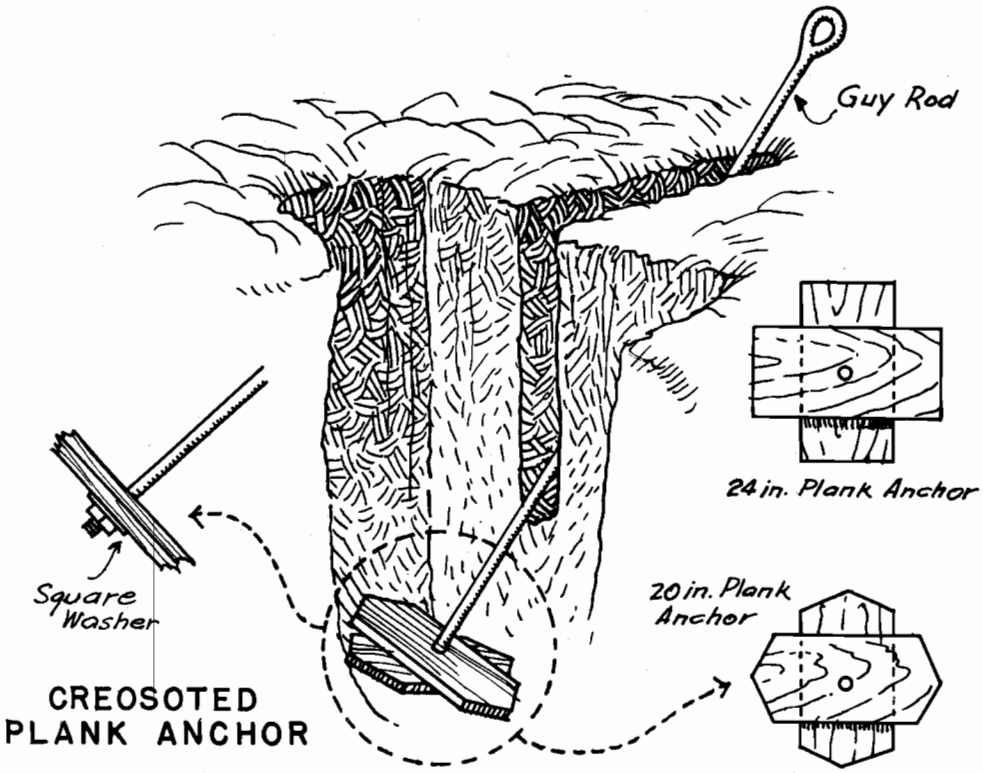
Guys should bisect the angle of strain. In order to lessen the strain, it is preferable to use a two-pole corner rather than make the curve on one pole.

65. Anchors

The most economical types of anchors are logs and planks. Planks should be treated before being set, but untreated logs may be used. Logs should have a diameter of 6 to 8 inches and should be from 4 to 6 feet long. A hole should be bored through the log at its mid-point, and an anchor rod attached. Log anchor installation is shown below.



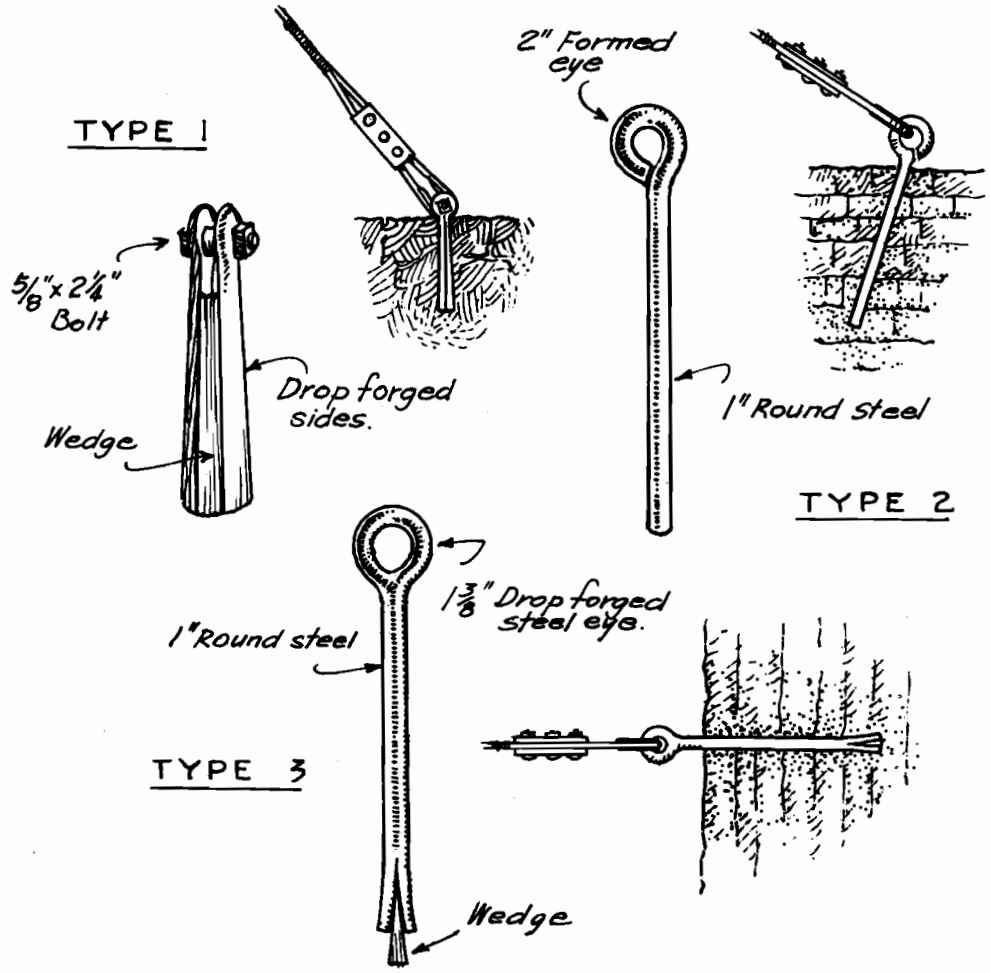
Plank anchors are installed as shown below:



The standard size for anchor guy rods is 5/8" x 6' except in moist or loose soil where an 8 foot rod is necessary to obtain sufficient purchase. Either galvanized iron or copper-covered rods may be used. Unless the thimble-eye rod is used, a guy thimble must be installed in the eye of the rod as a protection for the guy strand.

Patent anchors are satisfactory and are generally used in the commercial field. The cone type anchor is illustrated on Page 75. Other types of patent anchors include the four-way expanding plate anchor, the two-way expanding plate anchor and the screw anchor.

When necessary to set anchors in solid rock, any of the standard rock guy anchors may be used to advantage. Three types are illustrated on Page 74.

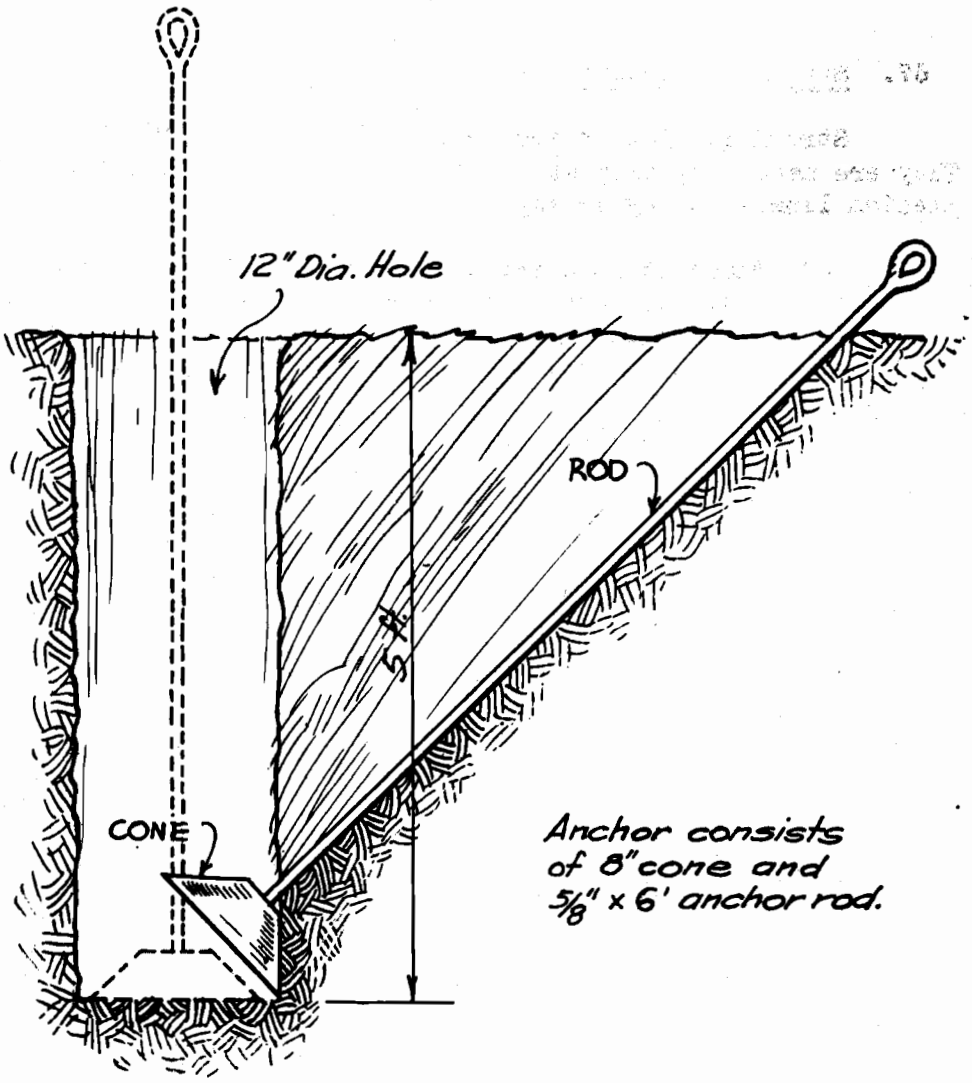


ROCK ANCHORS

Anchors should be located away from traveled ways in order to minimize the possibility of accidents.

66. Guy Protectors

Guy wire protectors or shields are not necessary at all installations. If there is a possibility that persons or animals will run into the guy, a protector must be attached. Metal shields are widely used, but for Forest Service use the standard is a wooden strip 1" x 3" x 8' attached in three places to the lower end of the guy wire.



METHOD OF SETTING ANCHOR

Hole must be at least 12" in diameter at the bottom and 4' deep for the average Forest Service lines having not more than six wires. If guy strain is unusually heavy on account of loose soil, hole depth should be increased to about 5'. Trench with shovel when digging hole. Then "bar out" just enough dirt to permit tilting the rod to proper angle, taking care to leave as much of an undisturbed shoulder of dirt as possible for the cone to pull against. Then fill and tamp thoroughly.

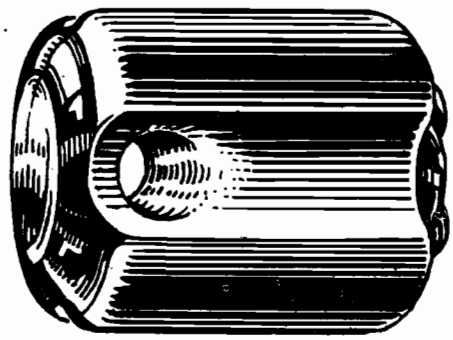
CONE TYPE ANCHOR

67. Strain Insulators

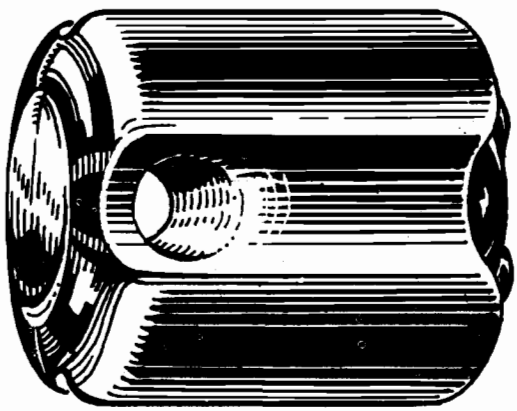
Strain insulators are not required in all guy installations. They are necessary only when the guy strand is exposed to power transmission lines. A guy is exposed:

(a) Where it is attached to a pole supporting power wires.
(b) Where it passes over, under or between power wires.
(c) Where the minimum horizontal distance between the guy and the power line is less than 10 feet.

A #500 strain insulator is sufficiently strong for most installations, but a #502 may be used with the heavier guy strand. Strain insulators should be placed at least 8 feet above the ground. If two are used, the second should be placed not less than 6 feet from the pole.



500



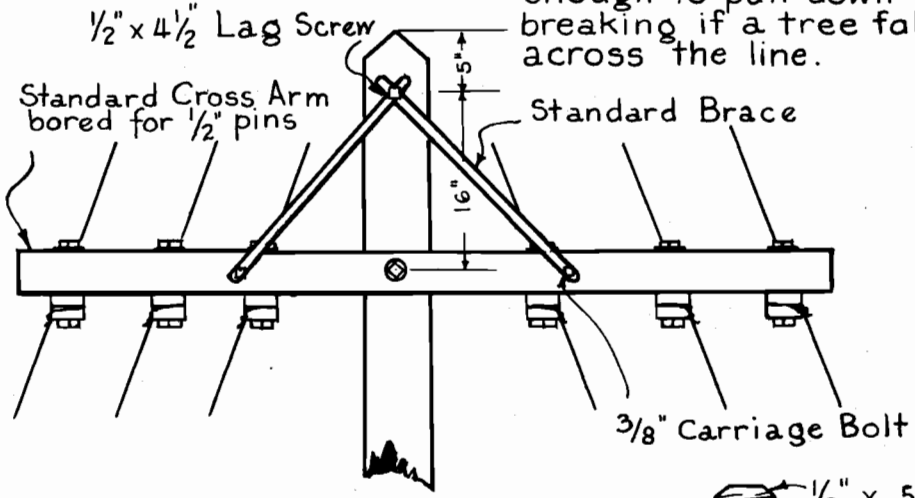
502

STRAIN INSULATORS

68. Underslung Insulators

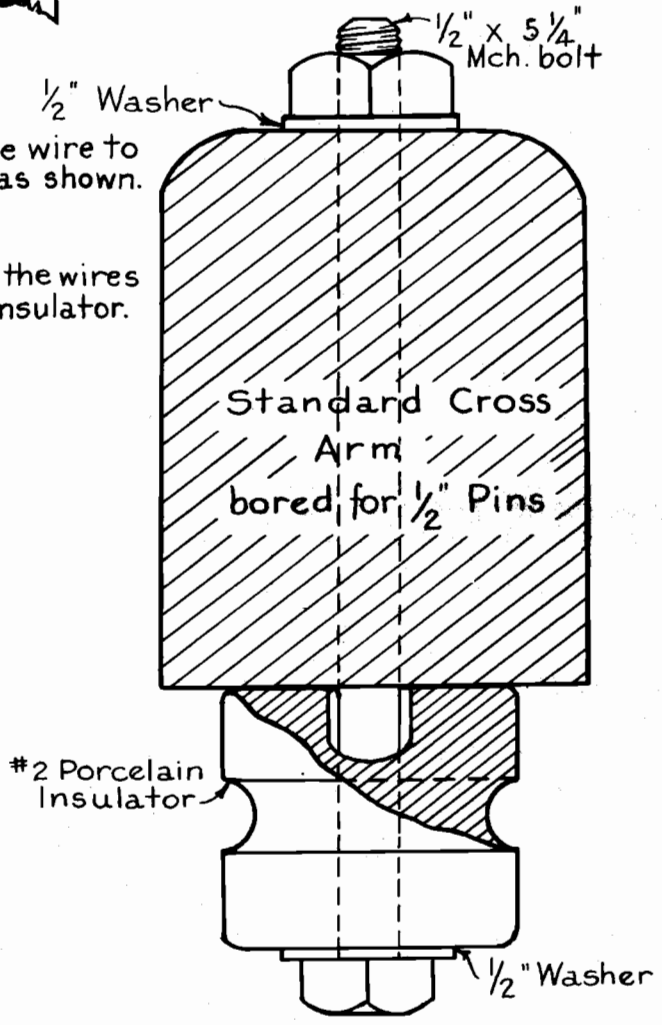
Underslung insulators permit tying the wires on the under side of the crossarm as shown on Page 77. The purpose of this type of construction is to allow the wires to strip off the insulator and fall to the ground without breaking the wire, crossarm or pole in case of falling trees or limbs. Better practice is to remove all trees and snags which may fall and cause trouble. This method of construction is not commercially recommended and should be used only in exceptional cases.

Use a Western Union tie, except only two wraps tight enough to hold the wire in place but loose enough to pull down without breaking if a tree falls across the line.



On straight-a-ways, the wire to be tied to the insulator as shown.

On corners and curves, the wires must pull against the insulator.



UNDERSLUNG INSULATOR CONSTRUCTION

69. Stub Construction

The use of stubs to reinforce telephone poles is not generally considered good practice in new lines, although it is permitted under Class C construction of Forest Service telephone lines. It is usually as expensive to set a stub as it would be to re-set a pole. The use of stubs should be confined to poles that are in good condition above the ground line and have sufficient height and diameter to meet the requirements of the wire load for the life of the reinforcement.

Stubs should be treated with preservative the same as poles. The kinds of timber considered satisfactory for poles are satisfactory for stubs. The standard sizes and lengths are given in Article 38.

Poles adjacent to highway, railroad or power line crossings should not be stubbed. The stub should always be placed on the side of the pole away from the road except on curves. On curves, the stub should be placed so that the pole will pull against its top.

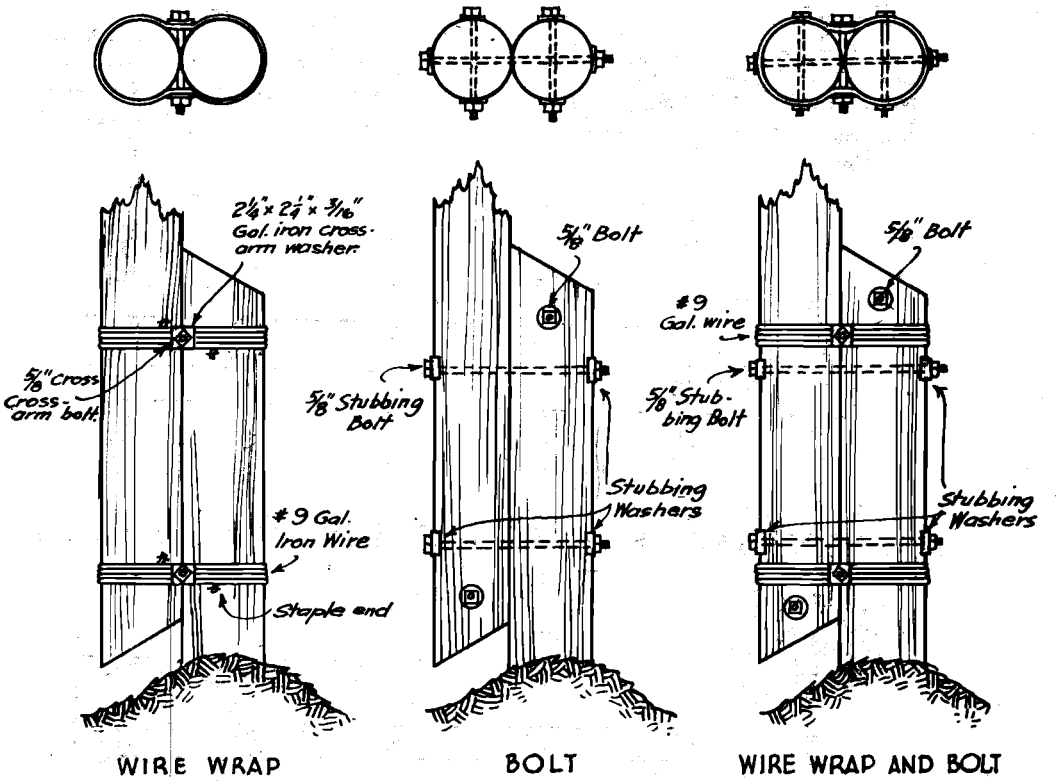
Standard methods of attaching stubs are shown on Page 79. The wrapped wire, tightened by bolts, is satisfactory for light duty service. In areas subject to strong winds which tend to cause side play, the wire wrapped bolt type is preferable. The band type or a combination of the wire and bolt types should be used for heavy duty service. In all cases a good contact between the stub and the pole must be provided.

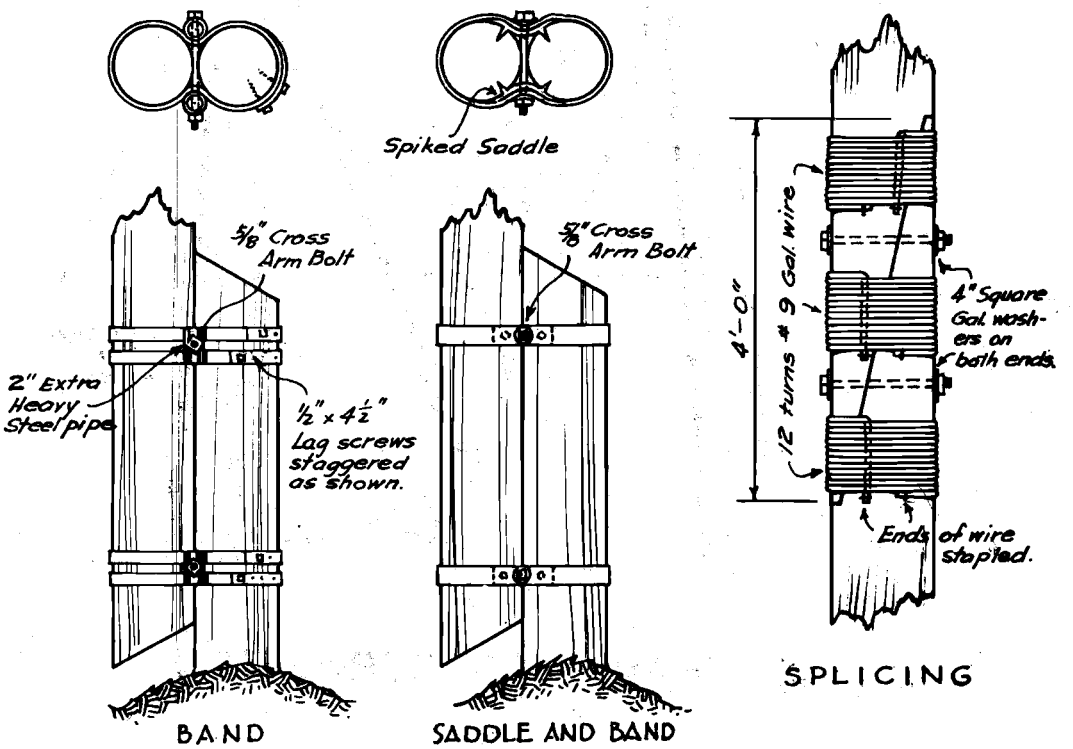
A rock is not needed under the pole. If the stub is properly installed, it will support the weight of the pole satisfactorily. The butt of the pole should be cut as shown on Page 79. This facilitates drainage and prevents decay from entering the butt. The cut should be made at the time the pole is removed from the old butt. The pole can then be set slightly to one side, resting on a flat rock, and the old butt removed.

70. Long Span Construction

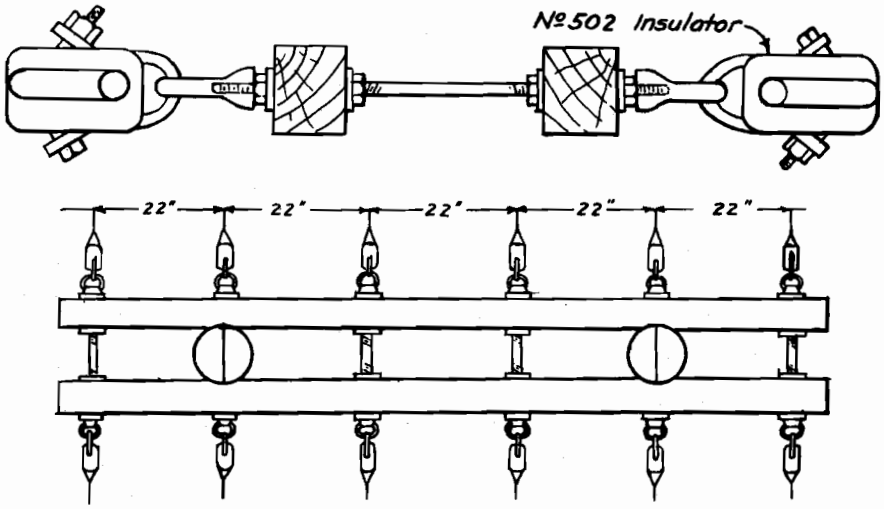
Long spans may be used at such places as river crossings, deep gorges, areas where snow slides are common, and where suitable line grading cannot be obtained. They should be used only in exceptional cases and not as a rule.

For more than four wires, a second crossarm should be used. For spans of 170 to 250 feet, space the pins 18" to 22", according to the length of the span. Page 80 shows the details for the "H" Frame type of construction for a 500 foot span.

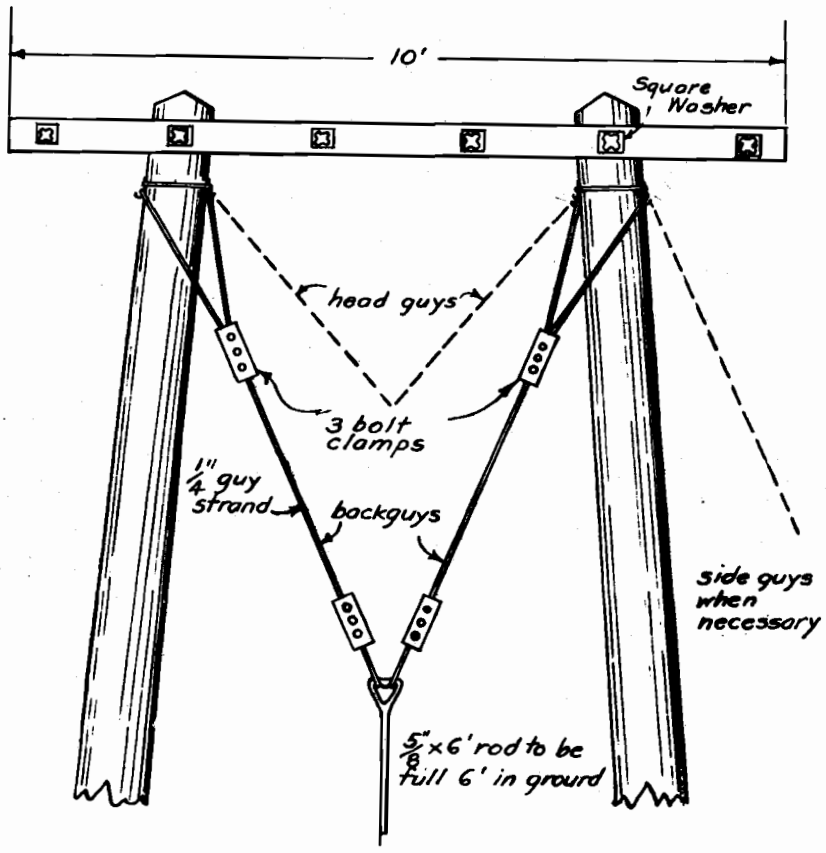




STUBBING METHODS



PIN SPACING FOR SPANS UP TO 500 FEET



H FRAME CONSTRUCTION

TABLE FOR LONG SPAN CONSTRUCTION

Length of Span (feet)	Kind of Wire to be used	Type of Construction	Minimum Pin Spacing
250 - 500	#10 Copper-covered	Vertical	22"
500 - 1,000	#8 Copper-covered	Vertical	28"
1,000 or over	#6 Copper-covered	Vertical	36"
250 - 500	#10 Copper-covered	Crossarm	22"
500 - 1,000	#8 Copper-covered	H Frame	36"
1,000 or over	#6 Copper-covered	H Frame	36"

71. Clearance

The following clearances above the ground will be satisfactory for lines extending along the side of the road.

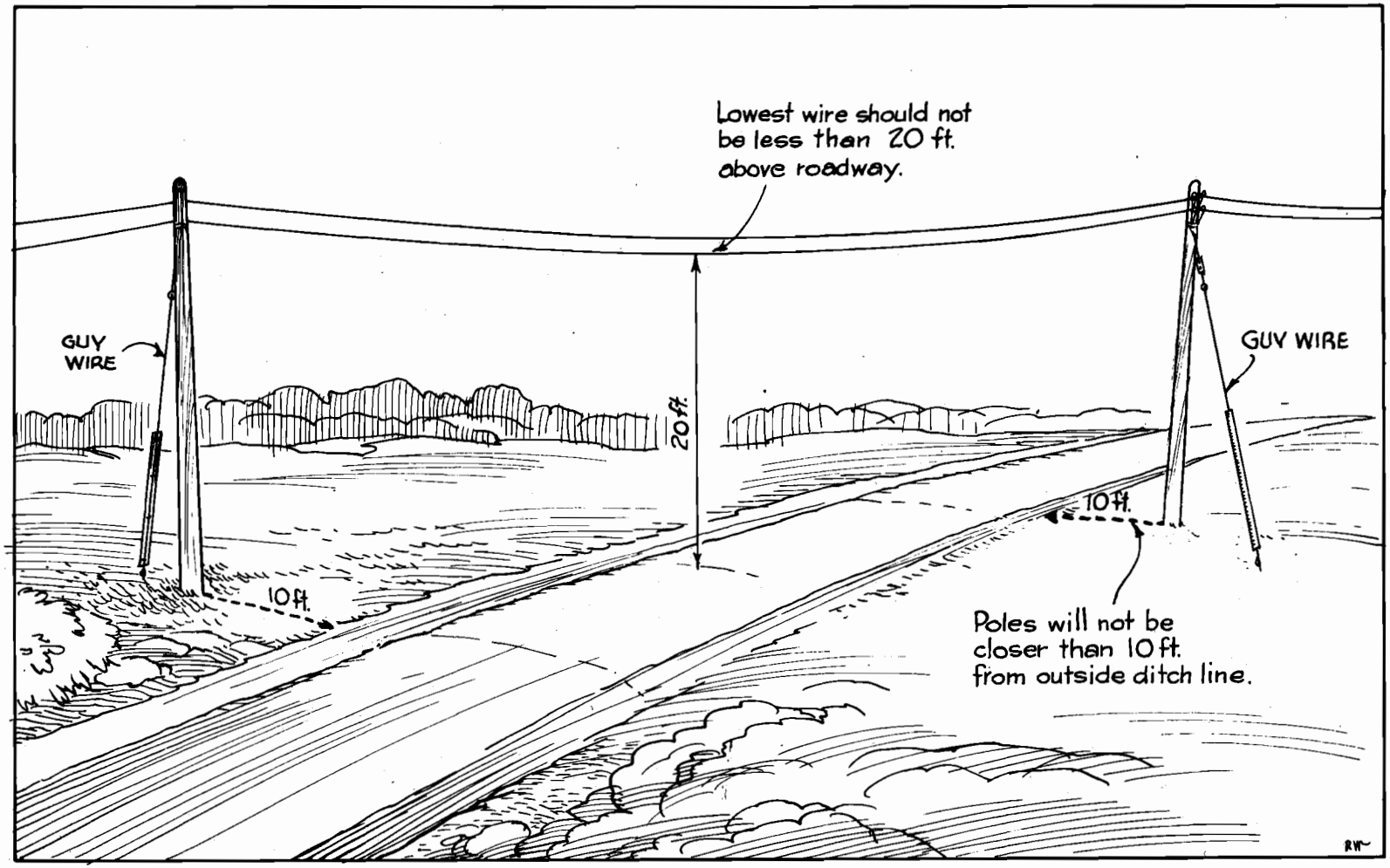
a. Along roads or highways in thickly settled districts, a minimum of 18 feet.
b. Along roads or highways in rural districts, a minimum of 15 feet.
c. When there is no probability of travel under the line a minimum of 12 feet.

72. Crossings

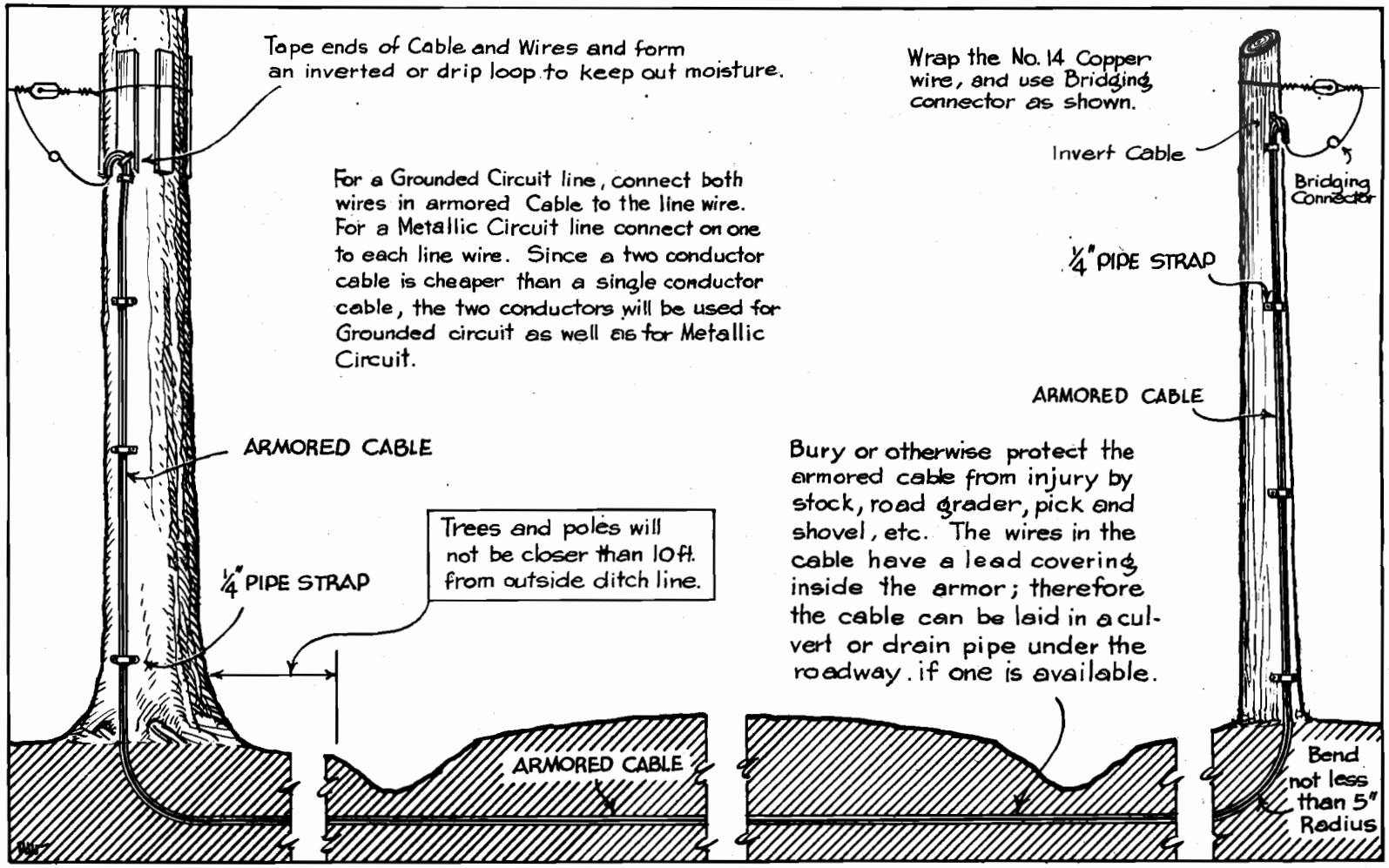
(1) Highways

Highway crossings should ordinarily be made overhead, if consistent with the State Highway Commission's policy, with short crossing spans made according to the best commercial practice. A crossing span should not ordinarily be over 100 feet in length. If it is a bracket line, two brackets should be used on the pole on either side of the road as shown on Page 82. These poles should be higher than the ordinary line pole so that a clearance of at least 20 feet will be secured.

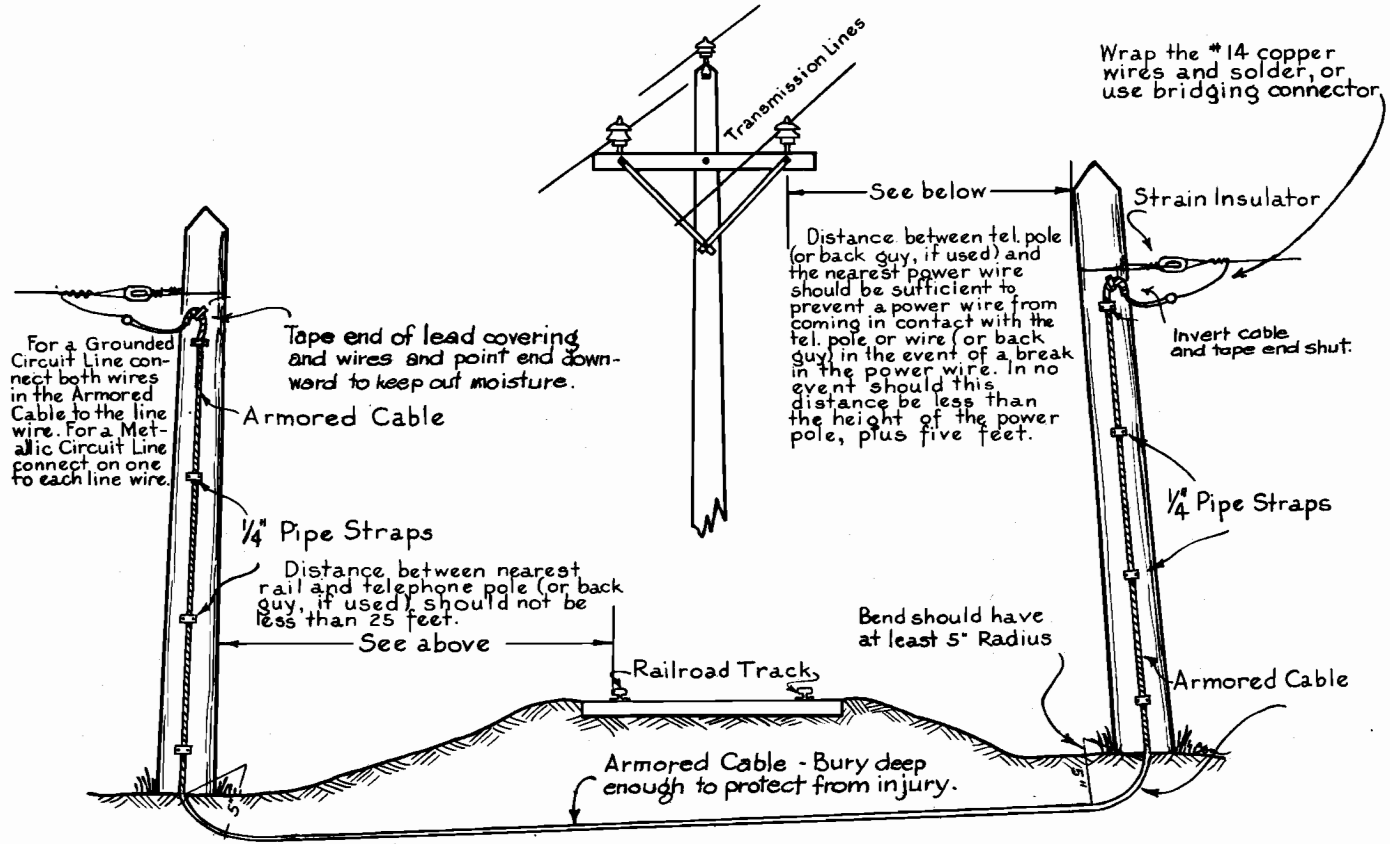
Along highways where aesthetic values are of prime importance, it will often be possible to cross over at a through cut and so keep the wires and poles well screened from view. With the approval of the Regional Forester, underground crossings may be made as shown on Page 83. This type of crossing is often necessary when it is impossible to secure the required overhead clearance, when aesthetic values are involved, or when it is required by the State Highway Commission.



OVERHEAD ROAD CROSSING



UNDERGROUND ROAD CROSSING



TELEPHONE LINE CROSSING UNDER RAILROAD OR TRANSMISSION LINE

(2) Railroads

A crossing with a railroad right-of-way must be made as required by the Railroad Company and in compliance with the State laws. A right-of-way easement must be secured from the Railroad Company. A crossing of this type should ordinarily be made underground as shown on Page 84. In no event should a guy or pole be set closer than 25 feet to the nearest rail.

(3) Electric Power Lines

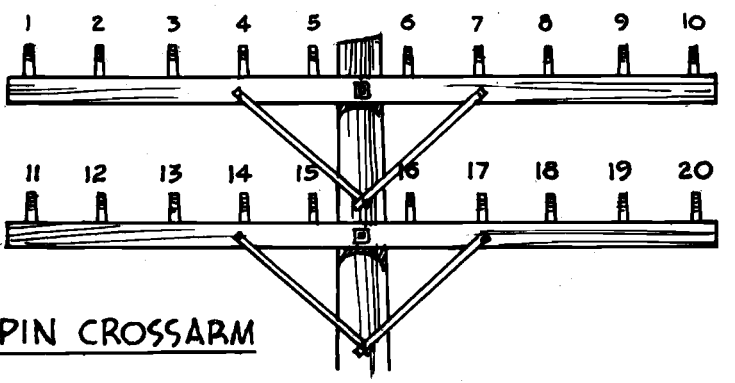
If the power line is properly constructed and carries not to exceed 7,500 volts, the crossing may be aerial with the telephone line at least 6 feet below the power wires. Where the line voltage is from 7,500 to 25,000 volts, an aerial crossing may be made with the telephone line at least 9 feet below the power line. Where the power line voltage is in excess of 25,000 volts, the crossing must be made underground. An underground crossing is the safest and most preferable method. Aerial crossings should always be at right angles to the power line so that inductive interference will be at the minimum.

(4) Other Telephone Lines

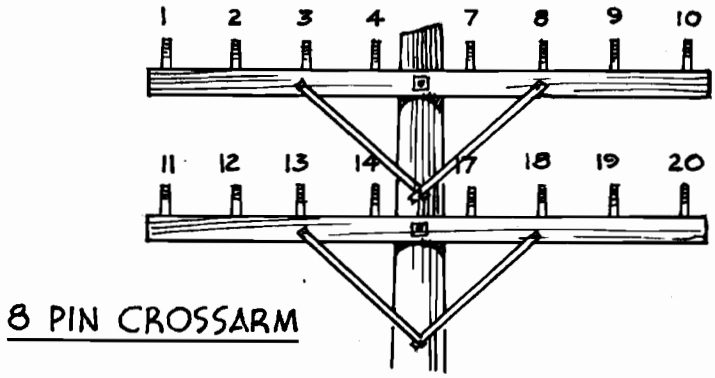
Crossings with other telephone lines should generally be aerial, with a short crossing span and a clearance of at least 3 feet between lines. Whether such crossings should be made with the telephone wire over or under the wires of the other lines will be determined by the danger of the other wires falling upon the telephone line or by other local conditions.

73. Numbering of Pin Positions

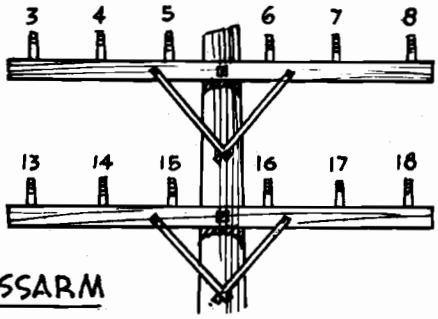
Pin positions are numbered from left to right facing along the line in the direction of the increasing pole numbers. The preferred numbering system for 6, 8 and 10 pin crossarms is shown:



10 PIN CROSSARM



8 PIN CROSSARM



6 PIN CROSSARM

74. Span Lengths

The length of spans should be governed by the best commercial practice. The average span lengths for various kinds of wire are shown below:

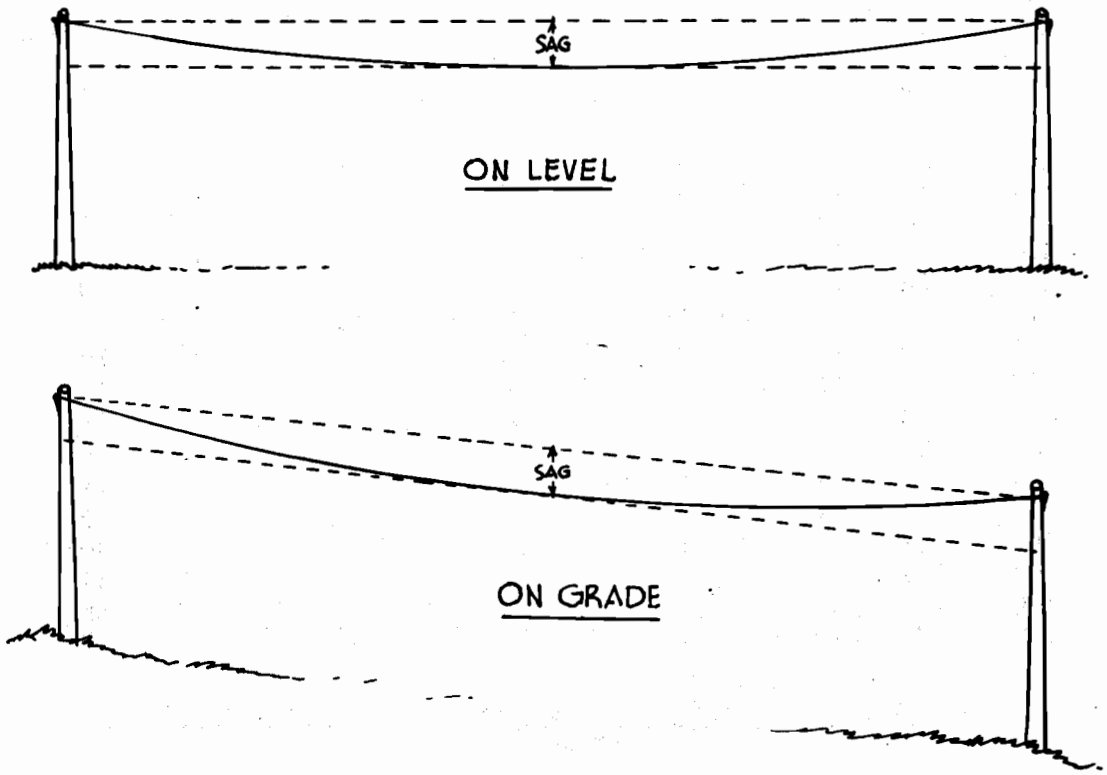
Kind of Wire	Span Length On Straight Stretches (feet)	Span Length On Curves or Corners (feet)
#9 iron	140 to 160	125 to 150
#12 copper-covered	160 to 175	135 to 150
#10 copper	125 to 140	100 to 125

In regions where there is no danger from sleet or ice, it will be permissible to increase the span length.

75. Sag

The stresses in telephone wire undergo changes with variations in temperature. This makes it necessary to provide for the extreme variations in each span, by allowing a sufficient amount of sag.

Sag is defined as the distance measured as shown below:



Correct sag is extremely important. Two methods are commonly used to determine the proper amount of sag in a span. One is the sighting method by the use of a sag gauge and the other is the oscillation method. In obtaining the proper sag by either method, proceed as follows:

MEDIUM LOADING SAG TABLE

NUMBER 12 - 40% COPPER-COVERED AND NUMBER 9 EBB IRON WIRE

Short Spans

Length of span in feet:	Temperature Degrees Fahrenheit										
	100	90	80	70	60	50	40	30	20	10	0
	Minimum Sag in Inches										
100	9	8	7	6	6	5	5	4	4	3	3
110	11	10	9	8	7	6	6	5	5	4	4
120	13	12	10	9	8	7	7	6	5	4	4
130	16	14	12	11	10	9	8	7	6	6	5
140	18	16	14	13	11	10	9	8	7	7	6
150	21	19	17	15	13	12	11	9	9	8	7
160	24	21	19	17	15	13	12	11	10	9	8
170	27	24	21	19	17	15	14	12	11	10	9
180	30	27	24	22	19	17	15	14	12	11	10
190	34	30	27	24	21	19	17	15	14	13	12
200	38	33	30	27	23	21	19	17	15	14	13
210	41	37	33	30	26	23	21	19	17	16	14
220	46	40	36	32	28	25	23	20	19	17	16
230	50	44	39	35	31	28	25	22	21	19	17
240	54	48	43	39	34	30	27	24	22	21	19
250	59	52	46	42	37	33	30	26	24	22	20
275	71	63	56	51	44	40	36	32	30	27	24
300	85	75	67	60	53	47	43	38	35	32	29
350	106	97	89	82	75	68	61	55	50	45	40
400	132	124	117	110	103	88	77	67	63	50	47
450	164	157	150	144	138	120	102	87	78	68	58
500	203	196	190	185	180	160	132	110	93	80	72

Number 8 - 40% Copper-covered Wire (Long Spans)

(Sag in Feet)

600	14	14	13	13	13	13	12	12	12	11	11
700	21	21	20	20	20	20	19	19	19	18	18
800	30	30	29	29	29	29	28	28	28	27	27
900	40	40	39	39	39	39	38	38	38	37	37
1000	51	51	50	50	50	50	49	49	49	48	48
1100	65	65	64	64	64	64	63	63	63	62	62

Number 6 - 40% Copper-covered Wire (Long Spans)

(Sag in Feet)

600	10	10	9	9	9	8	8	8	7	7	7
700	13	13	12	12	12	11	11	11	10	10	10
800	19	19	18	18	18	17	17	17	16	16	16
900	27	27	26	26	26	25	25	25	24	24	24
1000	36	36	35	35	35	34	34	34	33	33	33
1100	45	45	44	44	44	43	43	43	42	42	42
1200	55	55	54	54	54	53	53	53	52	52	52
1300	66	66	65	65	65	64	64	64	63	63	63
1400	78	78	77	77	77	76	76	76	75	75	75
1500	91	91	90	90	90	89	89	89	88	88	88

HEAVY LOADING SAG TABLE

NUMBER 6 and NUMBER 8 - 40% COPPER-COVERED WIRE (Short Spans)

Length of span in feet:	Temperatures Degrees Fahrenheit										
	100	90	80	70	60	50	40	30	20	10	0
	Minimum Sag in Inches										
100	9	8	7	6	6	5	5	4	4	3	3
110	11	10	9	8	7	6	6	5	5	4	4
120	13	12	10	9	8	7	7	6	5	5	4
130	16	14	12	11	10	9	8	7	6	6	5
140	18	16	14	13	11	10	9	8	7	7	6
150	21	19	17	15	13	12	11	9	9	8	7
160	24	21	19	17	15	13	12	11	10	9	8
170	27	24	21	19	17	15	14	12	11	10	9
180	30	27	24	22	19	17	15	14	12	11	10
190	34	30	27	24	21	19	17	15	14	13	12
200	38	33	30	27	23	21	19	17	15	14	13
210	41	37	33	30	26	23	21	19	17	16	14
220	46	40	36	32	28	25	23	20	19	17	16
230	50	44	39	35	31	28	25	22	21	19	17
240	54	48	43	39	34	30	27	24	22	21	19
250	59	52	46	42	37	33	30	26	24	22	20
260	64	59	54	48	42	38	34	31	28	26	24
270	69	63	58	53	48	44	40	36	33	30	28
280	74	69	64	59	55	51	46	42	39	36	33
290	79	75	71	67	63	58	53	49	46	43	40
300	84	81	78	75	72	67	62	58	54	51	48
Number 8 - 40% Copper-covered Wire (Long Spans) (Sag in Feet)											
350	12	12	12	11	11	11	10	10	10	9	9
400	17	17	17	16	16	16	15	15	15	14	14
450	22	22	22	21	21	21	20	20	20	19	19
500	25	25	25	24	24	24	23	23	23	22	22
600	37	37	37	36	36	36	35	35	35	34	34
700	53	53	53	52	52	52	51	51	51	50	50
800	71	71	71	70	70	70	69	69	69	68	68
900	91	91	91	90	90	90	89	89	89	88	88
1000	123	123	123	122	122	122	121	121	121	120	120
Number 6 - 40% Copper-covered Wire (Long Spans) (Sag in Feet)											
350	9	9	9	8	8	8	7	7	7	6	6
400	11	11	11	10	10	10	9	9	9	8	8
450	13	13	13	12	12	12	11	11	11	10	10
500	15	15	15	14	14	14	13	13	13	12	12
600	25	25	25	24	24	24	23	23	23	22	22
700	36	36	36	35	35	35	34	34	34	33	33
800	48	48	48	47	47	47	46	46	46	45	45
900	63	63	63	62	62	62	61	61	61	60	60
1000	79	79	79	78	78	78	77	77	77	76	76
1100	90	90	90	89	89	89	88	88	88	87	87
1200	115	115	115	114	114	114	113	113	113	112	112

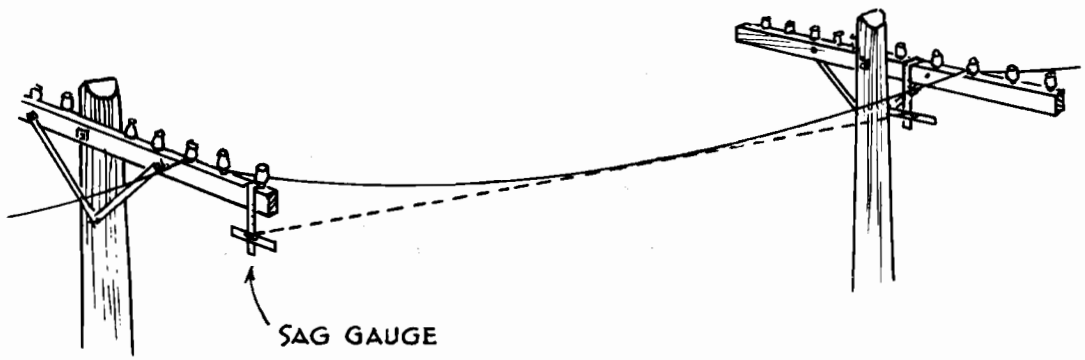
1. Estimate the length of the test span and use the value in the sag table for the span length within the nearest 10 feet.

2. Obtain the temperature of the air by means of a thermometer. Use the temperature column in the sag table nearest to the determined temperature.

SIGHTING METHOD OF OBTAINING SAG

1. Select a span of average length about 10 spans from the dead-end point, or point where the wire is permanently connected. Hang a sag gauge on the crossarm at each end of the span.

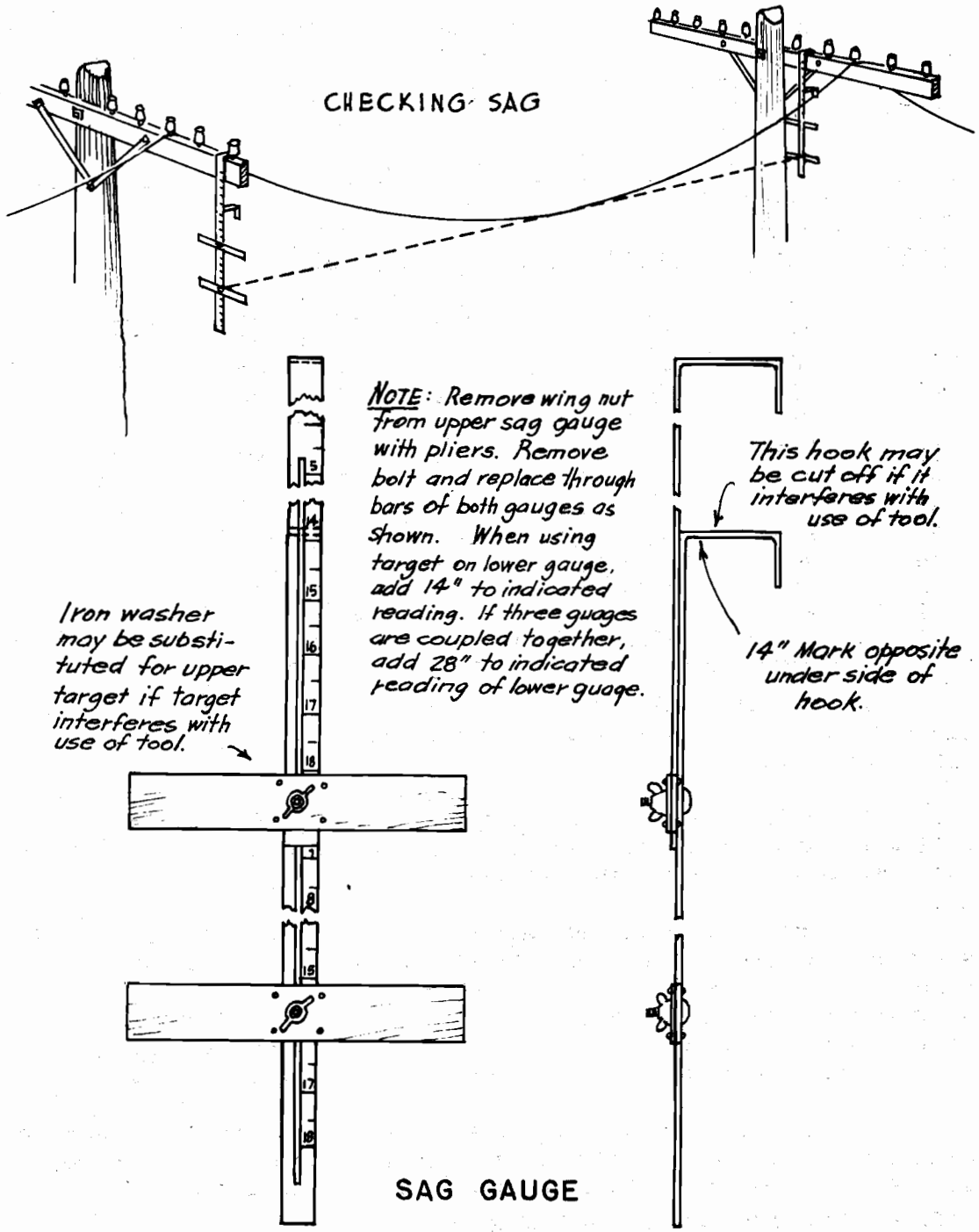
2. Set the targets on the sag gauges to the reading previously determined from the sag table. The best results can be obtained by offsetting the targets on the crossarms.



3. Sight across from the top of one target to the top of the other and with the wire resting on the top of the crossarms, adjust the sag in the wire by pulling up or slacking back until the lowest point in the span is in line with the tops of the targets. It is best to pull the wires slightly tighter than required and then slacken them back slightly. Let the wire rest for one or two minutes before taking the final sight in order to give the wire a chance to creep. Care should be taken that the wire is not wedged tight around corners or in the brackets, so that an even sag will be secured for the entire length.

4. Select another span about one-third the distance from the head end and check the sag. When the sag is correct, the wires should be tied to the insulators.

The sag gauge may be used for checking sags up to eighteen inches. Two gauges can be spliced together to read a greater amount of sag.



OSCILLATION METHOD OF OBTAINING SAG

By oscillation is meant the complete motion of the wire either from one side to the other and back, or vertically from the highest position to the lowest position and back again at the particular point at which the measurement is made.

The oscillation method consists of determining the actual sag by oscillating the wire and counting the oscillations. The number of oscillations in 15 seconds indicates the inches of sag as shown in the following table:

Sag Inches	Oscillations 15 Sec.	Sag Inches	Oscillations 15 Sec.	Sag Inches	Oscillations 15 Sec.
2	37	8	18½	20½ to 21½	11½
2½	33	8½	18	22 to 23½	11
3	30	9	17	24 to 26½	10½
3½	28	9½	16½	27 to 29½	10
4	26	10	16	30 to 33	9½
4½	24½	10½	15½	33½ to 38	9
5	23	11 to 13	15	38½ to 42½	8½
5½	22	13½ to 14	14½	43 to 46	8
6	21½	14½	14	47 to 52½	7½
6½	20½	15 to 15½	13½	53 to 60	7
7	20	16 to 17	13	60½ to 67½	6½
7½	19	17½ to 18½	12½	68 to 70	6
		19 to 20	12		

1. Select a span of average length with the crossarms on about the same level. The wire should be free to oscillate without contact with other wires.

2. Before the wire is oscillated, it should be pulled up slightly tighter than required and then slacked back slightly, as better results are obtained in that way.

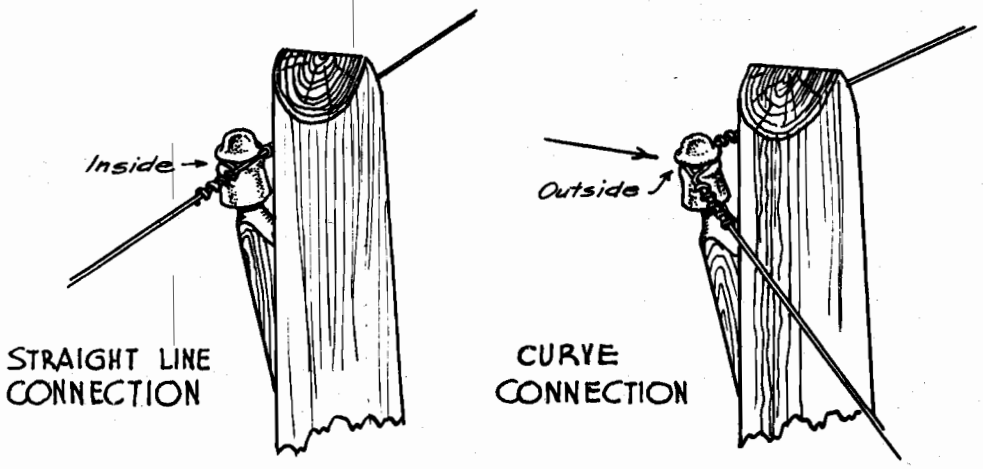
3. The wire should be made to oscillate by a man on the pole striking the wire with his hand at the crossarm. The number of oscillations should be counted by him. He should hold the wire on the insulator with one hand, and hold a finger of the other hand near the wire at the crossarm. The number of times that the oscillating wire strikes his finger in 15 seconds indicates the amount of sag.

If the number of oscillations is less than required, the wire should be pulled up; if the number of oscillations is greater than required, the wire should be loosened. The count should always be checked after each change in tension.

4. Where the number of oscillations is small, the wire should be made to oscillate sidewise. Where the number of oscillations is great, the wire should be made to oscillate up and down.

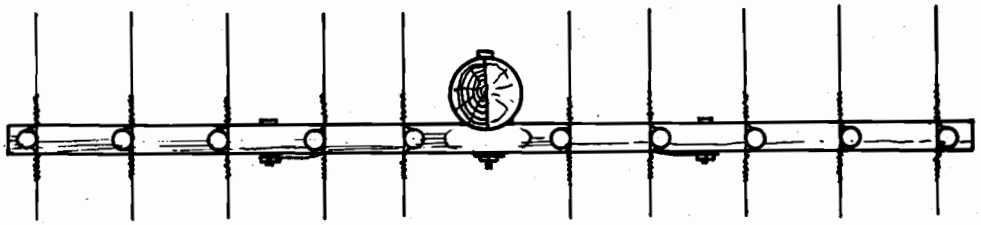
76. Position of Wires on Insulators

In bracket line construction the line wire should be tied on the side of the insulator toward the pole on straight sections, and so that the pull will be against the insulator on curves and corners.



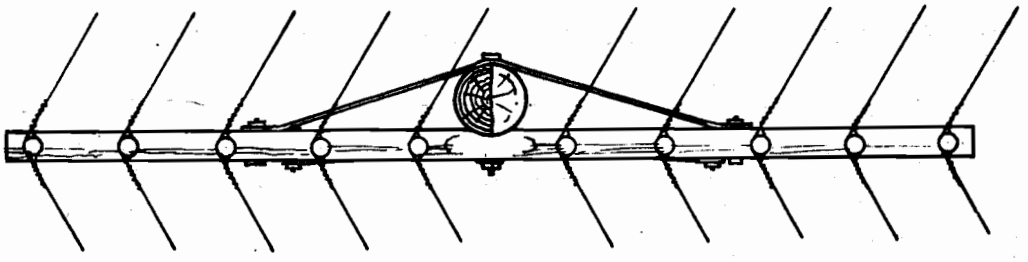
In crossarm line construction the wire should be fastened as follows:

1. On straight sections on the inside of the insulator except the pole pair which should be placed on the outside to afford climbing space.

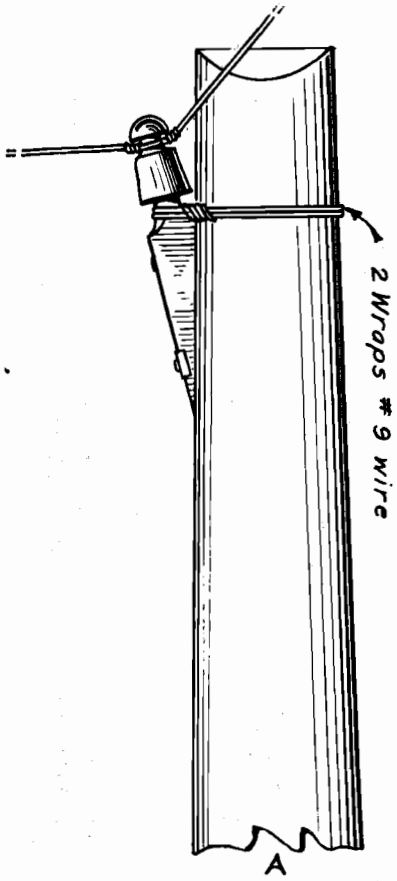


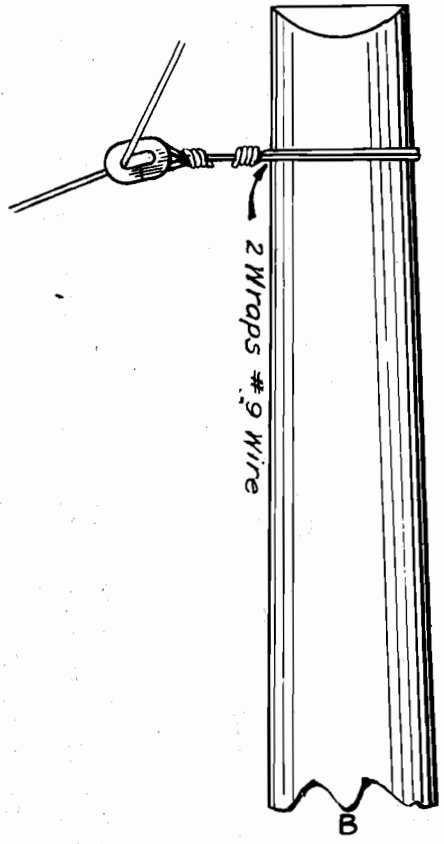
2. On straight sections exposed to heavy cross winds, on the side of the insulator facing the prevailing storm wind.

3. On corners so that the pull will be against the insulator.

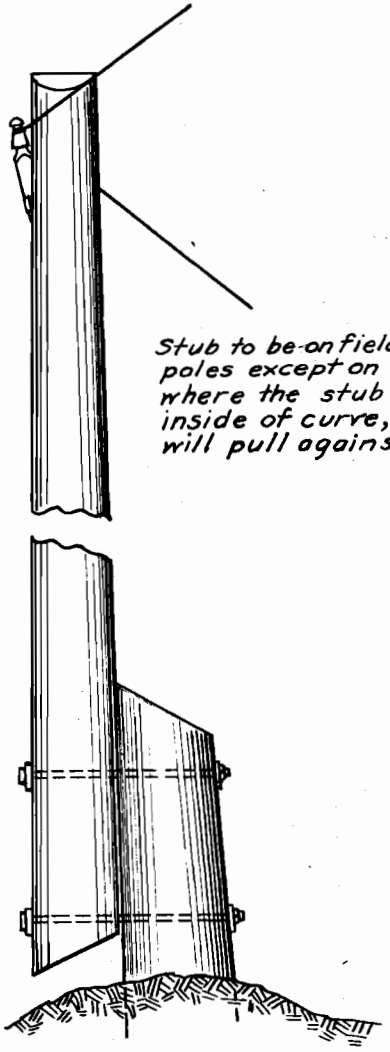


4. On transposition poles and on poles adjacent to transposition poles so that the pull will be against the insulator.





Method of attaching wire where pull away from pole is unavoidable. Method "B" is preferable.

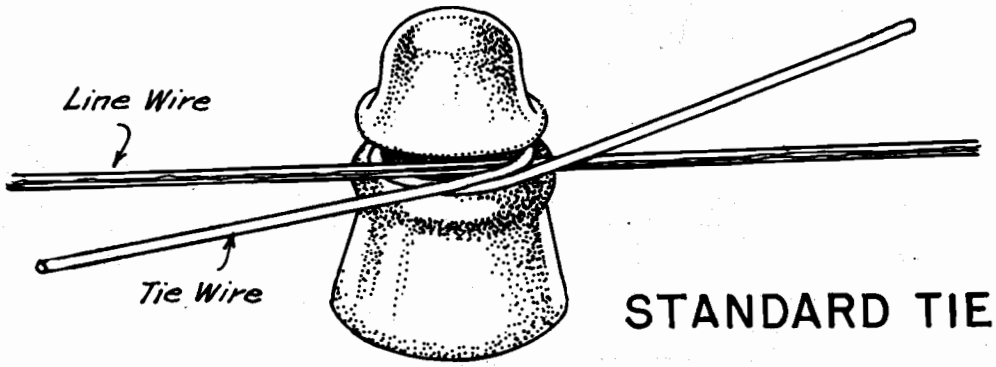


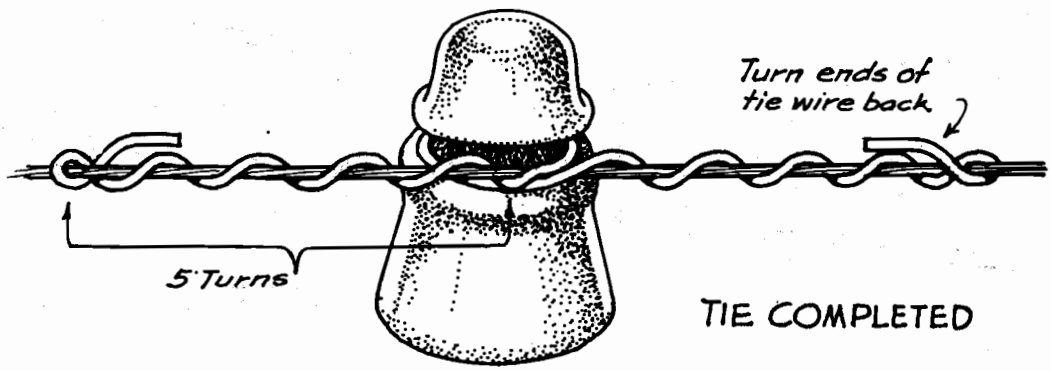
Stub to be on field side of poles except on curves where the stub is to be on inside of curve, so that pole will pull against stub.

ATTACHING WIRES AT CORNERS

77. Tying Line Wire

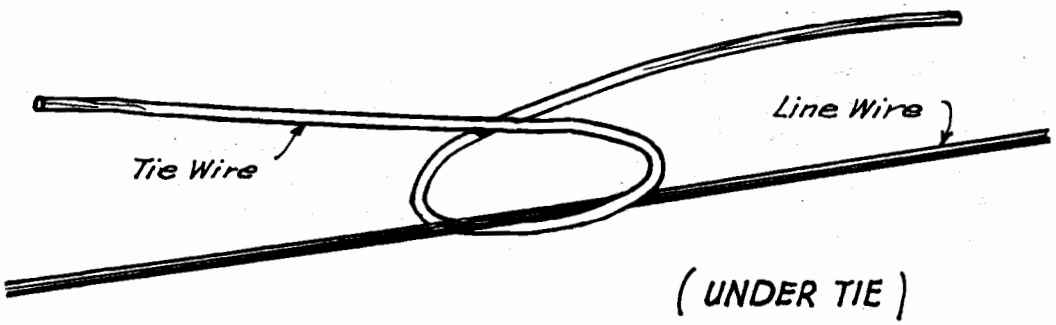
The line wire is not wrapped around the insulator, but is placed alongside of it and held in the groove by the tie wire. Two methods may be used for attaching the line wire to the insulator. The standard tie is commonly used on straight stretches where there is no heavy strain. It consists of a single loop of the tie wire around the insulator and is tied as shown below:

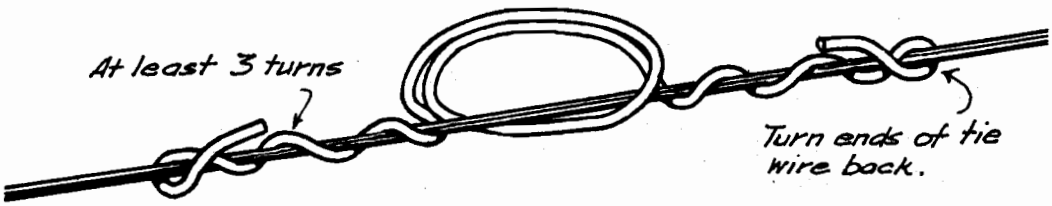




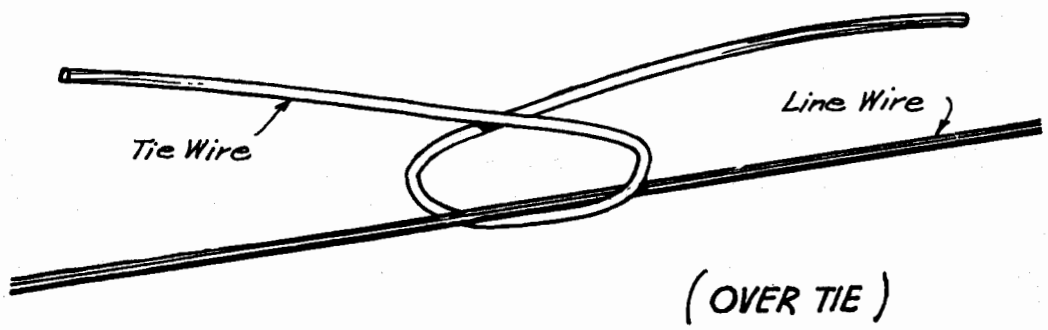
Tie completed with insulator removed.

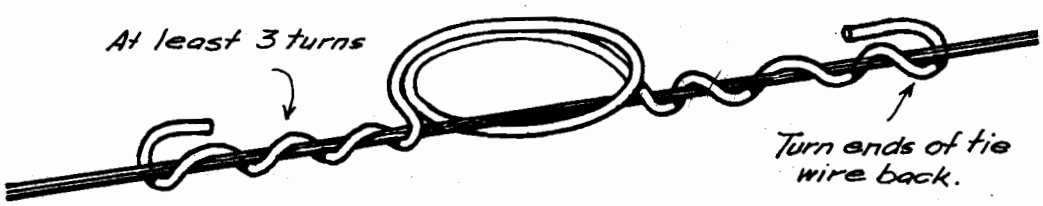
The modified horseshoe tie is used where there is a heavy strain, such as at corners, at abrupt changes in grade and at transposition points. It consists of a double loop of the tie wire around the insulator and is tied in two ways, the "under tie" and the "over tie." Both methods are shown.





MODIFIED HORSESHOE TIE



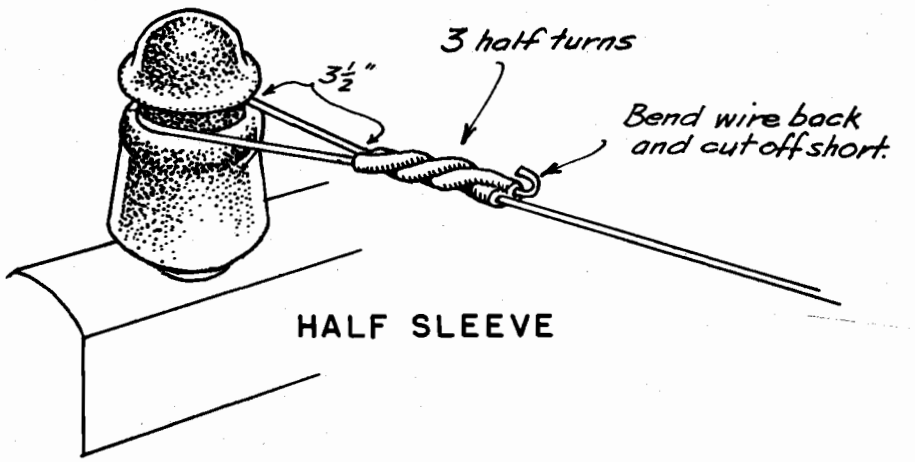


If the modified horseshoe tie is used where there is no change in grade, one end should be wrapped as shown for "under tie" and the other as shown for "over tie."

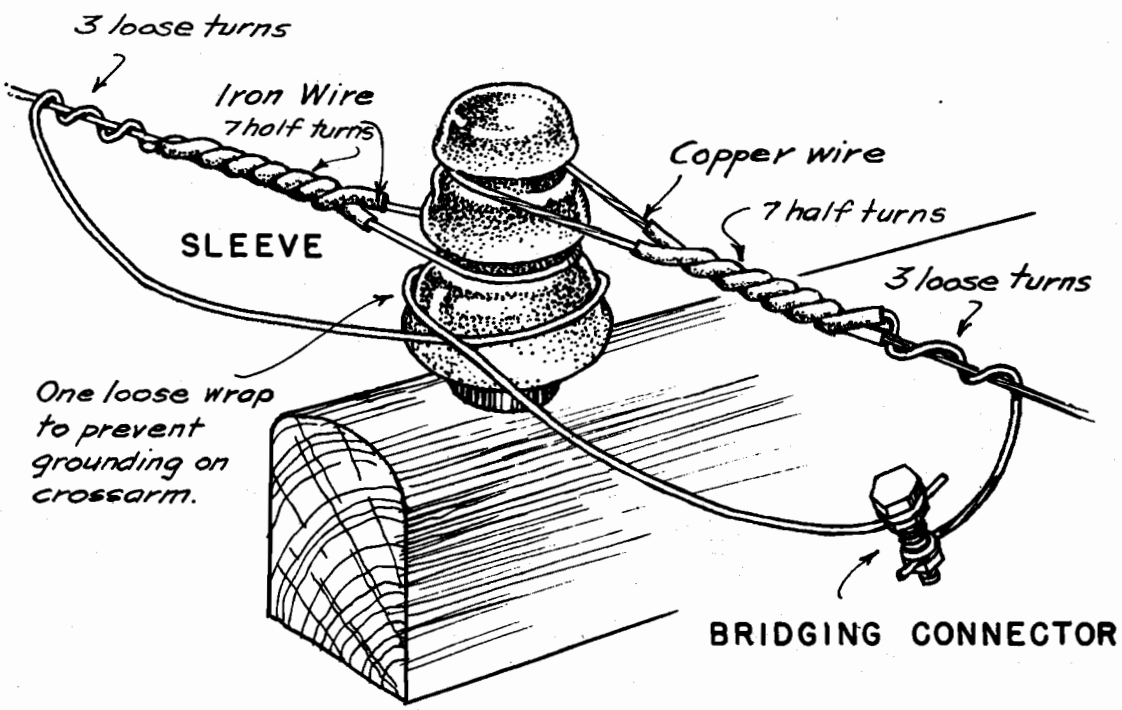
Tie wires for copper-covered wire should be soft drawn copper or copper-covered of the same diameter as the line wire. For iron wire, a #12 tie wire should be used. The #9 line wire is stiff and hard to tie. All tie wires should be 17 inches in length.

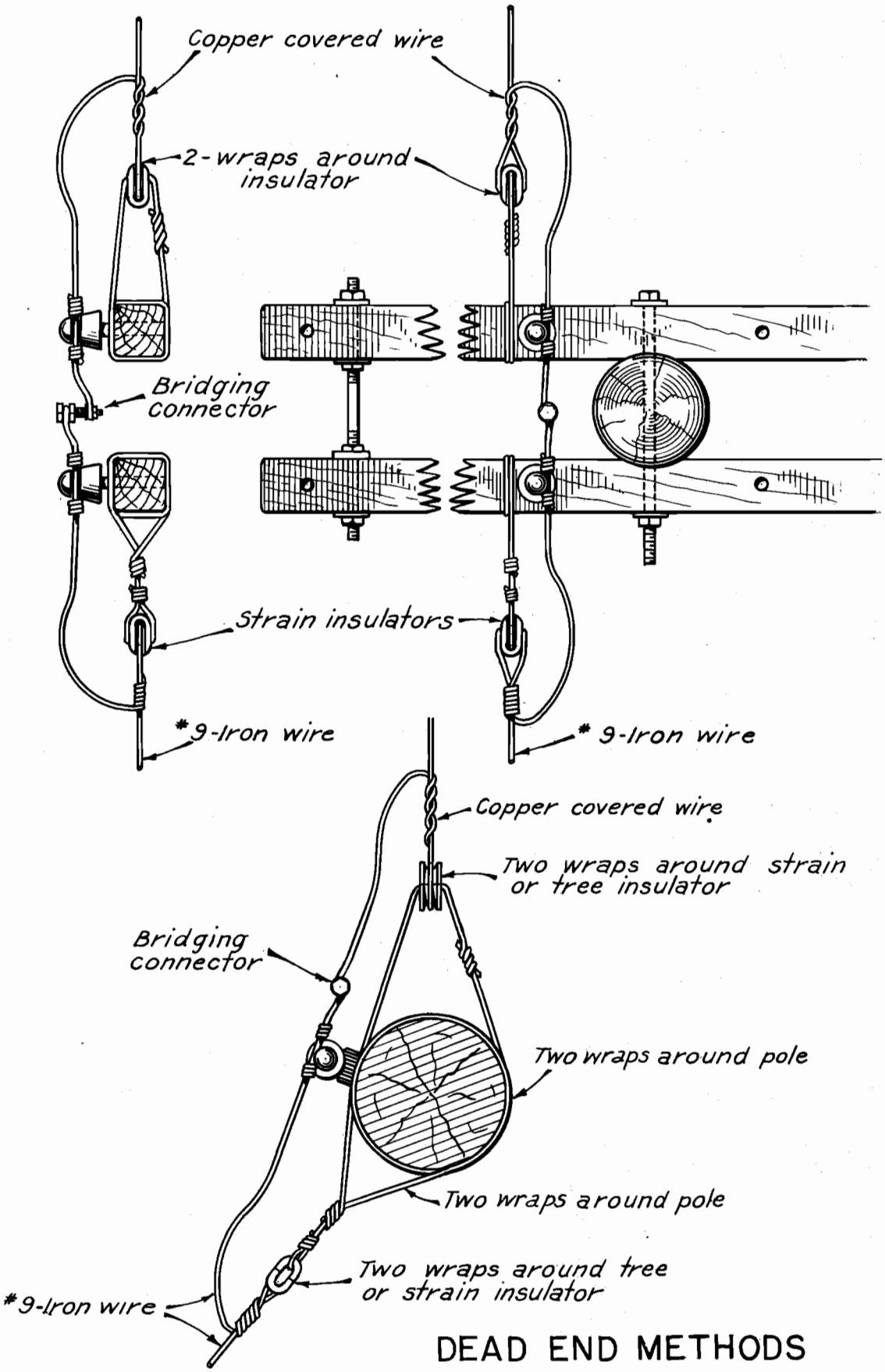
78. Dead-Ending

Various methods may be used for dead-ending line wire. Any method is acceptable provided that a solid connection is made. The following illustrations show some of the methods used.

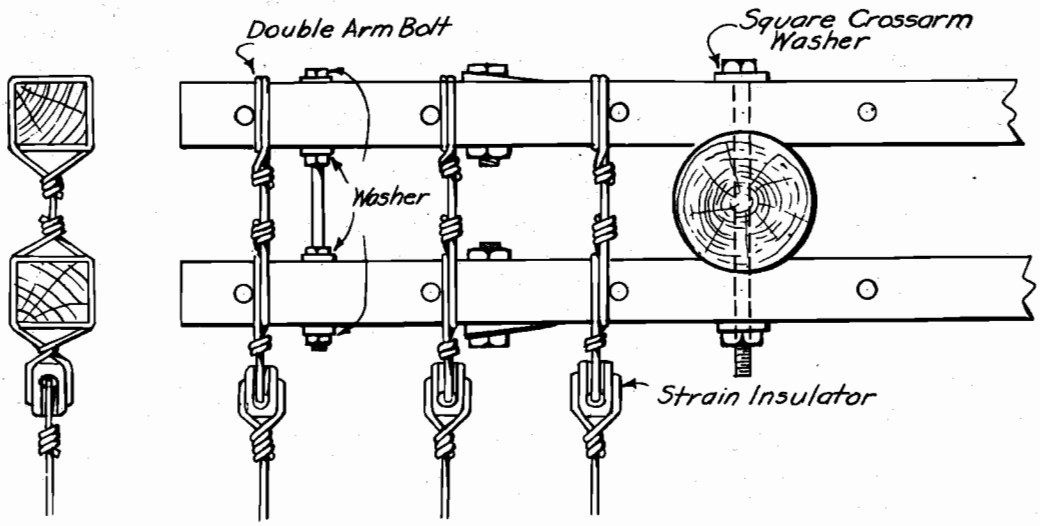


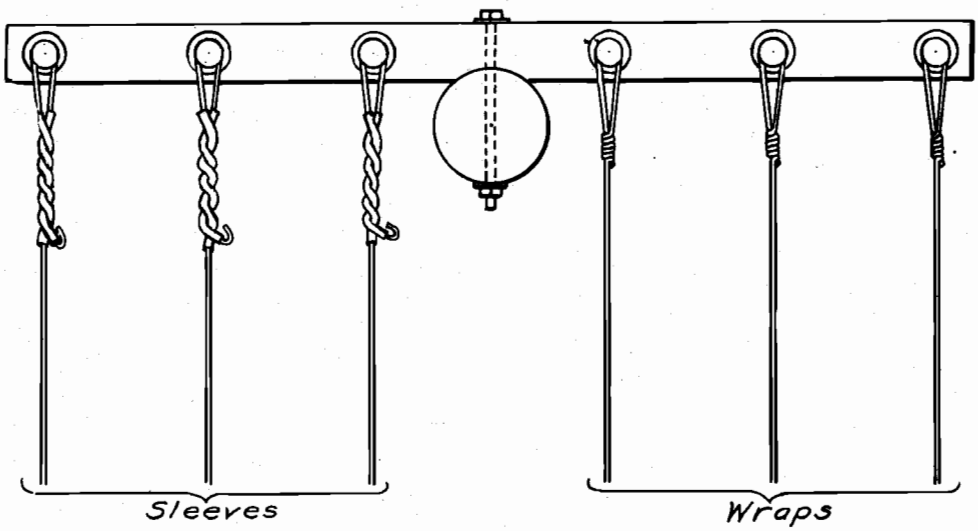
DEAD END METHODS





DEAD END METHODS





DEAD END METHODS

79. Interference

Interference may be either objectionable humming and buzzing in the receiver when the line is in use, or cross talk from adjacent telephone lines. It is caused by induction through the magnetic field of other lines in close proximity to the telephone line. The principal causes of interference are:

1. Grounded circuit telephone lines.
2. Metallic circuit telephone lines not properly transposed.
3. Electric power lines.
4. Telegraph lines.

In order to overcome such interference it is necessary to construct a metallic circuit and transpose it properly. An unbalance in a metallic circuit will result if the wires are not of equal resistance or if there is a high resistance leak from one side of the line to the ground.

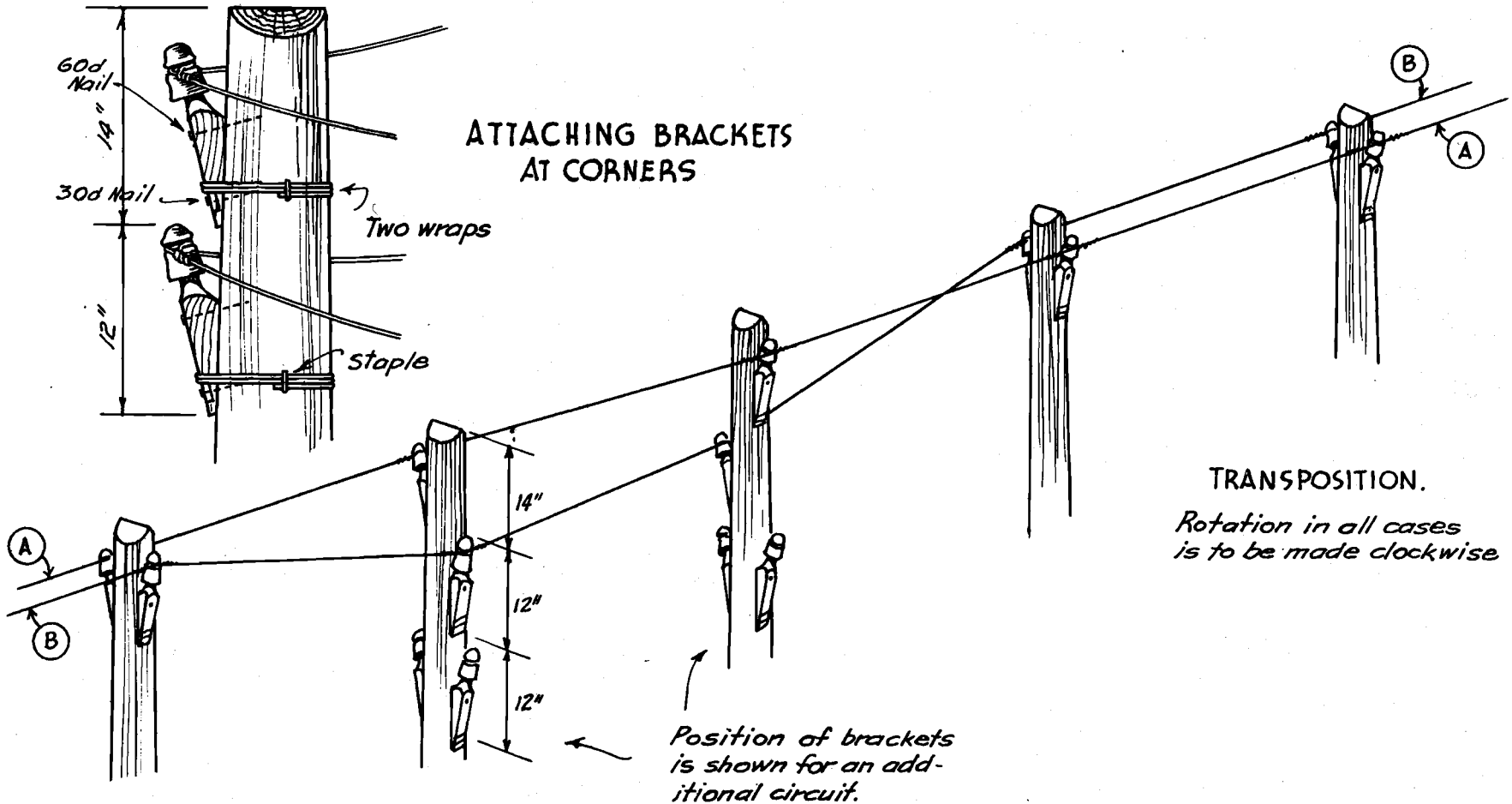
Interference in grounded circuit lines may be caused by paralleling lines, poor ground connections or poor switchboard installations.

It is not always possible to determine in advance the extent of the interference on a grounded circuit telephone line caused by an electric power line or a telegraph line, but it will probably be serious if either the power line or the telegraph line is within 500 feet of the telephone line and extends parallel to it for more than a mile or two. The interference from a power line may come from a leak in the line due to faulty insulation and may occur only after the line has been in use for some time.

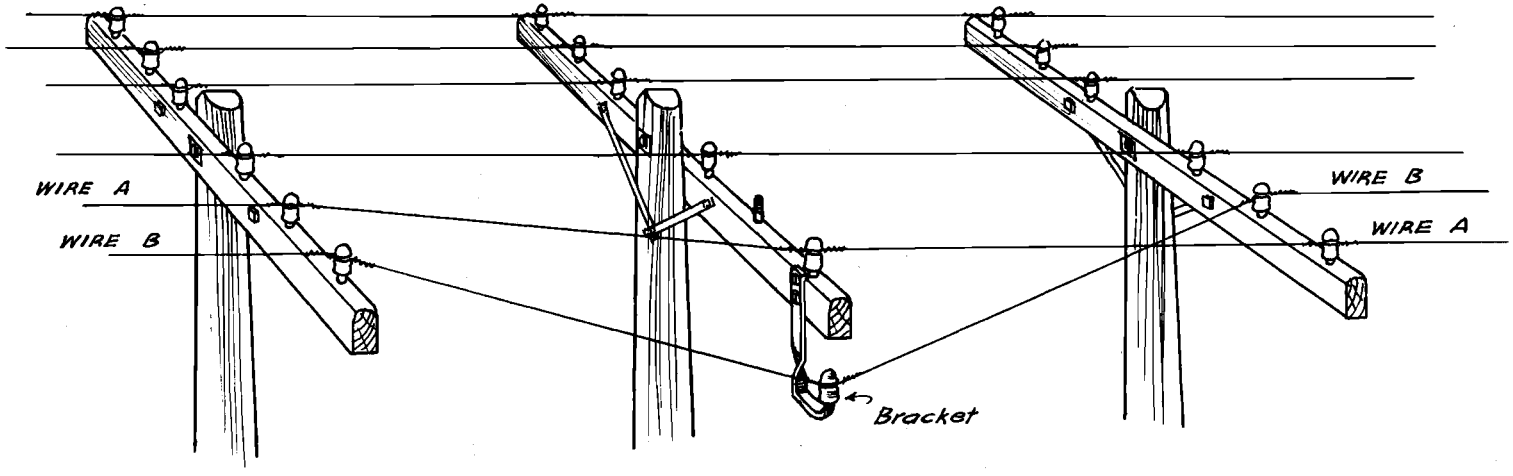
Two or more Forest Service grounded circuit telephone lines may be on the same pole for 4 or 5 miles, provided there is a minimum distance between the two wires of at least 2 feet. There will be little or no trouble caused by rings or howler signals, but there will be cross talk between the lines. The extent of this interference will be determined by the traffic (amount of talking) on the lines. If it can be avoided, a Forest Service grounded circuit line should not be strung on the same poles with grounded circuit lines owned by others. It is not good practice to place power leads on the same poles as telephone lines. This method of construction will be used only in exceptional cases, and then only with the permission of the Regional Forester.

80. Transpositions

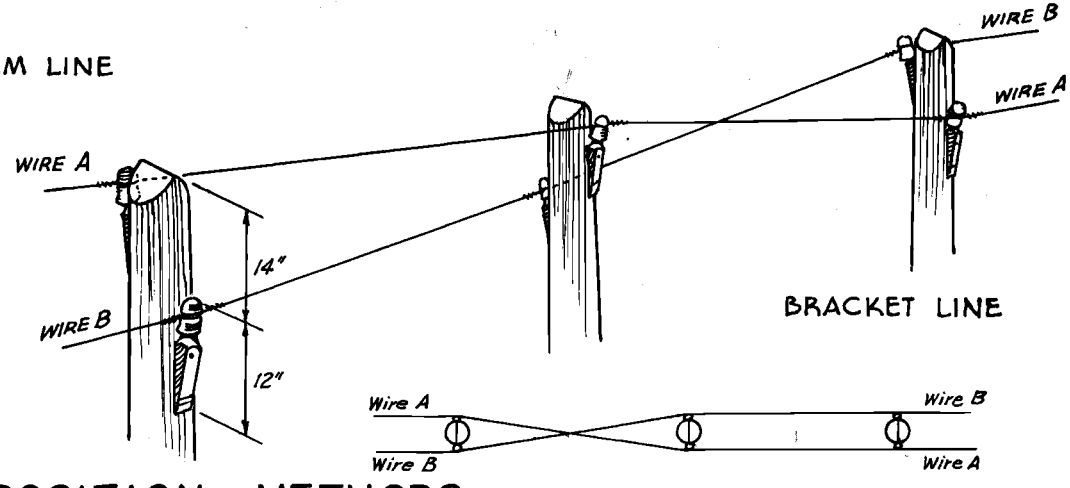
Transpositions in a metallic circuit are simply the reversals of the positions of the two wires at stated intervals so that the induced voltages will be cancelled. Metallic lines should be transposed as shown on Page 102 so that the amount of interference from other lines may be reduced in magnitude. Ordinarily, transpositions made as shown are satisfactory. However, if it is a region of ex-



METALLIC CIRCUIT BRACKET CONSTRUCTION



CROSS ARM LINE



TRANSPOSITION METHODS

cessive static or if there is a fairly close parallel to a high tension transmission line, there will be a better balance secured if the wires are kept about the same distance from the ground and transposed as shown on Page 101.

The rotary form of transposition which consists of carrying the left-hand wire over the other at each transposition is the most satisfactory. Transposing the relative position of two grounded circuit lines on the same pole does not reduce the cross talk between them.

Transposition schemes will ordinarily be secured through the Regional Forester, who will require a complete description of the line, including its location, proximity to and description of other lines; if telephone, metallic or grounded circuit, and if power line the voltage, whether single phase or three phase and the extent of the parallel.

The engineers of the American Telephone & Telegraph Company will furnish advice about transposition schemes upon request. When Forest Service lines are on telephone company poles, the transposition scheme used will be furnished by the company. When private lines are on Forest Service poles, the transposition scheme will be furnished by the Forest Service.

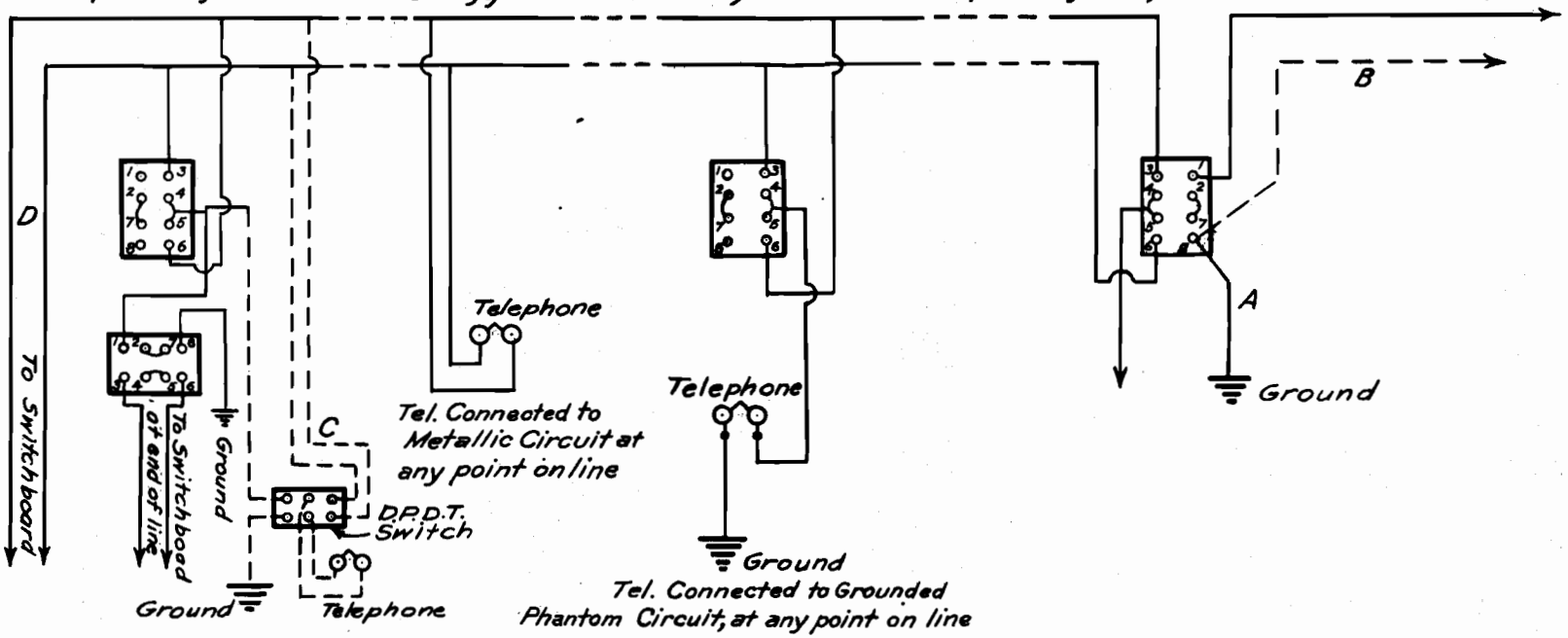
Care in placing thraspositions is important. Changes in the system after it is once installed should not be made without the consent of the Regional Forester.

81. Phantom Circuits

Phantom circuits are arrangements of telephone wires whereby more working, non-interfering telephone lines exist than there are sets of actual wires. When four wires are arranged to provide three metallic circuits for telephone purposes, two of the lines are physical circuits and one is a phantom circuit. Currents from the telephones connected to either physical pair of wires pass, at any instant, in opposite directions in the two wires of the pair. The phantom circuit uses one of the physical pairs as a wire of its line. It does this by tapping the middle point of the line side of each of the repeating coils. The impedance of the repeating coil winding is lowered because all the windings being on the same core, the phantom line currents pass from the middle to the outer connections so as to neutralize each other's influence. The currents of the phantom circuit, unlike those of the physical circuits, are in the same direction in both wires of a pair at any instant. Their potentials, therefore, are equal and simultaneous.

Phantom circuits are formed most simply when both physical lines end at the same place. However, a phantom circuit may be formed if one physical line is longer than the other, by inserting the repeating coil in the longer line where it passes through the terminal station of the shorter. A circuit may be built up by

For superimposing a grounded phantom circuit on a metallic circuit, using Kellogg No 21A repeating coil. For Kellogg # 24 A or Graybar No.77A repeating coil, connect as shown on page 117



At End of Line

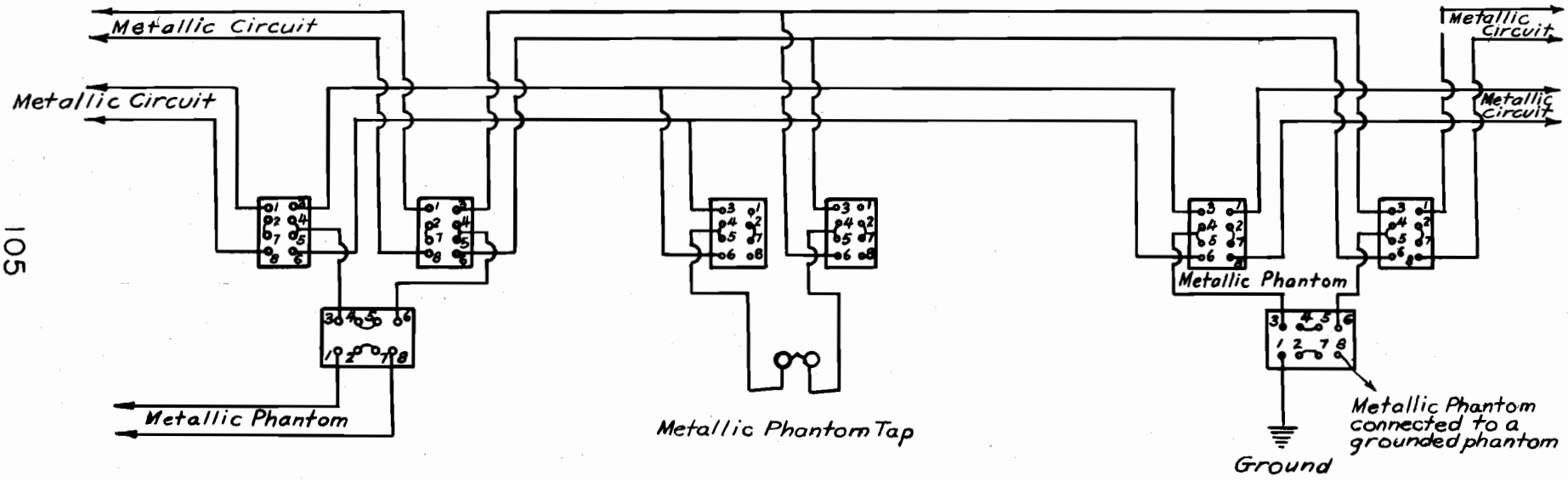
If both the grounded phantom and metallic circuits are to be connected to a switchboard, the connection should be made as shown in solid lines, using **both** repeating coils.

If the circuits are to be connected to a telephone through a switch, instead of a switchboard, wire as shown in dotted lines "C" and omit lower repeating coil and wires connected to it. Also omit wire "D."

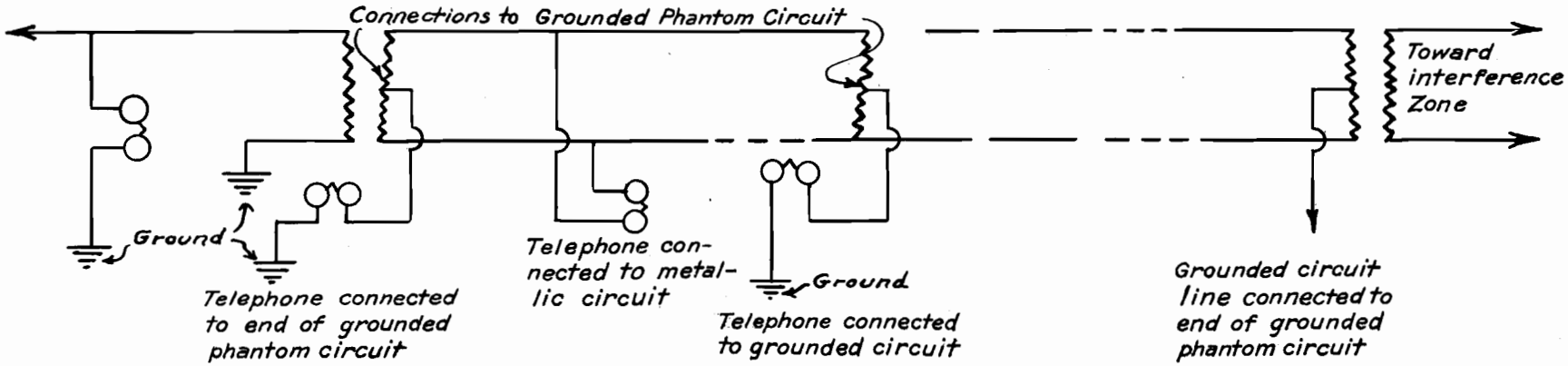
Connect as shown in solid lines for a grounded phantom connection to a metallic circuit at point where metallic circuit changes to grounded circuit. If the metallic circuit extends beyond this point and parallels either electric power line or grounded circuit telephone lines, connection should be made as shown above except that the ground wire "A" is omitted and the other wire of the metallic circuit "B" (shown as dotted line) is connected to the repeating coil instead of the ground wire.

GROUNDED PHANTOM CIRCUIT

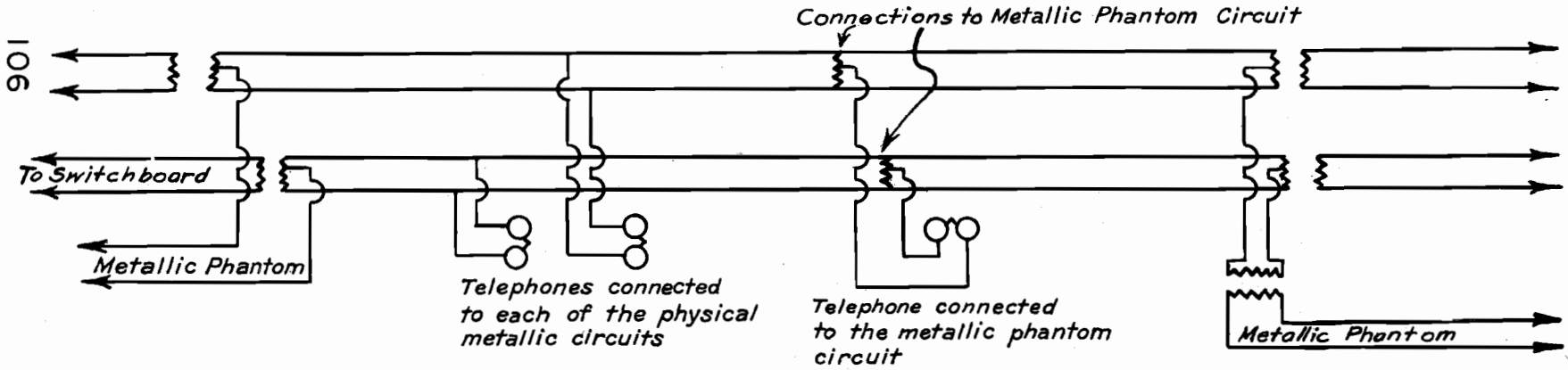
For superimposing a metallic phantom circuit on two physical metallic circuits, using all Kellogg # 21A repeating coils. For Kellogg #24A or Graybar #77A repeating coils, connect as shown on page 117



METALLIC PHANTOM CIRCUIT



SCHEMATIC DIAGRAM SHOWING CONNECTIONS FOR A GROUNDED PHANTOM CIRCUIT



SCHEMATIC DIAGRAM SHOWING CONNECTIONS FOR A METALLIC PHANTOM CIRCUIT

SCHEMATIC DIAGRAMS

adding a physical circuit to a phantom. It may also be made up by connecting two or more phantom circuits by physical circuits.

Under proper conditions phantom circuits are better than physical circuits, because of the better transmission over them. While the capacity of the phantom circuit is somewhat greater than that of the physical circuit, its resistance is considerably smaller. In the actual wire of the phantom loop, there is only half the resistance of either of the physical lines from which it is made, but to this resistance must be added the resistance of the repeating coil.

A grounded phantom circuit line, Page 104, can be operated on a physical metallic circuit line and simultaneous use of both circuits will be possible without an appreciable amount of cross talk between them, provided the metallic circuit is well balanced, that is:

a. Both wires are of the same size and resistance and are free from grounds.
b. The two wires are properly transposed (see paragraph on transpositions) and, except at transpositions, have a uniform separation and are spaced not to exceed 15 inches apart.
c. In bracket construction, except at transpositions, the wires are spaced equal distances from the ground as shown on Page 101.
d. There are no paralleling lines which would cause interference in an ordinary grounded circuit line.

A metallic phantom circuit, Page 105, can be operated on two physical metallic circuits, and simultaneous use of all three circuits will be possible without cross talk between them. There will not be inductive interference caused by other telephone, telegraph, electric power lines or static, provided:

a. Each of the two metallic circuits are constructed in accordance with the instructions in paragraphs (a) and (b) under grounded phantom circuits above.
b. There is an electrical balance between the two metallic circuits, which could be properly transposed.
c. The metallic circuits themselves are properly transposed.

A schematic diagram of both grounded and metallic phantom circuits is shown on Page 106.

82. Tools needed for Pole Line Construction - 5 man crew

1 - wire reel	1 - pole support
1 - DB axe	3 - tree climbers
1 - hand axe	3 - lineman's belts
1 - cross cut saw, 5 ft. 2-man	3 - safety straps
2 - shovels, round point	1 - tree trimmer with saw
2 - bars, digging	1 - lineman's wrench
1 - spoon shovel	1 - crescent wrench, 8"
1 - cant hook	3 - pliers, 8"
2 - pike poles	2 - connectors, 11"
2 - tamping bars	2 - files, 8", flat

83. Material needed to Construct One Mile of Pole Line

Material	Grounded Circuit (bracket)	Metallic Circuit (bracket)	6-wire Crossarm
Wire, line - #12 copper-covered	1 mi.	2 mi.	6 mi.
Wire, tie - #12 copper-covered	60 ft.	120 ft.	360 ft.
Insulators, glass, #16	35	70	210
Sleeves	2	4	12
Crossarms, 6 pin	-	-	35
Bolts, carriage, 3/8" x 4"	-	-	70
Bolts, carriage, 3/8" x 4½"	-	-	12
Bolts, crossarm, 5/8" x 12"	-	-	33
Bolts, double crossarm, 5/8" x 16"	-	-	2
Braces, for 6-pin crossarm	-	-	70
Washers, crossarm, 2¼" x 2¼" x 3/16"	-	-	70
Brackets, transposition	-	-	12
Brackets, wood, 2" x 2-3/8" x 12"	35	70	-
Bracket pins, transposition	-	-	12
Bracket clips	35	70	-
Lag screws	-	-	35
Guy strand, 3 per mile	80 ft.	80 ft.	80 ft.
Guy clamps, 3-bolt light	6	6	6
Guy hooks	6	6	6
Anchors	3	3	3
Anchor rods	3	3	3
Strain plates	3	3	3
Serving sleeves	6	6	6
Staples for lightning conductors	1/2 lb.	1/2 lb.	1/2 lb.
Bridging connectors	2	4	12
Nails, 30d	2 lb.	4 lb.	-
Nails, 60d	3½ lb.	7 lb.	-

Miscellaneous items as needed:

Guy Thimbles	Rock Anchors	Stubbing Bolts
Angle Guy Hooks	Strain Insulators	Stubbing Washers
Guy Rod Washers	Transposition Insulators	Thimble Eye-bolts

84. Service Wires

The service wire from the terminal pole to the station or other building may be either iron or copper-covered wire if the service is overhead, but must be copper wire in an armored cable or multipair cable if the service is underground. If overhead construction is used, a sufficient amount of slack in the wire should be allowed. The overhead service wire should be dead-ended on the terminal pole and on the building. On the building end the wires should lead through a vacuum arrester located on the outside of the building to the telephone on the inside. Standard building wiring methods should be used in all cases. Overhead service wires may be either single wire, twisted pair or parallel wire.

Type ACL (BXL) #14 two-conductor armored cable or multipair cable should be used for underground construction. The cable should be attached to the terminal pole with 1/4" pipe straps. The underground cable should be buried a sufficient depth for protection. The building end should be connected through a vacuum arrester located on the outside of the building to the telephone on the inside.

In either event the line wire or wires should be dead-ended on the terminal pole. In areas which are not exposed to severe electrical storms, the line wire and service wire may be joined by a bridging connector. In other areas the use of a lightning arrester is mandatory, and the connection between the line wire and the service wire is through the arrester. Overhead construction is shown on Pages 110 and 111. Underground construction is shown on Pages 112 and 113.

85. Instructions for the Use of Type ACL (BXL) Armored Cable

The cable should be buried or otherwise protected to prevent injury to it. The galvanizing on the armor is easily damaged by rough usage. The armor itself may be bent or broken unless a sufficient protective covering has been provided.

Before installation, the cable should be painted with aluminum paint to prevent rust.

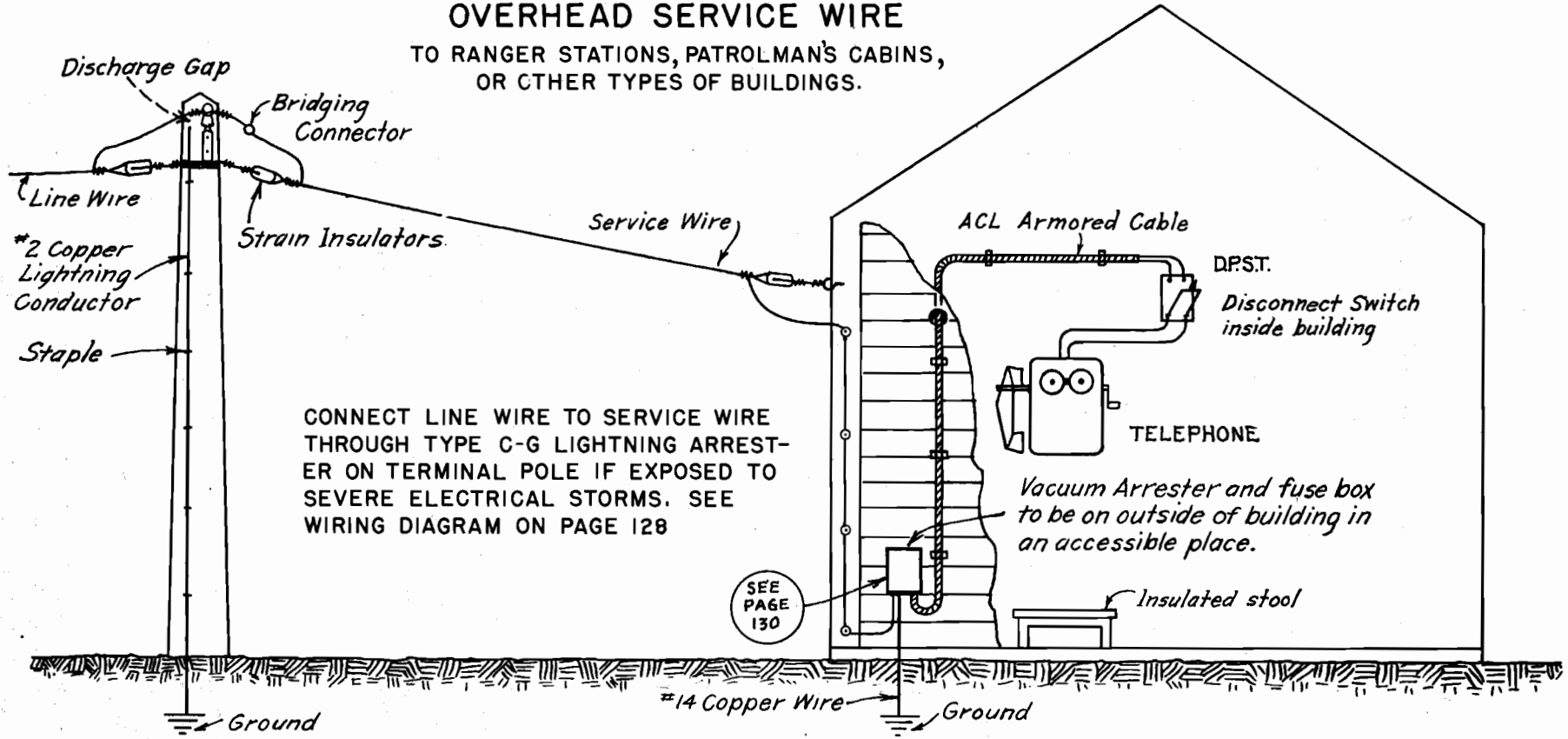
Use 1/4" pipe straps for fastening the cable to the pole or sides of buildings, etc.

Bends in the cable should have at least a 5" radius.

For telephone installations in lookout stations, etc., the cable should be extended from the vacuum arrester box to the inside of the building. About 8" of the armor and lead sheath should be removed from the end of the cable so that the No. 14 rubber-covered

OVERHEAD SERVICE WIRE

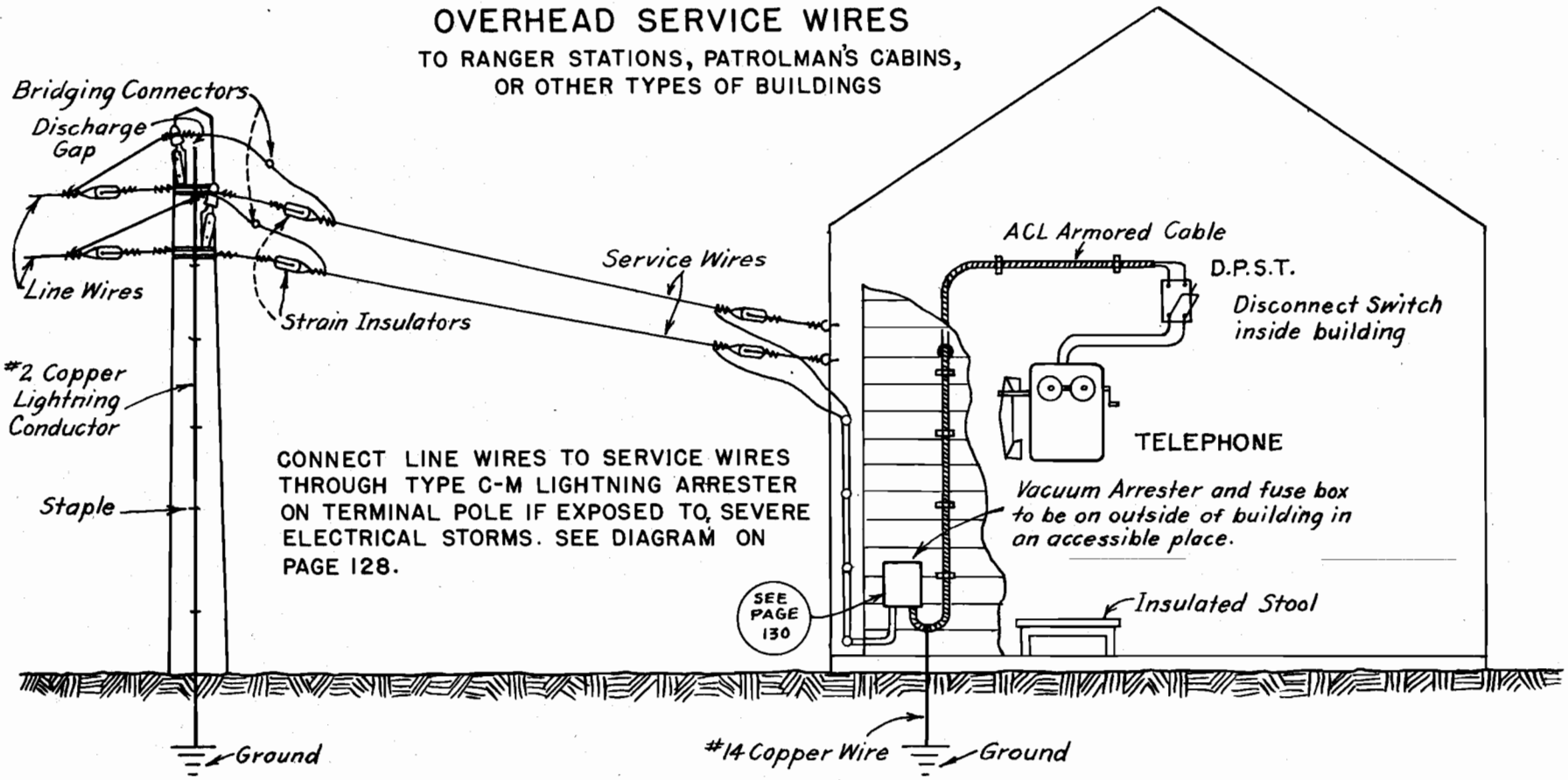
TO RANGER STATIONS, PATROLMAN'S CABINS, OR OTHER TYPES OF BUILDINGS.



GROUNDED CIRCUIT INSTALLATION

OVERHEAD SERVICE WIRES

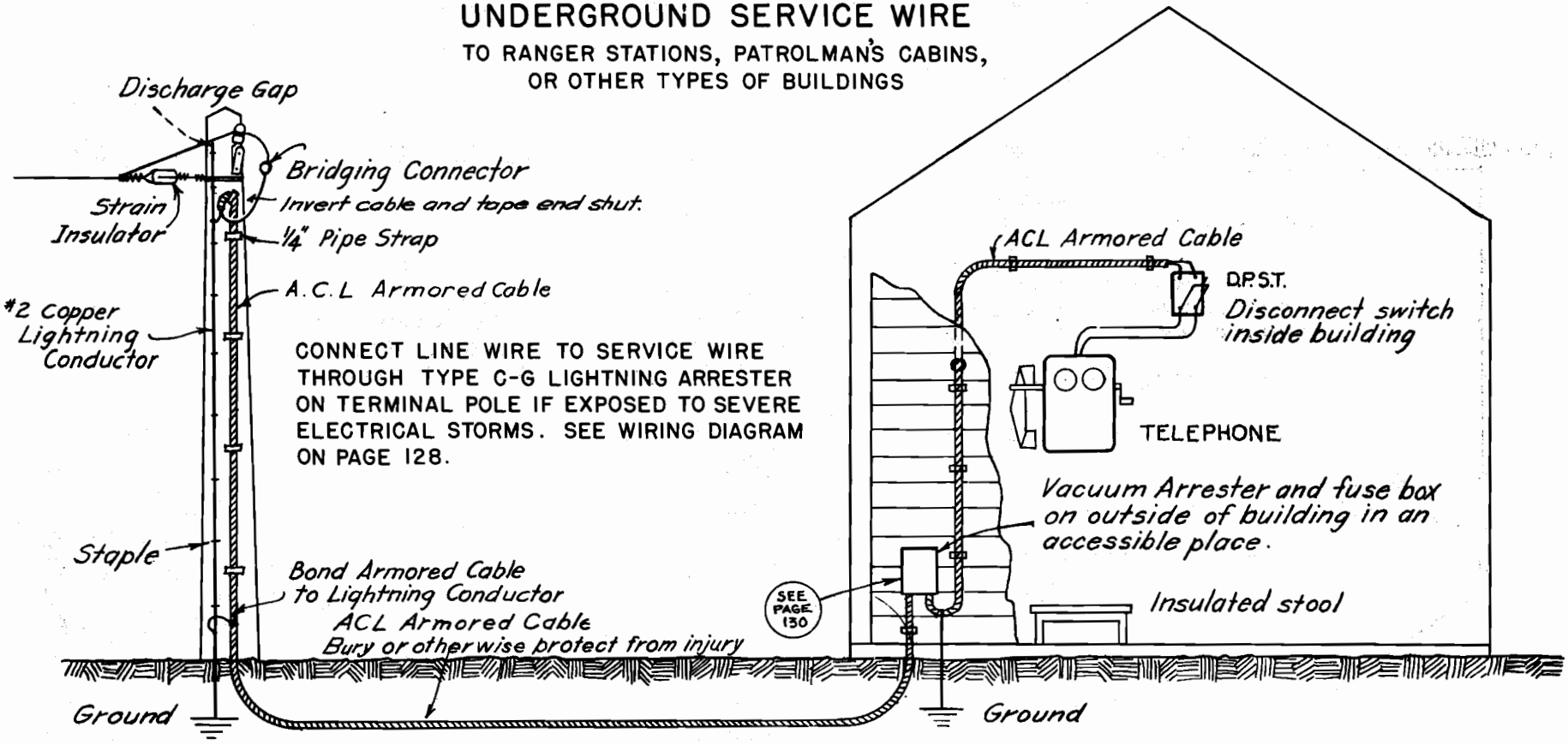
TO RANGER STATIONS, PATROLMAN'S CABINS, OR OTHER TYPES OF BUILDINGS



METALLIC CIRCUIT INSTALLATION

UNDERGROUND SERVICE WIRE

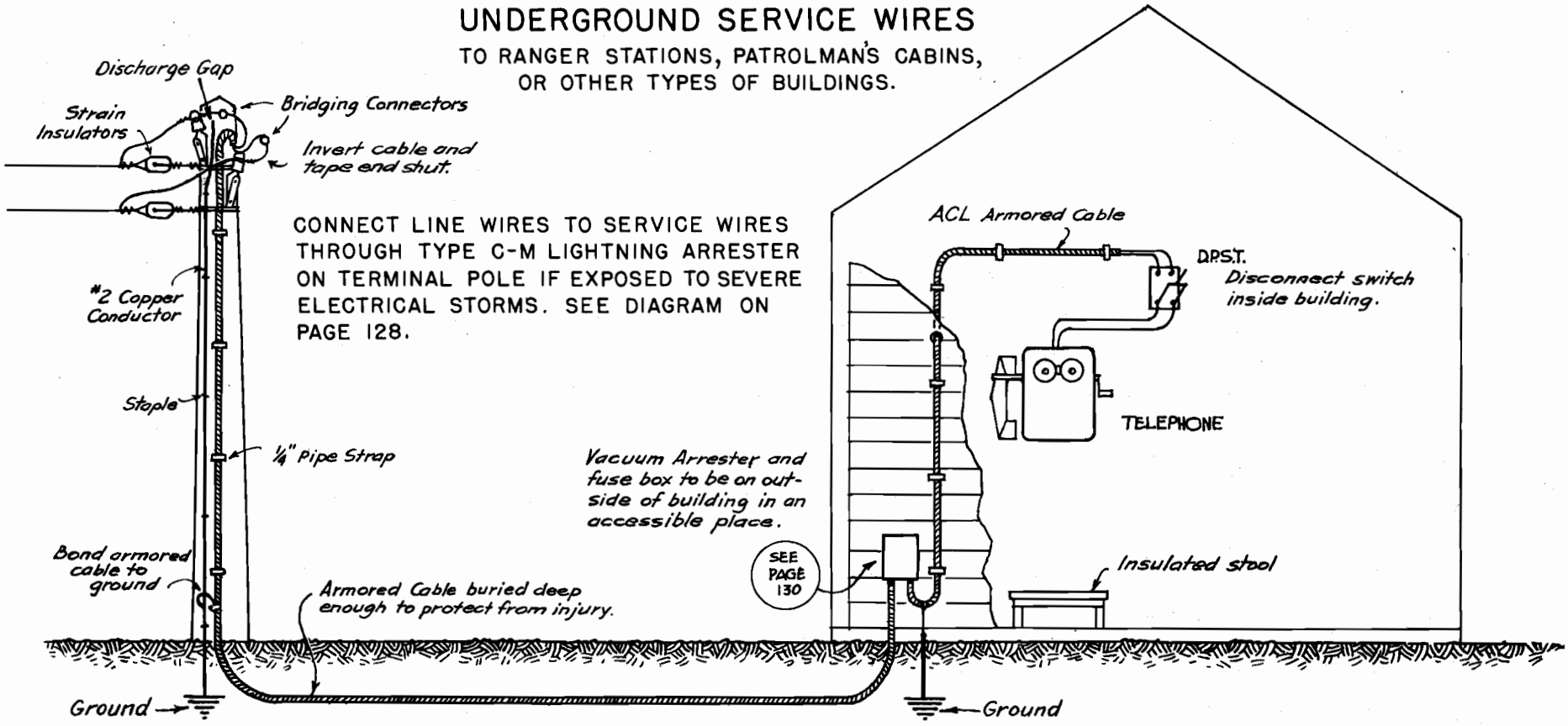
TO RANGER STATIONS, PATROLMAN'S CABINS, OR OTHER TYPES OF BUILDINGS



GROUNDED CIRCUIT INSTALLATION

UNDERGROUND SERVICE WIRES

TO RANGER STATIONS, PATROLMAN'S CABINS, OR OTHER TYPES OF BUILDINGS.



CONNECT LINE WIRES TO SERVICE WIRES THROUGH TYPE C-M LIGHTNING ARRESTER ON TERMINAL POLE IF EXPOSED TO SEVERE ELECTRICAL STORMS. SEE DIAGRAM ON PAGE 128.

METALLIC CIRCUIT INSTALLATION

wire can be connected to the disconnect switch.

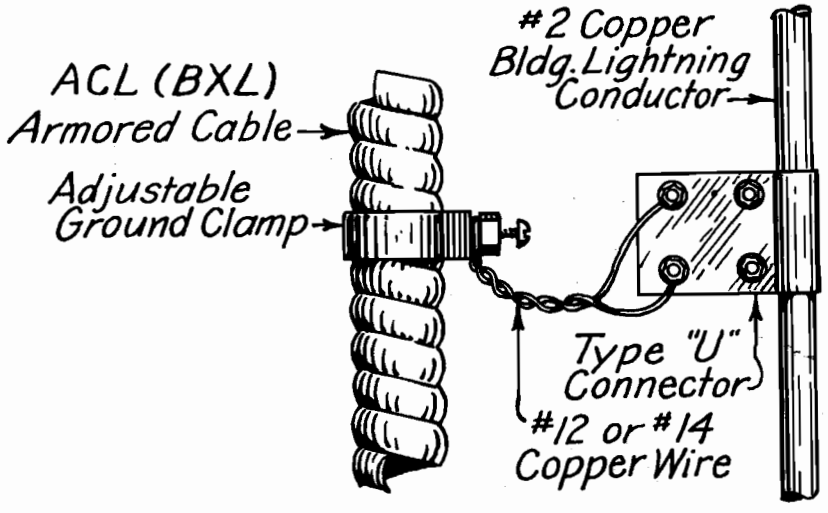
If the cable is within 6" of a lightning conductor, it should be connected or bonded to it.

The cable should enter the building at a point as near the telephone as possible.

Use standard cable cutters, bolt cutters or hacksaws to cut the cable in the required lengths.

To remove the armor and the lead sheath from the ends of the cable preparatory to making a connection, determine how much is to be removed and break it by bending sharply with the pressure of both hands at that point. This will force a loop of the armor to spring out. With one hand, hold the cable firmly with cutter or connectors close to where it was broken. With the other hand give a slight turn or twist until the loop raises in the armor. Then trim the armor smooth with cutters or snips.

To remove the lead sheath, ring lightly with a knife about 1/4" beyond the end of the armor. The lead sheath will break, if bent at that point, and can be easily slipped off the wire.

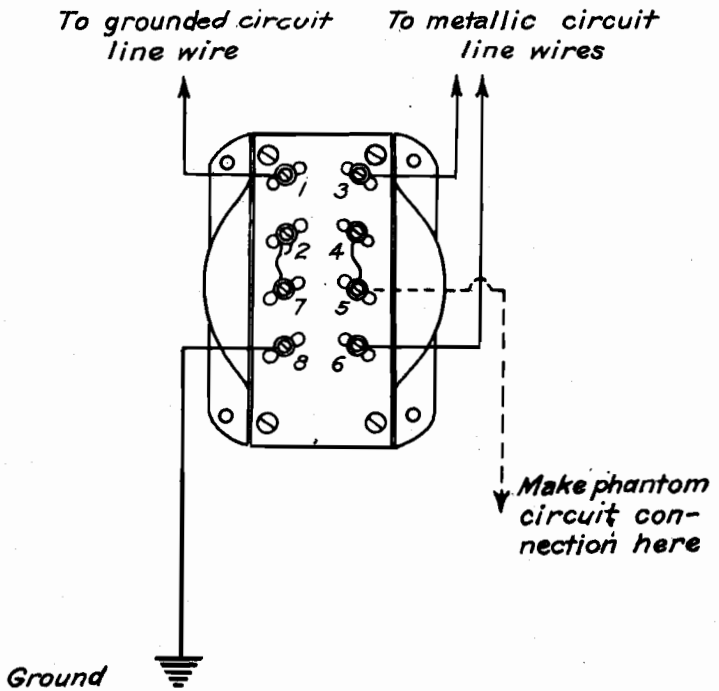


GROUNDING ARMORED CABLE

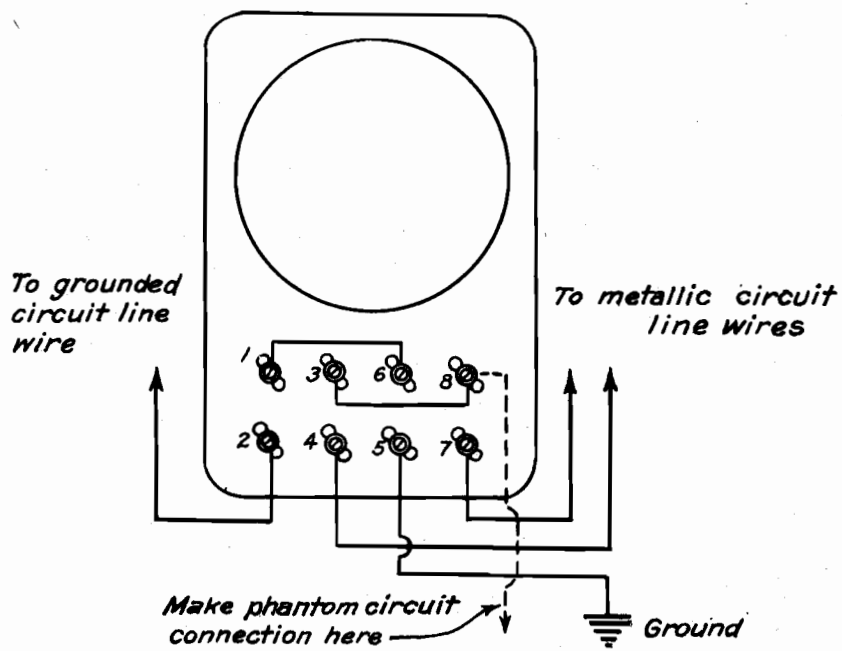
86. Repeating Coils

Repeating coils should be used where a grounded circuit is connected to a metallic circuit and where phantom circuits are super-imposed on physical circuits. Repeating coil connections should be made as shown on Page 115. The recommended types of coils are the Kellogg #21-A, #24-A and #22-A and the Graybar #77-A. The #21-A is for use in switchboards. The #24-A is a #21-A coil mounted on a wooden base and wired to soldering lugs. The #22-A is the same as the #24-A except that two #21-A coils are mounted on one base. The Graybar #77-A is

For changing from grounded to metallic circuit or reverse



KELLOGG NO. 21A REPEATING COIL



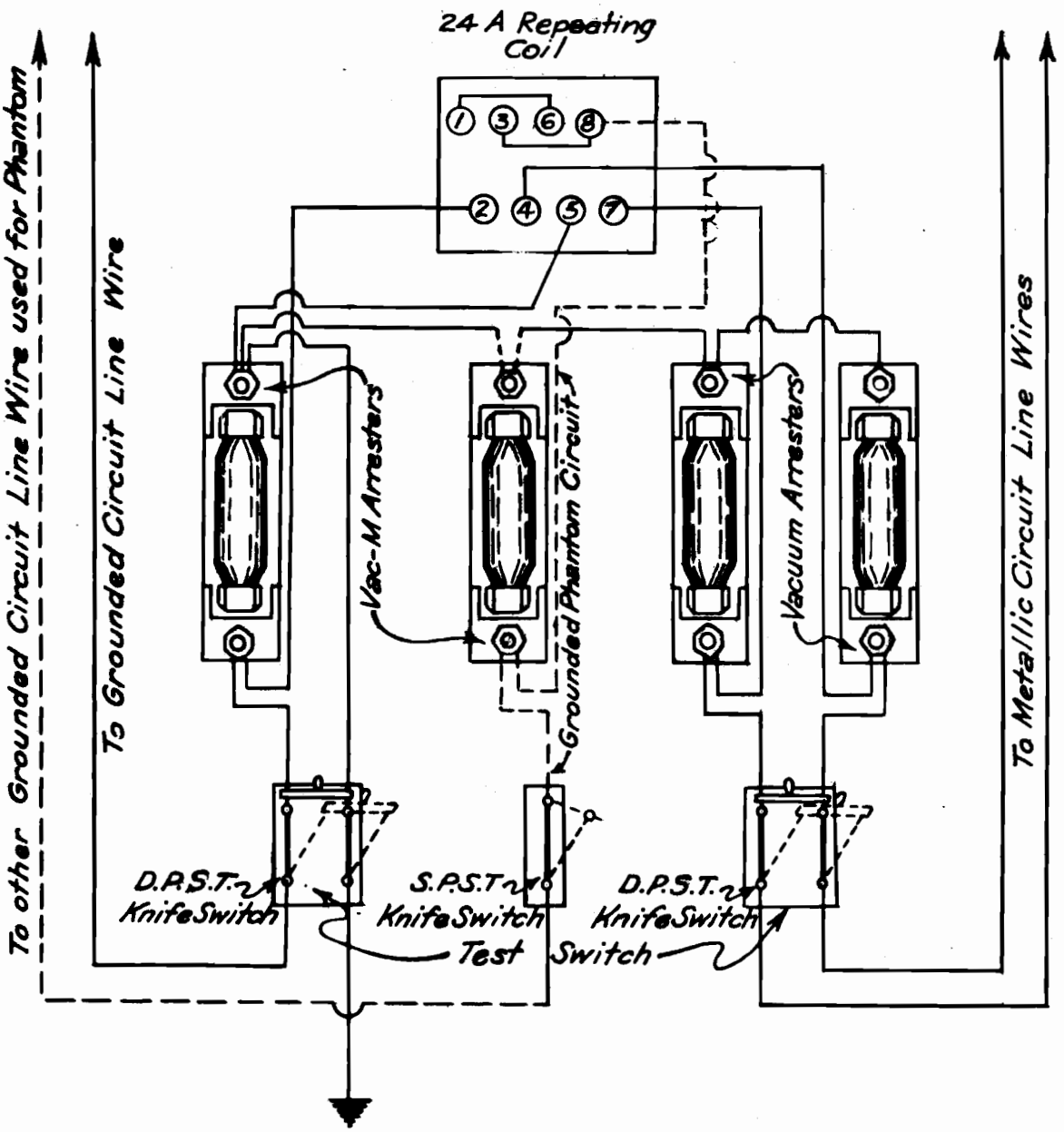
GRAYBAR NO. 77A REPEATING COIL
KELLOGG NO. 24A REPEATING COIL

If coils are mounted outside, (on pole or elsewhere) vacuum protectors are to be used, two on the metallic circuit side and one on the grounded circuit side

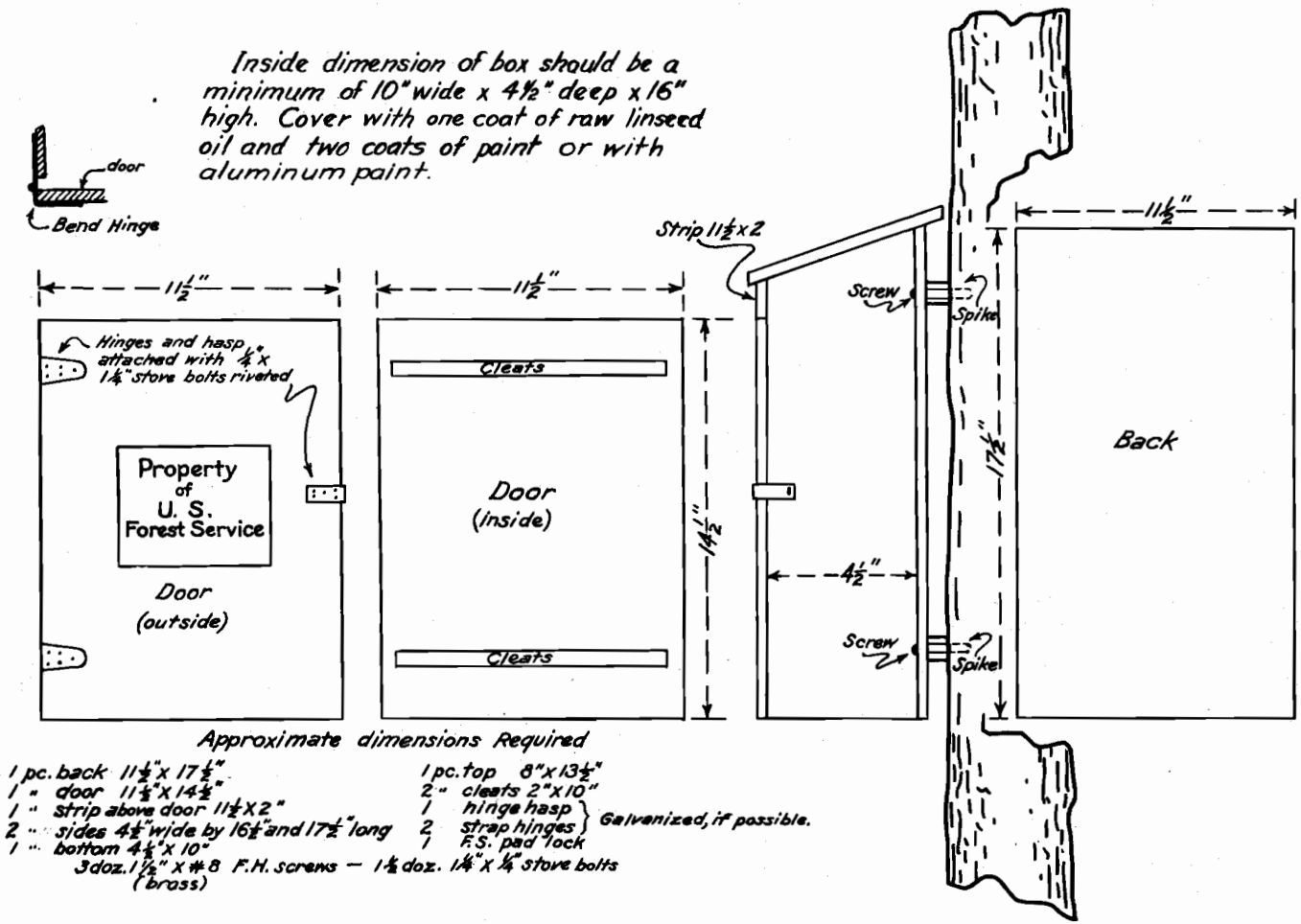
Neither the coils nor the arresters are waterproof and must be protected from the weather.

REPEATING COIL CONNECTION

For connecting grounded and metallic circuits together.
Showing Protection and Test Switches
Connection for a grounded phantom circuit on
a metallic circuit shown in dotted line.



TEST SWITCH CONNECTIONS

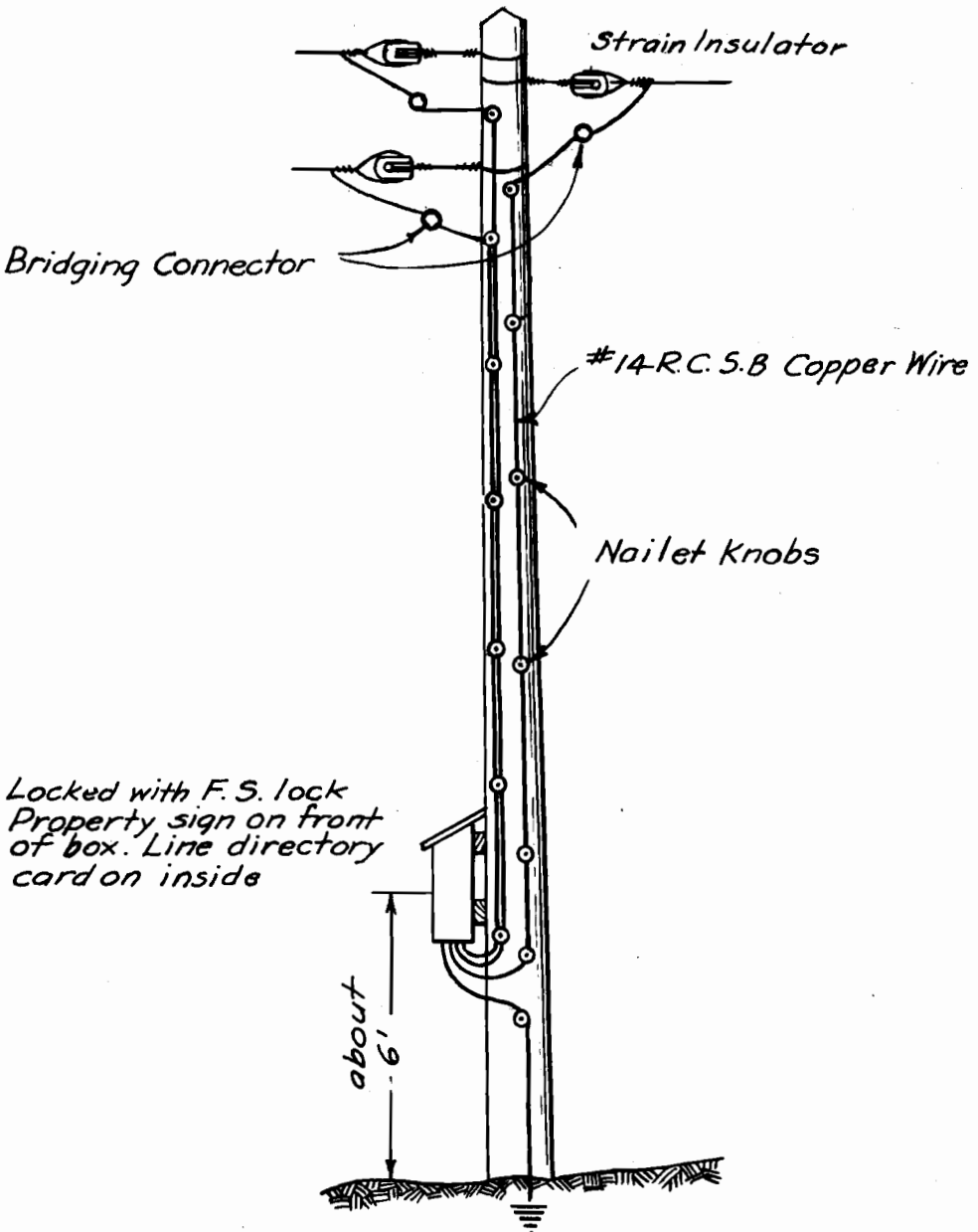


Approximate dimensions Required

1 pc. back 11½" x 17½"
1 " door 11½" x 14½"
1 " strip above door 11½ x 2"
2 " sides 4½" wide by 16½" and 17½" long
1 " bottom 4½" x 10"
3 doz. 1½" x #8 F.H. screws (brass) — 1½ doz. 1¼" x ¼" stove bolts

1 pc. top 8" x 13½"
2 " cleats 2" x 10"
1 hinge hasp
2 strap hinges
1 F.S. pad lock
} Galvanized, if possible.

REPEATING COIL AND TEST BOX



MOUNTING

REPEATING COIL AND TEST BOX

wired exactly the same as the Kellogg #24-A. The use of the Kellogg #18 coil is optional, but is not recommended. For outside use of repeating coils, protection and test switches should be installed as shown on Page 116. Outside installation requires protection against the weather. A plan of a weather-proof box is shown on Page 117, and the mounting of this box on a pole is shown on Page 118.

87. Lightning Protection

Lightning protection for telephone installation includes discharge gap arresters on the terminal poles, vacuum arresters or carbon block protectors on the buildings and line fuses if required for protection against electric light or power lines. In areas which are not subject to severe electrical storms, the discharge gap arrester is sometimes omitted, except when the lookout station is on a tower. At all lookout tower installations the maximum lightning protection is essential. In addition to the equipment mentioned, a discharge gap should be located on the terminal pole at all installations in areas of severe electrical storms. This is the principal "line of defense" and should be installed as shown on Pages 110 and 112. Installations at switching stations in lightning zones are shown on Pages 120 and 121. Proper lightning protection for lookout buildings is shown on Pages 122, 123, 124 and 125.

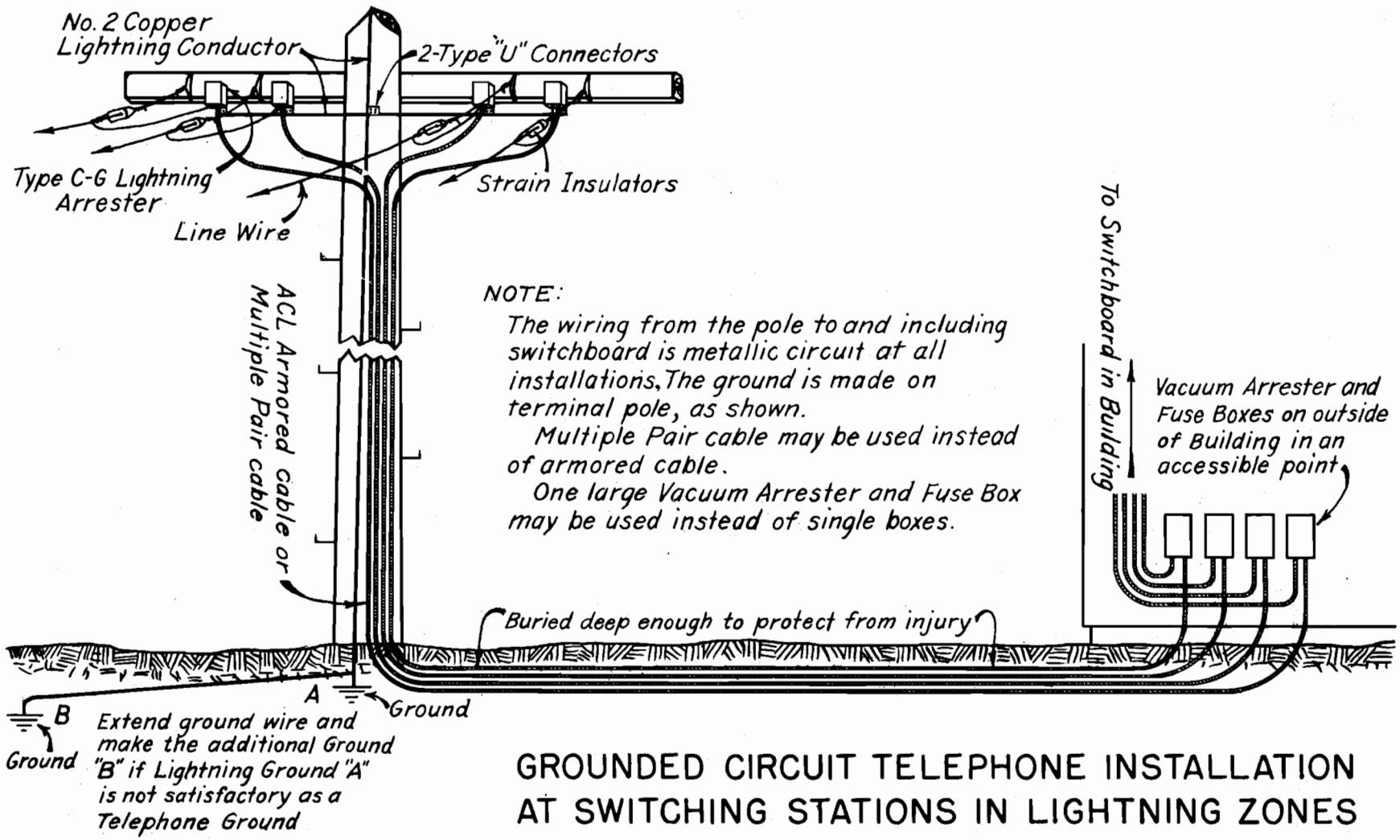
88. Discharge Gap Arresters

Two types of discharge gap arresters are used in Forest Service telephone line installations. Type C does not have a "disconnect" switch and is used at most station installations except in areas subject to severe electrical storms. The type C arrester is made for both grounded and metallic circuits. The designation, "G", or "M" following the type letter, "C" indicates the circuit on which it is to be used. See Page 126 for wiring diagrams.

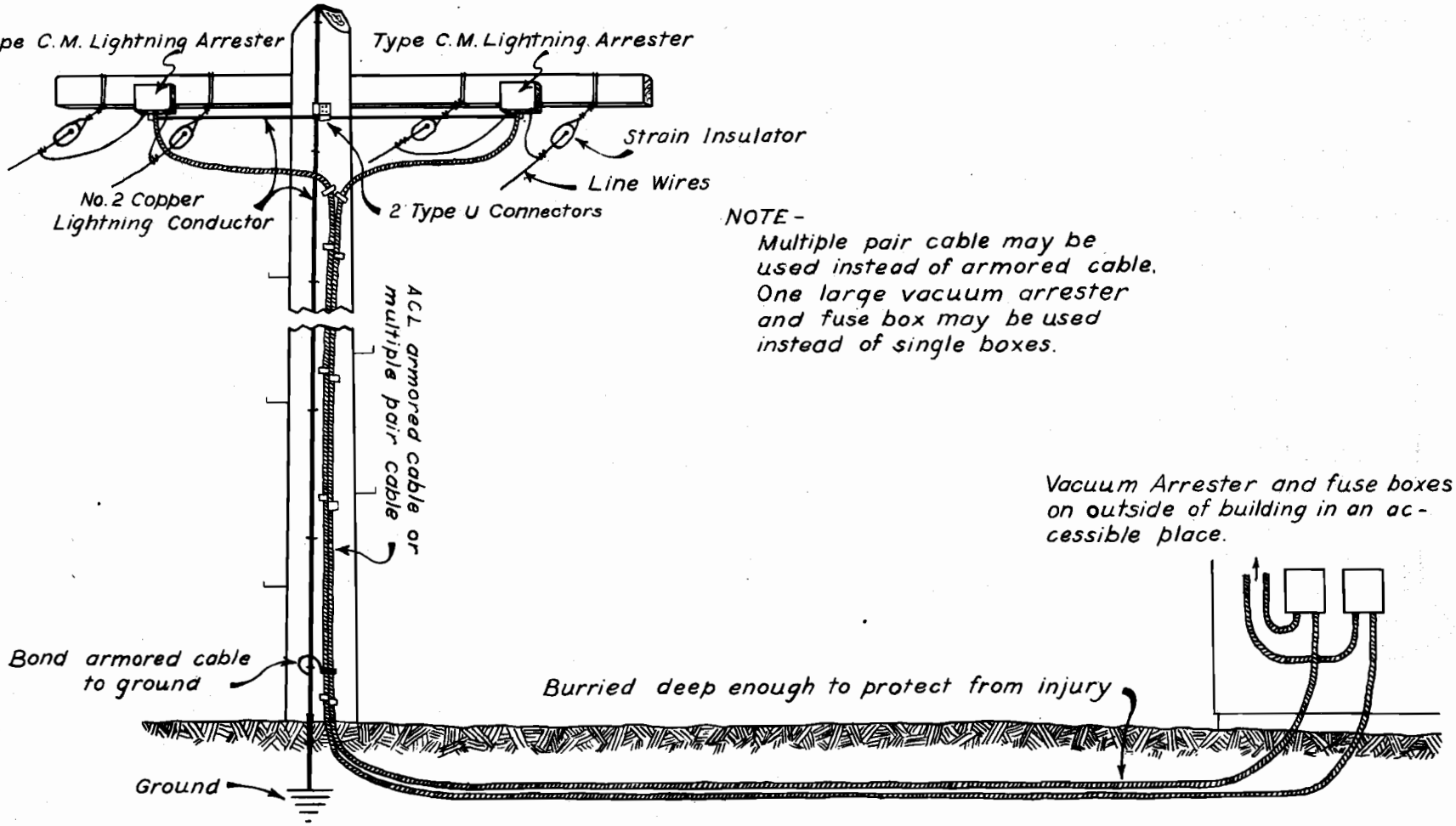
The type B arrester is made with disconnect switches and is used in station installations in areas subject to severe electrical storms and at all lookout tower installations. It is also made for use on both grounded and metallic circuits and, as stated above, the letter following the type letter indicates the circuit on which it is to be used. See Page 127 for wiring diagrams.

89. Vacuum Arresters

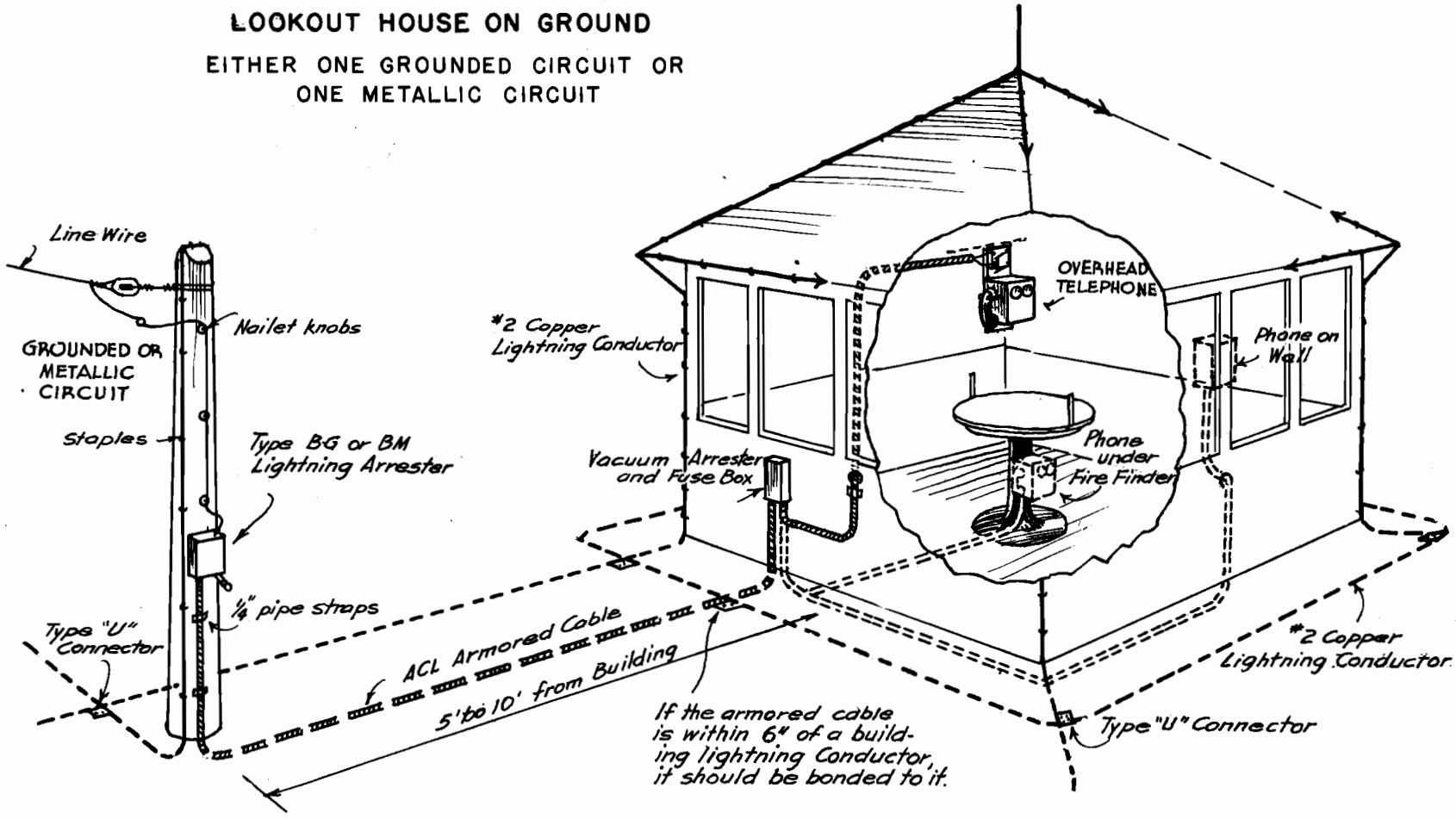
Vacuum arresters are now used at all Forest Service telephone installations. The single pole type is used for grounded circuits and the double pole type for metallic circuits. On account of fire hazard, the vacuum arrester should be placed on the outside of the building in an accessible place. It should be enclosed in a weather proof box. If fuses are used, the box should be of a sufficient size to contain both the vacuum arrester, or arresters, and the fuses. See Page 128 for wiring diagrams



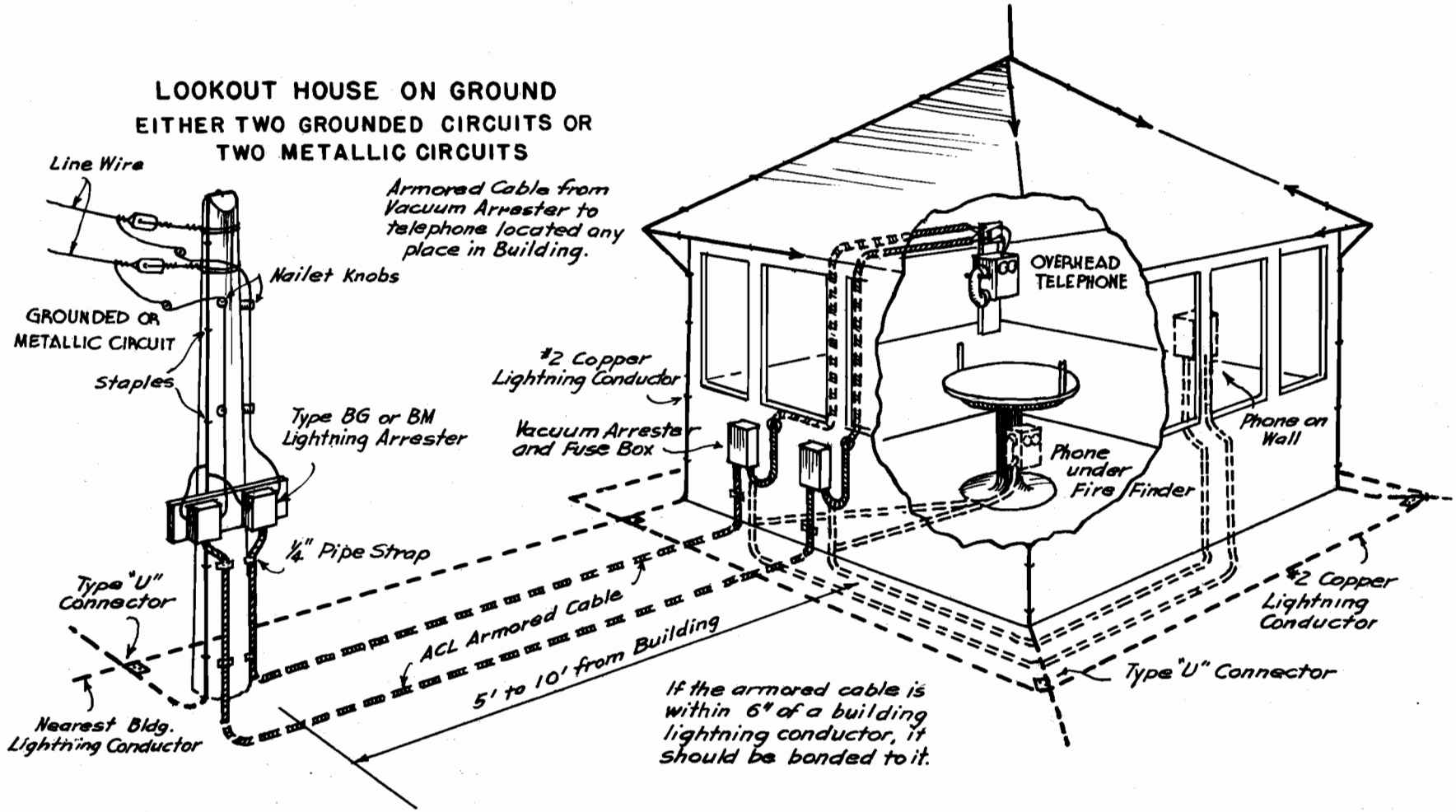
GROUNDED CIRCUIT TELEPHONE INSTALLATION AT SWITCHING STATIONS IN LIGHTNING ZONES



METALLIC CIRCUIT TELEPHONE INSTALLATION AT SWITCHING STATIONS IN LIGHTNING ZONES



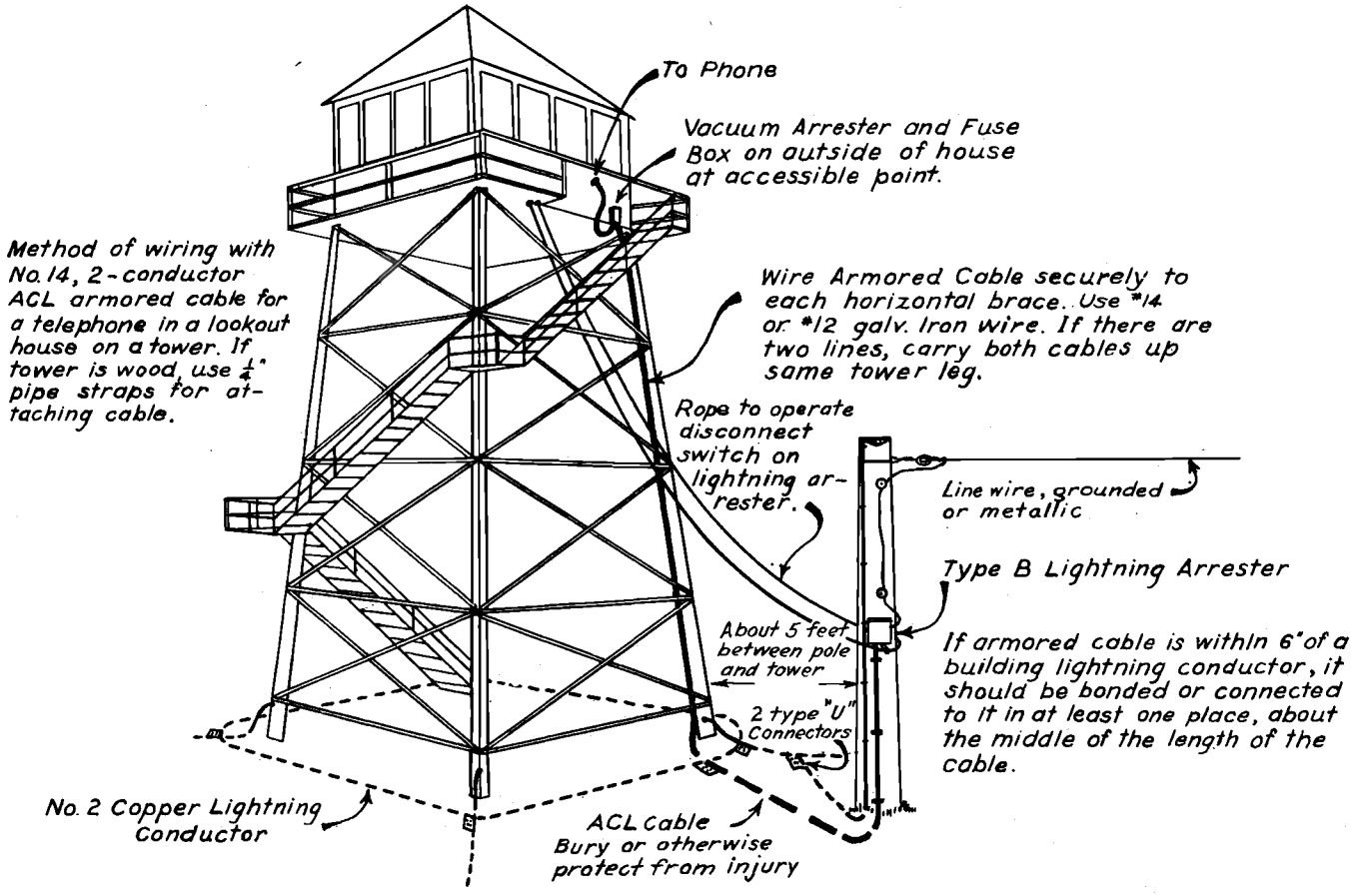
PROTECTION FOR LOOKOUT TELEPHONE INSTALLATIONS



PROTECTION FOR LOOKOUT TELEPHONE INSTALLATIONS

LOOKOUT HOUSE ON A TOWER

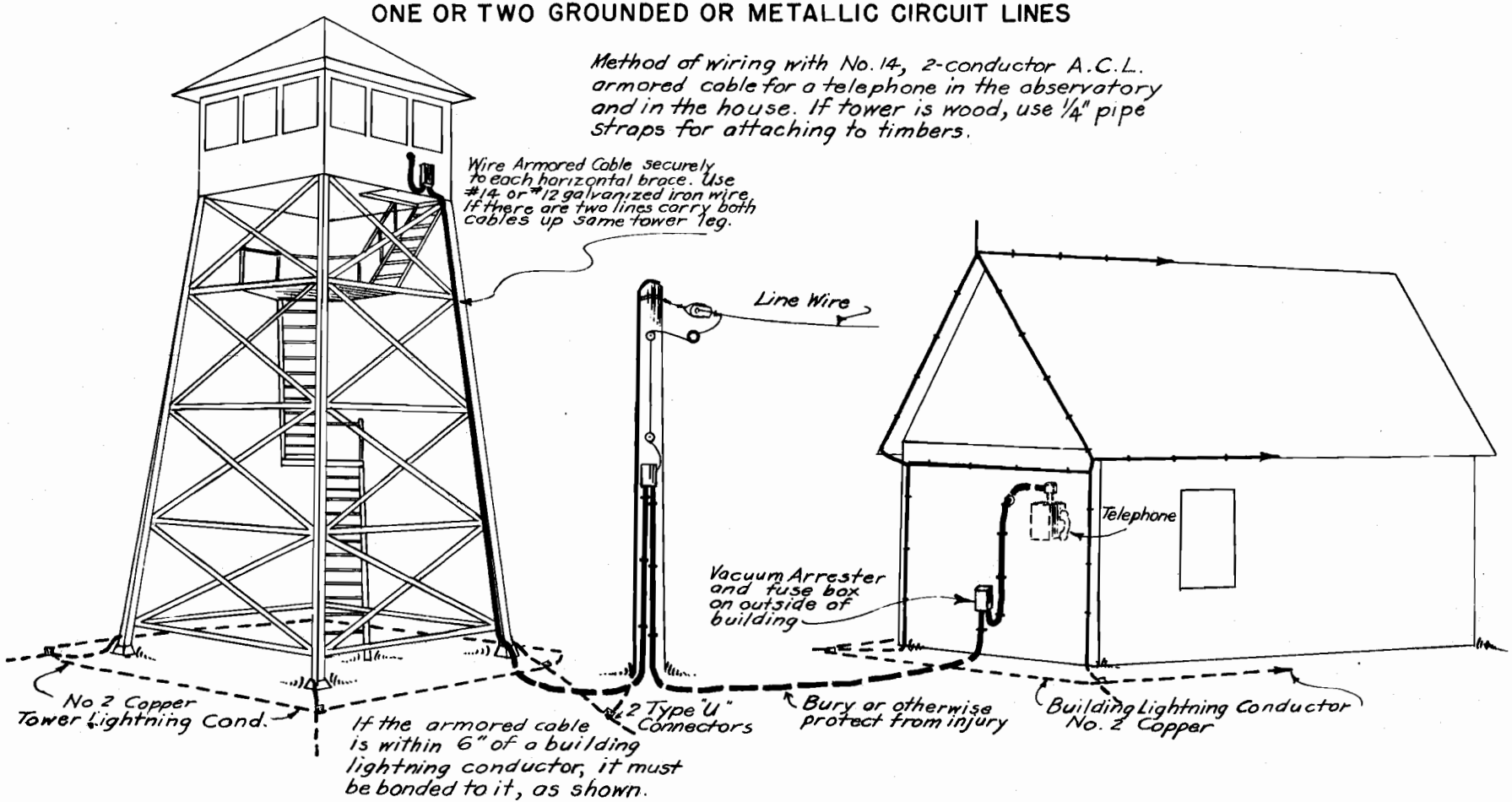
ONE OR TWO GROUNDED OR METALLIC CIRCUIT LINES



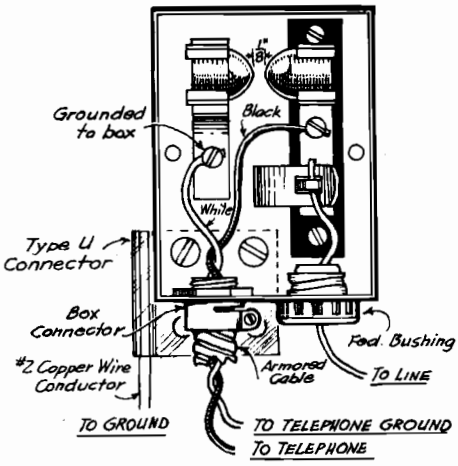
PROTECTION FOR LOOKOUT TELEPHONE INSTALLATIONS

OBSERVATORY ON TOWER WITH HOUSE ON GROUND

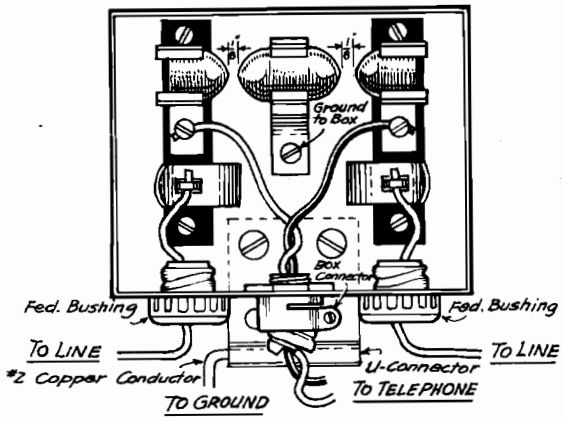
ONE OR TWO GROUNDED OR METALLIC CIRCUIT LINES



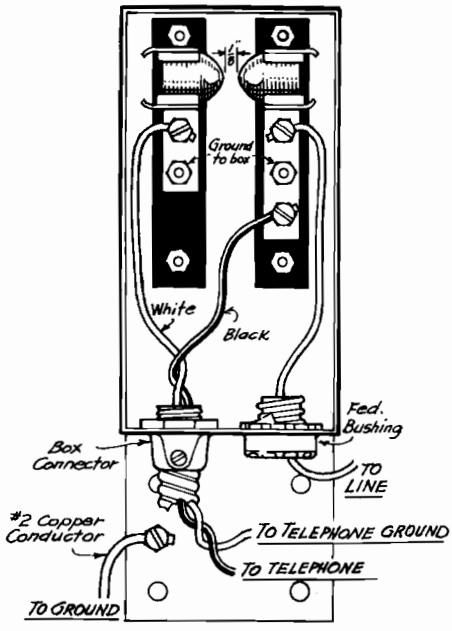
PROTECTION FOR LOOKOUT TELEPHONE INSTALLATIONS



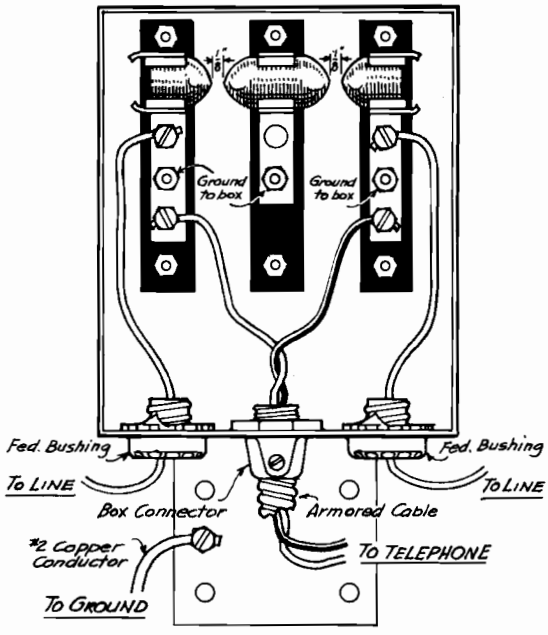
FOUCH C-G
(GROUNDED CIRCUIT)



FOUCH C-M
(METALLIC CIRCUIT)

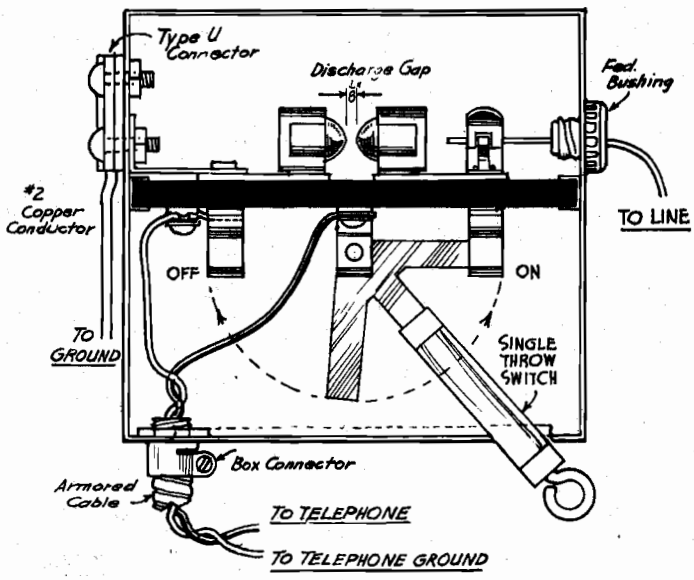


COOK-KELLOGG C-G
(GROUNDED CIRCUIT)

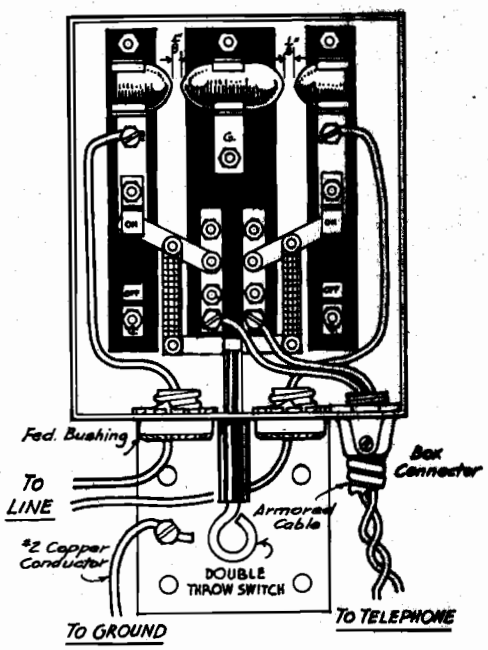


COOK-KELLOGG C-M
(METALLIC CIRCUIT)

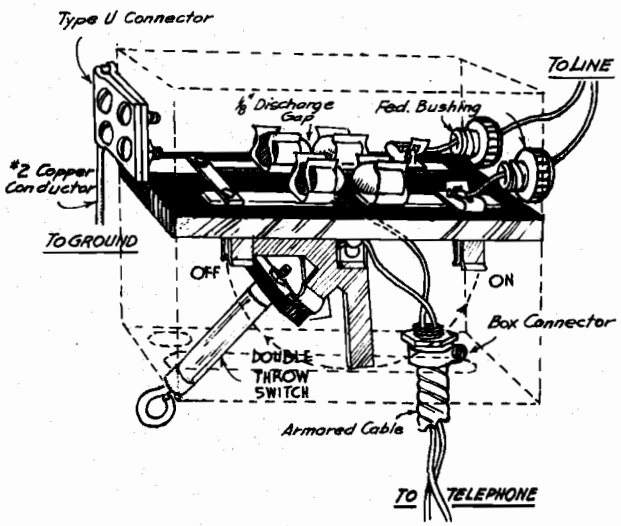
TYPE C LIGHTNING ARRESTERS



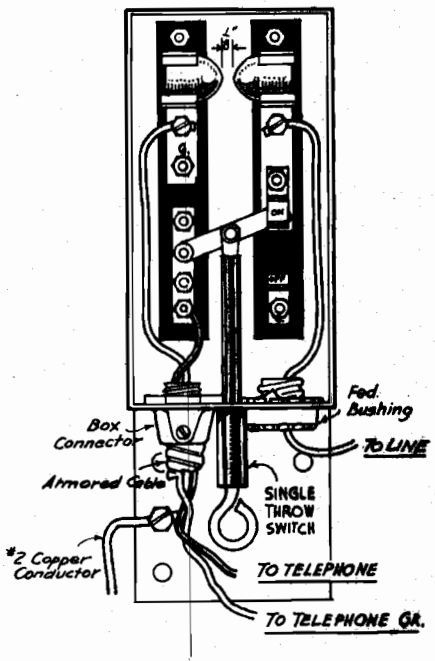
FOUCH B-G
(GROUNDED CIRCUIT)



COOK-KELLOGG B-G
(METALLIC CIRCUIT)



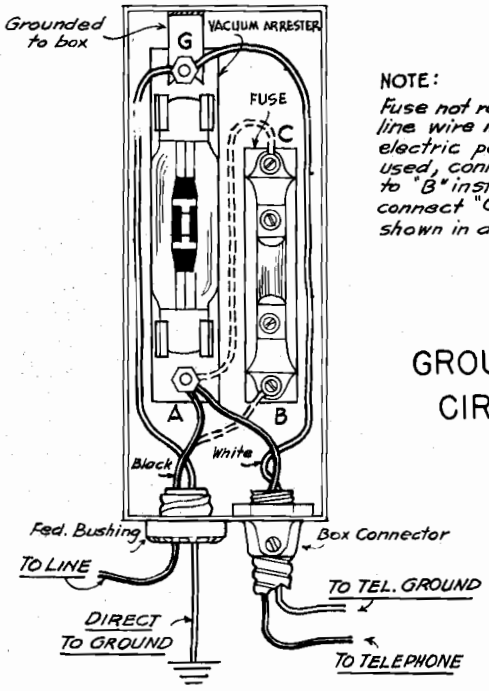
FOUCH B-M
(METALLIC CIRCUIT)



COOK-KELLOGG B-M
(GROUNDED CIRCUIT)

TYPE B LIGHTNING ARRESTERS

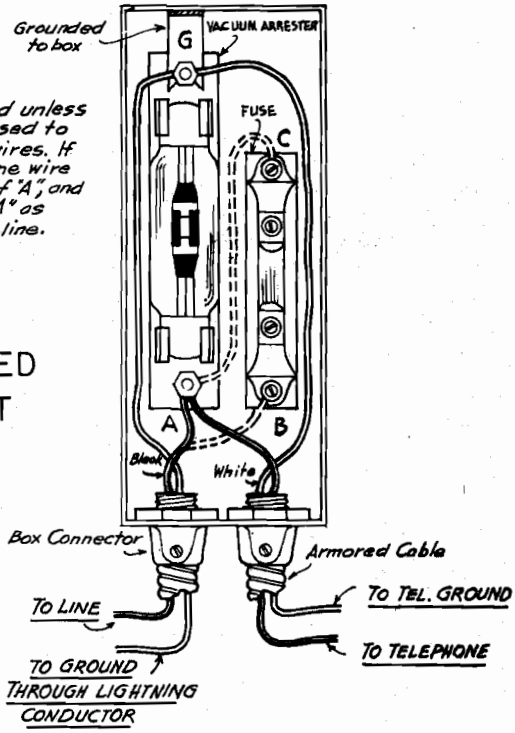
OVERHEAD SERVICE



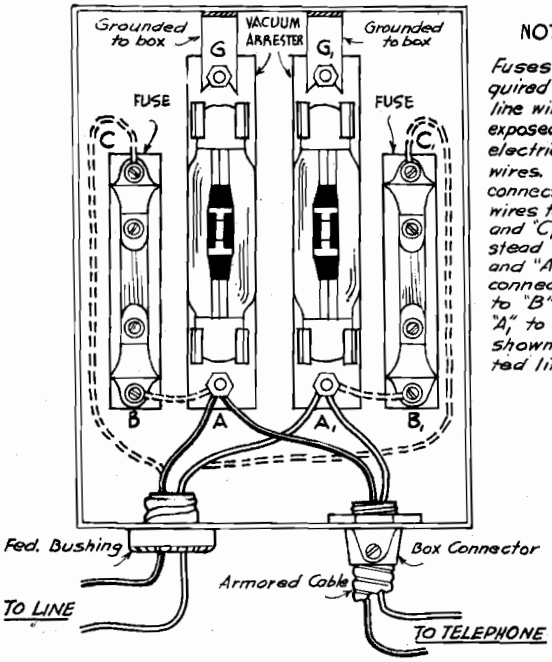
NOTE:
Fuse not required unless line wire is exposed to electric power wires. If used, connect line wire to "B" instead of "A", and connect "C" to "A" as shown in dotted line.

GROUNDED CIRCUIT

UNDERGROUND SERVICE

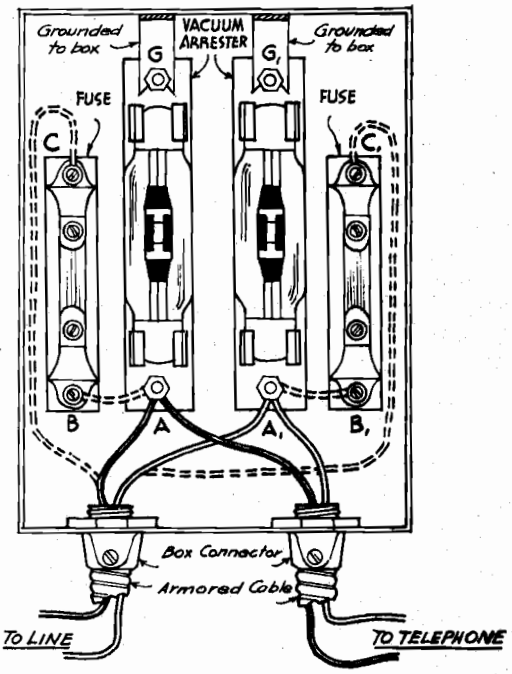


OVERHEAD SERVICE



NOTE:
Fuses not required unless line wires are exposed to electric power wires. If used, connect line wires to "C" and "C," instead of "A" and "A," and connect "A" to "B" and "A," to "B," as shown in dotted lines.

UNDERGROUND SERVICE



METALLIC CIRCUIT

WIRING DIAGRAMS

VACUUM ARRESTER AND FUSE BOX

90. Carbon Block Protector

Commercial companies do not use vacuum arresters at telephone installations. They do not believe that vacuum tubes give the proper protection because of a very decided time lag before the arresters act. Commercial companies use some form of carbon block cut-out protector. There are a number of types on the market, and any one of them may be used. The basic idea of this type of protector is to relieve telephone circuits from high potential electric charges without permanently grounding the line.

The type most commonly used by commercial companies consists of a solid porcelain base on which are mounted the protector and the fuse terminals. The protector consists of two blocks. One block is a solid piece of hard, non-dusting carbon with the face especially ground to present a smooth surface. The other block consists of a porcelain frame with a counter-sunk, hard carbon plug which is fastened in place with a low temperature fusing cement. The surface of the frame which bears against the first block, when assembled in a mounting, is finished by grinding. The air gap between the two carbons is held to close limits by grinding, and is usually limited to three mils.

Ordinary lightning discharges will cause an arc across the air gap between the carbon blocks but will not heat them sufficiently to melt the cement used for holding the carbon plug in place. A cross with an electric light or power line will cause a discharge or repeated discharges of such duration that the heating of the carbon insert will melt the cement holding it in place. This will allow the mounting spring to push the insert into direct contact with the solid carbon block, thus permanently grounding the line.

The carbon block protector may be used with or without fuses the same as the vacuum arrester.

91. Line Fuses

Line fuses will not be required unless the line is exposed to electric light or power lines. The recommended capacity fuse is 7 amperes. Fuses are not required for lightning protection because a lightning discharge is of such short duration that it will not blow a fuse of even very low capacity.

92. Grounds

Every reasonable effort should be made to protect telephone equipment from excessive electric current. Protection depends entirely upon proper grounding.

Telephone and lightning arrester grounds should have a low resistance and should be made in a soil that is a good conductor. A marshy soil or a soil which receives the runoff from cesspools and sinks contains both the moisture and electrolyte necessary to make it a good conductor.

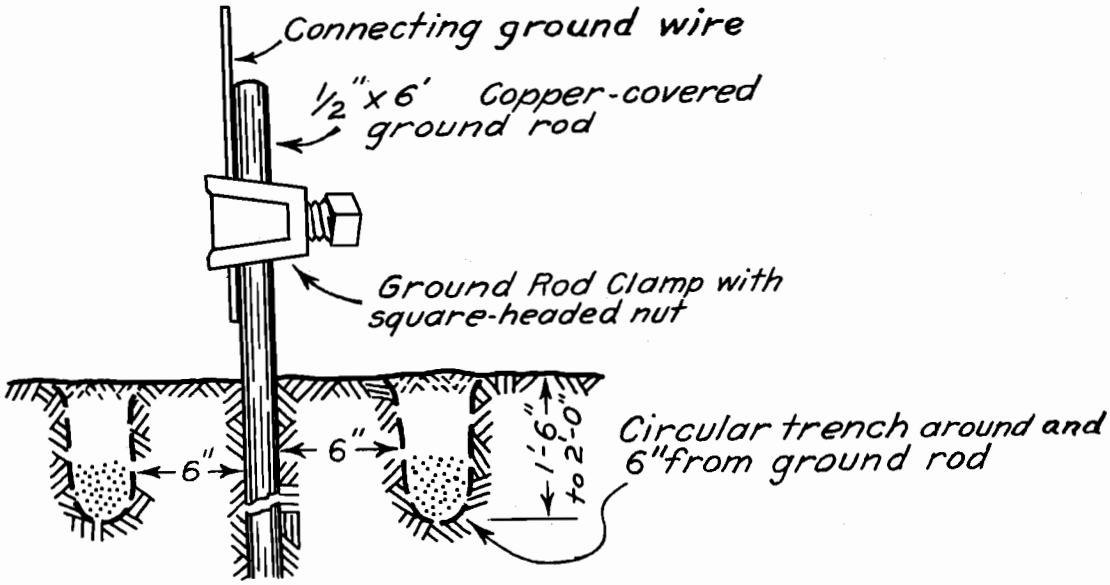
Eighty percent of the resistance of a ground is in the soil within 6 or 8 feet of the ground electrode. The diameter or surface area of an electrode has little to do with the ground resistance.

A galvanized iron water pipe, two or three hundred feet long, buried in moist electrolytic soil usually makes a good ground. Use a regular ground clamp for making connection with it.

The following instructions are useful for making a ground when a water pipe is not satisfactory or not available:

1. Copper makes the best ground electrode:- either a copper wire about 8' long, No. 2 or No. 4 B & S gauge, or a $\frac{1}{2}$" x 6' copper-covered ground rod. Galvanized iron rods $\frac{1}{2}$" x 8' are used commercially and have a useful life of from 5 to 10 years.

2. When it is necessary to make a ground in soil that does not contain moisture and an electrolyte as described above, salt must be added. Rock salt contains more calcium chloride than ordinary salt and will last longer. If this is not available, use stock salt. Use about 50 lbs., applied in a circular trench near the surface of the ground, as shown in the diagram, taking care to keep the salt from coming in direct contact with the ground rod. In dry soil, add water occasionally, and renew the salt every two or three years.



TELEPHONE GROUND

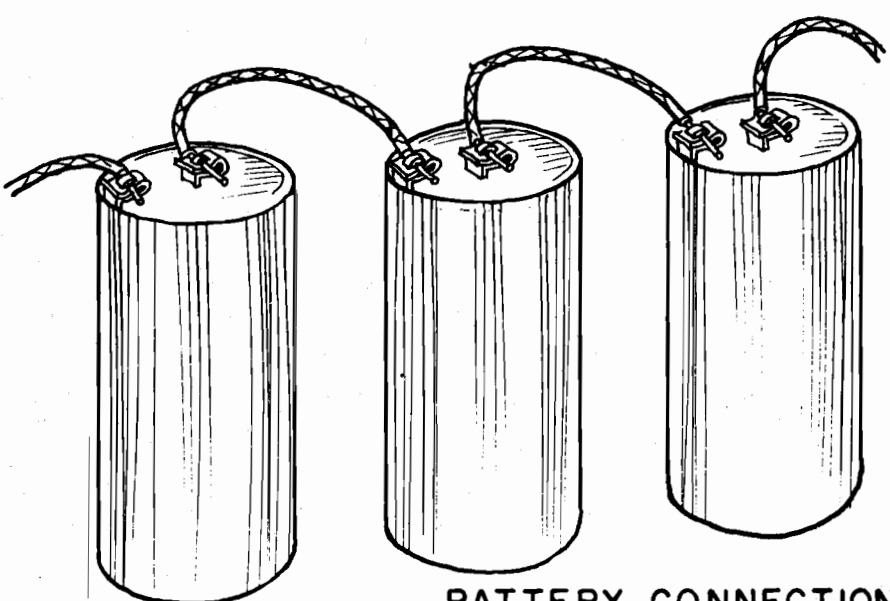
3. If one ground does not give satisfactory results, a second ground made not less than 9 or 10 feet away, will usually lower the resistance from 30 to 40%. In very dry soil 3 or 4 electrodes, separated as above, may be necessary. In every case where more than one electrode is used, they should all be connected together.

93. Wire

The ground wire on the terminal pole should be #2 solid copper connected at the lower end to a suitable ground rod. The wire used for connections between the service wire and the vacuum arrester and the disconnect switch or telephone inside the building should be #14 R.C.S.B. copper. All connections whether inside or outside of the building should be soldered and taped unless the service wire is iron. A connection between iron and copper wire should be made with a bridging connector because the average man will not make a good soldered joint between the two kinds of wire.

94. Switches

Knife switches are satisfactory as telephone disconnect switches. Although their resistance is extremely high, they are often used in making switch connections between two or more lines at stations, and should always be located between the telephone and the vacuum arrester and should be disconnected when the telephone is not to be used for a considerable length of time. The proper hook-up for a two-line switching operation is shown on Page 133. The proper hook-up for a three-line operation is shown on Page 134.



BATTERY CONNECTION

95. Batteries

At least three regular telephone dry batteries should be used in each standard telephone. On long lines the instrument farthest away often gives better service if four batteries are used. The use of more than four batteries is harmful to the fine wiring inside the telephone. A battery should be fresh when installed. They should be connected in series, carbon to zinc, as shown on Page 131.

Tests are being made of an extra long life battery which has recently been developed. This new battery is expected to have life enough to last through two seasons under ordinary service conditions. Batteries should not be left connected together in unoccupied stations during the winter months. This is particularly important in the case of iron box telephones.

96. Switchboards

Three satisfactory types of switchboards, A, B and E, have been developed for use on Forest Service lines. Type A, 6 line capacity, and type B, 9 line capacity, are key boards. Type E is a combination key board and plug and jack board made in 12, 18 and 24 line sizes. The cabinets for the boards contain all the switchboard parts and are made in Models 5 and 6. The Model 6, in addition to keys, ringers, etc., includes howlers and equipment for sending howler signals. The Model 5 does not include the howler and howler signal set. Both the type A and type B boards are for table or wall mounting. The type E cabinet is for wall mounting with space for cords and cord weights to hang below.

The installation and operating instructions and wiring diagrams for the type A switchboard are shown on Pages 135, 136 and 137.

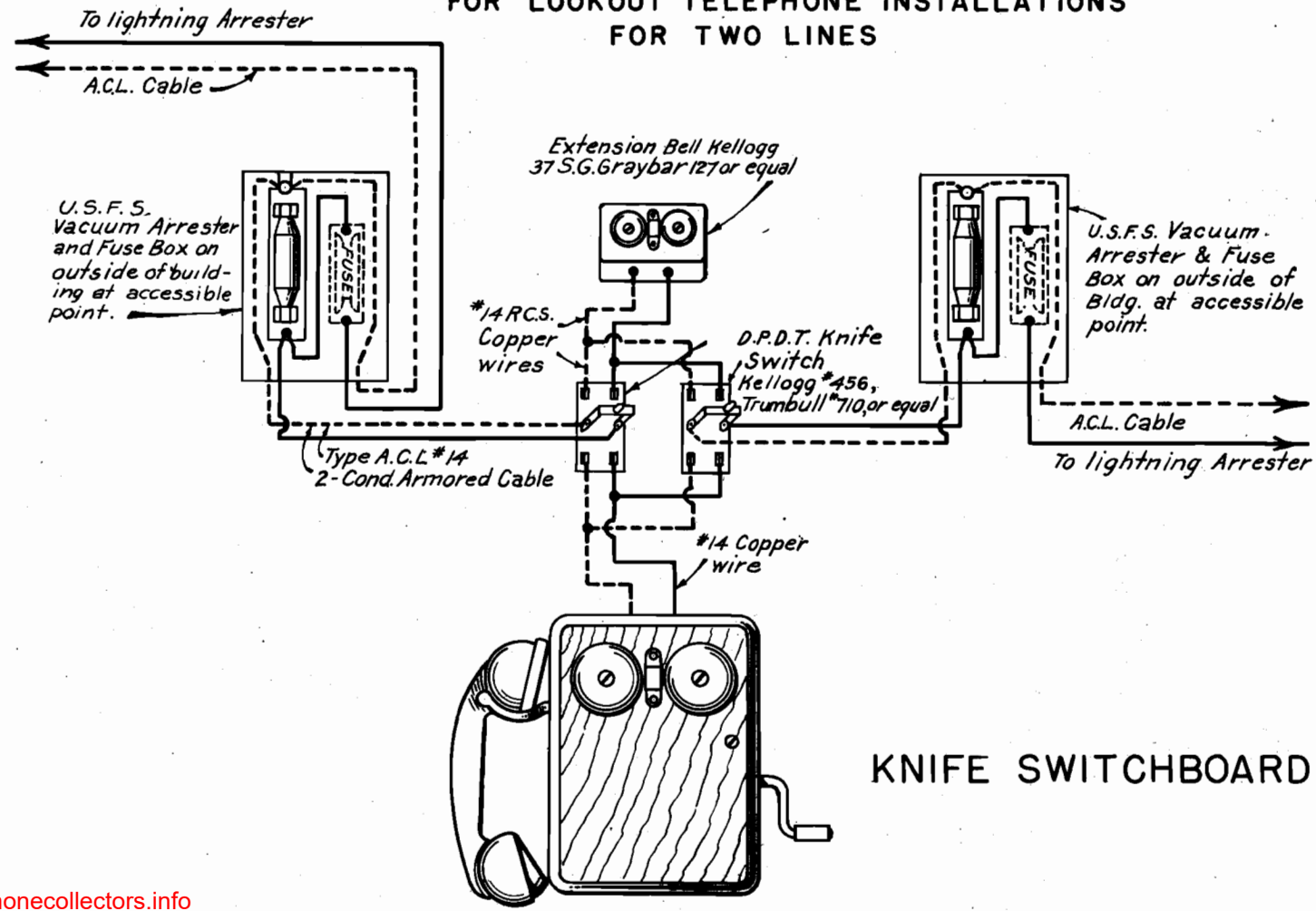
The installation and operating instructions and wiring diagrams for the type B switchboard are shown on Pages 138, 139 and 140.

The installation and operating instructions and wiring diagram for the type E switchboard are shown on Pages 141 and 142.

97. Dispatcher's Desk

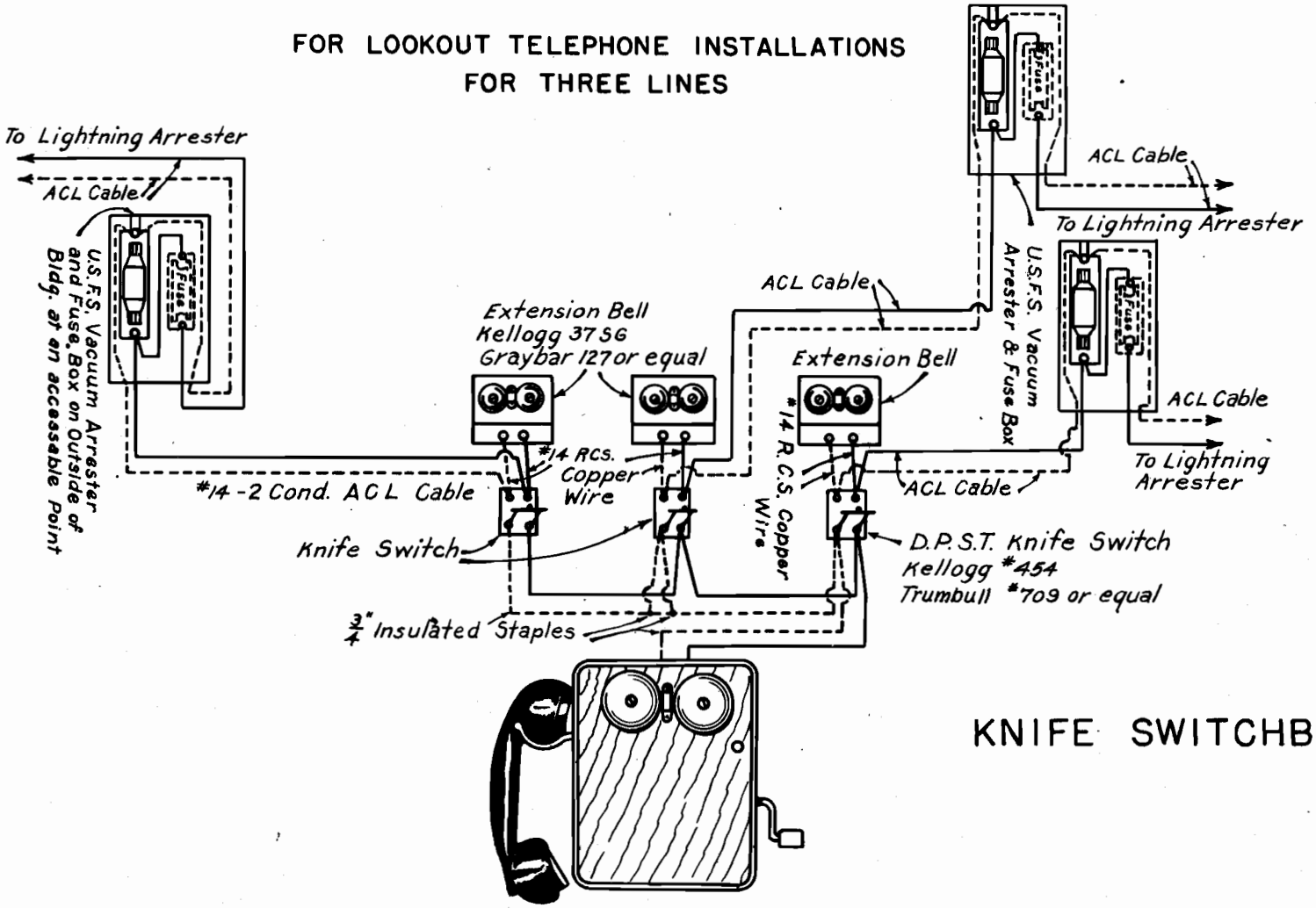
A special desk has been designed for use at Rangers' Headquarters. It contains the switchboard and standard operator's switchboard cord set, which leaves the dispatcher's hands free for writing notes or working on the fire map while receiving messages. The desk has adequate space for all fire control records. The map board is mounted on a movable easel so that it can be used either in a vertical or horizontal position. The wiring diagram for the dispatcher's desk hook-up is shown on Page 143.

FOR LOOKOUT TELEPHONE INSTALLATIONS FOR TWO LINES



KNIFE SWITCHBOARD

FOR LOOKOUT TELEPHONE INSTALLATIONS FOR THREE LINES



KNIFE SWITCHBOARD

INSTALLATION AND OPERATING INSTRUCTIONS

for

Type A Switchboard
Either Model 5 or Model 6

Line wires enter the switchboard cabinet through holes in the back and are connected to the proper binding screws in the lower terminal strip, which is attached to the back of the equipment panel. It is customary to set the cabinet on a shelf or table and to fasten it in place with small angle irons attached to the outside of the cabinet, after the line wires are connected.

Each line is connected to a key (black handle) and to a bell (and howler, if used).

The operator's telephone, including the magneto, is connected to the left hand, or operator's key (white handle).

The howler signal set, if installed, is connected to the operator's telephone circuit, through the right hand key. This key has a red handle, and operates only one way and is self-restoring.

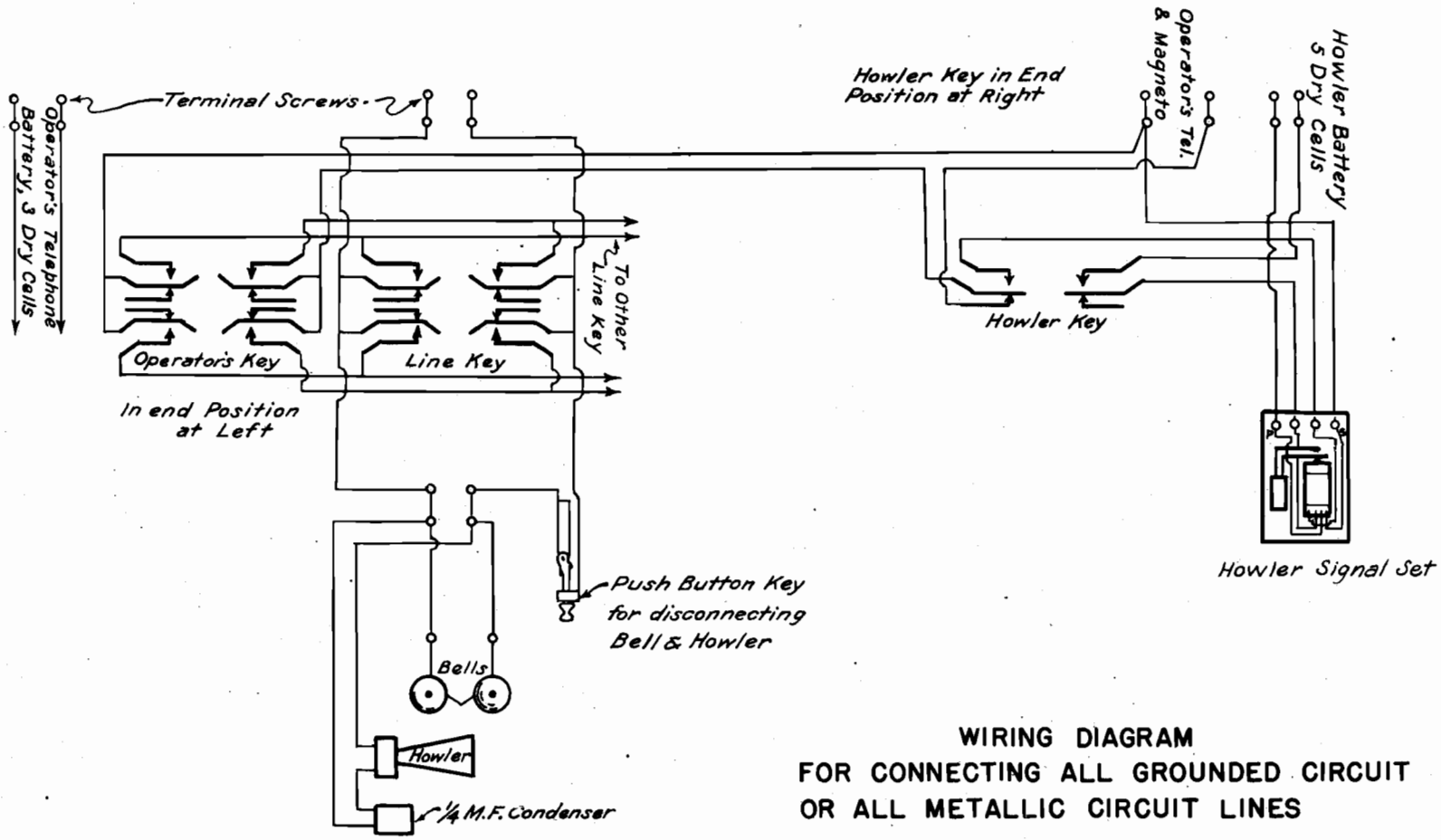
To talk or ring on a line, pull the operator's key and the line key in the same direction, either up or down.

To connect two or more lines together, which are either all grounded or all metallic, pull the corresponding numbered line keys in the same direction, either up or down.

To connect grounded circuit and metallic circuit lines together, pull the corresponding line keys up. This cuts the repeat coil in to the circuit.

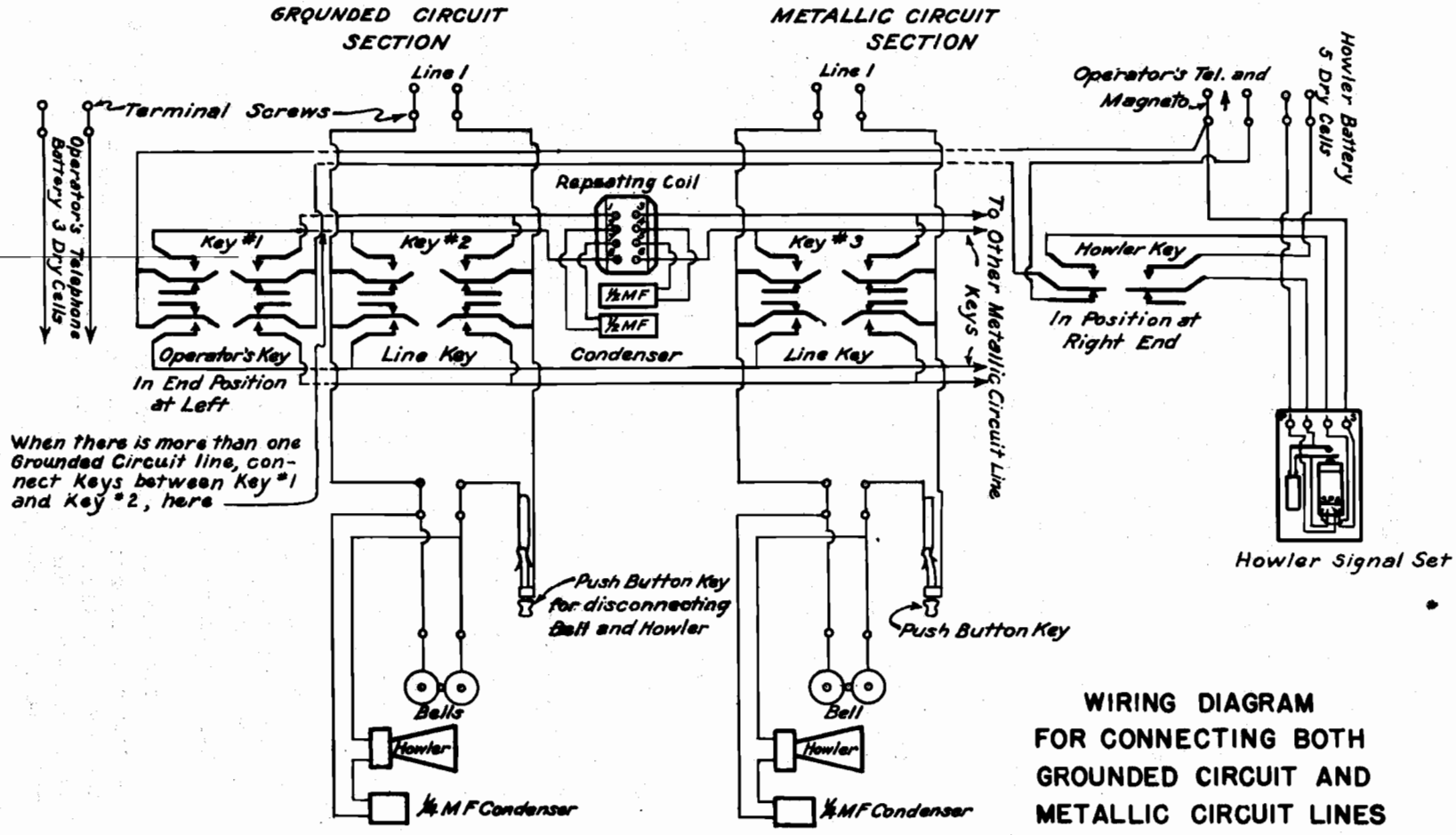
To send a howler signal on a line, pull both the line and operator's keys in the same position, up or down, and push the key handle up intermittently to send proper signals, long or short, etc.

The push button disconnect switches are installed in order to permit the disconnecting of ringers and howlers on a line and thus eliminate their line load when it is desired to answer calls from an auxiliary switchboard at the station.



WIRING DIAGRAM
FOR CONNECTING ALL GROUNDED CIRCUIT
OR ALL METALLIC CIRCUIT LINES

TYPE A MODEL 6 SWITCHBOARD



WIRING DIAGRAM FOR CONNECTING BOTH GROUNDED CIRCUIT AND METALLIC CIRCUIT LINES

TYPE A MODEL 6 SWITCHBOARD

INSTALLATION AND OPERATING INSTRUCTIONS

for

Type B Switchboard
Either Model 5 or Model 6

Line wires enter the switchboard cabinet through holes in the back and are connected to the proper binding screws in the lower terminal strip, which is attached to the back of the equipment panel. It is customary to set the cabinet on a shelf or table and to fasten it in place with small angle irons attached to the outside of the cabinet, after the line wires are connected.

Each line is connected through the line operator's key to the line switching key and to the corresponding numbered bell (and howler, if used).

The keys in the upper row, with black handles, are line keys and are used only for connecting lines together. There is one key for each line.

The keys in the lower row, with white handles, are operators' keys and are used for either talking or ringing on a line. There is one key for each line.

The howler signal set, if installed, is connected to a one-way, non-locking key with a red handle, at the right in the lower row of keys.

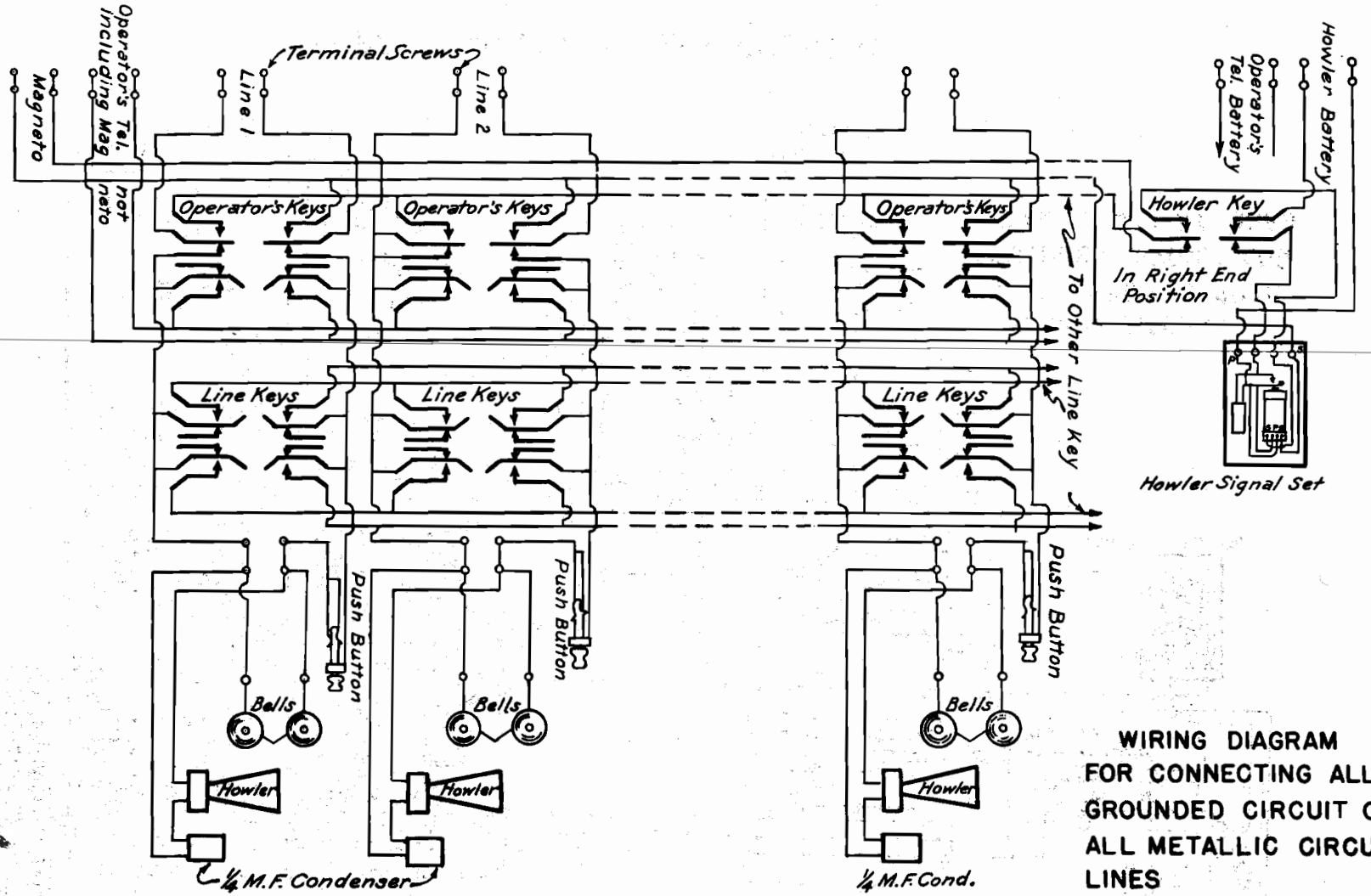
To talk on a line, pull the corresponding operator's key down.

To ring on a line, hold the corresponding operator's key up, while ringing the desired code ring.

To connect two or more lines together, throw the corresponding line keys in the same direction, either up or down.

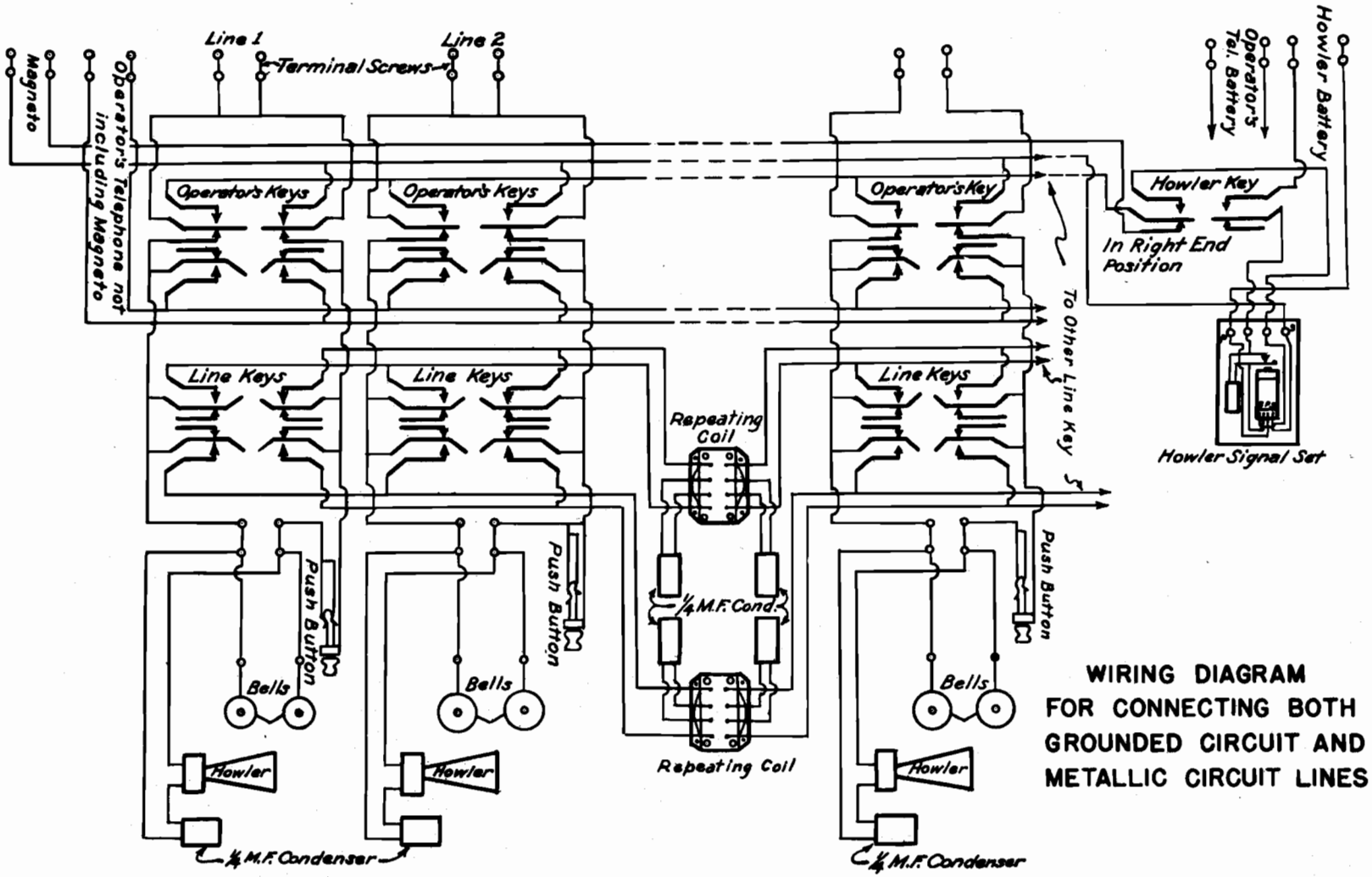
To send a howler signal on a line, hold the corresponding operator's key up, and at the same time pull the howler key up intermittently, to make proper signals, long or short, etc.

The push button disconnect switches are installed in order to permit the disconnecting of ringers and howlers on a line and thus eliminate their line load when it is desired to answer calls from an auxiliary switchboard at the station.



WIRING DIAGRAM FOR CONNECTING ALL GROUNDED CIRCUIT OR ALL METALLIC CIRCUIT LINES

TYPE B MODEL 6 SWITCHBOARD



WIRING DIAGRAM FOR CONNECTING BOTH GROUNDED CIRCUIT AND METALLIC CIRCUIT LINES

TYPE B MODEL 6 SWITCHBOARD

INSTALLATION AND OPERATING INSTRUCTIONS

for

Type E Switchboard
Either Model 5 or Model 6

If the cabinet is to be attached to a wall, use the four angle irons furnished for this purpose. Two are attached to the sides of the inside of the cabinet and the other two furnished are attached underneath the the cabinet for bottom support.

The line wires, also the wires for operator's telephone, hand generator, power ringer, etc., enter the cabinet, either through a hole bored in one side or the bottom, and connect to the binding screws on the upper side of the line terminal strip attached to the back of the cabinet.

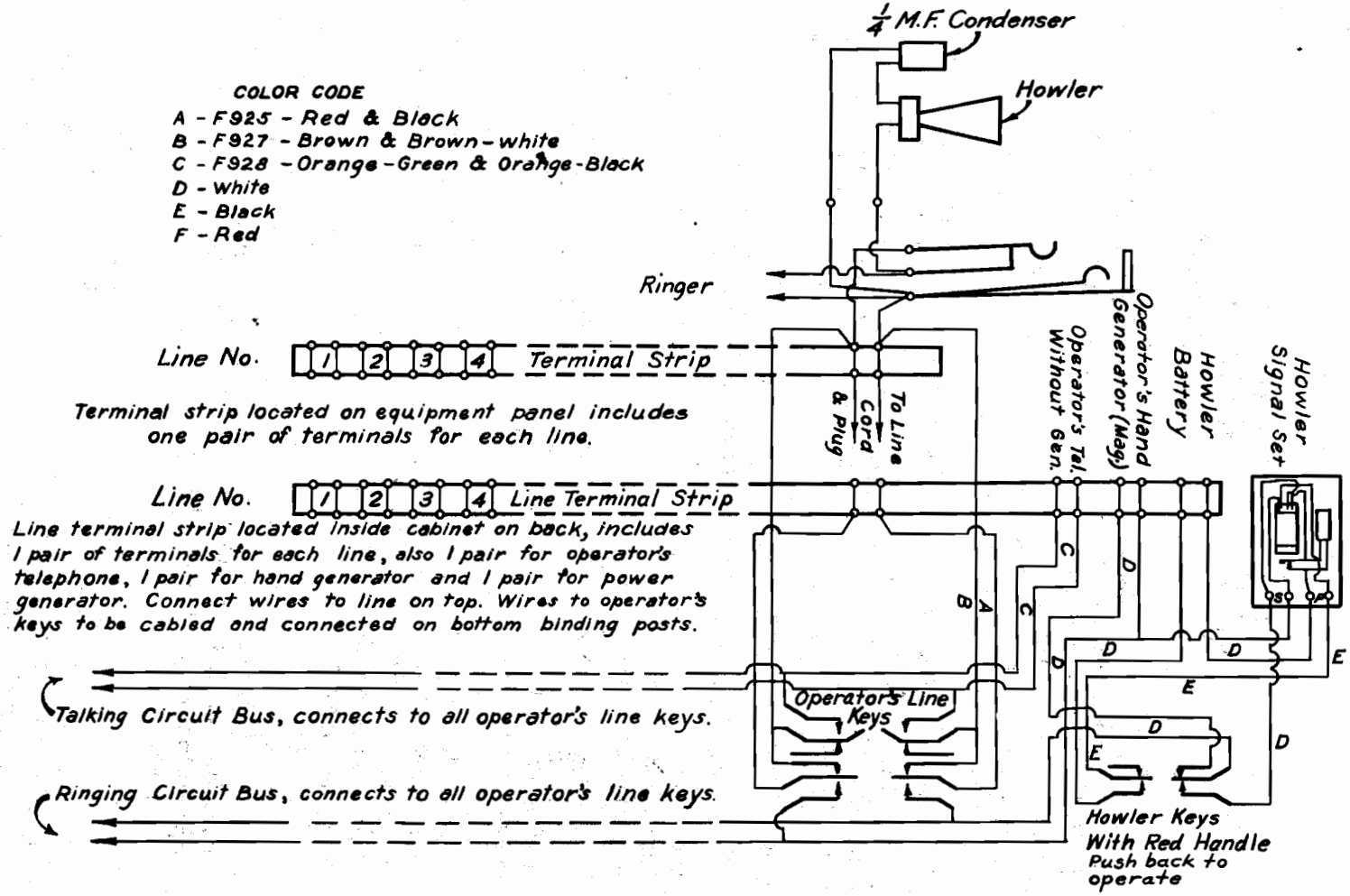
The row of operating keys, with black handles, includes one key for each line, and one power ringer (or howler key) with red handle, located at the right end of the key row.

To talk on a line, pull the handle of the operator's key forward. This connects the line to the operator's telephone talking circuit.

To ring on a line, hold the handle of the operator's key back, and either turn the magneto crank or operate the power ringer key by pushing the handle back. This connects the line to the ringing circuit and cuts out the operator's telephone line plug and cord, jack and ringer.

To "howl" on a line, (howler signal set, if installed, will be connected to the power ringer key), the operation will be the same, except the magneto will not be used.

The plugs and cords are used for connecting lines together. To connect, for instance, line 1 with line 5 either the line 1 plug may be inserted in the line 5 jack, or the line 5 plug may be inserted in the line 1 jack. When a plug is inserted in another line jack, the ringer (and howler, if used) of the other line is cut off. Therefore, if it is desired to connect any number of lines together, there will only be one set of ringers or howlers on the line.

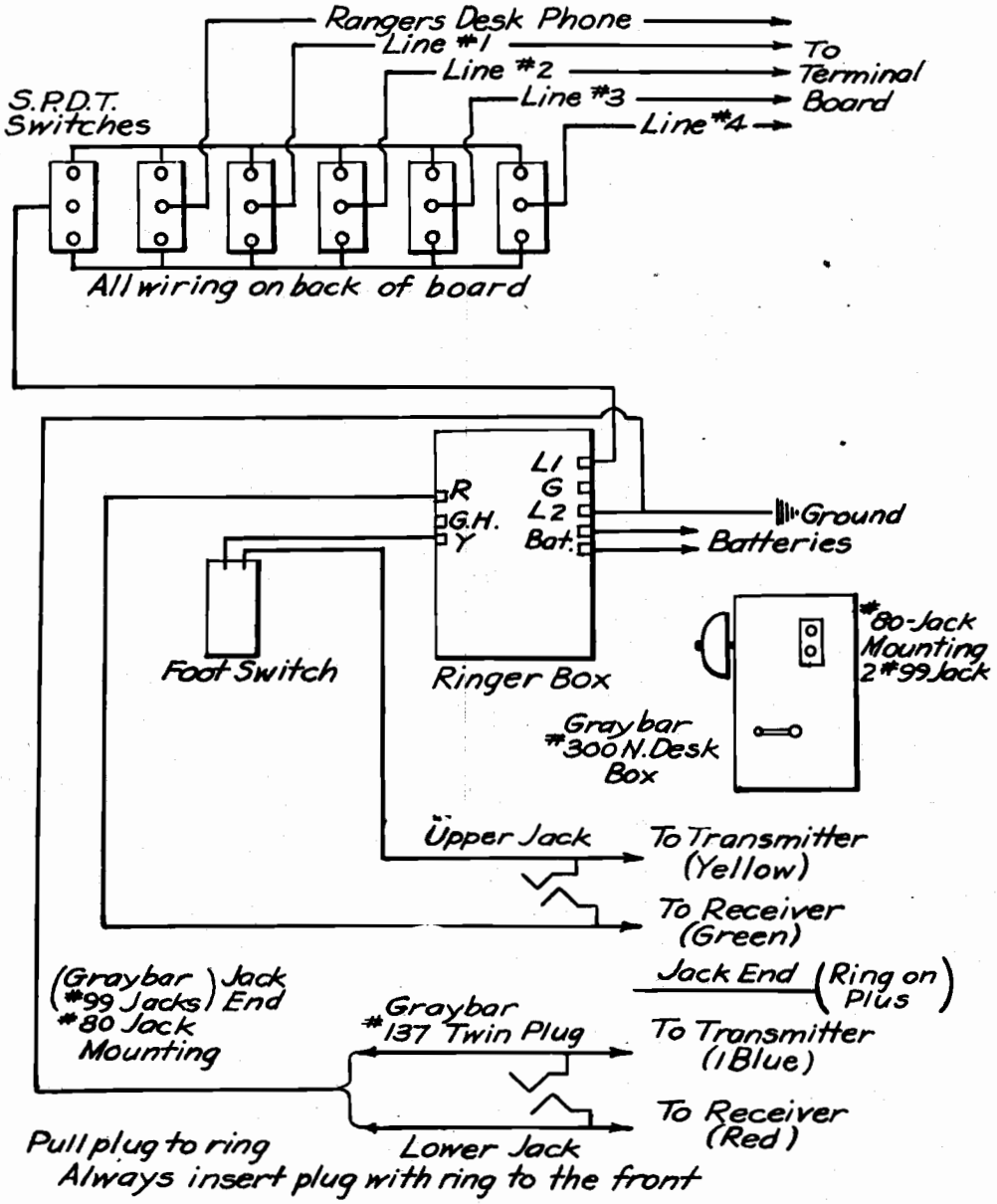


WIRING DIAGRAM FOR

TYPE E MODEL 6 SWITCHBOARD – 12 LINE

Material

1-Box Telephone Ringer	Graybar	#300 N or equal
1-Jack Mounting	"	# 80
2-Jacks	"	# 99
1-Transmitter Breast Type	"	# 234
1-Receiver, Head Set	"	#528
1-Attachment, transmitter	"	# 3
1-Plug Twin	"	#137
1-Cord Switchboard 6"	"	#L4E
1-Switch foot	"	# 1-B
6-Switches Baby Knife S.P.D.T.		



WIRING DIAGRAM FOR DISPATCHERS DESK

98. Station Telephone

All station telephones must be equipped with a generator having a ringing strength of not less than that of a 5 bar magneto, a 2500 ohm ringer or bell coil, and a condenser in the receiver circuit. Some Regions use telephone equipment with a 6 bar magneto for better and more efficient service. Station telephones may be of the wall type with a cabinet large enough to contain the batteries or a wall type using a handset and with the batteries in a separate box.

99. Lookout Telephone

The standard lookout telephone consists of a modified wall telephone equipped with an operator's breast transmitter and head receiver set. The telephone is usually mounted on the upright leg of the fire finder. In this telephone the switch hook is replaced by a plug and jack and the operator's cord is connected at that point on the side of the telephone. An installation diagram is shown on Page 145.

100. Heavy Duty Telephone

A new desk set type of telephone has been developed for Forest Service use. It has a double microphone transmitter and has a much greater range than the ordinary telephone. It is very effective for use on long, heavily loaded lines and for combating static. It uses a 6 volt storage battery or 12 dry cells and is fitted with a plug and jack to provide for the use of head phones. The wiring diagram for this telephone is shown on Page 146.

101. Field Telephone

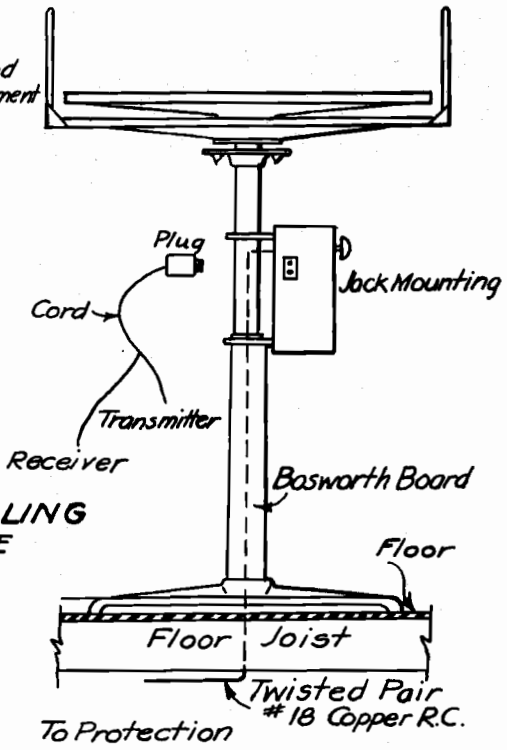
The Model A-1 is a camp or trail telephone, similar to the iron mine set except that the case is made of aluminum, is reasonably waterproof, and will withstand exposure to the weather. Standard telephone parts are used, including a 6 bar magneto, a 2500 ohm ringer, an induction coil, a 1/2 M.F. condenser in the receiver circuit, 3 dry cells, a hook switch, and a one piece hand set with standard transmitter and receiver. The talking and ringing range of this telephone is equal to that of the average heavy duty telephone. It weighs about 30 pounds, including the batteries.

102. Portable Telephone

The Model C magneto telephone is designed primarily for use by patrolmen or others traveling by automobile, and is reasonably waterproof. It has a folding crank handle, and, when the hand set is in place and the door is shut, it is ready for transportation. The case is made of hard wood with substantial corner reinforcements and is provided with a leather carrying strap. Standard telephone parts are used, including a 5 bar magneto, a 2500 ohm ringer and a condenser in the receiver circuit. Standard 3-cell flashlight batteries or 3 unit cells are used. The talking and signaling range is equal to that of the average telephone and it may be used to re-

Materials Needed

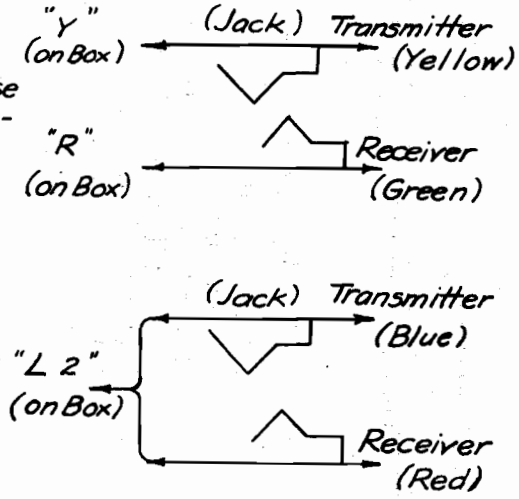
1-1317-3 Telephone, without Trans. or Rec.
1-Head Receiver 528 with #11A Head Bond
1-Breast Transmitter #234 with #3B Attachment
1-Twin Plug #137
1-Jack Mounting #80
2-Jack #99
1-Operaters Tel. Cord #L4B (10'-0")



INSTRUCTIONS FOR INSTALLING LOOKOUT TELEPHONE

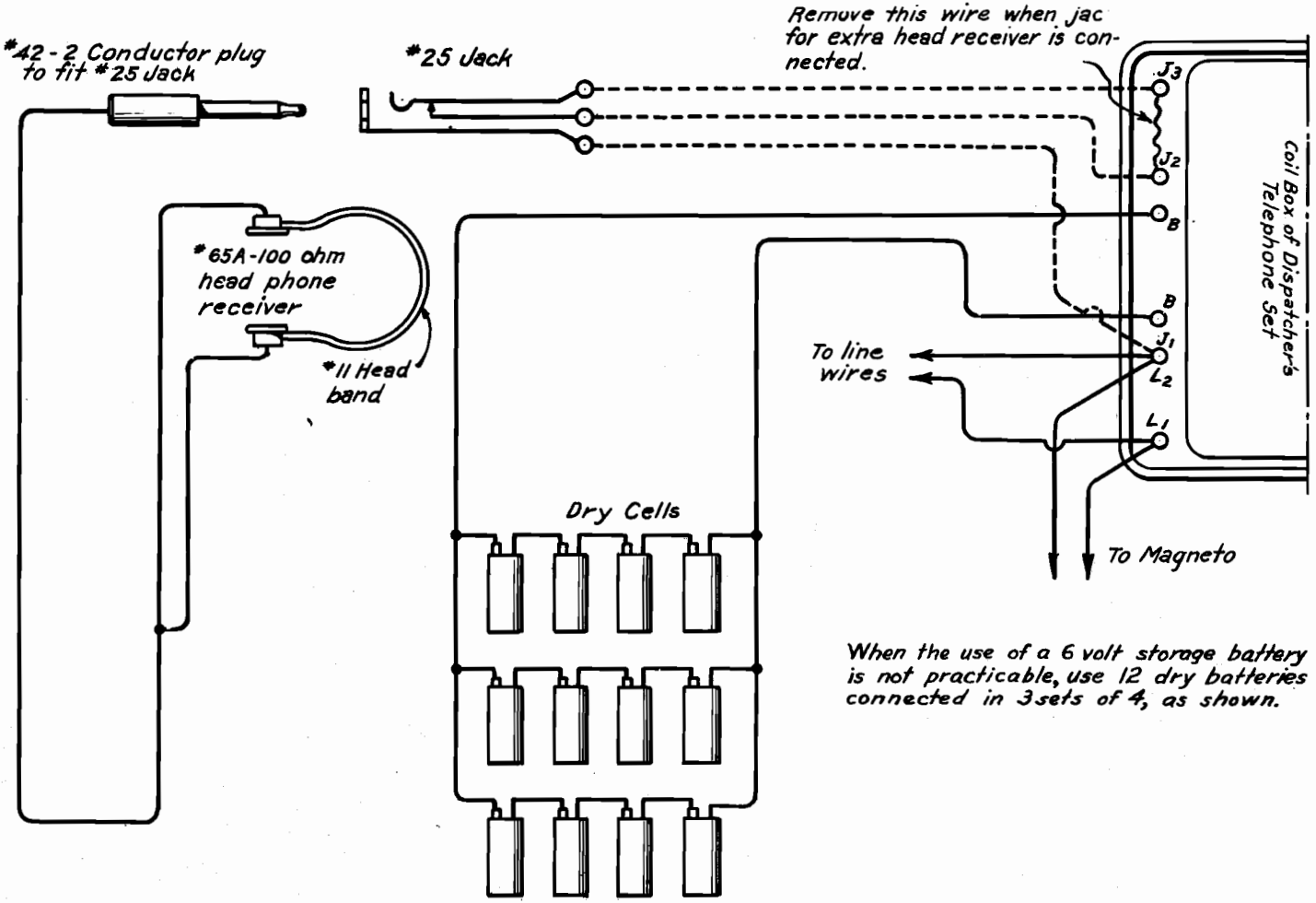
The telephone box will be clamped to the pedestal of the fire-finder. A small hole has been drilled in the pipe about 6 inches below the plate. The hole in the back of the telephone box should be placed opposite to the hole in the pipe. The lead-in wire (#18 copper twisted pair) should be threaded through the pipe and through a hole in the floor of the lookout house and brought out to the lightning protection and line wire at the outside edge of the house. Plenty of slack should also be left in the lead-in wire under the floor so that the base of the fire-finder can be shifted without interfering with the telephone connection.

The jack mounting in the side of the telephone box and the twin plug at the end of the operator's cord take the place of the switch hook in the regular instrument. <u>The plug must be removed when the telephone is not in use</u>.



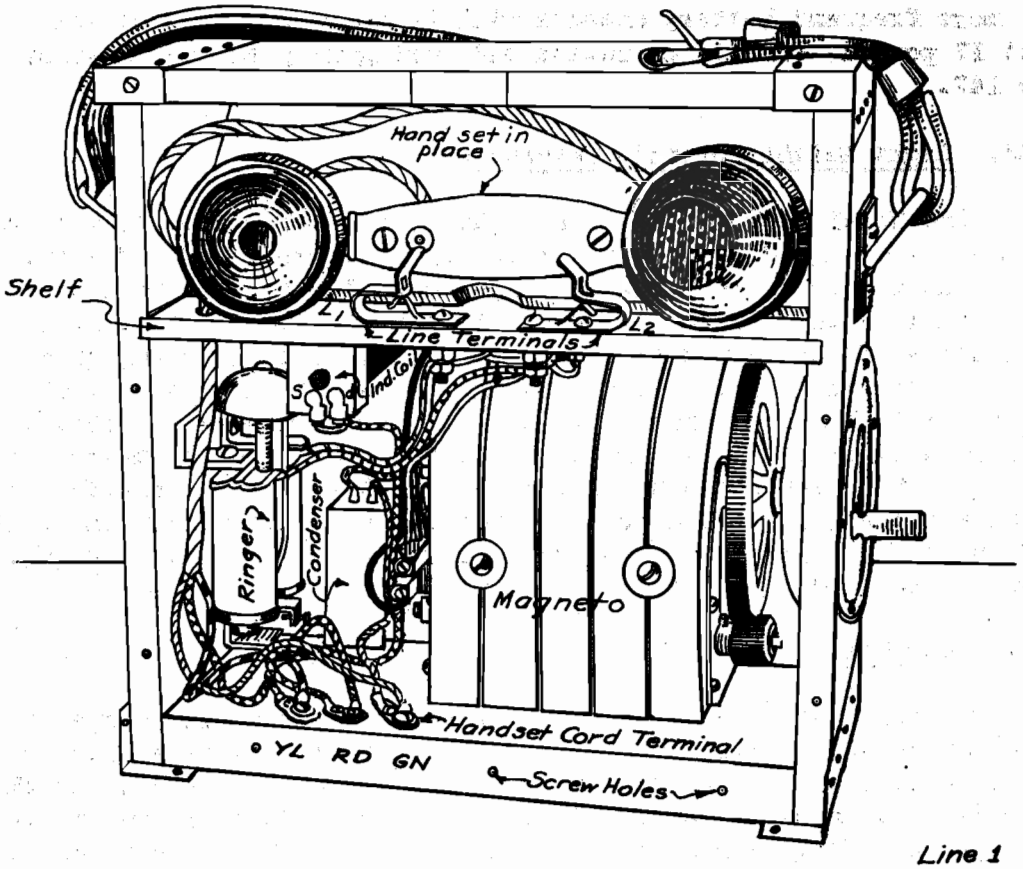
WIRING DIAGRAM

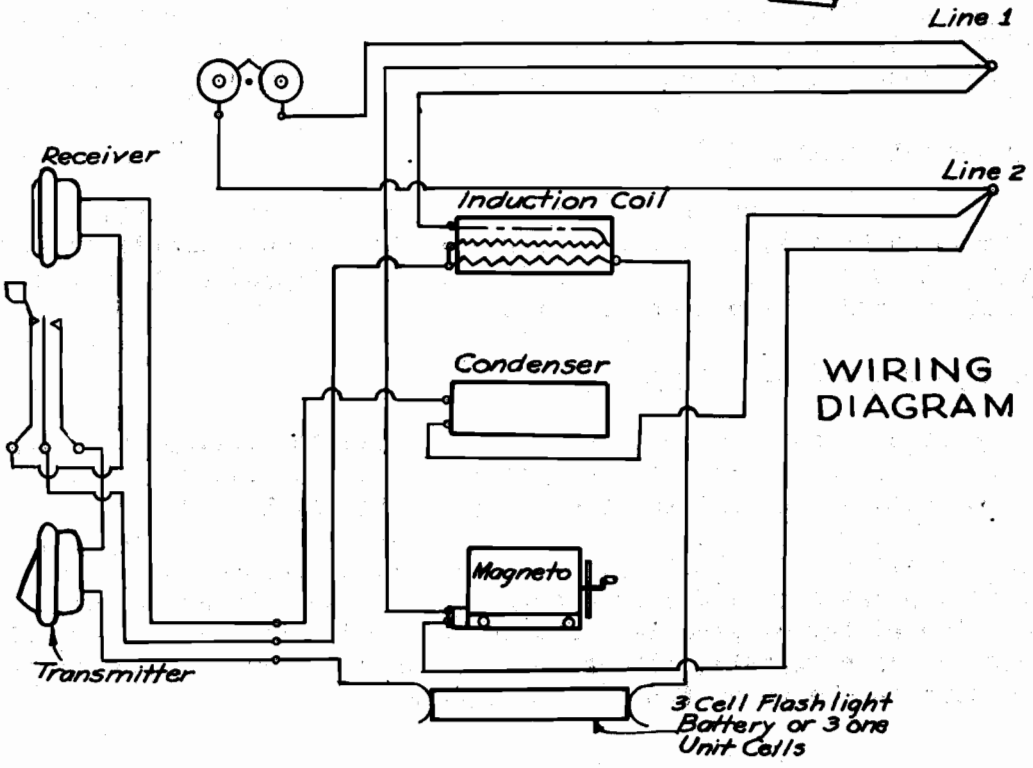
LOOKOUT TELEPHONE



WIRING DIAGRAM OF

HEAVY DUTY TELEPHONE





PORTABLE TELEPHONE MODEL C

place any Forest Service telephone, if desired, except that for heavy use, more frequent battery changes will be necessary. It weighs about 17 pounds. The illustration and wiring diagram are shown on Page 147.

103. Light Weight Portable Telephone

The Model B telephone is a light aluminum hand set in a canvas case and is designed primarily for use by foot patrolmen. The transmitter and receiver are standard, and the hand set has a talking range equal to that of the average telephone. Standard 3-cell flashlight batteries or 3 unit cells are required. The out-going signaling range is equal to the talking range. In-coming howler signals can be heard in a room from 15 to 25 feet away from the telephone. There is a condenser in the receiver circuit, and the telephone can be left on the line without grounding it. It is better practice to disconnect the telephone when it is not in use. The weight is about 4-1/4 pounds. Illustration is shown on Page 149. Wiring diagram is shown on Page 150.

104. Howlers

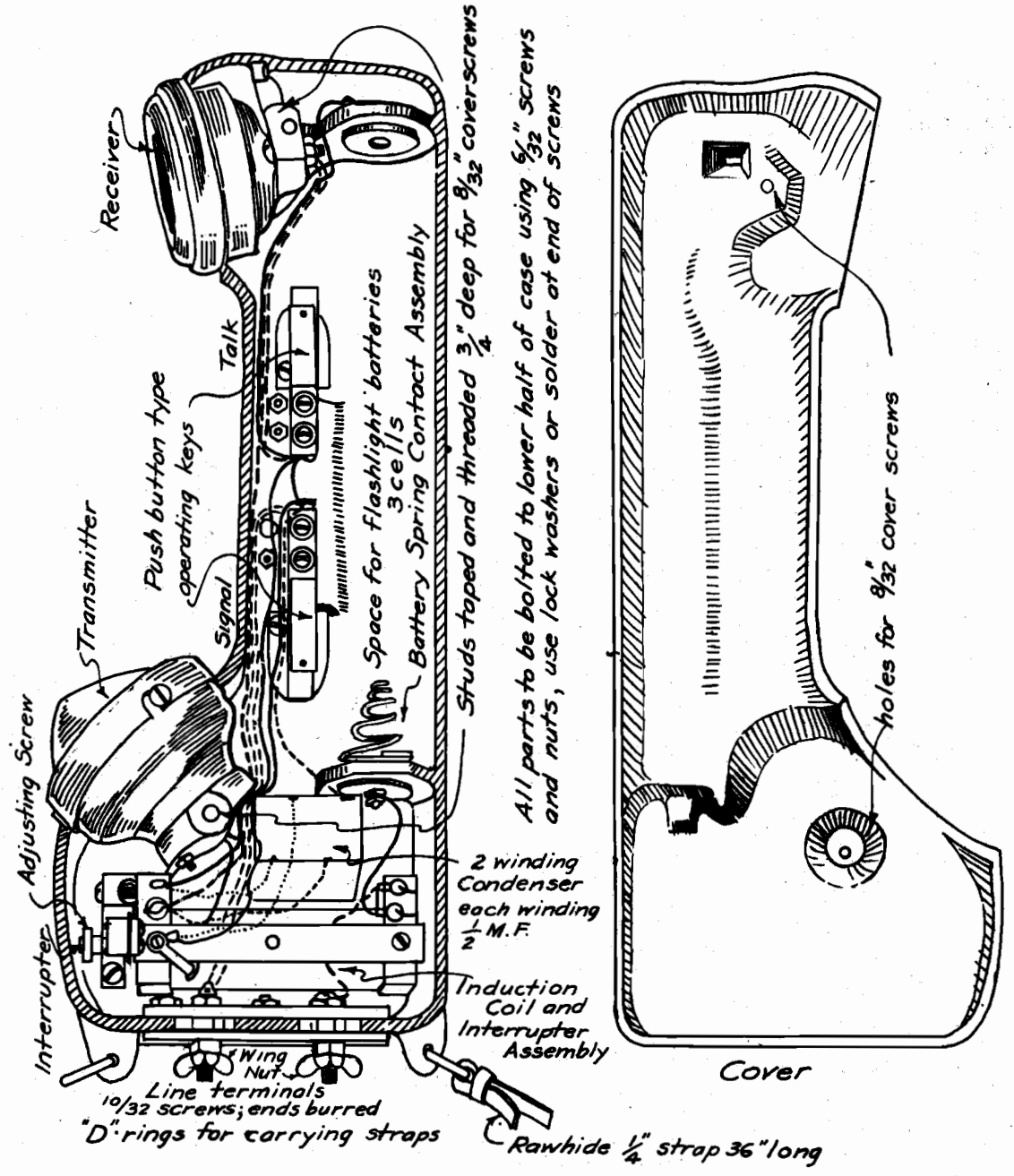
A howler is merely a high resistance receiver with a special diaphragm having a horn attached to it. It is much more effective than a telephone bell. While it is more efficient for receiving the high frequency howler signals, it will also receive very weak ringing signals. Howlers must be used in stations where it is necessary to receive signals from a light aluminum portable telephone or from a howler signal sending set. Howler connections are shown on Page 151.

105. Howler Signal Set

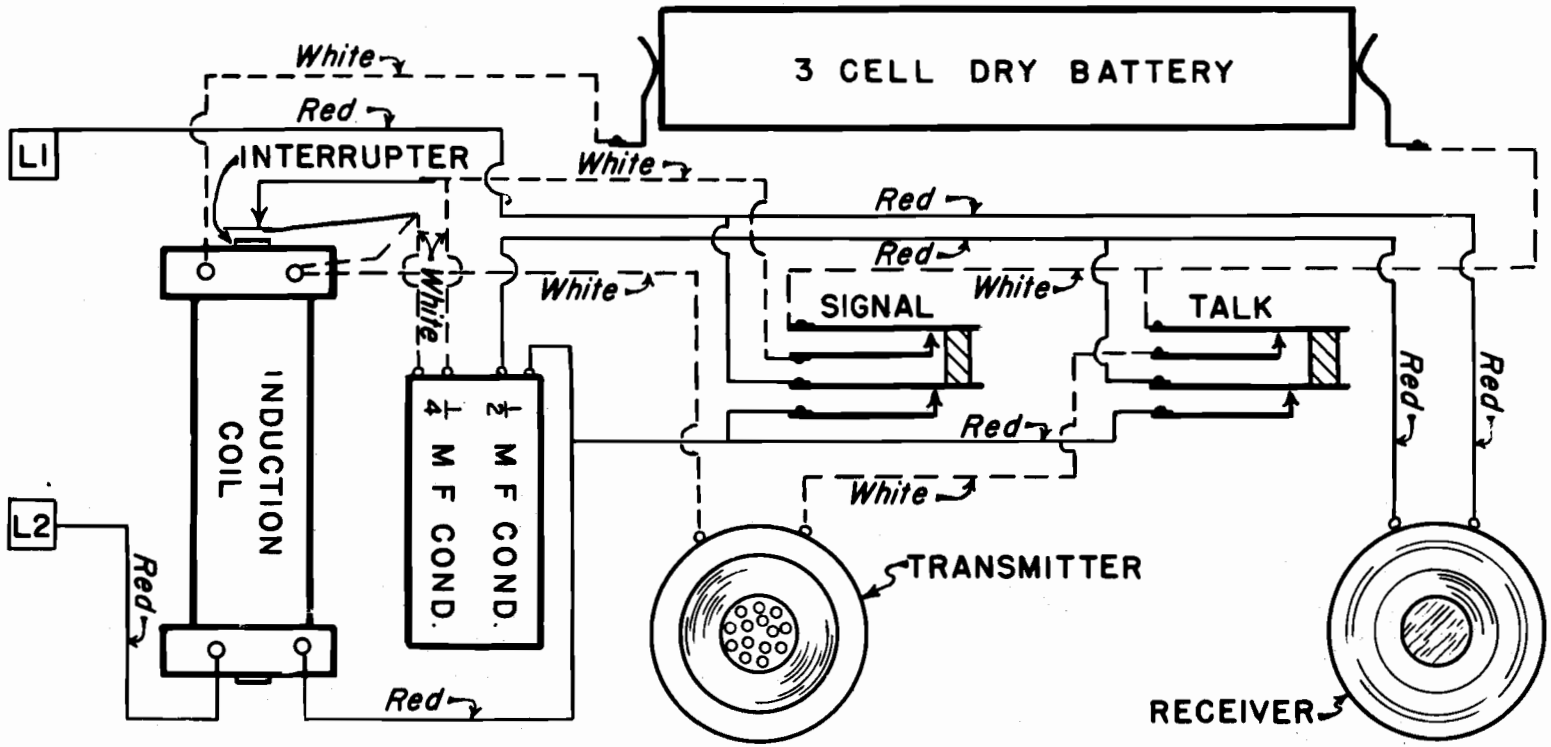
The howler signal set was developed for sending signals over long lines so heavily loaded that ringing signals were unable to go through. It can be used only where lines are equipped with howlers. A wiring diagram is shown on Page 152.

106. Loud Sounding Signal Set

A loud sounding signal set was developed to amplify the ringing signals on Forest Service telephone lines. It consists of a 2500 ohm sensitive polarized line relay, a special loaded 6 volt direct current relay, a 6 volt Benjamin Industrial horn, a battery disconnect switch, and batteries. The set will operate on a 5-cell Hot Shot dry battery, a 6 volt storage battery or 6 telephone dry cells. The wiring diagram is shown on Page 153. The relays will reproduce the code signals, either long or short, as rung. The sound of the horn can be heard from 1/2 to 1 mile.

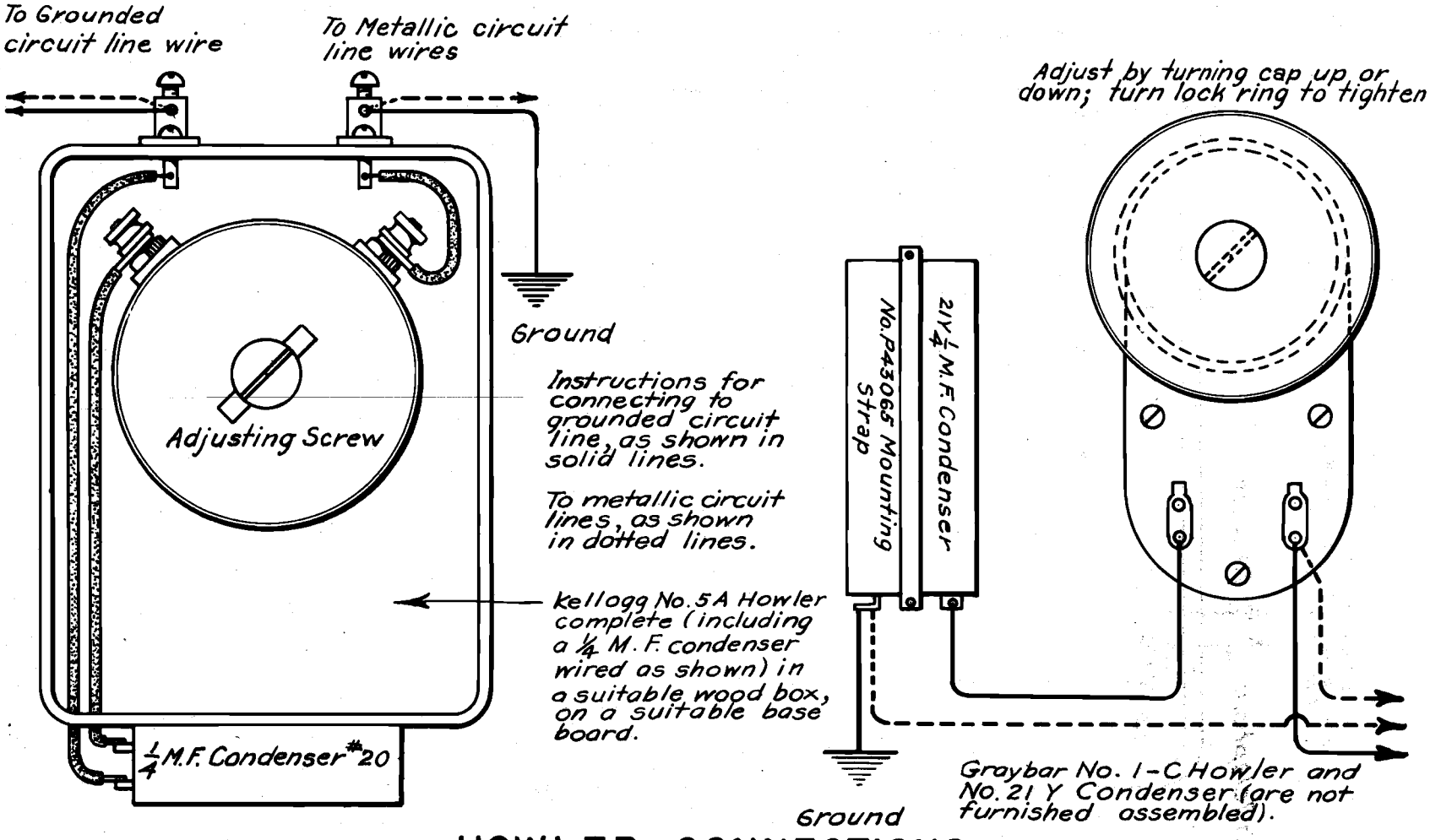


MODEL B PORTABLE TELEPHONE



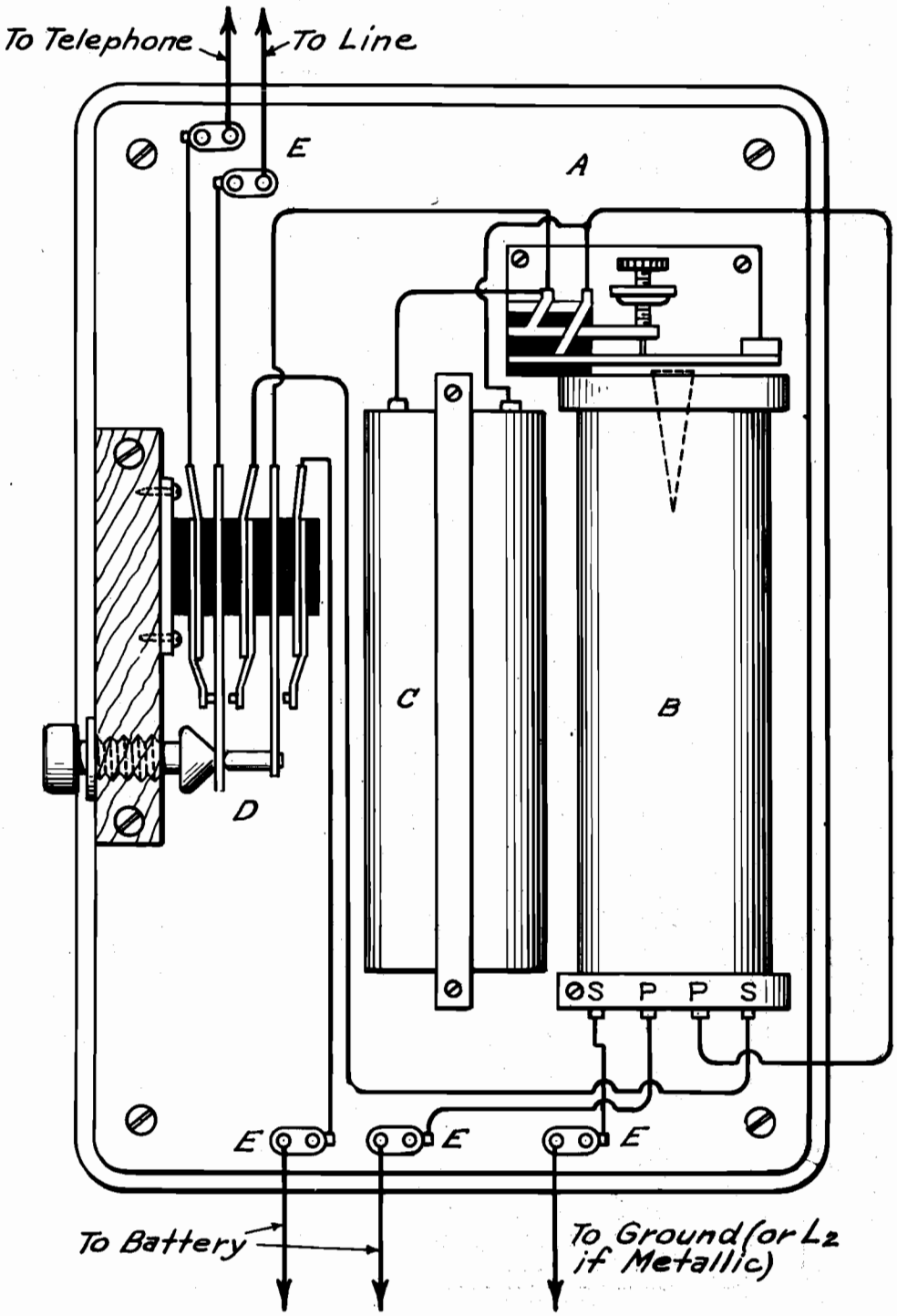
WIRING DIAGRAM OF

MODEL B PORTABLE TELEPHONE

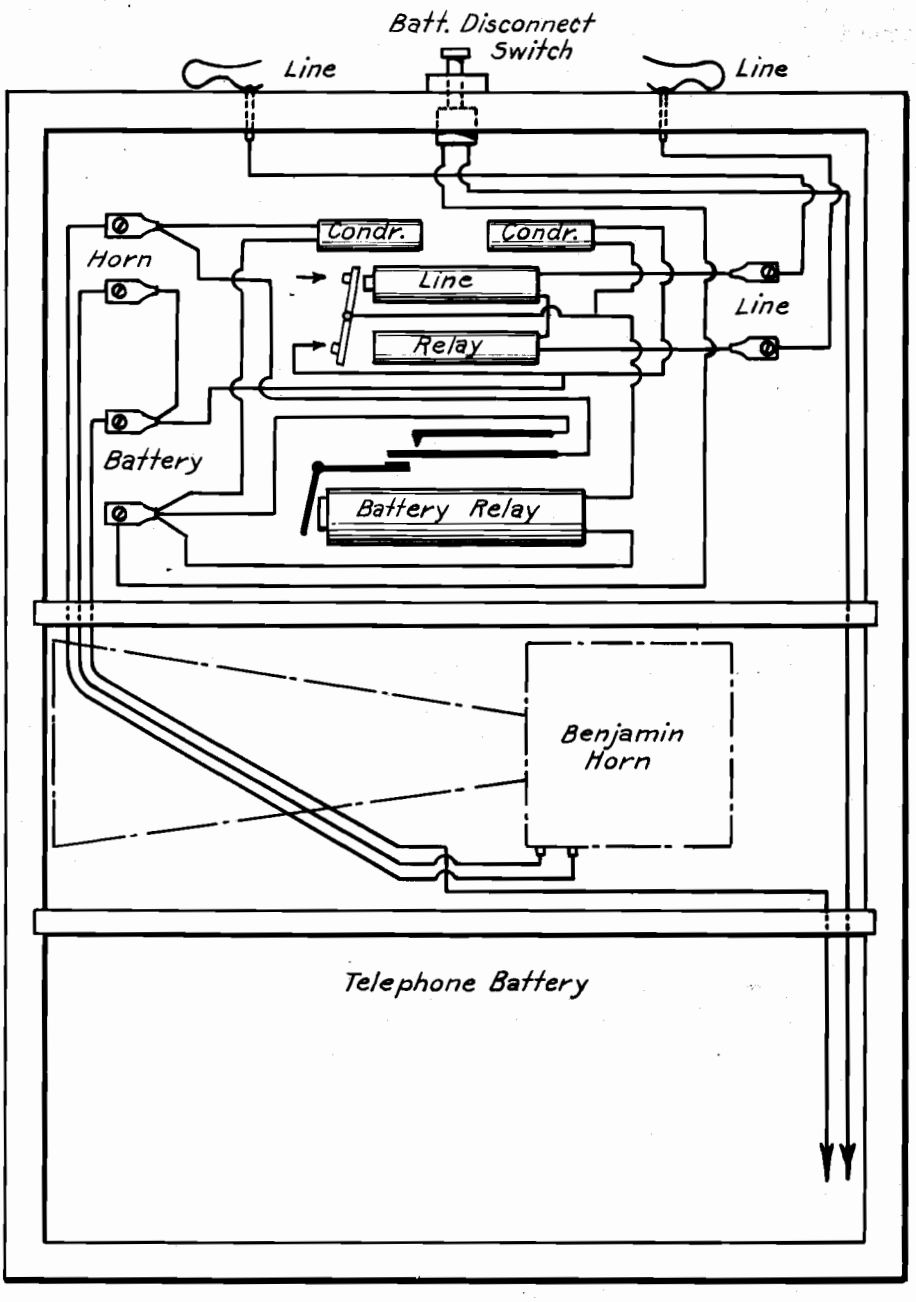


HOWLER CONNECTIONS

A – No. P101495 Interrupter
B – Special No. 5 Induction Coil
C – 1 M.F. Condenser
D – No. 1022-A Push Button
E – Terminals
F – Wood Base



WIRING DIAGRAM FOR HOWLER SIGNAL SET



PORTABLE TYPE
LOUD SOUNDING SIGNAL SET

Two types of sets are available. One type is portable and includes all of the equipment and a battery in a case suitable for transportation. Terminals for line connections are located on the outside of the carrying case. The weight including the dry battery is about 17 pounds. The other type is for permanent installation at Forest Service stations. The relays, battery disconnect switch and battery are for inside mounting. The horn should be mounted outside not more than 25 feet away. Weather protection for the horn must be provided on the job.

CHAPTER VII - CIRCUITS AND EQUIPMENT INSIDE THE TELEPHONE

107. Telephone Circuits

The four circuits in a magneto telephone are shown in the schematic diagram of a Graybar telephone on Page 156. The wiring diagram of the Kellogg telephone is essentially the same except that the ringer is not connected directly between line 1 and line 2, but is connected directly to line 2 and through the generator circuit to line 1 as shown on Page 157.

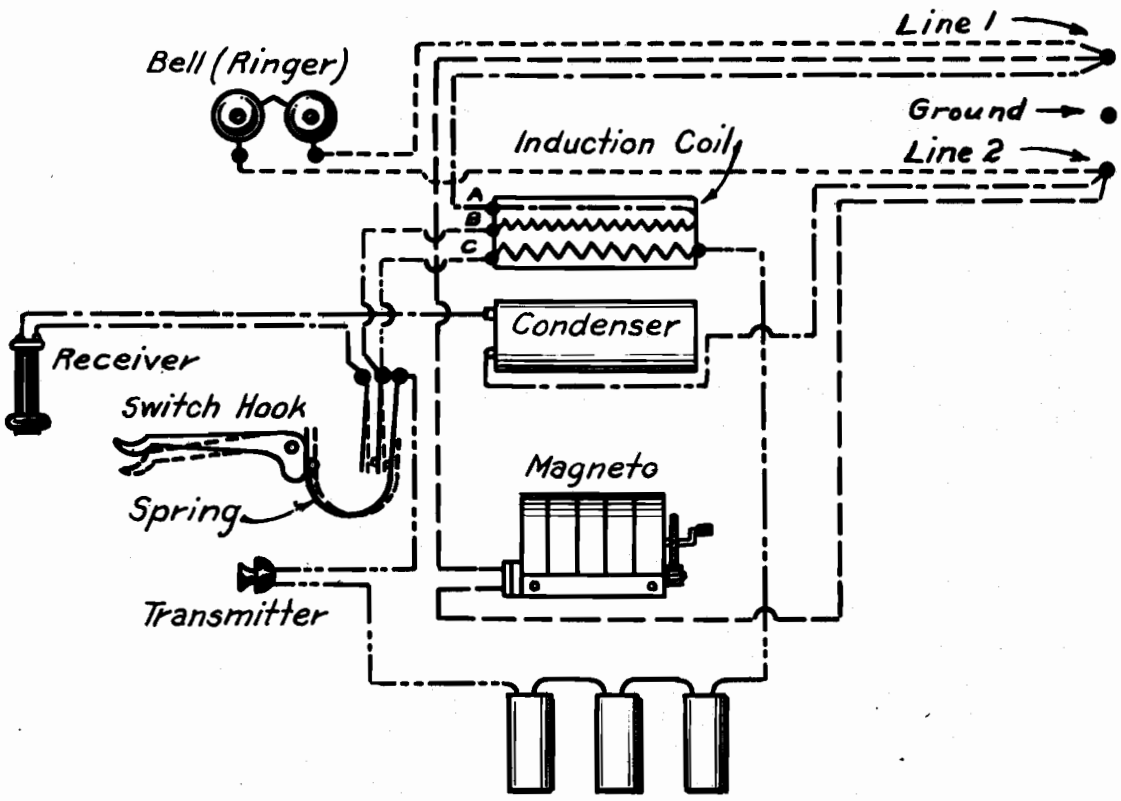
(1) The ringer circuit includes only the ringer coils.
(2) The magneto circuit includes only the magneto or generator.
(3) The receiver circuit includes the receiver, the hook switch, the condenser and the secondary or fine winding on the induction coil. This circuit is sometimes called the secondary or line circuit.
(4) The transmitting circuit includes the battery, the hook switch, the transmitter and the primary or heavy winding on the induction coil. This circuit is sometimes called the primary or battery circuit. It is connected to the line only through the induction coil.

108. Ringer or Bell

The same type of ringer is used in both the telephone and the extension bell. The Kellogg ringer is shown on Page 158, and the Graybar ringer is shown on Page 159. The operating principles and the most important adjustments are essentially the same. All ringers contain two gongs with adjusting screws, two ringer coils wound to a resistance of 1250 ohms each, two iron cores inside the ringer coils forming the electro-magnets, a pole piece suspended in front of the ends of the electro-magnets, and a frame to which the above parts are attached.

109. Magneto or Generator

This is merely a type of a dynamo having permanent magnets in horseshoe shape, and an armature consisting of a single coil wound on a round piece of soft iron for a shaft. The magneto contact assembly is shown on Page 160 and a diagram illustrating the operating plan of the magneto is shown on Page 161. The action of turning the crank causes the armature to revolve between the ends of the magnets, producing an electric current which alternates in direction in the



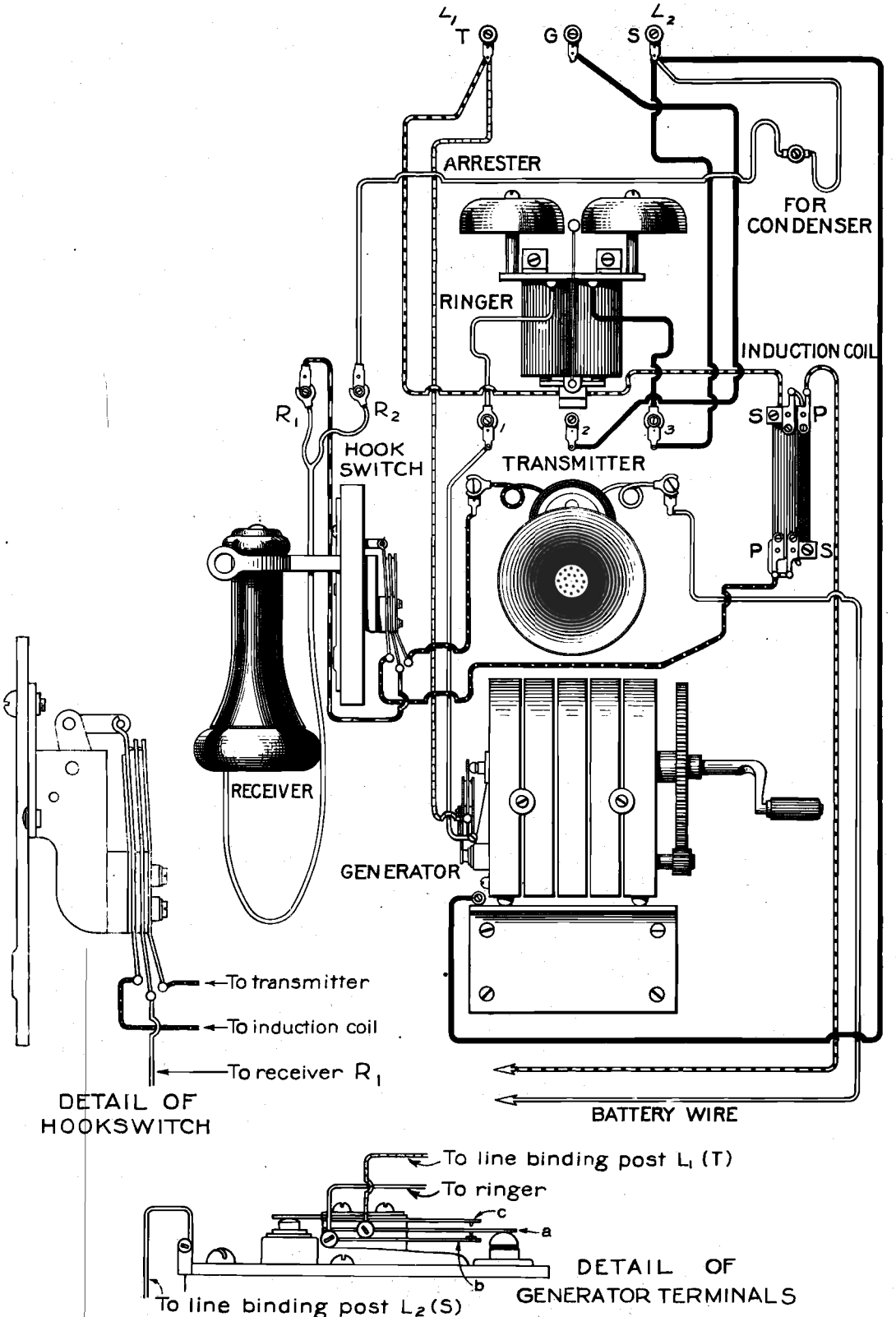
In many Telephones "B" and "C" are connected together at the induction coil, with only one wire extending to the switch hook.

CIRCUIT LEGEND

----- Bell (Ringer)
--- Magneto
---- Transmitter (Battery or Primary)
—— Receiver (Line or Secondary)

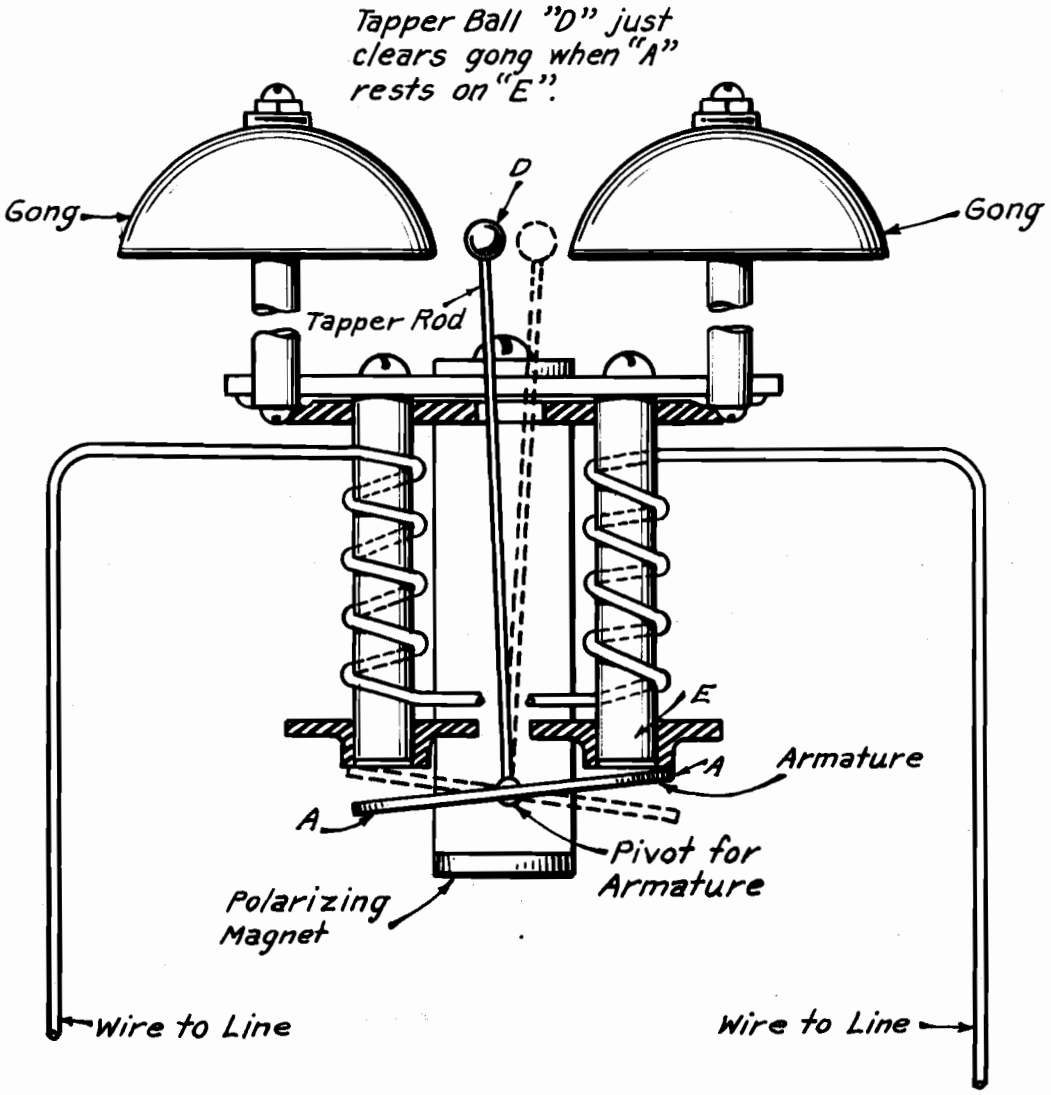
WIRING DIAGRAM

GRAYBAR TELEPHONE

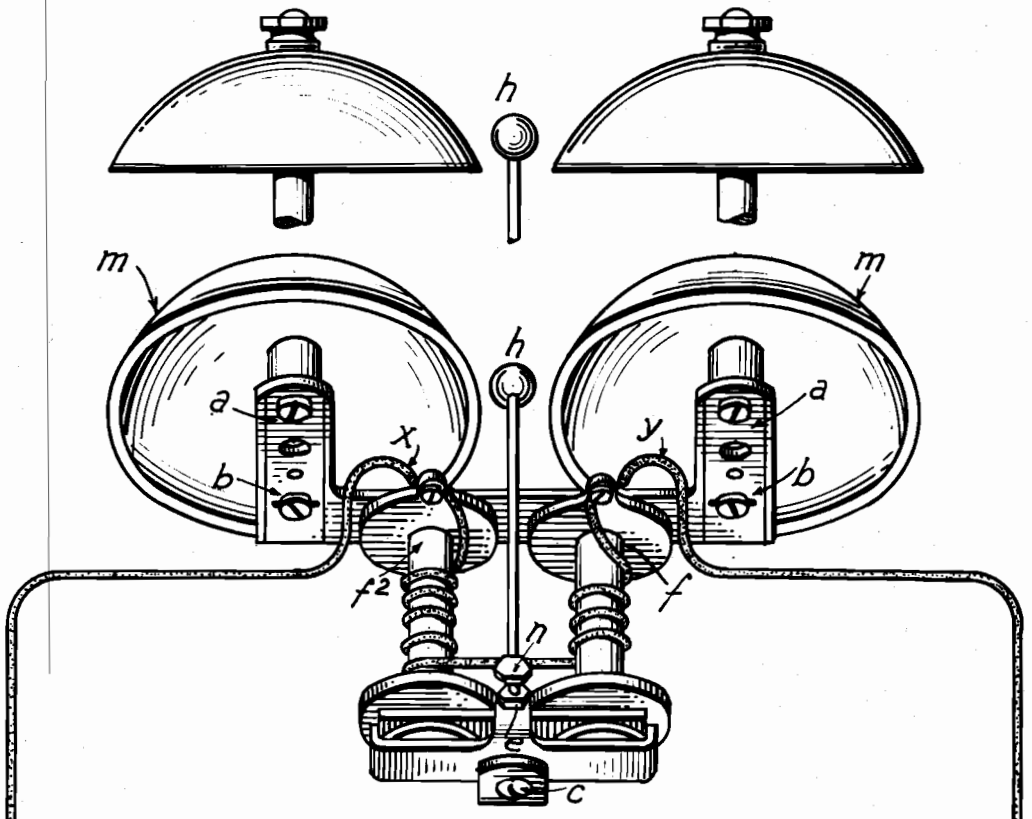


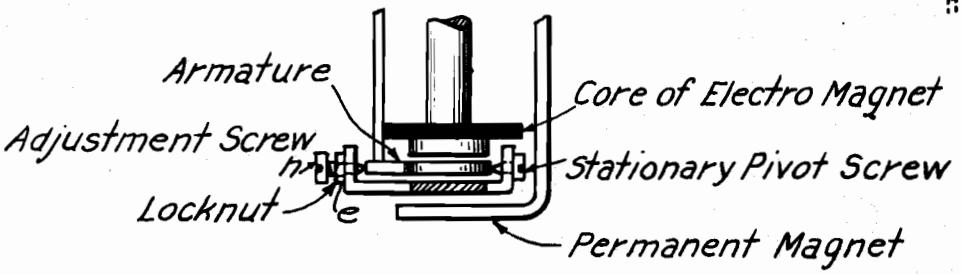
WIRING DIAGRAM OF KELLOGG TELEPHONE

As the ringing currents alternate in direction, the magnetism in the ringer coils is reversed, alternately pulling first one end of the armature and then the other.

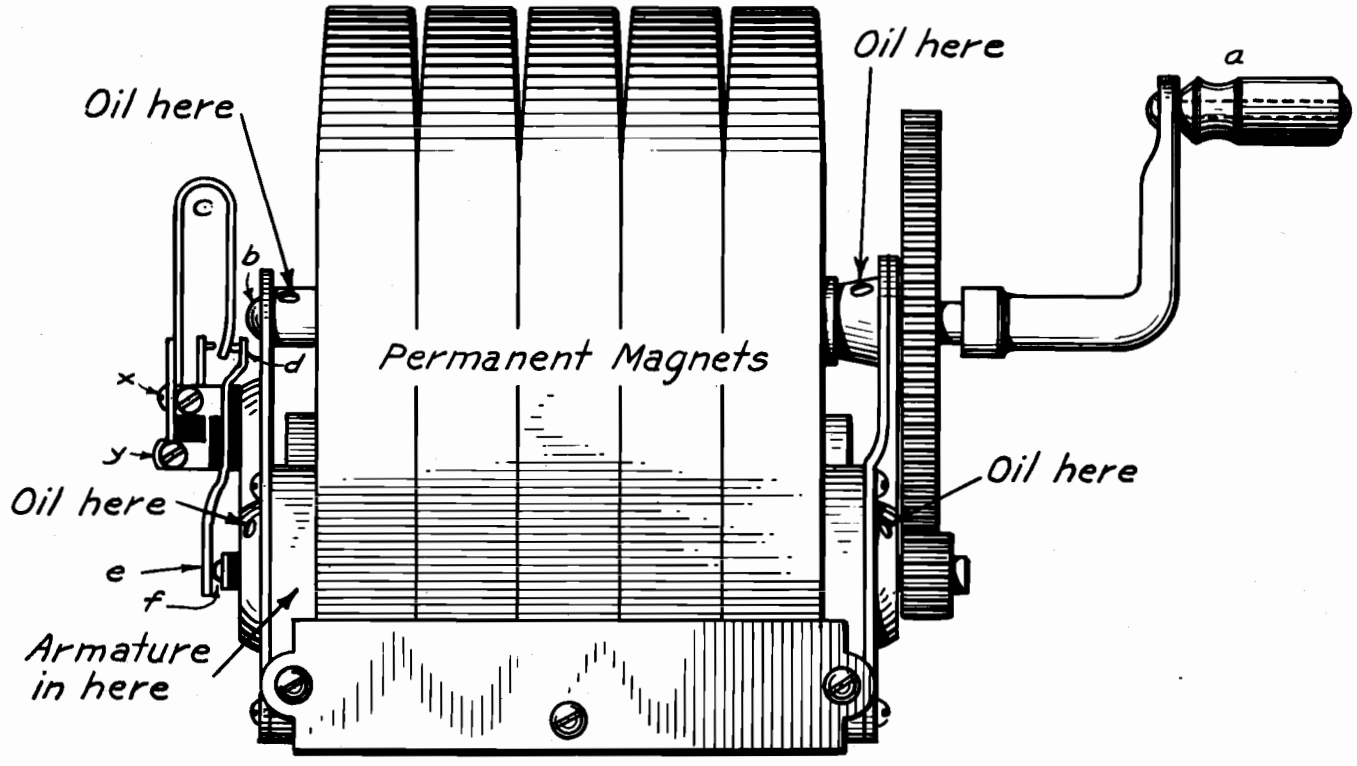


KELLOGG RINGER NO. 78 G



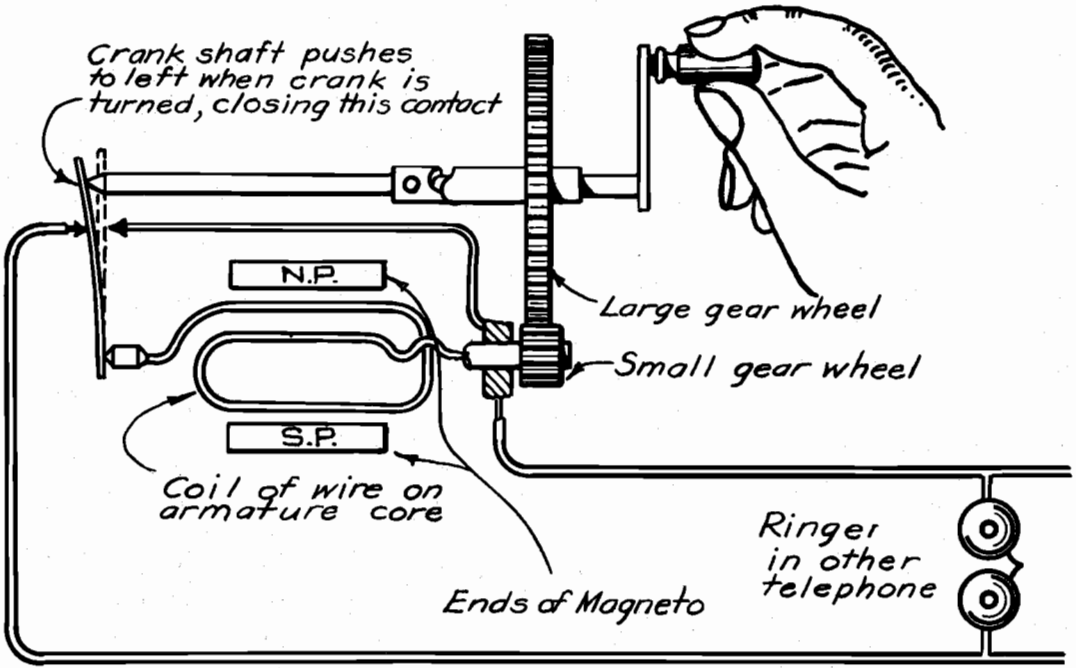


GRAYBAR TELEPHONE RINGER



THE MAGNETO CONTACT ASSEMBLY

Diagram illustrating the principle of the operation of the magneto. The strength of the ringing current is increased to some extent by turning the crank more rapidly. The current thus generated alternates or reverses in direction once for each revolution of the armature (from 16 to 20 times a second).



MAGNETO OPERATION

armature coil. One end of this coil is connected to the metal frame of the magneto. The other end is connected to an insulated conductor through the center of the armature shaft, which is hollow, to the left end, "f", and makes contact with an outside spring "e". This is not connected directly to the line wire, but when the crank is turned, the crank shaft is forced to the left by a coil spring in the shaft pushing the upper end, "c", of the spring against the line contact. This completes the ringing circuit, as the ground wire is connected to the other end of the armature coil through the frame. The sliding action of the crank shaft connects the armature coil to the line when the crank is turned and breaks the connection when the turning motion is stopped, thus keeping the generator disconnected from the line when it is not in use. This is necessary because the resistance of the armature coil is low enough to cause a ground on the line if it is left connected at all times. In the Kellogg telephone, illustrated on Page 157, the action of the magneto spring contacts is the same as for the Graybar telephone described above, except that the ringer connection which is made between contacts "a" and "b" is broken when the generator crank is turned, because the action of turning the crank causes the crank shaft to slide forward to the left.

110. Receiver

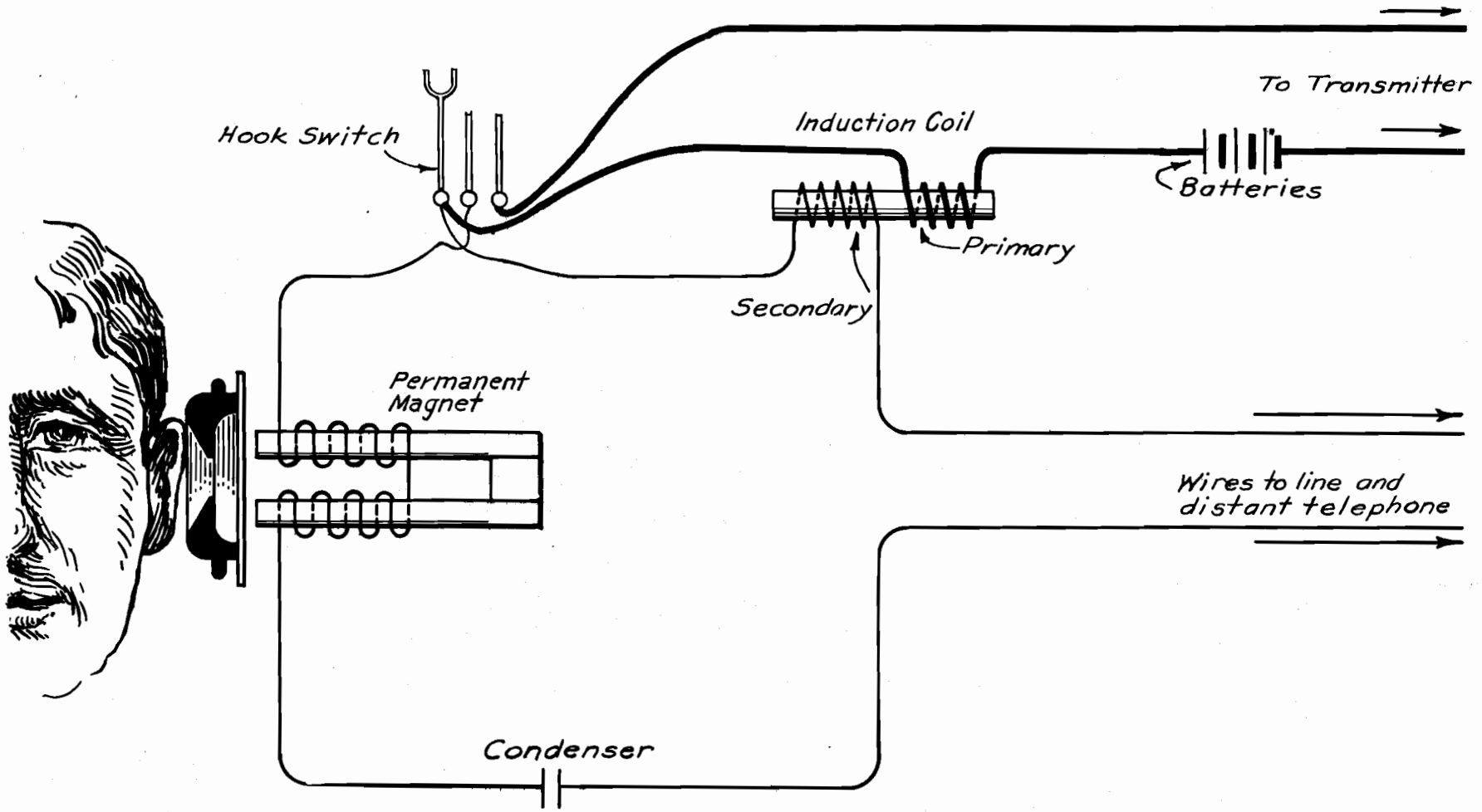
The wiring diagram of the receiving circuit is shown on Page 163. The receiver itself consists of a permanent magnet, an electro-magnet wound with fine wire and a soft iron diaphragm which fits over the ends of the electro-magnet. These three parts are enclosed in an insulated case. The wires leading from the condenser and from the induction coil through the hook switch are connected to the fine wiring on the electro-magnet. There is only about 1/64 of an inch clearance between the diaphragm and the ends of the receiver electro-magnet cores, so it is important that the receiver be handled carefully to prevent disruption of the receiving service.

111. Hook Switch

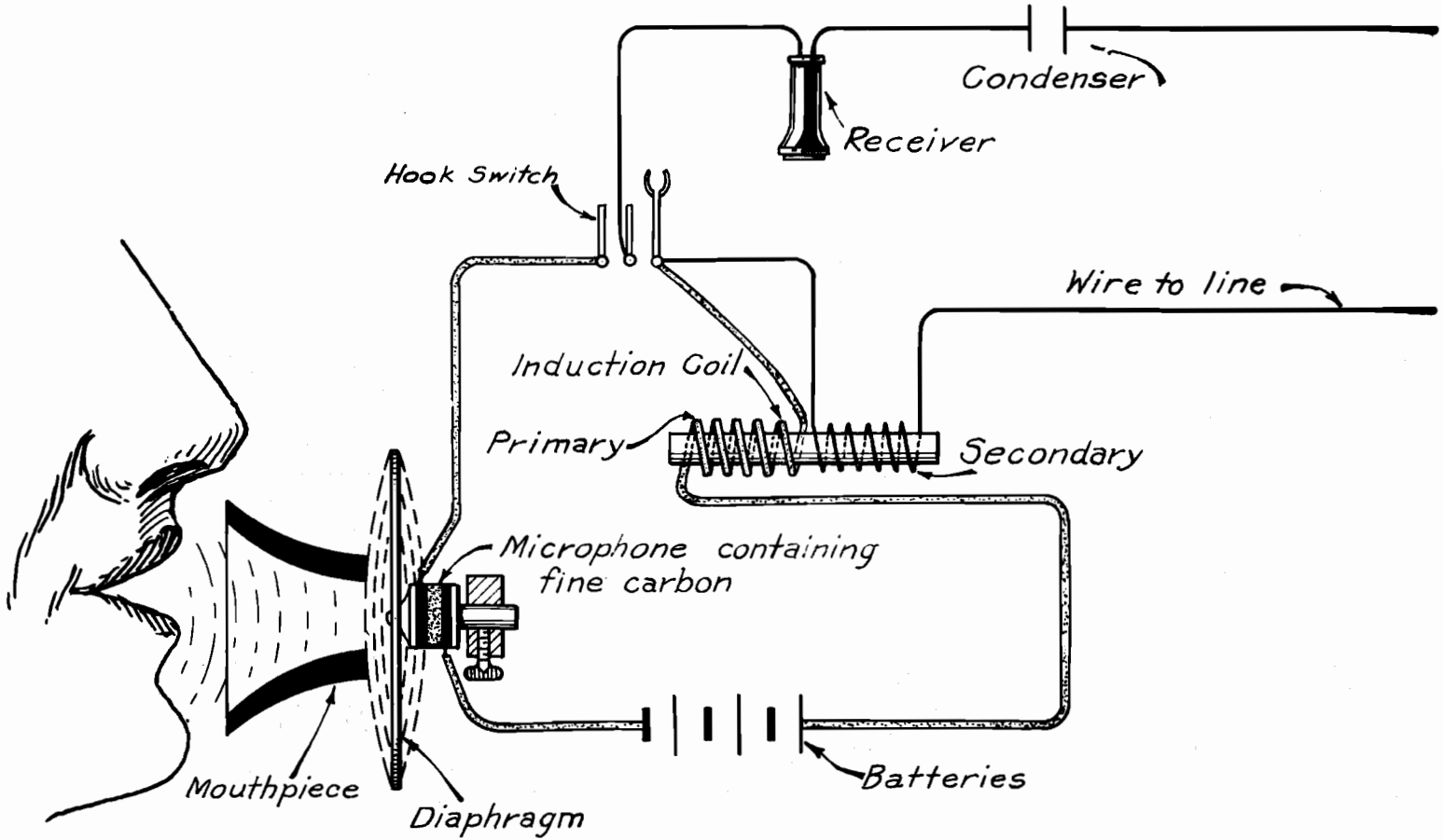
The hook switch is in both the receiving and transmitting circuits. A detailed drawing of a hook switch is shown on Page 157, with the wiring diagram of the Kellogg telephone. When the receiver is off the hook, all of the springs make contact, and when it is on the hook, all of the springs break contact. If the springs do not clear each other when the receiver is on the hook, the circuit will remain closed and the battery will run down rapidly. The springs may be bent to secure the proper clearance.

112. Transmitter

The wiring diagram of the transmitting circuit is shown on Page 164. The transmitter consists of a microphone containing fine pulverized carbon and a diaphragm both enclosed in a case to which is attached a mouth piece. The vibrations in the transmitter diaphragm set up by the voice sound waves compress the pulverized carbon in the microphone with varying degrees of intensity. This changes



RECEIVING CIRCUIT



TRANSMITTING CIRCUIT

the resistance of the transmitter circuit, resulting in electric current variations corresponding to the sound wave variations.

The current variations set up by the transmitter pass through the primary winding of the induction coil which induces a similar varying current with a higher voltage in the secondary winding. This current passes through the line wire to the receiver at the receiving telephone and produces changes in the magnetic strength of the receiver magnet. These changes alternately attract and repel the receiver diaphragm causing it to have a vibration similar to that imparted to the transmitter diaphragm by the sound waves and thereby reproduces the sound.

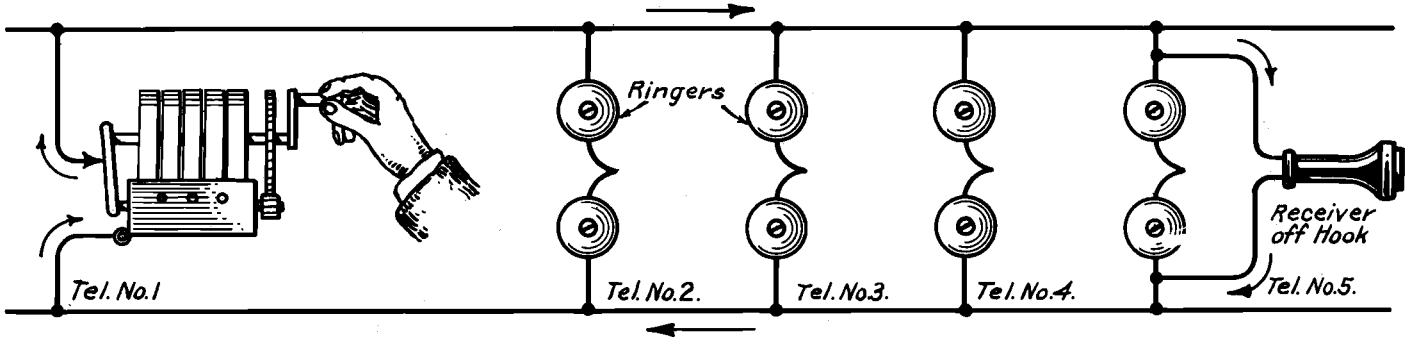
113. Induction Coil

The induction coil is composed of a bundle of annealed iron wire upon which is placed the primary and a secondary winding. The primary winding is always made with comparatively heavy insulated copper wire while the secondary winding is made with a fine insulated copper wire. The primary winding is usually made directly on the iron, and the secondary winding is super-imposed upon it. The number of turns in the secondary winding is large in comparison with the number of turns in the primary winding, and the generated secondary voltage is thus made quite high. This increase of voltage is necessary because the voltage furnished by the three dry batteries in the transmitting circuit is too low to overcome the resistance of the line. Wiring connections to the induction coil from both the receiving circuit and the transmitting circuits are shown on Pages 163 and 164.

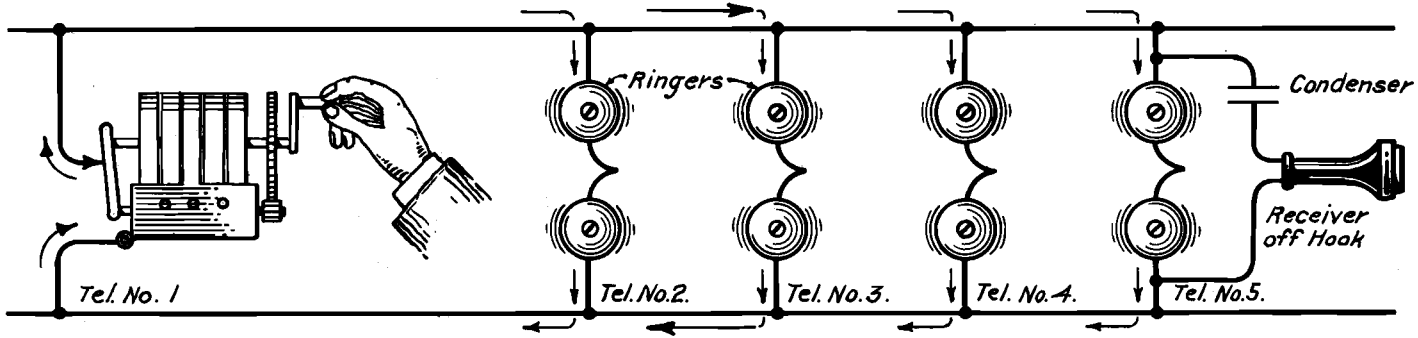
114. Condenser

The condenser is made of strips of tin foil separated by thin sheets of paraffined paper. It has a high resistance to the low frequency ringing current and practically no resistance to the high frequency talking current. A condenser should always be connected in the receiving circuit between the receiver and the line to enable other telephones to ring by when the receiver is off the hook.

If there is no condenser in the receiving circuit, when the telephone receiver is off the hook, the circuit connected to the line by means of the hook switch would include only the receiver and the secondary winding of the induction coil. Their combined resistance is only about 150 ohms which is very much lower than the 2500 ohm resistance of the ringer coil. This would amount to a bad ground on the line and other bells on the line would not ring. This is shown graphically on Page 166.



IMPOSSIBLE TO RING OTHER TELEPHONES, DUE TO RECEIVER OFF HOOK AT TELEPHONE NO.5, ALLOWING MOST OF THE RINGING CURRENT TO PASS, INDICATED BY ARROWS



CONDENSER IN CIRCUIT WITH RECEIVER PREVENTS RINGING CURRENT GOING THROUGH RECEIVER, AND RINGERS ARE ALL FASILY RUNG

USE OF CONDENSER IN RECEIVING CIRCUIT

CHAPTER VIII - TELEPHONE TROUBLES

115. General

If the telephone does not work properly, the trouble may be found in the set, the inside wiring, the vacuum arrester or carbon block protector, the line fuses, the service connection, the grounds, or the line. The most common causes of trouble in a telephone set are weak batteries, broken receiver cords, and loose connections. Other parts of the set may cause trouble, but are usually in good condition. The tests and adjustments of all the parts are described below. Line troubles may be caused by broken wires, loose connections, poor grounds, grounded line wires which short circuit, or crossed wires.

116. Telephone Tests and Adjustments

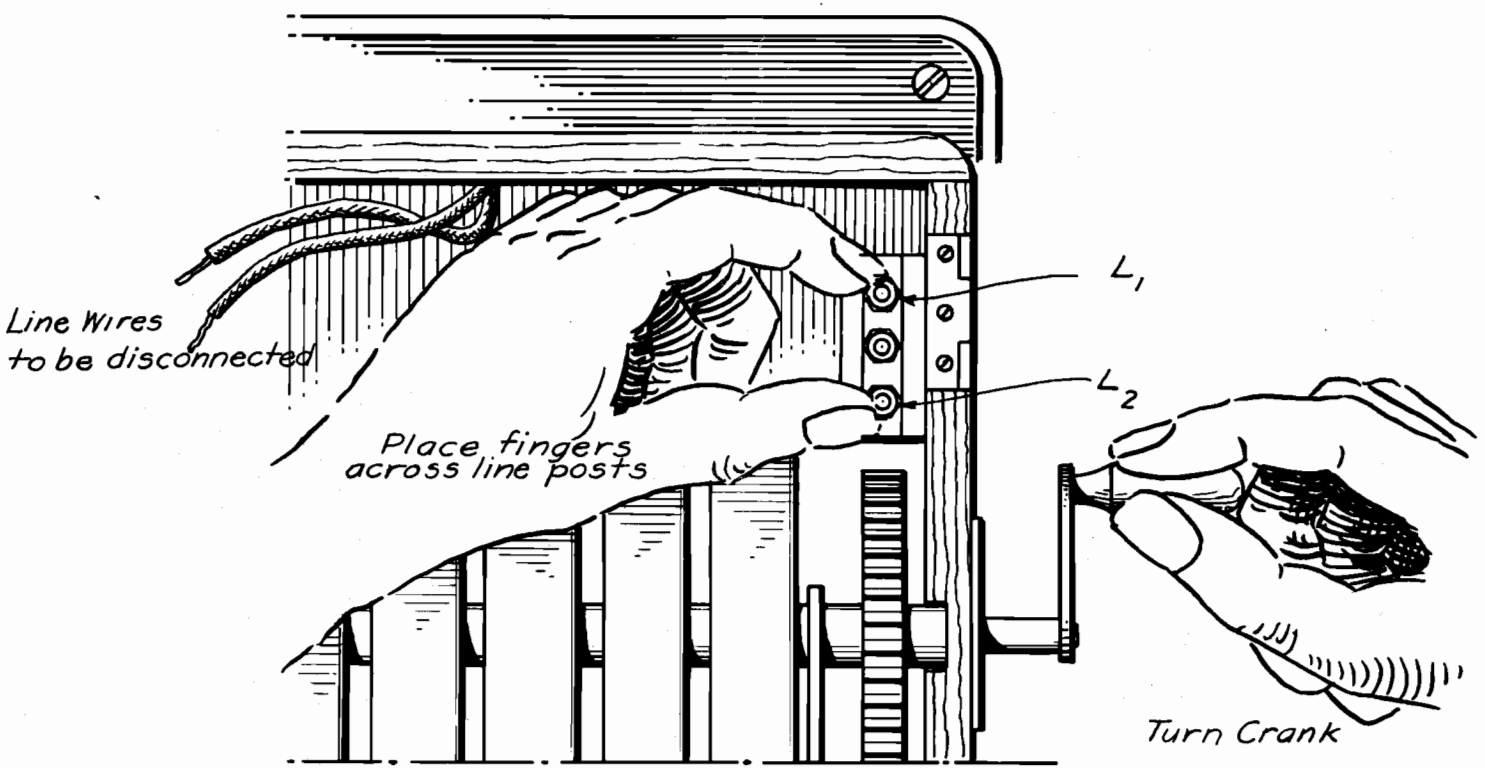
There is nothing difficult about testing a telephone set. All of the parts are accessible and may be easily tested if the following instructions are observed:

(A) Magneto Generator:

In making magneto generator tests be sure that the receiver is on the hook and then disconnect the line wires, L_1 and L_2, as shown on Page 168. Moisten the fingers; place them across these terminals, and turn the crank. If a stinging sensation is felt in the fingers while the crank is being turned, it indicates that the generator is operating properly. If there is no stinging sensation felt, there is trouble in the wiring inside the telephone or in the generator.

The next step is to test for bad telephone wiring. To make this test, remove the wires from the binding post on the generator terminals and again turn the crank with the fingers across the terminal binding posts. If a stinging sensation is felt, it is definitely known that the trouble is in the wiring, and it must be traced wire by wire to discover breaks or loose connections.

If no stinging sensation was felt in the latter test, the trouble is definitely in the magneto generator, and may be caused by an open circuit or a short circuit. If the generator crank turns easily, there is an open circuit, but if the crank turns hard, the generator is probably short circuited in the rubber bushings separating the spring contacts. This short circuit is usually caused by too much oil. In either case there will pro-



TESTING MAGNETO WITH THE FINGER

bably be an odor of burning rubber. In order to check for this short circuit it will be necessary to take the generator out of the telephone. The entire spring contact assembly should then be removed from the generator, by taking out the two end screws. This must be done carefully for if the trouble is not here, the springs and insulating strips must be put back exactly as they were.

Again turn the crank, and if it still turns hard, the trouble is in the armature instead of the spring contact assembly. Armature trouble may consist of a short or of lack of oil. In case of a short the armature must be replaced. If lack of oil is the cause of the trouble, put one drop of good typewriter oil in each of the oil holes located as shown on Page 160. Wipe off any excess oil. If the crank turns easily, the trouble is in the spring contact assembly. It is advisable to have an extra complete assembly on hand, but temporary repairs can be made by taking the old assembly apart, locating the defective insulating strip and replacing it with a thin piece of cardboard. When the repair has been made, replace the parts again and check to be sure that the trouble has been eliminated.

It sometimes happens that the permanent magnets on the generator become weak after long usage. This will be indicated by a reduction in the amount of current produced by the generator when the crank is turned rapidly. If the magnets are weak, they should be replaced with a new set. Sometimes, the generator is weak because it has been taken apart and a magnet replaced incorrectly. Each magnet has a punch mark on it, and these marks should all face in the same direction. If one magnet is reversed, the strength of the generator is greatly reduced.

(B) Ringer:

Before testing the ringer be sure that the telephone receiver is operating properly. Disconnect the line wires, L_1 and L_2, as shown on Page 168. Moisten the tips of the fingers and place them across these terminals and turn the crank. If current is felt, the wiring from the generator to the ringer is all right. If no current is felt, the wiring is open between the generator and the ringer. This may be caused by improper adjustment of the armature or by a burned out ringer coil. If the ringer coils have been burned out, they must be replaced by new ones.

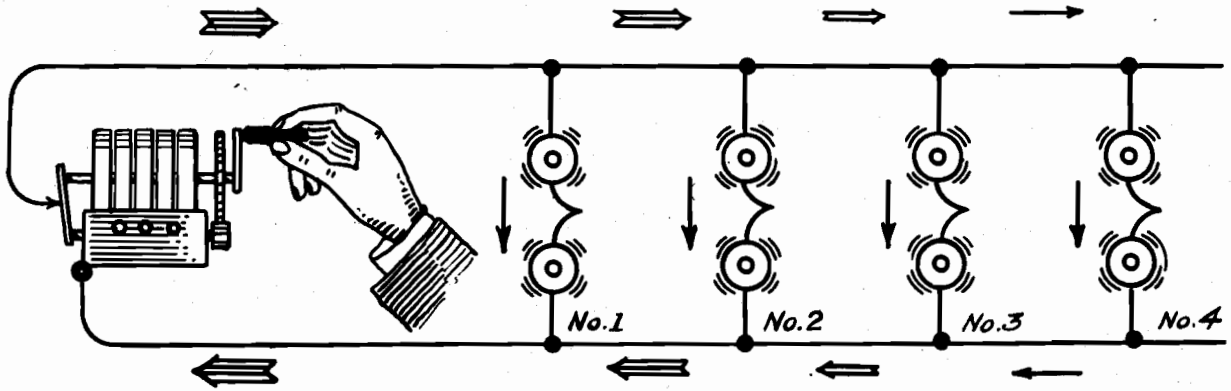
It is very important that all ringer coils have the same resistance. The standard resistance for Forest Service telephones is 2500 ohms, but many telephones are still equipped with 1600 ohm ringers. These low resistance ringers must not be connected on the same line with 2500 ohm ringers because they will take more than their share of the ringing current, and the other ringers will operate weakly or not at all. This is shown graphically on Page 171.

A number of adjustments must be made on the Graybar ringer in order to secure proper results. The ends of the armature to which the tapper rod is attached should have a movement of about 3/32 of an inch back and forth in front of the ends of the electro-magnet. For short lines the movement should be a trifle more, and for long, heavily loaded lines the movement should be a trifle less. The adjustment may be made by turning the screw, "c". The ends of the armature are covered with a non-metallic material to prevent their coming in direct contact with the iron cores of the coils. The armature is suspended by two pivot screws. One screw is stationary, while the other, "n", is adjustable and is held in position by a locknut, "e." The screw, "n", should be just tight enough to hold the armature in place and allow a free movement without lost motion. The gongs, "m", should be set so that the tapper ball, "h", rebounds after striking the gong and does not hang to it. The adjustment of the gongs is made by loosening the set screw, "a", and turning the adjusting screw, "b", to the right or left as required.

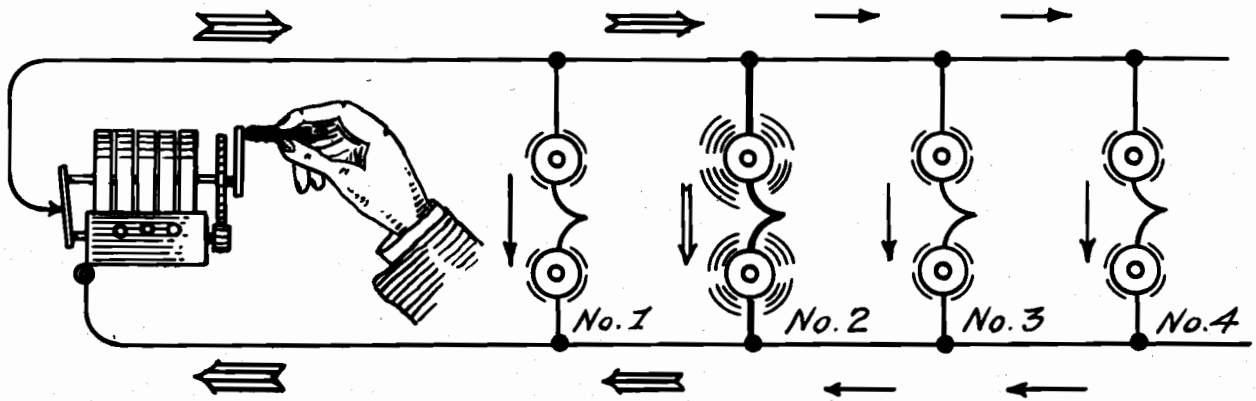
The Kellogg ringer is made with a non-adjustable armature, "AA". The only adjustment which can be made on this ringer is that of the gongs. Each gong should be adjusted so that the tapper ball, "D", just clears it when the end of the armature, "A", rests on the end of the iron core, "E."

(C) Hook Switch

An inspection of the hook switch will show whether it is functioning properly. When the receiver is on the hook, the spring contact should should be open and when the receiver is off the hook, the spring contacts should be together. The only adjustment that can be made is the slight bending of the springs to make them operate properly. The main spring used for raising the hook lever up becomes weakened by constant usage and should be replaced if necessary.



RINGERS ALL SAME RESISTANCE – CURRENT DIVIDED EQUALLY



RINGER NO.2 LOW RESISTANCE – TAKES MOST CURRENT

RINGER RESISTANCE

(D) Receiver

The telephone receiver is subject to few troubles. The most frequent troubles are dirt in the receiver or dented or bent diaphragm. These may usually be corrected by cleaning out the dirt and reversing the diaphragm. Sometimes the permanent magnets become weak after long usage and must be replaced. Occasionally the electro-magnets are burned out by lightning or other electric current. If this happens the entire magnet assembly should be replaced.

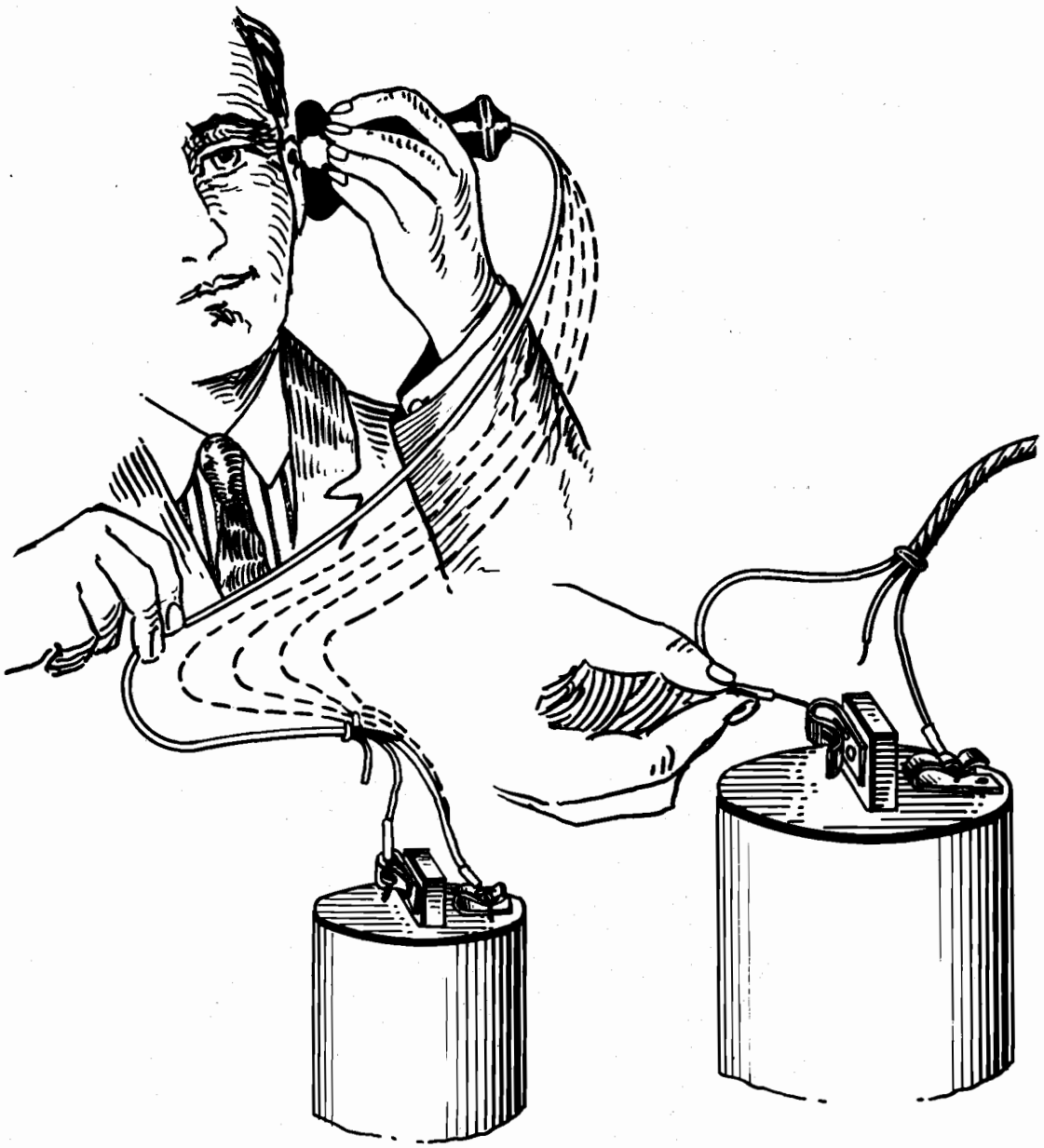
A simple method of testing a receiver is shown on Page 173. One wire of the receiver cord is attached to one terminal of the battery. When the second wire is touched to the other terminal of the battery, a distinct click is heard in the receiver, if it is in good condition. If no click is heard, the receiver circuit is open from one of the above mentioned causes or from a broken receiver cord.

The method of testing for a break in the receiver cord is also shown on Page 173. Both wires of the receiver cord are attached to the battery at one end and to the receiver at the other end. By moving the wire backward and forward it is very easy to locate a break in the cord, because when the loose ends come together, a distinct click will be heard in the receiver. A broken receiver cord should be replaced.

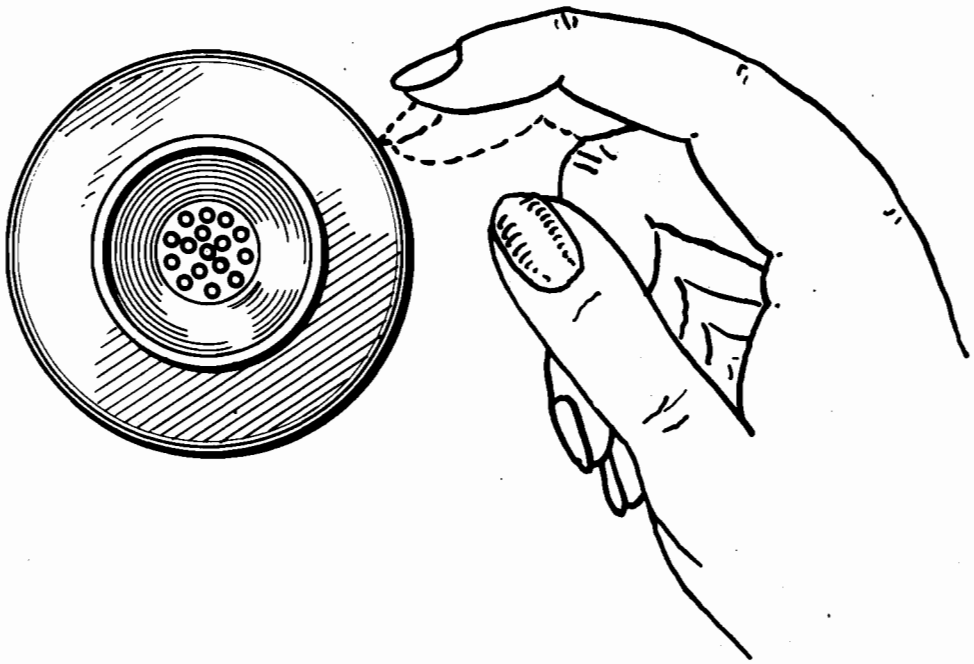
A receiver may be used in conjunction with the battery to test for broken wires in the ringer coils and the induction coil. One wire of the receiver cord should be attached to a terminal post of the battery. Another wire should run from the other terminal post of the battery to one side of the coil to be tested. The test is made by touching the loose end of the second receiver cord wire to the other side of the coil being tested. If the coil is in good condition, a distinct click will be heard in the receiver. If no noise is heard, there is a broken wire in the coil being tested.

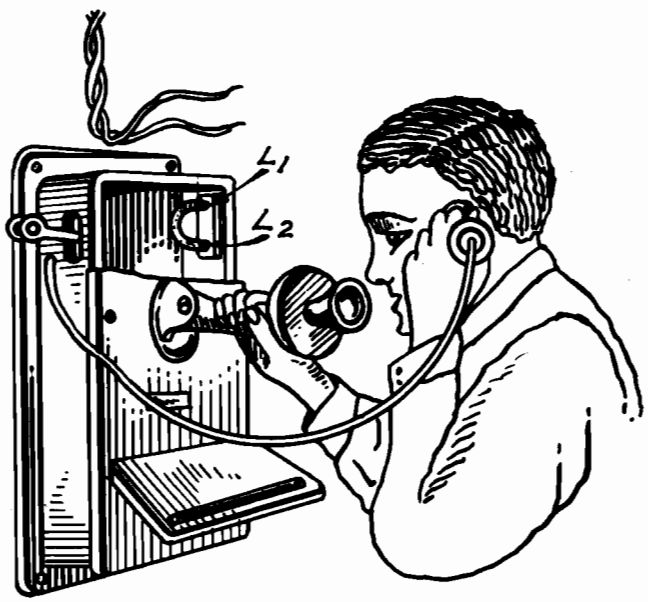
(E) Transmitter

The transmitter seldom causes trouble, but if it has stood in one position for some length of time, the fine, pulverized carbon in the microphone may become packed. If this happens, the transmitter will not function properly. A gentle shake may loosen the carbon granules and put the transmitter in proper condition. The transmitter may



TESTING THE RECEIVER CORD





TESTING THE TRANSMITTER

be tested as shown on Page 174. The line wire should be disconnected at L_1 and L_2 and a jumper wire put between these two binding posts. With the receiver to the ear, blow into the transmitter or tap lightly. If nothing is heard through the receiver, shake the transmitter to loosen the carbon and repeat the test. Do not jar the transmitter too much, and NEVER take it apart. If no noise is heard through the receiver after repeated tests, remove the transmitter and send it to the factory for adjustment. The telephone lineman making the tests should always carry an extra transmitter to be prepared for this emergency.

(F) Batteries

The proper method of connecting dry batteries is shown on Page 131. Batteries should be replaced when the reading on the ammeter used for testing them shows less than 8 amperes. It is the usual practice to replace batteries each spring before the summer work begins. Never connect 1 or 2 new batteries to an old one, but replace all three. Do not remove the paper covers from around the battery because this cover acts as an insulator of the zinc electrode in the battery.

(G) Induction Coil

Induction coils do not usually give trouble unless they are burned out by lightning or other electric current. The receiver test as described above should be used to determine whether the induction coil is in good condition. A burned out coil should be replaced, but, in cases of emergency, the old coil may be used by attaching a wire across the two primary contacts and another wire across the two secondary contacts. This practice is not recommended.

(H) Condenser

A condenser may be short circuited by lightning or other electric current, but it will not interfere with the operation of the telephone for receiving and talking. A short circuited condenser will not permit ringing past a station when the receiver is off the hook at that station. Damaged condensers must be replaced or repaired.

117. Common Causes of Line Trouble

The five most common causes of line trouble are listed below with a short explanation of each of the terms:

(A) Open Line

A line may be open at any one of several places: at a break on the main line; at the point where the service wire leads off to go into the building; on the service wire to the arrester; at a fuse, or on the inside wiring from the arrester to the telephone. Sometimes a ground wire or a loose or poor connection on the line will show up as an open line.

(B) Short Circuit

Short circuits may be caused by line wires becoming twisted together or by pieces of wire or metal being thrown across two wires. Even twisted insulated wires may become short circuited if the insulation wears too thin. Burned out vacuum arresters or line fuses will often be responsible for short circuits.

(C) Grounded Lines

Lines may be grounded by coming in contact with the ground or with conducting material connected to the ground, such as trees, brush, etc. A poor ground connection may be the cause of a grounded line.

(D) Crossed Wires

Crossed wires may be caused by a foreign wire falling across a telephone line or by a telephone line coming in contact with a foreign wire. An evidence of crossed wires is the jumbled talk of a number of people on the line at the same time.

(E) High Resistance

Resistance troubles may be caused by loose, rusted or corroded connections on the line, at the service wires, at the arrester or at the ground connections.

118. Methods of Locating Line Trouble

Several methods are used to locate trouble on telephone lines. The most effective method is by using a Wheatstone bridge, but this is too complicated a method for ordinary use except by experienced

telephone repair men. The simpler method is by the use of the magneto generator in the telephone set. A short description of each of these methods is given below:

(A) Wheatstone Bridge

The Wheatstone bridge is a form of resistance box used to measure the resistance of a line in ohms. All wire, regardless of size or material, has a certain known electrical resistance. By connecting the Wheatstone bridge to the line and knowing the resistance of the wire being tested, any increase in resistance due to line trouble can be easily located. The entire method is quite complicated, involving quite a bit of mathematics and a knowledge of electricity. Its use is not recommended except for an expert telephone lineman who has knowledge of its functions and capabilities.

(B) Magneto Generator

The method of testing a line for trouble by using the magneto generator of the telephone is very simple, and can be used to good advantage by anyone who has only a slight knowledge of electricity. The greater the load on the telephone line, the harder the generator turns; conversely, the fewer the telephones and the lighter the load, the more easily the generator turns. When short circuits occur on a line, the generator will turn very hard. The ease with which the generator turns varies inversely with the distance of the trouble from the telephone set on which the test is being made; that is, the farther away the trouble the more easily the generator will turn. Even though the trouble is at a considerable distance, the generator will turn harder than when the line is in a normal condition.

When a generator turns more easily than it does under normal conditions, it is a sure sign that the line is open. The open line may be at the switch on the line itself or in a fuse. It will be found that the generator will turn more easily when the open line is close to the telephone than it will if the open line is quite a distance away. Line capacity will have to be taken into consideration when attempting to locate the open wire.

119. Testing to Locate Trouble

When making tests to locate trouble, the following procedure should be observed as closely as conditions will permit. Never

start in to clear trouble by tearing down the set before it has been proved that the set is at fault.

First, disconnect the wires at the telephone binding posts, L_1 and L_2, and test the various parts of the set by using the magneto generator as described above. If no trouble is found in the set, reconnect the wires at the binding posts and disconnect the wires on the vacuum arrester. Check again, and if no trouble is found, the telephone and the inside wiring are in good condition. Next, check through the vacuum arrester or carbon block arrester and the line fuse. The next check is from the terminal pole to the telephone. If no trouble has been located in these tests, the line itself is at fault.

If the trouble is on the line, it may be in either direction from the station. To determine the location, open the line and test each way. Temporarily, attach the drop wire to one side of the open line and make a test. Next attach the drop wire to the other side of the open line and make a test. In this way definite information may be obtained as to the location of the trouble.

120. Testing a Station Ground

A simple test can be made of the ground on any intermediate station on a grounded circuit. The test can not be made for either a terminal or a lateral station, but is applicable only to stations on the main line. First call up two persons, one on either side of the station to be tested; ask them to talk to each other, and while they are talking, attach a ground to be tested directly to the line. If they are still able to hold a good conversation with the ground on the line, the ground is in poor condition. If they are unable to hold a conversation with the ground on the line, it may be considered satisfactory.

121. Troubles and Causes

Various troubles are listed below with possible causes of the trouble in each case. When trouble occurs, look at the headings listed, and if the trouble is shown, check the possible causes by making the tests previously described:

(A) Your telephone bell rings faintly or not at all when others call:

(a) Defective ringer - either open or out of adjustment.

(b) Broken wire or loose connection in the telephone set.

(c) Short circuit in your telephone or some other telephone on the line.

(d) Receiver off the hook at some telephone where there is no condenser

on the receiving circuit.

(e) A low resistance ringer connected somewhere on the line.

(f) Open fuse at the arrester on the outside of the building.

(g) Short circuited line.

(h) Broken line wire or service wire.

(i) Line wire grounded by touching trees, brush or ground, if grounded circuit.

(j) Over loaded line - too many telephone instruments on the line.

(B) Bell rings frequently without apparent cause:

(a) Line crossed with other telephone line.

(C) All bells at a switching station ring when only one line is called:

(a) Wires crossed with another telephone line.

(b) Poor ground connections.

(c) Too high resistance of service wires.

(D) You can not ring bells of other telephones:

(a) Defective ringer at telephone being called - either open or out of adjustment.

(b) Defective generator - either at your own telephone or at the telephone called.

(c) Broken wire or loose connection in telephone set.

(d) Open fuse.

(e) Short circuited line, if metallic circuit.

(f) Line wire grounded by touching

trees, brush or ground, if grounded circuit.

(g) Low resistance ringer connected somewhere on the line.

(h) Broken line wire or service wire.

(i) Poor ground connection.

(j) Over loaded line - too many telephone instruments on the line.

(E) Others can not hear you talk:

(a) Packed transmitter.

(b) Loose or defective connections to transmitter.

(c) Poor connections on receiver circuit of telephone being called.

(d) Open induction coil on either telephone.

(e) Hook switch out of adjustment at either telephone.

(f) Defective battery at either telephone.

(F) You can not hear others talk:

(a) Defective or dirty receiver.

(b) Poor connections on receiver circuit.

(c) Hook switch out of adjustment.

(d) Open induction coil.

(e) Open condenser on receiver circuit.

(f) Defective transmitting circuit on other telephone.

(G) Your conversation is interrupted so that at times you only hear parts of words and sentences:

(a) Loose connections somewhere on the line.

(b) Poor ground wire, if grounded circuit.

(c) Line wires short circuited, if metallic circuit.

(d) Line wire grounded by touching trees, brush, or ground, if grounded circuit.

(e) Line crossed with other telephone line.

(f) Defective receiving circuit.

(H) The telephones at terminals of the line have difficulty in ringing or hearing each other:

(a) Over loaded line - too many telephones on the line.

(b) Poor ground connections.

(c) Defective line connections.

(d) Line wire grounded by touching trees, brush or ground, if grounded circuit.

(e) Line wires short circuited, if metallic circuit.

(f) Line crossed with other telephone line.

CHAPTER IX - MAINTENANCE

122. General

In order to secure good telephone service, the lines must not only be constructed according to proper standards, but must be kept in as good condition as may be consistent with modern Forest Service standards.

Maintenance must be done systematically. All lines, inside wires, switches, telephones, etc., must be examined carefully at least once a year. The following general instructions should be carefully read before work is started.

123. Maintenance of Tree Lines

Study the instructions for tree line construction. It is important that district rangers take an active part in the maintenance of the telephone system of a forest. Keep the lines currently maintained.

A. Down Timber

Remove all limbs or trees that may be down over the line, or that are likely to fall on the wire during the field season. Brush must be disposed of so as not to form a fire menace. See that the line wire has not been injured and that it swings back in place when the obstructions have been removed.

B. Brushing Out

Trim all brush, limbs, etc., to a distance of not less than four feet from the line wire, making due allowance for wind, rain and snow. Young cottonwoods, alders, and other rapid growth timber should be removed.

C. Tie Wires and Insulators

Inspect all insulators and ties. Replace broken insulators and see that tie wires are twisted around insulators. Be sure that ties are hooked into staples so that they will pull loose readily without breaking the line wire. If an insulator is on the wrong side of a tree and the line wire pulls against it instead of away from it, either put in a tree pin, swing another insulator from a nearby tree and pull the line wire clear, or change the insulator and wire to the other side of the tree.

D. Connections

Examine line wire closely for loose or rusty splices. If bad connections are found, they should be cut out and good connections made.

E. Breaks

Try to find out what caused the break, and, if possible, make changes to avoid a repetition of the trouble.

F. Slack

There should be enough slack in the line wire to permit it being pulled to the ground readily in any span. If the wire is too tight, put in more slack.

G. Ties Pulled out of Staples

Examine the tie wire. If it is damaged, put on a new tie wire and hang properly. If the trouble is due to a strain caused by a sharp bend in the line wire, put on two insulators or change the tie wire to another tree.

H. Service Wire

Enough slack should be allowed for tree or pole sway and the wires, if more than one, must be far enough apart to prevent them from becoming crossed. Connections between iron wires should be soldered or made with a Western Union splice.

I. Vacuum Arresters

Vacuum arresters and line fuses must be properly located. All connections must be tight. Replacements must be made if either is short circuited.

J. Tools and Material

Following is a list of tools and material suggested as necessary for a two-man crew for tree line maintenance:

Tools	Material
1 - light ladder, 16'	Line Wire
2 - pliers, 8"	Tie Wire
2 - connectors, 11"	Staples
2 - tree climbers	Split tree insulators
2 - lineman's belts	Sleeves
2 - safety straps	Bridging connectors
1 - axe, double blade	Iron tree pins
1 - cross cut saw, 2-man, 6'	Wood tree pins
1 - hand axe	
2 - small 2-sheave pulley blocks	
1 - rope, 3/8" or 1/2", 50'	
2 - grips	
1 - abrasive cloth	

124. Maintenance of Pole Lines

Study the instructions for pole line construction. Keep the lines currently maintained.

A. Poles

Inspect each pole for rot at the ground line. Test by pushing against the side of the pole with a shovel. Do not gouge and damage the pole in making the test. If it is not safe, set a stub or a new pole. Straighten up leaning poles unless they were raked intentionally. Put on extra guys if needed.

B. Guys

See that all guys are pulled up tight and that the wire is in good condition. If the guy is in a road or other exposed place, a guy guard should be wired to it just above the ground.

C. Line Wires

Cut out bad splices and pull up slack so that all wires have the same tension. See that there is sufficient clearance above the ground at road crossings. Put on new ties where needed and see that crossings with railroad tracks or electric power wires are in good condition.

D. Lightning Conductors

See that the conductor wire is securely stapled to the pole in the proper position. Examine connections to ground rods at terminal poles.

E. Brackets

Replace pulled off or loose brackets in the proper position. Wrap the pole with wire if it is split or has large season checks. If brackets are split, put on new ones or use bracket clips.

F. Crossarms

See that the crossarm is fastened tightly to the pole. Check crossarm brackets to be sure that they are tight. Replace all broken or damaged crossarm pins.

G. Insulators

Replace broken insulators. Be sure that all insulators are screwed tight on the pins or brackets.

H. Tools and Material

Following is a list of tools and material suggested for a two-man crew for pole line maintenance.

Tools	Material
1 - shovel, round point, 5'	#12 copper-covered wire
2 - pliers, 8"	#9 EBB iron wire
2 - connectors, 11"	Sleeves
2 - pole climbers	#16 glass insulators
2 - lineman's belts	Tie wire
2 - safety straps	Brackets
1 - axe, double blade	Bracket clips
1 - hand axe	Nails, 30d and 60d
1 - hammer	Crossarm pins
1 - lineman's wrench	Serving sleeves
1 - tamping bar	Bridging connectors
1 - block and tackle with grips	
1 - rope, 3/8" or 1/2", 50'	
1 - tree trimmer and saw	
1 - abrasive cloth	

125. Maintenance, Inside Wiring and Instruments

Study the instructions for installing telephones and making ground connections.

A. Insulated Wire

All insulated wire should be replaced if the insulation is badly worn. If the wire hangs loosely and is run in a careless manner, fasten neatly and securely in place with insulated staples.

B. Connections

Carefully examine all connections. If they are not properly made, they should be replaced.

C. Switches

Go over all screw contacts and see that the knife blades work freely and fit tight in the spring clips. Bend the spring clips together to make them fit tight. Replace the switches if they are not in good condition.

D. Ground Connections

Go over ground wire and connections carefully. This is very important. See that the soil is moist and that the ground connection is made according to instructions. Do not forget that soil that is moist in spring may be dry and make a very poor ground in the summer.

E. Extension Bells

See that the binding screws are tight. Test the bells and make the necessary adjustments when the telephone is tested.

F. Batteries

Batteries should be renewed at the beginning of each season or oftener if necessary. Periodic battery tests should be made throughout the field season.

G. Testing Telephones

Read the instructions in Chapter VIII.

H. Tools and Material

Following is a list of tools and material suggested for a one-man crew for inside wiring and instrument maintenance:

Tools	Material
1 - screw driver, large	Insulated wire
1 - screw driver, small	Tape, rubber
1 - pliers, 8"	Tape, friction
1 - pliers, side cutting, 6"	Circular loom, 7/32"
1 - pliers, long nose, 5"	Insulated staples
1 - hammer, small	Solderless connectors
1 - wrench, small, adjustable	Screws, round head, 1", No. 8
	Receiver cords
	Receiver diaphragms
	Knife switches, all types
	Dry batteries

126. Stringing Emergency Wire

Emergency wire lines should always be strung in such a manner that the wire will be out of the way of travelers, stock and game. Two men can string the wire advantageously. One man should do the unreeling. The wire should slide through the hand as it is unreeled, and all splices must be checked to be sure of proper connections. The second man should hang the wire on limbs but should not tie it. The use of a forked stick will help get the wire up high enough to clear game or stock.

Sufficient slack must be provided in the wire to allow for tree sway. If it is necessary to cross a railroad track, the wire must be placed underneath the rails. Underground highway crossings are preferable, but if aerial crossings must be made, the wire should be tied on each side, high enough to give a 20 foot clearance over the roadbed. Crossing spans should not be more than 100 feet in length.

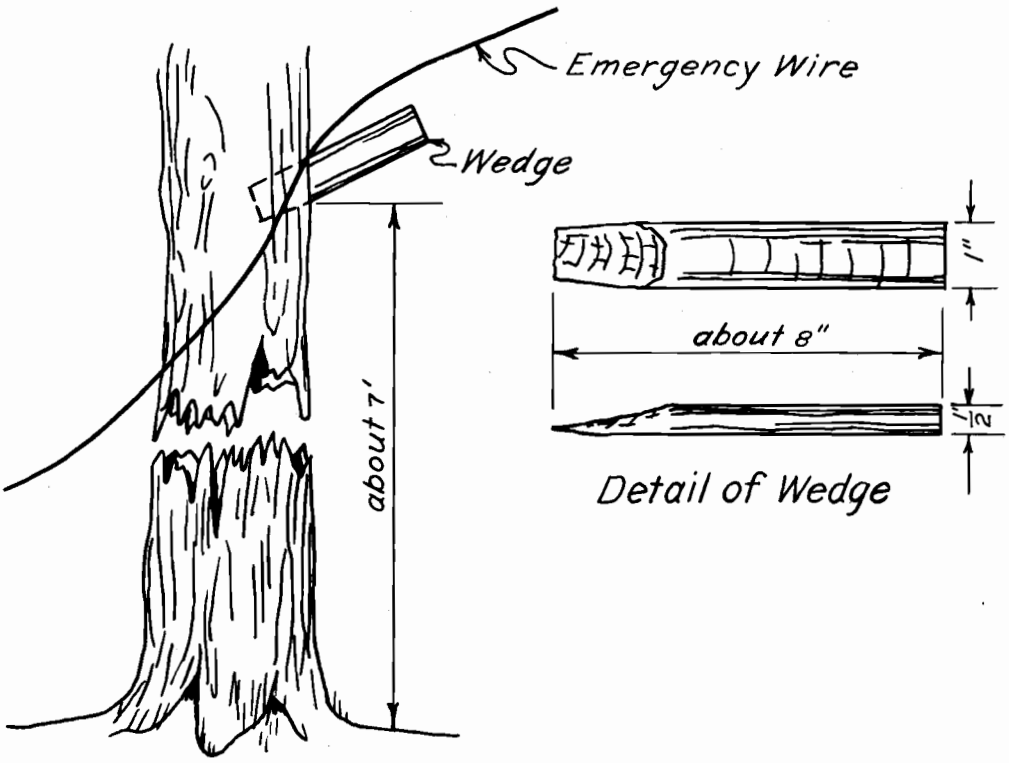
If trees or snags do not have limbs suitable for supporting the wire, wooden wedges about 1/2" x 1" x 8" may be driven into the tree by first cutting a perpendicular gash in the tree trunk as shown on Page 190.

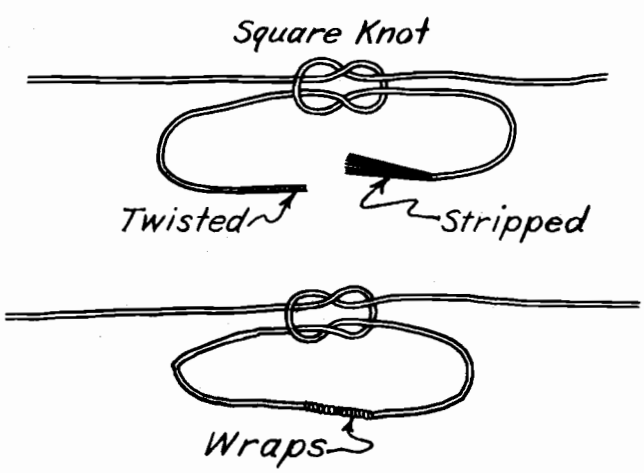
To make splices in the emergency wire, first tie a square knot, as shown on Page 190; then strip off the insulation, taking care not to break the strands, and make a regular line connection with 2 or 3 twists and 5 or 6 close wraps on each side. Tape all connections to avoid excessive line grounds. When connecting to a line wire, first dead-end the emergency wire by tying it securely with a square knot to an insulator or dead limb. Then bare and clean about 6" of the end of the emergency wire, make 8 or 10 tight wraps around the line wire and tie the end back on itself to keep it from unwrapping.

A collapsible take-up reel has been developed for use with the later emergency wire, as shown on Page 191. It holds the steel spool on which the wire is furnished, and has carrying straps for hanging around the neck while winding up or paying out the wire.

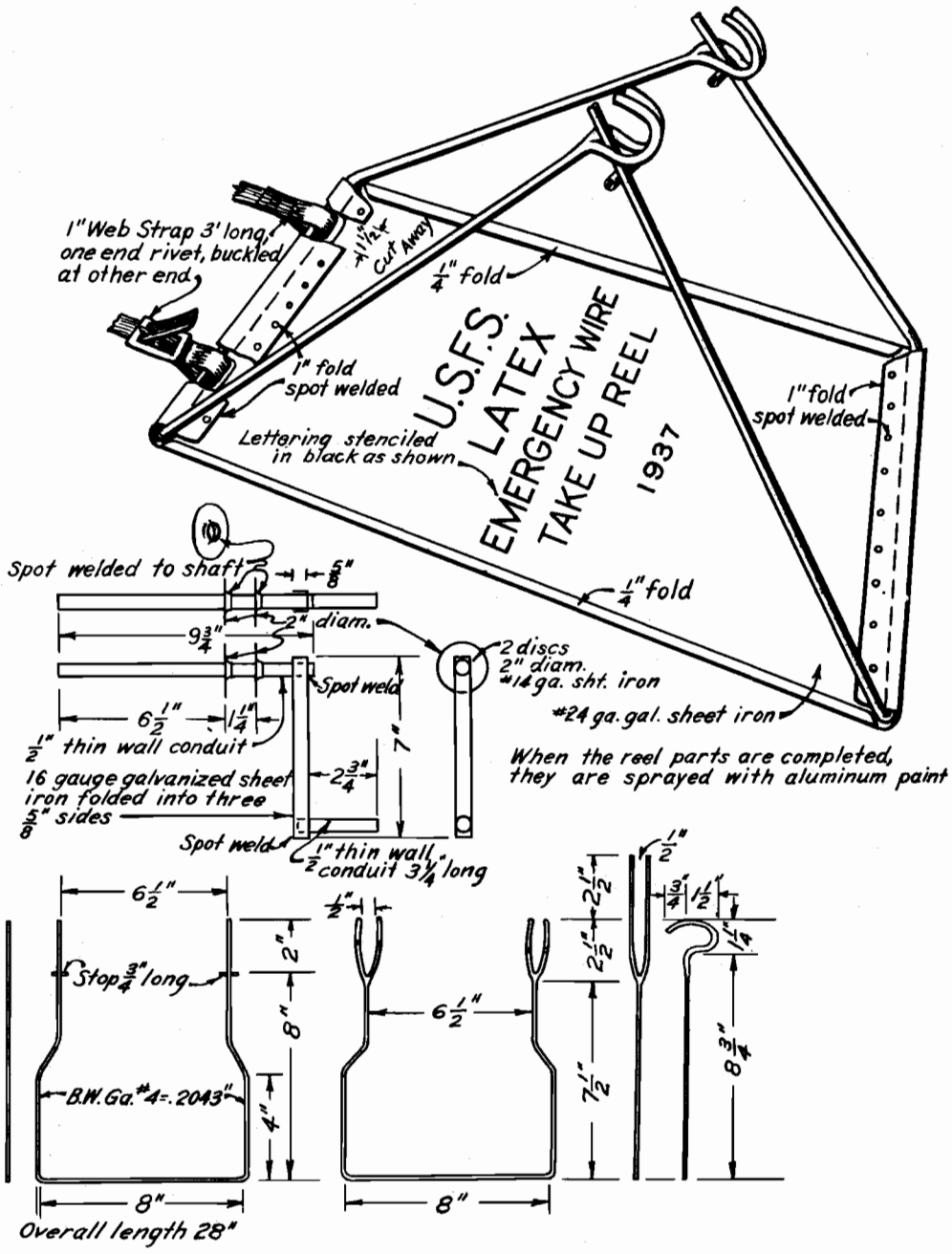
127. Sharpening Gaffs (Spurs) on Climbers

Always use a sharp file. NEVER grind to a point on any kind of wheel as heat may be produced which will spoil the temper of the gaff and make it dangerous.





EMERGENCY WIRE METHODS



EMERGENCY WIRE REEL

Set the climber in the vise with the gaff uppermost so that it can be filed from the heel to the point of gaff. Remove only sufficient material to obtain a good point. Do not make a needle point but leave a shoulder about 1/8" back from the point, and from there work over to the point. At the shoulder there should be a width of approximately 5/32".

If it is necessary to remove any metal from the underside of the gaff, be careful not to round off towards the point or there may be a tendency to "cut out" when climbing. The underside of the gaff should be left perfectly straight.

Safety Engineers recommend that climbers should not be used after the gaffs are worn to 1-1/4" (measured on the underside). When the climbers get in this condition, they should be re-gaffed or a new pair obtained. By following these simple directions a satisfactory job can be secured.

ANCHORS

Anchors, cone, 8", Chance Pyramid or equal.

Anchors, plate, 6" x 15", Nevercreep or equal.

Anchors, expanding, 8", Everstick or equal.

ARRESTERS

Arrester, Vacuum, single pole, VAC-M Type No. 4 or equal.

Arrester, Vacuum, double pole, same as above except the necessary difference required to make it a double pole type. VAC-M Type 3-B or equal.

Arrester, lightning, Type B-G, with disconnect switch, for grounded circuit lines. Fouch Electric, Cook-Kellogg, or equal.

Arrester, lightning, Type B-M, with disconnect switch, for metallic circuit lines. Fouch Electric, Cook-Kellogg, or

Arrester, lightning, Type C-G, no disconnect switch, for grounded circuit lines. Fouch Electric, Cook-Kellogg, or equal.

Arrester, lightning, Type C-M, no disconnect switch, for metallic circuit lines. Fouch Electric, Cook-Kellogg, or equal.

AXES

Axe, lineman's belt, 1-3/4 lb. head, not less than 3-1/4" cutting edge. Plumb's Hunter type, Stilletto, or equal.

Axe, lineman's belt, 2 lb. head, not less than 3-1/4" cutting edge. Plumb's Hunter type, Stilletto, or equal.

Axe, double blade, with handle.

BANDS

Bands, reinforcement, hot galvanized, #12 gauge, 2" x 68½", Hubbard #7850 or equal.

Bands, reinforcement, hot galvanized, #12 gauge, 2" x 89½", Hubbard #7851 or equal.

BARS

Bar, tamping, 7', Oshkosh #1054 or equal.

Bar, digging, 1-1/8" x 8', Oshkosh #1064 or equal.

Bar, digging, can be made locally with 6½' black iron pipe having 15" of 1" steel welded in the ends.

BATTERIES

Battery, dry cell, #6 Federal Specifications WB-101.

BELLS

Bell, extension, 2500 ohm ringer, with 3" gong, Western Electric No. 127-F; Kellogg No. 37-SG or equal.

Bell, extension, 2500 ohm ringer, with 6" gong, Western Electric No. 392-B; Kellogg No. 65-SG or equal.

BELT

Belt, lineman's body, width 3½", Klein's Tool Belt No. 5204 or equal.

BLOCK TACKLE

Block tackle, light type, 3/8" rope, Klein's self-locking, No. 1802-30 or equal.

Block tackle, heavy type, 1/2" rope, Klein's No. 1802-40 or equal.

BOLTS

Bolt, carriage, for crossarm braces, 3/8" x 4", hot galvanized.

Bolt, carriage, for transposition brackets, 3/8" x 4½", hot galvanized.

Bolts, crossarm, 5/8" x 12", hot galvanized, threaded 6".

Bolts, crossarm, 5/8" x 14", hot galvanized, threaded 6".

Bolts, double arming, 5/8" x 16", hot galvanized, threaded both ends 7".

BOLTS (Cont'd)

Bolts, stubbing, 5/8" x 18", hot galvanized, threaded 6".

Bolts, thimble eye bent, 5/8" x 8", for attaching guys - Joslyn #8150, Hubbard #6008, or equal.

Bolts, screw eye, for guying to trees, 1/2" x 7", Hubbard #9930 or equal.

BOX

Box, dry cell battery, for 3 cells, Western Electric #2-A or equal.

Box, vacuum arrester and fuse, for single pole arrester and one fuse (grounded circuit). Forest Service Specifications.

Box, vacuum arrester and fuse, for double pole arrester and one fuse (metallic circuit). Forest Service Specifications.

Box, vacuum arrester and fuse, for two single pole arresters and two fuses (metallic circuit). Forest Service Specifications.

Box, desk set, 5 bar magneto, 2500 ohm ringer, Kellogg #F-2371; Western Electric #300-N, or equal.

Box, desk set, 6 bar magneto, 2500 ohm ringer, Kellogg #F-2415 Special, or equal.

BRACES

Brace, crossarm, hot galvanized, 9/16" hole at one end and 7/16" hole at the other. 1-1/4" x 1/4" x 20" for 6 pin electric arm.

Brace, crossarm, hot galvanized, 9/16" hole at one end and 7/16" hole at the other. 1-1/4" x 1/4" x 26" for 6 pin pacific arm.

Brace, crossarm, hot galvanized, 9/16" hole at one end and 7/16" hole at the other. 1-1/4" x 1/4" x 30" for 8 pin pacific arm or 10 pin electric or pacific arm.

Brace, diagonal, with step, angle iron, hot galvanized, 2 x 2 x 3/16 - 83". Hubbard #8050 or equal.

Brace, vertical, angle iron, hot galvanized, 1-3/4 x 1-3/4" x 1/4 - 30-5/8". Hubbard #8054 or equal.

BRACES (Cont'd)

Brace, back, 6 pin arm, angle iron, hot galvanized, 2 x 2 x 1/4 - 54½". Hubbard #8051 or equal.

Brace, back, 10 pin arm, angle iron, hot galvanized, 2 x 2 x 1/4 - 66-7/16". Hubbard #8052 or equal.

BRACKETS

Brackets, wood, 2" x 2-3/8" x 12", Standard No. 6 WU or equal.

Brackets, transposition, single point, hot galvanized, 1" channel with U-bolt for 3-1/4" x 4-1/4" crossarms. Kellogg #111-19; Hubbard #111, or equal.

Brackets, transposition, single point, hot galvanized, steel, 1-1/4" x 5/16" to fit 3-1/4" x 4-1/4" crossarms. Kellogg #450; Hubbard #9251, or equal.

BUSHING

Bushing, Federal, A-2 type, 1/2" size.

CABLE

Cable, type ACL (BXL) No. 14 AWG copper, two conductors, laid parallel in lead sheath, armored.

Cable, type ALS, No. 19 AWG, copper, two or four conductors, laid parallel in lead sheath, armored.

Cable, multipair, #19 AWG copper, twisted, 5 or 10 pairs, moisture proof sheath.

Cable, switchboard, #22 AWG tinned copper, silk and cotton, lead sheath. Western Electric type G.A. or equal.

Cable, guy, (guy strand) 1/4" Siemens Martin or equal.

CLAMP

Clamp, ground rod, connecting 1/2" rod to #2 copper conductor, Seyler #8591; Hubbard #9591 or #6591, or equal.

Clamp, ground, 3/8" to 1-1/4" pipe, Kellogg #A-1-S or equal.

Clamp, guy, 3 bolt, 4 inch, for 1/4" and 5/16" guy strand. Joslyn #1031; Hubbard #7449, or equal.

CLEVIS

Clevis, Hubbard #805, to be assembled with Hubbard #7502 eye nut and #502 strain insulator for long spans.

CLIMBERS

Climbers, lineman's, pole, Klein's #1903 or equal.

Climbers, lineman's, tree, Klein's #1907 or equal.

CLIP

Clip, bracket, #14 gauge, malleable iron, 2-3/16" x 1" x $\frac{1}{2}$" with 5/16" hole. May be made up locally. Forest Service Specifications.

COILS

Coil, repeating, Kellogg #18, #21-A, #22-A, and #24-A; Graybar #77-A.

Coil, induction, Kellogg #108-A; Western Electric #13 or equal.

CONDENSERS

Condenser, $\frac{1}{2}$ M.F. Kellogg #28 or equal.

Condenser, 1 M.F., with mounting strap. Western Electric #21-W or equal.

Condenser, 1/4 M.F. Western Electric #21-Y; Kellogg #20, or equal.

CONDUIT

Conduit, steel pipe, hot galvanized.

CONDULET

Condulet, Type F, Form 6, Graybar #F-363 with 5 wire cover.

CONNECTOR

Connector, armor, for connecting together armor of Type ACL (EXL), hot galvanized after fabrication. Forest Service Specifications.

Connector, box, for attaching Type ACL (EXL) #14-B & S 2-conductor cable to metal box. General Electric #7120; Graybar #2163 or equal.

Connector, bridging, split bolt type, Kearney #902-10; Graybar #109-W or equal.

Connector, bridging, for connecting iron wire to copper or copper-covered wire. #6-A.

Connector, bridging, for connecting copper or copper-covered wire to copper or copper-covered wire. #3-A.

CROSSARM

Crossarm, electric light style, six pin, 3-1/4" x 4-1/4" x 6', Douglas fir, long leaf yellow pine, bored for 1-1/2" wood pin or 1/2" iron pin.

Crossarm, electric light style, ten pin, 3-1/4" x 4-1/4" x 10', Douglas fir, long leaf yellow pine, bored for 1-1/2" wood pin or 1/2" iron pin.

Crossarm, pacific arms style, same as above except:

six pin - 7'
eight pin - 9'
ten pin - 11'

FUSE

Fuse and holder, single pole, line, WBG, 7 ampere. Foote Pierson & Company or equal.

Fuse, line, outside, Western Electric #47-A, 7 ampere or equal.

GLOVES

Gloves, lineman's, rubber, 14 inch length, insulated for 10,000 volts. Graybar #90 or equal.

GRIPS

Grip, wire, for No. 6 AWG and smaller bare wire. Klein's "Chicago" No. 1613-30 or equal.

GRIPS (Cont'd)

Grip, wire, for ½" and smaller guy strand. Klein's Haven type, No. 1604-20 or equal.

HOOKS

Hook, guy or J hook, 1-1/4" x 1/4" x 3". Joslyn #1016; Hubbard #7583½ or equal.

Hook, guy, angle, 1-3/4" x 3/8" x 9", 3-bolt, Seyler #6587 or equal.

Hook, Tree-long, 5" length. Forest Service Specifications.

Hook, Tree-short, 3" length. Forest Service Specifications.

Hook, cant, 2½" x 4', Oshkosh #199 or equal.

HOWLER

Howler, Western Electric #1-C equipped with W. E. No. 21-Y condenser; Kellogg #5-A complete with #20 condenser or equal.

INSULATORS

Insulators, glass, No. 16, Hemingray style, square groove, 2-5/8" x 4".

Insulators, glass, No. 10, Hemingray style, transposition, double groove, 2½" x 3-1/4".

Insulators, glass, #50, transposition, 2-piece, 3-1/4" x 5".

Insulators, strain, porcelain, No. 500, 2-1/4" x 1½", with 5/16" hole.

Insulators, strain, porcelain, brown, No. 502, 2½" x 3", with 3/8" hole.

Insulators, tree, split, porcelain. Forest Service Specifications.

Insulators, nail knob, porcelain, 1-3/16" x 1-3/4", for two wires.

JACK

Jack, pole pulling, 15-ton lift. Simplex #329 or equal.

LOOM

Loom, non-metallic conduit commonly known as Flextube and Flexiduct, for inside wiring.

NAILS

Nails, 30d, 50d, and 60d, galvanized.

NUMERALS

Numerals, house, 3", stamped aluminum with pins, for pole numbering.

NUTS

Nuts, eye, drop forged, galvanized, for 5/8" bolt, Hubbard #7502 or equal.

PINS

Pins, crossarm, steel, Western Union style, ½" x 9-1/4", hot galvanized, with wood top. Joslyn #1190; Hubbard #8000 or equal.

Pins, crossarm, wood, standard, 1½" x 9", locust; Kellogg, Graybar, or equal.

Pins, transposition bracket, iron, ½" x 5-1/4" with 4½" above shoulder. Hubbard #8010 or equal.

PIPE

Pipe, reinforcement, for use with reinforcement bands, hot galvanized, 2" x 5", extra heavy.

PLATES

Plates, strain, hot galvanized, #14 gauge, size 4" x 8". Kellogg #1034 or equal.

Plates, guy hook strain, hot galvanized, #14 gauge, size 4" x 8". Kellogg #6577 or equal.

Plates, guy, hot galvanized, size 7" x 2½" x 5/16", with two 9/16" holes at top and 1-1/16" hole at bottom. Hubbard #8891 or equal.

PLIERS

Pliers, lineman's, 8" side cutting, Klein's #201-8 or equal.

Pliers, lineman's 6" oblique cutting, Klein's #202-6 or equal.

Pliers, 6" long nose, Klein's #316-6 or equal.

POLES

Poles, Pike, 2½" x 10', A. T. & T. pattern, Oshkosh #817 or equal.

PROTECTORS

Protector, carbon block, two-wire, single mounting, two 7 ampere fuses. Western Electric #98-A or equal.

Protector, equipped with true gap discharger and 7 ampere fuses, Cook No. 1586 or equal.

REELS

Reel, folding take-up, Kellogg #10-501-897; Graybar #897; Joslyn #10-501, or equal.

Reel, pay-out, without handles, Oshkosh #902; Kellogg #10-510-902, or equal.

Reel, line wire, Forest Service Specifications.

Reel, emergency wire, Forest Service Specifications.

RINGER

Ringer, 2500 ohm, Kellogg #78-G, #55-G, #109-G, #78-EG, #55-EG, Western Electric #38-B, or equal.

RINGS

Ring, drive, 1-1/4" eye, length 3", #9 wire, Kellogg, Graybar, or equal.

Ring, drive, ½" eye, length 2", #11 wire, Kellogg, Graybar, or equal.

RODS

Rod, ground, ½" x 6', copper, Anaconda Wire & Cable, or equal.

Rod, ground, 1/2" x 6', copper-covered steel, Copperweld or equal.

RODS (Cont'd)

Rod, ground, ½" x 8', copper-covered steel, Copperweld or equal.

Rod, ground, ½" x 8', hot galvanized - without copper wire - Hubbard #9568, or equal.

Rod, anchor guy, 5/8" x 6', Kellogg Thimbleye #J-7416; Hubbard Guyeye #8416; Graybar thimble eye #56, or equal.

Rod, anchor, 5/8" x 8', hot galvanized, Kellogg Thimbleye #J-7418; Graybar thimble eye #58, or equal.

Rod, anchor guy, ¾" x 6', hot galvanized, for attaching two guy strands to one anchor. Kellogg Twineye #J-7526; Hubbard Tu-Guyeye #8526; Graybar Twineye #360, or equal.

Rod, anchor guy, 5/8" x 6', hot galvanized, standard. Joslyn #1006; Hubbard #7416, or equal.

ROPE

Rope, 7/8" high climber's safety, Manila with flexible steel center.

Rope, 3/8" Manila.

Rope, 1/2" Manila.

SAWS

Saw, pruning, long handled. Franco Saw Works, Bartlett #44, Klein #3628 with saw blade, Seymour-Smith #10 or equal.

Saw, hand pruning, Bushman, Kellogg, or equal.

SCREWS

Screw, lag, ½" x 2½", hot galvanized, fetter drive thread. Hubbard #9752½ or equal.

Screw, lag, ½" x 4½", hot galvanized, fetter drive thread. Hubbard #9754½ or equal.

Screws, wood, standard sizes.

SCREWDRIVER

Screwdriver, 6" blade. Klein #909-6 or equal.

SHEATH

Sheath, lineman's belt axe, Forest Service Specifications.

Sheath, pliers, Klein's #5107 or equal.

SHOVEL

Shovel, round point, 8', Graybar #1033; Kellogg #10-017-1033, or equal.

SIGNAL SET

Signal set, loud sounding, for permanent installation, 2500 ohm line relay, 6 volt Industrial horn, storage battery. Forest Service Specifications.

Signal set, loud sounding, portable, in carrying case, same as above except using dry cell batteries. Forest Service Specifications.

SLEEVES

Sleeves, full length, double tube splicing, for AWG copper-covered wire and copper wire. National Telephone Supply or equal.

Sleeves, single tube splicing, for AWG copper-covered wire. Kearney "A-B-C"; National "Nicopress"; Anaconda "Seamless", or equal.

Sleeves, single tube splicing, for BWG galvanized telephone wire. Kearney "A-B-C"; National "Nicopress"; Anaconda "Seamless", or equal.

Sleeves, serving, for $\frac{1}{4}$" and 5/16" guy strands, hot galvanized, length $1\frac{1}{4}$" to $1\frac{1}{4}$". Hubbard #7452 and #7453 or equal.

SOLDER

Solder, rosin core, in 1 lb. spools, Kester's or equal.

Solder, flux, Allen's soldering stick or equal.

SPLICING TOOLS

Splicing tool, roller, for single tube Anaconda seamless connectors, 5 types, Anaconda Wire and Cable Co.

SPLICING TOOLS (Cont'd)

Splicing tool, crimping method, for single tube National sleeves, Nicopress, National Telephone Supply Co.

Splicing tool, roller, for single tube Kearney sleeves, Model #6, Kearney.

Splicing tool, clamp twister, for double tube sleeves, Klein's #132-15 or equal.

SPOONS

Spoon, digging, 8-ft. handle, Graybar #1024; Kellogg #10-051-1024, or equal.

STAPLES

Staples, insulated, $\frac{3}{4}$", Blake #6 or equal.

Staples, $2\frac{1}{2}$" long, square top, $\frac{1}{2}$" spread at head and points, #9 gauge, regular barbed wire fence staple material. Forest Service Specifications.

Staples, 4" wrought iron, Stanley #976 or equal.

Staples, 3", galvanized, Hubbard #8522 or equal.

STEPS

Steps, pole, steel, hot galvanized, 5/8" x 9". Hubbard #7124; Joslyn #1117, or equal.

STRAND

Strand, guy, $\frac{1}{4}$" Siemens-Martin, hot galvanized, 7 strands #14 steel, breaking strength 3150 lbs.

Strand, guy, 5/16", hot galvanized, steel, 7 strand #12, breaking strength 5350 lbs. Siemens-Martin.

Strand, guy, approximately $\frac{1}{4}$", 3 strands #10 wire, copper-covered, breaking strength 3140 lbs. Copperweld or equal.

Strand, guy, approximately 5/16", 3 strands #7 wire, copper-covered, breaking strength 5610 lbs. Copperweld or equal.

Strand, seizing, #18, diameter 1/8". Forest Service Specifications.

STRAPS

Strap, lineman's safety, 1-3/4" x 5'8", Klein-Kord #5233, or equal.

Strap, lineman's safety, 2" x 5'8", Klein's #5353, or equal.

Straps, and pads, lineman's climber. Klein's #5301-2, or equal.

Strap, lineman's, with swivel hook and arranged for attaching wire grips. Howes Wire Tool #1702; Klein's Chicago Lineman's Tool #1700-30, or equal.

Straps, pipe, 1/4", hot galvanized, two-hole type. Hubbard #2140; Graybar BX, or equal.

SUPPORTS

Support, pole, 6-ft. size, Oshkosh #842 or equal.

SWITCHBOARDS

Switchboards, all types may be made up in Regional shops to meet needed requirements. See Western Electric #1800 and Kellogg #9B Special - 5 line.

SWITCHES

Switch, knife, single pole, single throw. Kellogg #450; Trumbull #707, or equal.

Switch, knife, single pole, double throw. Kellogg #452; Trumbull #708, or equal.

Switch, knife, double pole, single throw. Kellogg #454; Trumbull #709, or equal.

Switch, knife, double pole, double throw. Kellogg #456; Trumbull #710, or equal.

TAPE

Tape, friction, 3/4" wide in 1/2 lb. rolls. Government Specifications HHT-101 dated 3/4/30 for Grade A.

Tape, rubber, gum, splicing compound, in 8 oz. rolls. Victor's splicing tape or equal.

TELEPHONES

Telephone, wall, light duty, 5 bar magneto, 2500 ohm ringer, condenser in the receiving circuit, space for dry cells in box. Western Electric #1317-S; Kellogg #F-4886, or equal.

Telephone, wall, heavy duty, 6 bar magneto, 2500 ohm ringer, condenser in the receiving circuit, space for dry cells in box. Kellogg #F-4884 or equal.

Telephone, wall, short, light duty, 5 bar magneto, 2500 ohm ringer, condenser in the receiving circuit, no battery box. Kellogg #3880-M or equal.

Telephone, wall, short, heavy duty, 6 bar magneto, 2500 ohm ringer, condenser in the receiving circuit, no battery box. Kellogg #2245 or equal.

Telephone, portable desk, light duty, 5 bar magneto, 2500 ohm ringer, condenser in the receiving circuit, no battery box. Desk Stand - Kellogg #F-118; Western Electric #1040-AL, or equal. Desk Set Box - Kellogg #F-2371; Western Electric #300-N, or equal.

Telephone, portable desk, heavy duty, 6 bar magneto, 2500 ohm ringer, condenser in the receiving circuit, no battery box. Desk Stand - Kellogg #F-118 or equal; Desk Set Box - Kellogg #F-2415 Special, or equal.

Telephone, Grab-a-phone, 6 bar magneto, 2500 ohm ringer, induction coil, condenser in the receiving circuit, wired for 3-conductor cord, cradle type, no battery box. Kellogg Masterphone #700-A or equal. Desk Set Box - Kellogg #F-2415 Special, or equal.

Telephone, Grab-a-phone, 5 bar magneto, 2500 ohm ringer, condenser in the receiving circuit, long cord to desk set box, no battery box, cradle type. Hand Set - Western Electric #202-A; Kellogg #700-A, or equal. Desk Set Box - Western Electric #300-N; Kellogg #F-2371, or equal.

Telephone, portable field, Model C, 5 bar magneto, 2500 ohm ringer, condenser in receiving circuit, wood box case, uses flashlight batteries. Kellogg #3000; Western Electric #1330-E, or equal,

Telephone, portable field, Model B, light weight, aluminum case, very compact, uses flashlight batteries. Kellogg #ES-2207 or equal.

Telephone, lookout, standard wall telephone, 6 bar magneto, 2500 ohm ringer, condenser in receiving circuit, modified to use breast transmitter and head phone. Kellogg #ES-2162 or equal.

Telephone, lookout, standard wall telephone, 5 bar magneto, 2500 ohm ringer, condenser in receiving circuit, modified to use breastplate transmitter and head phone - Kellogg ES-2411, or equal.

Telephone, field, semi-portable, Model A-1, 6 bar magneto, 2500 ohm ringer, condenser in receiving circuit, heavy aluminum case, waterproof. Kellogg #2887-G or equal.

Telephone, outdoor weatherproof, cast iron housing, light duty, 5 bar magneto, 2500 ohm ringer, space for dry cells, condenser, receiving circuit, when specified - Kellogg #4883 or equal.

TELEPHONES (Cont'd)

Telephone, outdoor weatherproof, cast iron housing, heavy duty, 6 bar magneto, 2500 ohm ringer, space for dry cells, condenser in receiving circuit, when specified, Kellogg #4888, or equal.

TERMINALS

Terminals, cable, protected type, Cook No. S-6 type or equal.

Terminals, cable, unprotected type, Western Electric No. 12-A type or equal.

Terminals, cable, unprotected type, Western Electric No. 12-B type or equal.

THIMBLES

Thimbles, guy, for strand up to 1/2" and anchor rods up to 3/4" galvanized. Hubbard #7594; Kellogg #1059, or equal.

WASHERS

Washers, crossarm, 2-1/4" x 2-1/4" x 3/16" square with 11/16" hole, hot galvanized, Hubbard #7814, or equal.

Washers, stubbing, square, 3" x 3" x 1/4" with 13/16" hole, hot galvanized. Hubbard #7817 or equal.

Washers, curved, for guy construction, 3-1/4" x 3-1/8" x 1/4" with 3/4" hole, hot galvanized. Hubbard #7825 or equal.

Washers, round, 1-1/4" x 5/64" with 1/2" hole, hot galvanized. Hubbard #7802 or equal.

WIRE

Wire, drop, No. 14 B & S, twisted pair, solid conductor for outside use.

Wire, interior, No. 19 B & S, twisted pair, solid conductor, braided.

Wire, switchboard, No. 20 B & S, solid conductor, twined, insulation consisting of two silk and one cotton wrap wound in reverse direction with an outer braid in colors. Note:- Colors to be specified in accordance with wiring diagram used. Both wraps and the outer braid to be moisture proofed by being saturated with wax. Outer braid applied very tightly to cause insulation to adhere closely to the conductor.

WIRE (Cont'd)

Wire, emergency, single conductor, 10 strand, #29 AWG copper, waterproof. Latex Emergency Wire Specifications.

Wire, emergency, two conductor, 10 strand, #29 AWG copper, waterproof. Latex Emergency Wire Specifications.

Wire, telephone line, #9 BWG galvanized, EBB, diameter 0.148 inch, in accordance with Forest Service Specifications for Galvanized Iron Telephone Wire dated January 1937.

Wire, telephone line, #12 AWG, copper-covered steel, diameter 0.081 inch, in accordance with Forest Service Specifications for Copper Covered Steel Telephone Wire dated May 1936.

Wire, line, #8 AWG, bare, copper-covered steel. Copperweld or equal.

Wire, line, #6 AWG, bare, copper-covered steel. Copperweld or equal.

Wire, line, #10 AWG, diameter 0.102 inch, solid copper.

Wire, tie, #12 AWG, copper-covered tie wire for #12 copper-covered line wire.

Wire, tie, #12 BWG, galvanized iron for #9 EBB iron line wire.

Wire, drop, #17, telephone, copper-covered steel, twisted pair.

Wire, ground, #2 B & S, soft drawn copper, bare.

Wire, ground, #14 B & S, hard drawn copper, weatherproof, single conductor.

Wire, tree, #12 BWG, weatherproof iron, triple braid. Kellogg type #912-AAA or equal.

WRENCH

Wrench, lineman's, Klein's #3146 or equal.

INDEX OF ILLUSTRATIONS